

ANNEX 2

FEASIBILITY STUDY

Ninth Revision

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Acronyms

ADB	Asian Development Bank
AE	Accredited Entity
BAU	Business As Usual
BBR	Bhutan Building Rules
BCTA	Bhutan Construction and Transport Authority
BPC	Bus Priority Corridor
BPL	Bus Priority Lane
BRT	Bus Rapid Transport
CBS	City Bus Service
LEDs	Low Emission Development Strategy (LEDs) for Surface Transport 2021-2050
LRCP	Bhutan Livable and Resilient Cities project
LTS	Long Term Strategy
BIS	Bureau of Indian Standards
BPL	Bus Priority Lane
BPS	Bus Priority Scheme
CA	Competent Authority
CCAP	City Core Action Plan
CCDR	Country Climate Development Report
CO2	Carbon Dioxide
DECC	Department of Environment and Climate Change
DHS	Department of Human Settlement
DMA	Demand Management Area
DMDF	Department of Macro-fiscal and Development Finance
EA	Environmental Assessment
EC	Environmental clearance
EFA	Economic and Financial Analysis
ESIA	Environment and Social Impact Assessment
EV	Electric Vehicle
FNCA	Forest and Nature Conservation Act
FNCRR	Forest and Nature Conservation Rules and Regulations of Bhutan
FYP	Five Year Plan
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gases
GNHC	Gross National Happiness Commission
ITS	Intelligent Transport System
KPI	Key Performance Indicator
LEDs	Low Emission Development Strategy
LETMP	Low Emission Transport Master Plan
LRCP	Livable and Resilient Cities Project
MIS	Management Information System
MLD	Million Litres per Day
MoENR	Ministry of Energy and Natural Resources
MoIT	Ministry of Infrastructure and Transport
NAP	National Adaptation Plan
NCWC	National Commission for Women and Children
NDC	Nationally Determined Contribution

NEC	National Environment Commission
NHCM	National Centre for Hydrology and Meteorology
NEPA	National Environment Protection Act
NMT	Non Motorized Transport
NRW	Non Revenue Water
TP	National Transport Policy
PIU	Project Implementation Unit
PMU	Project Management Unit
RBP	Royal Bhutan Police
RGoB	Royal Government of Bhutan
RSTA	Road Safety and Transport Authority
SCADA	Supervisory Control and Data Acquisition
SOE	State Owned Enterprise
SRF	State Reserved Forests
SuDS	Sustainable Drainage Systems
TA	Technical Assistance
ToR	Terms of Reference
TT	Thimphu Thromde
UNFCCC	United Nations Framework Convention on Climate Change
UHI	Urban Heat Island
WTP	Water Treatment Plant

Executive Summary

Bhutan has maintained a net-zero carbon status for decades, largely due to its reliance on hydropower and extensive forest cover. However, economic development is driving emissions upward, with national GHG emissions projected to reach 8,217.42 GgCO₂e by 2050 under a Business-As-Usual (BAU) scenario. The transport sector in Bhutan is a significant source of greenhouse gas (GHG) emissions, responsible for roughly 11% to 22% of total national emissions, with over 60% of energy-related emissions coming from transport. Bhutan heavily depends on road transport, leading to a steady increase in emissions from fuel combustion. Urbanization trends have exacerbated this challenge, with Thimphu's population nearly doubling since 2005.

Bhutanese cities, particularly Thimphu, are highly exposed to pluvial and fluvial flooding. Thimphu has the largest built-up areas exposed to pluvial flooding in Bhutan, with exposed areas increasing from approximately 0.6 sq km to 1.7 sq km between 1985 and 2015. Models show a 100-year pluvial flood could recur every five years by the 2060s. The city is also vulnerable to riverine flooding caused by heavy monsoon rains and glacial melt, with the Wang Chhu River flowing through the city center. Additionally, Thimphu faces significant rainfall-triggered landslide hazards due to its location and heavy seasonal rainfall. The built environment in many Bhutanese cities generates an urban heat island effect, with Thimphu experiencing surface temperatures reaching 43 degrees Celsius in the summer months. These climate risks interact across urban systems, with flooding, water stress, and transport disruptions jointly affecting service delivery, economic productivity, and urban resilience in Thimphu.

The Livable and Resilient Cities Project (LRCP) will serve as a demonstration project, pioneering a paradigm shift in climate-resilient water and low-carbon transport service delivery across Thimphu and serving as a pathfinder for national scaling. The project addresses two interlinked challenges: increasing climate vulnerability of essential urban services and rising greenhouse gas (GHG) emissions from urban transport. It will support integrated investments in climate-resilient water infrastructure and clean, inclusive mobility systems, aligned with Bhutan's National Adaptation Plan, Low Emission Transport Master Plan, and Water Services Masterplans. The project is financed through a combination of Green Climate Fund resources (US\$28 million, including grant and concessional loan components), International Development Association financing (US\$20 million), and complementary Government investments. The Project Development Objective is to enhance livability and climate resilience in Thimphu by improving targeted urban infrastructure and service delivery, strengthening institutional capacity, and enabling a shift toward sustainable urban systems.

In the water sector, the project will strengthen the resilience and reliability of urban water supply services through a package of integrated infrastructure and systems upgrades. These include reinforcing and climate-proofing raw water intake structures, stabilizing landslide-prone transmission corridors, and upgrading Water Treatment Plants (WTPs) to enhance performance under climate variability. The project will also improve treated water distribution networks to ensure reliable service during droughts and extreme rainfall events, while reducing system losses and improving operational efficiency. In addition, the introduction of Supervisory Control and Data Acquisition (SCADA) systems will enable real-time monitoring of flows, pressure, and leakage, supporting adaptive, data-driven management of water services under climate stress.

In the transport sector, the project will support a significant modal shift toward low-emission and climate-resilient urban mobility. Mitigation investments include deployment of 50 electric buses, development of an 18.9 km of bus priority corridor with dedicated bus lanes, bus bays, bus shelters, construction and upgrading of bus terminals and depots, and rollout of Intelligent Transport Systems (ITS) and fleet management tools to improve operational efficiency and service reliability. These interventions are expected to reduce transport-related emissions by approximately 69,519 tonnes CO₂e by 2048 compared to a business-as-usual scenario, while enabling a broader modal shift toward public and non-motorized transport through improved pedestrian infrastructure and first- and last-mile connectivity. In addition to mitigation benefits, the project will enhance climate resilience by improving the ability of the transport network to function during extreme rainfall and flood events, with upgraded corridors, improved drainage integration, and enhanced system redundancy reducing service disruptions, congestion, and travel delays under climate stress conditions.

Finally, the project will support substantial institutional strengthening and regulatory changes. It will establish a ring-fenced municipal water services division within Thimphu Thromde and introduce private sector management expertise through performance-based contracts. The project will also transition the City Bus Service (CBS) into an autonomous State-Owned Enterprise (SOE) with a national mandate to develop low-emission public transport through Public Service Agreements (PSAs). Technical assistance will help prepare additional RGoB investments, incorporating lessons learned under the project and extending first-phase improvements city-wide before expanding nationally.

The project will drive substantial change through the introduction of technology and greater knowledge sharing, enabling other Bhutanese cities to adopt evidence-based climate-resilient urban services. By improving service standards and reliability, the project will help shift public behavior towards greater use of low-emission transport and increased appreciation of the economic value of reliable water services. The project will also empower service providers through greater autonomy and accountability, strengthening financial sustainability and opening space for private sector participation. Overall, the project integrates climate resilience and low-emission development across urban water and transport systems, delivering both enhanced service continuity under climate extremes and significant reductions in transport emissions through more efficient and sustainable mobility.

Introduction

Background and Context

1. Bhutan's development is anchored in the philosophy of Gross National Happiness (GNH), which seeks to balance economic growth with environmental sustainability, cultural preservation, and good governance. This commitment to a holistic development model has made Bhutan unique among nations: it remains the world's only carbon-negative country, with forests covering over 70% of its territory and absorbing more carbon dioxide than the country emits. Yet despite this remarkable environmental record, Bhutan is undergoing rapid urbanization that is placing increasing strain on its cities and testing the resilience of its infrastructure and institutions.
2. Thimphu, the national capital and primary administrative and economic hub, sits at the centre of this urban transition. The city's population grew from approximately 79,000 in 2005 to over 114,000 by 2017¹ – a compound annual growth rate of 3.8% – and is estimated to have reached around 149,000 by 2023.² This growth reflects a broader national trend: Bhutan's urban population share rose from just 7.5% in 1974 to nearly 44% in 2023, driven by rural-to-urban migration attracted by urban incomes that are nearly three times higher than rural ones. The pace and scale of this demographic shift has significantly outstripped the capacity of Thimphu's existing water and transport infrastructure, which was designed to serve a much smaller population.
3. In the water sector, Thimphu's poor distribution infrastructure and growing climate vulnerability together threaten the city's long-term water security. Non-revenue water losses exceed 50% in the city core due to aging, corroded, and undersized distribution pipes, with many dating back to the 1960s. This results in an intermittent supply of as little as three to nine hours per day in core areas, with over 77% of households resorting to portable water storage during dry periods. The Jungzhina treatment plant is already operating beyond its design capacity, and storage buffers cover only around 12 hours of demand, leaving the system with little resilience to absorb shocks. Climate change is compounding these weaknesses at every point in the supply chain with (i) more intense monsoon rainfall is increasing sediment loads and clogging intake structures, (ii) landslides are severing transmission lines with growing frequency, and (iii) dry-season flows in the Wangchhu basin – already as low as 3–5 m³/s – are projected to decline by a further 4.7% to 5.8% by mid-century. Without targeted investment in infrastructure resilience and climate-proofing, the gap between supply and the needs of a growing urban population will continue to widen.
4. The transport situation is of particular concern from a climate mitigation standpoint. Transport is currently the largest and fastest-growing contributor to greenhouse gas emissions in Bhutan's energy sector, and the country's continued dependence on imported fossil fuels for private vehicle use risks undermining its hard-won carbon-neutral status. Bhutan's third Nationally Determined Contribution (NDC 3.0, 2025) and its Long-Term Strategy (LTS) explicitly identify a modal shift away from private cars toward mass transit and non-motorized transport (NMT) as a national priority, with a target of 100% electric bus sales by 2045. Without decisive intervention, the business-as-usual trajectory, which is characterized by rising car ownership, a declining share of public transport users, and an underperforming bus network, would lock in high-emission mobility patterns for decades. The Low Emission Transport Master Plan (LETMP), finalized in May 2024, sets out the strategic framework for this transition.
5. These overlapping pressures – rapid urbanization, deteriorating infrastructure, and the compounding effects of climate change across both the water and transport sectors – make Thimphu a critical test case for integrated, climate-resilient urban development. Thimphu is also exposed to broader urban climate risks, including pluvial flooding, with 100-year flood events projected to recur every five years by the 2060s, and an expanding urban heat island effect expected to affect 20% of the city by 2031. Addressing these challenges in an integrated and coherent manner requires coordinated investment across sectors, grounded in a clear climate rationale and supported by strong institutional capacity. It is against this backdrop that the Livable and Resilient Cities Project (LRCP) has been developed, seeking GCF financing to deliver transformative, climate-resilient improvements to Thimphu's water supply and urban transport systems.

Objective of the Feasibility Study

6. This feasibility study assesses the technical and financial viability of the Livable and Resilient Cities Project (LRCP) in Thimphu, which is being developed for financing by the Green Climate Fund (GCF). The study demonstrates the climate rationale and technical soundness of the proposed investments across the water and urban transport sectors. Specifically, it: (i) analyzes the climate and development context underpinning the project; (ii) presents a barrier analysis identifying the key technical, institutional, financial, and social constraints to climate-resilient urban development; (iii) appraises project design options and their technical feasibility; and (iv) assesses the project's economic viability and alignment with GCF investment criteria. The study also demonstrates the Royal Government of Bhutan's institutional

¹ UNESCAP. 2020. The Sustainable Urban Transport Index (SUTI) Report for Thimphu City. Available at <https://www.unescap.org/sites/default/files/Thimphu.pdf>

² National Statistics Bureau of Bhutan. 2023. Population and Housing Census

capacity to implement the project in line with national plans, including the Thimphu Water Sector Masterplan and the Low Emission Transport Master Plan.

Structure of the Report

7. This report is organized into nine chapters. Following this introduction, Chapter 2 presents the climate and development context, covering urbanization trends and climate projections for Thimphu. Chapter 3 reviews the climate policy and institutional framework at national and local levels. Chapter 4 provides a baseline assessment of the current state of Thimphu's water and transport systems. Chapter 5 identifies the barriers to climate-resilient development that the project seeks to address. Chapter 6 describes the project components and their technical feasibility, including the Theory of Change, while Chapter 7 highlights project risks and their mitigation measures. Chapter 8 presents the economic feasibility assessment. Chapter 9 outlines the implementation arrangements and Chapter 10 assesses alignment with GCF investment criteria.

Climate and Development Context

Bhutan's Development and Urbanization Context

8. **Bhutan is a small, landlocked country located on the southern slopes of the eastern Himalayas**, with a population of approximately 760,000 people dispersed across steep mountain terrain, valleys, and remote settlements. National development is guided by the philosophy of Gross National Happiness (GNH), which promotes a holistic approach to development that balances economic growth with environmental conservation, cultural preservation, and good governance. This framework has shaped Bhutan's development trajectory over recent decades and has supported significant progress in poverty reduction, expansion of basic services, and environmental stewardship. Bhutan maintains forest cover exceeding 70 percent of its territory and remains the only country in the world that is carbon-negative, with its forests absorbing more greenhouse gases than the country emits.
9. Over the past two decades, Bhutan has achieved notable economic progress while maintaining a strong commitment to environmental sustainability. Economic growth has been driven primarily by hydropower development, public sector investment, and an expanding service sector. Hydropower exports to India represent a major source of government revenue and contribute significantly to national GDP. Despite these achievements, Bhutan continues to face structural development challenges, including limited economic diversification, constrained domestic markets due to its small population, geographic isolation, and the need to generate employment opportunities for a growing youth population.
10. **Bhutan's population has been steadily increasing in recent years.** According to Macrotrends, the total population in 2023 was approximately 787,424, rising to 792,382 in 2024, and is projected at 797,335 in 2025, reflecting a consistent annual growth rate of about 0.63%. These estimates are based on the de facto definition of population, counting all residents regardless of legal status or citizenship, and highlight the gradual but steady demographic pressure on the country's urban and rural infrastructure.
11. **Urbanization is emerging as a key driver of Bhutan's socio-economic transformation.** The share of the population living in urban areas has increased rapidly over the past several decades, rising from 7.5 percent in 1974 to approximately 44.4 percent in 2023, with the urban population growing significantly faster than the national population as a whole. This transition is driven largely by rural-to-urban migration, as people move to cities in search of employment opportunities, education, and improved services. Median household incomes in urban areas are nearly three times higher than in rural areas, highlighting the growing importance of cities as engines of economic activity and service delivery.
12. **Bhutan's urban system is dominated by Thimphu, the national capital** and the country's primary administrative, economic, and cultural center. As the seat of national government institutions, the hub of private sector activity, and home to the country's main higher education facilities, Thimphu functions as the undisputed engine of Bhutan's urban economy. The city has experienced rapid population growth, nearly doubling since 2005. According to the SUTI report for Thimphu City, the population increased from 79,185 in 2005 to 114,551 in 2017, compounding annually at 3.8% over 36 years.³ This growth, driven by both natural population increase and sustained rural-to-urban migration, has been accompanied by significant expansion of the city's built-up area across the Thimphu valley and into surrounding hillsides, placing increasing pressure on the city's infrastructure, services, and natural environment.
13. **This rapid expansion has placed increasing pressure on Thimphu's urban infrastructure and public services.** The city's water supply systems, originally designed for a much smaller population, are struggling to meet growing demand while contending with increasing climate variability that affects the reliability and quality of source water. On the transport side, rising incomes and the city's physical expansion across a steep and constrained valley have fuelled a sharp increase in private vehicle ownership in Thimphu, contributing to worsening traffic congestion along the city's limited road network,

³ UNESCAP. SUTI Report for Thimphu City. Retrieved from <https://www.unescap.org/sites/default/files/Thimphu.pdf>

rising transport-related emissions, and a declining share of residents using public transport. As Thimphu continues to grow, these pressures are set to intensify, underscoring the urgent need for climate-resilient investment in both sectors.

14. Recognizing these challenges, the Royal Government of Bhutan has placed increasing emphasis on strengthening urban infrastructure and improving service delivery in cities. National development strategies highlight the need for more resilient water systems, improved urban mobility, and stronger municipal institutions capable of managing the growing complexity of urban service provision. In this context, Thimphu represents an important entry point for testing innovative approaches to climate-resilient and low-carbon urban development that can later be replicated in other Bhutanese cities.

Climate Change Trends and Projections

15. **Bhutan has made ambitious commitments to climate change mitigation and resilience.** In 2020, it emitted just 2,723 Gg of CO₂e while its forests sequestered more than three times that amount. However, maintaining this net-zero status is becoming increasingly difficult as economic growth drives up emissions. At the same time, Bhutan faces high vulnerability to climate impacts, including rising temperatures, changing rainfall patterns, and retreating glaciers. Climate projections show that Bhutan could warm more severely than the global average, with the likelihood of heatwaves increasing tenfold by 2100. Models also predict higher median annual rainfall across all emissions scenarios. This includes reduced rainfall during the dry season and more intense monsoon events, which together threaten water storage, increase flood risk, and challenge the distribution of safe drinking water and urban planning. These impacts are particularly acute in rapidly growing urban centers like Thimphu, where climate change is intensifying existing weaknesses in infrastructure and service delivery.⁴

Temperature Increases

16. According to the World Bank and Asian Development Bank (ADB), Bhutan has experienced rising temperatures since the 1960s. Observations indicate that minimum temperatures have increased at a faster rate than maximum temperatures, with an overall acceleration in warming over the past 50 years. Temperature variability is particularly pronounced in February and March. Lower elevation and southern regions tend to be warmer and receive more precipitation, while northern areas remain cooler and drier. Seasonal patterns show higher temperatures during summer and cooler conditions in winter.
17. The World Bank's Climate Change Knowledge Portal (CCKP), using data from the Coupled Model Intercomparison Project Phase 5 (CMIP5) and the IPCC's Fifth Assessment Report (AR5), provides projections of future temperature and precipitation in Bhutan. The analysis focuses on two Representative Concentration Pathways (RCPs): RCP2.6, representing a strong global mitigation scenario, and RCP8.5, reflecting a high-emissions, business-as-usual scenario. These models indicate a consistent warming trend for Bhutan, with the degree of warming varying based on the emissions pathway.⁵

Table 0-1 Projected anomaly (changes °C) for maximum, minimum, and average daily temperatures in Bhutan for 2040–2059 and 2080–2099, from the reference period of 1986–2005 for all RCPs. The table shows the median of the CCKP model ensemble and the 10–90th percentiles in brackets⁶

Scenario	Average Daily Maximum Temperature		Average Daily Temperature		Average Daily Minimum Temperature	
	2040–2059	2080–2099	2040–2059	2080–2099	2040–2059	2080–2099
RCP2.6	1.3 (–0.6, 3.5)	1.3 (–0.6, 3.4)	1.3 (–0.1, 2.8)	1.2 (0.0, 2.9)	1.2 (–0.3, 3.2)	1.3 (–0.4, 3.2)
RCP4.5	1.7 (–0.3, 3.7)	2.5 (0.3, 4.8)	1.6 (0.2, 3.0)	2.4 (0.8, 4.0)	1.7 (0.0, 3.6)	2.3 (0.8, 4.5)
RCP6.0	1.5 (–0.6, 3.6)	2.8 (0.6, 5.2)	1.5 (0.1, 3.0)	2.8 (1.3, 4.5)	1.6 (–0.2, 3.4)	2.9 (1.2, 5.0)
RCP8.5	2.3 (0.2, 4.2)	4.7 (2.4, 7.0)	2.2 (0.8, 3.6)	4.5 (2.8, 6.5)	2.2 (0.7, 4.0)	4.6 (2.8, 7.1)

18. According to Meteoblue, the yearly temperature change in Thimphu District has changed from 5.2°C in 1979 to 7.0°C in 2024. The top graph shows an estimate of the mean annual temperature for the larger region of Thimphu District. The dashed blue line is the linear climate change trend. Since the temperature trend is positive and it is getting warmer in Thimphu District due to climate change, as noted by Meteoblue. In the lower part the graph shows the so-called warming

⁴ World Bank Group. (2021). *Bhutan: Climate Risk Country Profile*. Retrieved from https://climateknowledgeportal.worldbank.org/sites/default/files/2021-08/15874-WB_Bhutan%20Country%20Profile-WEB.pdf

⁵ Ibid

⁶ Ibid

stripes. Each colored stripe represents the average temperature for a year - blue for colder and red for warmer years. The graph shows the warming trend over the years⁷.

Changes in Precipitation Patterns

19. Rainfall in Bhutan is primarily influenced by the Southwest Monsoon, which dominates the Indian subcontinent during the summer months. This results in a distinct seasonal pattern, with most of the country experiencing heavy rainfall from June to September. During this period, much of Bhutan—especially the southern Dzongkhags—has a nearly subtropical climate and is vulnerable to dry spells and droughts caused by monsoon variability. Bhutan receives over 70 percent of its annual precipitation during the monsoon season (June to September). Recent studies suggest a decline in rainfall in Bhutan’s traditionally wettest regions and a broader weakening of the Indian Summer Monsoon. While monsoon-season rainfall (June to September) has increased, the dry season (December to February) has become more arid. Rainfall distribution also varies widely across the country, with the highest precipitation levels occurring near the northern and southern borders.⁸ In 2021, severe rainfall impacted 2,500 acres of farmland across 18 Dzongkhags, resulting in damaging 2,400 metric tons of crops.
20. According to Meteoblue data (figure 2-1), the yearly precipitation change in Thimphu District has changed from 1928.4mm in 1979 to 2250.8mm in 2024. The top graph shows an estimate of mean total precipitation for the larger region of Thimphu District. The dashed blue line is the linear climate change trend. The precipitation trend is positive and it is getting wetter in Thimphu District due to climate change according to Meteoblue. In the lower part the graph shows the so-called precipitation stripes. Each colored stripe represents the total precipitation of a year - green for wetter and brown for drier years. The trend of more frequent wetter years in Thimphu District can be seen in the graph.⁹

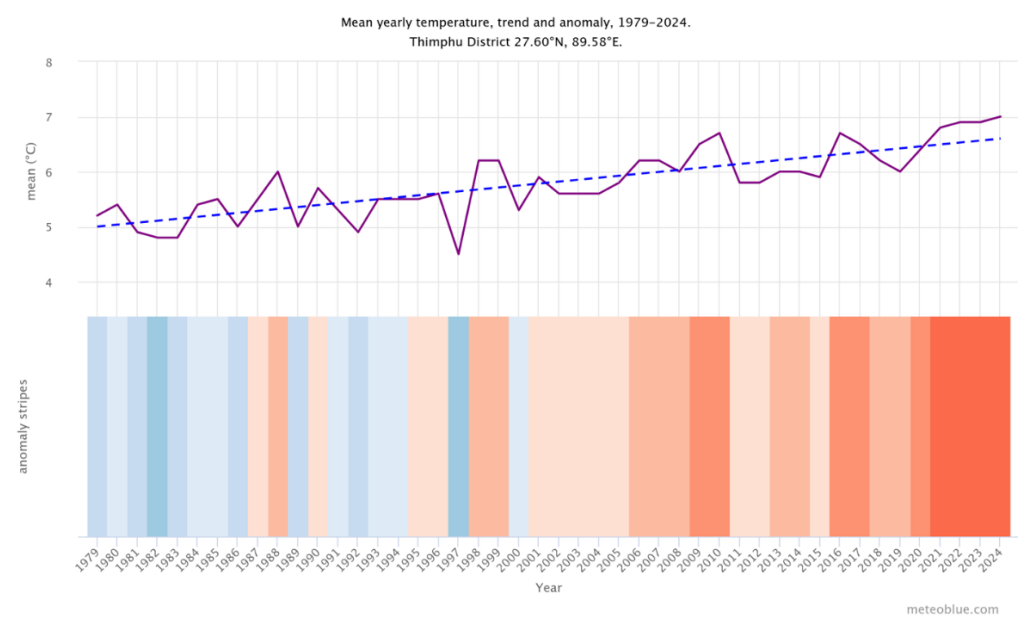


Figure 2-1 Mean yearly temperature, trend and anomaly in Thimphu District 1979-2024

⁷ Meteoblue. Climate Change Thimphu District. Retrieved from https://www.meteoblue.com/en/climate-change/thimphu-district_bhutan_1337293?month=1

⁸ Ibid

⁹ Meteoblue. Climate Change Thimphu District. Retrieved from https://www.meteoblue.com/en/climate-change/thimphu-district_bhutan_1337293?month=1

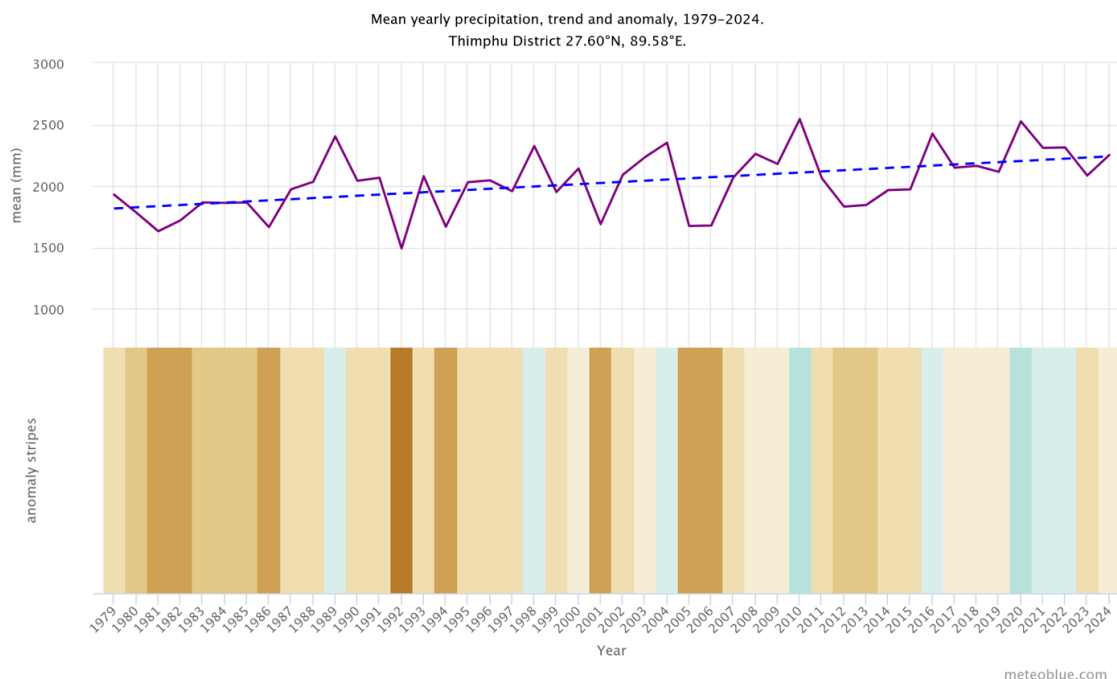


Figure 2-2 Mean yearly precipitation, trend and anomaly in Thimphu District 1979-2024

21. Thimphu also shows a projected increase in the Warm Spell Duration Index (WSDI), with a longer number of days annually experiencing sustained heat. These conditions can worsen the effect of Urban Heat Island (UHI) and reduce soil infiltration capacity. Thimphu's exposure to rapid, high-intensity rainfall is important given its steep topography and seasonal rainfall concentration patterns.
22. Moreover, Thimphu is projected to face growing drought conditions by mid-century, with longer dry periods and increased water stress driven by climatic shifts. Climate projections show that the number of Consecutive Dry Days (CDD)—defined as days with less than 1mm of rainfall—will rise significantly, reaching approximately 140 to 160 days per year under SSP2-4.5 and SSP3-7.0, respectively. This represents a marked increase from historical patterns, indicating a trend toward prolonged dry spells interspersed with fewer, more intense rainfall events. Even with relatively stable or slightly increasing annual precipitation totals, water availability is likely to become more erratic due to the uneven temporal distribution of rainfall.
23. Temperature increases in the range of 1.0–2.5 °C will also drive-up evapotranspiration rates, amplifying moisture loss from soils and vegetation and thereby intensifying drought severity. The Standardized Precipitation Evapotranspiration Index (SPEI) projections suggest negative anomalies for Thimphu under all SSPs, with values ranging from approximately -0.3 to -0.1, indicating a trend toward increasing drying. Furthermore, the number of tropical nights (minimum temperature >26 °C) and hot days (maximum temperature >35 °C) is projected to increase, reinforcing warming trends and their hydrological consequences. The number of hot days of over 30 °C in Thimphu is at risk of rising from 4 days a year to 80 days a year, requiring people to have reliable access to water to manage the health risks.¹⁰ The combined impact of these shifts is a higher likelihood of meteorological droughts, especially during the dry season, which could exacerbate seasonal water shortages.¹¹ Research by Zam et al. (2021) suggests that dry season river flow in the Wangchhu River basin could decline by 4.73 to 5.77 percent under different climate scenarios, increasing water scarcity, water supply costs, and economic pressures.¹²

Climate Risks Affecting Bhutan's Urban Systems

24. Thimphu is exposed to a complex and interrelated set of climate risks that pose growing threats to its urban systems, particularly transport and water infrastructure. Shaped by Bhutan's Himalayan geography, steep terrain, and rapidly changing land-use patterns, these risks are being intensified by climate change and accelerating urbanization. The city

¹⁰ Lehner, F., Nadeem, I., & Formayer, H. (2024). Future climate change implications in Bhutan from a downscaled and bias-adjusted CMIP6 multimodel ensemble. *International Journal of Climatology*, 44(14), 5057–5074. <https://doi.org/10.1002/joc.8623>

¹¹ World Bank. Bhutan Country Climate and Development Report. Forthcoming.

¹² Zam, Phub, Shrestha, S., & Budhathoki, A. (2021). Assessment of climate change impact on hydrology of a transboundary river of Bhutan and India. *Journal of Water and Climate Change*, 12. https://www.researchgate.net/publication/352843316_Assessment_of_climate_change_impact_on_hydrology_of_a_transboundary_river_of_Bhutan_and_India/citation/download

faces multiple climate hazards, including riverine and flash flooding, landslides, urban heat stress, and periodic drought, each of which has the potential to disrupt mobility, damage critical infrastructure, and compromise water security.¹³

Fluvial and Pluvial Flood hazard

25. **Flooding represents the most significant climate hazard affecting Bhutan**, and the city of Thimphu is exposed to both urban pluvial flooding (intense rainfall overwhelming local drainage capacity) and fluvial flooding resulting from elevated water levels in the Wang Chhu River. Approximately 20% of all settlements lying within high-risk flood zones concentrated along river valleys and flood-prone basins.¹⁴ Fluvial flooding is particularly acute along the Wang Chhu River, which bisects Thimphu and is fed by seven tributaries. The basin experiences extreme seasonal variability — dropping as low as 3–5 m³/s during the dry season and rising to 135 m³/s during peak monsoon months — making it highly susceptible to rapid inundation.¹⁵ The combination of steep terrain and intense monsoon rainfall also frequently triggers landslides and flash flooding. Over the past 50 years, Thimphu has experienced six major riverine and flash flooding events affecting over 10,000 people. Flooding events have accelerated sharply in recent decades, with 65 of Bhutan's 116 recorded event occurring between 2012 and 2020.¹⁶ Historical events illustrate the scale of impact: Cyclone Aila in May 2009 caused severe flash floods across 17 districts (including Thimphu), claiming twelve lives and causing property damage of USD 17 million;¹⁷ the 2016 floods driven by a heavy monsoon season partially collapsed the Kamji Bridge and disrupted the Phuentsholing–Thimphu highway — the country's primary supply route for food, fuel, and essential goods — causing panic among residents and a 0.36% reduction in Bhutan's GDP.¹⁸
26. **Thimphu's vulnerability to flooding has been significantly compounded by rapid and poorly managed urban expansion.** Among all Bhutanese cities, Thimphu exhibits the highest rate of "slow-risky growth" — a pattern of steady urban expansion that progressively increases disaster risk exposure. Between 1985 and 2015, the built-up area exposed to pluvial flooding nearly tripled, rising from approximately 0.6 to 1.7 square kilometres across both older neighbourhoods and newer developments (Figure 2-3).¹⁹ The widespread use of concrete and limited adoption of green infrastructure have increased impervious surfaces, altered natural watercourses, and generated higher levels of surface runoff. Thimphu's stormwater infrastructure lacks both sufficient coverage and appropriate technical design to manage increased water volumes — sewer overflow onto major roads in the city core during heavy rainfall has become increasingly frequent. Research published in the *International Journal of Scientific Research in Engineering and Management (IJSREM)* found that poor drainage alignment and slope conditions account for over 70% of flood incidents, with blockages contributing an additional 13%.²⁰ A recent household survey found that 30% of Thimphu households reported experiencing extreme weather events — including heavy rainfall and floods — in the past five years, with 21% reporting damage to houses, water supply infrastructure, and roads.²¹

¹³ World Bank Group. Bhutan: Climate Risk Country Profile. (2021). Retrieved from https://climateknowledgeportal.worldbank.org/sites/default/files/2021-08/15874-WB_Bhutan%20Country%20Profile-WEB.pdf and <https://www.gfdrr.org/sites/default/files/publication/Bhutan%20Roadmap%202015.pdf>

¹⁴ — "Bhutan." Climate Crisis, Displacement, and the Right to Stay, Othering & Belonging Institute, University of California, Berkeley,

¹⁵ Department of Engineering Services (2020). Ministry of Works and Human Settlement. Integrated Stormwater Management Plan for ThimphuThromde (2021-2020).

¹⁶ Tempa K (2022) District flood vulnerability assessment using analytic hierarchy process (AHP) with historical flood events in Bhutan. *PLOS ONE* 17(6): e0270467. <https://doi.org/10.1371/journal.pone.0270467>

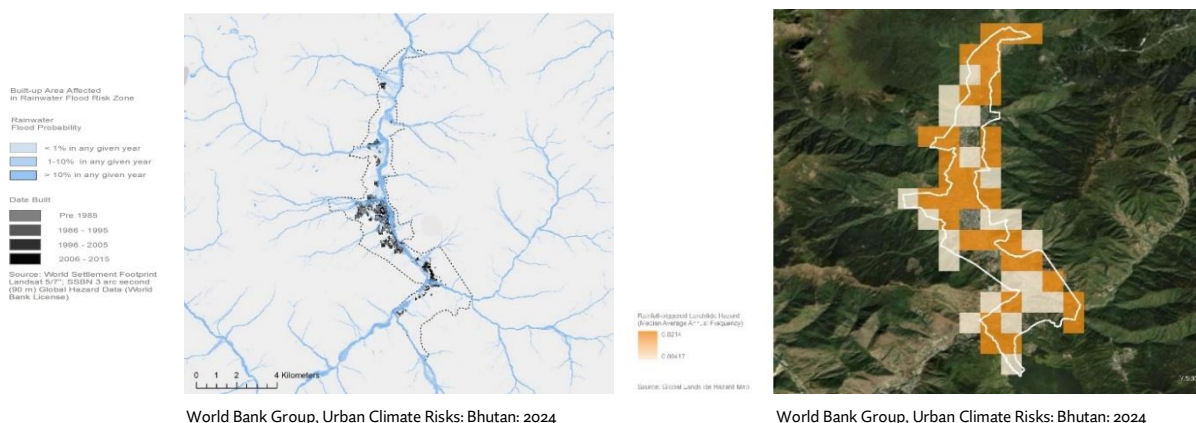
¹⁷ Shrestha, M. S., Goodrich, C. G., Pranita Udas, P. U., Rai, D. M., Gurung, M. B., & Vijay Khadgi, V. K. (2017). Flood early warning systems in Bhutan: a gendered perspective.

¹⁸ Tshering, Dechen (2018) Building up Bhutan's resilience to disasters and climate change. Available at <https://blogs.worldbank.org/en/endpovertyinsouthasia/building-bhutan-s-resilience-disasters-and-climate-change>

¹⁹ World Bank (2025) Bhutan Country Climate and Development Report (CCDR). Washington, D.C: World Bank.

²⁰ Adhikari, K., et al. (2023). Assessing Flood Risk in Thimphu: Analyzing Contributing Factors through Urban Flood Modeling. *International Journal of Scientific Research in Engineering and Management*. Retrieved from <https://ijsrem.com/download/assessing-flood-risk-in-thimphu-analyzing-contributing-factors-through-urban-flood-modeling/>

²¹ UNDP (2025). Enhancing Climate Resilience of the Urban Landscapes and Communities in Thimphu-Paro Region of Bhutan: Project Document. Retrieved from <https://www.undp.org/sites/g/files/zskgke326/files/2025-02/undp-bhutan-project-doc-urban-resilience-project-feb-2025.pdf>.



World Bank Group, Urban Climate Risks: Bhutan: 2024

World Bank Group, Urban Climate Risks: Bhutan: 2024

Figure 2-3 (i) Built-up area in rainwater flood risk zone, and (ii) Rainfall triggered landslide hazards

27. **Climate change is expected to significantly intensify these flood hazards in the coming decades.** The number of days with heavy rainfall — defined as precipitation exceeding 20mm — is expected to reach 10 or more annually in Thimphu by mid-century under both SSP2-4.5 and SSP3-7.0 scenarios, and long-term precipitation is projected to increase by approximately 160mm under SSP2-4.5 and 375mm under SSP3-7.0. The likelihood of extreme rainfall over a 5-day period, which can trigger pluvial and fluvial flooding, also increases under these scenarios, with 20-year and 50-year return period precipitation events projected to become 1.3 to 1.5 times more likely compared to the 1995–2014 baseline. A pluvial flood with a current 100-year return period could occur every five years by the 2060s. The frequency of 1-in-10 and 1-in-30 year maximum flow events in Thimphu's catchment areas is projected to increase under all emissions scenarios for both 2035 and 2085. This intensification is partly explained by rising temperatures — projected to increase by 1.0–2.5°C by mid-century — which, through the Clausius-Clapeyron relationship, increase the atmosphere's moisture-holding capacity by approximately 7% per degree of warming, amplifying the volume of precipitation released during storm events and elevating the probability of extreme flood episodes in the years ahead. Fathom-Global 3.0 data indicates that flood depths in the core urban areas typically range from approximately 0.2 to 1.2 meters under low to high emissions scenarios respectively.
28. **More frequent and intense flooding will have cascading impacts across Thimphu's urban systems.** In the water sector, flash flooding can damage intake structures, distribution pipes, and storage facilities, contaminating water sources and disrupting supply, while increasingly erratic seasonal patterns require the same infrastructure to operate under prolonged dry spells and drying springs during winter months. Thimphu's water supply systems were not designed for this level of variability, and their vulnerability is compounded by already significant non-revenue water losses and aging infrastructure that is ill-equipped to absorb additional climate stress.²² In the transport sector, Thimphu's road network and bridges face growing exposure to flood and landslide damage, with many bridges built to 20- or 25-year design standards that are likely to be exceeded with increasing frequency as extreme events intensify.²³ Damage to road linkages extends beyond infrastructure costs — projected flood depths observed in exposed areas are sufficient to impair vehicle movement, reduce road passability, and in some cases render key corridors temporarily unusable, leading to increased congestion, travel delays, and higher vehicle operating costs for users. Past flood events along the Phuentsholing–Thimphu highway demonstrated how flooding disrupts the supply of essential goods, isolates communities, and limits access to health care, education, and economic opportunity.²⁴ More broadly, urban infrastructure and services — including stormwater drainage, sewerage, and buildings — face growing risk of inundation, erosion, and structural damage as surface water flooding becomes more frequent and more severe. The concentration of development along flood-prone slopes and valley floors, combined with construction practices that prioritize concrete over permeable or nature-based materials, means that the built environment channels rather than absorbs floodwaters, amplifying damage to property, businesses, and public spaces.²⁵ In the absence of targeted adaptation investment, the compounding effects of increased flood frequency, aging infrastructure, and urban expansion will render Thimphu's critical systems increasingly unable to maintain service delivery under projected climate conditions.

Landslides

29. **Thimphu's Himalayan setting makes it inherently susceptible to landslides**, which are among the most frequent and destructive natural hazards in the city. The combination of steep terrain, complex geology, highly variable rainfall, and fragile soils create conditions that are highly prone to slope instability. Landslides in Bhutan are primarily rainfall-triggered

²² World Bank. 2025. Bhutan Crisis Preparedness Gap Analysis: Technical Report. Washington, D.C: World Bank.

²³ World Bank. 2025. Bhutan Country Climate and Development Report (CCDR). Washington, D.C: World Bank.

²⁴ World Bank. 2025. Bhutan Crisis Preparedness Gap Analysis: Technical Report. Washington, D.C: World Bank.

²⁵ World Bank. 2019. Regional Development and Economic Transformation. Washington, D.C.: World Bank.

and occur most frequently during the monsoon season, when intense and prolonged precipitation saturates hillside soils and reduces slope stability.²⁶ At the national level, landslides represent the hazard to which the largest share of the population is exposed: an estimated 43% of Bhutan's population, and 47% of the poor, live in areas exposed to significant landslide risk at a 100-year return period.²⁷ Figure 2-3 above shows the spatial distribution of rainfall-triggered landslide risk.²⁸

30. **Thimphu's vulnerability to landslides has been significantly amplified** by rapid urban expansion and increasing development on steep slopes. Construction activity often involves slope cutting and earthworks undertaken without comprehensive geotechnical assessment, slope stabilization measures, or adequate drainage management. These practices destabilize hillside soils and increase surface runoff, creating conditions conducive to slope failure. At the same time, the clearing of vegetation to accommodate urban development has further reduced the vegetative cover that would otherwise anchor hillside soils and regulate water infiltration. These factors are compounded by gaps in hazard mapping and limited technical capacity to systematically integrate landslide risk into land use planning and building regulation, meaning that new development continues to encroach on high-risk terrain.²⁹
31. **Climate change is projected to intensify landslide hazard in Thimphu**, primarily through increased precipitation intensity during the monsoon season. More frequent and prolonged rainfall accelerates soil saturation on vulnerable slopes, lowering the threshold at which slope failures are triggered, while more frequent extreme rainfall episodes such as cloudbursts can destabilize slopes rapidly and with little warning. Rising temperatures compound this dynamic by altering seasonal precipitation patterns, contributing to elevated soil moisture levels in upper catchments, and gradually weakening bedrock and slope stability over time. Changes in temperature and precipitation may also gradually weaken bedrock and slope stability, increasing the likelihood of both shallow and deep-seated landslides.
32. **Intensifying landslide risk will have significant impacts to Thimphu's urban systems.** In the water sector, as highlighted in the August 2024 flash floods, landslide events can dislodge or damage transmission pipelines, causing major leaks and breakages. The severity of damage often makes repairs challenging and can leave entire neighbourhoods without water supply for extended periods.³⁰ In the transport sector, landslides are the most significant threat to road and bridge infrastructure in Bhutan, often triggered by heavy monsoon precipitation and weak geological foundations leading to slope failures.³¹ Road network disruptions isolate communities, delay emergency response, and interrupt the supply of essential goods, compounding the impacts of other concurrent hazards such as flooding. More broadly, utility networks and residential areas that have expanded onto steep hillsides without adequate risk assessment face growing exposure to direct structural damage and service disruption as the frequency and intensity of triggering rainfall events increases under climate change.

Urban Heat Island Effect

Thimphu is experiencing a measurable and intensifying urban heat island (UHI) effect, driven by the rapid replacement of natural vegetation and permeable surfaces with dense built-up areas. Between 2001 and 2021, Thimphu's built-up area increased by nearly 17%, while vegetation cover declined by more than 19%, and built-up areas are projected to exceed 72.8% of the municipality by 2031. The concentration of multistorey reinforced concrete buildings, corrugated galvanized iron roofing, and asphalt pavements — which absorb and re-radiate heat far more than natural surfaces — has created localized thermal hotspots across the city, with some zones recording land surface temperatures up to 6.9°C above surrounding areas and peak surface temperatures reaching 43°C during summer months.³² Average surface temperature data from 2013 to 2022 (as shown in

33. [Figure 2-4](#) [Figure 2-4i](#) illustrate this warming trend. Extreme UHI zones have been identified in high-density commercial and institutional areas including the Thimphu Clock Tower, Motithang, Tashi Commercial, and the Jigme Dorji Wangchuk National Referral Hospital. Bhutan's National Adaptation Plan (NAP) recognizes the UHI effect as an emerging urban climate risk, noting that local governments have yet to develop dedicated heat adaptation strategies.³³
34. **Thimphu's vulnerability to heat stress is compounded by its confined valley topography**, which limits air circulation and traps heat, amplifying the UHI effect relative to less constrained urban settings. The city's ongoing urban expansion

²⁶ Dikshit, A., Sarkar, R et.al. 2019. Estimating Rainfall Thresholds for Landslide Occurrence in the Bhutan Himalayas. *Water*, 11(8), 1616.

²⁷ World Bank. 2024. *Bhutan Poverty and Equity Assessment 2024: Sustaining Progress in Poverty and Inequality Reduction in Bhutan*. Washington, D.C.: World Bank.

²⁸ ThinkHazard. Thimphu – Landslides. Retrieved from <https://thinkhazard.org/en/report/635-bhutan-thimphu/LS>

²⁹ World Bank. 2019. *Bhutan Urban Policy Notes: Urban Resilience*. Washington, D.C.: World Bank Group.

³⁰ UNDRR and CDRI. 2024. *Bhutan National Plan for Infrastructure Resilience*, United Nations Office for Disaster Risk Reduction (UNDRR) and Coalition for Disaster Resilient Infrastructure (CDRI).

³¹ Ibid.

³² Pasang, S. et al. 2025. Modeling and Simulation of Urban Heat Islands in Thimphu Thromde Using Artificial Neural Networks. *Atmosphere*, 16 (12) 1410. Retrieved at <https://www.mdpi.com/2073-4433/16/12/1410>

³³ Ministry of Energy and Natural Resources. (2023). *First National Adaptation Plan 2023*. Retrieved from <https://unfccc.int/sites/default/files/resource/NAP-Bhutan-2023.pdf>

continues to erode the green cover that would otherwise moderate temperatures through evapotranspiration and shading. Vegetation cover in the municipality is projected to decline to 23.5% by 2031, and new heat islands are likely to emerge along the city's expanding outskirts as urban sprawl replaces open land and vegetation.³⁴ The growing demand for artificial cooling driven by rising indoor temperatures further increases energy consumption and CO₂ emissions, creating a feedback loop that compounds both the UHI effect and broader climate pressures.

35. **As global temperatures rise, the UHI effect in Thimphu is projected to intensify.** Hot and very hot zones — currently covering approximately 16% of the city's area — are expected to expand to over 20% by 2031, and this trend will accelerate under mid-century warming scenarios as rising background temperatures, projected to increase by 1.0–2.5 °C by mid-century, interact with and amplify existing urban heat dynamics.³⁵ More frequent and prolonged heat episodes will increase the risk of heat stress, particularly for vulnerable groups including children, the elderly, and those with pre-existing health conditions, with broader consequences for outdoor labor productivity and respiratory health. Higher temperatures will also accelerate ground-level ozone formation, worsening urban air quality, while heated stormwater runoff will raise river temperatures in the Wang Chhu, reducing dissolved oxygen levels and threatening aquatic ecosystems downstream.³⁶
36. **These changes to urban heat have important implications for Thimphu's urban systems.** In the water sector, extreme heat exacerbates water scarcity by accelerating evaporation, drying up natural water sources, degrading watershed catchments, and reducing groundwater recharge capacity — compounding existing water supply pressures in a city where demand already outstrips supply. In the transport sector, sustained heat stress accelerates the deterioration of asphalt road surfaces and structural materials, increasing maintenance burdens and reducing the operational lifespan of infrastructure assets. More broadly, rising energy demand for cooling places additional pressure on urban power systems, while the combined effect of heat, air pollution, and reduced outdoor comfort degrades the livability of public spaces and undermines the functionality of the city as a whole. Without proactive integration of heat adaptation measures — including urban greening, heat-reflective building materials, and green roof standards — into Thimphu's urban planning frameworks, the UHI effect will increasingly undermine the resilience and service continuity of the city's critical systems.

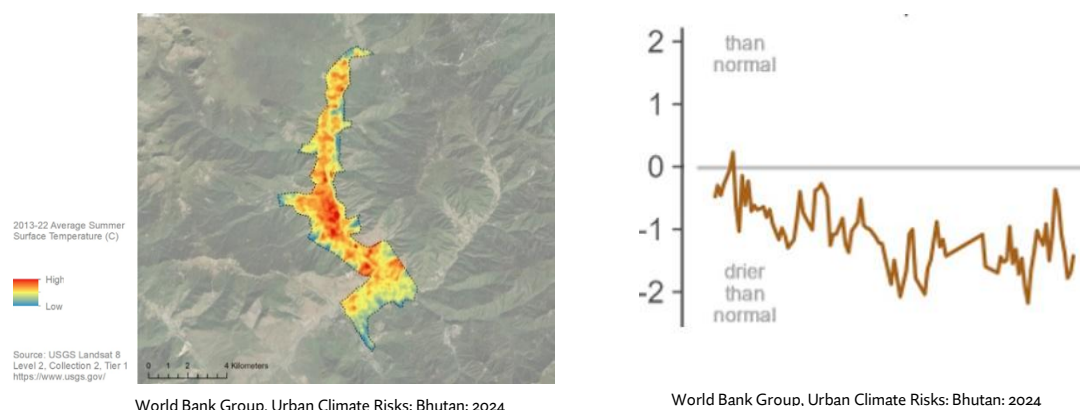


Figure 2-4 (i) Average summer surface temperature and (ii) Thimphu TWS anomaly, 2011 - 2020

Drought Risk and Water Shortages

37. **Despite Bhutan's high per capita water availability, Thimphu faces growing exposure to localized and seasonal water scarcity** due to the pronounced contrast between the wet monsoon season and a prolonged dry winter period. Analysis of Standardized Precipitation Index (SPI) data over the 1983–2022 period identifies several episodes of severe to extreme drought across Bhutan, most notably during 1984–86, 1990–93, 1996, 1999, and 2019 — confirming that while wet years outnumber dry years, drought events when they occur tend to be intense and impactful.³⁷ This seasonal water stress is compounded by the progressive drying of springs and natural water sources; at the national level, nearly 25% of Bhutan's water sources are in the process of drying up, with 149 out of 530 sub-watersheds already dry.³⁸ Total

³⁴ Pasang, S. et al. 2025.

³⁵ ibid

³⁶ ibid

³⁷ Dorji, T. et al. 2024. El Niño Southern Oscillation and Indian Ocean Dipole teleconnection to the wetness and drought trend of Bhutan using time series (1983–2022) PERSIANN rainfall data. International Journal of Applied Earth Observation and Geoinformation. Volume 135.

³⁸ Department of Water, Royal Government of Bhutan. 2023. Assessment of Climate Risks on Water Resources for National Adaptation Plan (NAP) for Bhutan.

Water Storage (TWS) anomaly data from 2011 to 2020 0-4ii) further illustrate a pattern of worsening dryness in Thimphu and surrounding areas, pointing to the urgent need for improved inter-seasonal water storage and management

38. Thimphu's vulnerability to seasonal water scarcity is significantly compounded by the limitations of its existing water supply infrastructure, which was not designed to manage pronounced inter-seasonal variability. Approximately 50% of urban areas in Bhutan do not receive a continuous 24-hour water supply, and over 77.5% of Thimphu households resort to portable water during dry periods due to intermittent supply.³⁹ The city's Jungzhina water treatment plant, with an installed capacity of 6,500 m³/day against an average daily demand of 7,560 m³, is already operating beyond its design capacity — leaving little operational buffer during dry-season shortfalls.⁴⁰ According to Thromde engineers, approximately every three years the city experiences a severe decline in raw water availability during the dry season, forcing authorities to curtail supply and manage minimum distribution levels. During these periods, emergency measures are deployed — including the drilling of temporary borewells, direct injection of untreated water into distribution lines, and temporary installation of pumps to extract dead flow from the Wang Chhu River into reservoirs. These measures provide limited, often untreated water access for only short periods each day, exposing residents to significant health risks and underscoring the structural gap between current infrastructure capacity and the city's actual water security needs.
39. Climate change is projected to intensify drought risk through two mutually reinforcing dynamics. Under drier climate scenarios, dry season precipitation is expected to decline, reducing river discharge and spring recharge rates during the months when water demand is already most constrained.⁴¹ Simultaneously, rising temperatures will accelerate evapotranspiration, further drawing down soil moisture and surface water availability; projections for the Wang Chhu River basin indicate a reduction in river flow of between 4.7% and 5.8% relative to the 1980–2005 baseline under RCP 4.5 and RCP 8.5 scenarios respectively.⁴² Critically, Thimphu's drought exposure is partly driven by large-scale ocean-atmosphere dynamics — particularly El Niño events, which have a demonstrable effect on suppressing monsoon rainfall across Bhutan — meaning that severe dry years can occur with limited predictability and little warning, making planning for water storage and supply continuity particularly challenging.⁴³ Over the longer term, glacier retreat will progressively reduce the dry-season contribution of glacial meltwater to river systems in ways that current infrastructure is entirely unprepared to absorb.
40. These trends pose significant challenges for Thimphu's urban systems. Intensifying drought conditions will reduce the reliability and volume of raw water available to the city's intake structures, increasing the frequency and severity of dry-season supply shortfalls and placing growing pressure on emergency management measures that are already inadequate. Water quality will also deteriorate as reduced dry-season flows concentrate pollutants and lower dissolved oxygen levels in surface water, compounding public health risks associated with supply interruptions.⁴⁴ Drought also interacts with and amplifies other hazards; prolonged dry periods increase the risk of forest fires in Thimphu's surrounding catchment areas, degrading the watershed ecosystems on which water supply depends, while the compounding effect of drought and extreme heat poses growing risks to public health and the operational continuity of urban services.⁴⁵ Without targeted adaptation investment — including expanded storage capacity, catchment protection, and climate-resilient water infrastructure — more frequent and severe dry seasons will progressively undermine the reliability of Thimphu's water supply systems and the resilience of communities that depend on them.

Climate Policy and Institutional Framework

National Climate Commitments and Adaptation Priorities

41. Bhutan has demonstrated a long-standing and internationally recognized commitment to climate action, anchored in its constitutional mandate to maintain a minimum of 60% forest cover at all times (currently standing at approximately 71%) and its pledge first made at the 15th Conference of Parties in Copenhagen in 2009 to remain carbon neutral. This commitment has been progressively formalized through a series of national climate instruments, most recently Bhutan's Third Nationally Determined Contribution (NDC 3.0), its Long-Term Low Greenhouse Gas Emission and Climate Resilient Development Strategy (LTS 2023, currently being updated based on the NDC 3.0), and its National Adaptation Plan (NAP 2023). The carbon-neutral commitment and the urgent need for adaptation and resilience have been integrated into the country's national development and economic planning strategies, such as the 13th Five Year Plan (FYP 2024-2029)

³⁹ Chathuranika, I. M. et al. 2023. Assessing the water quality and status of water resources in urban and rural areas of Bhutan. *Journal of Hazardous Materials Advances*. Volume 12. Retrieved from <https://www.sciencedirect.com/science/article/pii/S2772416623001481>

⁴⁰ Ibid.

⁴¹ World Bank. 2025. *Bhutan Country Climate and Development Report (CCDR)*. Washington, D.C: World Bank.

⁴² Chathuranika, I. M. et al. 2023.

⁴³ Dorji, T. et al. 2024.

⁴⁴ Chathuranika, I. M. et al. 2023.

⁴⁵ ⁴⁵ World Bank. 2025. *Bhutan Country Climate and Development Report (CCDR)*. Washington, D.C: World Bank.

and the 21st Century Economic Roadmap: 10x National Economic Vision. The NDC 3.0, LTS and NAP instruments establish the policy foundation within which climate action in Bhutan's urban sector is framed.

42. Bhutan's NDC 3.0 (2025) reaffirms the country's commitment to remain carbon neutral through 2035 by ensuring greenhouse gas emissions do not exceed the carbon sequestration capacity of its forests and land-based sinks. Grounded in Bhutan's 21st Century Economic Roadmap, the NDC 3.0 lays a clear economy-wide target, integrating emission projections, mitigation potentials, and adaptation priorities across all sectors. For the transport sector, the NDC 3.0 identifies transport as a significant vulnerability in Bhutan's otherwise carbon-negative status given its complete reliance on imported fossil fuels, and prioritizes the adoption of stringent fuel emission standards, promotion of electric vehicles and nationwide EV charging infrastructure, piloting of electric buses, introduction of light-rail transit, and expansion of non-motorized transport.⁴⁶ In fact, the NDC 2.0 provided a sectoral target of scaling mass transit opportunities through improvements in bus systems such as the introduction of open-bus rapid transit (BRT) network, as well as a light rail transit.⁴⁷ In the water sector, the NDC 3.0 highlights reduced winter precipitation and intense monsoons that are undermining water security and threatening communities and infrastructure and prioritizes integrated watershed management, nature-based approaches to groundwater recharge, efficient water distribution systems and strengthening governance and institutions for improved water management. And in terms of urban planning, the NDC 3.0 prioritizes the development of climate-resilient and energy-efficient infrastructure, risk-sensitive land-use planning, green urban development, and the use of ecosystem-based approaches to manage urban flooding and heat.
43. Bhutan's LTS (2023) sets out the country's decarbonization and resilience pathway to 2050, providing a comprehensive economy-wide roadmap to maintain carbon neutrality while supporting sustainable economic growth. It is currently undergoing revision following the launch of the NDC 3.0 and major long-term initiatives aimed at transforming Bhutan's economy, including the 21st Century Economic Roadmap. The LTS warns that a business-as-usual trajectory would put Bhutan's carbon-neutral status at risk by 2047–2048 as rising emissions and declining forest sink capacity converge. For the transport sector, the LTS identifies transport as the primary source of energy-related GHG emissions, accounting for over 60% of the energy category, and sets ambitious targets including 100% of light vehicle and bus sales to be electric by 2045 and 25% of heavy vehicle imports to be electric by 2050. Key transport interventions include the adoption of stringent fuel efficiency standards, development of non-motorized transport infrastructure, deployment of electric Bus Rapid Transit, and the piloting of ropeways and cable cars to reduce road pressure and improve connectivity in steep terrain. The LTS also calls for the climate-proofing of road infrastructure to withstand intense monsoons, landslides, and GLOFs. For the water sector, the LTS frames water as facing a "dual problem" of scarcity and abundance, subject simultaneously to seasonal shortages and flood risk, and prioritizes the implementation of Integrated Water Resource Management (IWRM), construction of multi-purpose storage reservoirs to manage seasonal variability, lowering of dangerous glacial lake levels to prevent GLOFs, and adoption of innovative water distribution technologies including pressurized systems to reduce losses. For the urban development, the LTS emphasizes decoupling growth in urban areas from emissions growth, and prioritizes energy-efficient building design, rollout of solar rooftop systems and the development of climate-smart cities through sustainable construction and low-emission urban transport integration.⁴⁸

Bhutan's NAP (2023) sets out the country's medium-term adaptation framework in response to growing climate risks to its socio-economic development. It identifies three cross-cutting challenges for adaptation action: (i) seasonal water shortages driven by drying water sources and declining winter precipitation; (ii) increasing forest fire risk due to warmer and dryer conditions, threatening Bhutan's constitutionally mandated carbon sink; and (iii) energy insecurity from reduced hydropower generation during drier winters. In response, the NAP outlines adaptation priorities across key sectors, including water and human settlements, alongside enabling measures on policy, institutions, and capacity building. For the water sector, the NAP highlights increasing drought, drying of springs, seasonal water shortages, and water-induced disasters as key adaptation challenges. Priority interventions include ensuring a climate-resilient supply of safe drinking water through proper monitoring, planning, and water system management, and on the reduction of non-revenue water losses to improve water security under increasingly variable climate conditions. For the human settlements sector, the NAP emphasizes the climate-smart urban development through green infrastructure and the climate-proofing of critical infrastructure against floods, landslides, and urban heat. [Table 0-1: National Mitigation Priorities for Transport Sector in Bhutan as documented in the NDC 3.0 and LTS.](#)

⁴⁶ Royal Government of Bhutan. 2025. Kingdom of Bhutan Third Nationally Determined Contribution. Retrieved at https://unfccc.int/sites/default/files/2025-11/Third%20NDC%20%28Provisional%29_10%20November%202025.pdf

⁴⁷ Royal Government of Bhutan. 2021. Kingdom of Bhutan Second Nationally Determined Contribution. (2021). Retrieved at <https://unfccc.int/sites/default/files/NDC/2022-06/Second%20NDC%20Bhutan.pdf>

⁴⁸ Royal Government of Bhutan. 2023. Long-Term Low Greenhouse Gas Emission and Climate Resilient Development Strategy

<u>Transport Sub-sector</u>	<u>Key Emissions Trends</u>	<u>Strategic Priorities</u>	<u>Illustrative Mitigation Actions</u>
<u>Road Transport</u>	- Under the energy category, a major portion of the emissions is attributed to road transport and civil aviation. - In 2020, for road transport, Bhutan imported 50.96 million liters of motor gasoline (petrol), 154.62 million liters of diesel, and 2.92 million liters of lubricants for the road transport sector - preliminary estimates for 2019 road transport emissions around 429 GgCO₂e.	<u>Sustainable Low-Emission Surface Transport</u>	- Introduction of fuel efficiency measures in the form of vehicular emission standards and fuel quality standards to reduce emissions from road transport - Promotion of low-emission vehicles like electric vehicles and hydrogen vehicles - Promotion of non-motorized transport such as walking, bicycling, and Public Bicycling Sharing - Electric Bus Rapid Transport (BRT) system and electric buses as a less polluting public transport alternative

44. ~~Table 0-2~~~~Table 3-1~~ and ~~Table 0-3~~~~Table 3-2~~ below summarize the adaptation priorities for the water and climate smart cities sectors, synthesized across key sub-sectors.⁴⁹

Table 0-1: National Mitigation Priorities for Transport Sector in Bhutan as documented in the NDC 3.0 and LTS.

Transport Sub-sector	Key Emissions Trends	Strategic Priorities	Illustrative Mitigation Actions
Road Transport	- Under the energy category, a major portion of the emissions is attributed to road transport and civil aviation. - In 2020, for road transport, Bhutan imported 50.96 million liters of motor gasoline (petrol), 154.62 million liters of diesel, and 2.92 million liters of lubricants for the road transport sector - preliminary estimates for 2019 road transport emissions around 429 GgCO₂e.	Sustainable Low-Emission Surface Transport	- Introduction of fuel efficiency measures in the form of vehicular emission standards and fuel quality standards to reduce emissions from road transport - Promotion of low-emission vehicles like electric vehicles and hydrogen vehicles - Promotion of non-motorized transport such as walking, bicycling, and Public Bicycling Sharing - Electric Bus Rapid Transport (BRT) system and electric buses as a less polluting public transport alternative

Table 0-2: National Adaptation Plan Priorities for Water Management and Water Security in Bhutan

Water	Key Climate Risks	Strategic Priorities	Illustrative Adaptation Actions
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⁴⁹ Royal Government of Bhutan. 2023. National Adaptation Plan (NAP) of the Kingdom of Bhutan.

Sub-sector			
Watershed & Ecosystem Management	- Changing precipitation patterns - Spring drying - Land degradation and erosion	Protect and restore watersheds to sustain water availability and regulate flows	- Watershed and spring-shed mapping and assessment - Wetland and catchment restoration - Afforestation and bioengineering measures - Promotion of ecosystem-based adaptation
Drinking Water Supply	- Reduced dry-season flows - Increased variability in supply - Water quality deterioration	Ensure reliable, climate-resilient water supply systems	- Climate-resilient design of water supply infrastructure - Source protection and recharge interventions - Leakage reduction and system rehabilitation - Water safety planning and quality monitoring
Irrigation & Productive Water Use	- Water scarcity during cropping seasons - Erratic rainfall affecting agriculture	Improve water-use efficiency and climate resilience in agriculture	- Rehabilitation and modernization of irrigation systems - Promotion of water-efficient technologies - Crop-water management improvements - Diversification to less water-intensive crops
Water Resources Governance & Institutions	- Fragmented management - Limited coordination across sectors - Weak local capacity	Strengthen integrated and adaptive water governance systems	- Implementation of Integrated Water Resources Management (IWRM) - Strengthening water user associations - Institutional coordination mechanisms - Capacity building at national and local levels
Hydrological Data, Monitoring & Knowledge Systems	- Limited data for decision-making - Uncertainty in climate projections	Improve data systems and climate-informed water management	- Expansion of hydrometeorological monitoring networks - Development of water information systems - Climate and hydrological modelling - Knowledge generation and sharing platforms
Urban Water Management	- Rapid urbanization (e.g., Thimphu) - Increasing demand and system stress - Climate-induced variability	Enhance resilience of urban water systems	- Demand management and efficiency improvements - Improvements to reduce Non-Revenue Water - Integrated urban water planning - Stormwater and drainage management

Table 0-3: National Adaptation Plan Priorities for Human Settlements & Climate Smart Cities in Bhutan

Water Sub-sector	Key Climate Risks	Strategic Priorities	Illustrative Adaptation Actions
Climate Resilient Urban Planning & Governance	- Unplanned urban expansion into hazard-prone areas - Weak integration of climate risks in planning - Institutional fragmentation	Strengthen institutional and policy environment to enable climate resilient planning and implementation	- Climate-informed urban master planning - Integration of risk into land-use regulations - Strengthening institutional coordination and capacity - Development of urban data and decision-support systems

Resilient Urban Infrastructure & Services	- Damage to infrastructure from floods, landslides, extreme weather - Disruptions to essential services	Climate-proof urban infrastructure and ensure service continuity	- Climate resilient design and retrofitting of infrastructure - Resilient water supply and urban service systems - Protection of critical facilities and lifelines
Urban Flood Management & Nature-Based Solutions	- Increasing flood intensity and stormwater overload - Reduced natural drainage and ecosystem services - Urban heat island effects - Rising temperatures & heat stress	Enhance resilience to flooding and urban heat through integrated grey infrastructure and ecosystem-based solutions	- Upgrading urban drainage systems - Flood risk management infrastructure - Green infrastructure (parks, wetlands, etc) - Watershed-informed urban planning - Urban greening (trees, parks, green corridors)
Climate-Resilient Urban Mobility	- Landslides and extreme weather disrupting transport - Increasing congestion and emissions	Enhance climate resilience of urban transport systems and connectivity	- Climate-resilient road infrastructure - Slope stabilization and corridor protection - Transport system planning incorporating climate risks
Disaster Risk Management & Urban Resilience Systems	- Increased frequency and intensity of extreme events - Limited preparedness and response capacity	Strengthen urban disaster preparedness and response systems	- Urban risk assessments and early warning systems - Emergency preparedness and response planning - Capacity building and community awareness - Strengthening service continuity during shocks

45. The financing gap facing Bhutan is significant and growing on both the mitigation and adaptation fronts. On the mitigation side, the total estimated cost of implementing NDC 3.0 mitigation interventions is estimated at USD 9,419 million for 2026–2030 and USD 4,264 million for 2031–2035.⁵⁰ As stated in the NDC 3.0, the ability to remain carbon neutral and the implementation and achievement of Bhutan’s target will depend on the level of international support received and is therefore conditional upon such support. Bhutan continues to call on the international community to strengthen cooperation and provide adequate financial, technological, and capacity building support to sustain its mitigation efforts and address the adverse impacts of climate change. On the adaptation side, the total estimated cost of implementing priorities identified across the NAP and NDC 3.0 is approximately USD 14 billion over the 2023–2038 period, a figure that vastly exceeds Bhutan's domestic fiscal capacity.⁵¹ Domestic climate financing remains severely constrained, and development assistance — while still a major source of financing for sustainable development programs — cannot alone bridge a gap of this magnitude. This financing challenge is further compounded by Bhutan's graduation from least developed country status, which will progressively reduce its access to the concessional financing windows and preferential terms that have historically underpinned its development investments. In this context, international climate finance instruments such as the GCF play an indispensable role in translating Bhutan's strong and well-articulated climate commitments into concrete, investable programs.

National Development Plans and Relevant Sectoral Frameworks

46. **Thirteenth Five-Year Plan, 2024-2029 (13th FYP):** Bhutan’s 13th FYP sets an ambitious course toward a “High-Income Gross National Happiness Economy” by 2034, balancing economic transformation with the country’s holistic development philosophy. Launched after Bhutan’s graduation from Least Developed Country (LDC) status, the plan reaffirms Gross National Happiness (GNH) principles while placing a stronger emphasis on jobs, innovation, and diversification to boost incomes and reduce youth unemployment. Its strategic objectives span four clusters – economic, social, security, and governance – with eight national programs and 34 targets designed to accelerate sustainable

⁵⁰ Royal Government of Bhutan. 2025. Kingdom of Bhutan Third Nationally Determined Contribution.

⁵¹ Royal Government of Bhutan. 2023. NAP.

growth. Cross-cutting themes such as climate resilience, equity, and good governance are integrated throughout the plan to ensure that economic gains do not come at the expense of environmental sustainability or social well-being.

47. In the transport and water sectors, the 13th FYP emphasizes sustainability, resilience, and inclusivity as guiding principles for infrastructure development. In transport, the plan prioritizes the transition to a low-carbon, efficient, and climate-resilient system by promoting sustainable mobility solutions such as public transport, non-motorized transport (NMT), and intelligent transport systems (ITS). Strategic investments will support the development of green urban mobility, including electric buses and multimodal connectivity, while also enhancing rural-urban linkages to reduce emissions and improve access. The plan aligns with Bhutan's broader climate commitments by integrating transport planning with land use, encouraging compact urban development, and reducing reliance on private vehicles. In the water sector, the FYP advances sustainable water resource management through the implementation of a National Water Master Plan, river basin management strategies, and climate-resilient infrastructure guidelines. These efforts aim to ensure 24/7 access to safe drinking water, improve irrigation systems, and enhance resilience to climate-induced water stress, thus contributing to Bhutan's goals for environmental sustainability, public health, and economic diversification.
48. **Bhutan 21st Century Economic Roadmap: National 10x Economic Vision (2025)** sets out an ambitious vision for a resilient, inclusive, and sustainable economy by 2050. It aims to transform Bhutan into a developed, knowledge-driven economy with a tenfold increase in GDP by mid-century. The strategy is guided by Gross National Happiness principles, emphasizing well-being, equity, and environmental stewardship alongside prosperity. It focuses on diversifying the economic base, strengthening core industries like hydropower, organic agriculture, and high-value tourism, while accelerating emerging sectors such as the digital economy, green manufacturing, services, and sustainable mining. These moves, coupled with policy and human capital reforms, are intended to achieve full employment and high-income status within a decade, all while maintaining Bhutan's carbon-neutral development path.
49. In the transport and water sectors, the Roadmap emphasizes sustainable infrastructure as a cornerstone of economic transformation. For transport, it calls for upgrading connectivity and modernizing transport networks as part of the growth strategy. In line with Bhutan's climate commitments, the plan reaffirms a pledge to maintain carbon neutrality through 2050, and encourages low-emission mobility solutions like improved public transit and electric vehicles. On water, while the Roadmap does not single out a dedicated water program, it identifies hydropower as one of three "core industries" and highlights the need for adaptation measures to manage climate risks to hydropower generation.
50. **Bhutan Transport 2040: Integrated Strategic Vision (2013):** Developed in partnership with Asian Development Bank (ADB) and the Australian government, this long-term vision document sets the overarching goal to provide safe, reliable, affordable, and environmentally friendly transport for all. It contains nine strategies addressing physical infrastructure, services, and regulation across sub-sectors and geographies (road network, aviation, passenger, freight, regional, urban, road safety, road regulation), with the ninth strategy concerning the coordination and management of the transport sector overall. It emphasizes urban public transport and pedestrian infrastructure as top priorities for cities, stating that urban transport strategies should make public transit attractive and restrain private car growth, while walking should be the dominant mode in Thimphu's core area. To realize these goals, the Vision calls for a robust public bus network (introducing larger buses, better service coverage, and incentives for lower-emissions buses and taxis), integrated transport and land use planning, and pedestrian-friendly urban design.
51. **Low Emission Development Strategy (LEDS) 2021 for Transport:** As part of Bhutan's climate change commitments, LEDS 2021 is a 30-year roadmap to decarbonize the transport sector. It re-evaluates the recommendations of the previous LEDS 2016 and improves upon it by introducing Marginal Cost Abatement analysis to inform prioritization and more clearly defined targets for identified interventions. LEDS 2021 identifies public transport improvements (including Bus Rapid Transit implementation), non-motorized transport (improved sidewalks, crosswalks, and bicycle sharing systems), vehicle electrification (targeting 100% of taxi sales and 70% of bus and private car sales to be EVs by 2035), shared mobility (carpooling incentives, parking restrictions), and transit-oriented planning (increasing density near transit lines) as key mitigation measures.
52. The RGoB governs water supply, irrigation and flood management through four different ministries, as shown in Figure 3-1. In 2001, the Bhutan Water Partnership – a non-profit entity affiliated to the Global Water Partnership, was created to achieve the goals of Integrated Water Resource Management (IWRM) which incorporates water industry members beyond the four ministries. The 2011 Water Act and the 2014 Water Regulation Act govern the management of water resources and regulation of water prices respectively (National Environment Commission, 2014).

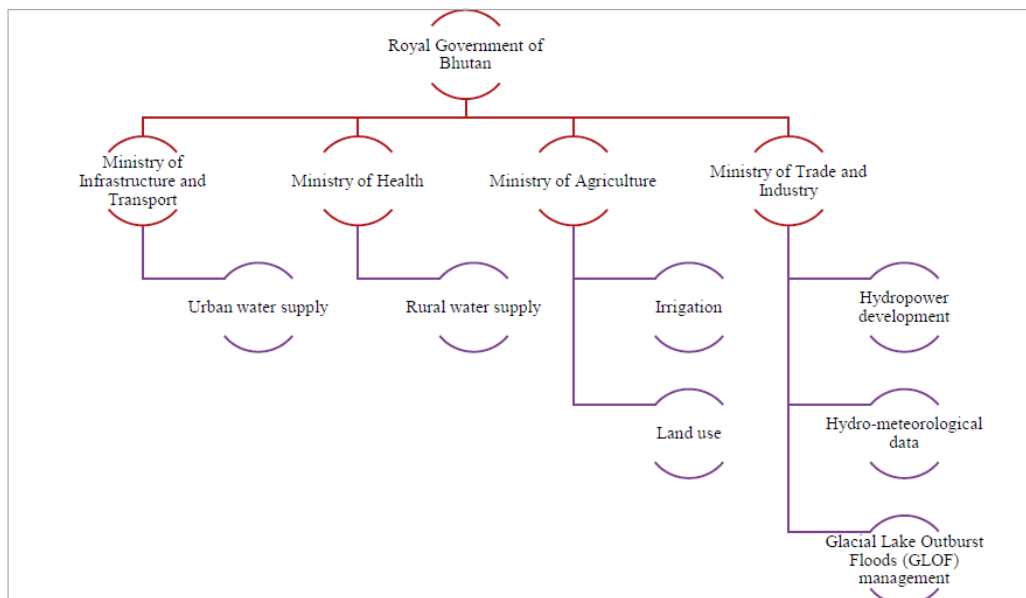


Figure 3-1 Water Governance in Bhutan⁵²

53. **Bhutan Water Vision (2025)** sets out a long-term aspirational goal for sustainable, equitable, and climate-resilient water management in Bhutan. It envisions water as a vital natural, economic, and life-sustaining resource that must be available in adequate, safe, and affordable quantities for present and future generations, while maintaining the integrity of natural ecosystems. To achieve this, the Vision emphasizes sustainable, efficient, and equitable use and management of water resources, guided by environmental, social, cultural, and economic values. It calls for informed, educated, and engaged water users and decision-makers who value and protect water in all its forms and uses, and supports integrated approaches to watershed conservation, water supply, distribution, and disaster risk prevention. It sets as one of the goals to achieve safe water supply with 100% coverage in urban areas and identifies flood control and management as a priority.
54. **National Integrated Water Resources Management Plan (2016)** establishes the framework and priorities for the implementation of integrated water resources management (IWRM) in Bhutan. The Plan is based on a baseline analysis and future climate change scenarios. In this baseline analysis, the plan identifies the districts of Thimphu and Paro's sub-basins as areas susceptible to monsoon flooding. The Plan establishes the principles and mechanisms under which agencies involved in the water sector, together with river basin stakeholders, can coordinate their respective plans and activities, as well as collectively monitor progress toward attainment of Bhutan's IWRM objectives.

Relevant Policy and Regulatory Framework

Summary of Relevant Policies and Regulations

55. Bhutan's national climate commitments are grounded in a broader constitutional, policy, and legal framework that has long prioritized environmental conservation and sustainable development. This section reviews the key instruments that collectively establish this foundation, including the Constitution, national policies, and sectoral legislation governing environmental protection, climate change, water and waste management, transport, human settlements, and gender equality. These frameworks define the principles, standards, and institutional responsibilities through which climate considerations—both mitigation and adaptation—are embedded into development planning, infrastructure investment, and service delivery. The section also situates Bhutan's domestic regulatory architecture within the context of international conventions and commitments to which the country is a party, highlighting their role in shaping and reinforcing national policy direction.
56. The **constitution of the Kingdom of Bhutan (2008)** entrusts every citizen to contribute to the protection of the natural environment, conservation of the rich biodiversity of Bhutan, and prevention of all forms of ecological degradation including noise, visual and physical pollution. It accords the rights over mineral resources, rivers, lakes, and forests to the state to be regulated by law. It requires the state to preserve, protect, and promote the country's cultural heritage, including monuments, places, and objects. The state is assigned to ensure a safe and healthy environment, always maintaining a minimum of sixty percent of Bhutan's total land under forest cover. It must secure ecologically balanced sustainable development and sovereign rights of the state over its biological resources, including legislation to ensure

⁵² MoIT. 2023 Thimphu Water Services Masterplan: Water supply, Wastewater and Stormwater Masterplan.

sustainable use of natural resources and intergenerational equity. By the constitution, the Parliament can, by law, declare any part of the country to be a National Park, Wildlife Reserve, Nature Reserve, Protected Forest, Biosphere Reserve, Critical Watershed, and such other categories meriting protection.

57. The **Climate Change Policy of the Kingdom of Bhutan (2020)** provides the overarching strategic framework for addressing climate change, with the dual objective of maintaining carbon neutrality while building resilience to climate impacts. Anchored in Bhutan's constitutional mandate for environmentally sustainable development, the policy promotes a low greenhouse gas (GHG) emission development pathway that supports economic and social progress while safeguarding ecological integrity. It sets out key objectives, including pursuing carbon-neutral development, strengthening climate resilience, enhancing technology transfer and capacity building, and ensuring coordinated and effective climate action across sectors. On the mitigation side, the policy emphasizes decoupling economic growth from GHG emissions through transformative approaches in key sectors such as transport, industry, and waste, supported by Low Emission Development Strategies (LEDS). On the adaptation side, it prioritizes building resilience to climate risks through integrated planning, stakeholder participation, and the mainstreaming of climate considerations into development processes. The policy also provides the foundation for the development and implementation of Bhutan's Nationally Determined Contributions (NDCs) and National Adaptation Plan (NAP), thereby serving as a central instrument for aligning national development with long-term climate goals.
58. The **National Environment Protection Act (NEPA) 2007** serves as Bhutan's umbrella legislation for environmental conservation and protection, establishing the overarching legal and institutional framework that governs sustainable development across all sectors. The Act sets out key principles requiring that any individual or entity utilizing natural resources or deriving economic benefits from the environment ensures their sustainable use and management, while safeguarding ecosystem integrity. It provides the basis for an integrated system of environmental governance led by the National Environment Commission (NEC) and other designated competent authorities, which are responsible for developing standards, regulations, and measures to protect environmental quality. NEPA also underpins the development of sector-specific legislation, including the Water Act and the Waste Prevention and Management Act, and enforces accountability by assigning liability to polluters for environmental damage, including costs related to mitigation, restoration, and compensation. By promoting the sustainable use of both renewable and non-renewable resources, reducing waste generation, and ensuring proper environmental management, the Act plays a central role in safeguarding Bhutan's natural resource base and environmental quality.
59. The **Environmental Assessment Act (2000)** establishes the legal framework for assessing and managing the environmental impacts of policies, plans, programs, and projects in Bhutan. It requires that environmental considerations be systematically integrated into decision-making processes and mandates that Environmental Clearance (EC) from the designated Competent Authority is a prerequisite for the approval and implementation of any activity with potential environmental impacts. The Act sets out procedures for environmental assessment, including screening, review, consultation, and information disclosure, and provides the basis for identifying mitigation measures to minimize adverse impacts while enhancing environmental benefits. Supported by a suite of regulations and guidelines—such as those governing project-level environmental clearance and strategic environmental assessment—the Act plays a central role in ensuring that development is undertaken in an environmentally responsible and sustainable manner, with clear provisions for monitoring, compliance, and enforcement. Regulations and guidelines supporting the Environmental Assessment Act include the Regulation for the Environmental Clearance of Projects, Regulation on Strategic Environmental Assessment, Application for Environmental Clearance Guidelines, and Environmental Codes of Practices.
60. The **Water Act of Bhutan (2011)** establishes the legal framework for the allocation, protection, and sustainable management of water resources, recognizing water as a state-owned resource held in trust by the government for the equitable benefit of all citizens. The Act sets clear priorities for water use—placing drinking water at the highest priority—followed by agriculture, energy, industrial use, tourism, recreation, and other needs, while ensuring that water use by any individual or entity does not deprive other users, including upstream and downstream communities. It further regulates water quality by prohibiting the discharge of effluents into water bodies unless compliant with established standards, thereby safeguarding both human health and ecosystems. Overall, the Act promotes the efficient, sustainable, and equitable use of water resources and provides an important regulatory basis for managing drinking and irrigation water and ensuring environmental safeguards in project areas.
61. The **Waste Prevention and Management Act (2009)** establishes Bhutan's comprehensive legal framework for the prevention, reduction, and environmentally sound management of waste. Grounded in key environmental principles, including the Precautionary Principle and the Polluter Pays Principle, the Act mandates that all individuals and entities take necessary measures to maintain a clean and healthy environment, while holding polluters accountable for the full costs associated with environmental damage, including avoidance, abatement, mitigation, remediation, and restoration. The Act defines clear institutional roles and responsibilities for lead and collaborating agencies and sets out mechanisms for waste reduction, segregation, treatment, and disposal. It further empowers the National Environment Commission (NEC), as the apex regulatory authority, to oversee and monitor waste management practices, ensuring compliance with environmental standards and prohibiting activities and products that contribute to hazardous waste generation. Collectively, the Act provides a holistic and enforceable framework for sustainable waste management in Bhutan.

62. The **National Transport Policy (2017)** covers policy objectives and a framework for institutional arrangements. It also introduces financing mechanisms and a framework for monitoring and evaluating outcomes. The previous 2006 NTP was updated in 2017 following a request from UNDP to address policy gaps and other key issues that had surfaced since the adoption of the 2006 policy, and to develop a more inclusive and sustainable transport plan. As a result, the 2017 NTP features improved coverage of sub-sector policies, clearer delineation of roles & responsibilities, and linkages to other sectoral policies and international climate goals. In particular, it provides the rationale and guiding principles for sub-sector policies. For example, it describes the existing landscape for important transport sub-sectors (roads and road transport; urban transport; civil aviation; regional connectivity) and details policy objectives, along with policy statements as benchmarks for meeting the objectives. A new National Surface Transport Policy is currently under development and expected to reinforce the current NTP's sustainability objectives, with added focus on electrification and climate resilience.
63. The **National Human Settlement Policy of Bhutan (2019)** outlines a strategic framework for managing human settlements in Bhutan, emphasizing sustainable urban development, housing accessibility, and environmental conservation. Developed in response to rapid urbanization driven by economic growth and rural-to-urban migration, the policy addresses emerging challenges such as housing shortages, informal settlements, and increasing pressure on urban infrastructure. Anchored in the principles of Gross National Happiness (GNH), it seeks to ensure that urban development enhances overall well-being while preserving Bhutan's cultural and natural heritage. The policy promotes integrated land use planning, inclusive and affordable housing development, and the provision of essential infrastructure services—including water supply, sanitation, and waste management—while encouraging coordinated urban governance and community participation. It also incorporates disaster risk reduction and climate resilience into settlement planning, recognizing Bhutan's exposure to natural hazards. Importantly, the policy requires the protection of environmentally sensitive areas, including biodiversity hotspots, watershed areas, and critical water resources, ensuring that urban growth is aligned with ecosystem conservation and long-term sustainability.
64. The **National Gender Equality Policy (2020)** provides an overarching framework for promoting women's empowerment and achieving substantive equality between women and men in Bhutan. Anchored in the principle that fundamental rights are equally bestowed and that discrimination and abuse are not tolerated, the policy envisions a society where women and men, boys and girls have equal opportunities to realize their full potential and benefit equitably from social, economic, and political development. It serves as a guiding instrument to ensure that laws, policies, programmes, and practices are gender-responsive and deliver equal rights, opportunities, and benefits across the family, community, workplace, and wider society. The policy establishes key objectives, including providing a coherent strategic framework for advancing gender equality, strengthening accountability and operational mechanisms, and fostering coordination across sectors and stakeholders. It further outlines priority areas across political, social, and economic domains, supported by institutional arrangements, implementation strategies, and monitoring and evaluation systems. Importantly, the policy emphasizes the mainstreaming of gender considerations across all sectors, including the integration of gender equality into climate change and disaster risk management initiatives, reinforcing Bhutan's commitment to inclusive and equitable development.
65. Bhutan is a signatory to a range of international agreements and global frameworks on climate change, sustainable development, and disaster risk reduction, which provide important guidance for national policy formulation and sectoral planning. These frameworks establish overarching principles, targets, and reporting obligations that inform Bhutan's approach to mitigation, adaptation, and resilience-building across key sectors. They also reinforce the country's commitment to aligning domestic development pathways with global priorities on low-emission and climate-resilient development. The table below summarizes the most relevant international frameworks and conventions to which Bhutan is a party, along with their key objectives and applicability. [Error! Reference source not found.](#)

Table 0-4: Relevant International frameworks and Commitments of Bhutan

Convention	Description	Ratified/Adopted	Applicability to Transport and Water Sectors in Urban Areas
2030 Agenda for Sustainable Development	A 15-year global framework to end poverty, protect the planet, and ensure peace and prosperity for all. Centered on 17 Sustainable Development Goals (SDGs) and 169 targets, it aims to achieve sustainable, inclusive, and equitable development by 2030	01 Jan 2016	Promotes safe, low-carbon mobility (Sustainable Development Goal 11, Sustainable Development Goal 13) and ensures access to clean water and sanitation (Sustainable Development Goal 6), supporting inclusive and climate-resilient urban development.

Paris Agreement	Aims to limit global warming to well below 2°C—preferably 1.5°C—by reducing greenhouse gas emissions and strengthening countries’ climate resilience. It aims to achieve net-zero greenhouse gas emissions by mid-century through Nationally Determined Contributions (NDCs) that require countries to report and strengthen emission targets every five years.	12 Dec 2015	Encourages low-emission, energy-efficient transport systems and supports climate-resilient water infrastructure to manage risks such as flooding, droughts, and changing rainfall patterns in cities.
Sendai Framework for Disaster Risk Reduction (2015-2030)	Aims to significantly reduce disaster risks and losses across lives, livelihoods, and assets. It sets seven global targets and four priorities: understanding risk, strengthening governance, investing in resilience, and enhancing preparedness and “Build Back Better” in recovery.	18 Mar 2015	Promotes risk-informed planning, resilient infrastructure, and improved preparedness in cities. It supports reducing disaster impacts—such as floods and infrastructure damage—while strengthening urban mobility systems to maintain connectivity and enable evacuation, and enhancing water infrastructure to ensure reliable supply, drainage, and flood management during and after disasters.
New Urban Agenda	Sets a global standard for sustainable urban development over the next 20 years, guiding how cities are planned, designed, financed, and managed. It promotes inclusive, resilient, and environmentally sustainable cities, supporting Sustainable Development Goal 11 and positioning urban areas as drivers of prosperity and well-being.	20 Oct 2016	Promotes integrated, inclusive, and sustainable planning. It supports efficient and low-emission urban mobility systems, as well as equitable and resilient water infrastructure and services, to enhance livability, environmental sustainability, and urban resilience.

Relevance of Policies and Regulations to Urban Investments in Water and Transport Sectors

66. The policy and regulatory framework outlined above is directly relevant to urban investments in the water supply and public transport sectors, as it defines the enabling conditions, compliance requirements, and institutional responsibilities for planning, implementing, and operating urban infrastructure. These instruments shape how services are designed, approved, and managed, including requirements for environmental and social safeguards, resource use, land management, waste handling, and climate resilience. They also establish the basis for regulatory approvals, inter-agency coordination, and stakeholder engagement, while embedding cross-cutting priorities such as gender equality and climate change, which are central to ensuring that urban water and transport investments are sustainable, inclusive, and resilient. The table below presents a summary of the relevance of each policy and regulation to project investments in the urban water and transport sectors.

Table 0-5 Relevance of policy and regulatory framework to project investments in the urban water and transport sectors.

Policy or Legal Framework	Relevance to an Urban Livability Project focused on Water and Transport Sectors
Constitution of the Kingdom of Bhutan (2008)	For urban water and transport infrastructure, the Constitution establishes fundamental requirements related to environmental protection, sustainable development, and state stewardship of natural resources. Infrastructure works that involve land acquisition or removal of urban vegetation must comply with constitutional provisions requiring ecological balance, including maintenance of forest cover. The constitutional mandate for a safe and healthy environment also reinforces the need for climate-resilient and environmentally responsible infrastructure design, including in water supply systems and urban mobility improvements.
Environmental Assessment Act 2000	The Environmental Assessment Act (2000) is directly relevant to water and transport sectors, as infrastructure such as water supply systems, bus depots, terminals, and roadway improvements may generate environmental and social impacts. The Act requires that foreseeable impacts, including cumulative effects and feasible alternatives, be assessed prior to implementation through the preparation of an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA), depending on the scale and risk category. Environmental Clearance from the designated Competent Authority is a prerequisite for implementation, and the process includes stakeholder consultation, disclosure, and the identification of mitigation measures. The Act therefore establishes the procedural requirements for environmental screening, assessment, and approval prior to implementation.
National Environment Protection Act (2007)	From an implementation and operational perspective, the National Environment Protection Act establishes the environmental governance system that underpins compliance, monitoring, and enforcement. Water and transport infrastructure investments must adhere to environmental quality standards and pollution control requirements throughout construction and operation. The Act also establishes liability for environmental damage, requiring contractors and implementing agencies to apply mitigation measures, manage pollution risks such as runoff and waste, and restore affected sites where necessary. Institutional oversight by environmental authorities ensures ongoing compliance beyond initial project approval.
The Water Act of Bhutan (2011)	For water supply systems, the Water Act governs abstraction, allocation, and protection of water resources, with drinking water receiving the highest priority use. Infrastructure investments must ensure that water withdrawals do not adversely affect other users within the catchment, including downstream communities. In addition, transport infrastructure located near rivers and drainage networks must manage construction runoff and operational discharges to prevent pollution of water bodies, in line with national water quality protection requirements.
The Waste Prevention and Management Act (2009)	In the context of construction and operation of urban water and transport infrastructure, the Waste Prevention and Management Act defines mandatory requirements for waste minimization, segregation, handling, and disposal. Activities such as excavation, demolition, and vehicle depot operations are likely to generate both solid and hazardous waste streams, requiring formal waste management plans to be integrated into design and contractor obligations. The Act further requires environmentally sound disposal practices and compliance with approved facilities, with regulatory oversight ensuring proper implementation throughout the project lifecycle.
National Transport Policy (2017)	The National Transport Policy is directly relevant to investments in the public transport sector, as it provides the overarching policy framework guiding the planning, development, and management of transport systems. The policy emphasizes the need for an efficient, inclusive, and sustainable transport system, and establishes the institutional and governance arrangements for urban transport services, including the delineation of roles and responsibilities across agencies. It supports improvements in public transport service delivery, including enhanced operational efficiency, service quality, and monitoring systems, which are relevant to investments in bus service modernization, fleet upgrades, and intelligent transport systems. The policy also reinforces alignment with climate objectives and provides a basis for low-emission transport interventions, including electrification and modal shift towards public transport and non-motorized transport.
The National Human Settlement Policy of Bhutan (2019)	The National Human Settlement Policy of Bhutan is directly relevant to urban livability investments, as it provides the overarching framework for sustainable urban development and integrated infrastructure planning. The policy promotes coordinated development of urban services, including water supply, sanitation, drainage, waste management, and

	transport systems, to ensure efficient and inclusive service delivery in rapidly urbanizing areas. It also emphasizes the development of accessible and climate-resilient urban infrastructure, which is relevant to improvements in pedestrian networks, bus services, and multimodal connectivity. In addition, the policy requires the protection of environmentally sensitive areas such as watersheds and critical ecosystems, which informs the siting and design of water infrastructure and transport corridors. Its focus on disaster risk reduction and climate resilience further reinforces the need for infrastructure investments that can withstand climate variability and extreme weather events.
National Gender Equality Policy (2020)	The National Gender Equality Policy is relevant to urban livability investments in the water and public transport sectors, as it provides the overarching framework for ensuring gender-responsive planning, implementation, and service delivery. The policy requires that development programmes promote equal access to services and benefits for women and men, and that sectoral interventions address structural barriers to participation and inclusion. In the context of urban infrastructure, this includes ensuring that water services are accessible and reduce time burdens associated with water collection and management, and that transport systems are safe, inclusive, and responsive to the mobility needs of all users, including women, children, the elderly, and persons with disabilities. The policy also supports gender mainstreaming in project design, implementation, and monitoring, including through equitable employment opportunities and attention to safety, accessibility, and participation in decision-making processes.

Institutional Landscape, Climate Finance, and Investment Gaps

Institutional Arrangements and Climate Finance Architecture

67. Bhutan has established a comprehensive institutional framework for addressing climate change and environmental management, anchored by the National Environment Commission (NEC) as the apex cross-sectoral policy and regulatory body. The NEC provides overall strategic direction and oversight for climate policy and functions as the National Climate Change Committee (NCCC), ensuring alignment with national priorities and coordination across sectors in the implementation of the Climate Change Policy. Established under the National Environment Protection Act (NEPA) and chaired by the Secretary of the Ministry of Energy and Natural Resources (MoENR), the NEC is supported by its technical and operational arm, the Department of Environment and Climate Change (DECC). The DECC is responsible for translating policy into action, leading the development and implementation of key instruments such as the NAP, LTS, NDCs, and National Communications, while also serving as the national focal agency to the UNFCCC. Complementing this structure, the Climate Change Coordination Committee (C4) serves as a multi-stakeholder technical coordination platform, chaired by the Director General of the DECC and comprising representatives from government agencies, the private sector, civil society organizations (CSOs), and community-based organizations (CBOs). The C4 facilitates whole-of-government coordination, monitors progress, and reviews climate-related initiatives, providing technical guidance and consolidated recommendations to the NEC/NCCC to support coherent and effective implementation across sectors.
68. While the NEC, DECC, and C4 provide the overarching architecture for climate governance, the translation of national climate commitments into sectoral action and on-the-ground implementation relies on line ministries and local government bodies. At the sectoral level, each line ministry is responsible for integrating climate priorities into its own sector plans, budgets, and programs in line with the NDC, NAP, and LTS. The Ministry of Infrastructure and Transport (MoIT) plays a particularly critical role in the urban context, holding the primary mandate for urban planning, human settlements, and the development of sustainable infrastructure. Within MoIT, the Department of Human Settlement (DHS), is mandated to plan, regulate, and guide the development of human settlements through the preparation of national spatial strategies, land use and infrastructure plans, and development control regulations, ensuring that urban growth is coordinated, resource-efficient, and aligned with national policies. It also provides technical support to local governments, undertakes research and spatial analysis, and promotes environmentally sustainable, culturally appropriate, and disaster-resilient development across the country. Complementing this, the Department of Infrastructure Development (DID) serves as the government's principal technical agency for the design and implementation of urban infrastructure, including water supply, sanitation, and flood management systems, supporting the delivery of resilient and standards-compliant infrastructure across human settlements.
69. The implementation of Bhutan's national climate commitments is ultimately cascaded to the local level through Thromdes, Gewogs and Dzongkhags, which serve as the primary interface between national climate policy and urban communities. Local governments are the main implementing agencies for both climate adaptation and mitigation measures on the ground, responsible for delivering the urban services — including water supply, sewerage, stormwater management, and local road maintenance — that are most directly exposed to climate risk, and for integrating climate considerations into local land use planning, infrastructure investment, and service delivery. On the adaptation side, local

bodies are responsible for implementing flood and landslide risk reduction measures, managing stormwater and drainage systems, ensuring climate-resilient water supply, and maintaining the green infrastructure that provides natural buffers against flooding and urban heat. On the mitigation side, local governments play a growing role in promoting energy-efficient buildings, facilitating the transition to low-emission public transport, and improving data collection systems for monitoring and reporting of emission reductions in line with national targets.⁵³ However, local governments often lack the technical expertise and resources needed to effectively implement adaptation and mitigation measures, and coordination between national and local agencies remains limited.⁵⁴ Thimphu Thromde, as Bhutan's largest and most rapidly urbanizing municipal authority, exemplifies both the centrality and the constraints of local climate action: it holds direct responsibility for the urban services and infrastructure most critical to climate resilience, yet faces significant capacity and financing limitations in fulfilling this mandate. A clear delineation of roles and responsibilities between central and local government – combined with dedicated investment in awareness, capacity building, and data systems at the municipal level – is recognized in the LTS as a prerequisite for effective and accountable climate implementation.⁵⁵

70. Climate action in Bhutan is financed predominantly through external sources, relying heavily on international grants and concessional finance, supplemented by limited domestic public resources, dedicated climate funds, and emerging private and innovative mechanisms. The country has accessed resources, especially grants, from all dedicated sources of climate finance (*Figure 3-2 Sources of Climate Finance in Bhutan*Figure 3-2Figure 3-2). The Department of Macro-fiscal and Development Finance (DMDF) of the Ministry of Finance is the key focal point for all international public climate finance discussions, and the National Designated Authority (NDA) for the Green Climate Fund (GCF), the Global Environment Facility (GEF), and the Least Development Country (LDC) Fund. A list of relevant prior and ongoing climate finance interventions is provided in the following section. Climate priorities are integrated into public budget allocations through Bhutan's Five-Year Plans, with the GNHC coordinating planning across central and local governments and the MoF leading budget formulation. However, this integration remains incomplete; while a climate budget tagging system was introduced in 2022/23, climate considerations are not yet systematically embedded across all fiscal planning instruments.⁵⁶ UNESCAP estimated that climate finance flows in Bhutan over the 2013–18 period at about \$0.5 billion, with the public sector and development finance institutions accounting for most of these flows.⁵⁷ Despite these efforts, Bhutan faces a significant climate financing gap due to its severely constrained domestic fiscal space, limited domestic resource base, and high vulnerability to climate risks; a gap that is further compounded by its recent graduation from least developed country status and the progressive reduction in access to concessional financing windows that follows. This underscores the continued need for predictable, grant-based and highly concessional financing from mechanisms such as the GCF to support long-term, resilient, and low-carbon development.

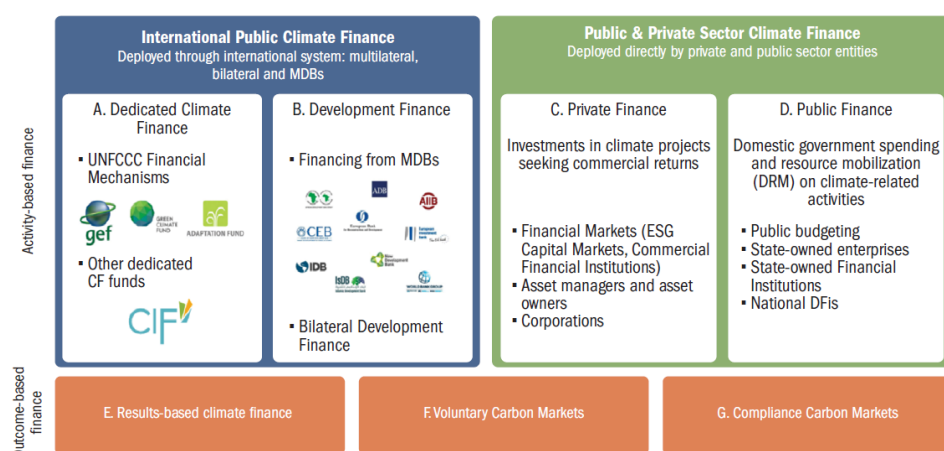


Figure 3-2 Sources of Climate Finance in Bhutan⁵⁸

⁵³ Royal Government of Bhutan. 2023. Long-Term Low Greenhouse Gas Emission and Climate Resilient Development Strategy

⁵⁴ NEC and UNDP. 2022. Skills Assessment for National Adaptation Plan (NAP) Formulation Process in Bhutan. Thimphu: National Environment Commission and United Nations Development Programme.

⁵⁵ Ibid.

⁵⁶ World Bank. 2025. *Bhutan Climate Change Institutional Assessment*. Washington, D.C.: World Bank. Available at: <https://documentsinternal.worldbank.org/Search/40035152>

⁵⁷ UNESCAP. An Introduction to Sustainable Finance. Retrieved from: https://www.unescap.org/sites/default/d8files/event-documents/Intro%20to%20Sustainable%20Finance_0.pdf

⁵⁸ World Bank. 2025. *Bhutan Country Climate and Development Report*. Washington, D.C.: World Bank. Available at: <https://documentsinternal.worldbank.org/Search/40024650>

Overview of Relevant Climate Finance Initiatives

71. This subsection provides an overview of key climate finance initiatives relevant to urban water and transport resilience in Bhutan. These interventions illustrate current efforts to address climate risks and strengthen climate-resilient infrastructure.

Bhutan Sustainable Low-emission Urban Transport Systems, 2018-2022 (GEF)

72. The Bhutan Sustainable Low-Emission Urban Transport Systems project aimed to facilitate the low-carbon transition in Bhutan's urban transport sector by promoting wider uptake of low emission vehicles (LEVs), with a particular focus on electric vehicles (EVs) and taxi sector. The total planned project financing was US\$ 12.9 million, with US\$ 2.6 million in financing from the Global Environment Facility (GEF) and the remaining in co-financing from the Government of Bhutan. It was implemented from September 2018 to September 2022 and closed with an overall Satisfactory rating. The GEF agency was the UNDP and it was executed by the Ministry of Information and Communications (MoIC), which has the governmental mandate to promote low emissions and efficient transportation system in Bhutan. The project was later brought under the direct supervision of the Prime Minister's Office (PMO) to enhance delivery of its objectives.
73. The project achieved a substantial scale-up in the adoption of electric vehicles, particularly in the taxi segment, helping to expand the EV fleet several-fold and contributing to measurable reductions in greenhouse gas emissions in the urban transport sector. It also established key enabling conditions for market transformation, including concessional financing schemes, partnerships with financial institutions, and the rollout of initial charging infrastructure, alongside strengthened policy and institutional support for low-emission transport (UNDP, 2022). Collectively, these outcomes demonstrated the technical and financial viability of electric mobility in Bhutan and laid a strong foundation for the continued scaling up of low-carbon urban transport solutions. The project highlights that strong government ownership and a whole-of-government approach were critical to success, enabling coordinated policy, financing, and implementation—even in the face of disruptions such as COVID-19. It also underscores the importance of developing a full enabling ecosystem, including private sector engagement, financing mechanisms, infrastructure, and awareness-building, to support the adoption and long-term scalability of electric mobility.⁵⁹

Promoting Green Electric Mobility Solutions for Urban Transport in Bhutan and the Wider Hindukush-Himalaya Region, 2019-2022 (UNIDO-Austrian Development Agency)

74. The Promoting Green Electric Solutions for Urban Transport in Bhutan project, led by UNIDO in collaboration with the Prime Minister's Office, Thimphu City Council, and City Bus Service (CBS), introduced Bhutan's first electric bus and charging infrastructure in Thimphu. With €500,000 in funding from the Austrian Federal Ministry for Europe, Integration and Foreign Affairs, the initiative aimed to create an enabling environment for e-bus adoption by combining technology deployment with policy advisory and capacity building. It supported the 2040 Integrated Strategic Transport Vision and its broader goal of transitioning to a low-carbon Intelligent Transport System (ITS) and reducing greenhouse gas emissions, air pollution, and fossil fuel dependency.⁶⁰
75. The project integrated South-South and Triangular Industrial Cooperation, facilitating technology transfer from China and knowledge exchange with Austria and New Zealand via hands-on training, study tours, and expert support to strengthen local capacity in e-mobility planning and procurement. Lessons learned have been disseminated regionally through the Renewable Energy and Energy Efficiency Capability (REEECH) platform hosted by the International Centre for Integrated Mountain Development in Nepal, promoting replication across the Hindukush-Himalaya region. The pilot set a benchmark for CBS's long-term goal of electrifying its entire bus fleet, establishing foundational capacity to procure and operate e-buses.⁶¹

Advancing Climate Resilience of the Water Sector in Bhutan (ACREWAS), 2023-2028 (GEF-LDCF)

76. The Advancing Climate Resilience of the Water Sector in Bhutan (ACREWAS) project is a US\$34 million initiative (including US\$8.9 million from the LDCF and US\$25 million in co-financing from the Royal Government of Bhutan) running from 2023 to 2028. On the ground, the project will restore and manage water catchments, introduce climate-resilient agricultural practices and livelihoods, and climate-proof water storage and irrigation infrastructure. At a governance level, the project will look at increasing the coherence of national and local policies related to climate-resilient water resource management, also strengthening the capacity of government and community-based institutions to manage these

⁵⁹ UNDP. 2022. Bhutan Sustainable Low-Emission Urban Transport Systems project Terminal Evaluation Report. Available at <https://www.undp.org/sites/g/files/zskgke326/files/2022-11/Terminal%20Evaluation%20Report-%20Bhutan%20Sustainable%20Low%20Emission%20Urban%20Transport%20System%20Project-2022.pdf>

⁶⁰ UNIDO, 2019. Promoting green electric mobility (e-mobility) solutions for urban transport in Bhutan and the wider Hindukush-Himalaya region Project Document. Available at <https://downloads.unido.org/ot/30/45/30456591/290819%20E-Mobility%20Project%20in%20Bhutan%20REEECH.PDF>

⁶¹ UNIDO, 2024. SSTIC Impact Stories: Promoting green electric solutions for urban transport in Bhutan and the wider Hindukush-Himalaya region. Available at <https://www.unido.org/sites/default/files/unido-publications/2024-02/Fact%20Sheet%20-%20Promoting-Green-Electric-Solutions-Bhutan-DIGITAL.pdf>

resources in an efficient, innovative and sustainable way. The project targets the three Dzongkhags (districts) of Gasa, Punakha, and Tsirang, some of the most climate vulnerable regions of the country. It is being implemented by the UNDP with the MoIT as the implementing partner.

77. Project interventions span four components covering the full cycle of climate-resilient water management, including: (i) governance and institutional strengthening, (ii) watershed restoration through nature-based solutions, (iii) climate-smart water infrastructure, and (iv) knowledge management. Component 1 focuses on water governance and institutions, supporting the alignment of national and local policies with climate-resilient water management, strengthening institutional and community-level capacity for climate-smart watershed management, and introducing innovative financing mechanisms including water tariff assessments and Public-Private Partnership models for local water utility services. Component 2 delivers nature-based solutions for watershed restoration across the Punatsangchhu River Basin, implementing afforestation, reforestation, and agroforestry measures to restore degraded catchments, improve forest cover, and stabilize spring and stream flows, while establishing Payment for Ecosystem Services (PES) schemes and engaging local communities and the private sector in the long-term management of critical watersheds. Component 3 addresses the adequacy and efficiency of water supply infrastructure by enhancing water tapping, storage, conveyance, and distribution systems across three Dzongkhags, constructing two water treatment plants to serve approximately 8,965 people, and deploying ICT-based monitoring technologies to detect and respond to climate-induced infrastructure failures in a timely manner. Component 4 supports knowledge management and awareness, documenting and disseminating lessons learned on climate-resilient water and watershed management in a gender-responsive and inclusive manner, and establishing monitoring and evaluation systems to track project results and inform future investments.

Enhancing Climate Resilience of Urban Landscapes and Communities in Thimphu-Paro Region (ECRUL), 2025-2030 (GEF-LDCF)

78. The objective of the ECRUL project is to strengthen the management of climate risks and reduce the vulnerability of urban landscapes and communities to the impacts of climate change in the Thimphu-Paro region. It has recently been approved and will be implemented over the 2025-2030 period. The project includes US\$20 million in grant funding from the GEF Least Developed Countries Fund (LDCF) and co-financing commitments of more than \$62 million from the Royal Government of Bhutan. The project targets 146,298 direct beneficiaries (48.9% women) in Thimphu and Paro, building urban climate resilience through improved risk management and adaptation measures. It will address various climate-related challenges, including riverine and surface water flooding, water stress, landslides, forest fires, cyclonic events and others, by effectively managing watershed and spring shed, enhancing river corridors through urban forestry techniques, developing retention ponds, rain gardens, and urban wetlands, as well as rehabilitation of stormwater drainage networks in Thimphu and Paro. The ECRUL project adopts a comprehensive approach to strengthening urban resilience through three interlinked components, as described below. It is being implemented by the UNDP with the MoIT as the implementing partner. Within MoIT, the Department of Human Settlement will house the Project Management Unit (PMU) and will be responsible for Components 2 and 3 and the Policy and Planning Division will be responsible for Component 1.⁶²
79. Component 1 of the ECRUL project focuses on strengthening the institutional, technical, and financial foundations for climate-resilient urban planning in the Thimphu-Paro region. Its overarching outcome is to build institutional coordination, stakeholder engagement, and climate adaptation capacity to support inclusive and resilient urban development. Key activities include harmonizing inter-agency mandates and establishing functional coordination mechanisms to improve policy coherence across national and local institutions; upgrading climate and geospatial information systems and training urban planners in risk-informed planning tools including GIS and downscaled climate data; integrating Nature-based Solutions (NbS) gender-responsiveness, and active citizen participation into 27 Local Area Plans (LAPs); and introducing educational and training programs in colleges and technical schools to skill, reskill, and upskill approximately 200 planning professionals and technicians in climate resilience. The component also pilots innovative financing solutions — including Public-Private Partnerships (PPP), Payment for Ecosystem Services (PES), and a green taxonomy — to mobilize public and private investment in climate-resilient projects, technologies, and services, and assesses water tariff systems to ensure long-term operational and maintenance funding sustainability. Expected results include a transformative shift from fragmented to coordinated climate-resilient urban planning, improved technical capacity at the local government level, enhanced climate risk data for infrastructure management, and increased participation of women, youth, and vulnerable groups in urban planning and decision-making.
80. Component 2 of the project delivers the bulk of the project's physical climate resilience interventions across the Thimphu-Paro region, shifting urban management from conventional grey infrastructure toward a hybrid approach that integrates Nature-based Solutions (NbS). Its overarching outcome is to design and implement climate risk management measures for water management systems and urban infrastructure, benefiting over 146,000 residents. Key activities are organized around four outputs. The first focuses on climate-proofing water and stormwater management systems, including the rehabilitation of primary and secondary storm drains in Thimphu, the development of an Integrated Stormwater

⁶² UNDP. 2025. Enhancing Climate Resilience of the Urban Landscapes and Communities in Thimphu-Paro Region of Bhutan (ECRUL). Project Document, 2025–2031.

Management Plan for Paro, the renaturalization and capacity upgrade of 3.48 km of drainage systems, and the installation of SCADA systems for digital monitoring of two water supply systems. The second output deploys NbS for flood, heat island, and landslide adaptation, including the enhancement of 30 km of river corridors and 39.8 km of streams through gabion walls and natural flow path restoration, the restoration of 800 hectares of watershed and springshed areas, the creation of 85 hectares of urban and riverine forests, and the construction of fire lines to protect against forest fires in both Thimphu and Paro. The third output increases the climate resilience of building and design of urban spaces by integrating green building standards into the revised Bhutan Building Code, developing an online green building tool for architects and developers, and retrofitting an existing public building with inclusive, climate-resilient technologies. The fourth output establishes a rainfall threshold-based flood Early Warning System, including installation of four stream gauging stations and five weather and climate monitoring stations, flood forecasting integrating downscaled weather forecasting data, development of a web-based flood warning dissemination platform and staff training and community sensitization of the EWS. Together, these interventions are expected to substantially reduce flood, landslide, and heat stress risks across the region while lowering long-term operational costs for the Royal Government of Bhutan.

81. And finally, Component 3 of the ECRUL project focuses on knowledge management and effective monitoring and evaluation that is gender-responsive and can inform adaptive project management to capturing lessons learned. On the knowledge management side, key activities include developing a gender-responsive communication and dissemination strategy, producing 20 gender-friendly knowledge products covering climate and urban resilience themes, publication of key project outputs, organizing exchange programs for representatives from other Thromdes to support replication of project approaches across Bhutan, and attending international and regional conferences and study visits to connect the project with global best practice. On the monitoring and evaluation side, the component establishes robust systems for tracking project progress and results, including annual planning and review workshops, baseline surveys, Technical Advisory Committee meetings, safeguard and gender action plan monitoring, and independent mid-term and terminal evaluations. Together, these activities are designed to ensure that ECRUL's investments in climate-resilient urban infrastructure and governance generate knowledge and evidence that can be institutionalized, replicated in other Bhutanese municipalities, and contribute to the broader global evidence base on urban climate resilience in mountainous and least developed country contexts.

Adaptation to Climate-Induced Water Stresses through Integrated Landscape Management in Bhutan, 2022-2028 (Adaptation Fund)

82. The project for climate resilience building in water-stressed communities in Bhutan proposes an articulated approach that will lead to healthier ecosystems and improved associated services, better management of water used for human activities, improved information systems and decision-making, and linking with the most relevant level of governance. Issues related to water availability and use all along the watershed, the various components of sustainability (including at technical, financial and institutional level), and the participation of the beneficiaries are key aspects of the project. Expected impacts of climate change will place additional stress on ecosystem-based livelihoods and on already vulnerable groups. As such, the project will focus on local level adaptation, increasing potential benefits for exposed or sensitive groups, and act as a force for change towards the foreseen improvements at different levels. The project aims to benefit 36,464 people directly and rehabilitate 21,251 hectares of natural habitats.
83. The project consists of an approximate US\$10 million in grant financing from the Adaptation Fund and was approved in 2022, with a planned closing in 2028. The implementing entity is the Bhutan Trust Fund for Environmental Conservation, and the four components are being executed across several department within the Ministry of Agriculture and Forests, MoIT, and the Ministry of Home and Cultural Affairs. The project is being implemented in three dzongkhags, namely Dagana, Paro and Tsirang and 13 gewogs. These gewogs have been identified as priorities for intervention under the government's "water flagship programme" due to their specific vulnerabilities exacerbated by climate change that need to be specifically addressed through targeted water and agricultural adaptation activities.

Bhutan Water Flagship Program Sector Project, 2023-2030 (Asian Development Bank)

84. The US\$20 million Bhutan Water Flagship Program Sector Project is financed by the Asian Development Bank (ADB) and aims to provide access to safe, sustainable and inclusive drinking water, and irrigation services to about 100,000 people who suffer from water insecurity in the peri-urban northern area of Thimphu (Pamtsho) and the districts of Zhemgang and Wangdue Phodrang in Bhutan. It will adopt disaster- and climate-resilient designs and improve institutional and local communities' capacity for sustainable drinking water and irrigation services. The Department of Infrastructure Development (DoID) under MoIT is the primary executing agency.
85. The project will develop climate-resilient drinking water and irrigation infrastructure, (ii) implement climate-smart water management systems, and (iii) strengthen institutional and community capacity for safe and sustainable water management and sanitation. In terms of infrastructure, the project will build gravity-fed integrated drinking water supply and irrigation systems in the Hetshosamchu area of Wangdue Phodrang district and Zhemgang town and surrounding villages, which collect surface water from upstream sources. This will include the rehabilitation of irrigation networks and drinking water treatment facilities. A new drinking water supply system, including a new water treatment plant, will be established to provide safe and continuous water supply to benefit more than 1,300 households in the Thimphu–

Pamtsho area. The water systems to be established will integrate climate-smart digital water management to provide real-time monitoring for early warning in case of emergencies such as floods. In terms of capacity building, and to ensure efficient operations of these systems, water service delivery and management capacities will be strengthened at the MoIT, Ministry of Agriculture and Forests, and municipal units and districts. Water users associations in Zhemgang and Hetshosamchu will also be created to train and build community awareness in water resources conservation and management, sanitation and hygiene; and improve farmers’ livelihoods and resilience to climate change.

Remaining Gaps in Climate Investments for Urban Water and Transport

86. Collectively, the above initiatives demonstrate Bhutan’s growing engagement in climate-related investments across both urban transport and water management. In the transport sector, recent interventions have primarily focused on piloting electric mobility solutions, including the introduction of a single electric bus and the scaling up of electric taxis. While these efforts have been important in demonstrating technical feasibility and building institutional capacity, they have largely functioned as proof-of-concept initiatives and have not yet achieved the scale required to transform urban mobility systems or significantly shift travel demand toward low-emission public transport. As such, these pilots have not yet delivered a paradigm shift in urban transport. Substantial gaps therefore remain in expanding electric bus fleets, improving service quality, and integrating low-emission transport within broader urban mobility planning.
87. In the water sector, ongoing projects have made important contributions to climate-resilient water resource management, watershed restoration, and infrastructure development. However, many of these interventions are focused on upstream catchments, peri-urban areas, or other dzongkhags, rather than addressing the concentrated infrastructure pressures within dense urban cores. Given the scale of climate risks identified for urban areas — including increasing flood exposure, stormwater management challenges, and growing stress on municipal water supply systems — significant needs remain for investments that directly strengthen climate-resilient water and drainage infrastructure within city environments. Overall, while existing programs provide valuable foundations, further integrated, city-scale investments are required to address remaining gaps in both sectors and respond comprehensively to urban climate risks.

Baseline and Sector Assessment

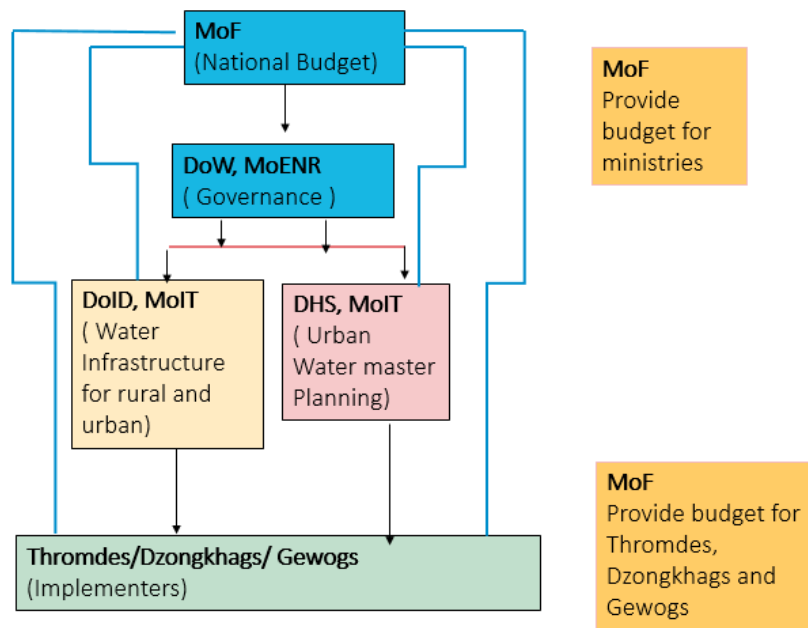
Urban Water Supply System Baseline

Institutional Arrangements and Policy Context

88. The institutional structure for funding, managing, and regulating the water sector in Bhutan is given below.

Table 4-1: Institutional Framework for Planning and Funding Water Networks in Bhutan

Institutional Framework



1

89. Responsibility for urban water services in Bhutan is devolved to local governments, though fragmented service provision – a legacy of different technologies adopted by different development partners over time – has complicated consistent delivery and efficient management. Capital investment remains sourced from the central RGoB budget. The Ministry of Infrastructure and Transport (MoIT) oversees the sector, operating through the Department of Human Settlements (DHS), which is responsible for urban planning and regulatory guidance, and the Department of Infrastructure Development (DoID), which serves as the principal technical agency for developing urban water supply systems. The Ministry of Natural Resources and Energy sets standards for water quality and management and oversees policy and the management of the country's water resources; it therefore receives reports on water quality, effluent quality, and infrastructure plans from the thromdes. In the future, this ministry could assume additional responsibilities similar to those of a regulatory body, as it would be premature to establish a dedicated regulator given the fragmented nature of water services and the limited investment base across the country. The importance of managing this sector well extends beyond service delivery as the water sector contributes 10.8 percent of Bhutan's GDP. Governance failures and climate-induced disruptions can therefore carry significant economic consequences for the country as a whole.
90. Thimphu Thromde, as the local government authority, is responsible for the direct management and delivery of both water supply and wastewater services under this decentralized framework. The general organogram of Thimphu Thromde for infrastructure development is shown in Figure 4-1. The two functions of water and wastewater, while closely related, are managed through separate sections within the Thromde's organizational structure. Both fall under a single infrastructure hierarchy headed by a Chief Engineer, which oversees two divisions: an Infrastructure Development Division responsible for planning, design, and capital project implementation; and an Operations and Maintenance Division responsible for day-to-day service delivery. Within the O&M Division, a dedicated Water Supply Section – staffed by one engineer, eleven technicians, thirty-one helpers, and two drivers – handles technical operations, while a separate Billing and Metering Section, staffed by one engineer, one technician, and eighteen helpers, manages revenue collection and customer administration. Wastewater is handled by a distinct Sewerage Section under the same division, staffed by one engineer, four technicians, twenty-five helpers, and six drivers.
91. The current structure presents two key institutional challenges that bear directly on service quality and climate resilience. First, responsibilities within each sector are divided between development and O&M functions with planning and design sitting with the Infrastructure Development Division, while service delivery and maintenance fall under the O&M Division. This internal fragmentation complicates coordination and weakens overall service management, as the two divisions must align on priorities, budgets, and technical decisions without a shared sectoral home. Second, and more fundamentally, there is no dedicated Water Services division. Resources, staff, and management attention are shared across multiple infrastructure sectors – including roads, drainage, electrical systems, and footpaths – reducing the efficiency and operational control that effective water and wastewater service management requires. This has strained the Thromde's ability to maintain consistent service standards, with investments often redirected toward expanding coverage rather than improving service quality.

92. Consultations with Thimphu Thromde concluded that staffing levels within the water supply function are insufficient for the scale and complexity of the city's needs. The water supply section within the O&M Division is led by a single engineering manager supported by a small team – a level of resourcing that is inadequate for addressing the leakage, pressure management, and service reliability challenges described in the following section. Connections are made regardless of pipe capacity, causing low pressure and reduced supply hours across parts of the network. While the Thromde operates a metered, volumetric billing system for water services, metering is incomplete and tariffs remain below the true economic cost of provision, limiting the revenue available for maintenance and investment. Together, these operational constraints reinforce a cycle in which understaffed teams are unable to maintain the network to a standard that would justify, or sustain the cost recovery reforms needed for long-term financial viability.

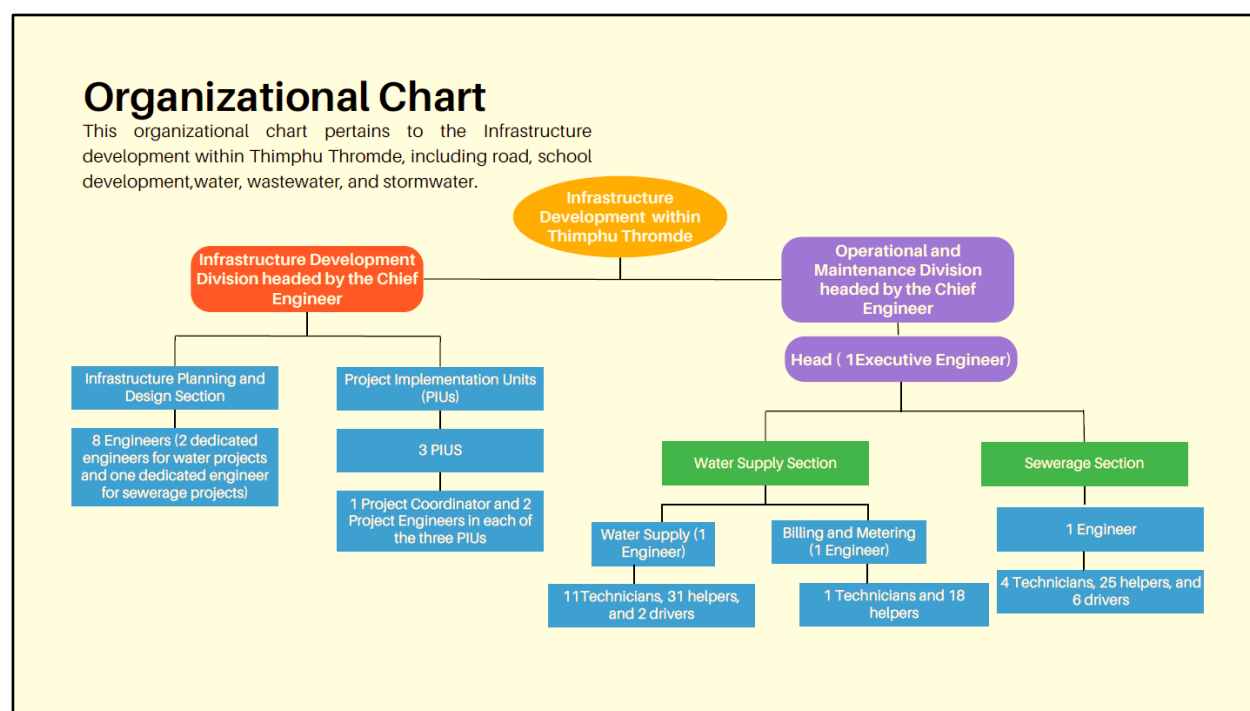


Figure 4-1 Organization Chart of Thimphu Thromde for Infrastructure Development

93. The RGoB prepared a Thimphu Water Services Masterplan in October 2023, as part of the Thimphu Structure Plan, covering water supply, wastewater, and stormwater. The Masterplan was developed to respond to the 13th FYP Plan, which prioritizes climate-proofed cities, and the NAP 2023, which highlights water resource vulnerability. The central ambition of the Masterplan is to establish a safe, equitable, reliable, and resilient water services network for Thimphu – one that meets international drinking water standards, supports the city's projected growth, and protects natural watercourses and public health. Specifically in terms of water supply, the objective is to provide all Thimphu residents and businesses with continuous, high-quality, and equitably distributed water that meets international standards, supports city growth, and maintains adequate firefighting capacity, while being operated efficiently, sustainably, and resiliently in the face of climate change and other shocks. Only 85% of residents are currently connected to the municipal water supply in the city, and the supply for many residents is intermittent, particularly during the dry season, because of high levels of leakage and imbalances in the system caused by a lack of capacity at some treatment works. There is a reliance on boreholes in the south of the city because the supply is insufficient during the dry season. Non-revenue water losses of over 50%, and a shortage of experienced operators, materials, and equipment reduces the efficiency of the supply system.
94. In terms of water supply, the hydraulic modelling undertaken for the Water Services Masterplan confirmed that the existing trunk main system has sufficient capacity to meet projected future demands without major upgrades, provided that non-revenue water (NRW) reduction and demand management measures are implemented. It was also noted that upgrades due to poor pipe condition may be required, but these were not examined as part of the development of the Masterplan. One of the key recommendations was to reduce NRW losses, particularly leakage, as an essential step for supporting sustainable growth within the city and ensuring there is adequate water for living. To support this, Supervisory Control and Data Acquisition (SCADA) systems were proposed across the Demand Management Areas and at the treatment plants to monitor flows, pressures, and water quality, alongside the installation of additional pumps and pressure release valves. Together, these measures would enable more efficient system operation, faster leak detection

and response, and improved pressure management, thereby reducing water losses and enhancing the reliability and climate resilience of the water supply system.

Infrastructure and Network Coverage

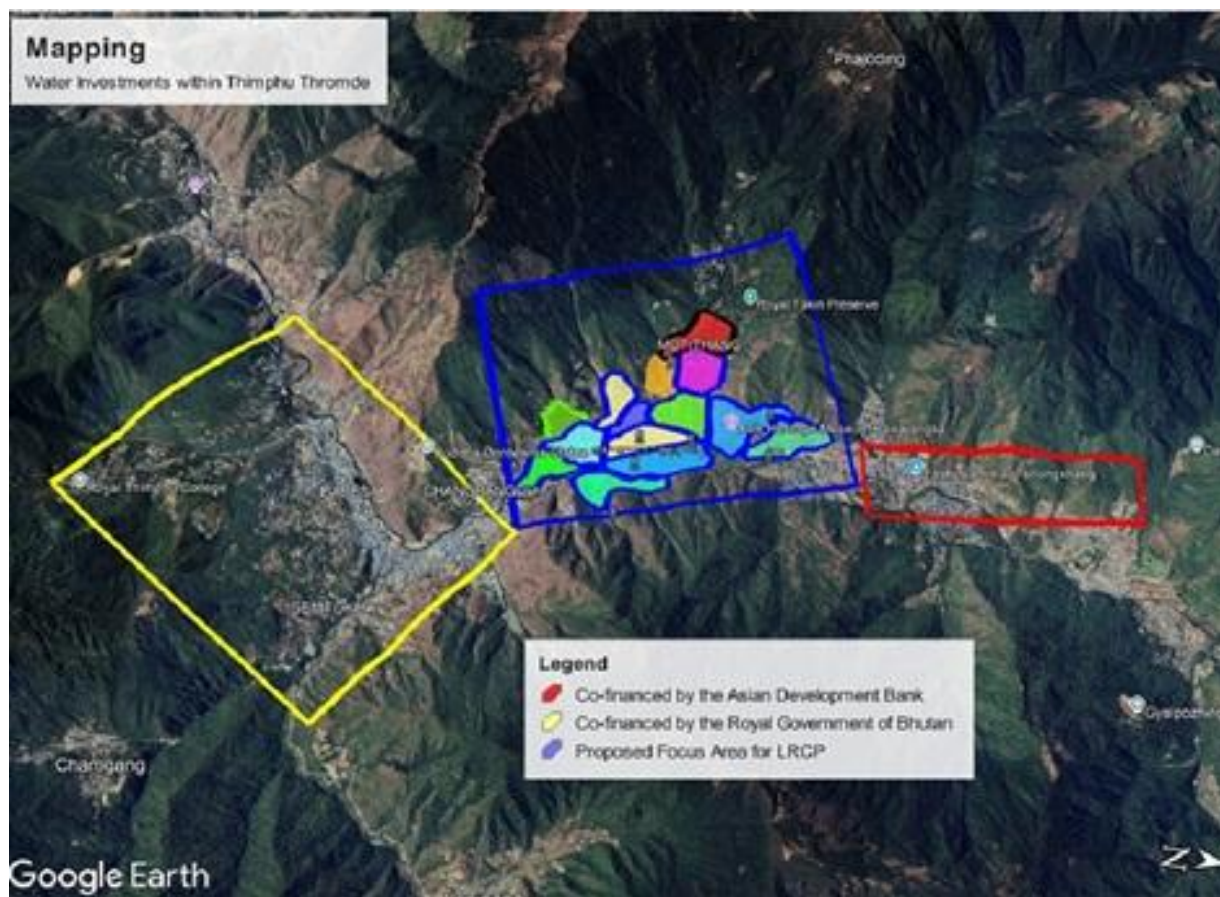
95. Thimphu currently faces inadequate, inconsistent, and unreliable water supply that fails to meet the needs of all its residents. Thimphu is the capital city and the largest municipality in Bhutan, housing approximately 15 percent of the country's total population and accounting for around 40 percent of its total urban population. It is situated in the northwest at an altitude of 2,320 meters above sea level, with the urban area lying in a valley surrounded by forests. Thimphu Thromde stretches about 15 km in length and 3 km in width, spread linearly along the Wang Chhu river, which originates from snow and glaciers in the north and serves as a key source of water for the city. Bhutan is one of South Asia's most rapidly urbanizing countries, and Thimphu has been at the center of this transformation, with its population growing significantly through sustained rural-to-urban migration over the past two decades. This rapid urban expansion has far outpaced infrastructure investment, leaving the water supply system unable to meet current demand. High rates of non-revenue water (NRW) loss from leakage, illegal connections, and an aging distribution network, combined with seasonal variability in source water availability driven by glacial dependence and climate change, further undermine the reliability and adequacy of supply.
96. The World Bank carried out a study of non-revenue water in Thimphu in 2023 and the MoIT developed the Thimphu Water Services Masterplan for Water Supply, Wastewater and Stormwater Management in 2023. Information from both documents provide the underlying data and information for much of the below analysis.

Water Supply System

97. The total current demand for potable water in Thimphu is approximately 30.6 million liters per day (MLD) inclusive of domestic, institutional, commercial, and industrial uses, as well as water losses, serving an estimated population of 125,000. Within the core city, total demand (inclusive of water losses) is 18 MLD for 81,106 people, with a maximum production capacity of 28 MLD, though this latter figure varies according to seasonal water availability, climate shocks, and the quality of system management. In practice, the core city system produces about 19 MLD on average. The additional 12.6 MLD is met through community and private sources or represents unmet demand that the current system is unable to provide to meet a per capita daily consumption rate of 150 lpcd, largely due to water losses. Thimphu Thromde's water supply system comprises surface water intakes, raw water transmission mains, boreholes, treatment plants, storage tanks, pumps, and distribution networks. Water is abstracted from surface sources and conveyed to treatment facilities, where it undergoes treatment, storage, disinfection, and distribution. Although the Thromde provides around 85% of the city's water supply, its network does not fully cover all areas within its jurisdiction, particularly smaller and more dispersed settlements to the north and south. As a result, households in these areas rely on community or private water sources, which are typically not chlorinated and are therefore more susceptible to contamination.
98. While Thimphu benefits from relatively good watermain coverage in the core urban areas, system performance is constrained by high levels of NRW. Assessments conducted across Thimphu, Gelephu, and Phuentsholing thromdes indicate NRW levels of 35% to 40%, equivalent to approximately 1,230–1,900 liters per connection per day. In Thimphu, these losses are primarily due to physical leakage from ageing, corroded, and undersized pipes. The assessments recommend prioritizing investments in distribution network rehabilitation over expanding production capacity, as losses are likely to increase significantly if the system transitions from intermittent to continuous supply. In addition, network limitations affect service reliability, including inadequate firefighting capacity due to insufficient water availability at certain times, limited hydrant coverage, and constrained pipeline capacity.

The Thimphu water distribution network is organized into three main service areas: the northern area (Dechencholing), the core urban area, and the southern area. Across the city, more than twelve separate water supply systems operate within designated District Metered Areas (DMAs). While recent investments by the Asian Development Bank (ADB) and the Global Environment Facility (GEF) focus on peri-urban distribution systems, this assessment concentrates on the core urban area, as defined in [Google Earth](#)

99. [Figure 4-2](#) below.



Google Earth

Figure 4-2 Study area of the water technical assessment for Thimphu's city core.

100. A simplified assessment of water demand was undertaken by comparing projected demand and available supply in the study area. The population to be served is conservatively estimated at 81,106. Based on typical per capita demand of 150 liters per day (lpcd), which includes domestic use and allowance for 15% losses, total daily demand is approximately 12.17 MLD. When commercial, institutional and other non-domestic users are included, total demand is estimated around 15 MLD.
101. However, assessments in the core city area indicate that physical water losses exceed 35%, and are as high as over 50% in the area around Norzin Lam. To ensure end users receive an effective supply of 150 lpcd, the system must account for these losses at production stage. For the total urban population of 125,000, this results in a required supply of approximately 26.72 MLD for domestic use, which increases to around 30.6 MLD when commercial, industrial, and institutional demand is included.
102. The location and status of the city's water treatment plants (WTPs) serving the core area are presented in the following table. The total available supply capacity is estimated at 19 MLD, which is broadly sufficient to meet the estimated core area demand of 18 MLD, including losses. This indicates that additional investment in production capacity is not a primary constraint. However, as shown in [Table 0-Table 4-2](#), the supply delivered to households remains unreliable and falls far short of continuous (24/7) service, highlighting the need to address distribution system inefficiencies rather than expand capacity.

Table 0-2 Core City Water Supply Arrangements (Source: WB's NRW Investment Roadmap)

Core City Water Supply Arrangements					
	Water treatment Plant (WTP) (Year of construction)	Capacity of WTP (in MLD)	Actual Supply to Core City	Raw Water Intake	Supply Area
1	Motithang (1960)	6.5 MLD	5.8 to 10.0; average 7 MLD (variation as per demand)	Pumla, Damilum and Phajoding streams	Upper and lower Motithang, Changangkha, NPPF colony, JDWNRH area, Yangchenphu, and PWD colony
2	Jungshina (2004)	6.5 MLD	3.0 MLD (under-performing)	Tail race of Mini Hydro Power Project of Bhutan Power Corporation	Langjophakha, Core area, Centenary Farmer's Market, Hejo, Zilukha, JDWNRH area, Changzamtok, Changjiji, Tashichodzong, and Chubachu.
3	Bore Holes	1.2 MLD	0	WangChhu (infiltrated water)	Changzamtok (operated during dry season)
4	Taba (2019) Taba (2024?)	10 MLD 5 MLD	9 MLD (allocated to core city)	Dodena Taba stream RBA campus	Taba, Jungshina-Pamtsho, Hejo – Samteling, Langjophakha, Yangchenphu, and Changjiji housing colony area.
	Total	28 MLD	19 MLD		

Table 0-3 Typical hours of daily water supply in the city core (Source: WB's NRW Road Map report)

Supply Area	ZONE	Water Source	Hours of supply
Core City	Zone 1A-Upper Motithang	Motithang WTP	3
	Zone 1B-Lower Motithang		3
	Zone 2A-K.Jangsa/Hejo		6.5
	Zone 2B-Yangchenphu Area	Boreholes	6.5
	Zone 3A-RICB Colony	Jungshina WTP	17
	Zone 3B-Changzamtok		5
	Zone 4-Chhubachhu		6
	Zone 5-PWD Colony		9

	Zone 6-Norzin Lam	Taba	6
	Zone 7-Hongkong Market		5
	Zone 8-Changjiji Colony		24
	Zone 13-Taba		6

Water Sources

103. Sources for Motithang WTP: The sources are three rivulets that have been connected with intake structures. Source No. 1 has a length of 1.2 km with a 150 mm diameter GI main, Source No. 2 has a length of 1.8 km with a 150 mm diameter GI main, and Source No. 3 has a length of 0.8 km with a 150 mm diameter GI pipe main. These sources are considered stable and sustainable. They provide sufficient water even when the WTP operates to deliver a higher volume of water. Apart from minor repairs, no additional improvements are required.
104. Source for Jungshina WTP: The source is the Samtenling Stream, downstream of a mini hydro-power plant. Water is transported via a 200mm DI pipe to Jungshina WTP, with an alternative tapping point 200m upstream using a 200mm HDPE pipe. This setup is unreliable during the low season. The WTP currently produces 3 MLD out of its 6.5 MLD capacity. Although there is enough water from the stream, limitations in the clear water transmission network may hinder distribution. Improved raw water pipes and clear water lines might be needed to reach full capacity.
105. Sources for Taba WTPs: For the 10 MLD WTP, water is drawn from the Wang Chhu river's right bank via a 400mm DI pipe to a pre-sedimentation tank 350m downstream. An alternative source from Barshong uses two 150mm DI pipes of 750m length when the Wang Chhu swells. The pre-sedimentation tank has a capacity of 1035m³. Water is then transported 13km through a 350mm DI pipe to Taba WTP. The newly built 5 MLD WTP relies on the nearby Taba stream at the RBA campus, but this is unreliable. This limits the WTP to 3 MLD during the dry season.



Figure 4-3 Example of (i) intake structure during low flow conditions, and (ii) slope failure exposing the transmission water line from the Wang Chhu River to Taba WTP

106. With the exception of the Wang Chhu river intake described above, all other water sources are feeder 'streams' on the valley slopes that are less prone to flooding but discharge less during the dry season. The intakes are located at higher elevations, because the raw water supply systems are gravity fed to avoid the need for pumps, but making them difficult to access. Dependence on streams limits resilience. The Thimphu Water Services Masterplan (TWSM) proposes that a new intake and raw water transmission lines to each of the WTPs is constructed at a proposed future hydropower dam on the Wang Chhu. However, this is a longer-term option and will require significant investment.

107. It is therefore proposed to improve the collection efficiency of the existing raw water intakes even under low flow conditions (refer to Figure 4-3), whilst also protecting them from pluvial flooding. These works would be done in parallel with nature-based solutions to protect the watersheds being funded under the ECRUL project.

Raw Water Transmission Lines

108. Figure 4-3(ii) shows a slope failure exposing the ‘transmission water line’ from the Wang Chhu River to Taba WTP. This was reconstructed immediately to resume supply, but according to field staff the failure of transmission lines happens frequently during high floods/high precipitation. Dislocation of transmission lines is common due to unstable hill slopes along which they were laid. Gravity-fed raw water systems are preferred to avoid the need for pumps. This vulnerability threatens the water supply and disruption can last for several days. As a short-term measure, strengthening these vulnerable points with investments is necessary, and a detailed investigation required to identify and design support systems to prevent service interruptions.

Water Treatment Plants

109. [Table 0-Table 4-4](#) indicates varying efficiency levels in water treatment plants (WTPs), which should be evaluated with flow metering. The table shows the average efficiency of existing WTPs. The inspections revealed they are climate-resilient but need efficiency improvements for reliable service. Adding SCADA systems and enhancing efficiency will benefit overall system performance.

Table 0-4 Water Treatment Plants

WWTP Name	Year of establishment	Efficiency
Motithang WTP	1960s	90%
Jungshina WTP	2004	75%
Taba WTP	2019	90%



Figure 4-4 The high elevation of the Taba WTP creates pressure in the transmission pipelines resulting in more leakages

Storage Reservoirs

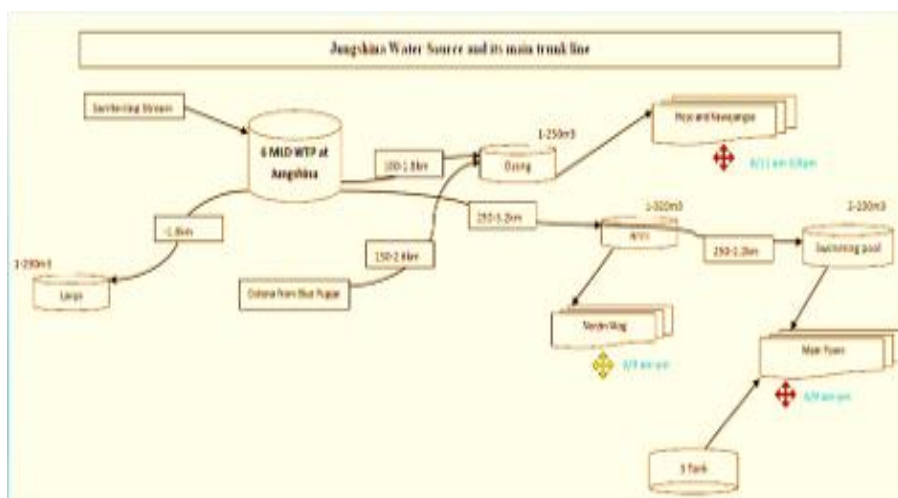
110. Most storage reservoirs, about 40, are reinforced concrete structures built on the firm ground (not elevated). They receive a constant rate of water supply 24 hours a day from WTPs and distribute water according to varying consumption levels – mainly these reservoirs play good role in supplying more water to meet peak time consumption demand by

These reservoirs are structurally robust and unaffected by climate change. They are essential for maintaining resilient water services during low season or dry weather conditions when water production is minimal, as well as ensuring some water availability during high floods or heavy rainfall when operation of sources and water treatment plants are disrupted.



The Thimphu Water Master Plan, 2023 (page 16) recommends “Increas[ing] water storage from <12 hours to >48 hours to prevent a loss of supply during planned or unplanned interruptions”. Such a fourfold increase in storage would make services more resilient but may be quite cost-intensive (and finding land would also be a challenge) and therefore could be considered not as an immediate but rather a medium-term measure. In the short term, it is important to bring back several reservoirs that are currently not in service to improve the reliability of water supplies.

The following figures show the transmission layout of the three systems covering the core city (source: NRW report). The layout shows criticality to supply water evenly across the zones the WTP serves.



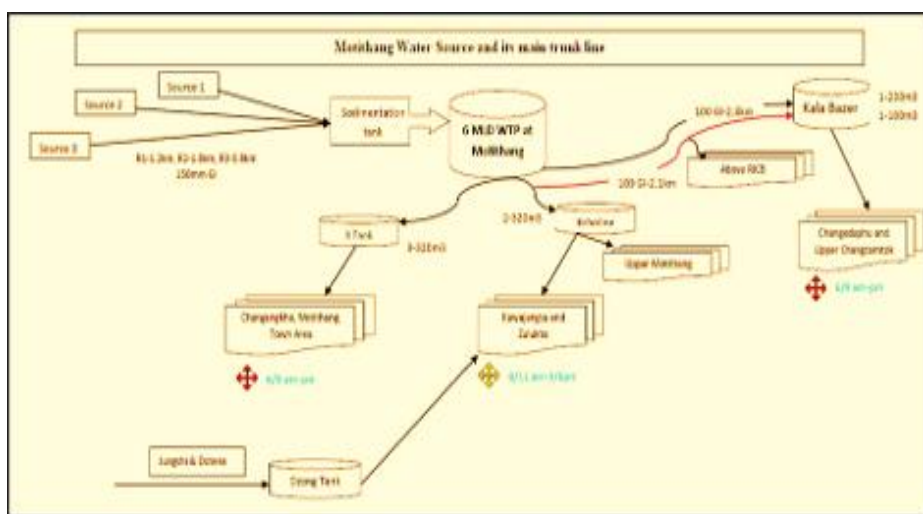
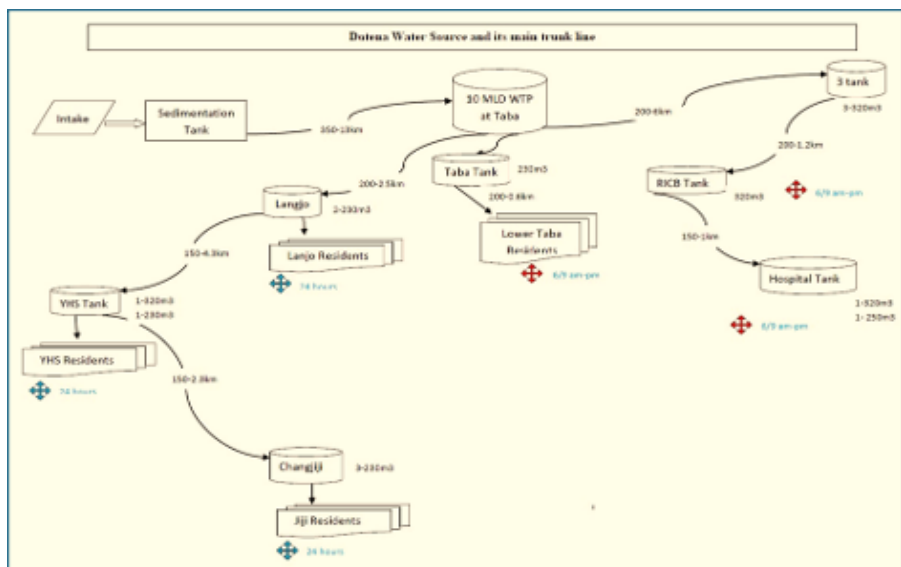


Figure 4-6 Transmission layout of the three systems covering the core city area

114. Hydraulically well-designed transmission lines are essential for ensuring equitable water distribution across the city and for managing supply constraints during periods of low flow. The three transmission networks require recalibration to adequately supply all service areas and to improve operational balance. There is also a mismatch between available treatment and storage capacity and the way water is conveyed and distributed through the network, resulting in underutilization of some facilities and insufficient supply in others. Aging and leaking pipelines currently reduce delivered volumes and exacerbate losses, particularly during drought conditions. Furthermore, vulnerable sections of transmission infrastructure are exposed to erosion during flood events, increasing the risk of major service disruptions. Strengthening and optimizing transmission systems is therefore central to improving the reliability and resilience of water supply services.

115. A detailed technical assessment is needed to build on the feasibility analysis to identify priority actions and categorize recommendations into short-term and medium-term measures, ensuring that immediate needs related to system efficiency, loss reduction, and climate resilience are addressed while planning for longer-term network improvements.

Distribution Network

116. The water distribution network in the city core was first installed in the 1960s and has been expanded incrementally over time. As a result, the condition of distribution lines varies considerably, reflecting different installation periods and materials. The networks receive water from service reservoirs but are unable to meet current demand, leading to variations in supply hours across the city. In addition, irregular household connections from undersized supply pipes further constrain system capacity. Combined with high operating pressures and inadequate maintenance, these factors contribute to significant water losses. The NRW report supported by the World Bank indicates that leakage levels in both transmission and distribution lines are high. The findings from the Norzin Lam study are summarized below:

Table 3. Norzin Lam IWA water balance

IWA Water Balance Sheet				
System Input Volume (67837) 100%	Authorized Consumption (35587.14) 52.45%	Billed Authorized consumption (32506) 47.91%	Billed Meter consumption (32506) 47.91%	Revenue Water (32506) 47.91%
			Billed unmetered consumption (0) 0%	
		Un Billed Authorized Consumption (3081.14) 4.54 %	Unbilled metered consumption (462.17) 0.68%	Non-Revenue Water 52.73%
			Unbilled unmetered consumption (2618.97) 3.86 %	
	Water Losses (32249.86) 47.54%	Apparent Losses (6487.86) 9.56%	Unauthorized Consumption (1925.71) 2.83%	
			Customer Meter Inaccuracies and Data Handling Errors (4562.15) 6.72%	
		Real Losses (26225) 38.65%	Leakage in Transmission and Distribution mains (11593) 17.08%	
			Storage Leaks and Over Flow (262.25) 0.38%	
			Service Connection Leaks upto the Meter (14369.75) (21.18%)	

117. High levels of non-revenue water (NRW) mean that consumers receive only about 50% of the water that is treated and supplied. While water may be produced at approximately 130 lpcd, only around 65 lpcd reaches end users. During low-supply conditions, particularly in the dry winter season, overall production may drop to about 60 lpcd, and system inefficiencies can further reduce the delivered volume to roughly 30 lpcd, resulting in serious shortages for drinking and hygiene. Similarly, during periods of intense rainfall, pipe breakages caused by erosion can disrupt supply for several days. Strengthening piped networks to improve efficiency and enhance resilience to climate-related vulnerabilities is therefore essential.

Climate Vulnerabilities to the Water System

118. Urban water supply systems in Thimphu face significant climate-related vulnerabilities that affect both water availability and service reliability. The principal hazards include drought and seasonal water scarcity, intense rainfall and flooding, and climate-induced sedimentation and erosion. These hazards increasingly stress infrastructure that was not designed for heightened hydrological variability. Climate risks interact with aging assets, high levels of system losses, limited buffering capacity, and constrained hydraulic flexibility, increasing the likelihood of supply disruptions and inequitable service delivery across the city.

119. Drought and seasonal water scarcity: Declining winter precipitation and reduced dry-season flows are increasing the risk of seasonal water shortages. These conditions reduce abstraction at source intakes and limit the volume of water available for treatment and distribution. Climate-induced variability in flows places additional pressure on storage infrastructure, which provides only limited buffering against short-term fluctuations in supply. During prolonged dry periods, constrained operational flexibility reduces the ability to redistribute water between service zones or balance available storage and treatment capacity across the network. Seasonal shifts in water availability also lead to periods when treatment facilities cannot operate at optimal levels, reflecting limited capacity to regulate supply under increasingly variable hydrological conditions.

120. Interaction of drought conditions with system losses: System inefficiencies further compound climate-related shortages. Although water production levels are estimated at around 130 liters per capita per day (lpcd), high levels of non-revenue water mean that consumers receive only about half of this volume. During dry-season conditions, effective supply can fall to approximately 30 lpcd, indicating that climate-induced reductions in source availability interact with system losses to significantly worsen service shortages. Variability in inflows combined with limited operational balancing between treatment, storage, and distribution increases the sensitivity of service delivery to drought conditions and reduces the system's ability to maintain continuity during extended low-flow periods.
121. Intense rainfall, flooding, and landslides: More intense monsoon rainfall increases the risk of flooding, slope instability, and landslides, particularly in steep terrain where much of the water infrastructure is located. Raw water intake structures situated along streams are vulnerable to high flows, debris impact, and bank erosion, which can damage infrastructure and interrupt abstraction. Transmission pipelines traversing hillside corridors are exposed to landslides and washouts during heavy rainfall events, leading to breakages and extended service disruptions. During periods of intense rainfall, pipe breakages caused by landslides or erosion have historically disrupted water supply for several days at a time, highlighting the growing exposure of transmission infrastructure to extreme weather events. Limited redundancy in the network means that failures in key transmission lines can significantly affect large service areas, while access constraints during extreme weather further delay repairs and prolong outages.
122. Sedimentation and erosion: Climate-driven increases in runoff and watershed erosion elevate sediment loads in source streams, affecting both intake performance and downstream infrastructure. High sediment concentrations can clog intake structures, reduce conveyance capacity, and increase wear on system components. Sedimentation also reduces effective storage capacity in reservoirs, limiting the ability to regulate supply across seasons. In addition, erosion along exposed pipeline corridors increases the likelihood of structural damage and water losses, particularly where pipelines lack adequate protection measures. These processes are expected to intensify as rainfall variability and extreme events increase.
123. Climate-related operational constraints: The impacts of climate hazards are further intensified by operational constraints within the water supply system that limit its ability to absorb shocks and redistribute available resources. During droughts, limited flexibility in conveying water between service zones reduces the capacity to balance supply from different sources and storage facilities. Similarly, during extreme rainfall events, localized damage to transmission corridors can affect large service areas where alternative supply routing is constrained. Storage infrastructure provides only limited buffering against short-term fluctuations in source flows, particularly where effective capacity is reduced by sedimentation, leakage, or operational inefficiencies. As a result, climate-induced variability in water availability translates more directly into service disruptions. These interacting factors reduce the system's ability to maintain continuity of supply under increasingly variable climatic conditions.
124. Together, these climate hazards and interacting system constraints reduce the resilience of Thimphu's urban water supply system. As climate variability intensifies, infrastructure exposure to drought, flooding, landslides, and sedimentation is expected to increase, heightening the risk of service disruptions. Strengthening the climate resilience of intake structures, transmission corridors, and operational management will therefore be critical to maintaining reliable and equitable water service delivery under future climate conditions.
125. The assessment of climate vulnerabilities highlights the need for a phased approach to strengthening the resilience of key water supply system components. Based on existing studies and operational priorities, a set of short-, medium-, and long-term actions has been identified to address climate-related risks, improve system flexibility, and enhance the reliability of water service delivery under increasing hydrological variability. These actions focus on improving the robustness of raw water sources, transmission systems, storage, and distribution networks, while strengthening operational monitoring and management. [Table 0-Table 4-5](#) summarizes the prioritized actions across different time horizons aimed at progressively improving the climate resilience and operational performance of the water supply network.

Table 0-5 Short- to Long-Term Actions towards Resilient Network Components

Components	Long term actions	Medium Actions	Short Term actions
Raw Water Sources	Switch to River Sources		Improve intake structures
Raw Water Transmissions		Redesign to carry current demand capacity	Identify vulnerable points to landslides during heavy rains to prevent pipe breaks

Water Treatment Plants			Provide minor repairs to improve performance. SCADA to moderate operations and to monitor performance
Storage Reservoirs	Increase storage to 48 hours to minimize supply disruptions	Increase storage where possible	Minor repairs to reduce leakage. Install flow and pressure valves SCADA systems
Clear Water Transmission lines		Replace old transmission pipes that are leaking Reorganize DMAs based on the study/future demand	Detailed study to strengthen supplies to DMAs. Reduce leakages Integrate with SCADA system
Distribution Networks		Develop networks in each DMA based on increased water demand Replace pipes as per hydraulic modeling	Improve operations Active leakage control implemented (NRW reduction) Reduce illegal connections Provide water meters to all properties

Urban Transport System Baseline

Institutional Arrangements and Policy Context

Institutional Arrangements

126. Responsibility for the planning and regulation of the transport sector is spread across several authorities in Bhutan, as outlined in the following table.

Table 0-6 Transport Sector Structure and Governance

Authority	Nature of responsibility
Ministry of Infrastructure	MoIT is the parent Ministry for all Thromdes, including Thimphu, and the custodian of all legislation and policies for human settlements and surface transport. Oversees public transport modernization, road network development, traffic decongestion strategies, and the transition toward low-carbon

and Transport (MoIT)	and electric mobility, working closely with Thimphu Thromde. Responsible for all legislation related to transport in the country.
Bhutan Construction and Transport Authority (BCTA)	Safety and compliance auditor of standards and regulations for surface transport and economic regulator of public transport fares (buses and taxis). Manages vehicle testing and driver licensing for public transport. Works closely with the Royal Bhutan Police and Thimphu Thromde to ensure compliance with road safety and transport standards.
Thimphu Thromde (TT)	Responsible for local-level transport planning and infrastructure delivery within the city (construction and maintenance of urban roads, footpaths, pedestrian crossings, parking facilities, street lighting, traffic calming measures). Manages parking systems and traffic control devices in coordination with the RBP, and implements urban mobility projects such as bus priority lanes, pedestrian underpasses, and road safety upgrades.
Royal Bhutan Police (RBP)	Enforcement of traffic management regulations, including parking controls, bus priority lanes, and bus operations. Regulates traffic during peak hours and public events, conducts accident investigations, manages crash data, and leads road safety awareness campaigns. Collaborates with BCTA and TT on traffic engineering measures, signage, pedestrian safety improvements, and traffic management during major events and emergencies.
City Bus Service (CBS)	Operator of public bus service in Thimphu. Scheduling, procurement, and operation and maintenance of buses; management of the ITS, fare collection, advertising, customer service, and public relations. Design and location of bus stops, bus terminals and the facilities for maintenance, charging, and servicing of buses.
National Commission for Women and Children (NCWC)	Monitors instances and respond to grievances filed by complainants related to sexual harassment occurring on city buses.
Bhutan Power Corporation	Responsible for supplying power to electric buses, taxis, and charging infrastructure. Designated as the lead agency for developing, owning, and maintaining public EV charging stations, including for the bus system.

Policy context

127. At the municipal level, Thimphu's urban transport policy is anchored in two major planning frameworks: the Thimphu Structure Plan (TSP) and the Low Emissions Transport Master Plan (LETMP).

128. **Thimphu Structure Plan (2023).** The TSP, recently updated for the 2024-2048 period, is a comprehensive plan addressing various aspects of the city, including the building industry, housing, education, social and cultural development, environment, and health and wellbeing. On transportation, the TSP envisions a system centered on public transit and active mobility, integrated with the city's land use strategy. It designates public transportation as the

backbone of mobility, aiming to shift away from car dependency by providing convenient bus services and enhancing walkability. The plan promotes compact, transit-oriented development rather than sprawl – housing, jobs, and services are to be clustered in a hierarchy of urban centers and along corridors so that they align with public transport routes and catchment areas. This integrated approach is meant to support well-managed growth within Thimphu's existing footprint, improving accessibility while safeguarding the city's livability and environment.

129. Key transportation initiatives in the TSP include developing modern public transport infrastructure and safer streets for walking and cycling. A dedicated north–south bus priority corridor (stretching roughly from Babesa to Dechencholing) is planned to provide fast, reliable transit through the city's spine, complemented by the creation of a central transit hub to streamline transfers and regional connectivity. The core area's main avenue, Norzin Lam, will be pedestrianized and upgraded into a people-friendly streetscape, and new pedestrian routes and cycling facilities (such as bike lanes, parking, and sharing schemes) are set to make NMT a convenient option. Meanwhile, primary roads like Doebum Lam are designated as key transport corridors with junction improvements and traffic management to ease movement. To reduce congestion, the plan calls for better parking management, including relocating surface parking to multi-use hubs and introducing parking tariffs, thereby discouraging car use in busy areas. Through these measures, the Thimphu Structure Plan aligns transportation and urban planning to create a more connected, inclusive, and low-carbon city for the future.

130. In 2018 the GCF Project Preparatory Facility approved a funding application based on a World Bank Concept Note for the preparation of a **Low-Emission Transport Master Plan** for Thimphu. The LETMP, finalised in May 2024, sets out several strategies for transitioning transport in Thimphu to low- or zero-emission vehicles and increasing climate resilience by integrating land use and transport planning through Transit-Oriented Development (TOD). The LETMP has been a contributory document to the TSP, the Non-Motorised Transport Plan, and the Public Transport Plan. The 11 strategies in the LETMP are:

- *Non-motorised transport*: prioritising pedestrians and active mobility
- *Public transport*: creating a bus priority lane in each direction along the trunk corridor through Thimphu and improving the quality, reliability, and frequency of bus services
- *Vehicular circulation*: creating a clear road hierarchy, improving junction designs, signage, and road markings, and restricting vehicular traffic in densely populated areas of the city (such as Norzin Lam)
- *Car parking*: controlling on-street parking and limiting parking at places of employment as well as providing off-street parking away from the city core and using charging to influence travel choices and to discourage long-term parking in the city centre
- *Freight and delivery*: restricting access for heavy goods vehicles (HGVs) to the city centre during normal business hours; providing neighborhood parcel lockers and other measures to improve the efficiency of freight deliveries and reduce their environmental impact
- *Low-carbon mobility*: encouraging the transition to low and zero-emission vehicles by the provision of charging points and other policy/fiscal measures
- *Mobility hubs and shared mobility*: providing facilities to encourage connectivity between modes, particularly public transport and encouraging car and bicycle pooling
- *Travel demand management*: encouraging off-peak travel through fare incentives and travel management planning at schools and workplaces
- *Transit-Oriented Development*: establishing high-density land use around key transport nodes and a mix of retail, residential and employment uses, and planning spatial developments around the transport network
- *Placemaking and wayfinding*: creating and distinguishing public spaces with clear signage and adequate connections which prioritise alternatives to private cars
- *Governance*: clear authority and coordination between institutions and effective enforcement and regulation, with public consultation and communication.

131. These LETMP strategies are designed to encourage a significant modal shift from private cars to public transport and active mobility. The RGoB is committed to implementing the strategies from the LETMP, and those that do not require additional investment, such as the car parking, travel demand, freight and delivery strategies can be planned and implemented in parallel with the envisioned construction of bus priority lanes and supporting infrastructure.

Infrastructure and Network Coverage

132. Located in the steep-sided valley of the Wang Chhu River, Thimphu has developed linearly along a narrow corridor. Population growth has averaged approximately 3.34 percent per year over the past two decades, resulting in the city's population nearly doubling since 2005. As urbanization and growth continue within the spatially constrained valley, and private vehicle ownership rises, traffic flows over the limited road network are projected to increase, particularly in the main north-south corridor. Even moderate growth in peak-hour car traffic is likely to exacerbate congestion, increase vehicle idling, and raise fuel consumption.
133. Thimphu's modal structure reflects this evolving dynamic. Estimates vary but indicate that roughly 35-50 percent of commuters travel by private car, compared to approximately 10 percent using the city bus service and around 20 percent using taxis. Non-motorized transport (NMT), particularly walking, accounts for approximately 22 percent of trips. Although walking remains the second most common mode of transport, its share has declined significantly from 48 percent in 2009. This shift has coincided with rising vehicle ownership and increasing trip distances associated with urban expansion.

Road network

134. In Thimphu, the Core Area is the center of economic activity and includes internal roads such as Norzin Lam, Chang Lam, Chorten Lam, and Chhogyal Lam. Babesa-Thimphu Expressway and Doebum Lam are the main roads providing access to the core area from the south, while Chhophel Lam and Dechen Lam provide access from the north. Intersections are not signalized; traffic police manage traffic at busy junctions. The 22 major intersections in Thimphu consist of 12 roundabouts and 10 non-signalized intersections. Attempts to introduce traffic signals in the 1980s were poorly received, but more recent consultations carried out by the Thromde suggest that the population would be accepting of introducing signals at critical junctions.
135. Roads within Thimphu are in fair condition overall, but many secondary and tertiary roads in residential areas suffer from potholes, poor surfacing, and drainage problems. Thimphu Thromde's Infrastructure Division carries out road repairs and resurfacing within the city, guided by an annual work plan and citizen complaints. In 2023, recognizing the backlog of poor roads, the Ministry of Infrastructure and Transport (MoIT) stepped in with a Nu 60 million project to make the city's roads "pothole-free." Under this collaboration, MoIT provides funds and technical oversight while Thimphu Thromde executes the works through contractors. While this has led to improvements, the road maintenance system remains generally reactive and resource-constrained. There is no dedicated budget line for road maintenance in the Thromde's finances; funding is drawn from the general municipal maintenance grant and, when large repairs exceed that, the city seeks support from the central government or external partners.⁶³
136. Baseline analysis (see Section 6.4 and Annex 22 for more detail on the traffic surveys and modelling conducted) reveals significant levels of congestion on the main corridor at peak hours, particularly at approaches to the Core Area. Traffic surveys undertaken in late 2022 assessed service level on a scale of A (free flow) to F (forced/breakdown flow). The Babesa-Thimphu Expressway and S Doebum Lam, which serve as the southern access routes to the Core Area, exhibit a service level of D to E ('approaching unstable' to 'unstable' flow). Similarly, the service level of the roads and intersections at the entrance of Norzin Lam and those on the access roads to the Core Area exhibit a service level of D to F. This is due to the bottleneck caused by the high volume of traffic entering from the southern side of Norzin Lam to the northern side, resulting in traffic congestion that exceeds capacity.
137. With population growth, overall traffic demand on Thimphu's main roads will increase significantly in the future under a Business as Usual scenario, particularly on the southern section of Norzin Lam (from RBP gate to Norzin Lam) where traffic already exceeded road capacity in 2022. Without investment, this congestion is expected to intensify progressively in the years to 2047 as shown in Table 6 below. Furthermore, due to traffic approaching the Core Area, the Babesa-Thimphu Expressway (Changjiji) section and S. Doebum Lam section, which were already close to their road capacity in 2022, are projected to exceed their capacity by 2047.

Table 0-7 Projected changes in traffic volume and Level of Service on major sections (Business as Usual)

Section	2022 (Current)		Do-Nothing			
			2027		2047	
	Volume	LOS	Volume	LOS	Volume	LOS

⁶³ <https://www.bbs.bt/194815/>

		(veh/day)		(veh/day)		(veh/day)	
Babesa-Thimphu Expressway	Babesa	30,478	D	31,728	D	38,771	F
	Changjiji	34,225	E	37,097	E	48,308	F
S Doebum Lam		20,049	E	22,987	F	28,964	F
Norzin Lam	Southern section	22,514	F	22,955	F	25,974	F
Chhophel Lam		20,672	C	23,312	C	31,828	C
Hejo Lam		17,531	B	20,431	B	27,389	C

138. The figure below shows the link-specific traffic flow intensity for major roads in Thimphu from 2022 to 2047. Norzin Lam, S. Doebum Lam, and the Babesa-Thimphu Expressway (Babesa, Changjiji) segments are predicted to exceed road capacity by 2047.

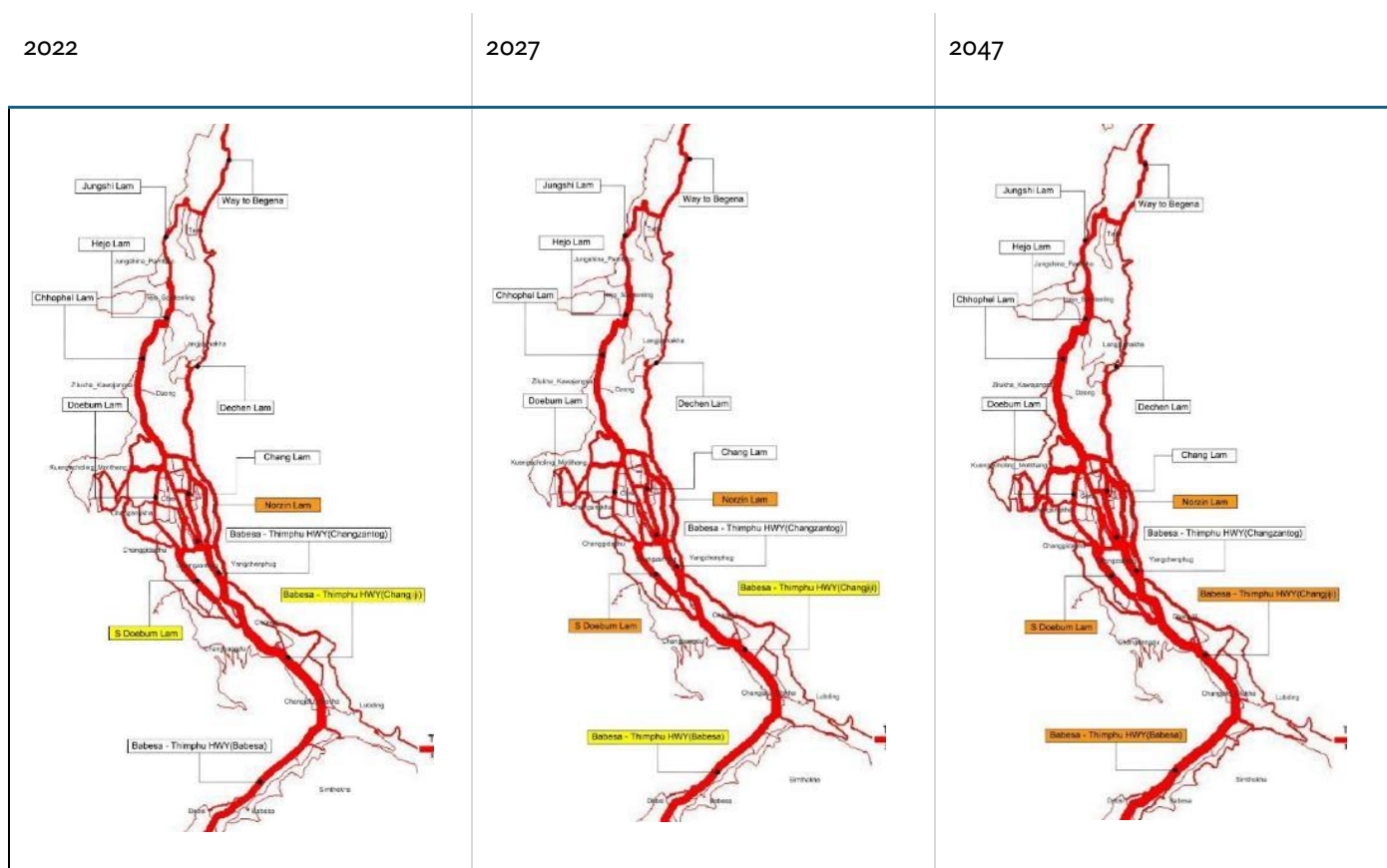


Figure 4-8 Travel demand assignment along major corridors

Note: The yellow shaded areas represent near capacity, and the orange shaded areas indicate road capacity exceeded.

Non-motorized transport (NMT)

139. Most of Thimphu's primary roads (e.g. Norzin Lam, Chang Lam, the Thimphu-Babesa Expressway) now feature paved sidewalks, typically 1.5–2m wide. Recent years have seen improvements to pedestrian infrastructure (e.g., an ADB-financed project, completed in 2021, added 6.59 km of new footpaths with proper drains and wheelchair-accessible ramps). However, the network remains inadequate overall, as only around 55% of roads feature sidewalks, and small streets and peripheral neighborhoods often have subpar or no sidewalks, forcing pedestrians to walk on the road shoulder or dirt edges. Even where sidewalks exist, they can be narrow or intermittently interrupted by driveways, open drains, or utility poles. The core area, particularly Norzin Lam, experiences high levels of pedestrian congestion. The Low-Emission Transport Master Plan flags “narrow and inaccessible footpaths and a disconnected pedestrian network” as a key issue hampering walkability in the city.
140. Currently, NMT in Thimphu consists almost exclusively of walking. Cycling is generally perceived as inconvenient and unsafe due to the steep terrain, lack of dedicated cycling facilities, high cost of bicycles, and difficulty of pedaling in ankle-length local dress (kira). However, the LETMP identifies potential to develop cycling in the city, recommending the implementation of associated infrastructure (bicycle parking, end-of-trip facilities such as changing rooms/showers), a bicycle-sharing scheme (using e-bikes to address hilly terrain), and a new greenway along the river.

Public transportation (bus & taxi)

141. In Thimphu, public transport is dominated by the bus system, operated by the government-run City Bus Service (CBS). CBS started in 1999 with the management and operation of four buses by the Thimphu City Corporation. Responsibility for the CBS was transferred to Bhutan Post in 2001, then to Thimphu Thromde in 2022.
142. Thimphu's bus system is not commercially profitable and relies on subsidies to sustain operations. The primary source of revenue is passenger fares, which have grown alongside increased ridership, roughly doubling between 2017 and 2023. Fares are set by the BCTA and revised regularly, typically twice per year. By design, fares are low (Nu 5 base fare + Nu 1 per additional stop), which helps ensure affordability for low-income users, but means that fare revenue covers less than half of operating costs. CBS recently started commercial advertising on buses and infrastructure, generating additional income, though this represents a small portion of total revenue. The funding gap is covered by RGoB subsidies. This financial structure hampers CBS's capacity to invest in fleet expansion and improvement.
143. CBS has a total of 55 buses operating 20 routes (15 daytime and 5 nighttime), of which the two Trunk Routes are key, accounting for over 60% of total demand. Daily ridership on Thimphu's buses has risen in recent years, from roughly 8,000 in 2017 to 20,000 in 2023. This growth followed targeted improvements (new routes, extended operating hours, added buses, introduction of smart farecards, and a 2021 route network revamp) that increased capacity and coverage, demonstrating the potential for improved service to generate demand. However, the system continues to face challenges:
1. Congestion: The increasing number of private vehicles on Thimphu's roads negatively impacts bus service, in particular along the Babesa-Thimphu Expressway, where passenger volumes are already highest. Bus priority lanes have been identified by CBS as a key need to maintain efficient and reliable service.⁶⁴ A Priority Lane pilot project was implemented along the Babesa-Thimphu Expressway (from Babesa Zero to the Changzamtog flyover bridge) in 2024, which showed promising early results in terms of reduced travel time for buses, although taxi drivers raised concerns about safety and convenience (e.g., with passengers needing to cross the priority lane to access taxis).⁶⁵
 2. Overcrowding remains an issue at peak times, especially on the Trunk Routes, indicating a need for greater capacity and more frequent service.
 3. Accessibility: Currently, there are many bus stops without sidewalks, with high steps between sidewalk and roadway, and/or without braille blocks, limiting the bus system's accessibility particularly for vulnerable users. In addition, while some route guidance and scheduling information is available via mobile apps, bus stops themselves lack route maps or real-time bus arrival data. Physical improvements to bus stops and the installation of bus information terminals (BIT) are needed to address these gaps.
 4. Maintenance capacity: There are three maintenance staff for all city buses, who only perform simple maintenance, conforming to the BS-IV standards. Major maintenance is possible at one automobile repair shop in the Olakha Workshop, but it takes an average of more than three months. While some improvements have been made in recent years (such as the addition of a mobile maintenance van in 2021), overall there is a need for more systematic management of bus operations and maintenance.
144. In 2023, the bus system acquired its first electric bus and chargers, through an Austrian Development Agency and UNIDO project (see 3.4.2). The project also supported associated training for CBS engineers, as well as capacity building in e-mobility procurement through a “learning by doing” approach (procurement was undertaken by CBS, under UNIDO supervision), establishing foundational expertise for CBS to manage an electric bus fleet.

⁶⁴ CBS Annual Report 2023, <https://thimphucity.bt/wp-content/uploads/2025/03/AR-2023-for-WEB-1.pdf>

⁶⁵ <https://www.bhutantoday.bt/thimphus-priority-lane-project-a-tale-of-two-perspectives/>

145. RGoB included the procurement of 45 e-buses within its 2025–2029 Five Year Plan (13FYP) to extend zero-emission public transport services to other urban centres and inter-urban services. As of 2026, the process of acquiring these buses has begun. Due to the urgent need to modernize CBS' aging fleet, the government has discussed potentially redirecting 33 of these buses to Thimphu, primarily to replace 9 diesel buses that are already past end-of-life and 18 diesel buses that are scheduled to be transferred to other districts of Bhutan to accommodate growing needs; the remaining 6 would serve as a marginal fleet expansion. However, even with this re-allocation to Thimphu, the CBS fleet would remain far below the roughly 111 buses needed to effectively operate the planned bus priority system, as determined by travel demand and traffic modelling and confirmed by CBS (see "Transport Options analysis" below). Attempting to introduce a bus rapid transit system without enough buses to provide adequate frequency and reliability of service would likely fail to generate meaningful, sustained modal shift and consequent revenue increases, leading to a domino effect as future fleet expansion and other system improvements become unaffordable for CBS, jeopardizing the sustainability of the BPS and any other improvements to the bus system.⁶⁶
146. **Taxis** play a major complementary and last-mile role, offering service virtually anywhere in the city. Many residents and visitors rely on taxis for daily mobility, especially for areas or hours not well served by the bus network. This flexibility makes taxis a key alternative to private car use in the capital, ensuring that people who do not own vehicles can still travel conveniently. There are roughly 3,000 taxis operating in Thimphu. The industry is tightly regulated by the Bhutan Construction and Transport Authority (BCTA) under the MoIT, which oversees licensing and enforces standardized fare structures. The LETMP proposes to integrate taxis into the system by providing ticketing for last-mile services to encourage modal shifts to buses from private cars for those households that do not have easy access to the core bus network.
147. The Bhutan Sustainable Low-Emission Urban Transport Systems project (2018-2022), described in section 3.4.2, promoted wider uptake of electric vehicles (EVs), with a focus on the taxi sector. The project achieved a substantial scale-up in adoption, helping to expand the EV fleet several-fold and establishing key enabling conditions for market transformation, including concessional financing schemes, partnerships with financial institutions, and the rollout of initial charging infrastructure, alongside strengthened policy and institutional support for low-emission transport. These outcomes demonstrated the technical and financial viability of electric mobility in Bhutan and laid a strong foundation for the continued scale-up of EV taxis. However, given Thimphu's rapid population growth and geographically constrained road network, sustainable and low-emission transport development will need to focus primarily on the bus system, with taxis playing a complementary last-mile role.

Transport Sector Emissions Trends

148. Within the energy sector, Bhutan's GHG emissions are dominated by transport. Road transport, which accounts for approximately 20 percent of total energy demand, depends almost entirely on fossil fuels. As a landlocked country, Bhutan relies heavily on road-based mobility to sustain economic activity and connectivity. A study by Deloitte predicts that under BAU conditions, demand for passenger transport is projected to double by 2050, while freight demand is projected to triple. As a result, the transport sector is expected to account for an increasing share of total emissions over time.
149. The growth of Thimphu without a corresponding expansion in public transport services has increased reliance on private vehicles. As neighborhoods have extended along the valley corridor, travel distances have lengthened, reducing the feasibility of walking and increasing dependence on motorized transport. Rising household incomes and improvements in road infrastructure have further contributed to steady increases in vehicle ownership.
150. Transport-related emissions are influenced not only by the number of vehicles but also by congestion patterns and travel efficiency. Thimphu's physical geography significantly constrains mobility options. Located in the steep-sided valley of the Wang Chhu River, the city has developed linearly along a narrow corridor with limited opportunities for road expansion. As a result, the existing transport configuration is characterized by growing private vehicle reliance within a spatially constrained network. Rising freight demand also poses a major challenge, as heavy-duty vehicles account for roughly 60% of vehicular GHG emissions. Under BAU conditions, continued population growth, increasing vehicle ownership, and rising passenger and freight demand are expected to reinforce this pattern, contributing to steady increases in transport-sector emissions.⁶⁷
151. The RGoB is committed to reducing GHG emissions from transport, given the rapid growth in private car ownership and use. This commitment is enshrined in several policies and strategies adopted by the government, from the 2007 Surface Transport Master Plan for Bhutan to the 2021 Low Emission Development Strategy, the Paro-Thimphu Regional Strategy, the 2024 Draft National Surface Transport Policy, the TSP, and the LETMP (cf. Section 3). These policies seek to place

⁶⁶ The importance of high-frequency service (low headways) to attracting ridership is well established in global literature on BRT; see, e.g., Hensher, D.A., Li, Z. Ridership drivers of bus rapid transit systems. *Transportation* 39, 1209–1221 (2012). <https://doi.org/10.1007/s11116-012-9392-y>

⁶⁷ <https://www.adb.org/sites/default/files/publication/513931/adb-brief-110-bhutan-vehicle-emission-reduction-strategy.pdf>

pedestrians, non-motorised and public transport over private vehicles in planning and infrastructure development, but implementing their proposed measures will require financing assistance from external sources.

152. The RGoB aims to encourage the transition to electric vehicles in Bhutan and will take the lead in converting government vehicles to zero-emission vehicles. There have also been several policy initiatives to encourage the take-up of electric vehicles. The draft Electric Vehicle Roadmap sets targets for the uptake of electric taxis and private cars, and a pilot scheme supported by UNDP/GEF provided a 20% subsidy for the purchase of 300 electric taxis by eligible drivers, with commercial loans available for the balance, the provision of seven free electric charging points across the city for taxis, and at least one charging point for private vehicles in all twenty districts (see section 3.4.2). This initiative closed in 2022, but imported electric vehicles are tax-exempt, and an electric bus is being operated in Thimphu on a trial basis (see 3.4.2). The LETMP's strategy for freight proposes to use zero-emission vehicles for deliveries within the city centre by constructing a transshipment terminal for HGVs at the southern approaches to the city, and funding for this has been allocated in 13th FYP, including for the procurement of 100 light EVs.
153. An additional incentive for Bhutan to transition to electric vehicles is that all fossil fuels are imported from India and represent a significant drain on foreign currency earnings. As Bhutan's grid is zero-emissions, with ongoing investment in developing its hydropower potential, electrification has the potential to play a major role in decarbonizing the transport system, particularly for the hard-to-abate freight subsector. However, considering Thimphu's geographical constraints and the risk of lock-in, reversing private vehicle dependency by strengthening public transport and active mobility is the most urgent priority.

Climate Vulnerabilities to the Transport System

154. Thimphu's transport network faces significant climate vulnerabilities. Flooding and landslides are the key hazards, leading to costly infrastructure damage and road network disruptions that isolate communities, delay emergency response, and interrupt access to essential goods and services, as illustrated by past flood events along the Phuentsholing–Thimphu highway.⁶⁸
155. Flooding and landslides: The combination of steep terrain and intense monsoon rainfall frequently triggers landslides and flash flooding. Over the past 50 years, Thimphu has experienced six major riverine and flash flooding events affecting over 10,000 people. Flooding events have accelerated sharply in recent decades, with 65 of Bhutan's 116 recorded event occurring between 2012 and 2020.⁶⁹ In 2016, floods driven by a heavy monsoon season partially collapsed the Kamji Bridge and disrupted the Phuentsholing–Thimphu highway – the country's primary supply route for food, fuel, and essential goods – causing panic among residents and a 0.36% reduction in Bhutan's GDP.⁷⁰ Climate change is expected to significantly intensify these flood hazards in the coming decades.
156. Thimphu's vulnerability to flooding and landslides has been compounded by rapid and poorly managed urban expansion, as the widespread use of concrete and limited adoption of green infrastructure have increased impervious surfaces, altered natural watercourses, and generated higher levels of surface runoff. Thimphu's stormwater infrastructure lacks both sufficient coverage and appropriate technical design to manage increased water volumes – sewer overflow onto major roads in the city core during heavy rainfall has become increasingly frequent. Construction activity often involves slope cutting and earthworks undertaken without comprehensive geotechnical assessment, slope stabilization measures, or adequate drainage management. These practices destabilize hillside soils and increase surface runoff, creating conditions conducive to slope failure and consequent landslides.
157. Thimphu's road network and bridges face growing exposure to flood and landslide damage, with many bridges built to 20- or 25-year design standards that are likely to be exceeded with increasing frequency as extreme events intensify.⁷¹ In the absence of targeted adaptation investment, the compounding effects of increased flood frequency, aging infrastructure, and urban expansion will render Thimphu's transport network increasingly unable to maintain service delivery under projected climate conditions. Planners and engineers have limited technical skills and capabilities to assess climate risk and integrate climate resilience into urban design and transport infrastructure works, and government budgets are insufficient to meet the urgent needs for climate resilience investments.
158. Extreme heat: Thimphu is experiencing a measurable and intensifying urban heat island (UHI) effect, driven by the rapid replacement of natural vegetation and permeable surfaces with dense built-up areas. As global temperatures rise, the UHI effect in Thimphu is projected to intensify. Hot and very hot zones – currently covering approximately 16% of the city's area – are expected to expand to over 20% by 2031. In the transport sector, sustained heat stress accelerates the

⁶⁸ World Bank. 2025. Bhutan Crisis Preparedness Gap Analysis: Technical Report. Washington, D.C: World Bank.

⁶⁹ Tempa K (2022) District flood vulnerability assessment using analytic hierarchy process (AHP) with historical flood events in Bhutan. PLOS ONE 17(6): e0270467. <https://doi.org/10.1371/journal.pone.0270467>

⁷⁰ Tshering, Dechen (2018) Building up Bhutan's resilience to disasters and climate change. Available at <https://blogs.worldbank.org/en/endpovertyinsouthasia/building-bhutan-s-resilience-disasters-and-climate-change>

⁷¹ World Bank. 2025. Bhutan Country Climate and Development Report (CCDR). Washington, D.C: World Bank.

deterioration of asphalt road surfaces and structural materials, increasing maintenance burdens and reducing the operational lifespan of infrastructure assets. At the same time, transport infrastructure contributes to the UHI effect, as asphalt pavements absorb and re-radiate heat far more than natural surfaces. The use of appropriate materials for road surfacing, adequate maintenance protocols, and the integration of urban greening can reduce the impact of extreme heat on the transport network while minimizing its contribution to the UHI effect.

Barrier Analysis and Climate Rationale

Technical and Infrastructural Barriers

159. As detailed in Chapter 4, the baseline assessment of Thimphu's urban water and transport systems reveals a combination of aging and climate-vulnerable infrastructure, limited redundancy, fragmented service delivery, and constrained system capacity that collectively undermine both service reliability and climate resilience. These technical and infrastructural constraints manifest differently across sectors but share a common underlying issue of systems operating beyond their design limits under increasing climate stress.

Transport

160. As identified in Chapter 4 (Sections [04.2.2](#) to [04.2.4](#)), Thimphu's transport system is characterized by inadequate bus priority infrastructure, aging and insufficient fleet capacity, discontinuous pedestrian networks, and growing exposure of road and bridge infrastructure to climate-related hazards such as flooding and landslides. The most immediate technical and infrastructural barriers relate to the conditions that make a shift toward low-emission urban mobility currently unviable. Reducing Thimphu's transport emissions requires a meaningful shift from private vehicles to public transport and non-motorized mobility, but the physical infrastructure needed to make that shift credible is largely absent. Bus priority infrastructure — dedicated lanes, bus bays, and terminals — is minimal, meaning buses compete with private vehicles for the same congested road space, and public transport cannot offer the reliability or journey time advantages needed to attract modal shift. Bus shelter coverage stands at just 6.3 percent of stops and bus bay coverage at 8.3 percent, leaving passengers without weather protection and buses without dedicated stopping areas — basic conditions that are prerequisites for attracting riders away from private vehicles. The CBS fleet, much of which is beyond its operational lifespan, is neither efficient nor reliable enough to serve as a credible alternative to car use, and the maintenance facility at Olakha lacks the equipment and systems needed to support a modernizing fleet. The limited size of the fleet and constrained route coverage also result in low service frequency outside peak periods, further reducing the attractiveness of public transport. The transition to electric buses, which is central to the project's mitigation ambition, requires charging infrastructure at terminals and the depot that does not currently exist. Sidewalk coverage at 55.2 percent of routes and the near-complete absence of dedicated cycling facilities mean that non-motorized transport remains unsafe and impractical for most residents, particularly during heavy rainfall and extreme weather conditions. In addition, pedestrian infrastructure is often discontinuous and not designed to universal accessibility standards, limiting safe use by persons with disabilities, the elderly, and other vulnerable groups. Without this foundational physical infrastructure in place, behavioral change toward low-emission mobility cannot realistically be expected regardless of the strength of demand management policies.

161. The transport sector faces significant climate resilience barriers due to gaps in infrastructure design standards, planning, and system capacity to withstand projected climate conditions. Much of Thimphu's road and bridge infrastructure — including key crossings such as the Kamji, Pamtsho, and Dechencholing bridges — has been designed to 20- or 25-year return periods, which are increasingly misaligned with evolving flood risk projections and the growing frequency of extreme weather events. Furthermore, existing depot and terminal facilities are located in areas exposed to pluvial and fluvial flooding from the Wang Chhu river, and they lack the physical fortifications necessary to ensure operational continuity during the extreme weather events projected for Thimphu. This exposes the current fleet and maintenance operations to significant climate risk. This results in infrastructure that is not adequately climate-proofed against scour, flooding, and landslide-induced embankment failure, creating critical points of failure in the urban transport network. In parallel, urban drainage systems are under-designed and insufficiently maintained relative to current and projected rainfall intensity, leading to frequent overtopping, road flooding, and sewer overflow along key corridors. These deficiencies reduce the reliability and accessibility of the road network, particularly for public and non-motorized transport during extreme events. In addition, the absence of climate-resilient road materials, maintenance standards, and protective design measures increases the vulnerability of transport infrastructure to heat stress and accelerates asset degradation. These infrastructure and design gaps are further compounded by the lack of dedicated and resilient public transport corridors and fleet management systems, limiting the ability of the bus system to maintain service continuity under climate stress.

Water

162. As identified in Chapter 4 (Sections [04.1.2](#) and [04.1.3](#)), the urban water supply system is constrained by high non-revenue water losses, aging and undersized distribution networks, vulnerable intake and transmission infrastructure,

limited storage capacity, and increasing sensitivity to climate-driven variability in water availability. The most acute technical barriers stem from the age and condition of the existing network, limited redundancy, and vulnerability of key infrastructure to climate hazards. As demonstrated in the baseline assessment, the distribution system, largely installed in the 1960s, suffers from corrosion, undersizing, and physical deterioration that drives Non-Revenue Water losses exceeding 50 percent in the city core, meaning more than half the water extracted from already climate-stressed sources is lost before reaching consumers. Similarly, intake structures are vulnerable to fluctuating flows and debris loads during intense rainfall and to severely reduced abstraction capacity during the increasingly prolonged dry seasons projected under climate change. Transmission pipelines traversing steep, landslide-prone terrain are regularly severed by slope failures and washouts, causing extended service disruptions with no redundant conveyance routes to maintain supply (refer to section [04.1.2](#)). Storage capacity — providing only around 12 hours of demand — offers minimal buffering against these disruptions, leaving the system almost entirely dependent on real-time source availability. The inability to redistribute water between service zones due to insufficient hydraulic integration between treatment, storage, and distribution infrastructure further reduces the system's capacity to respond when any single component fails. Finally, the city's undersized sewer system is frequently overwhelmed by intense rainfall, leading to overflows that contaminate water sources, damage road infrastructure, and pose a direct public health risk. This represents a critical barrier to achieving urban climate resilience, as it creates a cascade of negative impacts that undermine both water security and transport system functionality.

163. Together, these technical and infrastructural barriers limit the ability of both sectors to respond effectively to increasing climate risks and to support low-emission urban development. Aging and climate-vulnerable infrastructure, limited redundancy, and weak system integration reduce operational flexibility during extreme events, while inadequate mobility infrastructure constrains the shift toward climate-compatible transport modes. Addressing these physical constraints through climate-resilient design, improved system connectivity, enhanced redundancy, and infrastructure protection is therefore a prerequisite for strengthening urban resilience and enabling emissions reductions in Thimphu.

Information and Data Barriers

164. As detailed in Chapter 4, both the water and transport sectors in Thimphu lack integrated, real-time operational and planning data systems, significantly constraining the ability to manage infrastructure efficiently and respond to climate-related variability and disruptions. This limits the ability of service operators to make climate-informed planning and operational decisions, leaving them to manage complex, climate-exposed infrastructure with only a partial and delayed picture of what is happening on the ground. The water supply system lacks a SCADA system or any equivalent real-time monitoring of flows, pressures, and storage levels across the network. Without this visibility, operators have limited understanding of how water moves through the system, where losses occur, and how conditions are changing during periods of climate stress. This restricts their ability to manage supply dynamically during droughts, detect leakages that worsen scarcity, and maintain pressures that reduce pipe failure risk during extreme rainfall events. In the transport system, bus arrival information is provided through mobile applications using preset schedules rather than real-time tracking. Bus Information Terminals exist at only two locations and are currently not operational, and most bus stops have no route maps. Smart card data, while available, captures only fare-paying passengers and does not provide the operational visibility needed to manage routes, adjust services in response to disruptions, or measure system performance over time. As climate variability increases, the inability to monitor and respond to rapidly changing conditions in either system is becoming an increasingly serious operational challenge.
165. Gaps in hydrological, climate, and disaster risk data compound these operational deficits by constraining long-term planning and infrastructure design in both sectors. Limited information on seasonal flow variability, source yield, and sediment loads reduces the ability to assess future water availability and to design infrastructure capable of withstanding changing hydrological conditions. The insufficient integration of climate projections into water supply planning weakens the capacity to anticipate shifts in rainfall patterns, prolonged dry periods, and increased sedimentation. As a result, infrastructure is being designed and built to standards that may already be inadequate. In the transport sector, the absence of reliable, downscaled climate and disaster risk data creates an equivalent planning gap. Road and drainage infrastructure is not consistently designed to accommodate increased rainfall intensity, higher flood frequencies, or accelerated slope instability. This means that roads, bridges, drainage systems, and bus corridors continue to be built to standards that underestimate the hazard environment, accumulating future climate risk with each new investment.
166. Information gaps also undermine the efficiency and responsiveness of day-to-day service delivery in ways that climate change will continue to worsen. In water supply, incomplete metering coverage and the absence of an integrated billing and management information system make it difficult to identify high-loss zones, allocate scarce water efficiently during droughts, implement targeted demand management, or communicate effectively with consumers about supply conditions. Without improved data and billing systems, efforts to reduce Non-Revenue Water and strengthen drought resilience remain largely reactive. In transport, the lack of a systematic management information framework means that CBS has no reliable basis for tracking operating and maintenance costs, optimizing route performance, or planning the fleet investments and service adjustments needed to respond to changing travel demand. In both sectors, the absence of reliable meteorological and hydrological data further limits the Thromde's ability to anticipate and prepare for climate-

related service disruptions, highlighting the need for stronger institutional coordination and data integration across water and transport systems.

Policy, Regulatory and Institutional Barriers

167. The institutional and governance assessment highlights fragmented mandates, limited coordination mechanisms, and constrained technical capacity across agencies responsible for water and transport services, which collectively weaken integrated and climate-resilient urban service delivery. In the water sector, responsibilities are distributed across MoIT, DHS, DoID, and Thimphu Thromde, with NCHM providing the hydrological and climate data that underpins supply planning. Yet no formal inter-agency coordination mechanisms, shared planning platforms, or joint protocols for responding to climate-induced disruptions exist across these agencies. Thimphu Thromde, as the primary city-level institution responsible for service delivery, lacks a dedicated Water Services division. Instead, water supply and wastewater are managed through separate sections, and planning and design functions sit in a different division from operations and maintenance, creating an internal fragmentation that limits coordination, reduces operational efficiency, and weakens the Thromde's overall capacity to manage water services in an integrated and responsive way. In the transport sector, MoIT sets national transport policy and oversees road infrastructure standards, while city-level mobility planning and operations involve Thimphu Thromde, BCTA, RBP, and CBS, each operating under separate mandates with no formally structured coordination forum. Bus priority measures illustrate this fragmentation well: infrastructure sits with Thimphu Thromde, standards with BCTA, and enforcement with RBP, a three-way split that limits the ability to implement integrated, low-emission, and climate-resilient transport strategies coherently.
168. Compounding this fragmentation, local institutions in Thimphu face significant capacity constraints that limit their collective ability to plan, manage, and oversee climate-resilient urban services. Thimphu Thromde is chronically understaffed across the technical areas most critical to urban climate resilience — water system operations, urban transport planning, climate risk assessment, and infrastructure asset management — and its heavy reliance on central agencies for technical support reinforces dependence rather than building the autonomous, accountable city authority that sustained access to international climate finance requires. In the water sector, constrained technical and regulatory capacity weakens oversight of service delivery, asset management, and climate-resilient system planning. In transport, CBS faces significant institutional capacity constraints as it navigates a transition toward greater operational autonomy. Currently lacking the organizational systems, technical expertise, and staffing depth needed to function as a self-sufficient public transport operator, CBS is ill-positioned to plan and manage a modernizing, climate-resilient bus network without substantial institutional development support. Relatively high levels of turnover in technical staff (especially in Thimphu Thromde) compounds these constraints as specialist expertise is difficult to retain and institutional knowledge accumulates slowly. Both Thimphu Thromde and CBS also lack dedicated mechanisms to engage effectively with residents and service users. This limits opportunities to inform the public, promote behavioral change, and build support for climate-resilient water and mobility services.
169. Neither the water nor the transport sector in Thimphu currently operates with formalized disaster risk reduction or emergency response frameworks at the city level. Climate-related disruptions — whether extreme rainfall that simultaneously contaminates water supply and blocks road corridors, or prolonged drought that reduces source availability — are managed reactively rather than being anticipated and prepared for. In the water sector, this is particularly acute: there are no established operational procedures for responding to burst pipes, network blockages, or flood-driven supply failures, and the Thromde has limited access to the real-time meteorological and hydrological data that would enable early warning and proactive management of climate-related hazards. Response to infrastructure failures therefore depends on ad hoc decision-making rather than predefined protocols, leading to delays, inefficient resource deployment, and prolonged service disruptions that fall disproportionately on the most vulnerable residents. The absence of joint contingency protocols across the agencies responsible for water and transport compounds this problem: when a single climate event simultaneously affects both systems, responses are uncoordinated and the cumulative impact on urban service delivery is greater than it would be if institutions were equipped to act together. Without formalized emergency response procedures grounded in improved climate observation and forecasting, Thimphu's urban services will remain structurally unprepared for the increasing frequency and severity of climate-induced disruptions.
170. These city-level governance challenges are reinforced by a broader national policy environment in which sectoral frameworks — the Bhutan Water Policy (2007), the National Integrated Water Resources Management Plan, the Low Emission Transport Master Plan, and the Draft National Transport Policy — were each developed independently, with no overarching integrating mechanism to align their objectives or institutional responsibilities at the city level. Bhutan also does not yet have a dedicated climate change law, which the CCIA identifies as a foundational gap that weakens inter-agency accountability and long-term coherence in climate action across sectors. The absence of national technical standards and regulatory guidance for intelligent transport systems and digital service platforms further limits the city's ability to implement interoperable, efficient, and climate-resilient mobility solutions. While these national conditions operate beyond the scope of city-level interventions, they constitute the structural backdrop within which Thimphu Thromde and CBS operate and help explain why governance fragmentation at the local level has proven persistent and difficult to resolve through local action alone.

171. Taken together, these policy, regulatory and institutional barriers explain why Thimphu has been unable to make sustained progress toward climate-resilient water and transport services despite the existence of relevant national policies and the Thromde's formal mandate over urban service delivery. Fragmented governance, insufficient institutional capacity at the city level, and the absence of integrating policy mechanisms have left Thimphu without the organizational foundations needed to plan, implement, and maintain integrated, climate-resilient investments in its water and transport systems. Strengthened coordination mechanisms and targeted capacity building at both the Thromde and CBS are therefore essential preconditions for effective and durable urban climate resilience in Thimphu.

Social and Behavioural Barriers

172. The transport baseline assessment shows increasing dominance of private vehicle use, declining non-motorized transport share, and limited accessibility and capacity of public transport infrastructure, reflecting entrenched behavioural patterns and structural constraints that inhibit modal shift toward low-emission mobility. Drivers and residents are often reluctant to comply with parking restrictions, bus priority lanes, or other traffic management measures, particularly when these measures are perceived to limit convenience or access. This resistance is compounded by the economics of private vehicle ownership: once a household has made the significant upfront investment of purchasing a car, the marginal cost of using it for each additional journey is relatively low, making the financial case for switching to public transport weak even when bus services improve. Limited awareness of the benefits of public transport, combined with the fact that the system is currently not well designed for people with disabilities and is not perceived as practical for those carrying young children or transporting goods, further constrains the adoption of low-emission mobility. More broadly, urban planning and service design across both the water and transport sectors do not systematically account for gender, age, disability, or climate risk, increasing the vulnerability of already marginalized groups and raising the risk that interventions designed without this lens may inadvertently entrench rather than reduce existing inequalities.
173. Public attitudes and behaviors also influence the effectiveness of enforcement. Compliance improves when residents and drivers understand the rationale for regulations, but inconsistent enforcement or unclear communication can reduce trust and adherence. The high dependence on private vehicles, combined with ingrained habits around car use for daily commuting and errands, reinforces resistance to modal shift. Non-motorized transport faces its own behavioral and physical barriers: there is currently no established cycling culture in Bhutan, and Thimphu's topography is not always conducive to cycling, limiting its viability as an alternative to private car use for many residents. These social and behavioral factors — resistance to traffic management measures, the economics of car ownership, the absence of a walking and cycling culture, and the practical limitations of the current bus system — together slow the pace of modal shift and reduce the effectiveness of measures already in place to support low-emission urban mobility.

Financial and Economic Barriers

174. Thimphu's urban water and transport systems face financial and economic barriers that are structurally rooted in the same underlying condition. Both services are chronically underfinanced relative to the cost of delivering reliable, climate-resilient services. Neither has a revenue model capable of bridging that gap without external support. Local financial markets are undeveloped, with only four major banks in operation.⁷² Access to foreign currencies is controlled. The ngultrum is not easily convertible into foreign currencies, further limiting access to finance. Other potential investors, such as insurance companies, pension funds, etc. are also undeveloped. In the water sector, tariffs in Thimphu represent only around 0.4 percent of average household disposable income, which is well below the WHO guideline maximum of 5 percent and far below the level needed to recover the cost-of-service provision. This structural under-pricing deprives the Thromde of the revenue needed to fund routine maintenance, reduce the very high levels of Non-Revenue Water that drain the system's financial and physical efficiency, and invest in the climate adaptation measures that a changing hydrological environment demands. As the Bhutan CCDR notes, improving cost recovery is a prerequisite for financing climate-smart municipal services. Yet water tariff reform is politically sensitive and has not advanced at the pace that the financial sustainability of the system requires. The absence of an adequate digital billing system further limits the Thromde's ability to track consumption, enforce payment, and manage revenue efficiently, which compounds the cost recovery challenge. The cost of long-term infrastructure finance in Bhutan is relatively high due to limited competition in the banking sector and the absence of deep capital markets, which constrains the ability of municipalities to access affordable long-tenor financing. In addition, borrowing capacity at the subnational level remains limited, restricting the ability of Thimphu Thromde to finance large-scale capital investments without external concessional support.
175. In the transport sector, the City Bus Service operates in a similarly unsustainable financial position. Fare revenue covers less than half of CBS's operating costs, with the remainder dependent on government subsidies that are not

⁷² World Bank Group data on the real interest rate is only recent as of 2024 at 5.6 percent, though there has been major annual fluctuation since 2010, with a low of 4.7 percent in 2011 and a high of 12.7 in 2018. <https://data.worldbank.org/indicator/FR.INR.RINR?locations=BT> The Bank of Bhutan has rates for the transport sector (though not water or other relevant public infrastructure). These are 9.44 percent for non-commercial transport, 9.5 percent for commercial transport, and 9.7 for public transport. <https://www.bob.bt/interest-service-charges/loan-interest-rates/>

structured around performance incentives or long-term service commitments. While commercial advertising on buses and infrastructure generates some supplementary income, it remains a small share of total revenue. CBS has not yet developed the commercial strategies, including retail activities at mobility hubs, systematic advertising frameworks, or asset leasing, that could diversify its revenue base and reduce its structural dependence on public transfers. In addition, the limited development of institutional investors in Bhutan constrains access to long-term financing sources, meaning CBS relies primarily on government and donor funding rather than commercial debt markets. This financial fragility limits CBS's ability to invest in fleet renewal, maintain service quality, or absorb the additional operating costs associated with transitioning to electric buses and modernizing its operations. Without a credible path to financial sustainability, CBS cannot attract the long-term investment commitments from government, development finance, or the private sector that a climate-resilient and low-emission public transport system requires.

176. The transition to electric buses illustrates a broader private finance barrier that affects the transport sector specifically. Private investors and bus manufacturers are hesitant to engage with Bhutan's market given its small scale, the absence of proven revenue models for electric bus operations in the country's context, and the uncertain policy and regulatory environment surrounding public transport commercialization. This market failure means that the upfront capital costs of fleet electrification, which are substantially higher than for conventional diesel vehicles, cannot be met through private financing alone. Without concessional financing to de-risk the initial investment and demonstrate commercial viability, the shift to electric buses will remain financially out of reach for CBS under current conditions.
177. Together, these financial and economic barriers, including below-cost water tariffs, CBS's structural operating deficit, private sector hesitancy around e-bus investment, and the absence of climate-resilient capital investment planning, mean that neither system can self-finance the transformation required for climate resilience and low-emission service delivery. These financial constraints are consistent with the baseline assessment in the Section 4, which highlight limited cost recovery in water services, structurally subsidized public transport operations, and constrained municipal fiscal capacity for capital investment. Addressing them requires not only direct investment but also support for financial management reforms, revenue diversification strategies, and investment planning frameworks that can put both services on a sustainable long-term footing. These constraints reflect broader fiscal space limitations at the municipal level, where competing investment priorities and limited own-source revenues constrain the ability to scale climate-resilient infrastructure investments without external support.

Project Description and Technical Feasibility

Project Scope and Theory of Change

178. The Livable and Resilient Cities Project (LRCP) aims to transform Thimphu into a climate-resilient, low-carbon urban centre. It addresses two interlinked challenges: the increasing vulnerability of essential urban services to climate change and the growing greenhouse gas (GHG) emissions from urban transport. The project seeks to build a safer, healthier, and more sustainable city through integrated investments in water infrastructure and clean, inclusive mobility. The aims of LRCP are to provide climate resilient and accessible water networks in the city core and offer safe, reliable, convenient, efficient, and low-carbon public transport services to the residents of Thimphu in accordance with the National Adaptation Plan, the Low Emission Transport Masterplan, and the Water Services Masterplans.
179. LRCP's Project Development Objective (PDO) is to enhance livability and climate resilience in the project area by improving targeted urban infrastructure and service delivery. The Theory of Change is anchored in the goal: IF climate resilient and water management, urban pedestrian systems, and low-emission transportation systems are implemented and client capacity is improved, THEN the local population will have greater resilience capacity against climate shocks, access to safe and reliable water, and more resilient and sustainable urban mobility, BECAUSE water, urban pedestrian, and transport infrastructure will be less vulnerable to riverine floods, landslides, drought, and urban heat island effects AND a modal shift toward non-motorized and public transport will reduce GHG emissions from the city's transport system. To achieve this overarching goal, the project will generate several core outcomes. First, urban water services in the project area will become more reliable and more resilient to climate hazards, especially drought, flooding, and rainfall-triggered landslides. (The project is addressing climate risks outlined in Chapter 2 for all relevant sectors). Second, climate-resilient urban mobility infrastructure in the project area will encourage a shift from private vehicle use toward public and non-motorized transport. Third, climate-resilient urban passenger transport in Thimphu will encourage a modal shift from private vehicle use toward public transport, maintaining reliable mobility under climate stress and reducing GHG emissions from the transport sector. Fourth, the institutions responsible for water and public transport will have enhanced capacity to operate, maintain, finance, and replicate climate-resilient and low-emission urban systems. In addition, there will be co-benefits addressing improved access to jobs and income; improved household hygiene and health; and improved air quality and reduced pollution. More information on the improvements to the enabling environment and policy/regulatory frameworks are found in section D.2 of the Funding Proposal.
180. The project's outputs are organized across six major areas:

(1) Climate-resilient water supply infrastructure and distribution networks are established and operational, which will be achieved through activities such as improving raw water intake structures, stabilizing landslide-prone slopes, NRW reduction, reorganizing Water Treatment Plants (WTPs) and treated water transmission lines, and enhancing the water distribution network with smart meters.

(2) Climate-informed decision-making systems and operational control mechanisms are established and functioning in water supply operations will be informed through installing Supervisory Control and Data Acquisition (SCADA) systems, which will be integrated into the improved decision-making and management processes under the water TA activities.

(3) Climate-resilient pedestrian access and public realm infrastructure will be established. Urban pedestrian interventions - improving the safety and convenience of sidewalks, footpaths, and passageways to encourage non-motorized transport - will encourage pedestrian movement along the bus priority corridor by removing high kerbs and hazards on footpaths, upgrading sidewalks and connecting paths, installing communication cable ducts under sidewalks, implementing a comprehensive traffic circulation and management plan, and improving roadside drainage.

(4) A low-emission, efficient public transport system will be established and operational. To promote a modal shift toward low-emission public transport, the project will develop a 18.9 km bus priority corridor with dedicated bus lanes, bus bays and 75 bus shelters, deploy a fleet of 50 electric buses, construct two new bus terminals, roll out Intelligent Transport Systems (ITS) and Management Information Systems (MIS) to provide live service information, and install 23 signalized pedestrian crossings to enhance safety and accessibility. The initial investments will catalyze a transformative modal shift in Thimphu, driving the transition from private vehicle dependency towards sustainable public transit through the deployment of a bus priority corridor and expanded fleet of electric buses (detailed in Annex 3).

(5) Water sector institutional systems, tools, and capacities will be strengthened to independently and sustainably deliver climate-resilient water services and plan future investments. Currently, not only is the existing water supply infrastructure too exposed to climate risks to be resilient, along with high levels of NRW reducing system resilience, but the institutional setup, current level of technical capacity, and financial profile of the sector in Thimphu is inadequate to ensure forward-looking climate resilience capacity and an ability to be proactive in addressing and financing climate needs. The project aims to shift this dynamic through a paradigm shift towards a more climate-focused service provider through the following activities: Institutional capacity building is a central pillar of the project, with targeted outputs in the water, urban, and transport sectors. For water services, the project will establish a ring-fenced municipal water and wastewater division, strengthen day-to-day management through digital monitoring (SCADA), improve billing and tariff systems, develop disaster and emergency response processes, and deliver institutional strengthening and policy support, all underpinned by a targeted communications strategy. By project closing, the client should regularly prepare and apply maintenance strategies, emergency protocols, business plans, and budgets to guide climate-resilient water service management, with external support dropping over time as client capacity improves. All relevant municipal staff will be trained in SCADA use, climate-resilient planning, and emergency response, with continuous refresher training required as needed. These improvements aim to increase supply hours from 3-9 hours/day in the baseline up to 15 hours/day at closing (12 hours during the dry season). For urban services, the project will provide analytics which enable improved disaster risk management and recovery by correctly valuing land and property assets to better inform the government on the economic risks of climate shocks to help prioritize strategic resilience planning.

(6) The City Bus Service will be capacitated to become an independent SOE with a national mandate to sustainably operate low-carbon public transport and support its expansion to other cities, facilitating the replication of the model elsewhere in the country. CBS currently operates as a service without the institutional structure, operational expertise, or financial sustainability needed to lead Bhutan's transition to low-emission public transport. The project addresses this by delivering a series of targeted governance, operational, and capacity-building interventions that together contribute to a broader paradigm shift toward a self-sustaining, low-carbon public transport provider. The project will strengthen CBS's day-to-day operations through embedded bus operations consultants, support its transition to delivering services under Public Service Agreements (PSAs) with other Thromdes, help diversify non-fare revenue sources such as retail franchises, advertising, and bus leasing, build the capacity of the broader transport network, and analyze the potential for operators to provide dedicated services such as school buses to reduce peak-hour demand. It will develop national standards for ITS and smartcard payments, and provide policy and institutional support to implement national frameworks including the Low Emission Transport Master Plan, National Adaptation Plan, and Climate Change Action Plan, underpinned by a targeted communications and awareness campaign to drive behavioral change among Thimphu commuters.

181. The project recognizes several barriers and climate risks. The barriers identified in the previous chapter directly inform the design of the LRCP and are explicitly addressed through the project's Theory of Change ([Figure 6-1](#)~~Table 6-1~~). It reflects a structured response to the key constraints identified across the water and transport sectors, with each intervention designed to remove specific, technical & infrastructural information & data, institutional, behavioural and financial barriers to climate-resilient service delivery. The following table illustrates how the project aims to address the barriers identified in Chapter 5.

Table 6-1: Barriers and project response

Barrier (from ToC)	Category	Project response	Project outcome	Sector
Fragmented and weak water service delivery	Technical & infrastructural Information & data	Reorganized WTPs and treated water transmission lines, strengthened distribution network	Urban water services more reliable and resilient to climate hazards	Water
Water system vulnerable to drought, landslide, and flood disruption		Upgraded raw water intake systems, transmission corridor slopes stabilized, better monitoring and distribution control SCADA system installed		Water
Public transport too unreliable and unattractive to compete with private cars	Technical & infrastructural Social & behavioral	Bus priority corridor, e-buses deployed, bus terminals & ITS installed, safer pedestrian access to corridor Traffic circulation management plan developed, communication & awareness campaigns	Urban mobility infrastructure in the project area encourages shift from private vehicle use toward public and non-motorized transport, and becomes more resilient to climate stress	Transport
Low-emission public transport commercially and institutionally fragile	Policy, regulatory & institutional Financial & economic	CBS strengthening, public service agreements/SOE support Business planning, TA for revenue diversification (e.g., non-fare revenues such as advertising or transit-oriented development-associated fees)	The institutions responsible for water and public transport have enhanced capacity to operate, maintain, finance, and replicate climate-resilient and low-emission urban systems	Transport

Urban public realm does not support resilient bus access or safe walking	Technical & infrastructural	Norzin Lam pedestrianization, sidewalks, crossings, drainage, NbS/SuDS	Urban mobility infrastructure in the project area encourages shift from private vehicle use toward public and non-motorized transport, and becomes more resilient to climate stress	Transport
Institutions lack tools to sustain climate outcomes and scale them nationally	Policy, regulatory & institutional	TA: climate-resilient infrastructure design standards, DRM process, planning tools, maintenance systems, policy support for LETMP/NAP implementation	The institutions responsible for water and public transport have enhanced capacity to operate, maintain, finance, and replicate climate-resilient and low-emission urban systems	Both

182. The Theory of Change rests on several key assumptions regarding external factors: (1) Service users can pay higher fares and utility tariffs without unaffordable subsidies or cross-subsidies; (2) Improvements in the reliability, affordability, and accessibility of public transport and NMT options, combined with policies to limit parking, create mobility hubs, provide last-mile services, and other LETMP strategies, will be sufficient to change commuter behavior and encourage a modal shift away from private cars; and (3) There is a continuous political willingness to implement other urban development policies such as increased densification of the BPS corridor and Transit Oriented Development. During implementation, care will be taken to work with the client in a timely and flexible manner to address any of these external factors if they become relevant. In addition, relevant internal risks to the project include whether the project will have sufficient capacity to effectively procure civil works, equipment, and technical systems and that relevant agencies and development partners will coordinate effectively with each other and local stakeholders. The project activities to improve client capacity will work with the client to directly address these institutional capacity concerns through training and providing technical support.

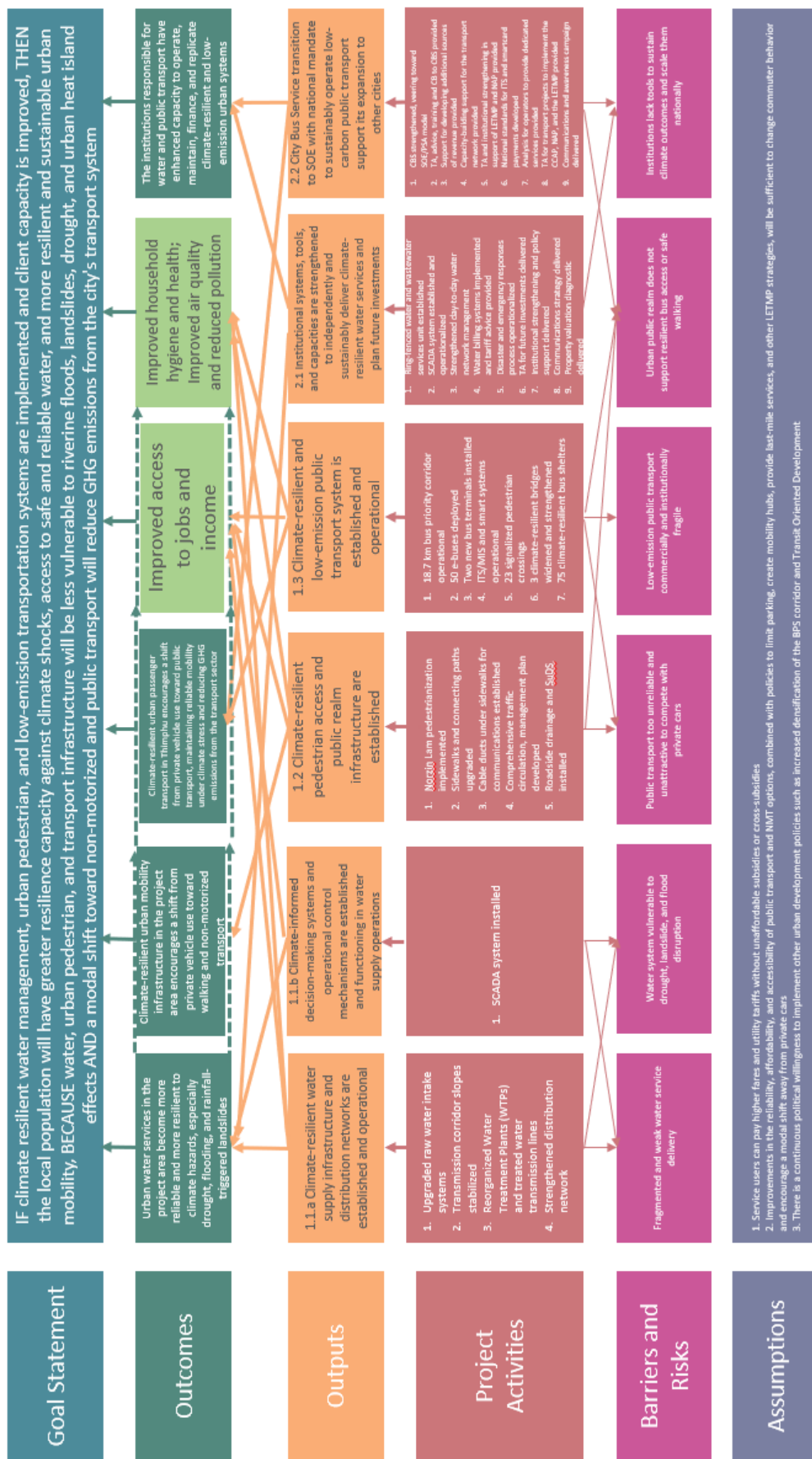


Figure 6-1: Theory of Change

Water Sector Options Analysis

Physical infrastructure investment options considered

183. The project focuses on the city core of Thimphu for water supply improvements. This reflects both (i) complementarity with ongoing ADB-financed investments targeting the northern periphery (see Section 3.4.6), and (ii) strong synergies with the LRCP's planned non-motorized transport (NMT) and streetscape upgrades in the city core. Coordinating water network rehabilitation with road and public realm improvements reduces overall costs and minimizes disruption to urban services.
184. The selection of priority investments is grounded in a consistent body of analytical work and government strategy, all of which identify reduction of non-revenue water (NRW) as the most immediate and cost-effective pathway to improving water security and climate resilience in Thimphu. NRW levels are estimated at over 50% in core areas such as Norzin Lam (GIZ/IWM, 2022) and approximately 37% at the city level (World Bank, 2023), with substantial investment required to reduce losses to acceptable levels. The Thimphu Water Services Master Plan (2023) similarly emphasizes that improving the performance of the existing system—rather than expanding supply—is the priority for ensuring reliable service delivery under increasing climate variability.
185. Beyond NRW, the system faces a set of interrelated constraints that undermine its resilience to climate risks (see Section 4.1), including: (i) inadequate and unreliable water supply, with most areas receiving less than nine hours of service per day; (ii) vulnerability of raw water intakes and transmission lines to sedimentation, erosion, and landslides; and (iii) limited capacity to manage and distribute water equitably, particularly during dry periods. These challenges highlight that NRW reduction alone is insufficient and must be complemented by targeted investments to strengthen the system's resilience to climate-induced shocks.
186. In response, the project adopts an integrated approach that combines efficiency improvements with climate-resilient infrastructure upgrades. The selected investment package includes: (i) installation of SCADA systems to monitor and manage network performance across district metered areas (DMAs); (ii) climate-resilient upgrading of raw water intake structures to withstand extreme flow and sediment conditions; (iii) slope stabilization measures to protect transmission infrastructure from erosion and landslides; and (iv) optimization of water treatment and transmission systems to improve storage utilization and enable more equitable and continuous supply during drought conditions. This approach reflects a shift from an initial focus solely on NRW reduction to a broader resilience-oriented strategy that addresses both efficiency and system robustness under projected climate conditions.
187. Additional infrastructure options were considered but not prioritized for inclusion in the project at this stage:
- i. Expansion of water storage capacity: Current storage capacity in Thimphu is approximately 12 hours, significantly below the 48-hour benchmark recommended for climate-resilient systems. While increasing storage would enhance the system's ability to buffer short-term disruptions, it would require substantial capital investment and faces significant land constraints in Thimphu's dense and topographically constrained urban environment. Given the high levels of NRW, improving the efficiency of the existing system is considered a more immediate and cost-effective priority. Expanded storage is therefore treated as a medium-term investment, contingent on improvements in system performance.
 - ii. Development of new water sources: Expanding raw water supply through new sources was also assessed but found to be less viable in the near term. The availability and quality of untapped sources remain uncertain, and increased abstraction raises concerns regarding environmental sustainability and competing water uses. Groundwater expansion is also constrained by technical limitations and risks to infrastructure durability. Moreover, without first reducing NRW, additional supply would likely result in continued high losses, reducing the efficiency of such investments. Strengthening and climate-proofing existing water sourcing and conveyance infrastructure is therefore considered a more effective and sustainable approach.
188. Overall, the selected package prioritizes high-impact, no-regret investments that improve both operational efficiency and climate resilience of the existing system, while deferring more capital-intensive supply expansion options to the medium term.

Water Sector Improvements

189. As a cross-cutting climate project LRCP has both climate mitigation and adaptation objectives. The main adaptation objectives will be met by creating a resilient water supply network and providing 100% coverage of treated water supplies to residents within the project area, from the current 85%. Supplies of raw water will be designed to be resilient to the effects of climate change by upgrading the intakes from the Samtenling stream in the south of the city which is not able to meet demand in the dry season without groundwater from boreholes, and at other water sources on the upper slopes of the Wang Chhu valley which will be increasingly at risk of drying out as a result of climate change. Slope stabilization for vulnerable hillside transmission lines will help ensure uninterrupted water supply during intense rainfall events and

associated landslides and erosion. Resilience will also be achieved by encouraging residents to reduce per capita water consumption to international norms. The water distribution network within the project area will also be replaced to address the 50% non-revenue water resulting from leakages across the transmission and distribution systems. The replacement of the water networks within the LRCP project area will be coordinated with the construction of the bus priority lanes and the improvements to Norzin Lam.

190. The installation of a Supervisory Control and Data Acquisition (SCADA) system on the water networks across city core Demand Management Areas will allow the system pressures and flows to be balanced to improve system reliability, identify problems requiring further repair or maintenance, and inform further investment decisions to improve climate resilience and capacity.
191. The LRCP will also support the Water Services Department in Thimphu Thromde improve system efficiency and resilience by bringing in private sector operating experience with the aim of creating a financially sustainable water service which is able to factor in climate resilience to its planning and management of the distribution network and in increasing the resilience of the transmission network and the WTPs. MoIT will be responsible for coordinating the parallel funding of other parts of the water networks in Thimphu funded through the 13FYP and other donor programs (see Section 3 above). The overall objective for the water network improvements in the Thimphu Water Services Masterplan is to provide all properties within the project area with a 24/7 supply of treated water, to reduce pluvial flooding during the monsoon by integrating the roadside drainage with the SUDS provided under the ECRUL project, and to ensure that all greywater is connected to the sewerage network to avoid contaminating the nature-based solutions for stormwater filtration and discharge. By providing institutional strengthening to the Water Services Division, LRCP will have a pivotal role in achieving these wider objectives whilst improving the water supply system specifically and by integrating these into the transport infrastructure improvements.
192. Leakage reduction will be a necessary part of any water sector adaptation plan for the city to ensure any system improvements are not lost to such leakages. For instance, the Chamgang WTP 2 has a production capacity of 6.5 MLD, but output is cut nearly in half to 3.5 MLD during the dry season due to climate change. Reducing NRW during the dry season below 50 percent will be a necessary part of the solution mix to drought management for the service area. Reducing NRW will also reduce the need to regularly tap existing groundwater sources within the Chamgang WTP 2 service area, which will build more flexibility into the system during emergencies. The new Taba WTP (not financed by LRCP) will provide an additional 15 MLD in production capacity, but NRW will need to be reduced below 50 percent to ensure this new capacity is best utilized to deal with both droughts and inter-seasonal variation. The reduction in NRW is designed in tandem with improvements and repairs to the sewage system. These works are a fundamental part of a comprehensive urban climate resilience program, particularly for populations facing the interrelated triple burden of poverty, climate risks, and unreliable sanitation access.⁷³ Such works are vital for increasing climate resilience due to Thimphu's acute pluvial flood risks – with 1-in-100 year rainfall events projected to occur every 5 years by the 2060s.. These intense storms cause frequent sewer overflows onto city roads, posing a severe threat multiplier that risks contaminating the municipal water supply and physically damaging the project's transport corridor investments.
193. NRW reduction will also reduce overdrawn of storage capacity during drought events. NRW reduction will also complement the Master Plan goal to more fairly, sustainably, and efficiently supply water to all consumers in the face of both expected climate shocks and population growth. On paper, the system currently sources 130 lpcd, but after taking NRW into account, this falls to 65 lpcd in the wet season and 30 lpcd in the dry season. Per the Master Plan, there is a target NRW rate of 30 percent in 2032, with a per capita consumption rate of 120 lpcd. By 2047, the target NRW rate is 15 percent and per capita consumption is 100 lpcd, inclusive of NRW, thus still representing a net increase in per capita water consumption while also achieving efficiency gains. Achieving the target NRW rate of 15 percent would see total demand at 18 MLD in the core city, with production capacity just above that at 19 MLD. Current and planned capacity is at 28 MLD based on the production needs of the current NRW rate of over 50 percent, but reducing NRW down to a more manageable level will allow the city to allocate more sourced water to storage needs. NRW reduction is thus an important part of any plan to help increase storage capacity to 49 ML by 2047.
194. The project will introduce climate risk-informed asset management: a geospatial asset register, condition assessments, and risk-based renewal planning aligned with capital budgeting. Pair with predictive maintenance, energy-efficient pumps and variable frequency drives, and optimized pump scheduling to lower operating energy and improve reliability. These steps are consistent with good practice for climate co-benefits in the Water sector. Planned improved integration of hydromet and urban risk information systems will help align operations with forecasts, early warnings, and hazard maps, thus improving both emergency response and routine planning.
195. An example of the combination of drains and SUDS that will be installed along the bus priority corridor and Norzin Lam is shown in the following diagram, taken from the Stormwater Masterplan.

⁷³ World Bank. The Global Sanitation Crisis : Pathways to Urgent Action Full Report (English). Washington, D.C.: World Bank Group. <http://documents.worldbank.org/curated/en/099082025114020787>

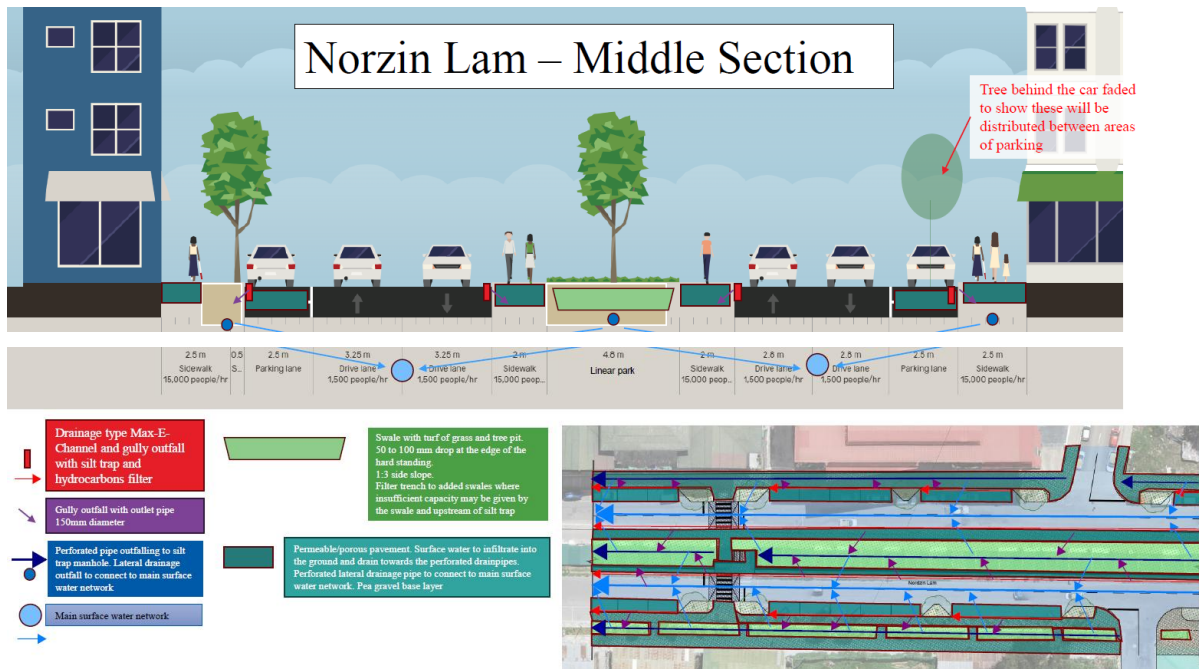


Figure 6-2 Norzin Lam Street Section Plan with SuDS Infrastructure Management Plan

196. The targets for creating resilient water networks are in the LRCP logframe.
197. The SCADA will be installed through the LRCP project, and technical assistance provided through Component 2 will procure the additional infrastructure to balance the system and reduce NRW using 13FYP funds as required. The technical assistance will also use the data to continue to optimise system performance and prioritise maintenance and continuing implementation of the Masterplan, using 13FYP funds. The WBG Country Partnership Framework (FY25–29) emphasizes integrating climate risk into infrastructure development and strengthening institutions for hydromet, risk-informed urban planning, and resilient services.
198. The LRCP project will deliver some of the proposed activities in the NAP including the provision of SCADA instrumentation in the city core District Metered Areas (DMAs), replacing those parts of the existing water distribution system which are corroded and leaking, and installing water meters at each property along the bus priority corridor and along Norzin Lam. It will also provide climate-resilient transport and clear water infrastructure within the city core as described in this Feasibility Study. It will support TT in prioritising these adaptation activities and implementing them through technical assistance and institutional strengthening to both MoIT and TT to ensure proper monitoring, planning, and reliable supply of drinking water, the promotion of water-efficiency technologies, the reduction of Non-Revenue Water (NRW) and strengthening drinking water quality monitoring and surveillance. LRCP will also contribute to some of the Key Performance Indicators for Human Settlements and Climate-Smart Cities included in Part II of the NAP: Detailed Priorities and Needs for Adaptation. society – population and demographics.

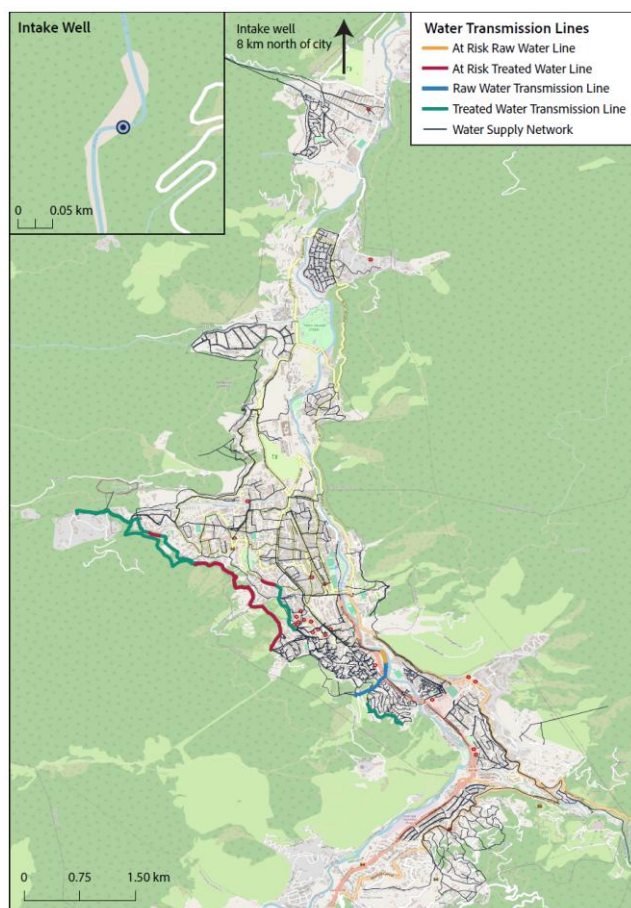


Figure 6-3 Map of existing water system and planned improvements

Transport Options analysis

199. The scope of the technical designs for the LRCP appraised several options for each of the components of the transport project separately:

- the design of an 18.9km Bus Priority Corridor, with dedicated bus priority lanes, along the north-south road parallel with the Wang Chhu River. This is the main corridor through the city of Thimphu and therefore the core of any bus priority scheme. Most of the existing route is dual carriageway, with several intersections and roundabouts, although no traffic signals.
- the specification and procurement of low or zero-emission buses;
- the design of an Intelligent Transport System, building on the entry-level system already in place, to provide information on routes, bus schedules and e-ticketing to make choosing public transport easier;
- a Management Information System to provide up-to-date information on the status of bus services, and to assist in the planning of maintenance and optimise the charging of e-buses and therefore battery life;
- technical designs for the terminal buildings;
- locations and designs for the bus bays, bus stops, and a bus depot for the maintenance, cleaning and charging of the bus fleet;
- based on traffic modelling, the size of the bus fleet required to provide sufficient capacity and headway of 10 minutes or less during the peak period on the bus priority corridor;
- designs for the pedestrianisation of Norzin Lam in three phases.

200. All of the options were presented to officials from MoIT, Thimphu Thromde PIU, and City Bus Service and most were subject to public consultation. The technical designs were modified to minimise the need to acquire private land and remove trees, and the social and environmental impacts of different options also informed the multi-criteria analysis that was used to select a preferred option for the design of the bus priority corridor. The project preparation provided an ESIA and Gender, Social Inclusion, and Resettlement Action Plans which are summarised in separate annexes to the FP. The

economic analysis considered the economic costs and benefits of the LRCP and the expected GHG reductions from its implementation. The financial analysis considered the financial viability of the City Bus Service as the operator of the public transport services and the cashflows within Thimphu Thromde as the Implementing Agency for the construction and maintenance of the bus priority lanes.

Bus Priority Lane Options

201. In preparing the technical designs for the LRCP, several options for the provision of the Bus Priority Lanes were considered:

- Option A: Do Nothing (Business as Usual)
- Option B: Widen the existing single-carriageway sections and provide a dedicated bus lane along the whole corridor, thus reducing the general lane to a single lane in each direction.
- Option C: Do minimum, which is to provide a dedicated lane along the dual carriageway sections of the corridor but to mix buses and general traffic on the single carriageway sections.

Travel demand modelling (TDM)

202. To determine the optimal design, a comprehensive analysis was undertaken to model travel demand and traffic service levels in various Bus Priority scenarios (i.e., different potential configurations of Options B and C).

203. **Data collection and inputs:** The TDM and scenario analysis were informed by a combination of primary field surveys and secondary literature reviews conducted in 2022-2023. Key primary data sources included: (i) a Trip Pattern (origin-destination) perception survey of 3,247 respondents; (ii) a geometric road network survey conducted along the corridor from Ngabiphu to Dangrina Terminal; (iii) a travel time and delay survey for bus access time, wait time, and dwell time; (iv) a passenger boarding and alighting survey for bus occupancy; and (v) a traffic volume survey covering 28 locations from Babesa to Kabesa, using both manual counting and camera recording at 6-hour, 12-hour, and 24-hour intervals. Secondary data drawn from literature reviews included socio-economic indicators (population, students, employees), population growth projections (from Population Projections Bhutan 2017–2047), fuel prices and efficiency, parking fees, bus and taxi fares, vehicle occupancy rates, passenger car unit (PCU) standards (from the Indian Highway Capacity Manual and Bhutan Urban Transport System, 2011), and road capacity parameters.

204. **Methodology:** The study employed a classic Four-Step travel demand model (trip generation → trip distribution → modal split → traffic assignment) implemented in TransCAD. Trip generation used a regression model with population, employment, and student numbers as independent variables across 30 modeling zones. Trip distribution applied a gravity model using zone-to-zone travel time as the impedance function. Modal split is estimated via a multinomial logit model for three modes—private car, taxi, and bus—incorporating travel time, travel cost, and dummy variables for urban density and bus terminal presence. Traffic assignment used the User Equilibrium method with a volume-delay function. The model was calibrated against 2022 observed traffic volumes at 39 locations, achieving an average error rate of –1.9%.

205. **Multi-criteria analysis:** The study evaluated three overarching scenarios — Business as Usual (no BPS), Business to Be (BPS implementation with/without road expansion), and Business to Be with Modal Shift (BPS plus a targeted shift from private vehicles to public transit). Within the BPS scenarios, seven busway design options were assessed along the corridor and scored through a multi-criteria analysis considering traffic capacity and level of service, bus service improvements (travel speed and time), traffic safety risk, technical feasibility (ITS and signal operation requirements), land acquisition and social/environmental impact, and implementation cost. The seven options evaluated were:

- Option 1 — Dual lane busway for the entire corridor (2/3-lane sections expanded to 4 lanes; one BPL + one general lane per direction)
- Option 2 (Center) — Single lane, dual-direction busway with block signaling (existing roads expanded by one lane; BPL in the center)
- Option 2-1 (Curb Side) — Single lane, dual-direction busway with reversible curbside BPL (lane direction changes by time of day)
- Option 3 (Center) — Mix of dual lane BPL on 4-lane sections and single center-lane BPL on expanded 3-lane sections
- Option 3-1 (Curb Side) — Mix of dual lane BPL on 4-lane sections and reversible curbside BPL on expanded 3-lane sections
- Option 4 (Dual & Mixed) — Dual lane BPL on 4-lane sections; mixed traffic (no dedicated BPL) on 2-lane sections
- Option 4-1 (Curb Side) — Dual lane BPL on 4-lane sections; mixed traffic on most 2-lane sections, with a curbside BPL expansion on S Doebum Lam

206. **Results:** The analysis identified Option 1 (Dual Lane Busway) as the recommended design. With ambitious modal shift driven by improved service and complementary policies (from 5% to ~30% over 20 years), the BPC maintains level of service (LOS) "A" on bus lanes and "D" or better on general lanes. By 2047, bus speed on the BPC improves by 11.8 km/h with a 50-minute travel time reduction. General vehicle speeds also improve (+11.3 km/h by 2047 vs. BAU), reducing

congestion and associated emissions. These improvements are conditional on an adequate fleet size – at least 40 buses operating on the BPS trunk route plus 30 on feeder routes initially, expanding to at least 111 total buses to accommodate growing ridership over time – to operate the system with sufficient frequency and reliability to attract substantial modal shift.

Chosen option for BPL

207. The recommended option from the TDM (Dual Lane Busway) was then subjected to a “value engineering” analysis to determine the optimal design of the corridor from a climate perspective, since it had the greatest benefits in terms of traffic management but also the highest cost of construction. A variation was identified with the potential to achieve the same climate benefits as the full duelling but at a lower capital cost. Each section of the corridor was considered separately for the future traffic growth that would result from planned residential developments in districts adjacent to the corridor, as set out in the Local Area Plans. Other factors were also considered, such as the proposed relocation of the inter-urban bus terminal (not part of LRCP) and the need to acquire private land to widen the road and accommodate the minimum standards for the sidewalks, bus bays, and shelters. This analysis concluded that the widening of the existing single-carriageway sections to add bus lanes as far as Dechencholing bridge (which would also be widened) was required, but that, given low projected traffic volumes in both BAU and with-project scenarios, the existing 2.5km of single-carriageway road from the Dechencholing bridge to Dangrina bridge need only be widened to provide for the minimum 3.5m carriageway and the minimum specification for the widths of sidewalks and bus bays using the standard road cross sections applied along the rest of the corridor, with buses operating in mixed traffic for this final segment. This resulted in a 10.2% saving in capital costs compared to Option 1 for the same GHG reduction benefits and no reduction in traffic or bus speeds.
208. The “value engineering” exercise also considered the safety of pedestrians needing to cross the Expressway to access the bus stops. There have been some pedestrian fatalities on the main corridor in recent years, because, although the existing crossings are often located on speed bumps and overseen by the traffic police, they are not always clearly marked and drivers may not always see pedestrians or give way when they are on the crossing. The BPS will potentially triple the number of passengers needing to cross the Expressway to access bus services; therefore, the project will provide 23 signalised crossings along the corridor to improve safe and convenient access to bus stops. The signals could be configured to give priority to approaching buses by a few seconds delay to the pedestrian phase if required, thereby allowing the bus to pass through without having to stop.
209. This value-engineered option for the design of the bus priority lanes and the supporting infrastructure described in the following sections, together with the introduction of the LETMP strategies for encouraging a modal shift to non-motorised and public transport that can be implemented immediately, such as restrictions on on-street parking, is presented as the preferred option for the further analysis of LRCP's economic and financial viability, and potential for reducing GHG emissions compared to Business as Usual in this feasibility study.
210. **Final chosen configuration (“Option 2A”):**
1. Provision of dedicated BPL in both directions along corridor up to Dechencholing Bridge, including widening 2- and 3-lane segments to 4-lane where necessary);
 2. 2.5km segment from Dechencholing Bridge to Dangrina to remain 2-lane with buses operating in mixed traffic; minor widening to accommodate bus bays, shelters, sidewalks (see section 6.4.5 for detail on this associated infrastructure).

Options for new and replacement buses

211. Given the primary objective for LRCP is to reduce GHG emissions and to benefit from the significant investment that Bhutan has made in developing its hydropower resources, several options were considered for transitioning the city's bus fleet from diesel vehicles to low- or zero-emission buses. In addition to GHG emissions from the power source of the buses, other environmental factors such as particulate emissions were also considered in the options appraisal against European Environment Agency (EEA) standards. Based on the TDM, a total fleet of 111 buses is considered necessary for effective operation of the improved bus priority system, meaning an additional 50 need to be added to the current fleet.

Zero-Emission Buses

212. Zero- or extremely low-emission vehicles, with no emissions of Carbon Monoxide (CO), Nitrogen Oxides (NOx), Particulate Matter (PM), and Methane (CH4).
213. Within this category, there are three basic options - plug-in hybrid, battery-electric, trolleybuses with overhead cables, and hydrogen fuel-cell vehicles. Given that Bhutan is developing its electric vehicle charging infrastructure, electric buses are recommended due to their cost-efficiency and significant reduction in energy consumption and emissions. However, plug-in hybrid and fuel cell vehicles could be considered in areas with inadequate charging infrastructure, cold climates,

or long daily driving distances where electric buses may not be suitable. Alternatively, Bhutan could consider fuel-cell buses for certain routes as it develops plans for the production of green hydrogen.

Table 0-2: Feature Comparison of Renewable Energy Buses by Propulsion System

Item	Plug-in hybrid system	Battery electric system	Fuel-cell system
Types of propulsion energy	Petrol, gas, & electricity	Electricity	Hydrogen & Electricity
Range	☆☆☆	☆☆	☆☆☆
Energy supply time	☆☆	☆	☆☆☆
Vehicle Price	☆☆☆	☆☆	☆
Operating expense	☆☆	☆☆☆	☆
Maintenance cost	☆☆	☆☆☆	☆
Life span	☆☆☆	☆☆	☆
Dependence on supporting facilities	☆☆	☆	☆
Reduction of pollutant	☆	☆☆☆	☆☆☆
CO2 reduction	☆	☆☆☆	☆☆☆
Safety	☆☆	☆☆	☆☆

BSIV (Equivalent to Euro 4) Diesel buses

214. The BSIV emission standard reduces fine particulate and pollutant emissions from vehicles by using fuels with a sulphur content of 50 ppm.

BSVI (Equivalent to Euro 6) Diesel buses

215. The BSVI emission standard further reduces nitrogen oxide and fine particulate emissions from vehicles by lowering the sulphur content of fuels to 10 ppm.

216. The choice of vehicle type in Bhutan should be based on factors such as temperature, terrain, energy infrastructure, and road conditions in specific cities.

Table 0-3: Comparative Assessment: Zero-Emission vs. Clean Diesel Buses

Category	Zero-Emission Buses	Clean Diesel Buses
Types	Mainly Electric Buses (Battery Electric Buses - BEB)	BSIV (Euro 4 equivalent) and BSVI (Euro 6 equivalent) are the cleaner versions.
Market Availability	Significant growth in availability due to global shifts towards electrification. Several manufacturers now offer multiple BEB models.	Widely available due to the well-established diesel engine industry.
Feasibility	Requires investment in charging infrastructure. The rate of charging can be an issue in continuous operations.	Ready to use with existing fuelling infrastructure. No additional infrastructural investment is required.
Emissions Benefit	BEBs produce zero tailpipe emissions.	They emit fewer pollutants than older diesel models but are not emission-free. BSVI (Euro 6) is significantly cleaner than BSIV (Euro 4), emitting lower NOx, CO2, and particulate matter.
Operational Range	Generally 150-300 miles per charge, depending on battery size and bus configuration.	Diesel buses typically offer long operational ranges without the need for refuelling, often exceeding 500 miles.
Cost	Higher upfront costs compared to diesel buses, but operational costs are lower due to cheaper electricity vs. diesel.	Initial costs are generally lower than zero-emission alternatives. However, they have continuous fuel costs, which can fluctuate based on global oil prices.

Chosen option for bus fleet

217. One of the objectives of the LRCP is to transition from the existing diesel bus fleet (euro1, BS III, BS IV) to electric buses (ZEB) to reduce GHG emissions and environmental pollution in the most cost-effective way taking into account the whole life costs of the buses and fuel, whilst also growing the bus fleet to provide the capacity for the significant modal shift from private cars to public transport that would be required to maintain an acceptable level of service from the existing constrained road network. The approved 2015 PPF grant application considered that all-electric bus technology was not sufficiently developed to transition directly to e-buses, but since then much more experience of the technology has been gained, particularly in China and India and prices are continuing to fall.
218. Given the cost and environmental advantages of locally generated hydropower over imported diesel, the preference that emerged from the stakeholder consultation during project preparation was to introduce 9-10 meter electric buses (with a capacity of up to 50 passengers) for the main BPL route, as the existing diesel buses (with an average capacity of ~30 passengers) reach the end of their economic life. There would be a phased transition to electric buses as the existing diesel buses approach the end of their operational life.
219. Following industry interviews and a review of the pilot project, comprehensive Bhutanese requirements and specifications for the procurement of e-buses were drafted. Potential electric bus manufacturers were assessed, resulting in the proposal of the following summarized key specifications for electric buses suitable for Bhutan (the specific bus model to be procured will be determined during implementation):

Table 0-4: Electric Bus Specification

Specification	Value
General Requirements	Introduction of a new, fully electric bus suitable for public passenger transport in Thimphu, Bhutan Purchase plan for up to 40 electric buses plus an additional 10 to replace the oldest diesel buses Emphasis on using the latest technology and models
Coach Aspects	Customizable bus dimensions (length, width, height) Minimum of 28 seats, including priority seats (total capacity ~50) Accessibility features for less-abled passengers Certification for maximum passenger capacity Specific requirements for doors, windows, flooring, and step height Energy-efficient lighting and air conditioning Passenger amenities like USB ports, Wi-Fi, and displays
Glider Component	Compliance with Indian road safety standards Assisted steering, turning capabilities, and road clearance Suspension and tyre specifications
Electric Drive System	Fully electric drive system with battery technology Speed capabilities, battery system details, and charging standards Motor power, circuit breakers, and instrumentation Regenerative braking and safety features
Safety	Speed limitations during open doors and charging Fire suppression with CO2 extinguishers Handrails, stanchions, and CCTV requirements Reversing camera
Performance	Acceleration and reliability expectations Durability requirements
Support Services	Availability expectations Operation manual with detailed information

	Mechanical warranty and service support
	Spare parts availability
	End-of-life battery management

220. Specifications for electric buses and electric bus chargers may require some customisation for service in Thimphu and throughout Bhutan. However, it has to be recognised that Bhutan will always be a small market and some customisation may not be economic or attract sufficient market interest to obtain competitive prices. It may be cost-effective to procure the bus chassis and body panels, seats etc. in kit form for local assembly. This option should be explored through the procurement process.

221. LRCP will finance the first phase of the planned fleet expansion with a tranche of 50 e-buses, operating on the trunk routes of the BPS corridor, and associated charging and other supporting infrastructure (see next section). After project close, CBS will be in a position to continue expanding the fleet with additional e-buses through 2048 and beyond (see Annex 3 for financial projections and indicative fleet expansion plan).

Assessment of Bus Priority Scheme supporting infrastructure

222. The infrastructure improvements to provide standard lane and sidewalk widths along the route and to provide easy and safe access to the buses, vehicle and pedestrian safety, as well as facilities for parking, cleaning, and maintaining buses when not in service, comprise:

- Terminal improvements at 3 locations (Ngabiphu Terminal, City Bus Depot, Dangrina Terminal)
- Bridge widening at 2 locations (Pamtsho Bridge, Dechencholing Bridge)
- Bus Stop improvements with the provision of a bus layby, shelter and widened sidewalk at 75 locations
- Sidewalk and crosswalk improvements
- Junction improvements

223. To meet these requirements, road cross-sections were designed with an appropriate lane width, median, shoulder, drainage, and sidewalks based on the specific conditions of each section while still meeting the minimum dimensions for the widths of the lanes, sidewalks (including bus stops), median, shoulder, and drainage. The following design criteria were followed:

- Lane Width: The minimum lane width needed to ensure safe vehicle operation and ensure efficient traffic flow. Bus lanes typically need sufficient width to prevent conflicts with other vehicles.
- Median: The median is used to divide the lanes and plays a role in enhancing vehicle safety and efficiency.
- Shoulder: Road shoulders are used in emergency situations or when vehicles need to stop and are included as part of the road cross-section.
- Sidewalk: Sidewalks are an important component for ensuring pedestrian safety and accessibility.
- Bus Stops: The location and design of bus stops are planned with efficient bus service and passenger convenience in mind.
- Drainage: will take into account future climate change in determining the design's appropriate return period

224. These design criteria are essential to ensure the safe operation of a bus priority lane and maximize the convenience of passengers and vehicles.

225. The specific design criteria were applied as follows. In areas without existing sidewalks, new sidewalks are proposed to improve accessibility to bus stops and to establish connections to surrounding roads. A minimum width of 1.2 meters is planned to ensure safe pedestrian access. In the sections where Bus Shelters are proposed, a sidewalk width of 2.5 meters is planned for Bus Shelter installation.

226. The road width for the Bus Priority Scheme (BPS) is proposed to be 3.5 meters, and this decision was made after reviewing design standards from the United States and Bhutan, and through discussions with relevant authorities.

227. Based on these design criteria, the typical cross-sections for the route with the Bus Priority lanes were as follows.

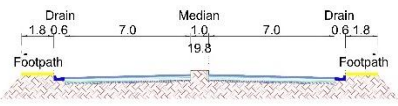
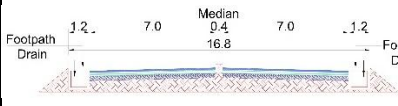
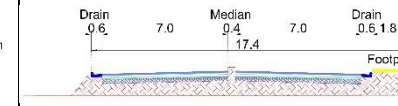
Type 1	Type 2	Type 3
 Footpath: 1.8m Drain: 0.6m Median: 1.0m	 Footpath & Drain: 1.2m Median: 1.0m	 Footpath: 1.8m Drain: 0.6m Median: 0.4m

Figure 6-34: Typical road cross-section (Minimum sidewalk width)

228. In designing the bus priority lanes, "ground level" and "design level" were important considerations:

- Ground Level: Ground level represents the actual elevation of the existing road or area. It is associated with the local topography and natural features of the area and primarily reflects the existing state of the land. Ground level is related to the surrounding environment, buildings, rivers, etc. It denotes the existing elevation of the land or area where the bus priority lane will be located.
- Design Level: The design level relates to the design of the road or other structures and indicates the specific elevation to which a particular road or lane should be designed to meet the efficiency, safety, accessibility, and other requirements of the road. It provides the specification for the future design of the road or infrastructure structure.

229. In the design of the bus priority lane, the relationship between ground level and design level is considered to determine the height or elevation of the bus priority lane. This is a critical factor in ensuring that the bus priority lane functions properly and provides convenience and safety for passengers and drivers. Therefore, the difference between these levels represents the amount of cutting or filling required during construction.

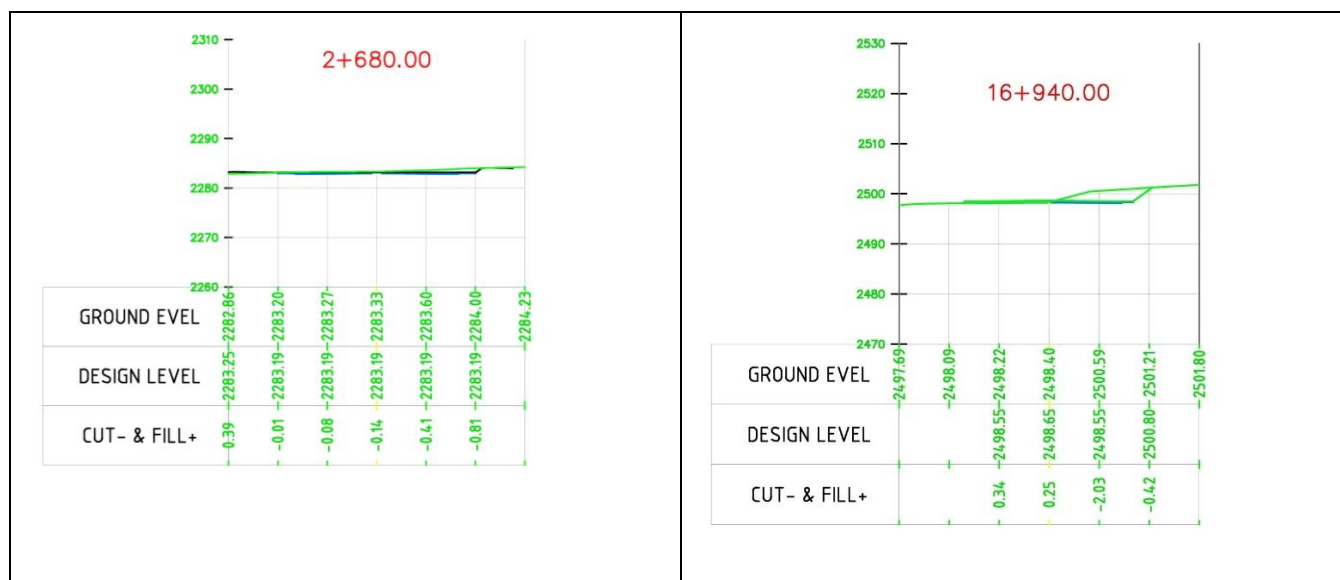


Figure 6-45: Road elevations

230. The design of junctions along the road was based on the following design principles to provide a safer, more efficient, and sustainable road network:

- Safety - through the provision of sightlines, speed management, and traffic control
- Efficiency of traffic flow to reduce congestion
- Accessibility for all road users, including pedestrians and cyclists.

231. Roundabouts were designed to promote continuous traffic flow, with entry and exit lanes that facilitate smooth entry and exit. They also serve as a traffic calming measure.
232. Junctions were designed to accommodate turning movements with appropriate radii and lane widths and included pedestrian facilities like crossings, sidewalks, and refuge islands.
233. Intersections were designed to guide and separate conflicting traffic streams and optimize visibility through signage, road markings, and lighting. Account was also taken of the recommendations in the LETMP as well as the phasing of the pedestrianization of Norzin Lam, as shown in the following diagram.

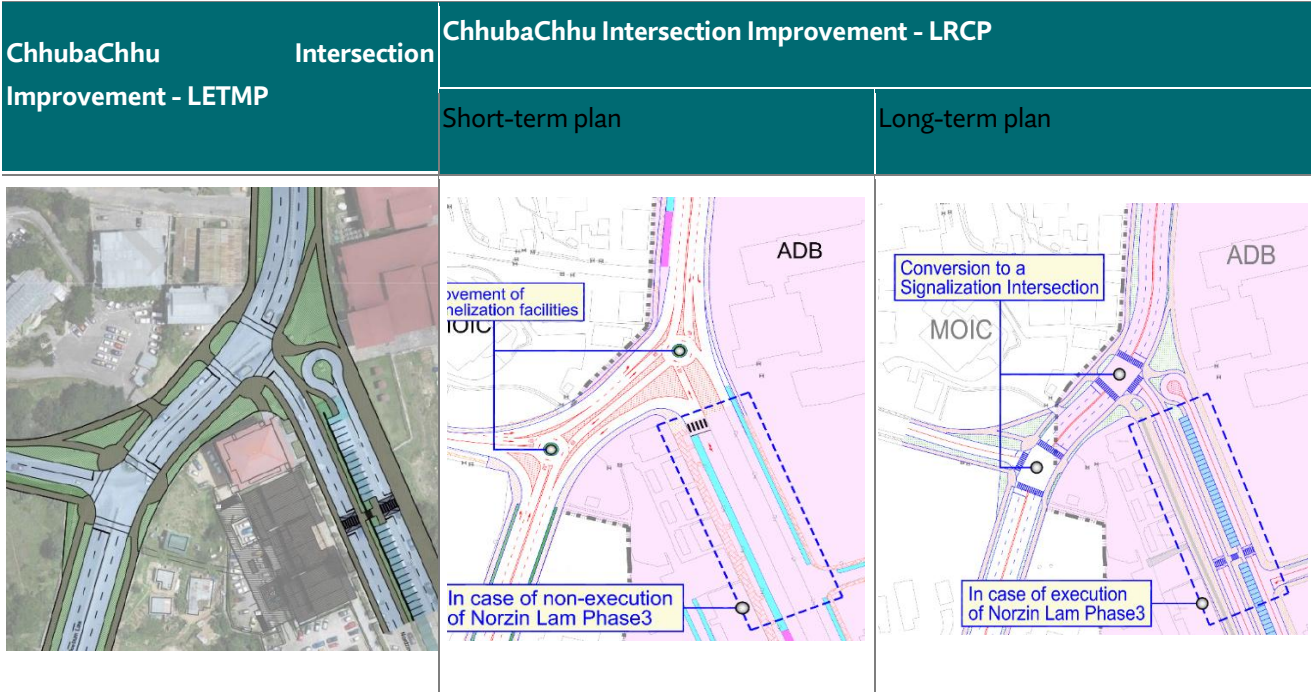


Figure 6-56: Proposed Road & Intersection Improvements at ChhubaChhu

234. The vertical alignment, or gradient of the road, was designed against the following criteria:
- Grade (Gradient): The vertical alignment was designed to ensure efficient vehicle movement and sharp changes in grade were avoided by having smooth transitions.
 - Maximum and Minimum Grade: The minimum grade ensures passenger and vehicle safety, while the maximum grade is restricted to maintain efficiency in vehicle operations.
 - Accessibility: Vertical alignment took into account the accessibility of pedestrians and individuals with disabilities and excessively steep grades were avoided.
235. The design criteria for bus bays were as follows:
- Length and Width: Sufficient space for buses to stop and load or unload passengers while ensuring space to avoid conflicts with surrounding traffic.
 - Grade: The cross-slope of the bus bay was designed to be flat to allow safe movement for passengers and drivers.
 - Accessibility: Bus bays were designed to offer easy access for pedestrians with a smooth transition between the pedestrian sidewalk and the bus bay.
 - Bus Bay Signage: The location of the bus bay is marked for road users.
 - Safety: The bus bay design considered the safety of passengers and drivers by preventing collisions between stationary buses and surrounding vehicles.
 - Amenities: Bus bays are equipped with shelters, lighting, benches, signs, and other facilities for passenger convenience.
 - Access: Access paths leading to each bus bay have appropriate design and signage to ensure the safety of bus operations.

Design of a typical bus bay

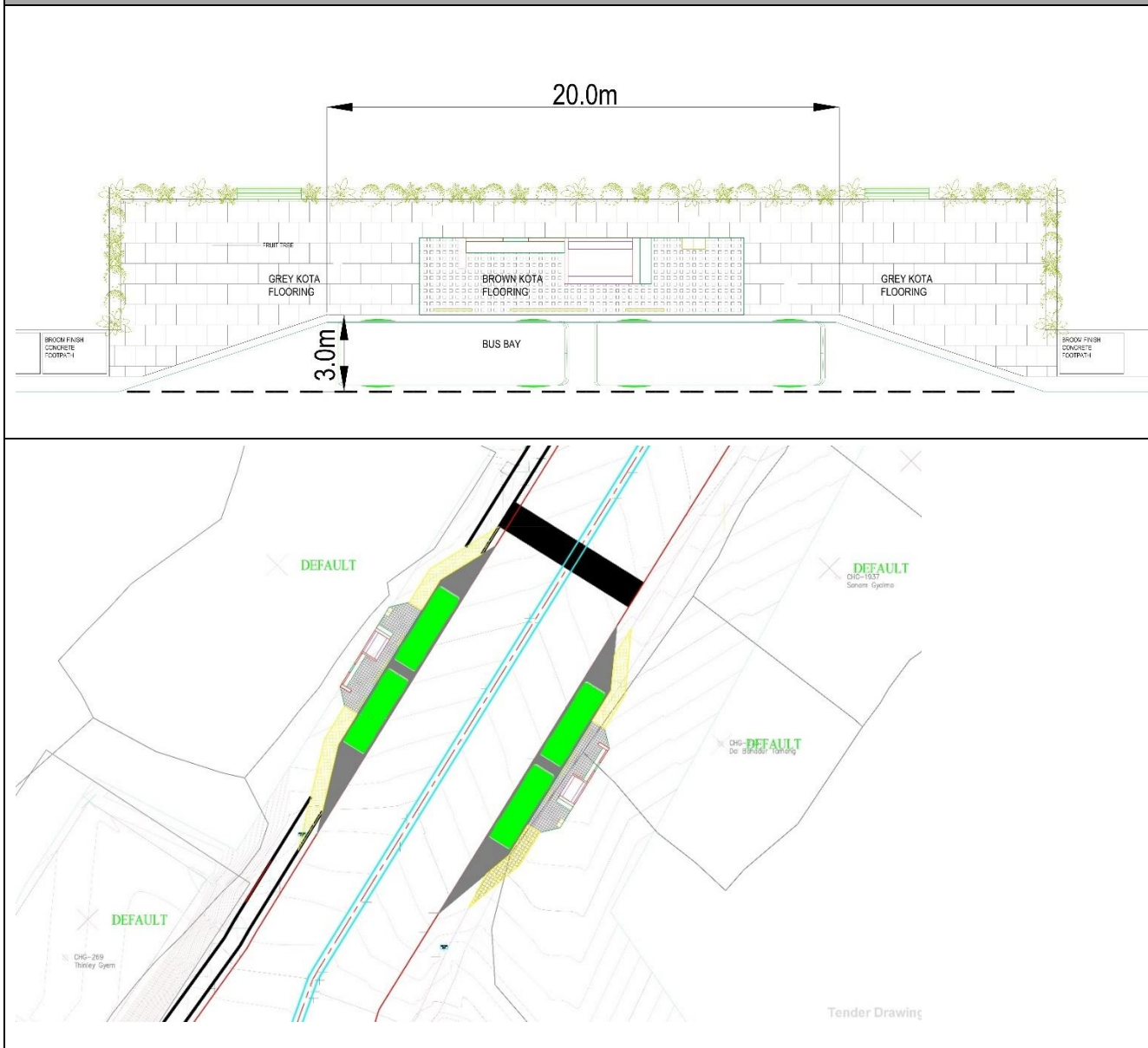
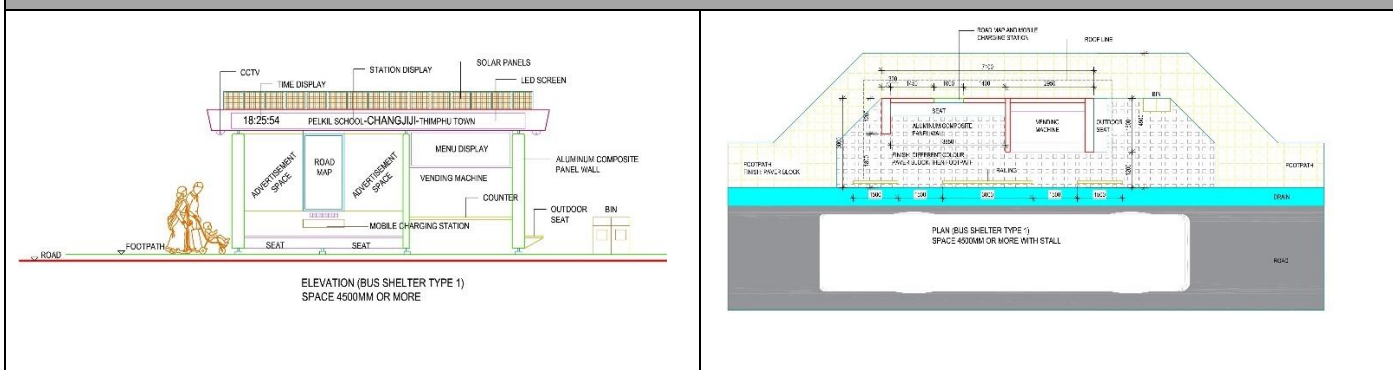


Figure 6-67: Bus bay layout plan

Type 1



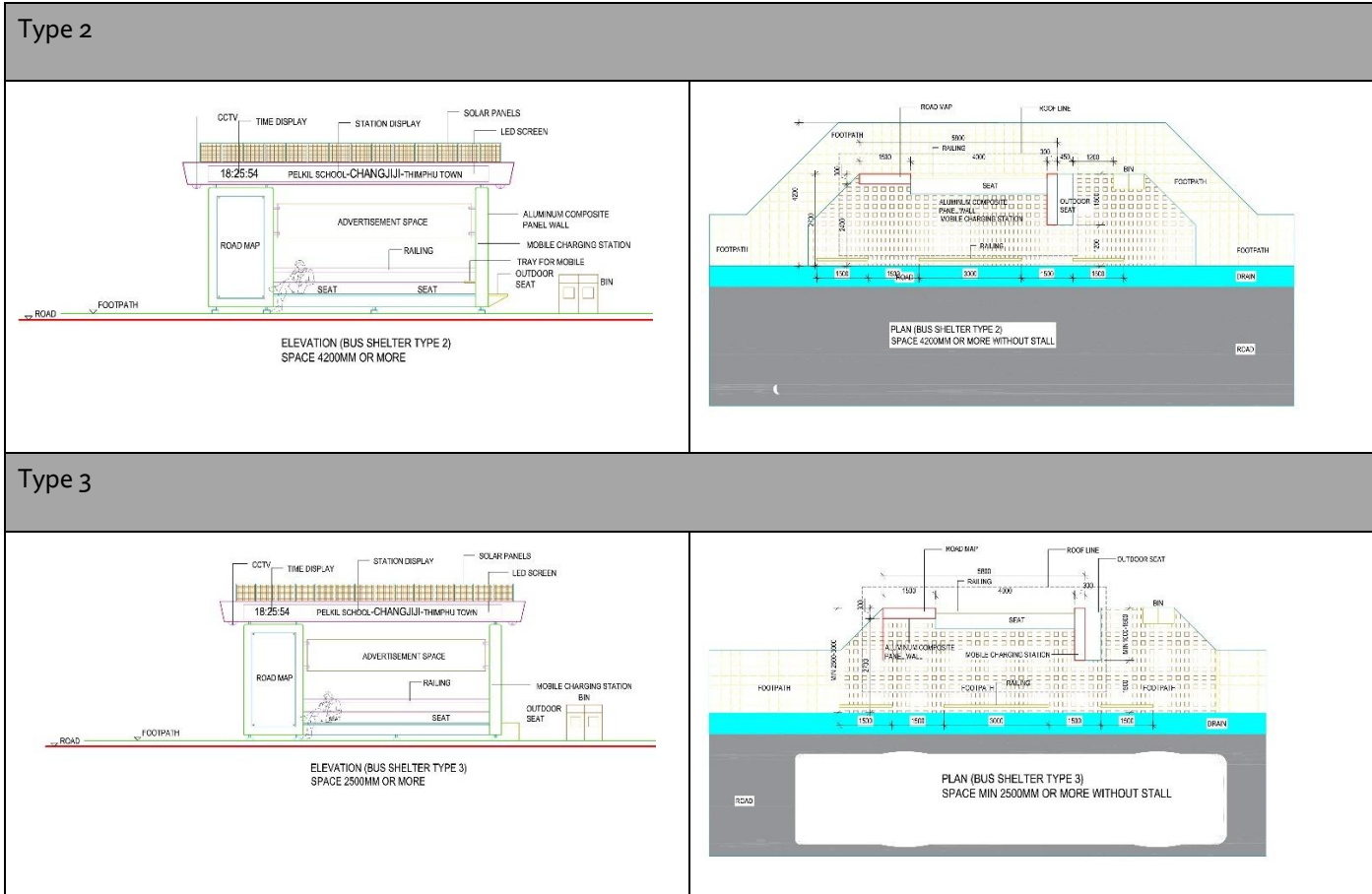
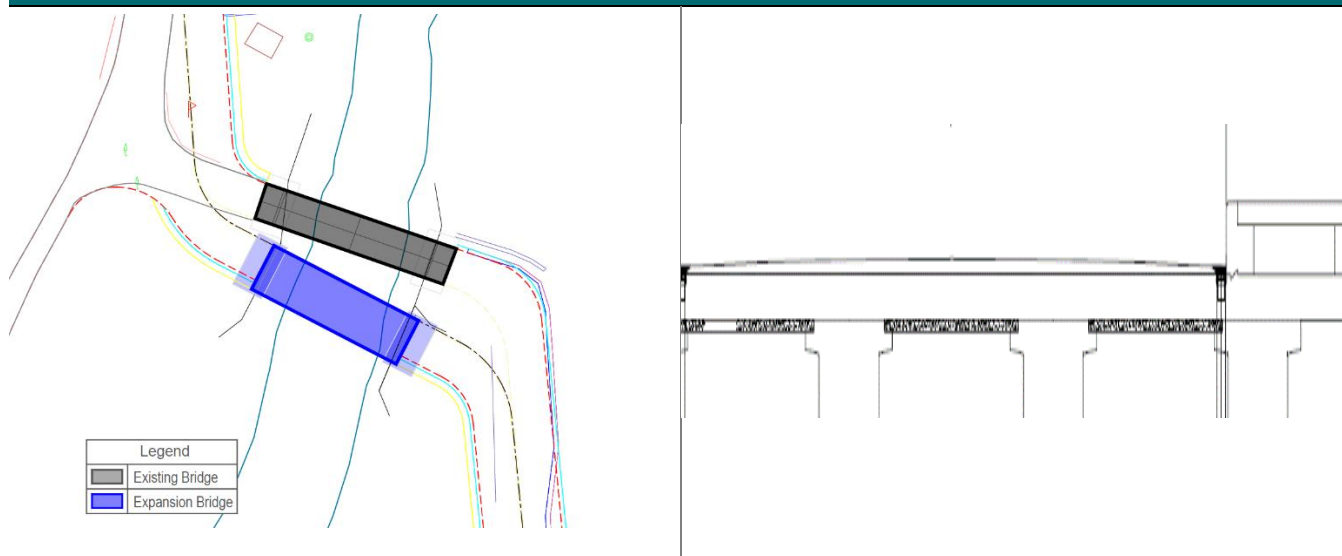


Figure 6-78: Bus shelter design

236. The design of the bridge widening is based on the following principles:

- **Load and Structural Reinforcement:** the structure, including the bridge supports and abutments, must be capable of accommodating the additional loads resulting from additional vehicles and bus operations.
- **Width:** The bridge should be able to accommodate the bus priority lane.
- **Vertical Clearance:** This should be capable of meeting the appropriate design standards.
- **Sidewalks and Pedestrian Accessibility:** The expanded bridge should be designed with sidewalks that allow pedestrians to safely traverse the bridge.
- **Environmental Impact:** The design takes into account flood control (climate change will be taken into consideration), water quality protection, and ecological considerations.
- **Signage and Lighting:** Proper signage and lighting were incorporated into the bridge widening design to ensure user safety.
- **Temporary Traffic Management:** to ensure the safety of vehicles and pedestrians during bridge construction.
- **Proper Construction Sequence:** to allow usable portions of the bridge to be maintained while other portions are widened.
- **Work Times and Traffic Flow:** to minimize disruption to traffic flow and bridge access during construction.
- **Temporary Support Structures:** to protect existing bridges and ensure the safety of workers and traffic participants.
- **Environmental protection and management:** to minimize the impact on surrounding areas and comply with environmental laws and regulations.

Dechencholing Bridge



Pamtsho Bridge

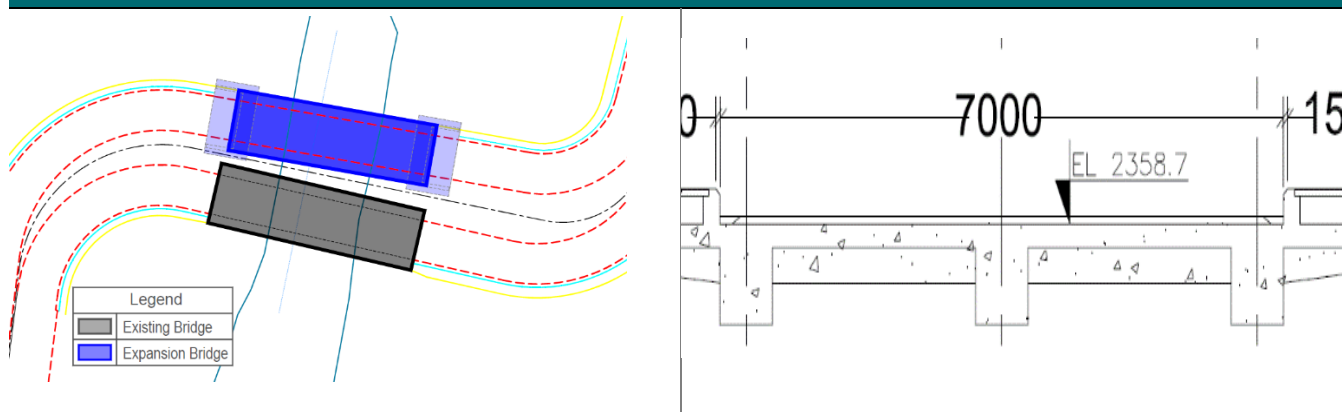
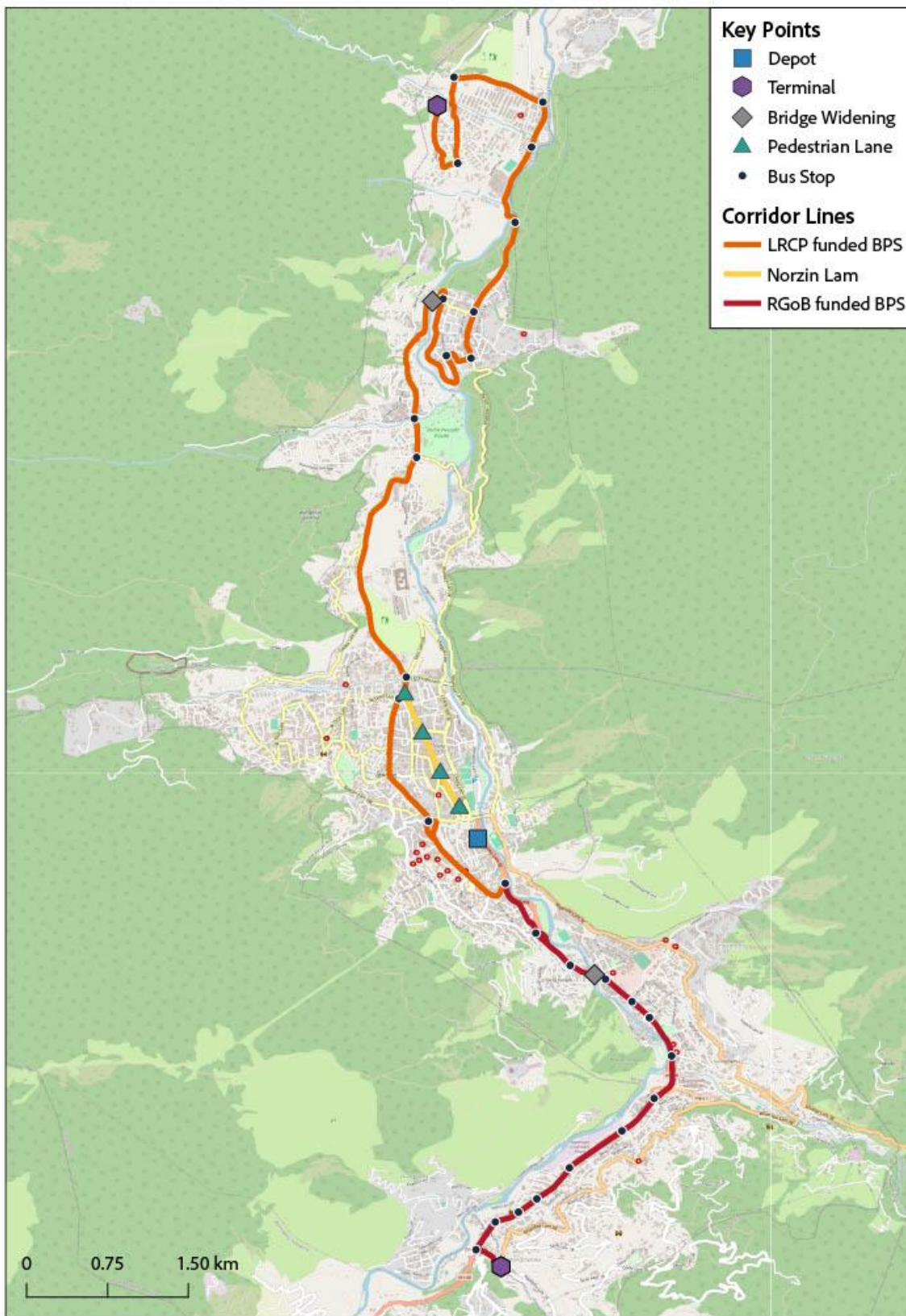


Figure 0-9: Bridge configurations

237. The following map illustrates the final chosen configuration of the bus priority corridor, along with the bridges to be improved and supporting infrastructure such as terminals and stops.



World Bank Group, LRCP investments, 2026

Figure 6-10: Map of BPC with bus stops and supporting facilities

Bus Terminals and Depot

238. The introduction of the Bus Priority Service will require the existing bus depot at Changzamtok to be upgraded to provide maintenance and charging facilities for the bus fleet. CBS has taken over the former Technical Training School which will be used as the periodic maintenance facility, and the new terminal buildings at Ngabiphu and Dangrina will provide facilities for routine maintenance, cleaning, and charging. Some of the existing diesel buses will remain in service until 2040 providing feeder and dedicated bus services and it is important that good maintenance practices are followed, and engine diagnostic facilities provided, to reduce GHG emissions and other harmful pollutants.⁷⁴ The facilities will also need to provide specialist facilities for maintenance and battery diagnostics for the new e-buses and for the transition to an all e-bus fleet over time. Good maintenance practices can extend battery life significantly. Both diesel and e-buses benefit from maintenance activities such as wheel balancing and alignment and tyre pressures to increase the fuel efficiency of diesel buses and the operating range of e-buses.
239. The new terminal facilities at each end of the route will provide modern facilities for the needs of passengers, bus crew and drivers, and management. Several options for the design of these facilities were developed and presented to relevant stakeholders for consultation.
240. To protect this investment against projected extreme weather events, all three sites will be engineered to withstand a 1.5-meter flood depth. Specific physical climate-resilience enhancements include the construction of hybrid concrete and earthen perimeter flood defenses and manual "stop-log" flood barriers, along with targeted gabion retaining walls for slope stabilization at the Dangrina and Ngabiphu terminals. At the central depot, resilience will be bolstered by high-capacity drainage systems, backflow preventers, and heavy-duty submersible diesel pumps. Furthermore, to ensure uninterrupted operations during grid failures, all critical electrical assets will be protected by localized waterproof dwarf-walls, and the central depot will be equipped with off-grid autonomy utilizing rooftop solar PV arrays, Battery Energy Storage Systems (BESS), and elevated resilient water storage, while the end-terminals will feature essential emergency backup power.
241. The BCTA as the regulatory authority developed a "Guideline on the functional requirements of a passenger bus terminal" in June 2022 which considered the following factors:
- Access and approach
 - Location
 - Operational parameters
 - Existing capacity and future demand estimation
 - Enhanced level of service
 - Integrating multimodal accessibility and feeder infrastructure
 - Integrating sustainable development practices
242. The two terminals and the depot play essential roles in Thimphu, serving as integral components of its transportation infrastructure, each with distinct functions.
243. The Ngabiphu Terminal and Dangrina Terminal serve as the starting and ending points of the trunk route connecting the city's north and south. The specification for the services to be provided in the terminals and depot is set out in the following table following comments/requirements from Thimphu Thromde and CBS. Cost considerations are outlined in Annex 4 (see budget note 13).

Table 0-5: Requirements of Facilities

Facility	Dangrina Terminal		City Bus Depot		Ngabiphu Terminal	
	Initial Requirement	Proposed	Initial Requirement	Proposed	Initial Requirement	Proposed
Passenger Areas						

74 Evidence from the SUTP and ESCBS projects in India suggests that reductions in emissions of 5-8% may be achieved from good maintenance, and similar reduction from good driving practice.

Public Toilets	Required	Yes	-	-	Required	Yes
Boarding/Departing Areas	Required	As shelters	-	-	Required	As shelters
Customer Service Center	Required	Yes	Required	Yes	Required	Yes
For Terminal Staff (Admin & Operations)						
Office Space for Relevant Authorities	Required	Yes	Required	Yes	Required	Yes
Canteen for Staff	Required	Yes	Required	Yes	Required	Yes
Control Room	-	-	Required	Yes	-	-
Security Staff Room (Security Quarter)	Required	Yes	Required	Yes	Required	Yes
For Bus staff (Operator, Driver)						
Resting Room	Required	Yes	Required	Yes	Required	Yes
Toilet with Shower	4	4	Required	4	4	4
Maintenance						
Bus Wash Bay(s)	2	2	Required	3	2	2
Maintenance Workshop Bay(s)	2	2	Required	10+2 ⁷⁵	2	2
Parking						
Buses	35	34	Required	21	35	13
Buses (Additional Nightly)	-	25	-	16	-	12

⁷⁵ 10 bays for inspections, tire management, body shop, and a paint booth. Additional 2 bays for future expansion.

Cars	10	9	Required	22	10	1
EB Charging Stations	Required	5	Required	5	Required	3

244. Ngabiphu Terminal

- Design emphasizes entrance and exit separation for efficient traffic flow.
- Administration building strategically placed near the entrance.
- Maintenance building detached to reduce noise and flooding risks.
- E-bus charging station on the lower ground for proximity to a transformer.
- Bus shelters and drop-off points located outside the terminal.
- Porous parking lot surface and rainwater harvesting and treatment for sustainability and environmental protection.
- Offers 13 bus parking spots, 2 E-bus charging stations, and a cafeteria.

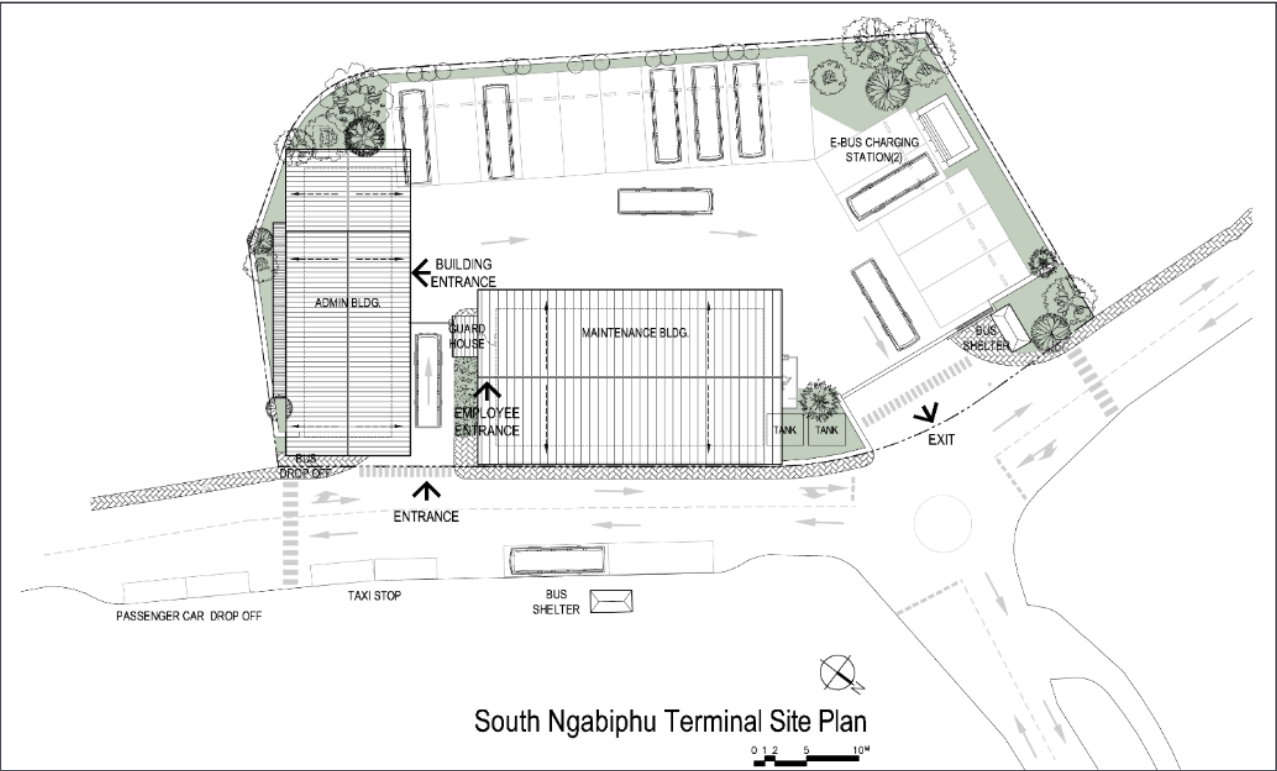


Figure 6-11: Ngabiphu Terminal Site Plan

245. Dangrina Terminal

- Administration and maintenance of buildings positioned away from residential areas.
- Efficient bus circulation with 34 parking spots, 7 staff parking spots, and 2 accessible parking spots.
- Stream rerouting to optimize layout.

- Porous parking lot surface and rainwater harvesting for sustainability.
- Ground floor amenities include a cafeteria, accessible toilets, and meeting rooms.

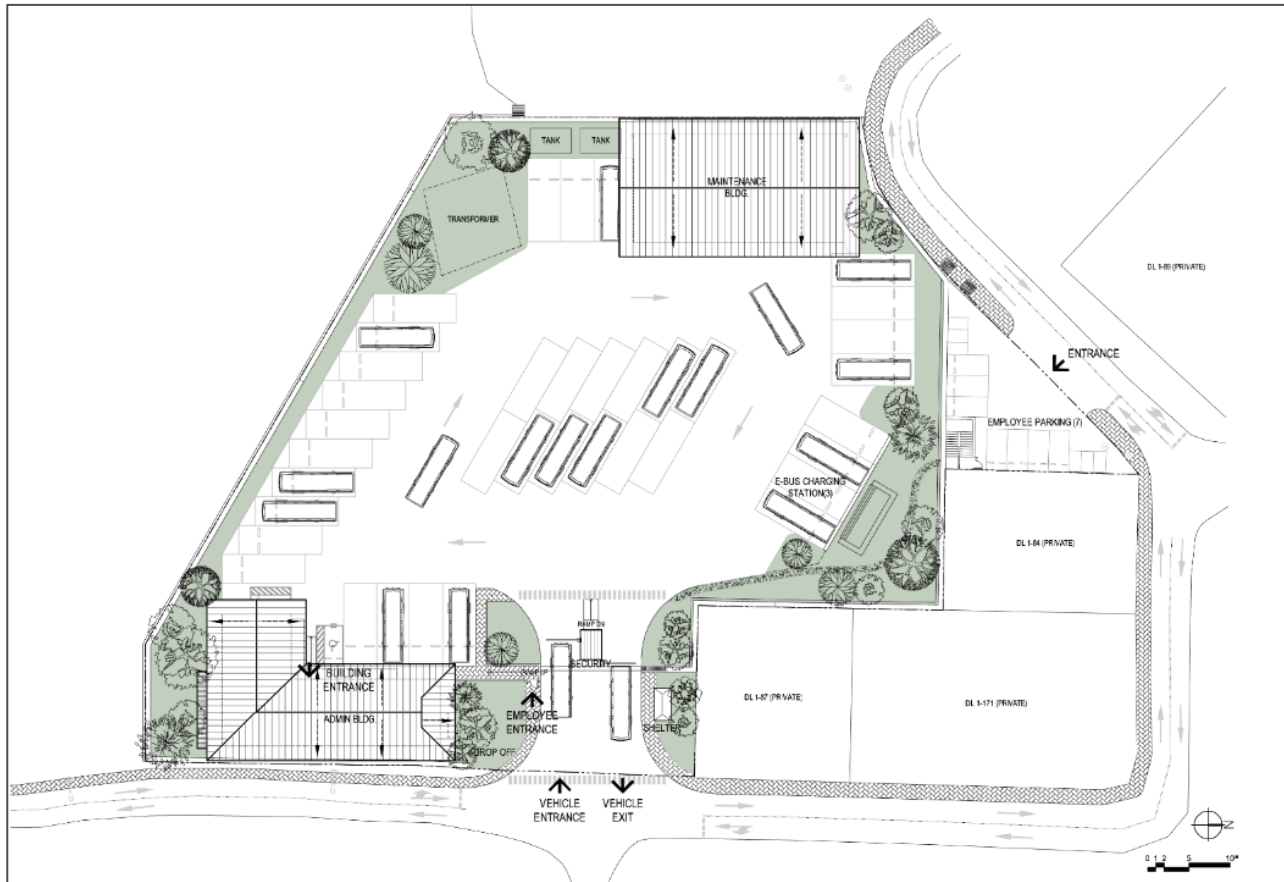


Figure 6-12: Dangrina Terminal Site Plan

246. City Bus Depot

- Shed demolished for improved functionality.
- New facilities to be introduced, including childcare facilities and solar panels for energy generation.
- Rainwater harvesting systems and replacement of the existing effluent treatment facility for sustainable water management.
- Enhanced security with lighting and security cameras.
- Layout modifications for safety and efficiency
- Upgraded maintenance equipment for both the new e-buses and the existing diesel buses.



Figure 6-13: City Bus Depot Site Plan

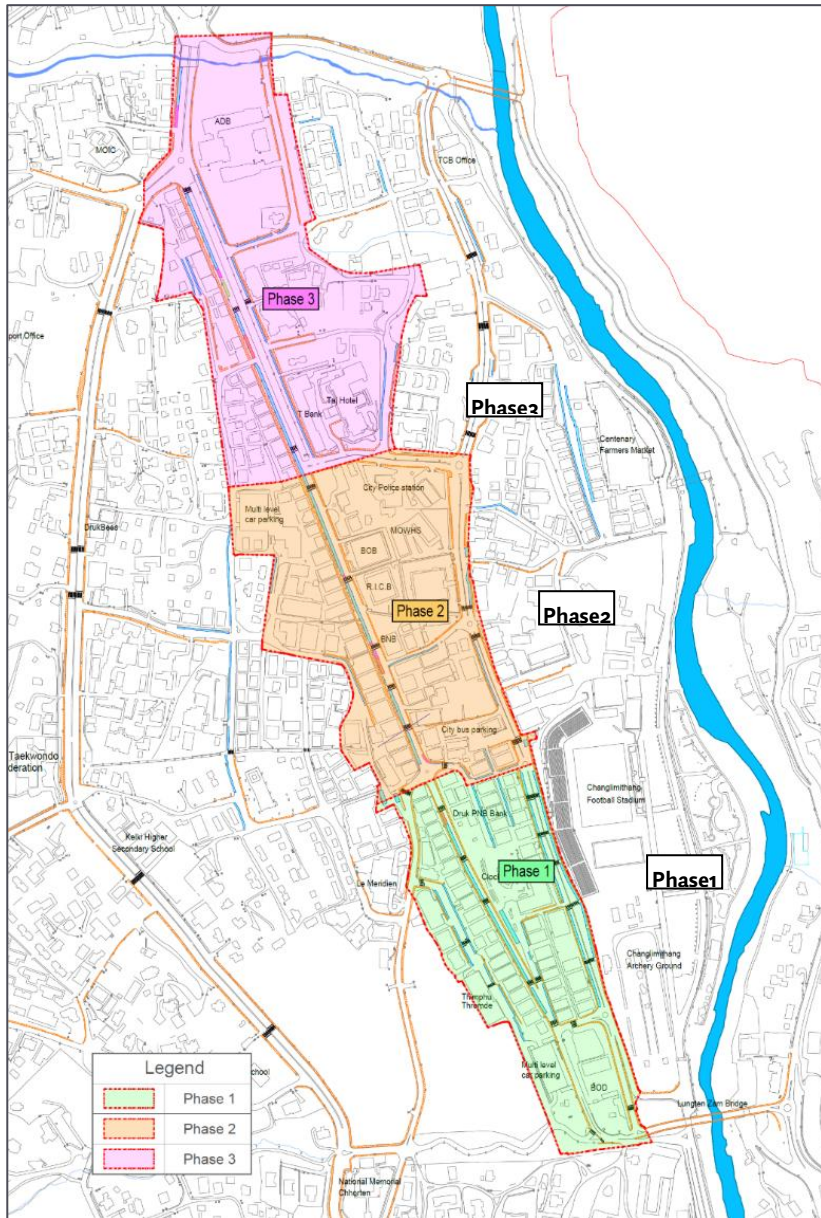
Removal of Through Traffic from Norzin Lam

247. The re-design of Norzin Lam was proposed in the City Core Action Plan (CCAP) and LETMP, based on a pedestrian-first policy, and was incorporated into the LRCP from the outset. The main objective is to improve the safety and convenience of pedestrians and non-motorized transport using this main thoroughfare in the city centre for commercial and business activities. The short-term objective includes traffic improvements and the establishment of a pedestrian-friendly system, while the long-term plan is to reduce car usage and promote non-motorized transportation to reduce air pollution.
248. Norzin Lam was conceived in three phases (south, central, and north), considering connectivity, accessibility, and pedestrian characteristics with the surrounding areas to establish the overall design concepts. All three phases are included in the LRCP together with traffic circulation and parking plans (the privately financed multi-storey car parks behind Norzin Lam were constructed to provide alternative off-street parking and are currently under-utilised).

The following table shows the improvements proposed for the area around Norzin Lam given in the CCAP and the LETMP, and those that will be provided through the LRCP.

Table 0-6: Comparisons of concepts for the pedestrianization of Norzin Lam

Concepts for pedestrianization of Norzin Lam	Suggestion		Upgrade
	CCAP	LETMP	LRCP
(a) Pedestrian-Exclusive Zone	☑		☑
(b) Sidewalk Expansion	☑		
(c) Lungtenzam Bridge and Approach Road Transformation	☑		
(d) Pedestrian Amenities	☑		
(e) Circulation Change	☑		☑
(f) Norzin Lam Intersection Improvement	☑	☑	☑
(g) Crosswalk Installation	☑		☑
(h) Building Alleys Improvement	☑		☑
(i) Bicycle and Pedestrian Bridge Installation	☑		
(j) Development of Bicycle Lane Network	☑		
(k) Introduction of Bicycle-Sharing Hubs	☑		
(l) Bicycle Parking Facilities and Amenities	☑		



Phase diagram for Norzin Lam

249. In Norzin Lam Phase 1, a pedestrianised zone will be established to improve pedestrian safety and convenience by restricting vehicle access for deliveries outside normal business hours.

250. In Phase 2 and Phase 3, roadside parking spaces will be removed or reallocated to expand sidewalk space to enhance pedestrian safety. Crosswalks will be strategically placed and, if necessary, relocated to accommodate traffic flow and pedestrian convenience. Facilities such as benches, lighting, and appropriate signage will be installed in Norzin Lam and on connecting pedestrian pathways and building alleys to enhance the pedestrian experience.

251. Under the planned programme of further projects for implementing the LETMP strategies, funded from 13FYP, a new bicycle and pedestrian bridge will be constructed on the east side of Centenary Park, connecting bicycle routes across the river and within the city, and a new bicycle lane network will be developed to support commuting and movement within the city, with strategically located bicycle-sharing hubs to facilitate convenient bike rentals and bicycle parking facilities, together with showers and other amenities to promote bicycle usage and support smooth modal connectivity. A new Greenway cycle route is being created along the Wang Chhu River with the financial support of the GEF.

252. The sketches prepared as part of the technical designs for Phase 1 include:

- Establishment of pedestrianized zone areas
- Removal of on-street parking spaces

- Strategic placement of crosswalks
- Installation of benches, lighting, and appropriate signage
- Planting of trees to provide shade and reduce the urban heat island effect that will increase as a consequence of climate change
- Improvement of building alleys for pedestrian convenience

253. The Design Guide that will accompany the publication of the Thimphu Development Strategy will be used to finalise the detailed designs for the scheme.

254. The existing traffic system in Norzin Lam and the Core Area, which combines two-way and one-way traffic, causes confusion and congestion. The plan addresses these problems by:

- Phase 1: Converting Norzin Lam Phase 1 into a pedestrian and public transportation zone with limited access for service vehicles.
- Phase 2: Implementing a two-way system in Norzin Lam Phase 2 and altering certain one-way sections.
- Phase 3: Reducing congestion by creating a Cul-de-sac on the eastern road of Handcraft in Norzin Lam Phase 3 and changing the western road to a two-way system.

255. Other complementary measures are proposed in the LETMP strategies which will enhance the amenity of the pedestrianisation scheme, but are not part of the LRCP technical design include:

- Road and intersection improvements, such as signal-controlled intersections and further pedestrianization.
- Implementing a parking policy which provides only short-term and disabled on-street parking.
- Installing safety measures like traffic signs, speed limits, and seasonal road coating.
- Managing freight and delivery by restricting HGVs and promoting low-emission transportation options.

256. Other measures to improve accessibility for pedestrians and persons with disabilities include new pedestrian walkways, ramps, reserved parking for people with disabilities, enhancing connecting building alleys by removing unnecessary structures and improving the safety and aesthetics of the thoroughfare.

257. Finally, to improve the resilience of the LRCP infrastructure along the bus priority corridor and the area around Norzin Lam, and then across the city more widely under 13FYP, planting and soft landscaping measures with dual purpose such as bioswales will be incorporated into the final designs.

The following are representative master plans and cross-sections for Phases 1, 2, and 3 of Norzin Lam:

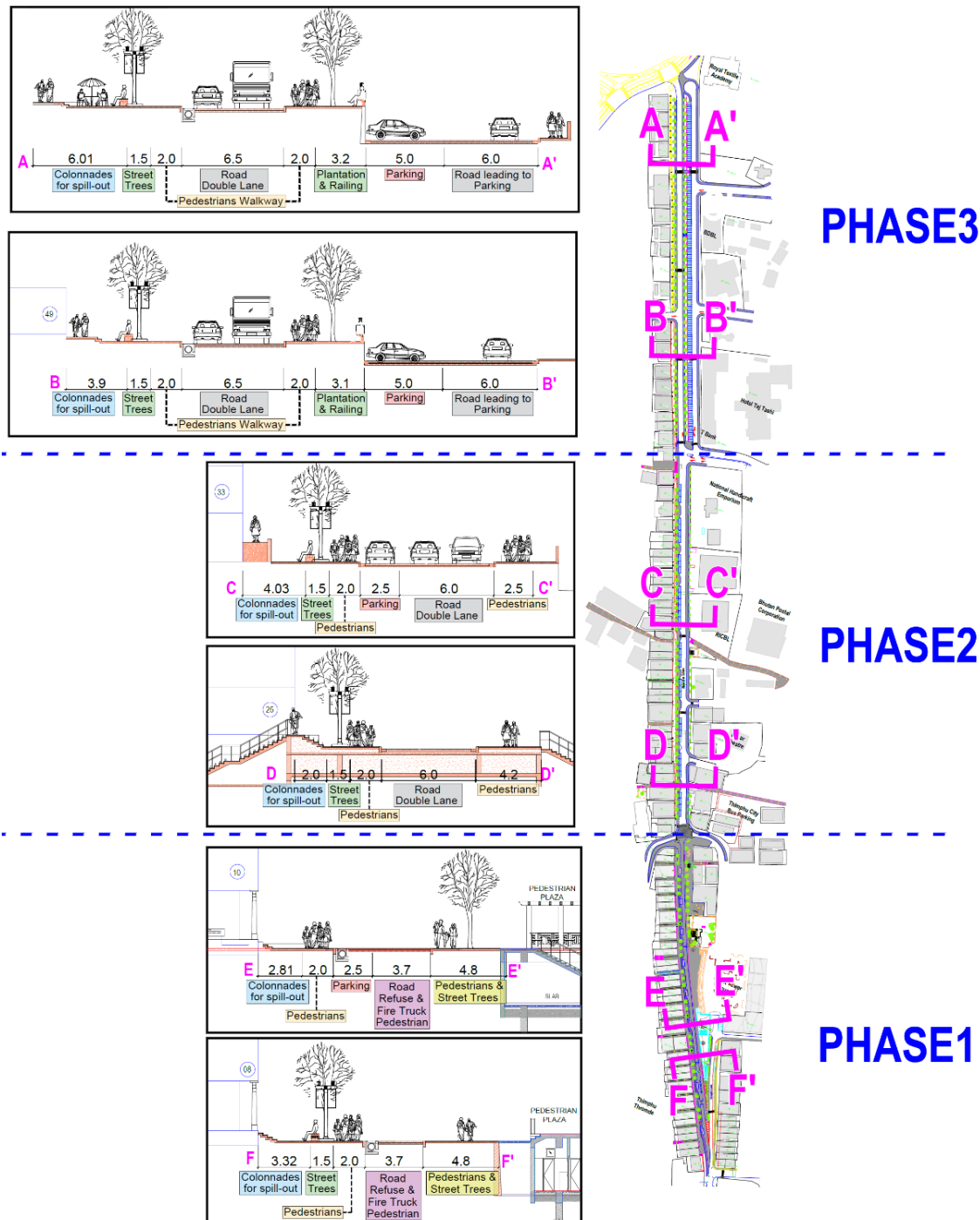


Figure 6-14: Norzin Lam Section Master Plan for low or zero-emission public transport

Provision of Charging Infrastructure

258. Options for specifying the charging infrastructure required to provide the zero-emission bus services were also considered:

- **Power Capacity:** The charging stations should be designed to provide enough power capacity to ensure that electric buses can be charged quickly and efficiently. This may involve upgrading the local grid infrastructure to support high-power charging.
- **Charging Standards:** The charging infrastructure should support the most common charging standards used for electric buses, such as CCS, CHAdeMO, and GB/T.

- **Charging Locations:** The charging stations should be strategically located along Thimphu's main north-south axis, taking into account factors such as traffic patterns, bus routes, potential flooding risk, and availability of space.
- **Network Integration:** The charging infrastructure should be integrated into a larger network, allowing buses to charge at multiple locations and ensuring that charging stations are not overcrowded.
- **Scalability:** The charging infrastructure should be designed to accommodate future growth in the number of electric buses operating in Thimphu.
- **Smart Charging:** The charging infrastructure should be equipped with smart charging capabilities, such as load balancing and demand response, to optimize the use of energy and reduce peak demand.
- **Interoperability:** The charging infrastructure should be designed to be interoperable with other electric vehicle charging systems, allowing electric buses from other regions or countries to use the infrastructure.
- **Renewable Energy Integration:** Thimphu has a strong commitment to renewable energy, so the charging infrastructure will be designed to integrate with renewable energy sources (solar power being installed in the terminals), to minimize the environmental impact of electric bus operations and ensure operational resilience in case of grid power outages.

259. Three charging stations, strategically situated at the two ends of Thimphu's north-south axis in the bus terminals, and at the city's central hub in the City Bus Depot, are proposed:

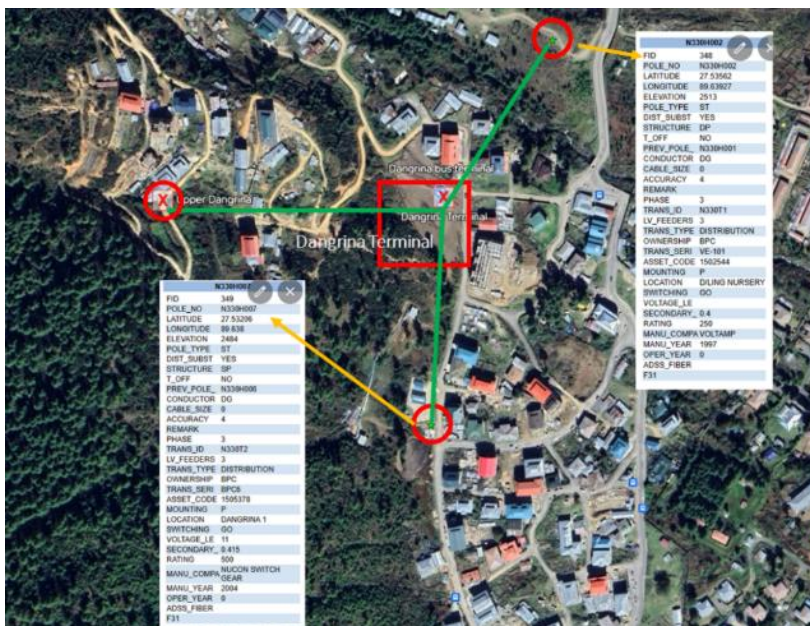


Figure 6-15: Location of power supply (Dangrinsa Terminal)



Figure 6-16: Location of power supply (City Bus Depot)

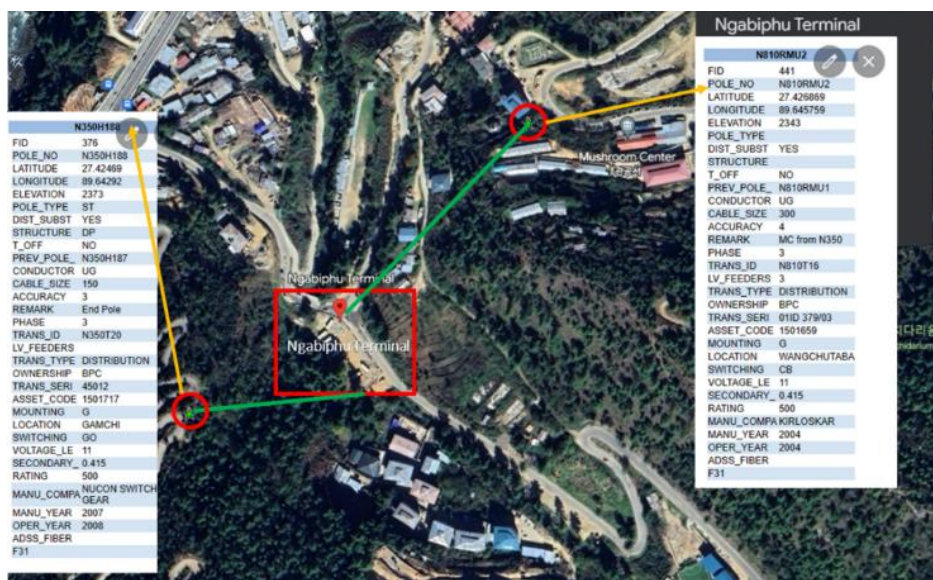


Figure 6-17: Location of power supply (Ngabiphu Terminal)

260. Thimphu has chosen to adopt the plug-in charging method due to its widespread technical acceptance and cost-effectiveness. Plug-in charging supports a variety of charging technologies and enables efficient charging management through the utilization of smart charging technology. Additionally, it offers the advantage of lower initial infrastructure costs, making it suitable for a wide range of bus types. However, it does have the drawback of longer charging times compared to other methods and the need to wait when other vehicles are charging with a consequent need for additional space for charging as the number of buses increases.

261. The charging methodology will depend on the service schedule and bus route length:

- If the number of daily charging N is less than 1, it is possible to operate for a day with one charge, so charging can take place at the depot.
- When the number of charging times N exceeds 1 and is less than 2, a mixed charging method such as depot charging and fast charging at the terminal during the driver break time can be used.

- If the number of charging times N exceeds 2, a rapid mixed charging method in parallel with fast charging during breaks and ultra-fast charging en route rather than charging at the depot.

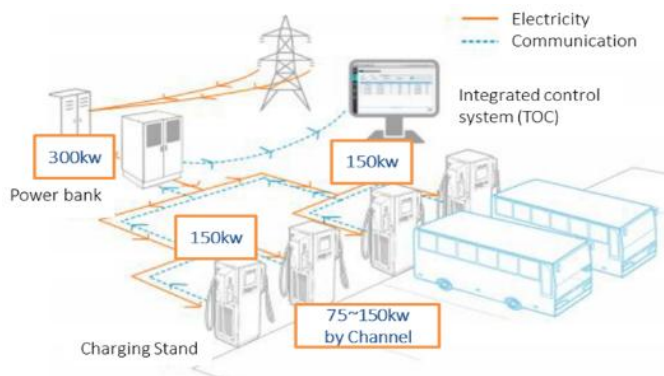


Figure 6-18: Depot charging system configuration (300kw, 4ch)

262. Bhutan Power Corporation is the institution charged with supplying power to EVs in Bhutan and will be responsible for installing e-bus charging systems as well as any grid extension/upgrades required to support the charging infrastructure.

Functional Requirements of ITS/MIS

263. CBS is currently utilizing a modular smartcard fare collection system, a component of a larger bus management system acquired from a Chinese vendor. An additional fleet management module, compatible with the existing GPS systems on buses, is under procurement to meet CBS's immediate needs. Given the extended timeline for the full implementation of the LRCP, there is a need to address operational gaps in the current entry-level bus Intelligent Transport System. A Fleet Management System (FMS) capable of real-time monitoring and operational oversight is crucial for enhancing efficiency and service reliability to achieve the full potential modal shift objective of LRCP.

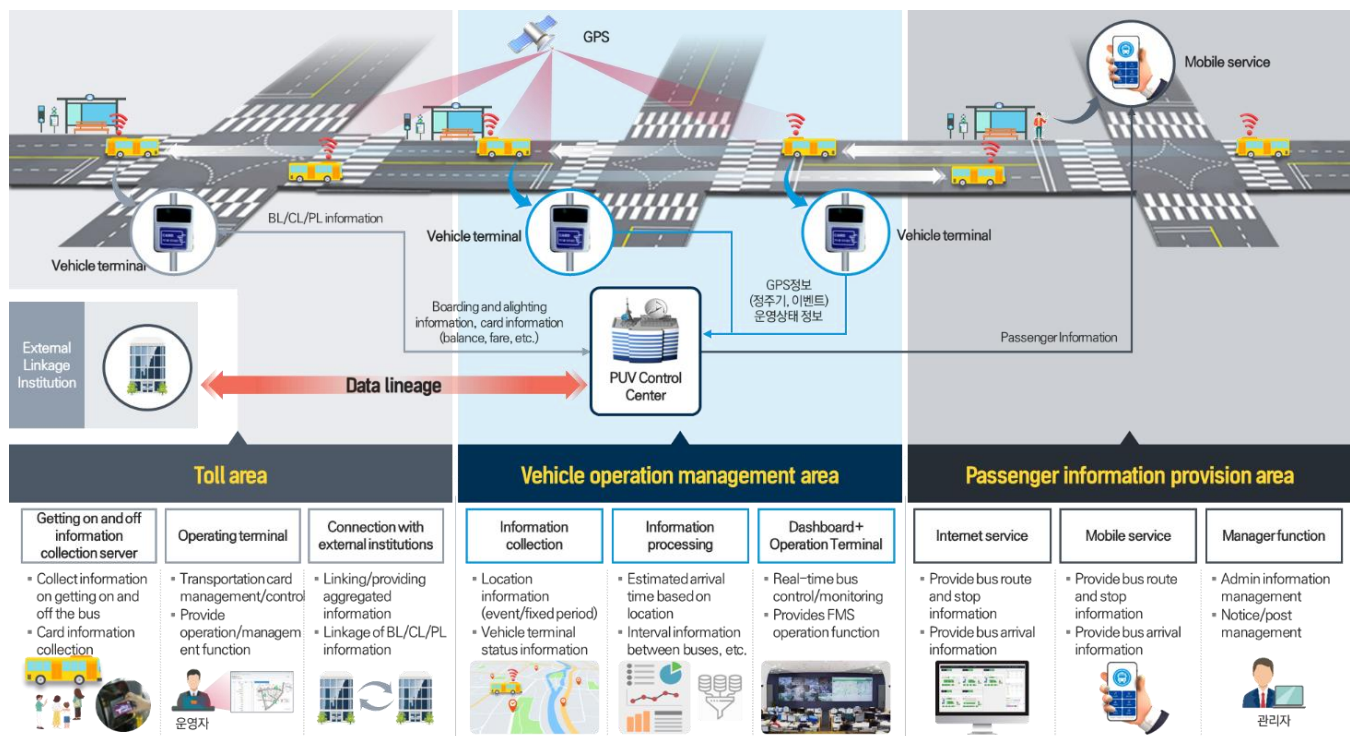


Figure 6-19: System Concept

264. LRCP ITS/MIS System Composition:

- The composition of the system concept map is divided into fare collection, vehicle operation and management, and passenger information provision.

- Fare collection provides boarding and disembarking information to a server, an operating terminal, and connections with external organizations.
- Vehicle operation management covers information collection, information processing, and a situation board + operation terminal.
- Passenger information provision covers an internet service, mobile service, and a manager function.

265. System Diagram

- The system consists of a field system and a centre control room.
- The field system includes a BIT, a bus terminal, an emergency bell and CCTV devices in the bus.
- The centre system includes various switches, servers, dashboards, and operating PCs as well as a screen to show the location of buses in real time.

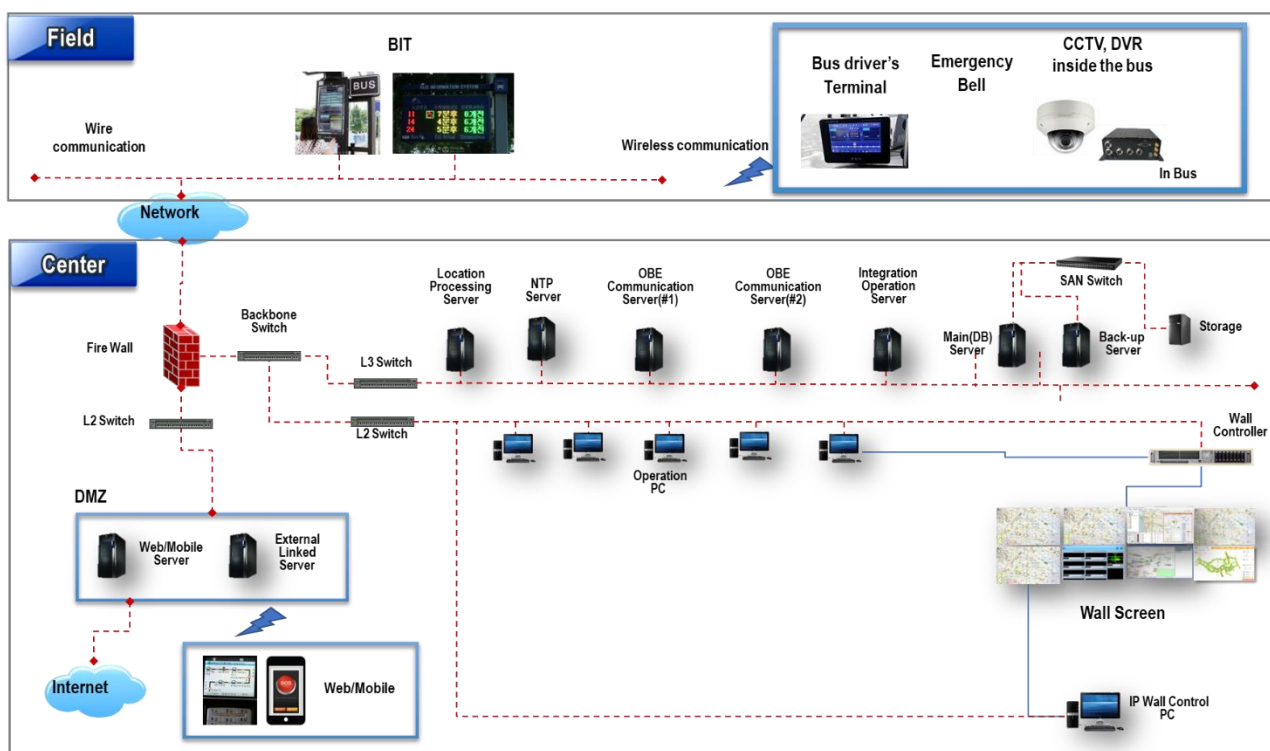


Figure 6-20: System Diagram

Transport Sector Improvements

266. The main climate mitigation objective of LRCP will be met by reversing the growing use of private cars as the primary means of transport within Thimphu by improving the reliability, journey times, and convenience of the public transport system and encouraging non-motorised transport. The geography of Thimphu within the steep-sided valley of the Wang Chhu River has resulted in the city growing linearly along the valley and the data shows a strong correlation between the population growth in the city and car ownership.⁷⁶ Bhutan has the highest number of vehicles per capita in South Asia as of June 2023 with a figure of 139 vehicles per 1000 people⁷⁷. During the period 2015-2022, Bhutan imported 1,234 vehicles per 1000 people, further highlighting the high private car use. With limited opportunities to increase the capacity of the road network, traffic congestion is expected to become an increasing problem for much of the day under a

⁷⁶ the ratio is 1.2:1 as shown in the Figures sheet of the transport economic model

⁷⁷ Asian Automotive Analysis. Asia's Ownership Volume of Motor Vehicles in 2022. 2023. <https://aaa.fourin.com/reports/946c9ea0-165b-11ee-8711-170a5bff50d0/asias-ownership-volume-of-motor-vehicles-in-2022?>

Business-as-Usual scenario. Currently public transport services are limited in Thimphu⁷⁸. Since alternative public transport modes such as light rail would not be cost-effective for a city with a population of only 149,000, there are few alternatives to providing a reliable and efficient public bus service.

267. Achieving a significant modal shift away from private cars for journeys in and around the city will reduce both congestion and the projected increase in GHGs from transport, enabling Bhutan to meet its NDC commitments. Moreover, LRCP will be accompanied by institutional and regulatory changes that will allow the lessons learned from the project to be applied nationally and through the technical assistance provided under Component 2, allowing RGoB to extend the provision of zero emission public transport to other cities in Bhutan and to inter-urban transport. RGoB included the procurement of an additional 45 e-buses within its 2025–2029 Five Year Plan (13FYP) to extend zero-emission public transport services to other urban centres and inter-urban services; as noted above, the acquisition of these e-buses is underway, with some potentially being redirected to Thimphu itself. LRCP will provide the template for extending RGoB's Low Emission Development Strategy (LEDS) nationally, and the institutional changes being supported through LRCP will be the means of doing this. For example, RGoB's 13FYP identifies five new Linked Urban Centres at Phuentsholing-Samtse, Tronga-Bumthang, Mongar-Trashigang, Samdrup Jongchar-Nganglam, and Punakha-Wangduephodrang which can be planned around new e-bus public transport services, thus locking in low emission and sustainable transport modes.
268. The LRCP also addresses longer-term issues of climate adaptation in Thimphu by taking into account the increased risk of flooding that will arise as a result of heavier monsoons or cyclones inundating the valley of the Wang Chhu as a result of climate change. The widened bridges on the bus priority lanes will incorporate measures to reduce the risk of scour of the abutments as well as providing additional capacity for potential evacuation routes or additional points of access to flood-prone areas. RGoB's parallel financing through 13FYP will fund the additional bridges across the Wang Chhu and Ola Rang Chhu that are part of the NMT Plan and will further reduce the risk of parts of the city becoming isolated through storm damage to the existing bridges over the rivers. The Transit Oriented Development strategy will reduce the need to travel to access essential services advantaging more vulnerable households that cannot afford to live close to the city centre and which are most affected by damage to critical public transport links. The LETMP proposes a hierarchy of city core, sub-districts, and local centres that provide basic services.
269. Through the infrastructure investments in Component 1 of LRCP, and the implementation of other strategies in the LETMP such as the creation of mobility hubs, improving NMT access to public transport, and making it easier to transfer to last-mile services, which are part of 13FYP, Thimphu will have a fully integrated transport system that facilitates switching between modes and makes the best use of modern technology. Hydropower is the dominant form of electricity generation in the country, accounting for 100% of generation in 2024⁷⁹. Bhutan has also been investing heavily in hydropower projects as part of its Low Emission Development Strategy, meaning that low-carbon electricity will likely continue to dominate the energy mix, maximizing the climate mitigation benefits of electrification and thus making Bhutan an ideal setting for the implementation of a large e-bus fleet. In short, the LRCP will help avoid trips by private car by providing a reliable, cost-effective, and faster alternative means of transport and together with strategies that restrict road and parking space in the city centre it will encourage a modal shift by investing in a modern, efficient, and reliable bus service, and improve the system by switching from diesel to electric power for its buses. In addition to reducing air and noise pollution, through plans to reduce heat island effects by providing green corridors, bus shelters and shade for pedestrians as part of its climate adaptation strategies, LRCP will result in a more pleasant and livable city, and by encouraging active mobility, a healthier population.
270. The analysis in this feasibility study, based on the modelling undertaken (see section 6.4.1), estimates a modal shift of 24% from private cars and taxis to buses along the BPS corridor by 2032 (the fourth year of BPS operation), and 30% by 2048, compared to BAU. This shift results from significantly improved service quality and frequency, reduced travel time for buses relative to general traffic due to BPL implementation, improved and more accessible bus stops, and larger capacity of e-buses, all supported by LRCP Component 1; and the implementation of complementary LETMP policies incentivizing the use of public transit over private cars (e.g., parking restrictions, mobility hubs, awareness campaigns, further bus network improvements), supported by LRCP Component 2. For Thimphu overall – beyond just the BPC – bus modal share is projected to grow from a baseline of ~8% (~22,000 daily trips) to 14.4% in 2029 and 28.2% by 2048, with roughly 89% of this increase resulting from the BPS, fleet enhancement, and complementary policies, and 11% from natural population growth (see Ridership analysis in Annex 3 - EFA).. Due to Thimphu's distinctive transport mix, featuring very high use of private cars and taxis but a relatively low share of two-wheelers (~2-3%), the vast majority of modal shift is expected to be from private car and taxi users. Likewise, no significant shift from NMT to bus is expected given that cycling share is marginal and walking trips are generally short, and that the project's pedestrianisation measures are expected to incentivize walking. These projections will be validated via surveys during project implementation. Further detail on the expected modal shift and associated GHG emissions reduction is provided in Annex 22.

⁷⁸ Business Standard. Only two buses for every 1000 people in India: CSE Report. 2017. https://www.business-standard.com/article/pti-stories/only-two-buses-for-every-1000-people-in-india-cse-report-117011901115_1.html

⁷⁹ International Renewable Energy Agency. 2024. Bhutan: Country Energy Profile. Available: https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Asia/Bhutan_Asia_RE_SP.pdf

271. Five case studies in South America, Africa, and China published by the World Bank for COP2880 demonstrate that investment in facilities that encourage active mobility and increase the catchment area for public transport can have measurable economic and climate benefits. There are only limited bridge crossings of the river at present which reduce the accessibility of the city centre to pedestrians and cyclists, and growing congestion has increased journey times for all road users making walking a less safe and pleasant experience. It has also increased vulnerability to climate shocks as there are a few alternative crossings if one becomes unpassable. The revised Development Strategy for Thimphu, as well as improving the safety, reliability, and convenience of the bus service, incorporates other LETMP strategies that taken together both mitigate climate change and provide greater resilience to its effects:

- removing through traffic from Norzin Lam (the main commercial thoroughfare in the city centre) and improving facilities for pedestrians will encourage the use of public transport, walking and cycling to access the city centre for business or leisure. Extensive planting being provided through the Green Infrastructure Masterplan and implemented through GEF funding and 13FYP will provide shade in the summer months and covered eating terraces protection from rainfall;
- managing freight traffic by restricting access to the city centre for heavy vehicles during normal business hours and the construction of a freight logistics hub for the transshipment of cargo to 100 smaller e-vehicles for the distribution of goods in the city centre will reduce air pollution. These initiatives are also being funded through 13FYP;
- controlling on-street parking will create a more pleasant urban environment and discourage journeys into the city by private car, freeing up road space for the bus priority lanes;
- creating mobility hubs to facilitate transfer between buses and last-mile services such as taxis or bicycle pools and electric micro-mobility scooters/bikes will increase the convenience of public transport and provide suitable locations for parcel lockers and other facilities for bus passengers;
- encouraging car and bicycle pooling will reduce the need for households to own their cars;
- creating new exclusive cycleways to improve pedestrian safety, and three new non-motorised pedestrian bridges across the Wang Chhu will result in further greening of the city and make non-motorised transport a more attractive option for moving around the city centre;
- Creating a bus corridor along Chang Lam to improve the reliability of services along the “via town” route to match that on the main corridor along Doebun Lam for the “via hospital” route (also part of 13FYP);
- Providing bus shelters and bus bays at stops along all of the feeder routes, funded through 13FYP;
- Promoting denser development around the BPC to further drive modal shift to transit, prioritized in the LETMP and Thimphu Structure Plan.

272. The implementation of these strategies will make Thimphu a more sustainable and resilient city in which to live and work and increase its attractiveness as a tourist destination. In providing the initial investments within the project area, and supporting continuing improvements to the transport and water networks from the parallel funding for transport in 13FYP, the legacy of LRCP for Thimphu will be a more efficient, environmentally sustainable, and climate-resilient transport system, enabling RGoB to deliver on the commitments to UNFCCC concerning transport made in Bhutan’s NDCs.

273. Several other co-benefits will also be realised through LRCP:

- Increasing access for women and People with Disabilities to an efficient public transport system and therefore creating better economic opportunities for disadvantaged people;
- Reducing road traffic accidents by providing better separation between pedestrians and traffic, and safer crosswalks;
- encouraging the transition to e-vehicles, particularly for buses and taxis, by investing in additional charging infrastructure;
- Providing a demonstration effect to other cities and urban areas in Bhutan and creating the institutional framework for transitioning transport across the country to a sustainable and low-emission system;
- Reducing the economic cost of transport by reducing reliance on fossil fuels and the use of private vehicles and significantly reducing foreign currency imports as a result.

80 World Bank 2023. The Path Less Travelled: Scaling up Active Mobility to Capture Economic and Climate Benefits. Washington, DC

Consultancy Options analysis

274. The RGoB has achieved significant economic growth since the COVID-19 pandemic, mainly on the back of hydropower developments, but has an underdeveloped private sector. The public sector has had problems in retaining younger qualified staff after they have completed their employment term following RGoB-financed study abroad⁸¹. LRCP provides institutional strengthening through Component 2 to both the City Bus Service and Water Services Division in Thimphu Thromde to address these technical deficits and the barriers discussed in Section 5 of this Feasibility Study. Component 2's technical assistance is critical to maximise the economic, financial, and social returns from the proposed capital investment under Component 1, effect a transformational change in travel behaviours and in water supply resilience in Thimphu, and extend the policies and lessons learned to improve service delivery nationwide.
275. LRCP does this by bringing in Bhutanese private sector expertise where this is available, but will also use international expertise in water and public transport service operations, investment planning, project definition and procurement, accounting and budgeting to build institutional capacity in the Implementing Entities (MoIT is the IE on behalf of CBS, but CBS will be a direct beneficiary of Component 2 support).
276. Bhutan has benefitted from technical support from GCF and other development partners in preparing plans and strategies across different sectors⁸², but these have often remained high-level and need to be developed into a prioritised list of investments, maintenance plans, and operational procedures that make the best use of data to improve service responsiveness and effectiveness⁸³. Component 2 addresses these gaps in preparedness in moving to provide a prioritised pipeline of implementable projects.
277. There are several characteristics of the LRCP project scope that need to be considered for the effective implementation of its institutional strengthening and technical assistance:
1. It integrates investment activities across two sectors, water and transport, involving separate responsible agencies – Thimphu Thromde's Water Services Directorate and City Bus Service – both of which will need to be restructured and made more accountable for service delivery. In the case of City Bus Service this means drafting and implementing a Public Service Agreement with Thimphu Thromde and potentially other Thromdes;
 2. The project needs to plan and coordinate with other complementary projects being delivered at the same time, for example stormwater and watershed management, urban tree planting, climate impact preparedness, and will need to provide practical as well as policy support to RGoB, and effective project management; it needs to encourage private sector participation on aspects of service delivery and operations, identify viable opportunities for private investment, commercialisation of some supporting activities (advertising, franchising, concessions), and develop forms of public engagement in improving services, changing behaviours, and awareness of new technologies. It introduces new technologies and systems for improving service efficiency and convenience which need to be supported during the testing and early implementation phases;
 3. It needs to provide hands-on training and knowledge sharing with the Implementing Entities but also other Thromdes and service providers to apply lessons learned as well as know-how nationally;
 4. It needs to comply with World Bank and GCF safeguards and requirements for procurement and fiduciary procedures;
 5. It needs to incorporate flexibility in how support is provided over time as priorities are agreed and budgets approved for specific assignments, drawing on international expertise as appropriate;
 6. It should, where practicable and cost-effective, provide some performance incentive structure measured against the LRCP milestones and stated deliverables in the contracts with its consultants.

Consultancy options considered

278. The way in which these consultancy services are procured and managed will determine how effectively the criteria described above are met and the subsequent impact of the Component 2 activities is maximised.
279. Option 1: Single consultancy contract with PIU support. This option would appoint a multi-disciplinary international firm to provide technical and policy expertise to all of the IEs with financial support for the two PIUs provided through the project management budget for the safeguarding, legal, and fiduciary experts required to comply with World Bank and GCF requirements under the Steering Committee oversight as well as project management support. The firm would need to be selected under a partial call-down arrangement with nominated experts across a range of disciplines covering policy development, project feasibility and prioritisation, together with full-time resident consultants with operational experience in water and public transport operations to work alongside the management in Water Services Division and City Bus Service in overseeing and implementing the organisational and operational changes required to achieve the project

⁸¹ See IMF's Article IV Consultation Report <https://www.imf.org/en/publications/cr/issues/2026/01/26/bhutan-2025-article-iv-consultation-press-release-and-staff-report-573462>

⁸² These include the National Adaptation Plan and Low Emission Transport Masterplan (LETMP) financed through GCF Readiness Funds

⁸³ For example, the LETMP lists possible interventions in terms of their cost and impact but does not provide cost estimates or a prioritised project pipeline. Similarly NAP provides highly aggregated cost estimates nationally to build climate resilience

objectives. The consultants would also provide a resident team leader to manage the overall support to the IEs and coordinate with the PIU in MoIT and Steering Committee. The consultancy contract would include milestones and deliverables for the duration of the project, with options to adjust these as priorities evolve and circumstances change. A variant of this option would be for the consultant to provide some of the required safeguarding expertise, supervision of construction, procurement and project management, with the IE's providing overall fiduciary management, reporting, and management.

280. Option 2: Separate consultancies for TT, CBS, and MoIT. This option would involve the procurement of three separate consultancies by each of the IEs, with overall coordination and project management provided by the consultants appointed to support MoIT. The consultants appointed to provide institutional strengthening to CBS and WSD would provide embedded full-time resident staff with international operational expertise in the respective service. The MoIT support would include locally-appointed safeguarding experts contracted by the project management consultants and working under the supervision of relevant experts within the firm. The only resident member of staff for the project management consultant being a team leader, who would deploy experts on specific assignments on a call-down basis against Terms of Reference and budgets agreed with the Steering Committee. The contract for each of the three separate consultancy appointments would have separate milestones and deliverables and performance-based incentives.

281. Option 3: Separate consultancies for TT and MoIT/CBS. This option would involve the consultancy support split between two separate water and transport specialist firms with the same embedded support to CBS and WSD with the policy and planning support to MoIT being provided by two firms separately. Again, there would be milestones and deliverables specified and performance-based incentives where these are measurable and appropriate.

Preferred Option

282. Option 2 is the preferred option. Option 1 has the benefit of lower procurement and administration costs, and there are firms who can provide all of the services required, either from their own staff or through associates and sub-contractors; however, separating out responsibility for safeguards and other common activities could reduce accountability for the full range of advice and reporting. It also presents a potential conflict of interest given that one of the principal objectives of LRCP is to create the Water Services Division as an autonomous entity within TT, and for CBS to become a SOE with its own management and operating under Public Services Agreements for the delivery of urban public transport nationwide. Both TT and MoIT, on behalf of RGoB, would be important stakeholders, but both WSD and CBS should have the benefit of independent technical and legal advice in operating at arms' length from their parent ministry/Thromde. The TT and CBS PIUs would perceive benefits in directly managing their advisers, and this split of responsibilities should not dilute overall coordination and efficiency since the oversight of the project is by the Steering Committee, on which both IEs are represented. The overall management costs of Option 2 should not be significantly greater than for the other options and there would be benefits to pooling expertise across different, more specialised firms, and potentially countries. This option would also permit performance measurement and incentives for consultants to be more focused on the results achieved by the relevant IE. Option 2 is therefore the preferred option, but with common safeguarding and reporting resources being provided through the MoIT's project management consultants to ensure full accountability and consistency across project activities. A fuller description of how these separate consultancy contracts would be implemented and incentivised to meet the LRCP project outputs and outcomes is provided in Annex 4: Indicative Budget Plan.

Summary of Overall Project Design and Deliverables

283. While The Funding Proposal outlines the details of project description, a summary is provided below based on the assessment of options in the water and transport sectors. The project is centred around two components: (i) Component 1: Resilient and Low-Carbon Urban Service Delivery and (ii) Component 2: Urban Management, Planning and Capacity Building for Improved Climate Resilience.

284. Component 1 finances integrated investments to enhance the resilience, efficiency, and low-carbon performance of core urban services in Thimphu. The city faces increasing climate and urbanization pressures, including more intense rainfall, landslides, seasonal water stress, and rising motorization, which together threaten the reliability of water supply and transport systems while increasing congestion, emissions, and infrastructure vulnerability. The component responds through an integrated package of climate-resilient infrastructure and low-emission mobility investments that improve service continuity, reduce climate risk, and support a shift toward public and non-motorized transport.

- Sub-component 1.1 (Water supply resilience, US\$5.71 million): Investments strengthen the resilience and efficiency of Thimphu's water supply system through rehabilitation of intake structures, protection of transmission corridors, reduction of non-revenue water, and deployment of SCADA-enabled network monitoring and district metering. These measures improve operational efficiency, reduce climate-related service disruptions, and enhance equity and reliability of water delivery.
- Sub-component 1.2 (Urban realm and NMT improvements, US\$6.15 million): This sub-component upgrades sidewalks, pedestrian infrastructure, drainage, and traffic management along Norzin Lam and the main transport corridor. It

includes pedestrianization, universal access improvements, SuDS-based drainage, and integration of utility ducts. These investments improve safety, reduce flood risk, and strengthen first- and last-mile connectivity to public transport, supporting modal shift.

- Sub-component 1.3 (Low-emission public transport, US\$28.14 million): This sub-component supports a transition to electric, high-capacity public transport through bus priority lanes, electric bus procurement, bus shelters, terminals and depot upgrades, ITS/MIS systems, and improved pedestrian crossings. These investments improve service quality and reliability while reducing emissions and congestion, and enhance system resilience through climate-proofed corridor infrastructure.

285. Component 2 strengthens the institutional, planning, and operational systems required to sustain and scale the investments under Component 1. The city faces growing climate and service delivery constraints, including increasing flood and landslide risks, water stress, and rapid urban expansion, alongside institutional fragmentation in urban service delivery. The component responds by strengthening utility-style service management, improving sector governance and planning systems, and embedding long-term technical capacity within key implementing agencies to ensure resilient and low-carbon urban service delivery.

- Sub-component 2.1 (Water sector institutional strengthening US\$3.96 million): This sub-component supports the establishment and operationalisation of a ring-fenced Water and Wastewater Services Division (WSD) within Thimphu Thromde. It strengthens governance, staffing, financial management, and business planning to enable utility-style service delivery. It supports deployment of SCADA-based network management, hydraulic modelling, pressure management, and preventive maintenance systems to improve operational efficiency and climate resilience. It also supports digital billing systems, tariff reform, emergency preparedness and business continuity planning, and water conservation and customer engagement. Complementary technical assistance supports sector policy, investment planning, and regulatory strengthening, including diagnostics on fiscal and property valuation systems relevant to long-term service sustainability.
- Sub-component 2.2 (Transport sector institutional strengthening US\$2.04 million): This sub-component supports the transition of CBS into a professionally managed State-Owned Enterprise responsible for urban electric bus operations under a Public Service Agreement with Thimphu Thromde. It supports institutional establishment, governance frameworks, business planning, and operational readiness for electric bus services, including staff training, shadow operations, and service rollout. It further supports revenue diversification, asset management planning, and deployment of ITS/MIS systems, including smart ticketing and interoperability standards. Additional technical assistance supports implementation of low-emission transport policies, including parking management, demand management, freight and inter-urban transport options, and communications campaigns to promote modal shift toward public and non-motorized transport.

286. The Funding Proposal logframe describes the following Activities and Deliverables:

Activities	Description	Sub-activities	Deliverables
1.1: Strengthening water supply systems to support resilient water services	These activities strengthen the resilience of Thimphu's water supply system against the increasing climate risks of drought, flooding, and rainfall-triggered landslides. Raw water intake infrastructure at key stream sources will be upgraded to function reliably under both flood and drought conditions, reducing the risk of service failure during extreme hydrological events. Vulnerable hill slopes and transmission line corridors will be stabilized against erosion and landslide risk, protecting supply continuity during high-rainfall events. Water treatment plant operations and transmission routing will be reorganized to optimize storage and distribution across DMAs, improving supply equity and continuity including during prolonged droughts. Non-	a) Installation of SCADA system to monitor the performance of water and wastewater treatment plants and key components of the distribution network across the city core DMAs, enabling real-time monitoring, leak detection, and hydraulic analysis b) Improve 2 raw water intake systems to function effectively under extreme climatic conditions, with structural	Operational SCADA system across the city's DMAs enabling real-time performance monitoring, leak detection, data-driven network planning, and changes in system downtime Climate-resilient intake infrastructure at key stream sources supplying the city, reducing the risk of service failure during hydrological events

	revenue water losses along Norzin Lam and the transport corridor will be reduced through replacement of deteriorated mains, active leakage control, and installation of advanced pressure valves, bulk water meters, and flow meters, conserving scarce resources and improving service reliability under increasing climate stress. The SCADA system will be installed to monitor the performance of water and wastewater treatment plants. It will also be integrated into the DMAs (District Metered Areas) around Norzin Lam and the transport corridor, including components like bulk meters and pressure relief valves. This system will enable accurate monitoring of capacity utilization and actual demand, and help Thromde forecast future demand for planning upgrades.	improvements to sediment handling and flow control c) Slope stabilization along vulnerable 1 raw and 3 clear water transmission corridors to reduce the risk of erosion and landslide-related service interruptions d) Reorganize WTP operations and transmission routing to optimize storage and distribution across DMAs, improving the equity and continuity of supply including during prolonged droughts e) Upgrade the distribution network along Norzin Lam and the transport corridor to reduce NRW through replacement of deteriorated water mains and active leakage control	Stabilized transmission corridors protecting key water supply routes Improved distribution management supporting more consistent and equitable service delivery Upgraded distribution network in the project area, contributing to the project's target of reducing NRW from over 50% toward 25%
1.2: Improving the safety and convenience of sidewalks, footpaths, and passageways to encourage non-motorize	The pedestrianisation of Norzin Lam, improvements to connecting building alleys and footpaths, and upgraded sidewalks along the bus priority corridor will together improve pedestrian safety, accessibility, and first- and last-mile connectivity to public transport, directly supporting the modal shift away from private vehicles that underpins the project's mitigation ambition. Works will be constructed to climate-resilient design standards, with upgraded roadside drainage linked to Sustainable Drainage Systems (SuDS) to manage stormwater runoff and reduce pluvial flood risk along the corridor and Norzin Lam. Continuous cable ducts installed beneath sidewalks will support real-time	a) Removal of high kerbs, obstructions, and hazards on footpaths and improvements to the amenity of the area with improved street furniture, with the first section of Norzin Lam being pedestrianised and two further sections having limited access for disabled and short-term parking b) Improvements to sidewalks and connecting paths along the bus priority corridor	Completed 1.3 kilometre pedestrianization scheme for Norzin Lam supporting walking, urban placemaking, and climate-resilient city-centre mobility Upgraded, climate-resilient sidewalks and connecting paths along the bus priority corridor,

d transport	passenger information displays and lighting at bus stops, enhancing the reliability and attractiveness of public transport under all weather conditions. A traffic circulation and management plan for central Thimphu will prioritize pedestrians and public transport while enabling emergency and delivery access. Roadside drainage will be improved and linked to Sustainable Drainage Systems to enhance stormwater management and reduce the risk of flooding.	c) Provision of continuous cable ducts under the sidewalks for connecting the display boards at bus stops, including spare ducts for any subsequent communications cabling. Provision of electrical power to each bus stop for lighting and information displays d) Implementation of a comprehensive traffic circulation and management plan for the central area, which allows for access by emergency services and for deliveries but prioritises pedestrians e) Improving roadside drainage along the bus priority corridor and Norzin Lam and connecting the stormwater drains to Sustainable Drainage Systems (SuDS) to slow run-off and filter stormwater before discharge	constructed to universal access standards Continuous cable ducting installed along corridor sidewalks with power connections established at all 75 bus stops Traffic Circulation and Management Plan for the central area implemented Improved roadside drainage and functioning SuDS installations along the corridor and Norzin Lam
1.3: Investments toward a modal shift to low-emission public transport	The project will deliver 18.9 kilometres of continuous bus priority corridor in both directions, two new bus terminals, upgrades to the city centre depot with electric bus charging infrastructure, junction improvements, and installation of 75 new bus bays and shelters, together creating the infrastructure conditions for a sustained modal shift from private vehicles to public transport. A tranche of 50 electric buses powered by Bhutan's 100% renewable hydropower grid will expand the fleet, enabling the frequency and reliability	a) Provision of bus priority lanes with bus bays and 75 bus shelters, widening of two bridges to provide for the bus lanes, and the construction of pier and abutment protection in the rivers to prevent bridge scour and provide greater resilience to extreme climate events	Continuous bus priority corridor with shelters and resilient corridor infrastructure improving service speed, reliability, and climate robustness

	necessary to generate modal shift and reduce transport emissions. An enhanced Intelligent Transport System with real-time journey planning, integrated e-ticketing, and a Management Information System will improve service reliability and passenger experience, reinforcing the attractiveness of low-emission public transport as the default mode of travel. Two bridges will be widened to accommodate the bus lanes and strengthened with scour protection and pier and abutment works to maintain corridor operability during flood and river erosion events. Finally, 23 signalized pedestrian crossings will be installed near bus stops to improve safety and support active travel.	b) Purchase a tranche of 50 e-buses to provide capacity for higher-frequency trunk services and enable transition to zero-emission public transport system c) Build new terminals for charging and maintaining e-buses and improving the central bus depot with e-bus charging facilities d) Procure ITS and MIS for live information on bus services for service reliability e) Installation of 23 signalized pedestrian crossings for the safety and convenience of pedestrians and bus passengers	Fleet of 50 electric buses ready for service on the corridor Two new bus terminals and an improved central depot with the infrastructure needed for e-bus operations Operational ITS/MIS system improving service reliability and passenger information 23 signalized pedestrian crossings
2.1: Capacity building and institutional strengthening for resilient and sustainable water service delivery	This activity builds the institutional capacity needed to manage Thimphu's water system on a resilient and financially sustainable basis, ensuring that the infrastructure investments under Sub-component 1.1 translate into durable improvements in service reliability under increasing climate stress. A ring-fenced Water and Wastewater Services Division will be established within Thimphu Thromde with its own budget, staff, and accountability mechanisms. Embedded international consultants under a performance-based contract will introduce SCADA-informed network management, prepare climate-resilient annual maintenance and capital investment plans, and build internal WSD capacity to operate and maintain the system under drought, flood, and landslide conditions. The TORs for the SCADA systems	a) Establish a ring-fenced water and wastewater services division within Thimphu Thromde which provides a sustainable basis for water supply and treatment that meets international standards, and which is affordable for customers b) Commission and integrate the SCADA system into day-to-day WSD operations, calibrate the hydraulic model, and train WSD staff to use the	Functional, ring-fenced water and wastewater services division established within Thimphu Thromde; first annual business plan and financial accounts endorsed by TT management; documented training records for WSD staff Commissioned and operational SCADA system integrated across the city's DMAs; calibrated hydraulic model; documented

	will include technical requirements to be able to be integrated with the ADB-supported SCADA systems, while taking care to avoid single source procurement issues, along with direct engagement with the operators of these SCADA systems to test integration of each system. A point person in the PIU will be identified to oversee system integration, with the ADB requirements and current performance defining the floor of the expected performance of the new SCADA systems. Digital billing systems and cost-reflective tariffs will strengthen the financial sustainability needed to fund ongoing climate adaptation investments. Emergency response procedures for floods, GLOFs, and drought-related disruptions will be developed and tested, ensuring the WSD can maintain or rapidly restore service continuity following climate-related shocks. Technical assistance to MoIT will support the prioritization of climate-resilient water investments and the development of nationally consistent service standards. A communications strategy will promote water conservation in line with the Water Sector Master Plan target of 100 litres per capita per day.	system for network monitoring, leak detection, maintenance planning, and capital investment decisions c) Introduce utility-style network management practices including pressure zone management and a structured preventative maintenance programme, and prepare annual maintenance and capital investment plans for WSD and Steering Committee approval d) Support the introduction of billing systems and provide advice on tariffs that allow greater cost recovery for water supply and wastewater treatment to enable financial sustainability e) Establish processes for disaster and emergency responses to burst pipes, blockages, floods, and GLOFs f) Provide policy and technical support to MoIT on climate-resilient water investment priorities, private sector participation options in smaller Thromdes, and regulatory frameworks for nationally consistent service standards, including two policy-focused workshops with water sector specialists from other Thromdes and MoIT officials g) Communications strategy	evidence that WSD operators are trained and using the system in daily network management At least one annual maintenance and capital investment plan prepared and approved; documented pressure zone management procedures adopted by the WSD Operational digital billing system covering the WSD's customer base; tariff review report submitted to TT and RGoB Documented and tested emergency response and business continuity plan, formally adopted by TT Policy briefs and technical reports on water sector investment priorities and reform options delivered to MoIT; one policy-focused workshop with water sector specialists from other Thromdes and
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			MoIT officials, held and documented Approved communications strategy; documented evidence of rollout including produced materials and outreach activities
2.2: Capacity building and institutional strengthening for resilient and sustainable transport service delivery	CBS will be established as a State-Owned Enterprise with a national mandate for urban and inter-urban transport, operating under Public Service Agreements with local Thromdes, providing the governance framework needed to embed low-emission public transport as the default mode of travel in Bhutan's cities. CBS will receive technical assistance to build the operational capacity, staff skills, and protocols required to manage an electric bus fleet reliably and efficiently, maximizing the GHG reduction potential of the e-bus investment. It will develop commercial strategies to diversify revenue streams and reduce dependence on public subsidy, strengthening the long-term financial viability of low-emission service delivery. Support will be provided for CBS and MoIT to formulate long-term, climate-resilient investment and maintenance plans aligned with the LETMP, ensuring the corridor infrastructure and fleet are maintained to a standard that sustains modal shift over time. A scalable ITS and integrated payment system will be designed, with national standards for ITS interoperability and smartcard payments developed, improving service reliability and passenger experience to reinforce public transport as a competitive alternative to private vehicles. The project will assess	a) Support CBS in its establishment as an SOE with a national mandate to develop low-emission public transport under PSAs with other Thromdes b) Provide technical support, advice, training and capacity building to CBS in the transition to the new bus services, and the introduction to service of the new e-buses, including training for drivers and customer service c) Support CBS in developing additional sources of revenue such as retail franchises at mobility hubs, advertising at bus stops and on buses, and	Legal instruments establishing CBS as an SOE; signed PSA between CBS and TT; first CBS annual business plan and financial accounts prepared under the new governance structure CBS staff trained in e-bus operations, maintenance, and customer care; documented readiness assessment completed following shadow operations; CBS operating scheduled e-bus services on the corridor under the PSA Revenue diversification strategy and associated implementation roadmap for CBS, endorsed by CBS management

	dedicated services to reduce peak congestion. A communications strategy will promote awareness of the environmental and health benefits of the new public transport system, supporting behaviour change in favour of low-emission mobility.	bus leasing for private or commercial use d) Provide capacity-building support for the preparation of climate-resilient capital, financing, and maintenance plans for the transport network e) Providing technical assistance and institutional strengthening for prioritising and implementing policies, strategies, and regulations in the LETMP and NAP (including parking restrictions and freight policies that will reinforce the modal shift) f) Develop national standards for ITS and smartcard payments. Finalise the specification of the ITS system upgrade and assist CBS with its installation, testing, and operation, and the use of survey and smartcard data to plan and improve services as appropriate g) Analyse the potential for operators to provide dedicated services such as school buses to reduce peak hour demand for the	Approved set of capital investment and asset management plans for the corridor infrastructure, bus fleet, and terminal facilities, endorsed by MoIT and the Project Steering Committee Policy briefs and draft regulations for priority LETMP measures, submitted to MoIT Commissioned and operational ITS/MIS system with CBS staff trained in its use; published national ITS interoperability and smartcard payment standards Demand analysis report and policy options for integrating dedicated services with the CBS
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		scheduled services as part of the wider rationalisation of services set out in Bhutan's LETMP and based on demand data h) Develop a communications and awareness campaign to inform Thimphu residents of the benefits of using public transport and NMT i) Bhutan Land Information System (BLIS)	network, submitted to MoIT Approved communications strategy endorsed by MoIT and CBS; documented record of outreach activities including produced materials and evidence of public engagement Conceptual design of BLIS; procurement specifications for BLIS development; Developer Inception Report; BLIS Implementation Plan; BLIS quality report; Developer Final Report; and the fully functional BLIS deployed at the National Land Commission Secretariat (NLCS) / GovTech data center
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Risk Assessment and Mitigation Measures

Institutional and Governance Risks

287. These risks are assessed as medium probability and high impact. The feasibility of the project depends on the timely establishment and operationalization of CBS as a State-Owned Enterprise (SOE), including its ability to enter into Public Service Agreements (PSAs) and assume responsibility for service delivery. Delays in defining governance, financial management, and reporting arrangements could constrain service rollout and undermine long-term sustainability. In parallel, weak coordination between the MoIT PMU, Thimphu Thromde PIU, and CBS may lead to delays across civil works, utilities, and system deployment. The effectiveness of the transport system is also contingent on the implementation and enforcement of demand-management measures such as parking restrictions and bus priority operations. If these are not effectively implemented, the project may not achieve the intended modal shift or associated GHG reductions.

288. These risks are mitigated through institutional strengthening and implementation support embedded in the project design. Under Component 2.2(a), the project supports the establishment of CBS as an independent State-Owned Enterprise with the legal, governance, financial management, and reporting arrangements required for PSA-based service delivery. Under Component 2.3, the project finances project management, coordination, procurement, and reporting functions for both the MoIT PMU and Thimphu Thromde PIU, ensuring alignment across agencies and activities. In addition, the Traffic Circulation and Management Plan under Component 1.2(d) supports the implementation of the revised street hierarchy and bus priority measures. Component 2.2(e) supports the implementation of policies and strategies under the Low-Emission Transport Master Plan, including parking restrictions and complementary mobility measures.

Technical and Operational Risks

289. These risks are assessed as medium probability and high impact. The project involves the deployment of interdependent systems, including electric bus operations, charging and depot infrastructure, Intelligent Transport Systems (ITS) and Management Information Systems (MIS), and SCADA-enabled water management systems. Risks arise from limited institutional capacity to manage implementation, as well as the need to recruit and train drivers, mechanics, and operational staff to support new service delivery models. Additional risks include the integration and operation of digital systems and the effective use of data for service planning and management. The operational performance of the transport system also depends on the reliability of charging and depot facilities and the ability to manage and maintain the new fleet and associated infrastructure.

290. These risks are mitigated through the integration of physical investments and institutional support within the project design. Under Component 1.3, the project provides bus priority infrastructure, electric buses, terminals, depot and charging facilities, and ITS and MIS systems that together establish the physical and operational backbone of the new transport system. Under Component 2.2(b), the project supports training, technical assistance, and operational readiness for CBS staff, including drivers, mechanics, and operational personnel, while also supporting shadow operations and readiness testing. Under Component 2.2(d), the project supports the preparation of capital investment, financing, and maintenance plans to guide asset management and system operation. In the water sector, SCADA systems introduced under Component 1.1 are supported by operational integration and capacity-building under Component 2.1(b), ensuring that digital systems are embedded in day-to-day system management.

Regulatory and Legal Risks

291. These risks are assessed as medium probability and medium to high impact. Delays in finalizing enabling standards, policies, and regulatory measures could slow procurement and delay implementation, particularly where they affect the rollout of public transport operations and supporting systems. Legal risks also arise from potential delays in establishing CBS as a State-Owned Enterprise (SOE) and formalizing Public Service Agreements (PSAs), which are essential for defining service obligations, operational responsibilities, and financial arrangements.

292. These risks are mitigated through targeted policy, regulatory, and institutional support embedded in the project design. Under Component 2.2(a), the project supports the establishment of CBS as a State-Owned Enterprise and the development of Public Service Agreements (PSAs), including the legal, governance, and financial management arrangements required for service delivery. Under Component 2.2(e), the project supports the prioritization and implementation of policies, strategies, and regulations under Bhutan's Low-Emission Transport Master Plan, including parking restrictions and complementary mobility measures. Under Component 2.2(f), the project develops national ITS standards, finalizes system specifications, and supports installation, testing, and operation of these systems. These measures are supported by implementation, coordination, and oversight arrangements under Component 2.3, ensuring alignment between institutional readiness, regulatory measures, and system rollout.

Macroeconomic and Market Risks (Including Forex and Imports)

293. These risks are assessed as medium probability and high impact. Inflation, foreign exchange volatility, and potential import constraints may increase costs and delay procurement of key inputs, including e-buses, charging systems, ITS, and SCADA components. The reliance on imported e-buses introduces an additional supply risk, as any disruption in international supply chains or trade conditions could affect implementation timelines and project scope.

294. These risks are mitigated through procurement and implementation arrangements embedded in the project design. Under Component 1.3, the project finances the procurement of electric buses, charging infrastructure, depot facilities, and ITS systems as part of an integrated package, allowing coordination of delivery timelines and system deployment. These activities are supported by implementation, procurement, and contract management capacity under Component 2.3, which strengthens coordination, sequencing, and oversight across packages and agencies.

Climate and Environmental Risks

295. These risks are assessed as medium probability and high impact. Increasing frequency and intensity of floods, landslides, and extreme rainfall pose risks to construction activities and infrastructure integrity, particularly for water transmission corridors and transport infrastructure, potentially delaying commissioning and early benefits.
296. These risks are mitigated through the integration of climate-resilient design measures into project investments. Under Component 1.1, the project includes slope stabilization, erosion control, and protection of raw and treated water transmission corridors, as well as improved water intake infrastructure to withstand extreme hydrological conditions. Under Component 1.2(e), roadside drainage improvements and Sustainable Drainage Systems (SuDS) reduce pluvial flood risks along the transport corridor and Norzin Lam. Under Component 1.3(a), bridge widening and protection works are designed to improve resilience to extreme climate events. These measures are supported by implementation oversight and coordination under Component 2.3.

Demand and Behavioural Risks

297. These risks are assessed as medium probability and high impact. Even with improved infrastructure and services, there is a risk that the expected shift from private vehicles to public transport may not fully materialise due to persistent behavioural preferences, including perceived convenience, comfort, and status associated with private vehicle use. In addition, behavioural responses to improved public transport services may differ from modelled assumptions, and the effectiveness of demand management measures will depend on consistent implementation and enforcement, which could constrain the projected modal shift and associated mitigation benefits.
298. These risks are mitigated through the combined design of infrastructure, policy measures, enforcement mechanisms, and user engagement embedded in the project. Under Component 1.2(d), the Traffic Circulation and Management Plan supports the implementation of the revised street hierarchy and bus priority measures. Under Component 1.3, the project delivers bus priority lanes, electric buses, terminals, and ITS systems to improve service speed, reliability, and passenger information, including real-time performance monitoring. These measures are complemented under Component 2.2(e) by the implementation of policies and strategies under the Low-Emission Transport Master Plan, including parking restrictions, pricing measures, and other demand management interventions. The project also incorporates continuous monitoring of transport demand and service performance, enabling adaptive management and refinement of policies over time. This is further reinforced by communication and awareness activities under Component 2.2(i) to support user uptake and behavioural change.

Financial Sustainability Risks

299. These risks are assessed as medium probability and high impact. The long-term viability of the project depends on adequate funding for operations and maintenance, as well as the implementation of tariff reforms and revenue generation mechanisms. If these do not materialize, service quality and resilience outcomes may not be sustained beyond the initial investment period.
300. These risks are mitigated through institutional and financial strengthening measures embedded in Component 2. Under Component 2.2(c), the project supports CBS in developing additional revenue sources, including commercial activities and advertising, to reduce reliance on subsidies. Under Component 2.2(d), the project supports the preparation of capital investment, financing, and maintenance plans for the transport network. In the water sector, Component 2.1(d) strengthens billing systems and provides advice on tariffs to improve cost recovery and financial sustainability. These measures are complemented by improved utility-style management arrangements under Component 2.1(a).

Environmental, Social, and Reputational Risks

301. These risks are assessed as medium probability and medium to high impact. Construction-phase risks, including community health and safety (CHS), occupational health and safety (OHS), and risks related to sexual exploitation and abuse and sexual harassment (SEA/SH), may lead to delays, grievances, and reputational impacts if not effectively managed.
302. These risks are mitigated through safeguards and implementation systems embedded in the project design. Under Component 1.2 and Component 1.3, safety and accessibility considerations are integrated into the design of public realm improvements, transport infrastructure, and service delivery systems. These are complemented under Component 2.2 by stakeholder engagement and communication activities that support inclusive implementation and responsiveness to community needs. Under Component 2.3, the project finances project management, safeguards implementation, supervision, and reporting functions for both the PMU and PIU, including oversight of contractors and compliance with environmental and social requirements.

Fiduciary and Integrity Risks (Prohibited Practices)

303. These risks are assessed as medium probability and high impact. The use of multiple procurement packages increases exposure to prohibited practices, including fraud, corruption, and collusion, which could delay disbursement and affect implementation performance.
304. These risks are mitigated through the project's procurement and fiduciary management arrangements. Under Component 2.3, the project finances procurement, contract management, financial management, reporting, and monitoring functions within the MoIT PMU and Thimphu Thromde PIU. These arrangements ensure structured procurement processes, oversight of contract execution, and accountability across all components and activities.

Economic Feasibility

Objective

305. The Economic and Financial Analysis (EFA) for this project aims to provide a clear and integrated assessment of its financial viability and economic impact. Its primary objectives include comprehensively defining the project for both financial and economic perspectives and ensuring alignment with budgets and funding sources. The analysis further seeks to integrate and consolidate financial indicators for the overall project, evaluating them against various sensitivities and scenarios. This process is crucial to clearly demonstrating the value addition of the project under both "with project" and "no project" scenarios.
306. For transport investments, the EFA specifically aims to demonstrate the financial viability of the transport component, including assessing project IRRs and illustrating the necessity of GCF concessionality for these investments, particularly for the higher upfront costs of electric buses compared to diesel equivalents and the non-revenue-generating nature of certain climate-resilient design features. The EFA shows that without GCF support, the transition to low-emission transport would likely not proceed, locking Bhutan into high-emission transport system.
307. For the water components, the EFA aims to demonstrate that grant financing is essential to support the additional upfront costs of climate-resilient water infrastructure, such as SCADA systems and specific adaptation measures, which are not recoverable via tariffs in the short term and would otherwise be underfinanced due to fiscal constraints.

Main Costs, Benefits and Sensitivities

308. For the transport component, the main costs include the substantially higher upfront cost for electric buses and associated charging infrastructure compared to diesel equivalents, which necessitates GCF support. Investments also cover the 18.9 km bus priority corridor, two new terminals and bus depot upgrade, 75 bus shelters, and 23 signalized pedestrian crossings. The key benefits are projected to be a reduction of roughly 69,519 tCO₂eq over 20 years, an Economic Internal Rate of Return (EIRR) ranging from 22.4% to 22.9%, and a Benefit-Cost Ratio (BCR) of 1.62-1.65. These arise from reduced journey times, lower vehicle operating costs, decreased traffic accidents, and substantial fuel savings for all road users.
309. Sensitivities influencing these outcomes include the critical need for sustained political willingness to implement demand-side measures like parking restrictions and traffic regulations, the fluctuating market prices of e-buses, and the successful achievement of a significant modal shift from private cars through effective policies and public acceptance. For this analysis, we assume that the price of e-buses will decline steadily over time, with sources suggesting that cost parity with diesel buses will be achieved by around 2035.⁸⁴ This trend is largely driven by the expected reduction in battery costs. In addition, fleet procurement is not assumed to occur upfront; instead, it is phased over time to both reduce the immediate fiscal burden and take advantage of declining technology costs.
310. For the water component, the primary costs involve additional upfront investments for SCADA systems, smart meters, and climate-resilient adaptation measures that are not commercially viable or recoverable through traditional tariffs in the short term. These costs also include upgrading raw water intake structures, stabilizing landslide-prone slopes, rehabilitating deteriorated distribution mains, and enhancing the water distribution network. The main benefits target a reduction in NRW from over 50% to 25%, and an increase in daily treated water supply from 3-9 hours to at least 15 hours for all households in the city core (12 hours during the dry season).
311. Sensitivities include the limitations of current tariff structures to cover the incremental costs of climate-resilient upgrades, the financial capacity of Thimphu Thromde to maintain and operate these systems, and the ongoing need for concessional financing to bridge the viability gap for critical adaptation measures.

⁸⁴ <https://about.bnef.com/insights/clean-transport/electric-buses-cities-driving-towards-cleaner-air-lower-co2/>

Consolidated Results

312. The financial analysis shows that while the modal shift to low-emission transport generates strong economic returns (EIRR of 22.4–22.9% and ENPV up to US\$26.53 million), it remains financially unviable without GCF support, with a financial NPV of approximately (-\$13.25 million). With concessional financing, the financial NPV improves to +\$0.41 million. The water resilience component, while financially positive (NPV of \$8.07 million), is insufficient on its own to offset the losses from the transport investments in a non-GCF scenario. This underscores the critical role of GCF funding in bridging the financing gap and enabling investment in low-carbon transport that would not proceed under purely commercial conditions.

Table 0-1a. Key economic performance indicators for LRCP with GCF Funding

Project Component	Economic NPV (US\$M)			Economic IRR			GHG Avoided (tCO ₂ e)	Flood Resilience Benefits (US\$M)
	Without GHG Benefits	With GHG Benefits (Low)	With GHG Benefits (High)	Without GHG	With GHG (Low)	With GHG (High)		
1.1 Resilience measures into water network [IDA funded]	\$3.06			19.1%				
1.2 Improved pedestrian infrastructure [GCF]	\$23.90	\$25.22	\$26.53	21.8%	22.4%	22.9%	69,519	\$64.14
1.3 Low-emission public transport [GCF]								
2.0 Institutional strengthening & enabling environment [Co-fin.]								

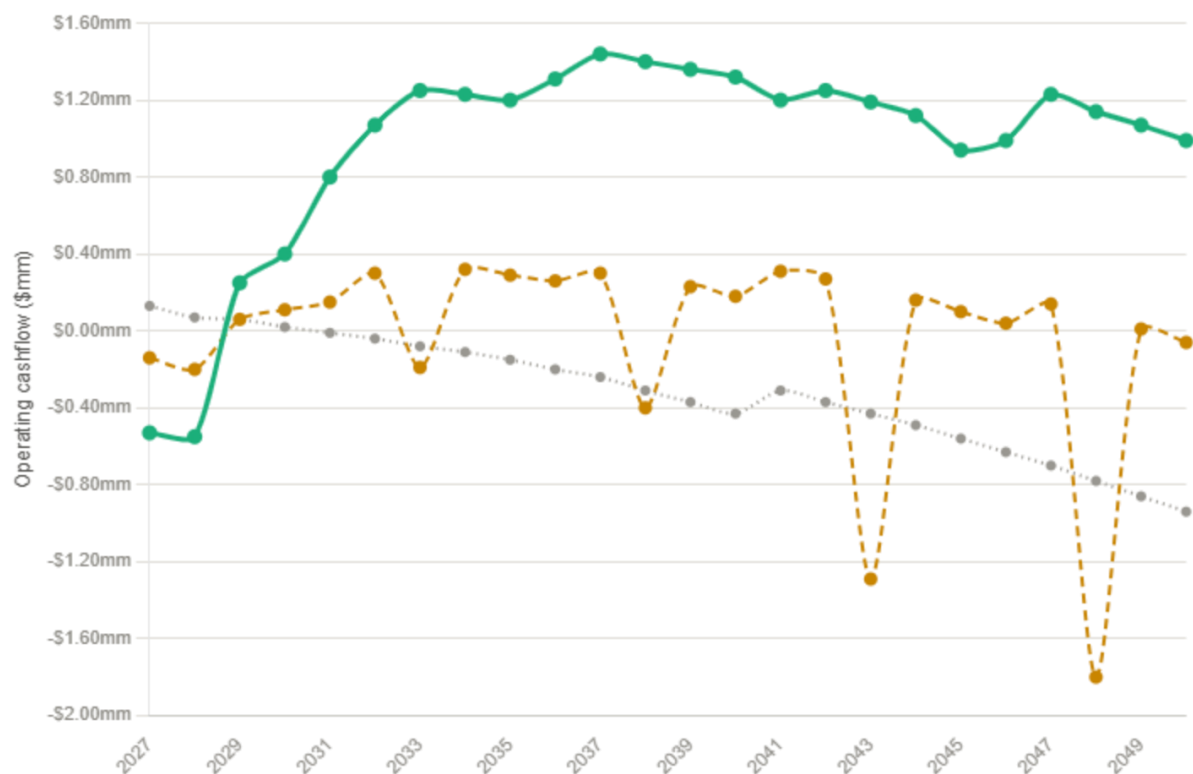
Table 0-1b. Key financial performance indicators for LRCP without GCF Funding

Project Component	Without GCF Fin. NPV (US\$M)	With GCF Fin. NPV (US\$M)	Without GCF Fin. IRR (%)	With GCF Fin. IRR (%)	GCF Additionality (US\$M)	GCF Additionality (%)
1.1 Resilience measures into water network [IDA funded]	\$8.07	\$8.07	-	-	\$0.00	-
1.2 Improved pedestrian infrastructure [GCF]	(\$0.80)	(\$0.80)	-	-	\$0.00	-
1.3 Low-emission public transport [GCF]	(\$13.25)	\$ 0.41	6%	13%	\$13.66	7%
2.0 Institutional strengthening [Co-fin.]						
WHOLE PROJECT TOTAL	(\$5.98)	\$7.68				

Transport investments

Operating cashflow projections show that durable financial sustainability is achievable only under the full project. Under business-as-usual, CBS slides from a modest surplus into deepening structural deficits, slipping into deficit by 2031 and reaching approximately -\$0.94 million by 2050 as operating costs outpace a largely static farebox. The BPC without the 50 GCF-financed buses follows a different pattern – for most of the appraisal period it hovers close to breakeven – but it is acutely exposed to fleet-renewal cost events, swinging to severe deficits of roughly -\$1.29 million in 2043 and -\$1.80 million in 2048. These shocks are not absorbed by the underlying operating base, and the scenario closes the appraisal period essentially at breakeven, at about -\$0.06 million in 2050. In other words, the corridor alone is not structurally loss-making in the way business-as-usual is, but it lacks the revenue cushion to withstand large, lumpy renewal costs without lurching into deep deficit. The full project is the only scenario that achieves durable financial viability. After a brief ramp-up dip in its first two years (-\$0.53 million in 2027 and -\$0.55 million in 2028), operating cashflow turns positive in 2029 and climbs above \$1 million by the early 2030s – reaching \$1.07 million in 2032 – before peaking near \$1.44 million in 2037. It remains positive every year thereafter, absorbing the same renewal-year cost shocks that push the corridor-only scenario into deep deficit: cashflow stays at \$1.19 million in 2043 and \$1.14 million in 2048, the very years in which the corridor-only scenario falls to its lowest points. This difference is driven by the incremental ridership and farebox revenue generated by the 50 buses, which transform CBS from an operator facing structural decline (under business-as-usual) or acute shock exposure (under corridor-only) into one with the financial depth to remain consistently cashflow-positive – establishing the operating surplus needed to fund fleet replacement and expansion without recurring fiscal support.

Figure 8-1: Operating cash flow of CBS with and without the project



Values below the breakeven line are operating deficits. \$mm.

■ With project (corridor + 50 buses) - - - Corridor only (no 50 buses) Business as usual

313. **Capital Investments:** Capital investments encompass electric buses and batteries, charging infrastructure, ancillary corridor works, and digital systems. Electric bus unit costs decline from \$170,000 in 2027 to price parity with diesel at \$30,000 by 2035, consistent with Bloomberg NEF projections. The first 50 buses are phased in between 2027 and 2028, with subsequent procurement covering fleet expansion and end-of-life replacements through 2050. Ancillary works — including bus priority lanes, terminals, shelters, pedestrian crossings, and Norzin Lam pedestrianisation — peak at \$8.47 million in 2028. MIS and ITS digital systems are procured in three tranches totaling \$3.84 million over the first three project years. Full cost details, including regional benchmarking for bus and charger prices, are provided in Annex 3.

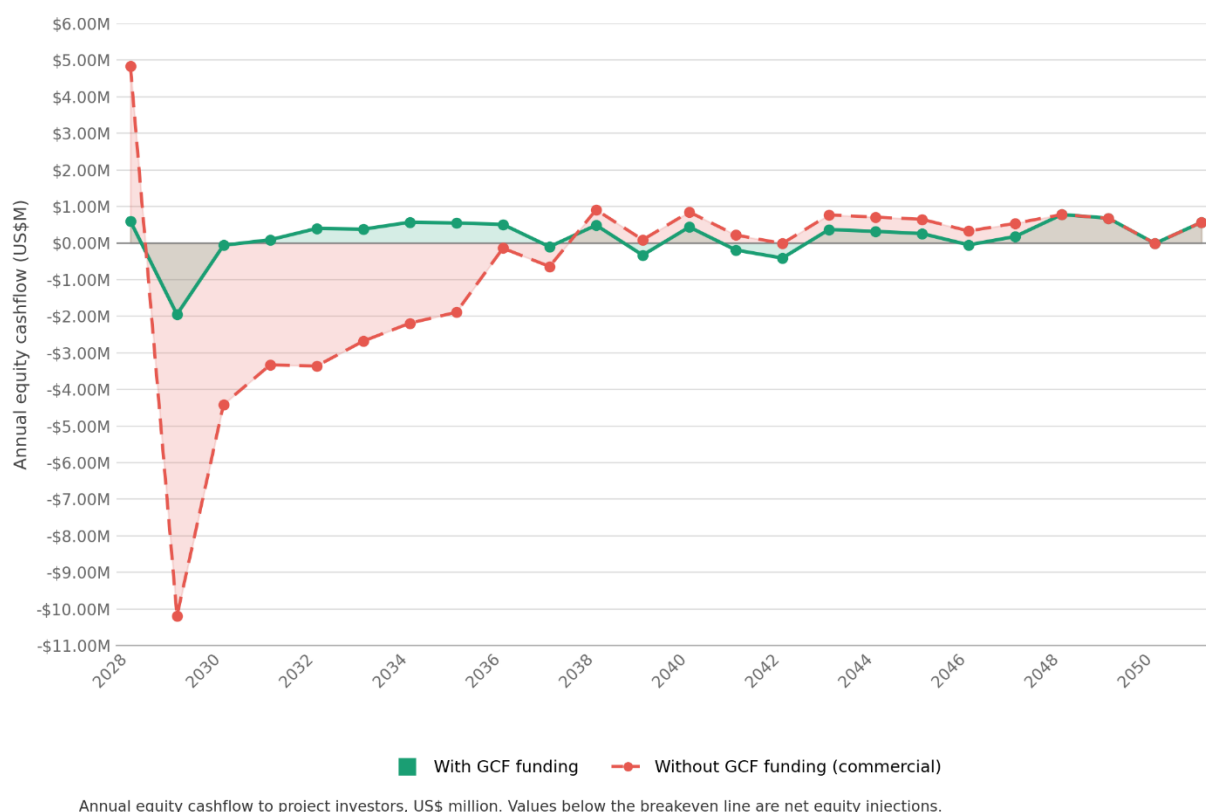
Financing Scenarios and the Case for GCF

314. The financial analysis compares three financing structures – no project, project with commercial lending, and project with GCF – to isolate the value of GCF concessionality and demonstrate why commercial lending alone cannot make the transition to a high quality, electric BRT system viable. See Annex 3 (Economic & Financial Analysis) for full details.

Commercial lending (no GCF)

315. Under commercial financing, annual debt service on the bus fleet rises sharply to a peak of \$2.47 million in 2030, with obligations remaining above \$1.4 million every year from 2029 through 2035, before the seven-year, no-grace loan is fully repaid - precisely the years in which the service is still building ridership and operating cashflows remain in early-stage recovery. Under GCF financing, debt service is both lower and very differently timed during this critical window. During the five-year grace period (2028–2032) it stays at or below \$0.15 million per year, and once principal repayment begins it rises to around \$0.53 million, easing slightly through the mid-2030s before reaching a peak of \$0.60 million in 2038, then gradually declining to \$0.54 million by 2046 as the balance is retired over the full twenty-year term. On a discounted basis, the commercial scenario yields a financial net present value of negative \$13.25 million at a 12 percent discount rate. This reflects a structural financing gap that is characteristic of first-of-kind electric mobility projects in developing country contexts, where the revenue ramp-up period, nascent ridership base, and limited track record combine to make commercial financing terms prohibitive.

Figure 8-2 Equity cashflows



Financial Justification for GCF Support

316. The financial analysis unambiguously demonstrates that the electric bus transition in Thimphu is not commercially bankable without concessional financing. Under market lending terms, the project yields a financial NPV of -\$13.25 million and is equity-negative for almost a decade – conditions that no private or commercial operator could accept. GCF financing at even the low concessional level transforms the project's financial profile, generating a positive NPV of +\$0.41 million and placing CBS on a sustainable long-term operating footing. Beyond the direct NPV impact, GCF support de-risks the initial fleet expansion, enabling the operational learning and infrastructure build-out that makes subsequent domestic or commercial fleet expansion feasible. Without the initial GCF intervention, the modal shift, climate mitigation, and financial sustainability benefits described in this analysis would not materialise. For full financial model details, refer to Annex 3.

Economic Benefits

317. The modal shift investment component of the LRCP project generates a strong economic return across all scenarios, with an economic NPV ranging from \$25.2 million to \$26.5 million depending on the carbon price assumption applied, and an economic IRR of 22.4% to 22.9%. These returns reflect the combined benefits of travel time savings, vehicle operating cost reductions, road safety improvements, and GHG emissions avoidance that accrue from shifting Thimphu's commuters from private vehicles to electric BRT. The BRT corridor reduces the overall volume of vehicles on the road, improving travel speeds for all road users, while dedicated bus lanes and improved access deliver an estimated three minutes of additional time savings per bus trip. Fuel savings are also substantial: as modal shift takes hold, diesel and petrol consumption decline progressively relative to the without-project scenario, with the substitution of imported fossil fuels by Bhutan's domestic hydropower-generated electricity through the electric bus fleet providing a further macroeconomic benefit through reduced fuel import dependence. GHG emission reductions deliver cumulative avoided emissions of approximately 69,519 tCO₂eq over the project lifetime (excluding methane), with monetised benefits ranging from US\$1.65 to \$3.30 million in present value depending on the shadow price of carbon applied, growing steadily as the electric fleet scales up and modal shift deepens (for more details, see Annex 3).

318. A distinctive and material component of the project's economic case is its flood resilience benefits, which accrue directly to vehicle users rather than to the operator. Thimphu is acutely exposed to pluvial flooding driven by intense monsoon rainfall, with flood depths projected to intensify significantly by 2050 under the SSP3-7.0 scenario. The 50-year event, for instance, is projected to reach 1.29 m by 2050, at which depth depth-damage functions indicate 100% loss for motorcycles, taxis, and cars, and 60% damage to buses. By shifting a substantial share of trips from private

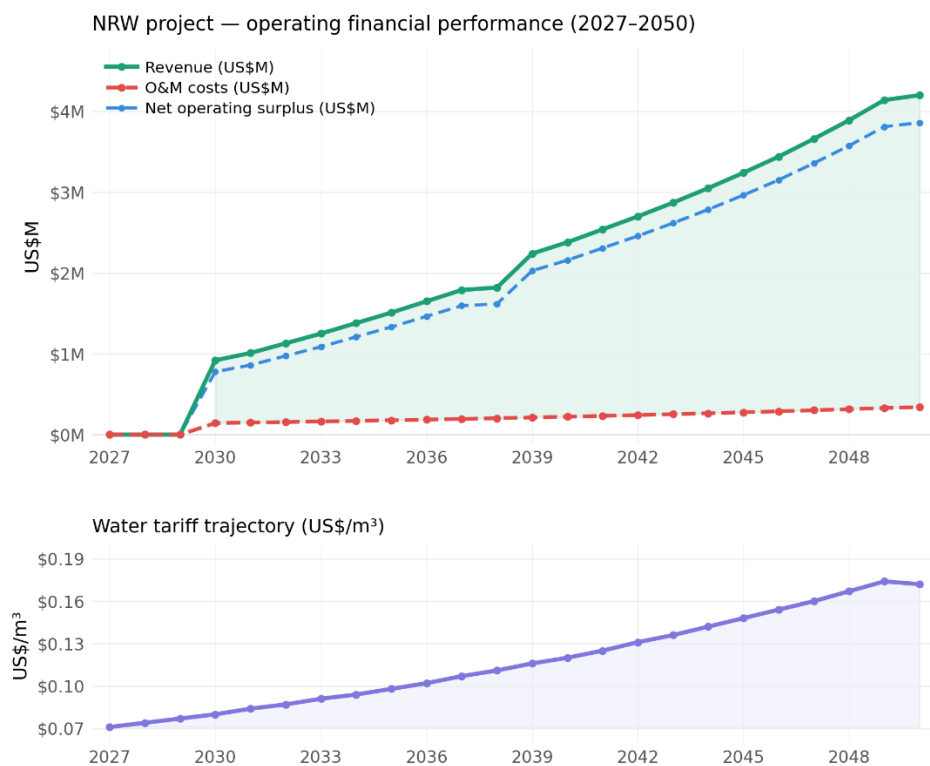
vehicles onto the BRT corridor, the project directly reduces the number of flood-exposed cars and motorcycles on the road network, dramatically lowering the aggregate vehicle repair cost burden on Thimphu's households. Sustainable Urban Drainage Systems deployed along the corridor reinforce this benefit by attenuating peak flows and reducing flood depths, with well-designed SUDS shown to reduce inundation depths by up to 29% for distributed source-control measures and by 50% or more where larger storage elements are incorporated. Flood resilience benefits amount to \$17.4 million in present value terms, representing the largest single benefit category after travel time savings and making the climate adaptation case for the investment highly tangible at the user level.

319. The project's climate benefits are central to the rationale for GCF participation. The transition from a diesel-dominated private vehicle fleet to electric BRT directly reduces urban transport emissions and places Thimphu on a substantially less emissive development pathway, leveraging Bhutan's near-zero-carbon hydropower grid to deliver low-emission mobility at scale. At the same time, the modal shift and SUDS investments build climate resilience against the increasingly intense pluvial flood hazard that climate change is imposing on the city, reducing the economic exposure of households to flood damage that will grow significantly in the absence of intervention. These climate benefits — mitigation and adaptation in combination — are precisely the category of co-benefits that GCF is designed to support, and they are not captured in the operator's financial income statement, creating the gap between strong economic returns and weak financial viability that concessional financing is designed to bridge.
320. Despite the project's strong economic performance, it is not financially viable without concessional support. Under commercial lending terms — 13.5% interest, 7-year tenor, no grace period — the financial NPV is -\$13.25 million, confirming that the electric bus transition cannot be financed on market terms. GCF financing at low concessionality (0.75% interest, 5-year grace period, 20-year tenor) transforms the financial profile, delivering a positive financial NPV of \$0.41 million and placing the City Bus Service on a sustainable long-term operating footing. This gap between economic and financial returns is characteristic of public transport investments where significant benefits accrue to users and society rather than flowing through the operator's income statement. GCF participation is therefore not a subsidy of convenience but a structural requirement for a high-return public investment to proceed — one that simultaneously delivers climate mitigation, climate adaptation, and economic development benefits that would not materialise at scale without the initial concessional intervention.

Water investments

321. The project's water component delivers a progressively improving financial operating position over the appraisal period, driven by a combination of revenue growth from expanded billed connections and rising tariffs, alongside a contained and relatively modest O&M cost base (see figure 8-3). Revenue grows from \$0.92 million in 2027 to \$4.20 million by 2050, reflecting both the expansion of the metered customer base as previously unregistered or under-metered connections are formalised, and the application of a gradually increasing tariff structure. The water tariff rises from \$0.071 per m³ in 2027 to approximately \$0.172 per m³ by 2050, a trajectory that remains affordable in absolute terms while progressively improving the utility's ability to recover its operating costs and move towards financial self-sufficiency. O&M costs, which are modest relative to revenue and grow from \$0.143 million in 2030 to \$0.34 million by 2050, reflect the ongoing maintenance requirements of the rehabilitated network and are well covered by the revenue stream throughout the appraisal period. The resulting net operating surplus widens consistently over time, growing from a small positive position in the early operating years to over \$3.8 million annually by the end of the period, demonstrating that the NRW investment not only reduces economic losses but materially strengthens the long-term financial viability of Thimphu's water utility. The project yields a financial NPV of \$8.07 million, demonstrating that the NRW investment not only reduces economic losses but materially strengthens the long-term financial viability of Thimphu's water utility, generating returns that comfortably justify the capital outlay on purely financial grounds.

Figure 8-3 Change in operating performance of the water utility in Thimphu



Revenue and O&M in USM. Tariff in US\$/m³. Green shading indicates operating surplus. Source: NRW financial model.

322. The economic analysis of the Non-Revenue Water reduction project in Thimphu evaluates costs and benefits over a 2027 to 2050 appraisal period, discounting all flows to present value using a standard social discount rate. The project targets a reduction in NRW from a baseline exceeding 50% to 25%, a transformation that is critical not only for utility financial sustainability but for conserving Thimphu's water resources and ensuring reliable supply during dry periods when the Wang Chhu's flow is most constrained. Capital expenditure is concentrated in the early years, with investments of \$675,000 in 2027, \$1.8 million in 2028, and \$2.664 million in 2029 covering primary network rehabilitation, metering, and pressure management works. Periodical repair costs of \$128,480 per year sustain the improved network through the appraisal period, with periodic replacement cycles reflected in higher expenditure in 2031, 2036, 2041, and 2046. Against these costs, the project generates three principal benefit streams — physical loss reduction, bill recovery, and avoided capital expenditure — that grow progressively as the improved network matures and system efficiency gains compound over time.
323. The largest and most direct benefit of the project is the reduction in physical water losses, which generates savings by reducing the volume of water that must be abstracted, treated, and distributed without reaching a paying customer. Physical loss benefits grow from \$193,900 in 2030 to \$910,600 by 2050 as the full effect of network rehabilitation takes hold and the gap between the with-project and without-project loss rates widens over time. Bill recovery benefits, arising from the reduction in commercial losses through improved metering and reduced illegal connections, provide a complementary stream, growing from \$93,100 in 2030 to \$1,404,200 by 2050 and ultimately becoming the largest single annual benefit category in the later years of the appraisal period. Together, these two streams reflect the dual nature of NRW reduction as both a physical and a commercial intervention, addressing losses on both the supply and revenue sides of the utility's operations.
324. By bringing physical losses under control, the project also eliminates the need for the utility to invest in oversized production, treatment, and transmission infrastructure to compensate for water lost in the system. This avoided capital expenditure, growing from \$71,900 in 2030 to \$300,800 by 2050, represents a genuine resource saving to Thimphu's water utility and public finances, and is included as an economic benefit on the basis that it reflects real avoided investment relative to the without-project counterfactual. Savings on water resource management contribute a further \$179,640 to \$752,090 annually over the same period.
325. The consolidated results of the cost-benefit analysis confirm the strong economic case for the NRW investment. The project delivers an Economic Internal Rate of Return of 19.1%, well above the social discount rate, indicating that the investment generates returns comfortably in excess of its opportunity cost. The Benefit-Cost Ratio of 1.58 confirms that for every dollar invested, the project generates \$1.58 in economic benefits, reflecting efficient use of public and

concessional resources. The economic Net Present Value of \$3.06 million represents the net economic surplus generated by the project in present value terms, capturing the aggregate benefit to Thimphu's water utility, its customers, and the broader public finances from bringing NRW under control. These results are robust across the benefit streams, with physical loss reduction, bill recovery, and avoided capital expenditure all contributing materially to the overall return, and reflect a conservative analytical approach that excludes physical loss benefits from the financial analysis to remain prudent about the translation of recovered water into billed revenue.

326. Justification for Grant Financing: The EFA demonstrates that grant financing is crucial because the additional upfront costs for climate-resilient water infrastructure, such as SCADA systems and specific adaptation measures, are not recoverable through traditional tariff structures in the short term. This grant addresses the viability gap, ensuring that critical climate adaptation measures are implemented despite existing fiscal constraints and the limited capacity for cost recovery through tariffs alone.

Financial Arrangements (where the GCF investment fits, what the co-financing arrangements are, management arrangements)

327. The financing arrangements on which this funding proposal is based are: the World Bank is the Accredited Entity to the GCF on behalf of RGoB, the Ministry of Finance is the Nationally Designated Authority, and the Ministry of Infrastructure and Transport (MoIT) is the Executing Entity. There are several opportunities for both donor and commercial co-financing of the further projects that will be defined and developed under Component 2, and the RGoB has prioritised NMT and public transport infrastructure in its current Five-Year Plan (2024 –2029) which has allocated US\$31.64 million to roads, NMT, and non-trunk bus services, water network improvements, and place-making in Thimphu as parallel funding to LRCP.
328. The LETMP strategies are designed to consolidate and increase the modal shift that is expected from the LRCP investments themselves and will be planned and implemented with the Component 2 support from GCF. The Department of Human Settlement will provide the secretariat to the Project Management Unit within MoIT and will both coordinate and project manage the LRCP Component 1 investments but also take forward the complementary further projects to implement the LETMP NMT strategy and the simultaneous implementation of the Water Sector Masterplan. These further projects will be supported by the technical assistance provided to MoIT, Thimphu Thromde, and City Bus Service under Component 2 of LRCP and will prioritise the allocation of 13 FYP funding but also advise on structuring projects that have the potential for private financing or other donor support. RGoB launched the Bhutan Climate Fund at COP28 in 2023, and it is possible that the replacement of the remaining diesel bus fleet, and other parallel investment projects in the LETMP may be classed as qualifying projects for carbon credits under the fund.

Implementation Arrangements

Accredited Entity and Executing Entity

329. The World Bank will serve as the Accredited Entity (AE) to the GCF and will administer GCF resources in accordance with the Accreditation Master Agreement (AMA) and the Funded Activity Agreement (FAA). The World Bank contractually requires that the Executing Entity to follow its policies and procedures relating to procurement, financial management, environmental and social standards, integrity, and monitoring and evaluation. The World Bank will supervise project implementation and report progress to the GCF in accordance with the reporting requirements established under the FAA. World Bank resources will be provided to the Kingdom of Bhutan through a Financing Agreement between the World Bank and MoF, consistent with standard IDA procedures.
330. The Executing Entity (EE) for LRCP is the Kingdom of Bhutan, represented by its Ministry of Finance and acting through its Ministry of Infrastructure and Transport (MoIT). Implementation of project activities will be coordinated by MoIT, which will host the Project Management Unit responsible for overall project coordination. Implementation responsibilities for specific project components will be carried out in collaboration with Thimphu Thromde (TT)'s Project Implementation Unit.
331. Figure 9-1 illustrates the overall institutional arrangements of LRCP, including the governance structure, the relationships between the Accredited Entity and the Executing Entity, and the roles of the implementing agency and operational beneficiary.

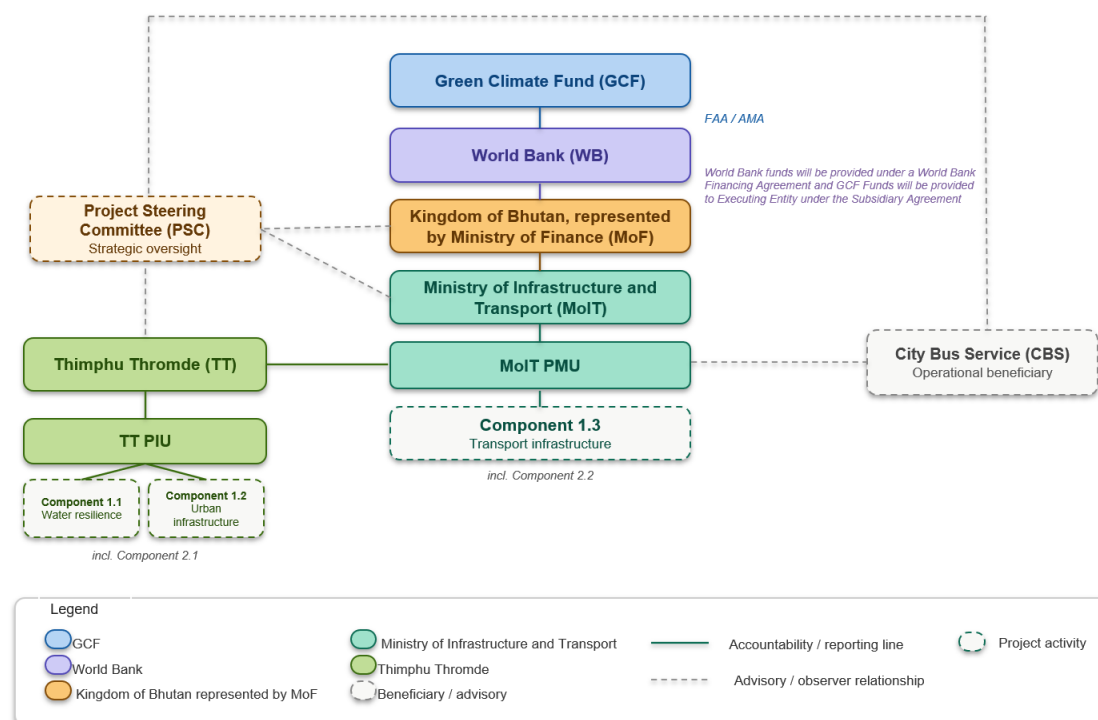


Figure 9-1 Institutional arrangements

Governance Arrangements

332. Strategic oversight of LRCP will be provided by a Project Steering Committee (PSC), which will be established by the Kingdom of Bhutan at the beginning of the project implementation period. The PSC will serve as the project's high-level decision-making and coordination body. Its role will be to provide strategic guidance, ensure alignment with national policies and development priorities, facilitate coordination among implementing agencies, and review overall project performance.
333. The PSC will be chaired by the Secretary of MoIT and will include representatives from the Ministry of Finance, Thimphu Thromde, the City Bus Service, and the Bhutan Construction and Transportation Authority. The World Bank will participate in PSC meetings as an observer to supervise alignment with World Bank policies, through which GCF requirements are met.
334. The PSC will meet at least twice per year and will review project progress, approve Annual Work Plans of the PMU and PIU, and provide guidance on major policy or implementation issues that may arise during implementation.

Project Management Arrangements

335. Day-to-day project coordination and management will be carried out by a Project Management Unit (PMU) established within the Department of Human Settlement (DHS) of the Ministry of Infrastructure and Transport. The PMU will be responsible for overall project management, including coordination across implementing entities, procurement oversight, financial management coordination, monitoring and evaluation, safeguards compliance, and reporting to the World Bank. The PMU will consolidate progress information from its own oversight activities and from TT. It will report to the World Bank which will in turn report to GCF. The PMU will also provide administrative and technical support to the Project Steering Committee.
336. The PMU will be led by a Project Director appointed by the Government and will include specialists responsible for procurement, financial management, environmental and social safeguards, monitoring and evaluation, gender, and legal matters. These specialists will be drawn from existing MoIT staff.
337. To strengthen implementation capacity, the PMU will be supported by a Project Management Consultant (PMC). The PMC will provide technical and operational support to the PMU, including assistance with procurement processes, engineering review, contract administration, and coordination of technical consultancies. The PMC will support the PMU in fulfilling its management responsibilities.

Project Implementation Arrangements

338. Implementation responsibilities for infrastructure investments will be carried out by the relevant sector institutions through dedicated implementation units. Responsibilities are organized by project component.

Ministry of Infrastructure and Transport (MoIT)

339. Through the PMU, MoIT will manage procurement and supervision of construction contracts under Component 1.3. These investments include bus priority lanes, bus stops and shelters, terminals, depots, charging infrastructure, and intelligent transport systems (see C1.3, activities a-e). MoIT will also coordinate institutional strengthening activities under Component 2.2. These activities support public transport governance reforms and the operational transition of the City Bus Service (see C2.2, activities a-i).

340. A Financial Management (FM) assessment of the implementing ministry has been carried out in accordance with World Bank policy. The assessment determined that acceptable financial management arrangements are in place to ensure that: (i) project funds will be used for the intended purposes in an efficient and economical manner; (ii) financial reports will be prepared in an accurate and timely manner; and (iii) project assets and resources will be adequately safeguarded. MoIT is currently successfully implementing another Project with the World Bank (P181278: Accelerating Transport and Trade Connectivity in Eastern South Asia (ACCESS)). Adequate staffing arrangements are in place where experienced and qualified Finance resources are deputed to the Projects managed by MoIT. MoIT follows Government budgeting processes to receive funds. Budgets are allocated to the ministries based on the requirements (for Projects) submitted to MoF. Sufficient and adequate budget is allocated to foreign-funded Projects managed by MoIT. Funds flow arrangements are noted as seamless. The Funds are received by MoIT in the segregated Designated Accounts established for each project. MoIT financial reporting submission are always on time. The latest audit report of the ACCESS Project was received by the Bank, wherein auditors expressed unmodified opinion on the financial statements. The management letter did not contain any audit findings, which demonstrate robust financial management arrangements being implemented by MoIT.

341. The MoIT is the ministry responsible for developing policies regarding surface transport, human settlement, and infrastructure and overseeing the activities of the thromde. In parallel with the technical studies for LRCP, the MoIT has been the focal point for the work to finalise the LETMP and the Thimphu Development Plan, together with the Non-Motorised Transport Plan and the Public Transport Plan. It therefore has the capacity and skills to plan and coordinate the finalisation of the funding for the project and to oversee the work of the Implementing Entities. It will be responsible for the fiduciary and compliance monitoring of the funding and for continuing to manage the Grievance Mechanism.

Thimphu Thromde (TT)

342. Thimphu Thromde established a Project Implementation Unit (PIU) to manage the technical design process, with oversight from a technical committee involving representatives from the relevant RGoB ministries, including MoIT, and CBS. The project preparation involved social, gender, and environmental impact assessments, including extensive consultation and engagement with representative groups, government officials, and Project Affected People as summarised in Annex 7: Consultations and Stakeholder Engagement Plan, as well as traffic and passenger surveys. The PIU was the focal point for engagement with the World Bank transport team and the Project Management Consultants as the technical studies for LRCP were finalised. The process has demonstrated the capacity of the TT to organise and execute the procurement and implementation of the Norzin Lam and water supply components of LRCP.

343. Through the PIU, Thimphu Thromde will manage procurement and supervision of construction contracts under Components 1.1 and 1.2. These investments include water system resilience measures such as SCADA systems, raw water intake upgrades, transmission protection works, and leakage reduction programs. They also include pedestrianization, sidewalk improvements, drainage upgrades, and improvements to public spaces and connectivity (see C1.1, activities a-e and C1.2, activities a-e). Thimphu Thromde will also coordinate institutional strengthening activities under Component 2.1. These activities support the establishment and strengthening of water service delivery systems (see C2.1, activities a-h).

344. A capacity assessment of Thimphu Thromde has been conducted in accordance with World Bank procedures. The assessment confirmed that the municipality has adequate institutional arrangements to implement infrastructure investments with the support of dedicated project management and technical consultants.

345. A Financial Management (FM) assessment of TT has been carried out in accordance with World Bank policy. The assessment determined that acceptable financial management arrangements are in place to ensure that: (i) project funds will be used for the intended purposes in an efficient and economical manner; (ii) financial reports will be prepared in an accurate and timely manner; and (iii) project assets and resources will be adequately safeguarded. Adequate staffing arrangements are in place where experienced and qualified Finance resources are deputed to the Projects managed by TT. TT follows Government budgeting processes to receive funds. Budgets are allocated to the implementing entities based on the requirements (for Projects) submitted to MoF. Sufficient and adequate budget is allocated to

foreign-funded Projects managed by TT. The Funds received by TT are kept in the segregated Designated Accounts established for each project. TT financial reporting submission are always on time. TT has also successfully implemented Bhutan Green Transport Project (P171012) with satisfactory FM performance upon closure. The last audit report of the World Bank administered Bhutan Green Transport Project implemented by TT was received by the Bank, wherein auditors expressed unmodified opinion on the financial statements. The management letter did not contain any audit findings leading to major internal control weaknesses or serious accountability considerations, which demonstrate robust financial management arrangements being implemented by TT.

City Bus Service (CBS)

346. CBS will not have a direct role in project management or procurement during project implementation. Instead, CBS will serve as the operational beneficiary of public transport infrastructure financed under Component 1.3 (see C1.3, activities a-e). CBS will also benefit from institutional strengthening activities under Component 2.2 that support its transition into an independently managed state-owned enterprise (see C2.2, activities a-i). Following completion of infrastructure investments, CBS will assume responsibility for operation and maintenance of the electric bus fleet, bus terminals, depots, and intelligent transport systems. Any potential procurement of replacement e-buses will only be undertaken by CBS once it is fully established as an independent SOE. It will provide the bus services under a Public Service Agreement which will include a specification for service standards and other targets that pass down elements of the Results Management Framework agreed with the GCF as part of the Financing Agreements. It will have embedded technical advisers who can support the implementation of the ITS and MIS and assist in optimising bus operations, including planning service routes and frequency, maintenance of e-buses, staff rostering and training. CBS will need to implement appropriate management controls and appoint staff to the positions set out in the Operations Manual (Annex 21) in time for the start of full operations in Q2 2028.
347. CBS has been responsible for developing and operating bus services across the city since its establishment in 1999 under the governance of Thimphu Thromde. It has recently expanded its fleet of buses, introduced an entry-level e-payment scheme and established a website with service schedules. In 2001, the management and operational mandate of city bus services was transferred to Bhutan Post. By 2020, CBS was formally declared a State-Owned Enterprise (SOE), reporting directly to the Thrompon of Thimphu Thromde. There are plans to establish CBS as an independent SOE with a nationwide mandate to deliver public transportation services to other urban areas in Bhutan, operating under Public Service Agreements (PSA) with the respective Thromdes. As an SOE, CBS will be managed on a commercial basis. While its fare policies will still be subject to the approval of BCTA, its investment decisions and performance against the targets in its Public Service Agreement, which will reflect many of the KPIs in this Funding Proposal, will be overseen by the MoIT as the Executing Entity for LRCP and by Thimphu Thromde as the counterparty to its Public Service Agreement. It recognises the need to improve standards of service in the cleanliness of its buses and the training of its staff in customer service and can manage the capacity building and training set out in the technical documentation prepared as part of the project preparation.
348. For the implementation of LRCP, CBS will be responsible for the maintenance and cleaning of the new bus stops and shelters and the management and maintenance of the two new terminals and city centre depot once they are constructed or upgraded. It will award franchises for commercial activities within the depot and any new transport hubs developed under the Thimphu Structure Plan, including any associated car and bicycle parks at the proposed Mobility Hubs in the LETMP, advertising at bus stops and on buses. It will continue to lease buses for private activities and could provide the new dedicated educational and workplace transport services, or these could be licensed to private operators.

Financial Management and Flow of Funds

349. GCF financing will be administered by the World Bank as the Accredited Entity. Following signature of the Funded Activity Agreement, GCF funds will be disbursed to the Royal Government of Bhutan through the Ministry of Finance, which will manage the project's Designated Account. From the Ministry of Finance, funds will be allocated to the MoIT and TT based on Annual Work Plans consolidated by the PMU and approved through the PSC. Both MoIT and TT will coordinate and be responsible for financial management reporting and ensure compliance with World Bank fiduciary requirements for the funds allocated/transferred by MoF to execute project activities. Financial flows and contractual arrangements between the AE, the EE, and implementing entities are illustrated in Figure 9-2.

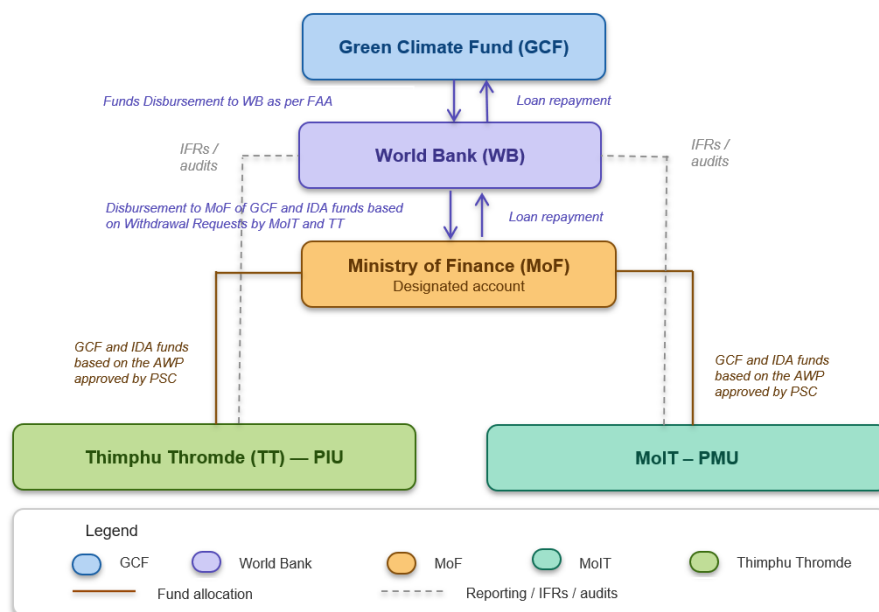


Figure 9-2 Flow of Funds

Procurement

350. The procurement process for Component 1 will be managed by the MoIT PMU as Executing Entity and Thimphu Thromde as an Implementing Entity. The two Entities will follow the requirements of the funders in terms of transparency, fairness, and efficiency. There will be five separate processes for the procurement of the initial works, goods, and services, and the activities will be planned and overseen by the Project Management Unit in MoIT, which will allocate the Component 2 funding for Institutional and Policy Development and capacity building support to the IEs as required. Although International Competitive Bidding will be used, local SME construction companies would be expected to have a significant role in any consortium and could have the capacity to lead on the Norzin Lam improvements, which will be procured separately from the BPS works as TT will be the procuring entity. They would then be in a position to bid for, and construct, further packages of work to implement the Non-Motorised Transport Plan and the relevant LETMP strategies funded from 13FYP. The tie-ins and utility connections to the works on the BPS will need to be clearly defined in the procurement documents for the Norzin Lam improvements, and the works planned and coordinated during construction. Other procurement processes will follow International Competitive Bidding requirements. The works contract will need to follow the traffic management, safety, and phasing plan prepared as part of the technical designs.

351. The MoIT PMU will be the Executing Entity for LRCP and responsible for:

- The procurement of the ITS, MIS, and e-buses, charging infrastructure, and maintenance equipment on behalf of CBS
- The procurement and implementation of the northern section of the bus priority lanes, including the widening of two bridges, the bus terminals, depot improvements, bus shelters, sidewalk improvements, and water supply network improvements along the bus priority lanes;
- The technical assistance and capacity building support being provided under Component 2 for the benefit of the EE and the IEs.

352. Thimphu Thromde will be the Implementing Entity for:

- The water network improvements within the project area including the installation of the SCADA systems on the existing water supply network and improvements to the raw water intakes, storage reservoirs, and transmission lines;
- The improvements to the Norzin Lam area with associated pedestrian and water network improvements to connecting footpaths in three phases in accordance with the technical designs and specifications;
- It will act as the counterparty for the Public Services Agreement with the CBS for all public bus services within the Thromde and be a member of the Supervising Committee alongside the MoIT and the MoF that would review and approve the CBS annual business plan.

353. City Bus Service will be the Operational Beneficiary for:

- The installation, testing, and commissioning of the upgraded ITS and MIS;
- The delivery, and testing of 50 e-buses, spare parts, the bus charging points in the terminals and depot, and any specialised maintenance equipment. Consideration should be given to transferring some responsibility for initial training and supervision of the maintenance of the buses through dedicated on-site staff, and the transfer of some operating risks to the supplier (see the FAME II trial reports from India) for the first two or three years of operation. The supplier should also be responsible for the replacement and safe recycling of the batteries at the end of their economic life. The procurement process could allow an option for local assembly of the bus bodywork onto the chassis as well as delivery of the complete vehicle by staff employed and trained by the supplier. This would offer the potential for developing local skills and providing additional employment.

354. Further projects will be developed and procured to the same standards as the initial projects, based on professional expertise and analysis, cost estimation, valuations, expected demand, and applicable design standards, including those proposed in the National Adaptation Plan, World Bank (or equivalent) social, environmental and gender safeguards, and with financial and economic modelling to support the recommended procurement strategy. The financial modelling should demonstrate a realistic return on investment from any private financing that may be possible for commercial developments associated with the project. The project development and options appraisal should be presented in a feasibility study for a decision on whether the project should proceed to procurement by the LRCP Steering Group.

Experience and Track Record of Implementing and Beneficiary Institutions

355. The World Bank has extensive experience supporting infrastructure and climate resilience projects in Bhutan and has implemented numerous operations in the water, transport, and urban sectors. The Bank has worked closely with the Ministry of Infrastructure and Transport, the Ministry of Finance, and Thimphu Thromde for several decades. The Ministry of Infrastructure and Transport has a strong track record of implementing infrastructure investments and managing donor-financed projects. The Ministry has led national transport and urban development initiatives and has experience coordinating multi-agency infrastructure programs. Thimphu Thromde is responsible for municipal administration and service delivery in Bhutan's capital city and has implemented several urban infrastructure projects, including water supply improvements and public space upgrades. Together, these institutions provide the institutional capacity required to implement the LRCP and sustain the project's investments beyond the implementation period. Given the complexity of the proposed urban resilience and infrastructure investments, additional dedicated procurement capacity and strengthened coordination arrangements within the PMU/PIU will be required, as reflected in the risk assessment below. A more detailed procurement capacity and risk assessment, including a review of institutional arrangements, staffing, procurement processes, and contract management capacity, will be carried out during project preparation and reflected in the Project Procurement Strategy for Development (PPSD).

Risk Assessment and Mitigation for Implementing Entities

356. The following risk management matrix identifies the key risks to the successful implementation of Components 1 and 2 of the project, potential mitigating actions, and the ownership of the risk, for CBS and TT.

Risk	Mitigation	Owners
MoIT		
Design standards for NMT infrastructure and legislation on maintaining Rights of Way are not completed in time for the procurement process	Provide support from the policy strengthening budget in Component 2 of LRCP	MoIT PMU
Poor coordination and project management between parties in implementing LRCP results in unforeseen delays in meeting the critical path deliverables and delays full implementation of the services	Utilise project management planning and best practices, maintain risk registers and provide effective oversight of the process Provide TA from Component 2	TT MoIT PMU

Lack of interest from suppliers and contractors results in an ineffective procurement process or poor value for money	Ensure effective marketing of the opportunity through technical and trade channels, and provide potential bidders with good information and sufficient notice of the bidding timetable and process	TT MoIT PMU
Thimphu Thromde		
Failure to retain staff within the Water Service with detailed knowledge of the existing water networks and treatment works. Lack of expertise in procurement and the use of SCADA to improve operational efficiency	Support Water Service by embedding experienced private sector operators to provide technical support and capacity building from Component 2	
Insufficient budget in 13FYP and subsequent FYPs to implement additional WSM improvements	Prioritise investments to focus on NRW and metered supplies. Increase water tariffs to cover economic costs of water services once service reliability has been improved	
Failure to retain staff with detailed knowledge of the technical design of the BPS and associated infrastructure in the PMU	Senior management should prioritise staff retention in critical areas through human resource planning and promotions. Embed experienced staff or second staff from the former TT PIU for project preparation into the PMU for LRCP implementation	TT
The PIU lacks the resources and experience to prepare procurement documents BPS to international and WB standards	Provide support from the procurement unit in MoF and TA from Component 2 Recruit or second experienced staff to TT PIU	TT MoIT PMU
TT is not able to recruit or retain experienced staff for the supervision of the range of construction activities and approval of detailed designs	Provide support from the institutional strengthening budget in Component 2 of LRCP Second or recruit additional staff and provide short-term budget cover	TT MoIT PMU
City Bus Service		
Failure or delay to establishing CBS as an SOE with powers to enter PSAs with thromdes and to procure buses and IT systems, and with governance arrangements for the preparation of annual business plans, budgets, and accounts	LRCP will fund TA to support RGoB in the preparation of the legal documentation and preparation of a PSA and support CBS in implementing the procedures and proposed staffing in the Operations Manual (Annex 21) and institutional strengthening and staff training	RGoB WB
CBS is not able to prepare for the implementation of LRCP services in recruiting and training drivers, mechanics, and administrative staff in time to deliver	Provide support from the institutional strengthening budget in Component 2 of LRCP	MoIT PMU

the additional services because of a lack of resources, budgets, or experienced managers		TT
CBS lacks experienced data analysts to plan bus routes, schedules, and dedicated services from surveys, transport plans, and smartcard data to optimise the use of resources and meet demand and reliability targets	Provide support from the institutional strengthening budget in Component 2 of LRCP	MoIT PMU
	Second or recruit additional staff and provide short-term budget cover	TT
Poor coordination and project management between parties in implementing LRCP results in unforeseen delays in meeting the critical path deliverables and delays full implementation of the services	Utilise project management planning and best practices, maintain risk registers and provide effective oversight of the process	MoIT PMU
	Provide TA from Component 2	TT
Lack of interest from suppliers and contractors results in an ineffective procurement process or poor value for money	Ensure effective marketing of the opportunity through technical and trade channels, and provide potential bidders with good information and sufficient notice of the bidding timetable and process	CBS MoIT PMU

Coordination with Relevant Projects

Several complementary initiatives are underway in Bhutan's urban resilience and water sectors. The UNDP Enhancing Climate Resilience of the Urban Landscapes and Communities in the Thimphu–Paro Region (ECRUL) project supports climate-informed urban planning and nature-based solutions to reduce flood and landslide risks across the wider metropolitan region. The ADB's Water Flagship Program Support Project (WFPSP) is expanding climate-resilient drinking water and irrigation services in Thimphu Valley and several other districts, with investments located primarily in upstream areas of the valley (see [Google Earth](#)).

357. [Figure 4-2 Study area of the water technical assessment for Thimphu's city core.](#) ~~Figure 4-2 Study area of the water technical assessment for Thimphu's city core.~~ for a relevant map of the ADB and LRCP investment areas). The UNDP Advancing Climate Resilience of the Water Sector in Bhutan (ACREWAS) project complements these efforts by strengthening basin-level water management and watershed restoration to improve long-term water availability. The Livable and Resilient Cities Project (LRCP) complements these initiatives by focusing on climate-resilient urban infrastructure and service delivery within the core of Thimphu. Investments by LRCP have been coordinated carefully with the projects of development partners. As outlined in [Table 0-1](#) ~~Table 9-1~~, project activities are geographically and thematically complementary. The overall benefits of these interventions are greater than the sum of their parts, strengthening the water supply, urban spaces, and transport networks at the city- and systems-level.

Table 0-1 Partners and nature of involvement

Partner	Nature of involvement/description
UNDP Advancing Climate Resilience of the Water Sector in Bhutan (ACREWAS)	ACREWAS (2023 – 2028, \$34.06 million) aims to ensure sustainable water management at a basin level. The project focuses on improving institutional and financial capacity to better manage the mismatch between water demand and supply. It also supports ecosystem-based activities to restore watersheds and their hydrological regulation. ACREWAS is complementary to LRCP, especially in its creation of urban forestry schemes and flood safety measures along the Wang Chhu (\$0.91 million) and Chuba Chhu (\$0.27 million) rivers and the creation of the greenway pedestrian and cycle routes along

	the Wang Chhu. These routes are part of the LETMP's NMT strategy. ACREWAS will be scaled up further through the ECRUL project.
UNDP Enhancing Climate Resilience of the Urban Landscapes and Communities in the Thimphu-Paro Region (ECRUL)	ECRUL (2025 – 2030, \$18 million) aims to enhance the resilience of 146,000 residents in the broader Thimphu – Paro region. Investments between ECRUL and LRCP are closely coordinated and complementary in addressing disaster risks. ECRUL focuses on flooding and landslide risks as well as Nature-based Solutions (NbS), strengthening capacity to make climate-informed planning and investment decisions. ECRUL will result in the development of (SuDS) and other NbS for stormwater management that will link up with the stormwater systems within the LRCP project area. It will also generate data on climate risks which will be used in the management of the drinking water networks within the Thimphu city core that will be made climate-resilient through LRCP. ECRUL is primarily concerned with protecting the drinking and sanitation water shortages from climate-related seasonal variations across the Thimphu-Paro region and focusing of the watersheds and collection systems on the urban periphery. LRCP focuses on addressing water network inefficiencies and losses within the city core and improving the technical capacity of Thimphu Thromde' Water Services Division. Both ECRUL and LRCP will work towards the implementation of key RGoB policy documents, including the Low Emission Development Strategy (LEDS), the TWSM, and the CCAP. Moreover, both projects will enhance the technological and technical capacities of local entities which manage, regulate, and invest in the water networks based on better information on climate change impacts and best international practices. The projects PMUs will both be housed under MoIT's DHS.
ADB Water Flagship Program Support Project (WFPSP)	WFPSP (2023 - 2030, \$22 million) aims to provide safe, sustainable and inclusive drinking water and irrigation services to people who suffer from water insecurity in Thimphu and Gelephu municipalities and Chhukha, Wangdue Phodrang, Zhemgang, and Mongar districts. It will adopt disaster- and climate-resilient designs and improve institutional and local communities' capacity for sustainable drinking water and irrigation services. The focus of LRCP's water component is the city core in areas that are geographically complementary to WFPSP. WFPSP investments are collocated further North in the valley.

358. In addition to the complementarities described above, coordination between LRCP and relevant projects will be facilitated through institutional and operational mechanisms during implementation. At the institutional level, coordination is expected to be supported through the Department of Human Settlement (DHS) under the Ministry of Infrastructure and Transport (MoIT), which hosts multiple project management functions, enabling regular information exchange and alignment of investment sequencing. Coordination mechanisms may include periodic inter-project meetings with UNDP and ADB project teams to review progress, address implementation issues, and promote technical consistency across interventions.

359. At the technical level, coordination is expected to include sharing of climate risk data, hydrological assessments, and design approaches (e.g., from ECRUL and ACREWAS), as well as alignment of engineering standards where appropriate. Opportunities for coordination will be explored in areas with geographic or thematic overlap, such as upstream watershed interventions and downstream urban infrastructure. Where appropriate, joint technical working groups may be established to coordinate specific areas such as water system resilience, non-revenue water reduction, and urban transport planning. These coordination mechanisms are intended to ensure that investments are not only complementary in design but also mutually reinforcing in implementation, maximizing system-level resilience outcomes and avoiding duplication of effort.

Alignment with GCF Investment Criteria

Impact Potential

360. Within the GCF's eight Results Areas, the LRCP is a cross-cutting project that integrates investments in urban water and transport systems to deliver both climate mitigation and adaptation outcomes, consistent with Bhutan's National Adaptation Plan and NDCs. The project strengthens the climate resilience of Thimphu's water supply system through targeted infrastructure upgrades, the introduction of a SCADA-based monitoring system, and strengthened service delivery arrangements incorporating private sector expertise. These interventions improve operational efficiency, reduce non-revenue water, and enable proactive maintenance and investment planning under RGoB's 13th Five Year Plan. Collectively, they strengthen the resilience of critical urban infrastructure and essential services, particularly water security and continuity of supply under climate stress conditions. The project also addresses rising congestion in Thimphu, where geographic constraints limit road expansion, alongside increasing emissions from motorization that threaten Bhutan's carbon-negative status. In response, LRCP supports a structural shift toward low-emission and climate-resilient urban mobility through integrated investments in electric buses, bus priority infrastructure, terminals, and pedestrian connectivity, complemented by policy and institutional support aligned with the Low Emission Transport Master Plan and National Adaptation Plan. These measures enable a sustained modal shift from private vehicles toward high-capacity public transport, delivering significant mitigation benefits while also strengthening urban transport resilience through improved reliability, reduced congestion, and greater operational redundancy during extreme weather events. It is conservatively estimated to reduce CO₂e emissions by 69,519 tonnes over 20 years compared to a BAU scenario, and reach 104,162 unique direct beneficiaries (see Adaptation Beneficiary Analysis) and at least 271,871 unique indirect beneficiaries (including tourists and visitors to Thimphu) as a result of the increased resilience of the city's water and transport systems. By improving access to essential services and strengthening system continuity during climate shocks, the project enhances urban resilience with direct benefits for vulnerable populations and critical institutions, including the Jigmi Dorji Wangchuk National Referral Hospital, the country's only tertiary referral facility. Overall, LRCP delivers integrated adaptation and mitigation benefits by strengthening urban water security, enabling resilient infrastructure systems, and supporting a transition to low-emission urban mobility, supported by complementary public investments under Bhutan's Five-Year Plans.

Paradigm Shift Potential

361. The LRCP Component 2 - institutional strengthening and policy support - will prepare and procure parallel investments from RGoB's 13th FYP and subsequent FYPs to build on the initial investments within the project area towards comprehensive and sustainable water and public transport services to be prioritised and implemented city-wide. The institutional changes within the Water Service in TT will provide greater transparency in the operation of water supply and wastewater treatment, and a model for service delivery in other thromdes. By establishing water services on a sustainable basis and addressing the maintenance backlog of the supply system it will provide the potential for greater private sector involvement in the sector in the future.
362. A Public Services Agreement, and associated changes to the status and role of CBS, will result in the introduction of a reliable, low emission, and more frequent bus service which, when combined with the complementary policies in the LETMP, will result in a significant modal shift from private cars to public transport and active mobility, and create a more resilient transport system. All eleven of the LETMP strategies are relevant to the development of transport networks in other cities in Bhutan, and the Component 2 funding provided by the GCF will support the process of planning and scaling a similar approach in these other cities. With support from the institutional strengthening in Component 2, the LRCP project will result in the City Bus Service becoming an efficient transport operator that is fully accountable for the services it provides under Public Service Agreements with other thromdes. LRCP also has the potential to provide a demonstration effect for other smaller cities in the region and the institutional arrangements will potentially apply the lessons learned, and the use of the latest transport technologies, to encourage a modal shift to public transport to be achieved nationally.

Sustainable Development

363. The LRCP project will generate significant sustainable development impacts across both adaptation and mitigation dimensions, in addition to reducing journey times and greenhouse gas emissions. A key adaptation outcome is improved access to safe and reliable treated drinking water, particularly for poorer households who are more dependent on private water sources and are therefore more vulnerable to climate-related supply disruptions. This directly contributes to strengthened water security under GCF Adaptation Results Area 2. The project will also improve access to employment and essential services through the provision of reliable, safe, affordable, and well-connected bus services integrated with non-motorised transport networks. These improvements will enhance climate resilience by ensuring more dependable mobility for vulnerable and disadvantaged groups, including women, who face more constrained access to private vehicles and fewer economic opportunities, as detailed in Annex 8: Gender Assessment and Action Plan. Improved

transport accessibility will therefore support more inclusive participation in urban economic activity and strengthen adaptive capacity. From a mitigation and environmental health perspective, the modal shift away from internal combustion engine vehicles towards a more efficient and progressively zero-emission public transport fleet will reduce local air pollution and noise levels in the city centre, contributing to improved urban livability and public health outcomes. In addition, enhanced non-motorised transport infrastructure around Norzin Lam will encourage active mobility, delivering further health benefits and improving the quality of the urban environment. The improvements to pedestrian infrastructure in the Norzin Lam corridor will also enhance the attractiveness of the city centre as a social and tourism destination, given its proximity to Clocktower Square and surrounding commercial and recreational areas, supporting broader economic vitality and urban vibrancy.

Needs of Recipient

364. Although Bhutan graduated from Least Developed Country status in December 2023, the country is heavily indebted because of the contingent liabilities that have been underwritten by RGoB for the construction of the new run-of-river hydropower projects. Although most of these debts have been incurred in Indian rupees and a substantial proportion of the hydropower project revenues will be earned in the same currency so that there is reduced currency risk (the ngultrum is pegged to the rupee), the government has little headroom to increase borrowing, particularly in currencies other than rupees. The RGoB recently placed a moratorium on the import of motor vehicles because of a fall in foreign currency reserves. Without grant and concessional finance for the buses and the bus priority infrastructure the current bus services would likely continue at their present level of service, and the existing bus fleet would not be able to expand over time or provide improved service to generate modal shift. This would extend Bhutan's dependence on imported fossil fuels and place Bhutan's NDC commitments at risk. The sustainable development goals for increasing economic opportunities for women and vulnerable groups would also be lost.

Country Ownership

365. The RGoB has been developing its sustainable development policies over many years and these provide a comprehensive range of policies not only for surface transport and the transition to low or zero-emission vehicles, but also for urban planning, energy supplies, water supplies, and economic development. The government has demonstrated its commitment to maintaining its carbon-negative status in its NDCs for transport, but delivering on these commitments will depend on achieving the changes in travel behaviours that are the primary outcomes of LRCP and the supporting strategies in the LETMP, NAP and WSM. The RGoB has provided counterpart funding from 13FYP to bring forward the first stage of the bus priority corridor and has committed \$24 million in parallel and counterpart funding in the 25-27 financial years to water and transport projects that are complementary to the objectives of LRCP. It is therefore committed to the Goal Statement in the Theory of Change and the outcomes in terms of modal shift to public transport. It will also implement the institutional changes that will allow these outcomes to be replicated across the country.

Efficiency and Effectiveness

366. The financial and economic modelling of the project, based on the traffic survey work and modelling done during the technical design, demonstrates that the GCF investment is critical to the realisation of the project and that the project outcomes will result in a significant economic return in terms of journey time savings, reduced vehicle operating costs, accident reductions, and fuel savings to all road users. The ENPV of the transport investment of the project is \$25.2 million at a 12% discount rate and the EIRR is 22.4% with a Benefit/Cost ratio of 1.62 (at low CO₂ price). The economic modelling for the water investments demonstrates an EIRR of 19.1% and an NPV of US\$3.06 million, with a B/C ratio of 1.58. The financial modelling also demonstrates that the City Bus Service will still be financially viable by increasing its revenues whilst maintaining fares at an affordable level, and without relying on increasing government subsidies. It will be able to finance further investments to increase the capacity and quality of its services and replace the existing bus fleet from its revenues.

367. The expected GHG reductions between 2029 and 2048 are 69,519 tonnes CO₂eq at \$301.9 per tonne in current prices from the \$21 million total GCF funding for the transport investments and technical advice to MoIT on transport policies and projects. The technical design of project interventions has drawn on international best practices, including experiences and case studies from around the globe to refine the design and maximise the opportunity for modal shift. For example, the project considered five case studies in South America, Africa, and China published by the World Bank for COP28 that demonstrate how investment in facilities that encourage active mobility and increase the catchment area for public transport can have measurable economic and climate benefits.

