Final Report

Climate Resilient WASH and Climate, Energy and Environment (CEE) Roadmap for Gwadar District

July 2026

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Acronyms

B-EPA	Balochistan Environmental Protection Agency
BCCP	Balochistan Climate Change Policy
BDA	Balochistan Development Authority
BER	Beyond Economical Repair
BOT	Build-Operate-Transfer
BPRA	Balochistan Public Procurement Regulatory Authority
BUITEMS	Balochistan University of Information Technology, Engineering and Management Sciences
CCVI	Climate Change Vulnerability Index
CEE	Climate, Energy and Environment
CFU	Colony Forming Units
CPEC	China–Pakistan Economic Corridor
CWIS	Citywide Inclusive Sanitation
CWPP&H	Communication, Works, Physical Planning and Housing Department
DBP	Disinfection Byproducts
DDMA	District Disaster Management Authority
DHO	District Health Officer
DMA	District Metered Area
DRR	Disaster Risk Reduction
dS/m	Decisiemens per Metre (unit of electrical conductivity)
DWASA	Dhaka Water Supply and Sewerage Authority
E. coli	Escherichia coli
EC	Electrical Conductivity
EPC	Engineering, Procurement, and Construction
FY	Financial Year
GDA	Gwadar Development Authority
GEDSI	Gender Equality, Disability and Social Inclusion
GIEDA	Gwadar Industrial Estate Development Authority
GIS	Geographic Information System
GPA	Gwadar Port Authority
GPCD	Gallons Per Capita Per Day
GoB	Government of Balochistan
HDPE	High-Density Polyethylene
HSE	Health, Safety and Environment
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
KII	Key Informant Interview
KPI	Key Performance Indicator
kWh	Kilowatt-hour
KVA	Kilovolt-Ampere
LG&RDD	Local Government and Rural Development Department
MCG	Municipal Committee Gwadar
MCQ	Metropolitan Corporation Quetta
MGD	Million Gallons per Day
MICS	Multiple Indicator Cluster Survey
MRG	Minimum Revenue Guarantee
MW	Megawatt
NAB	National Accountability Bureau
NAP	National Adaptation Plan
NCCP	National Climate Change Policy

NDMA	National Disaster Management Authority
NDWQS	National Drinking Water Quality Standards
NDC	Nationally Determined Contribution
NEECA	National Energy Efficiency and Conservation Authority
NEQS	National Environmental Quality Standards
NRW	Non-Revenue Water
O&M	Operation and Maintenance
P&DD	Planning and Development Department
PBS	Pakistan Bureau of Statistics
PC-1	Planning Commission Form-1 (project feasibility/approval document)
PCRWR	Pakistan Council of Research in Water Resources
PCSIR	Pakistan Council of Scientific and Industrial Research
PDMA	Provincial Disaster Management Authority
PHED	Public Health Engineering Department
PGT	Pakistan Green Taxonomy
PMD	Pakistan Meteorological Department
PPP	Public–Private Partnership
PSDP	Public Sector Development Programme
PSLM	Pakistan Social and Living Standards Measurement Survey
PVC	Polyvinyl Chloride
PWD	Persons with Disabilities
QESCO	Quetta Electric Supply Company
Q-WASA	Quetta Water and Sanitation Authority
RO	Reverse Osmosis
RPC	Reinforced Polymer Concrete
RM	Running Meters
SDGs	Sustainable Development Goals
SDO	Sub Divisional Officer
SCADA	Supervisory Control and Data Acquisition
STP	Sewage Treatment Plant
TDS	Total Dissolved Solids
TNA	Training Needs Assessment
UP&DD	Urban Planning and Development Department
WASH	Water, Sanitation and Hygiene
WASA	Water and Sanitation Authority
WSS	Water Supply Scheme
μS/cm	Microsiemens per Centimetre (unit of electrical conductivity)

1 Introduction and Planning Context

Gwadar is a coastal district located in the southern part of the Makran Division along the Arabian Sea, with an extensive coastline of approximately 600 kilometres. Notified as a separate district in 1977, it comprises the sub-divisions/tehsils of Gwadar, Pasni, Jiwani, and Ormara, and also includes Suntser as a sub-tehsil of Jiwani. Due to its strategic location along international maritime routes and its central role in the China–Pakistan Economic Corridor (CPEC), Gwadar has transitioned from a small fishing settlement into a rapidly emerging port city of national and regional importance[1].

According to the Population Census 2023, Gwadar District has a total population of 305,160. Of this, approximately 159,035 people reside in urban areas, while 146,125 live in rural areas, reflecting a relatively balanced urban–rural distribution. The district comprised 141 mouzas and spanned a total area of 12,637 square kilometres. The annual growth rate of 2.56 per cent, with an average household size of 6.0 persons.

The Gwadar Smart Port City Master Plan 2017–2050 (revised in 2019) presents an ambitious vision to transform the city into a modern and sustainable economic hub for trade, tourism and investment. The plan projects significant demographic and economic expansion, with the population expected to reach approximately 2 million by 2050, alongside large-scale infrastructure development including port expansion, a new international airport, major transport corridors, renewable energy initiatives and water management interventions such as wastewater treatment and rainwater harvesting[2].

The scale of projected urban and economic growth has major implications for water security, sanitation services, wastewater management and environmental sustainability. For WASH planning, this growth trajectory means that water supply, sanitation, wastewater management and climate-resilient drainage should be treated as enabling infrastructure for the port, airport, industrial areas and future urban expansion, rather than as social-sector investments alone. All major WASH infrastructure linked to the Gwadar Master Plan and CPEC-related development should therefore be subject to climate-risk screening for drought, flooding, heat stress, salinity intrusion and coastal hazards before approval, financing and detailed design.

Water supply and sanitation service delivery in Gwadar have evolved through an infrastructure-led institutional model. GDA developed major urban water supply and sanitation assets within the Gwadar Master Plan area, while PHED was generally expected to assume responsibility for operating these systems following their completion and handover. This separation between infrastructure development and subsequent operation created coordination and management challenges relating to asset ownership, system handover, operation and maintenance financing, technical responsibility and accountability for service delivery.

To address these institutional overlaps, the Government of Balochistan subsequently assigned responsibility for urban water supply and sanitation services within the Gwadar Master Plan area to GDA through an administrative decision. The Gwadar Development Authority (GDA), established under the Gwadar Development Authority Act 2003, is therefore currently responsible for urban WASH services within the Master Plan area, while the Public Health Engineering Department (PHED), a provincial line department operating under the Balochistan Rules of Business 2012, continues to be responsible for water supply and sanitation services in rural areas of the district and manages selected water sources, bulk water systems and water supply schemes.

[1] https://www.gda.gov.pk/about-gwadar
[2] https://www.gda.gov.pk/masterplan-2050

This evolving institutional landscape is occurring alongside rapid urban expansion and increasing service demand. While GDA is transitioning into an operational service provider for urban water systems, its water and sanitation function remains at a nascent stage, with limited dedicated capacity and evolving systems. PHED, on the other hand, maintains an established field presence in rural areas but faces constraints in technical capacity, financial sustainability and transitioning from scheme-based implementation to continuous service delivery. Together, these institutional dynamics shape the current service delivery environment in Gwadar and influence the sector's ability to respond to emerging challenges.

The current allocation of urban responsibilities to GDA provides an immediate basis for clearer operational accountability; however, it should be regarded as a transitional institutional arrangement rather than a predetermined long-term service delivery model. GDA's principal mandate relates to urban planning, infrastructure development and regulation of development within the Master Plan area. Assigning the same institution responsibility for planning, infrastructure development, regulation and utility operation may create institutional conflicts and place significant operational demands on a development authority.

Looking forward, the Government of Balochistan should undertake an institutional options assessment to determine the most appropriate long-term urban WASH service delivery model for Gwadar. Options should include a WASA-type authority, a ring-fenced utility arrangement, a municipal or provincial utility, a semi-autonomous utility company and other utility-based models informed by experience from Punjab and other provinces. The preferred model should provide a clear separation between policy and regulatory oversight and service operation, define asset ownership and operation and maintenance responsibilities, establish sustainable revenue arrangements and formalise coordination among GDA, PHED, GPA, local government institutions and other relevant agencies. In the interim, clearer functional responsibilities between GDA and PHED will remain essential to avoid duplication and maintain service continuity in urban, rural and peri-urban settlements.

As a rapidly developing urban district, Gwadar is undergoing large-scale infrastructure expansion while institutional systems and sector information frameworks are still evolving. Consequently, the development of the Climate Resilient Water, Sanitation and Hygiene (WASH) and Climate, Energy and Environment (CEE) Roadmap Gwadar was undertaken in a context of limited availability of consolidated operational data and detailed sector studies. Existing information on system performance, infrastructure condition and service delivery remains fragmented and incomplete.

In such contexts, the absence of comprehensive datasets does not constrain strategic planning; rather, it requires a shift toward a risk-informed and forward-looking approach. Accordingly, this roadmap emphasizes climate vulnerability, resource constraints, rapid urban growth pressures and operational uncertainties instead of relying solely on detailed performance diagnostics. The assessment draws on available secondary sources, policy and planning documents, climate projections, national and provincial datasets, stakeholder inputs and proxy indicators to develop a structured understanding of sector conditions.

The roadmap is therefore designed as a strategic and adaptive framework to support Gwadar District in strengthening climate resilience, improving service sustainability, identifying priority investments and guiding phased infrastructure and institutional development under conditions of uncertainty. It seeks to provide a practical pathway for aligning WASH and CEE systems with the district's long-term urban growth aspirations while addressing emerging climate and environmental risks. The roadmap also recognises that community consultation and participation should be integrated into subsequent feasibility studies, infrastructure design, implementation and performance monitoring to strengthen local ownership, responsiveness and long-term sustainability.

1.1 Background of the Roadmap

Gwadar is facing a growing water crisis driven by climatic, infrastructural and institutional constraints. In the context of accelerating climate change, the city's arid conditions have intensified, with rising temperatures, prolonged droughts and erratic rainfall reducing the reliability of surface water sources. Groundwater remains largely saline and unsuitable for use, further limiting available options.

Despite the potential for alternative solutions such as desalination, progress has been constrained by inadequate and underperforming infrastructure. Existing systems, including dams, pipelines and desalination plants, are often non-functional or operating below capacity due to gaps in planning, maintenance and integration. High operational costs, particularly for energy-intensive solutions like desalination, combined with unreliable power supply, further hinder sustainable service delivery. In addition, limited availability of skilled technical staff and weak institutional capacity have affected the operation and long-term management of water supply systems.

Based on the stated context, this roadmap focuses on strengthening climate-resilient water infrastructure, protecting and diversifying water resources, improving operational efficiency, developing appropriate utility and governance arrangements, building institutional and technical capacity and promoting sustainable and diversified water supply solutions to ensure reliable access to safe water in Gwadar.

1.2 Context of the Roadmap

The effects of climate change are already being felt everywhere. Most strikingly, they are felt through water. Rising temperatures, prolonged droughts and erratic precipitation patterns are reducing the reliability of water sources, while extreme rainfall events and flooding are damaging infrastructure and contaminating water supplies. These dynamics not only disrupt water availability but also increase the cost of water, contributing to inequitable access and limiting the ability of vulnerable populations to meet basic hygiene and sanitation needs[3].

Coastal communities such as Gwadar are particularly exposed to these risks. In addition to regional climate stresses, they face compounding impacts from sea-level rise, coastal flooding and saline intrusion. Groundwater aquifers in such settings are increasingly becoming saline, reducing their suitability for drinking and domestic use. At the same time, changing precipitation patterns are creating a mismatch between water supply and demand, where prolonged dry periods reduce water availability and intense rainfall events overwhelm already fragile infrastructure systems[4].

Climate change also poses significant risks to sanitation systems in coastal areas. Flooding and storm surges can damage sanitation facilities, inundate latrines and septic systems and lead to the discharge of untreated waste into the environment. This results in contamination of surface and groundwater resources, increasing the risk of waterborne diseases and creating unsafe conditions, particularly for vulnerable populations. These impacts are further exacerbated in low-resource settings where infrastructure is already weak and service delivery is limited[5].

Moreover, climate stressors, including increasing temperatures, storm intensity and ocean-related changes, are placing additional pressure on public health systems, water and sanitation infrastructure and local livelihoods. These interconnected risks highlight the urgent need for

[3] https://www.unicef.org/wash/climate
[4] https://www.epa.gov/cre/climate-change-coastal-communities
[5] https://jointactionforwater.org/addressing-the-impacts-of-climate-change-on-coastal-water-resources-and-ecosystems-adaptation-strategies/

integrated and climate-resilient approaches to water and sanitation management, particularly in rapidly developing coastal regions[6].

Table 1: Climate Change Impact on Coastal Regions

Climate Hazard	Water Supply Impacts	Sanitation Impacts	Hygiene Impacts	WASH Outcomes
Rising Temperatures	Increased evaporation reduces surface water availability; higher demand for water	Reduced water availability limits flushing and cleaning of sanitation facilities	Reduced water for handwashing and personal hygiene	Decline in hygiene practices; increased health risks
Prolonged Droughts	Depletion of groundwater and surface water sources; drying of wells	Insufficient water for sanitation systems (latrines, sewerage)	Compromised hygiene due to prioritization of drinking over washing	Increased inequity in access; higher disease vulnerability
Erratic Rainfall Patterns	Unpredictable recharge of aquifers; unreliable water supply systems	Disruption in sanitation service continuity	Difficulty maintaining consistent hygiene behaviours	Reduced service reliability and resilience
Extreme Rainfall & Flooding	Contamination of drinking water sources (surface & shallow groundwater)	Flooding of latrines/septic tanks → overflow of untreated waste	Unsafe hygiene conditions due to contaminated surroundings	Increased incidence of waterborne diseases
Sea-Level Rise	Saline intrusion into freshwater aquifers leads to reduced potable water	Limited availability of freshwater for sanitation use	Use of unsafe or saline water for hygiene	Long-term decline in safe water access
Storm Surges	Physical damage to water supply infrastructure (pipes, pumps, storage)	Destruction or submergence of sanitation facilities	Disruption of hygiene practices due to displacement	Service interruptions and emergency WASH needs
Saline Intrusion	Groundwater becomes saline and unsuitable for drinking	Reduced usability of water for sanitation systems	Skin and health issues due to use of saline water	Increased reliance on costly or distant water sources
Weak Infrastructure	Breakdown of water systems; prolonged service disruption	Failure of sanitation infrastructure in low-resource settings	Limited access to safe spaces for hygiene	Compounded vulnerability for poor and marginalized groups

(Climate Resilience and WASH Pathways: to Climate-Resilient WASH Programming, 2025), (United Nations Economic Commission for Europe, World Health Organization Regional Office for Eurpore, 2025)

[6] https://therevelator.org/climate-change-sewage/

2 Methodology

2.1 Overall Methodological Approach

The Roadmap was developed using a structured, mixed-methods approach grounded in resilience-based planning and system diagnostics. The methodology combined quantitative analysis of infrastructure, operational and financial data with qualitative insights from institutional consultations to establish an evidence-based understanding of Gwadar's water supply, sanitation and energy systems.

The approach was designed to assess system performance, institutional capacity, operational efficiency and climate-related vulnerabilities, while identifying practical entry points for strengthening service delivery under conditions of increasing climate stress, water scarcity and energy dependence. To ensure strategic relevance, the assessment was undertaken through a climate-resilience lens, considering both current system constraints and future risks associated with drought, heat stress, sea-level influence, salinity intrusion and extreme rainfall events.

The diagnostic assessment served as the foundation for developing a Climate-Resilient WASH and CEE Roadmap for Gwadar, ensuring that proposed actions are directly informed by operational realities and system-level constraints. In addition, the analysis considered medium- and long-term planning horizons up to 2030 and 2050, drawing on available national and provincial climate evidence to assess the implications of evolving climate risks for infrastructure, service delivery and resource management.

Accordingly, proposed interventions were prioritised based on their contribution to climate-risk reduction, population coverage, equity outcomes, operational feasibility and economic value, particularly in relation to Gwadar's projected urban expansion, port development, industrial growth corridors and associated infrastructure investments.

2.2 Inception Phase and Stakeholder Engagement

The study commenced with an inception meeting held on 2 December 2025 at the Balochistan Government Secretariat. The meeting was attended by the Secretary PHED, Mr Hashim Ghilzai, Deputy Secretary Development Mr Tanveer Rahim and UNICEF WASH and CEE Specialist Dr Muhammad Masud Aslam. The session focused on confirming the scope, objectives and methodological approach of the assignment, as well as identifying key data requirements and institutional stakeholders for engagement.

During the inception phase, a subsequent visit was made to Gwadar by UNICEF WASH and CEE Specialist UNICEF and AWF team leader to meet with institutions, including the GDA, PHED, Gwadar Municipal Committee and district administration for creating coordination, determining the expectations and sharing the ToRs of assignment. Relevant departments began sharing administrative records, operational data and technical documents to support the baseline assessment. Notes of field meetings were shared with Secretary PHED Government of Balochistan.

2.3 Desk Review

A comprehensive desk review was undertaken to develop an evidence-based understanding of the technical, institutional and climate-related dimensions of water supply and sanitation in Gwadar. The review covered thematic areas including water resources and availability, surface water systems and dams, desalination, water quality, sanitation and sewerage infrastructure, service coverage, climate variability and associated risks.

In addition, institutional and operational aspects were examined, including governance arrangements, financing flows, staffing structures, operational systems and service delivery constraints across GDA, PHED and other relevant agencies. The review also incorporated analysis of available operational data, infrastructure records and development plans to identify system-level gaps, emerging risks and potential implications of future climate and urban growth scenarios.

Continuous liaison with designated focal persons from GDA and PHED ensured validation of information, clarification of technical aspects and incorporation of additional data as required throughout the analysis phase.

2.4 Stakeholder Consultations and Data Collection

Stakeholder consultations were conducted to capture institutional, technical, financial and operational perspectives from key actors involved in WASH service delivery, governance and administration in Gwadar. Consultations were undertaken with representatives from provincial, district and local institutions, as well as technical staff directly involved in system operations.

Table 2: List of Key Informants Consulted During the Study

Sr. #	Name	Designation	Institution
1	Molana Hidayat ur Rehman Baloch	Member Provincial Assembly	Government of Balochistan
2	Mr Naqeebullah Kakar	Deputy Commissioner Gwadar	District Administration
3	Engr. Syed Muhammad	Chief Engineer	GDA
4	Mr Mir Abdul Nabi (Mir Jan)	Project Director Water	GDA
5	Mr Momim Ali	Executive Engineer	PHED Gwadar
6	Dr Abdul Shakoor	Assistant Commissioner	District Administration
7	Mr Maktoum Musa	Chief Officer	Gwadar Municipal Committee
8	Dr Wahid	Deputy DHO	Health Department
9	Mr Nazar Baloch	Deputy Director HR	GDA
10	Mr Muhammad Fazal	SDO Pasni	PHED
11	Mr. Dad Kareem	SDO Gwadar	PHED
12	Mr Nawaz	Sub-Engineer	PHED
13	Mr Qambar Ali	Assistant Engineer	GDA
14	Mr Hafeez Dashti	PRO	GDA
15	Mr Naseem Moosa	Assistant IT	GDA
16	Mr Khudabux	Clerk	PHED

These consultations enabled the study to capture both strategic and operational insights, including governance challenges, infrastructure performance, financial constraints, service delivery gaps and institutional capacity limitations. Stakeholders were also consulted on emerging climate risks, future service demands, infrastructure resilience needs and institutional readiness to support climate-resilient sector development.

2.5 Data Analysis

All data collected through desk review and stakeholder consultations were systematically organised into thematic areas aligned with the analytical framework of the study. Data triangulation was applied by cross-referencing institutional inputs, operational records and secondary sources to ensure reliability and consistency.

The analysis examined key dimensions including water supply systems, infrastructure performance, energy consumption, financial sustainability, institutional arrangements and climate-related risks. This process enabled the identification of critical bottlenecks, system inefficiencies and structural constraints affecting WASH service delivery in Gwadar. The analysis further assessed how existing vulnerabilities may be amplified under projected climate conditions and future population growth scenarios, providing the basis for prioritising adaptation and resilience-building interventions.

2.6 Development of the Climate-Resilient WASH and CEE Roadmap

Building on the diagnostic findings, a structured and prioritised Climate-Resilient WASH and CEE Roadmap was developed. The roadmap translates analytical insights into a sequenced set of interventions aimed at strengthening infrastructure resilience, improving energy efficiency, enhancing water security and addressing institutional and operational gaps.

The formulation process ensured alignment with identified system vulnerabilities, service delivery constraints and climate-related risks, while taking into account institutional capacity and implementation feasibility. Interventions were assessed and prioritised based on their contribution to climate resilience, service coverage, equity outcomes, operational feasibility, financial sustainability and long-term development objectives under the Gwadar Smart Port City Master Plan.

The roadmap is designed as a practical planning and decision-support tool to guide investment prioritisation, operational improvements and medium- to long-term sector planning in Gwadar. It also provides a framework for aligning future infrastructure investments with projected climate risks and Gwadar's anticipated urban, industrial and economic growth trajectory through 2030 and 2050.

2.7 Validation Workshop

A stakeholder validation workshop was conducted on June 16, 2026 to review and validate the proposed roadmap. The workshop brought together representatives from the Local Government Department, Q-WASA, PHED, Irrigation Department, GDA, the International Water Management Institute (IWMI), the University of Balochistan, Balochistan University of Information Technology, Engineering and Management Sciences (BUITEMS), UN-Habitat, and the Balochistan Environmental Protection Agency (B-EPA). The workshop provided a multi-stakeholder platform to review the proposed interventions, discuss institutional responsibilities, validate technical recommendations, and strengthen coordination among key government agencies, academic institutions, development partners and sector stakeholders to support the implementation of the roadmap.

The workshop provided a platform to assess the feasibility, coherence and relevance of the proposed interventions, build consensus around strategic priorities and strengthen institutional ownership of the roadmap. Engagement with stakeholders also helped assess implementation feasibility, operation and maintenance responsibilities, environmental safeguards and investment needs.

Feedback received during the workshop was incorporated into the final document to improve alignment with stakeholder expectations, implementation realities and institutional mandates.

3 Foundational Frameworks for the Roadmap

3.1 Overarching Global Principles

The roadmap is aligned with the global, national and provincial frameworks, ensuring strategic coherence across policy, planning and implementation levels.

Figure 1: Overarching Global Principles

Sendai Framework for Disaster Risk Reduction 2015–2030 Promote the resilience of new and existing water infrastructure and improve understanding of water-related disaster risks and their impact on society.	**Water Action Decade 2018–28** Focused on the sustainable development and integrated management of water resources.
Joint Monitoring Programme Enhance global monitoring of drinking water, sanitation and hygiene.	**UN General Assembly, 2010** Ensure access to safe drinking water and sanitation to all without any discrimination and elimination.
Sustainable Development Goals Sustainable Development Goals (SDGs) were adopted by the United Nations in 2015 to end poverty, protect the planet and ensure that by 2030 all people enjoy peace and prosperity. SDG 6 ensures universal access to safe and affordable drinking water by 2030.	

3.2 At the National Level

National frameworks establish the enabling policy and investment environment for climate-resilient and energy-efficient WASH services, guiding adaptation planning, financing priorities and institutional coordination that underpin the proposed reforms and roadmap.

Pakistan Nationally Determined Contribution (NDC)

Pakistan commits to aligning climate ambition with national development priorities, mobilizing support domestically and internationally and steering the nation towards a green, sustainable and prosperous future. Pakistan's NDC 3.0 outlines the country's climate action plan, aligning climate ambition with national development priorities and the Sustainable Development Goals (SDGs). It integrates climate action with food and water security, glacier protection, poverty reduction and green growth to support a low-carbon, climate-resilient future. The NDC estimates a total investment need of USD 565.7 billion, with major allocations for low-carbon power (USD163.7 billion), disaster risk preparedness (USD 139.1 billion) and universal water and sanitation (USD 89.5 billion), alongside investments in sustainable transport, efficiency, clean cooking, wastewater treatment and waste management.

National Adaptation Plan (NAP)

Pakistan's National Adaptation Plan aims to enhance the sustainable development of vulnerable communities by strengthening social, economic and environmental resilience through gender-responsive, participatory, transparent and inclusive approaches. The NAP aligns with the urban resilience agenda, emphasizing the integration of climate adaptation into all decision-making, long-term and evidence-based planning, nature-based solutions, local action, inclusivity, equity, institutional coordination, flexibility and capacity building.

The rationale for the NAP is rooted in Pakistan's high vulnerability to climate change and the urgent need to address its impacts. The NAP provides a structured framework to identify and prioritize adaptation needs, develop strategies and implement actions to reduce vulnerability and build resilience. By mainstreaming adaptation into national planning, it ensures coordinated and effective responses across sectors and governance levels.

The NAP also safeguards development gains by integrating climate risk management into policies and programs, protecting progress in key sectors such as agriculture, health, education and disaster risk reduction.

National Energy Efficiency and Conservation Policy 2023

Under the policy, energy efficiency measures include the implementation of efficiency standards and the solarization of water pumps and tube-wells by 2024. The policy indicates that in coordination with Provincial Designated Agencies, Power and Petroleum Division National Energy Efficiency and Conservation Authority (NEECA) will lead the work with water and sanitation utilities to introduce on-bill financing mechanisms to support energy efficiency investments across industrial, commercial, public and residential sectors.

National Climate Change Policy (NCCP) 2021

The National Climate Change Policy 2021 prioritizes climate risk assessment in the WASH sector, identifies resilient technology and infrastructure options, promotes PPP to improve financing and service quality and supports the adoption of water and sanitation safety plans in both rural and urban areas.

Implications of National Climate and Development Frameworks for Gwadar

In addition to the national policy frameworks outlined above, Gwadar occupies a unique strategic position within Pakistan's economic transformation agenda due to its role as the gateway of the CPEC and its planned expansion as a major port, industrial and logistics hub. As CPEC enters Phase-II, greater emphasis is being placed on industrial development, urban sustainability, green infrastructure and climate resilience. In this context, investments in water supply, sanitation, wastewater management, renewable energy and environmental protection should be viewed not only as social service investments but also as enabling infrastructure that supports port operations, industrial productivity, public health and sustainable urban growth.

The PGT provides an emerging framework for classifying investments according to their environmental and climate benefits. Several priority interventions identified under this roadmap align closely with green taxonomy principles and may therefore be positioned for climate and green financing opportunities. Climate adaptation investments include desalination systems, water storage infrastructure, drought-resilient water supply systems, climate-resilient drainage networks, groundwater protection measures and coastal ecosystem restoration. Climate mitigation investments include solarization of pumping systems, renewable-energy-powered desalination, wastewater treatment and reuse, energy-efficient water operations and resource recovery from wastewater and solid waste streams.

The alignment of Gwadar's WASH and CEE investments with national climate priorities, the Pakistan Green Taxonomy and CPEC Phase-II objectives creates opportunities to access a broader range of financing instruments. These may include public sector development funding, climate finance facilities, concessional financing, PPPs, build-operate-transfer (BOT) arrangements, grant financing and bilateral cooperation mechanisms. Given China's continued involvement in Gwadar's infrastructure development, climate-resilient water supply, desalination, wastewater reuse and renewable-energy-based utility systems may also be positioned for consideration under future Chinese-supported investment windows, subject to technical feasibility, environmental safeguards and financial viability.

Accordingly, the roadmap adopts an investment-oriented approach that seeks to improve service delivery while simultaneously enhancing climate resilience, supporting economic growth and creating opportunities for mobilizing sustainable financing for Gwadar's long-term development.

3.3 At the Provincial Level

The proposed reforms align with provincial policy, legal and planning frameworks and the roadmap reflects the Government of Balochistan’s commitment to advancing sustainable, climate-resilient and integrated WASH services, while addressing institutional fragmentation, groundwater vulnerability and service delivery gaps in Gwadar.

Table 3: Key Provincial Policy and Planning Frameworks

Balochistan Integrated Water Resources Management (IWRM) Policy 2024 The Balochistan IWRM Policy 2024 aims to address the province's critical water challenges through sustainable management and equitable distribution of water resources. The policy emphasizes the need for an integrated approach to water governance, aligning with national and global water management principles. It seeks to empower local communities, promote adaptive management and ensure long-term water security amidst the impacts of climate change.	**Balochistan Climate Resilient WASH Sector Plan 2025–2035** Outlines a pathway to equitable, climate-resilient WASH services, prioritising resilient infrastructure, inclusive governance, sustainable resource management, targeted investments for underserved communities, defined WASH targets and strengthened financing, monitoring and human resource capacity, fully aligned with the Balochistan Climate Change Policy (BCCP) and provincial adaptation and mitigation priorities.
Drinking Water Supply Policy/Strategy 2015 – 2025 The Policy/ Strategy seeks to ensure universal access to safe drinking water as a basic human right, improving public health by reducing water-borne diseases through affordable, equitable and sustainable services, while integrating sanitation, healthy practices and climate change adaptation.	**The Balochistan Climate Change Policy (2024)** Calls for climate-resilient urban WASH, reduced groundwater vulnerability, improved wastewater management and integrated cross-sectoral adaptation. However, these priorities are not yet consistently embedded in Gwadar’s institutional mandates or service delivery.

Balochistan Environment Protection Act 2012 Mandates the Balochistan Environmental Protection Agency (B-EPA) to undertake environmental monitoring and pollution control but enforcement remains weak due to limited technical and institutional capacity.	**Balochistan Local Government Act 2010** Assigns urban WASH functions to Municipal Corporation, but lack of formal coordination with GDA and PHED results in overlapping mandates and fragmented service delivery.
Gwadar Water Policy 2020 Recognizes Gwadar's water crisis as primarily a problem of economic water scarcity driven by weak governance, inadequate infrastructure and fragmented planning rather than absolute resource depletion and proposes a comprehensive regulatory and institutional framework to guide water law development, strengthen system performance, reduce non-revenue water, promote wastewater treatment and reuse, improve watershed management, modernize data systems, introduce fair pricing and conservation measures and align infrastructure expansion with population growth and climate change risks, emphasizing the need for an integrated, forward-looking governance structure to secure sustainable and reliable freshwater supply for Gwadar.	**Pakistan Green Taxonomy (PGT) 2025** PGT provides a science-based classification of green and transitional economic activities to guide investment toward climate mitigation, adaptation and environmental goals. It enhances transparency, supports sustainable finance and helps prevent greenwashing while aligning with international standards.

4 Baseline Situation

4.1 Climate Change

Climate change is increasingly affecting water resources and WASH service delivery in Gwadar. Rising temperatures, recurrent drought, erratic rainfall, flash flooding, cyclonic events and saltwater intrusion are placing growing pressure on already limited freshwater resources, coastal aquifers and fragile infrastructure systems. These hazards affect both the quantity and quality of available water, while also increasing the vulnerability of sanitation systems, drainage networks and public health conditions. Given Gwadar's arid coastal setting, dependence on climate-sensitive water sources and rapid urban development, climate change represents both an immediate operational challenge and a long-term planning concern for climate-resilient WASH service delivery.

4.1.1 Climate Change Vulnerability Profile of Gwadar District

This section has been adapted from the document "Climate Risk Profiling of 14 Districts of Balochistan 2024 Government of Balochistan" supported developed by UNICEF.

The climate vulnerability of Gwadar district has been assessed using a composite framework based on three key dimensions: exposure, sensitivity and adaptive capacity. A set of indicators was identified under each dimension to capture the district's climatic risks as well as its socio-economic and institutional ability to respond to climate-related hazards. The data for these indicators were compiled from multiple secondary sources, including the Provincial Disaster Management Authority

(PDMA) Balochistan, Pakistan Meteorological Department (PMD), the World Bank, Pakistan Bureau of Statistics (PBS) and the Planning and Development Department (P&DD).

The selected indicators provide a comprehensive understanding of vulnerability by incorporating climatic trends such as temperature and precipitation variability alongside socio-economic factors including demographic structure, access to water and sanitation services, health outcomes, disability prevalence, food security and literacy levels. Higher values of sensitivity and exposure indicate greater vulnerability, while higher adaptive capacity reflects improved resilience. Together, these dimensions form the Climate Change Vulnerability Index (CCVI), which provides an overall assessment of the district's risk profile and highlights priority areas for targeted interventions and long-term adaptation planning.

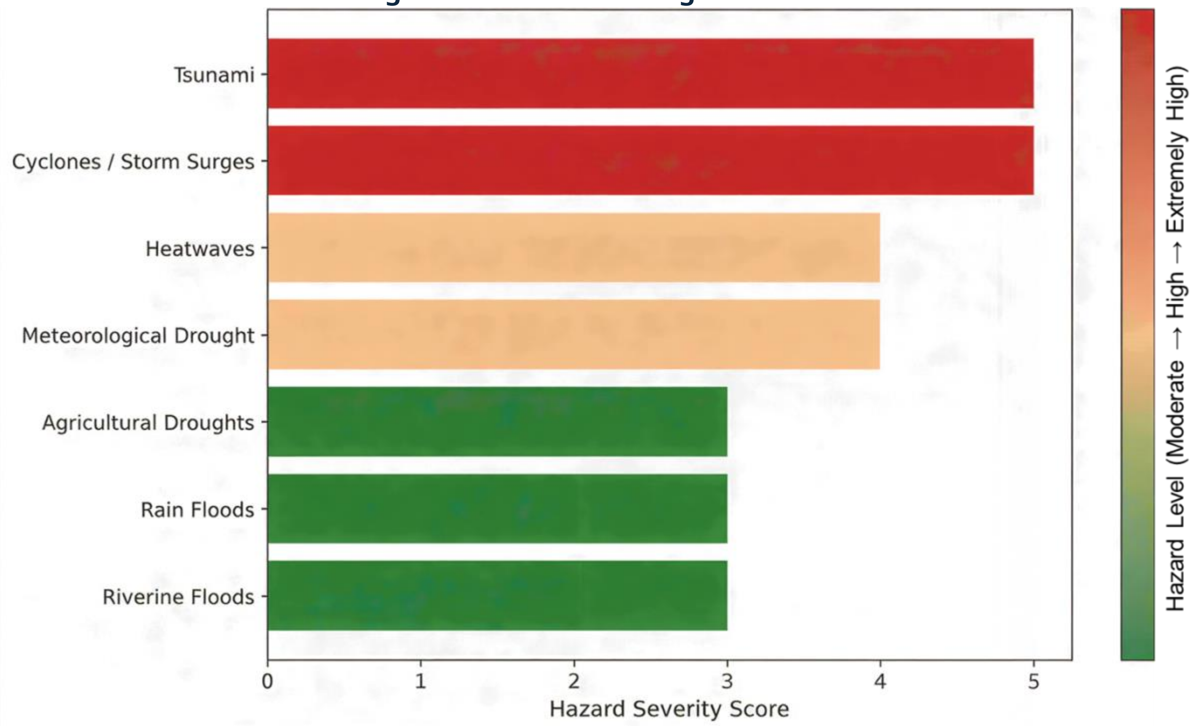
4.1.2 Climatic Characteristics of Gwadar

Gwadar district experiences a hot desert climate characterized by low and highly variable precipitation and significant seasonal temperature fluctuations. Its coastal location along the Arabian Sea moderate's extreme temperature conditions compared to inland areas. Sea currents contribute to relatively cooler summer conditions and warmer winter nights, resulting in a more moderate diurnal temperature range than other parts of Balochistan. Despite this moderating influence, the district remains highly vulnerable to climate variability due to its arid environment, limited freshwater availability and growing water demand associated with rapid urban development.

4.1.3 Hazard Risk Profile

Gwadar's exposure to climate change is shaped by a combination of hydro-meteorological and coastal hazards. The district faces multiple climate-related risks of varying intensity.

Figure 2: Hazard Ranking of Gwadar



Flood risk in Gwadar is categorized as moderate for fluvial, flash and riverine flooding. Although the district lies outside the primary monsoon belt, it receives light monsoon rainfall during June to August. More intense precipitation events are often associated with winter western disturbances.

Tehsil Jiwani is particularly vulnerable due to the risk of overflow and breaching of the Dasht River. In recent years, the urban areas of Gwadar have experienced repeated flash flooding, highlighting the increasing frequency and intensity of localized extreme rainfall events.

Drought represents one of the most persistent and critical hazards in the district. Gwadar is classified as being at high risk for meteorological drought and moderate risk for agricultural drought due to erratic and insufficient rainfall patterns. Major settlements including Pasni, Jiwani, Pishukan, Sur Bandar and Ormara face chronic water shortages. Historical drought episodes, particularly between 1997–2002 and again during 2013–2015, affected between 30 and 55 per cent of the district population, underscoring the long-term nature of water insecurity.

Although Gwadar has not historically been classified as a heatwave-prone district under earlier management plans, rising temperatures and increasing heat stress conditions have elevated its risk category. According to the PDMA Hazard Ranking (2024), the district now falls under high heatwave risk. Temperatures ranging between 39°C and 47°C have been recorded in several areas, particularly in regions bordering Kech district, with heat stress conditions increasingly observed between May and August.

Due to its coastal location, Gwadar is also highly exposed to cyclones and potential tsunami impacts. The district is categorized under extreme risk for cyclones and tsunami hazards. Past events such as Cyclone Phet (2010), which brought 372 mm of rainfall and strong winds and the cyclones Gonu and Yemyin (2007), which displaced approximately 250,000 people across Gwadar and neighbouring districts, demonstrate the severity of coastal climate risks.

4.1.4 Temperature and Precipitation Trends (2002–2023)

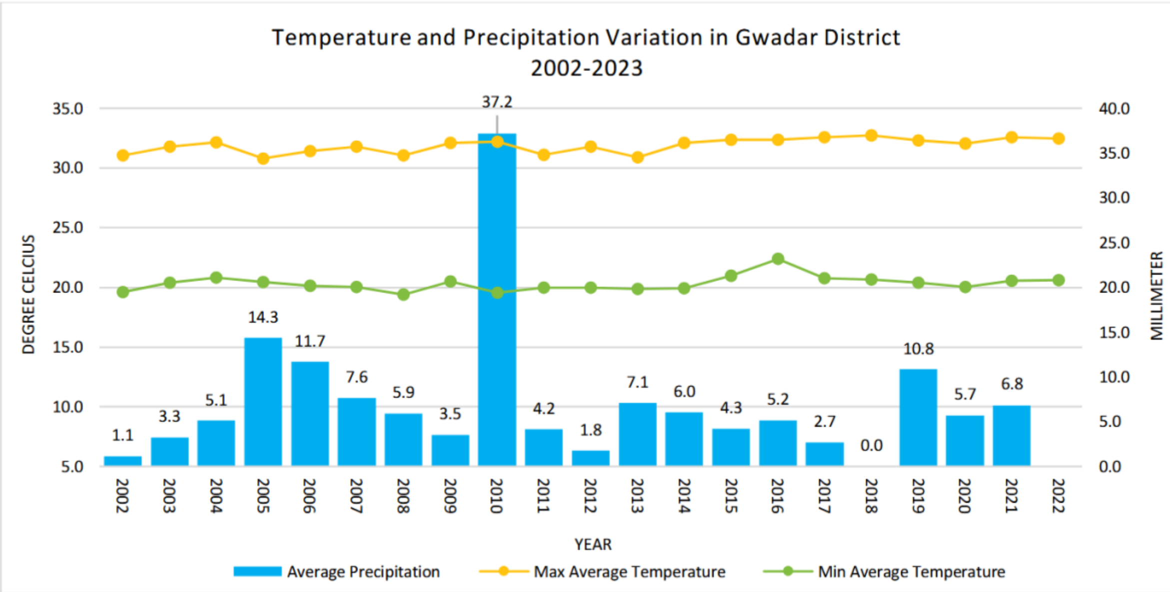
Gwadar’s exposure index is significantly influenced by long-term climatic trends. The district exhibits high temperature variability, with average monthly maximum temperatures frequently exceeding 36°C during May, June and July. The highest monthly average temperature of 38.5°C was recorded in May 2009. The mean annual maximum temperature is approximately 31.9°C, with peak annual values of 32.6°C and 32.7°C recorded in 2017 and 2018 respectively.

Minimum temperatures also show seasonal variation, increasing from approximately 12°C in January to around 27°C during summer months. The lowest recorded monthly temperature was 8.7°C in January 2006. While occasional cold spells occur, a more significant concern is the rising trend in night-time temperatures during summer, which increases heat stress risks for both human health and agriculture.

Precipitation in Gwadar remains low but highly erratic. Annual rainfall varies significantly, with some years receiving negligible precipitation while others experience intense short-duration rainfall events. For example, 2005 recorded an annual average of 14.3 mm, whereas June 2010 alone recorded 386 mm of rainfall. This pattern of prolonged dry periods followed by sudden heavy downpours increases the risk of both drought and flash flooding.

Trend analysis using linear regression indicates a warming climate. Maximum temperatures are increasing at a rate of 0.053°C per year, while minimum temperatures are rising by 0.013°C annually. Precipitation shows a slight increasing trend of 0.073 mm per year, largely influenced by occasional extreme rainfall events. Statistical analysis identified 11 extremely heavy rainfall events, four unusually high temperature events and nine unusually low temperature events. These were all among the most extreme recorded, meaning they were higher or lower than almost all other past measurements. This shows that extreme weather events are becoming more frequent and the climate is becoming more unpredictable.

Figure 3: Maximum and Minimum Temperature and Precipitation Trends in Gwadar District



4.1.5 Climate Change Vulnerability Index (CCVI)

The overall CCVI for Gwadar district has been assessed by integrating three key dimensions: exposure to climate hazards, sensitivity of the population and systems and the district's adaptive capacity. Based on district-level comparisons across Balochistan, Gwadar falls within the category of moderate vulnerability. This suggests that while the district faces notable climate-related risks, its existing coping capacity helps to partially offset overall vulnerability.

This indicates that while Gwadar is exposed to several climate-related risks, including rising temperatures, irregular rainfall, coastal hazards such as cyclones and ongoing water scarcity, its relatively stronger adaptive capacity helps reduce overall risk. However, the level of exposure and underlying socio-economic challenges mean that additional measures are needed to strengthen long-term resilience, particularly in the context of rapid urban growth and increasing pressure on natural resources.

Several district-specific actions are recommended to reduce vulnerability and enhance climate resilience. Water security should be a priority through the construction of check dams in the surrounding mountainous catchment areas. These structures would help capture seasonal runoff, reduce water losses and enhance groundwater recharge for both domestic and agricultural use. Given Gwadar's coastal location, mangrove restoration along the shoreline is another important measure. Mangroves can act as natural barriers against coastal erosion and storm surges while also supporting marine biodiversity and strengthening local livelihoods, particularly for fishing communities. Rising temperatures and increasing heat stress highlight the need for comprehensive heatwave management planning. This should include early warning systems, public awareness campaigns and the establishment of community cooling spaces to protect vulnerable groups such as the elderly, children and outdoor workers. Strengthening local preparedness through community-based disaster risk reduction (DRR) is essential. Developing local response plans, training community volunteers and improving early warning and communication systems can significantly reduce the impacts of floods, extreme weather events and other climate-related emergencies.

4.1.6 Climate Change Impacts on Gwadar District: WASH and Health

Climate change affects water resources through changes in precipitation and temperature, which influence hydrological balance and aquifer recharge. Increased temperatures intensify evapotranspiration, reducing water availability. Extreme events like floods and droughts affect water quality through dilution during rainfall and concentration of contaminants during drought.

4.1.6.1 Flooding

Floods significantly affect water supply systems and related infrastructure. They often cause interruptions in water supply services and lead to the contamination of water resources (Tufail, Nasir , Tariq , Ali, & Alarifi). Floods can disrupt water supply services and degrade water quality by damaging reservoirs and compromising dams, creating the risk of partial or total structural failure. They also cause sediment inflow, which reduces storage capacity. Flooding can further contaminate water sources through agricultural runoff and the leaching of pollutants from waste disposal sites and material storage areas due to the failure of safety features. In addition, floods can damage pumping stations and other water supply infrastructure, leading to contamination or complete interruption of water supply services (Barbetta, et al., 2022).

Floods also have significant impacts on water systems and infrastructure by damaging water treatment facilities, pipelines and other components of distribution networks, which are often located near rivers and therefore highly vulnerable to flooding. These impacts include direct damage such as the destruction of equipment and contamination of pipelines, as well as indirect effects such as prolonged interruptions in water supply. Flooding reduces the functionality of critical infrastructure, increases the risk of water contamination and can result in widespread service outages. During severe flood events, large sections of the water distribution system may require disinfection, leading to high economic costs. In such situations, the number of people affected by water service disruption can be several times greater than the population directly impacted by flooding (Arrighi, Tarani, Vicario, & Castelli, 2017).

Box 1: Gwadar Floods 2024

Gwadar suffered massive flooding in late February 2024 following record high rainfall. This event resulted in the declaration of a state of emergency, extensive damage to infrastructure, house collapses and loss of lives, affecting thousands of households due to poor drainage systems and intensified climate-related weather conditions. In the aftermath of the floods, health-related needs became critical priorities. Floods led to high health hazards including the spread of waterborne diseases, injuries and vector-borne illnesses such as malaria. Displacement of families significantly restricted access to healthcare services, contributing to high demand for medical assistance. The availability of adequate medical supplies, including first aid, medicines and hygiene kits, emerged as a primary issue. Additionally, the psychological well-being of affected individuals was impacted, highlighting the need for mental health support (IRFC, 2024).

4.1.6.2 Saltwater Intrusion

In recent decades, sea-level rise around Gwadar has more than doubled, with estimates showing that it could increase by 0.44 to 1.03 meters over the next 75 years. Local conditions have intensified this rise to ten to fifteen times the global average. The increasing sea level, saltwater intrusion and coastal erosion have elevated the groundwater table, leading to flooding in low-lying areas, infrastructure damage and overflowing sewage. Excessive rainfall in February 2024 flooded shallow aquifers and increased groundwater levels. Wastewater from cesspools and septic tanks infiltrated coastal sands, causing contamination. With nearly 80 per cent of the city lacking sewerage, the coastal aquifer contamination poses serious health risks. Measurements from 25 wells show that groundwater depth decreased from 16.5 feet in 2018 to 6.5 feet in 2024 and in certain areas, it is already reaching the surface (Ahmed, Gwadar's hidden flood-II, 2025).

Low-lying coastal areas are becoming more vulnerable to seawater flooding as sea levels rise and storms become more frequent and intense due to climate change. This flooding can cause freshwater coastal aquifers to become salty through a process known as vertical saltwater intrusion. However, this risk is often overlooked in coastal hazard assessments, despite its serious impact on freshwater supplies and salt-sensitive ecosystems that support coastal communities (Cantelon, Guimond, Robinson, Michael, & Kurylyk, 2022). In Gwadar, land subsidence is closely linked to seawater intrusion, a common challenge in many coastal cities. This intrusion is driven primarily by local geological conditions and rising sea levels. Elevated salinity levels in Gwadar's groundwater further confirm the growing influence of seawater (Bokhari, et al., 2023).

Saltwater intrusion and rising groundwater levels are also increasing, putting water and sanitation infrastructure at risk due to sea-level rise and strong rainfall events. Seawalls made by authorities using stone and concrete are only a part of defence against the intrusion of saltwater, since the city does not have a proper sewage and drainage system. The high-water levels in Gwadar, the porous nature of the soil, rising seas and heavier rainfall together are some of the factors that increase the vulnerability of the region to flooding and sanitation breakdown (Butt, 2025).

The coastal aquifer of Gwadar is highly vulnerable to saltwater intrusion due to rising sea levels and the combined influence of natural processes and human activities. To assess this problem, (Ahmed, Wasay, & Naseem, Assessing seawater intrusion in the municipal committee area of Gwadar, Balochistan, 2023) collected 35 groundwater samples from wells and boreholes and measured water levels at each location. Key water quality parameters, including electrical conductivity (EC), total dissolved solids (TDS) and pH, were recorded on site. The results showed that groundwater in the area was generally brackish to saline. EC values varied widely from 760 to 18,350 µS/cm, with an average of 6,884 µS/cm, indicating significant salinity levels. Salinity levels differed by location and environmental conditions: areas farther from the coast recorded values up to 11,650 µS/cm, while groundwater near low-lying elevations had an average salinity of 11,770 µS/cm. Tidal influence was also evident, with average salinity increasing from 3,566 µS/cm during low tide to 14,462 µS/cm during high tide. Overall, the elevated EC and TDS levels confirm widespread salinization of the coastal aquifer in the Municipal Committee Gwadar (MCG) area, primarily driven by seawater intrusion.

4.1.6.3 Droughts

Drought conditions can significantly affect water utility operations by reducing water availability and system pressure, which leads to insufficient supply. Droughts also degrade the quality of water sources and as a result, additional treatment is required to meet drinking water standards. At the same time, access to alternative or supplementary water sources can become limited due to increased demand. Together, these factors can result in higher operational costs and reduced revenues for water utilities[7].

Droughts affect the quality of drinking water supplies, including turbidity, taste and odor, pathogen concerns and challenges in managing disinfection byproducts (DBPs) (Wright, et al., 2014). They limit the recharge of both surface and groundwater by reducing rainfall and increasing evaporation, which lowers water levels in rivers, reservoirs and aquifers and leads to long-lasting water shortages (Loon, 2015).

[7] https://www.drought.gov/sectors/water-utilities

Drought significantly impacts water by altering its physical, chemical and biological characteristics. Reduced rainfall and river discharge limit the dilution of pollutants, causing higher concentrations of contaminants in water bodies. Evaporation during drought increases water temperature, TDS and conductivity, while also accelerating chemical and biochemical processes. Biological activity is affected as warmer, slower-moving waters promote bacterial growth and algal blooms, which can lead to unpleasant taste, odor and potentially toxic conditions. Dissolved oxygen levels decrease due to reduced flow and increased decomposition of organic matter, while key ions like calcium, magnesium and sulphate become more concentrated. Overall, drought degrades water quality, making water bodies more susceptible to contamination and ecological stress (Diwan, 2025).

Being a newly developing port town, Gwadar continues to struggle with its water needs (Maqsood, 2021). The city faces long-term effects of climate change, including multi-year drought cycles recorded from 1997 to 2012, with extreme dry periods in 2000, 2004, 2006, 2007, 2009-2011, 2014-2017, 2018, 2020 and 2024-2025. These droughts caused massive crop failures, livestock deaths and displacement in districts including Gwadar. The climate-induced scarcities have intensified vulnerabilities, resulting in depleted grazing lands, drying springs, drying dams and eroding coastal settlements. Residents increasingly rely on expensive water tankers, with queues lasting hours and costs ranging from 20,000 to 30,000 rupees per 30,000-litre tanker, beyond the means of most households[8].

4.1.6.4 Heatwaves

Due to the continued increase in global temperatures, heatwaves are becoming more frequent and prolonged. As a result, water utilities face growing challenges in ensuring a reliable supply of water. Heatwaves have both direct and indirect impacts, affecting the physical availability of water while also influencing patterns of water use and demand. They increase evaporation from reservoirs, lakes, rivers and other surface water sources, thereby reducing the availability of water for drinking, irrigation and wastewater treatment. Heatwaves often occur alongside drought conditions, which further limit rainfall, reduce freshwater collection and hinder groundwater recharge. These events also decrease the efficiency of water storage systems. Increased evaporation from reservoirs lowers the volume of usable water, while prolonged high temperatures can induce thermal stress on storage tanks and reservoirs, resulting in maintenance challenges and temporary reductions in storage capacity. Water utilities that rely on inter-basin transfers are particularly vulnerable during heatwaves. As source basins dry up or experience higher rates of evaporation, the volume of water available for transfer decreases, further limiting supply in regions already prone to water scarcity. Heatwaves also have significant impacts on water quality, making it more difficult for utilities to provide safe and clean water. Rising temperatures can alter the physical, chemical and biological characteristics of water in reservoirs, lakes, rivers and groundwater sources, increasing contamination risks and operational challenges. In addition, heatwaves can damage water supply infrastructure, including pipelines, pumping stations and treatment plants (ARCADA, 2025).

In coastal and low-lying areas, heatwaves combined with rising sea levels exacerbate saltwater intrusion into freshwater aquifers by reducing hydraulic pressure on the freshwater. This compromises the quality of water for drinking and irrigation if untreated (IPCC, 2022). Heatwaves also affect the microbiological safety of drinking water in complex ways, which is particularly concerning in coastal areas due to the higher frequency and intensity of extreme heat events. Furthermore, heatwaves impact the performance of water treatment processes, creating additional operational challenges (Xiao, Fu, & Yu, 2023).

[8] https://tribune.com.pk/story/2587773/running-out-of-water-and-time

4.1.6.5 Cyclones

Tropical cyclones indirectly affect water systems by causing major disruptions to water supply and sanitation infrastructure. Such disruptions often result in the contamination of water, increasing the spread of diarrheal diseases through unsafe water and through person-to-person transmission due to poor hygiene conditions. These impacts are often examined within studies that focus on heavy rainfall and flooding, where tropical cyclones are mentioned as contributing factors. However, these studies provide important insights into the broader linkages between climate hazards, water systems and waterborne diseases (Lin, et al., 2025). Tropical cyclones can also damage drinking water sources and sanitation infrastructure and in many cases, they lead to temporary contamination of water supplies with debris and saline water (Siddik & Moniruzzaman , 2013).

Cyclones further affect water quality by increasing turbidity and raising concentrations of total coliforms and E. coli due to the large volumes of sediment, waste and debris entering water supply systems. At the same time, they disrupt water and sanitation services, often leaving communities without access to toilets for several days. This situation can result in the disposal of untreated waste into stormwater systems, creating highly unsanitary conditions. Water supply and sanitation facilities are frequently damaged or destroyed, making them unsafe or non-operational and increasing public health risks (Siddik, Islam, & Reza, 2024).

In addition to infrastructure damage, cyclones directly affect water sources by making them unsafe for consumption, increasing turbidity and elevating bacterial contamination levels that threaten drinking water safety. Cyclone events also damage WASH facilities and cause sediment re-suspension and nutrient runoff within catchments. These processes can increase chlorophyll levels and further degrade overall water quality. Given these combined impacts, continuous community-level monitoring becomes essential to safeguard water quality and protect public health following cyclone events (Chilaule, et al., 2024).

4.1.7 Implications for WASH Operations and Service Delivery in Gwadar

The climate-related impacts described above highlight the urgent need for Gwadar’s WASH systems to adopt a climate-resilient approach to planning, operations and service delivery. Failure to integrate climate considerations into infrastructure planning and management could result in under-designed systems, more frequent service interruptions, accelerated infrastructure deterioration and higher risks to public health.

In Gwadar, these risks are compounded by the city’s coastal location, dependence on climate-sensitive water sources, limited storage, incomplete drainage and sewerage systems, and increasing salinization of groundwater. Flooding, drought, heatwaves and cyclones do not operate as isolated events. Rather, they place cumulative pressure on water supply reliability, sanitation performance and environmental health.

A climate-resilient operational approach will therefore require source diversification, protection of coastal aquifers, improved water quality surveillance, flood-resilient design of critical infrastructure, emergency preparedness for climate shocks and better integration of climate risk considerations into future WASH investments. These measures will be essential to protect public health, sustain service continuity and reduce the vulnerability of low-income and underserved communities.

Future infrastructure planning should incorporate climate-resilient design standards that account for projected increases in flooding, heat stress, salinity and coastal hazards. This includes flood-protected pumping stations, elevated electrical and sanitation infrastructure in vulnerable areas, corrosion-resistant materials for pipelines and mechanical systems, enhanced water storage and backup power arrangements, and drainage systems designed using future rainfall projections rather than historical averages. Similarly, desalination plants, wastewater treatment facilities and major transmission systems should undergo climate-risk screening during planning and design to ensure long-term functionality under changing climatic conditions.

4.1.8 Nature-Based and Low-Carbon Solutions

Given the limitations of conventional infrastructure alone in addressing Gwadar's complex climate challenges, nature-based and low-carbon solutions should be considered as complementary measures within this roadmap. Such interventions can help reduce climate risks, improve environmental performance and strengthen long-term WASH resilience.

For Gwadar, mangrove restoration and protection along the coastline offer an important nature-based option. Mangroves can serve as natural buffers against storm surges, coastal erosion and saline intrusion, while also supporting marine biodiversity and local livelihoods. Similarly, rainwater harvesting at household, institutional and community levels can help capture episodic rainfall and reduce dependence on increasingly stressed conventional sources.

Managed aquifer recharge may also be explored in suitable areas to improve groundwater conditions where hydrogeological circumstances permit. In urban areas, the use of permeable surfaces, retention areas and improved natural drainage channels can help reduce localized flooding and improve stormwater management. In the sanitation sector, decentralized and nature-based treatment systems, such as constructed wetlands and bio-filtration systems, may offer practical options in areas where full sewerage is not feasible, particularly in high groundwater and coastal zones.

Low-carbon solutions are equally relevant. Solarization of pumping systems, decentralized water treatment and selected desalination systems can help reduce operating costs and lower dependence on unstable grid electricity. Over time, integrating nature-based and low-carbon approaches into urban planning and WASH investments can support Gwadar's transition toward a more climate-resilient and environmentally sustainable service system.

4.2 Water Resources

Gwadar's water resources are shaped by an arid coastal environment, highly variable rainfall, limited freshwater reserves, saline groundwater conditions and increasing pressure from rapid urban and economic growth. Unlike inland districts where groundwater may serve as the primary and relatively stable source of supply, Gwadar faces a structurally constrained water resource base. Groundwater is largely saline and unsuitable for domestic use, surface water storage is limited and climate-sensitive, and desalination, despite its strategic importance, remains underdeveloped and operationally weak.

According to the Gwadar Smart Port City Master Plan 2017–2050, revised in 2019, access to safe and potable drinking water was identified as one of the most fundamental human needs for the city's future development. The Master Plan noted that Gwadar faced severe water scarcity due to its arid to semi-arid climatic conditions, low and erratic rainfall, and deteriorating groundwater quality resulting from salinization and seawater intrusion. In the context of port expansion, urban growth and industrial development, the demand for water is expected to rise sharply, making the sustainability and diversification of water resources a critical strategic priority.

4.2.1 Groundwater Sources

Groundwater in the district is primarily contained within unconfined alluvial aquifers, with smaller quantities present in perched aquifers. These aquifers are located within unconsolidated sediments, mainly sand and silt deposited by rivers over thousands of years, which are porous and allow water to flow relatively freely. Alluvial aquifers are located along major rivers in Gwadar district, including the Dasht, Basol, Shadi Kaur and Hingol rivers, and to a lesser extent within the Jiwani formation. Perched aquifers are distributed across the district but are limited in volume and highly vulnerable to over-extraction.

At the same time, Gwadar's geology imposes severe limitations on groundwater potential. Shale, mudstone and clay dominate large parts of the district, particularly in areas such as Ormara, Chatti and the Talar formation, restricting groundwater storage and abstraction potential. The major threat to unconfined alluvial aquifers is seawater intrusion, exacerbated by rising sea levels and broader climate change impacts. This intrusion not only compromises groundwater quality but has also contributed to land degradation in areas such as Dasht. Coastal areas further experience elevated groundwater salinity due to high concentrations of cations and anions in the soil.

(PCRWR, 2022) identified loam and clay loam as the dominant soil types in Gwadar city. These soils, being heavy-textured, significantly limited groundwater recharge from surface water sources, including dams, rivers, canals and rainfall. Groundwater in the city was generally shallow, ranging from 6 to 10 meters, but highly saline due to marine geological formations and restricted recharge potential resulting from the region's lithology. The water table within the city varied according to topography, with depth increasing to approximately 30 meters in surrounding areas. Beyond this depth, groundwater salinity intensified, ranging from 5.6–6 dS/m to 6.1–6.5 dS/m. Even at depths of 20 meters, salinity values ranged from 3.6 dS/m to 6.0 dS/m.

These findings indicate that Gwadar's groundwater is shallow, highly saline and poorly recharged. No fresh groundwater pockets were found down to 150 metres, making groundwater largely unsuitable for domestic or agricultural use. This confirms that groundwater cannot serve as the principal source for Gwadar's long-term water security and that alternative sources, particularly surface water, desalination and water recycling, are essential. Nevertheless, the limited freshwater resources that remain should be protected as strategic reserves. Development of additional tube wells should only be undertaken where supported by hydrogeological investigations demonstrating sustainable yield and minimal impacts on existing abstraction. Greater emphasis should therefore be placed on protecting existing groundwater resources through abstraction control, wellfield protection and groundwater recharge measures, including recharge wells and managed aquifer recharge where technically feasible.

4.2.2 Rainwater Harvesting Potential in Gwadar City

Gwadar city experiences a hot desert climate with low annual precipitation. Although it lies outside the main monsoon belt, the city occasionally receives minor monsoon showers and, at times, heavy rainfall due to western disturbances. Soil analysis conducted by (PCRWR, 2022) indicates that the predominance of heavy-textured soils severely limits groundwater recharge from surface water and rainfall. As a result, rainwater tends to accumulate on the surface, forming natural ponds that local communities have traditionally used for domestic purposes and crop production.

Despite limited resources, residents have developed small-scale rainwater storage systems that support tree growth and localized vegetation. These observations suggest significant potential for the formal development of rainwater harvesting ponds and local runoff storage systems to enhance water availability in Gwadar. In a water-scarce coastal city with limited freshwater reserves, rainwater harvesting should not be viewed as a marginal intervention but as a supplementary and climate-resilient water resource strategy, especially for public buildings, peri-urban settlements and community-level storage, and should be integrated with watershed rehabilitation, check dams, runoff management and recharge wells to maximise water capture and improve groundwater recharge where hydrogeological conditions permit.

4.2.3 Surface Water Sources in Gwadar

Gwadar's surface water resources have historically been limited, climate-sensitive and insufficient to meet the district's growing water needs. For more than two decades, Ankara Kaur Dam, also known as Akra Dam, with a storage capacity of 10,000 acre-feet, served as the principal source of water supply for Gwadar under the old Water Supply Scheme (WSS). However, as Gwadar's population increased and major infrastructure and industrial projects expanded under CPEC, demand for water rapidly outpaced the capacity of this single source. Prolonged drought conditions further reduced inflows, and Ankara Dam eventually dried up in 2017, exposing the vulnerability of Gwadar's heavy reliance on a single rainfall-dependent reservoir. However, following periods of heavy rainfall in 2022 and 2025, the dam was replenished and is currently supplying water primarily to rural areas of Gwadar tehsil.

The pressure on surface water resources became particularly evident during the severe drought period around 2015, when it became clear that additional storage and supply sources would be required to meet both domestic and industrial demand. In response, Sawad Dam and Shadi Kaur Dam were developed and completed in 2016 and 2022 respectively. Sawad Dam, with a storage capacity of 45,000 acre-feet and a designed supply capacity of 5 MGD to Gwadar city through a 67 km transmission pipeline, became the main source for the urban water system. However, the reservoir has come under increasing stress and reached dead storage levels during the drought period of 2020–21, highlighting its vulnerability to climate variability and over-reliance as one of primary urban water sources. In contrast, Shadi Kaur Dam, with a storage capacity of 37,000 acre-feet, remains one of the few major functional surface water sources. It supplies water to Pasni and is linked with the Sawad Dam system to support potable water supply to Gwadar city. According to current status, around 33,000 acre-feet remain available, making it the most reliable operational surface water source at present. (Feasibility study on Gwadar Water Supply Issues, 2025)

Beyond these major reservoirs, Gwadar's surface water network includes several seasonal rivers and streams, notably the Shadi Kaur, Sawad and Dasht rivers, together with tributaries such as Nilag and Daddeh. These watercourses feed a number of reservoirs intended to support both urban and rural water needs. Mirani Dam, located in the wider regional system and fed by the Kech and Nihing rivers, remains the largest reservoir with a storage capacity of 302,000 acre-feet and currently has sufficient water available. Given its storage capacity and regional significance, Mirani Dam represents the principal potential large-scale bulk water source for future urban Gwadar. However, its integration into the Gwadar water supply system should be subject to detailed technical, environmental and financial feasibility assessments covering water availability and allocation, transmission infrastructure requirements, pumping energy, lifecycle costs and institutional responsibilities.

According to Feasibility study on Gwadar Water Supply Issues, 2025, Several additional dams have been constructed or planned to strengthen local supply, but many of these are not yet contributing effectively. Shehzanik Dam, with a storage capacity of 57,000 acre-feet, is under construction and is expected to supply 4.7 MGD to Jiwani. Basol Dam, with a capacity of 47,000 acre-feet, is intended to supply Ormara, but currently has no available water. Dosi Dam and Shenzani Dam, with capacities of 16,000 and 17,800 acre-feet respectively, were planned to strengthen supply to Pasni and nearby settlements, but they remain non-functional because transmission and distribution infrastructure has not yet been completed. Smaller dams, including Makola, Kanero and Rumro, were developed for localized supply and irrigation support, but all currently report no water availability. Among the smaller systems, only Belar Dam retains limited storage, with around 1,500 acre-feet remaining out of its total capacity of 10,588 acre-feet.

Overall, Gwadar's surface water profile reveals a structurally fragile resource base characterized by high climate sensitivity, limited storage reliability and weak integration between available reservoirs and functioning supply infrastructure. While several dams exist on paper or in physical form, only a small number are currently operational and dependable. Many reservoirs are either dry, at dead storage, or constrained by incomplete conveyance systems. This indicates that Gwadar's water insecurity is not only a result of limited natural availability, but also of delayed infrastructure utilization, poor system integration and the absence of a diversified and resilient surface water management strategy. Surface water reservoirs will therefore continue to form the principal water supply base for much of Gwadar District, particularly for rural settlements that cannot be economically connected to large urban systems. Improving their long-term reliability will require greater emphasis on catchment protection, watershed management, desilting, dam safety, completion of conveyance infrastructure and systematic monitoring of reservoir storage and water quality. Accordingly, priority should be given to protecting, rehabilitating and optimising existing reservoirs and catchments before developing additional stand-alone infrastructure. Local dams should continue to serve as the principal water sources for rural populations, while the potential role of Mirani Dam as the main large-scale bulk water source for urban Gwadar should be assessed through comprehensive feasibility studies.

Table 4: Status of Surface Water Reservoirs in Gwadar as per Feasibility Study on Gwadar Water Supply Issues, 2025

Dam/Reservoir	Capacity (AF)	Distribution	Current Status
Ankara Dam	17,000 but currently 8000	Previously supplied Gwadar as part of the old water supply scheme; presently supplies water to rural area of Gwadar tehsil, Jiwani tehsil and surroundings via a 78 km pipeline	Working at half of its capacity
Mirani Dam	302,000	Reservoir fed by the Kech and Nihing Rivers; impounds the Dasht River	Sufficient water available
Shadi Kaur Dam	37,000	Supplies water to Pasni; connected with Sawad Dam to supply potable water to Gwadar	33,000 AF; Sufficient water available
Sawad Dam	45,000	Main source of water for Gwadar city via 67 km transmission pipeline; capacity to supply 5 MGD	19,000 AF; Reservoir has reached dead levels; water extracted using mechanical pumps
Shehzanik Dam	57,000	Planned to supply 4.7 MGD to Jiwani	Under construction
Basol Dam	47,000	Planned to supply water to Ormara	No water available
Dosi Dam	16,000	Planned to supply 2.5 MGD to Pasni and irrigate 8,500 AF	Pipeline not laid
Shenzani Dam	17,800	Planned to supply 2.5 MGD to Chur Town, Gurrani and Pasni Airport	-
Makola Dam	396	Constructed in 2016; designed to provide 0.3 MGD to Pasni	No water available
Belar Dam	10,588	Constructed in 2003; designed to supply 0.1 MGD to Kulanch and irrigate 1,200 AF	1,500 AF capacity remaining
Kanero Dam	930	Constructed in 1985; designed to supply 0.05 MGD to Kulanch areas	No water available
Rumro Dam	6,585	Constructed in 2017; designed to supply 0.05 MGD to Pasni	No water available

4.2.4 Desalination Plants in Gwadar

Desalination represents one of the most significant potential water sources for Gwadar, given its direct access to the Arabian Sea. However, despite this geographic advantage, desalination has not been effectively utilized due to a combination of infrastructural, financial, technical and energy-related constraints. The technology, while viable in principle, requires high capital investment, continuous power supply and skilled technical personnel, factors that have consistently limited its success in Gwadar[9].

Over the years, multiple desalination plants have been installed across the district with the objective of ensuring a sustainable water supply for the growing population and expanding economic activities associated with the port and CPEC developments. Despite establishment of multiple desalination plants over the years, the majority remain non-functional, underperforming or never operationalized. This has resulted in a situation where, despite substantial investments and infrastructure development, desalination has contributed minimally to the city's overall water supply[10].

A notable example is the 1.2 MGD desalination plant installed at Gwadar Port by Chinese authorities as a grant to supply potable water to the port and surrounding areas. The plant was originally powered by dedicated 1 MW generators and was handed over to the Gwadar Port Authority (GPA) in 2024. However, it initially remained non-operational due to the absence of a formal electricity connection. Although this issue was subsequently addressed on the instructions of the Ministry of Maritime Affairs, the plant has yet to be fully commissioned due to minor technical faults and the unavailability of specialized engineers required for testing and calibration. Even where operational, the plant is currently producing approximately 0.8 MGD against its installed capacity of 1.2 MGD, reflecting performance inefficiencies. (Feasibility study on Gwadar Water Supply Issues, 2025).

Despite these individual developments, the overall performance of desalination infrastructure across Gwadar remains weak. A total of eight desalination plants have been established with a combined design capacity of approximately 4.425 MGD. However, only one plant remains partially functional, while the rest are non-functional, abandoned or never operationalized. The detailed status of these plants highlights recurring issues related to design flaws, poor site selection, lack of maintenance, institutional discontinuity and financing constraints.

1. **GPA Residential Area Plant (1998):** Constructed in 2002 with a capacity of 0.2 MGD, the plant operated for nearly 18 years before becoming non-functional due to the completion of its operational life. Located approximately 1 km from the shoreline, it is owned by GPA and is now considered obsolete.
2. **Karwat Desalination Plant (2004):** Developed by Balochistan Development Authority (BDA) with UAE assistance, this plant had a design capacity of 2 MGD but operated for only a brief period due to poor site selection and silting issues. It is currently non-functional and under investigation by National Accountability Bureau (NAB). The estimated cost for rehabilitation ranges between Rs. 1.5 to 2.5 billion.
3. **PC Hotel Desalination Plant (2007):** Installed with a capacity of 0.025 MGD, this plant has remained operational for an extended period and is currently partially functional. It is located about 1.5 km from the shoreline and is owned by the PC (Golden Palms Society).
4. **Surbandar Desalination Plant – FWO (2018):** Built with a capacity of 0.2 MGD, the plant operated for approximately three years before being declared beyond economical repair (BER). The equipment has since been dismantled and is stored at the FWO camp site.
5. **GPA Desalination Plant – GPA/China (2023):** This is the only plant currently operational in the district. Constructed with Chinese assistance, it has a design capacity of 1.2 MGD but is operating

[9] https://thediplomat.com/2025/07/what-is-behind-gwadars-continued-water-woes/
[10] https://thediplomat.com/2025/07/what-is-behind-gwadars-continued-water-woes/

at a reduced output of 0.8 MGD due to pump and motor issues. The plant lacks a proper brine disposal system, contributing to environmental concerns.

6. **Sanghar Housing Desalination Plant (2004):** With a capacity of 0.2 MGD, this plant operated only briefly and is now non-functional. Its failure is largely attributed to the discontinuation of the Sanghar Housing Scheme. Estimated rehabilitation cost is Rs. 25–30 million.
7. **Gwadar Industrial Estate Development Authority (GIEDA) Desalination Plant:** Planned at Karwat with a capacity of 0.2 MGD, this project was never completed. Equipment remains unused in storage containers. Estimated operational costs range between Rs. 150–300 million.
8. **Jiwani Desalination Plant – BDA (2017):** Although planned with a capacity of 0.2 MGD, the plant was never operationalized. Equipment is currently stored in Quetta, and the project remains under NAB investigation. Estimated operational cost is Rs. 150–300 million.
9. **Pasni Desalination Plant – BDA (2017):** Similar to the Jiwani plant, this facility was never made operational. Equipment remains stored in Pasni, and the project is also under investigation. Estimated operational cost is Rs. 150–300 million.

Another 5 MGD desalination plant at Karwat has been proposed by GDA for implementation under a PPP model. However, the Planning Commission has recommended the installation of smaller desalination plants in different towns based on local demand, rather than a single 5 MGD plant. In this regard, GDA has proposed 10 locations for the installation of small desalination plants across various towns, in line with local requirements (as shown in the table below). However, there has been no update on this proposal since its submission. The proposal represents a shift towards more distributed and demand-responsive service provision. Nevertheless, desalination should be developed as a supplementary component of Gwadar's diversified water supply portfolio rather than as a stand-alone solution. Expansion should therefore proceed only where lifecycle affordability, reliable energy supply, operation and maintenance capacity, and environmental compliance, particularly with respect to brine management, can be demonstrated.

Table 5: Proposed Locations for Installation of Small Desalination Plants

Sr. #	Location	Demand (MGD)
1	Jiwani	1.05
2	Pishukan	0.70
3	Bandari	0.07
4	Ganz	0.06
5	Panwan	0.15
6	New Town	0.35
7	Surbandar	0.36
8	Kappar	0.127
9	Chur	0.066
10	Kalmat	0.083
	Total	**3.016**

In addition to the desalination project, two other plants have been proposed: the South Cantt plant with a capacity of 0.75 MGD and a plant at New Gwadar International Airport with a capacity of 0.5 MGD.

Box 2: Lessons from Failed Desalination Investments in Gwadar

Gwadar’s desalination history offers important lessons for future planning. Past failures were not due to the technology itself, but resulted from weak technical design, poor site selection, unreliable power supply, and inadequate Operation and Maintenance (O&M) systems. Several plants were never commissioned, while others became non-functional due to lack of spare parts, limited technical capacity, and insufficient provision for recurrent costs.

These challenges highlight the need to shift towards a Build-Operate-Transfer (BOT) model under a PPP framework, supported by a Minimum Revenue Guarantee (MRG) from the Government of Balochistan. This approach can reduce financial and operational risks by assigning clear responsibility for design, construction, and operations to the private sector, while ensuring performance accountability and service continuity.

These experiences also demonstrate that priority should first be given to independent technical audits of existing facilities, rehabilitation of technically viable plants, development of standard design and procurement specifications, strengthening local operational capacity, and establishing environmentally sound brine management systems before pursuing large-scale expansion.

Future investments must adopt a full lifecycle approach, including appropriate site selection, secured power supply, robust operation and maintenance systems, and realistic financial planning for long-term sustainability. Given Gwadar's high solar radiation, availability of land and increasing emphasis on renewable energy, solar-powered or solar-hybrid reverse-osmosis systems should be assessed as a medium- and long-term option. Initial investments should focus on modular pilot systems serving defined demand clusters to evaluate energy performance, water production costs, membrane replacement requirements, spare-part availability, operator capacity and brine management arrangements before wider scale-up. Successful pilot systems may subsequently be expanded through appropriate public, private or utility-based delivery arrangements.

For Gwadar, the key lesson is clear: desalination should be developed as a reliable supplementary component of a diversified water supply portfolio, supported by sound governance, appropriate risk-sharing arrangements, technical expertise, renewable energy integration and sustained operation and maintenance throughout the asset lifecycle.

4.2.5 Integrated Water Resource Constraints in Gwadar

Gwadar’s water resource base is constrained by the combined effects of aridity, climate variability, saline groundwater, underperforming desalination systems and limited surface storage reliability. Groundwater is not a dependable strategic source due to salinity and seawater intrusion. Surface water systems remain vulnerable to drought, silting and incomplete transmission infrastructure. Rainwater harvesting potential exists but is largely underutilized. Desalination, while strategically important, has not yet been institutionalized as a reliable and efficient large-scale source.

These conditions point to the need for a diversified water resource strategy for Gwadar, combining improved management of surface storage, climate-resilient local rainwater harvesting, selective groundwater protection, and a technically viable desalination programme supported by stronger energy and regulatory systems. At present, desalination development remains fragmented and largely project-driven, consisting of individual facilities developed under different institutions and financing arrangements. Despite Gwadar’s strategic dependence on seawater desalination as a long-term water security option, the district currently lacks a structured desalination programme with clear capacity targets, technology standards, environmental safeguards, financing mechanisms and long-term operation and maintenance arrangements.

Similarly, there is no integrated energy–water strategy linking desalination, bulk water conveyance systems, pumping infrastructure and renewable energy development. Given the high energy requirements of desalination and water transmission systems, the absence of coordinated planning between the water and energy sectors increases operational risks, contributes to system underperformance and limits opportunities for integrating solar and other renewable energy solutions into future water supply infrastructure.

Addressing these institutional and strategic gaps will be critical to ensuring that future investments in dams, desalination, groundwater management and wastewater reuse are planned as part of a coherent and climate-resilient water security framework rather than as stand-alone infrastructure projects. Long-term water security should therefore be based on a diversified and risk-balanced water resource portfolio rather than dependence on any single source. This portfolio should combine protection and optimisation of existing dams, assessment of Mirani Dam as the principal potential large-scale bulk water source for urban Gwadar, continued use of local dams for rural settlements, protection and carefully managed use of strategic groundwater reserves, watershed rehabilitation, managed aquifer recharge through recharge wells and other suitable interventions, rainwater harvesting, treated wastewater reuse and the phased development of technically, financially and environmentally sustainable desalination.

The sequencing of investments should prioritise conservation, rehabilitation and improved performance of existing water resources before major capacity expansion. This includes catchment protection, watershed management, dam desilting, completion of transmission infrastructure, control of groundwater abstraction, protection of well fields, groundwater recharge enhancement and reduction of physical water losses. New water sources, including desalination and future bulk water transfers, should then be introduced progressively to strengthen drought resilience and meet the growing domestic, commercial, industrial and port-related water demands associated with Gwadar's long-term development.

Box 3: Large-Scale Desalination Planning in Egypt, Lessons for Gwadar

Egypt’s desalination programme represents one of the most ambitious water security initiatives in the region, driven by acute and rapidly intensifying water scarcity. The Nile River provides approximately 97 per cent of Egypt’s renewable water resources, yet per capita availability declined from 800 to 550 m³ per year between 2004 and 2022, with projections approaching the absolute scarcity threshold of 500 m³ by 2025. In response, Egypt has positioned desalination as a central pillar of its long-term water security strategy, leveraging its nearly 3,000 km coastline along the Red Sea and Mediterranean.

By 2022, Egypt had completed 81 desalination plants across six coastal governorates, delivering a combined capacity of 913,690 m³ per day. Major facilities, such as El-Alamein and El-Galala, each produce 150,000 m³ per day, while additional plants under construction are expected to add approximately 465,000 m³ per day. The national 2020–2050 desalination strategy aims to expand total production to 6.4 million m³ per day, supported by an estimated investment of 134 billion Egyptian pounds (Elsaie, Ismail, Soussa, Gado, & Balah , 2022).

Reverse Osmosis (RO) is the dominant technology underpinning this expansion, selected for its cost efficiency and operational advantages. Capital investment for RO plants typically ranges from USD 800 to USD 1,200 per m³ per day of capacity, with relatively low energy consumption of 3–5.5 kWh per m³, significantly lower than thermal desalination alternatives. The average production cost of desalinated water ranges between USD 0.70 and USD 0.90 per m³, making it economically viable, particularly for coastal and remote areas where conventional water supply options are limited or costly. Egypt is also progressively integrating solar energy into desalination operations to further reduce long-term operational costs, especially in remote coastal regions.

Environmental regulation has been a critical component of this expansion. The Egyptian Environmental Affairs Agency mandates comprehensive Environmental Impact Assessments for all desalination projects, including strict controls on brine disposal. Salinity levels at the boundary of a defined mixing zone must not exceed ambient seawater levels by more than 10 per cent, with hydrodynamic modelling required to ensure compliance.

For Gwadar, the key lesson is the importance of adopting a strategic, phased, and standardised approach to desalination development. This includes prioritising cost-effective technologies such as RO, integrating renewable energy solutions, and embedding strict environmental safeguards within project design. Rather than pursuing isolated projects, desalination must be planned as part of a coherent, long-term water security framework to ensure technical, financial, and environmental sustainability.

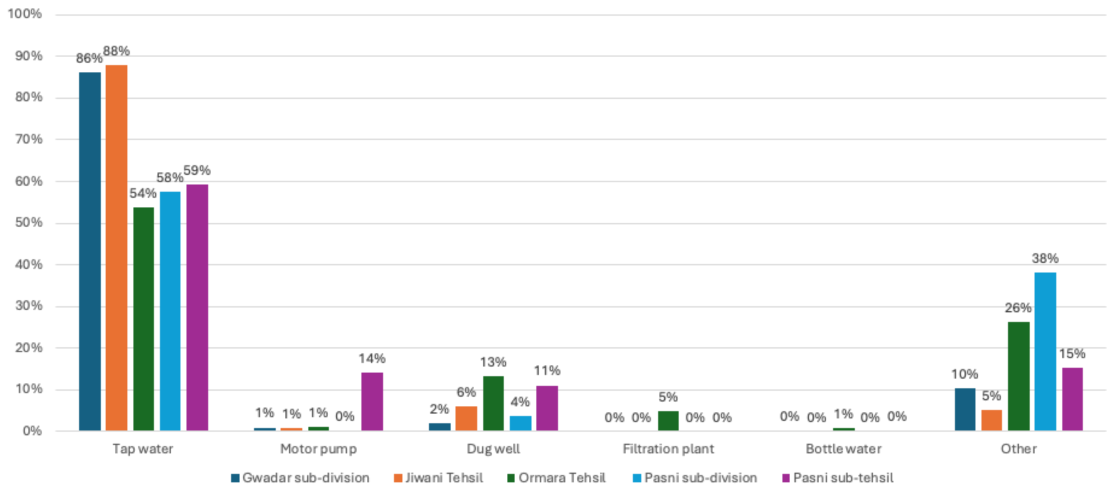
4.3 Water Supply

Gwadar's water supply system reflects a combination of infrastructure expansion, operational inefficiencies and increasing pressure from population growth and climate variability. While multiple supply schemes exist, their performance remains constrained by incomplete infrastructure, unreliable power supply and weak system integration.

According to Balochistan Multiple Indicator Cluster Survey (MICS) 2019–20, approximately 95.5 per cent of households in Gwadar rely on piped water. However, this high level of nominal access masks underlying service deficiencies, as only 49.7 per cent of households reported having sufficient water available, indicating a significant gap between access and service adequacy. In response to insufficient supply, reliance on private tanker services remains a key coping mechanism, often at high cost. Consultations with local stakeholders indicate that private tankers supply water at approximately Rs. 2,000 to Rs. 3,000 per chamber, although rates vary depending on availability. As these providers are largely unregulated, their exact numbers and pricing structures remain unclear.

More recent data from the Population and Housing Census 2023 indicate that 73.92 per cent of households use tap water, while 19 per cent rely on other sources, including water tankers. Only 5 per cent depend on groundwater due to high salinity levels, including 4 per cent using dug wells and 1 per cent using motorised pumps. However, the census does not capture the adequacy of water availability. At the tehsil and sub-division level, tap water access ranges from 88 per cent in Jiwani Tehsil to 54 per cent in Ormara Tehsil, with Gwadar sub-division also relatively high at 86 per cent, while Pasni sub-division and Pasni sub-tehsil report lower coverage at 58 per cent and 59 per cent, respectively. Reliance on alternative sources varies, with higher use of dug wells in Ormara Tehsil at 13 per cent and Pasni sub-tehsil at 11 per cent, and notable motor pump use in Pasni sub-tehsil at 14 per cent. Use of filtration plants and bottled water remains minimal across all areas. A significant proportion of households depend on other sources, particularly in Pasni sub-division at 38 per cent and Ormara Tehsil at 26 per cent, highlighting persistent service gaps.

Figure 4: Source of Water in Tehsils/ Sub-Divisions of Gwadar City - Population Census 2023



4.3.1 Water Supply and Demand

The Gwadar district presents a fragmented water supply landscape, where infrastructure development has yet to translate into reliable and equitable service delivery. Limited coverage, underperforming systems, and continued dependence on climate-sensitive sources constrain sustainable access to water across the district. Although multiple water supply schemes have been installed or are under development, a significant proportion remains partially functional or non-operational, reducing their effectiveness in meeting growing demand.

Across Gwadar’s administrative units, including four tehsils and one sub-tehsil, key schemes such as WSS Gwadar Town, Jiwani, Pasni, Ormara, Rakchai, and Suntser are in place, primarily managed by PHED and GDA. However, system functionality and service reliability remain inconsistent.

Population projections based on the 2023 Census estimate Gwadar’s population at 329,201 by 2026. Applying the PHED service benchmark of 25 gallons per capita per day, total water demand for universal household coverage is estimated at approximately 8.2 MGD, excluding additional demand from commercial, industrial and institutional users. In comparison, the current combined water supply from GDA and PHED is estimated at around 7.1 MGD, resulting in an overall deficit of approximately 1.1 MGD.

It is important to note that these projected demand estimates do not fully capture future water requirements associated with Gwadar Port operations, the New Gwadar International Airport, industrial estates, free-zone development and other CPEC-related investments. As these economic growth nodes expand, reliable water supply will increasingly function as enabling infrastructure for trade, logistics, industrial productivity and urban development. Future water resource planning should therefore account for both population growth and strategic economic demand corridors linked to Gwadar’s long-term development vision.

The estimated demand presented above is based on the assumption of universal service coverage across the entire population. In practice, the existing water supply systems currently serve approximately 22,572 domestic and commercial consumers. Based on the average household size of 6.0 persons (Census 2023), this corresponds to an estimated service population of around 135,432 individuals, representing approximately 41 per cent of the total projected population. This implies that while around 86 per cent of the total estimated water demand is being met in volumetric terms, it is concentrated on a limited proportion of the population, highlighting significant spatial and distributional inequities in service delivery.

This gap is further compounded by the limited spatial coverage of existing systems, which primarily serve urban centres and selected adjoining areas, leaving remote and peri-urban settlements underserved. As a result, communities in areas such as Kulanch, Kalmat and Sardasht continue to rely heavily on water bowser services, often at significantly higher costs and with persistent concerns regarding water quality, reliability and affordability.

At the tehsil level, disparities in supply and demand remain evident. Gwadar Tehsil, which receives supply from both GDA (in urban areas) and PHED (in rural areas), has a total demand for universal coverage of approximately 4.0 MGD and a supply of 3.7 MGD, resulting in a deficit of 0.3 MGD. Pasni has a demand of 2.0 MGD for universal coverage and a supply of 1.5 MGD, leaving a shortfall of 0.5 MGD. Jiwani and Ormara show relatively smaller absolute gaps for universal coverage, but still face supply deficits, with Jiwani receiving 0.8 MGD against a demand of 0.9 MGD and Ormara receiving 0.7 MGD against a demand of 0.8 MGD. Suntser experiences the highest proportional deficit for universal coverage, with a demand of 0.6 MGD and a supply of only 0.4 MGD, resulting in a shortfall of 0.2 MGD.

Table 6: Water Supply, Demand and Gap for Universal Coverage

Tehsil/ Sub-Tehsil	Population (2026)	Demand of Water (MGD) @ 25 GPCD	Water Supply by PHED	Water Supply by GDA	Total Water Supply	Gap (MGD)
Gwadar	159,307	4.0	0.2	3.5	3.7	0.3
Pasni	79,968	2.0	1.5	-	1.5	0.5
Jiwani	37,761	0.9	0.8	-	0.8	0.1
Ormara	30,024	0.8	0.7	-	0.7	0.1
Suntser	22,139	0.6	0.4	-	0.4	0.2
Total	**329,201**	**8.2**	**3.6**	**3.5**	**7.1**	**1.1**

The primary source of water supply to **Gwadar city** is Sawad Dam, which conveys water through a pipeline to the Chawad Dagar Airport Pumping Station (with a storage capacity of 7.5 MGD). A new WSS has been installed, comprising storage tanks (1 MGD at GDA Park, 2 MGD at City Works Station and 0.2 MGD at Koh-e-Bun) along with a 148 km distribution network. However, the system is not fully operational due to various technical and operational constraints.

In **Jiwani**, the water system relies on Ankara Dam through an existing conveyance network. A new WSS is under development (initiated in 2022 and expected to be completed soon), which includes a 99 km conveyance pipeline, additional storage at Paleri and improved connectivity to surrounding areas.

For **Pasni**, the main sources include Shadi Kaur Dam and groundwater wells at Swali Gurm. Although additional dams (Dosi and Shenzani) have been constructed to augment supply, they remain non-functional due to the absence of transmission pipelines.

In **Ormara**, the water demand is being met through six operational wells. A new WSS is in place to connect Basol Dam through a 24-inch conveyance pipeline. However, the dam is still under construction, with minimal work remaining before completion.

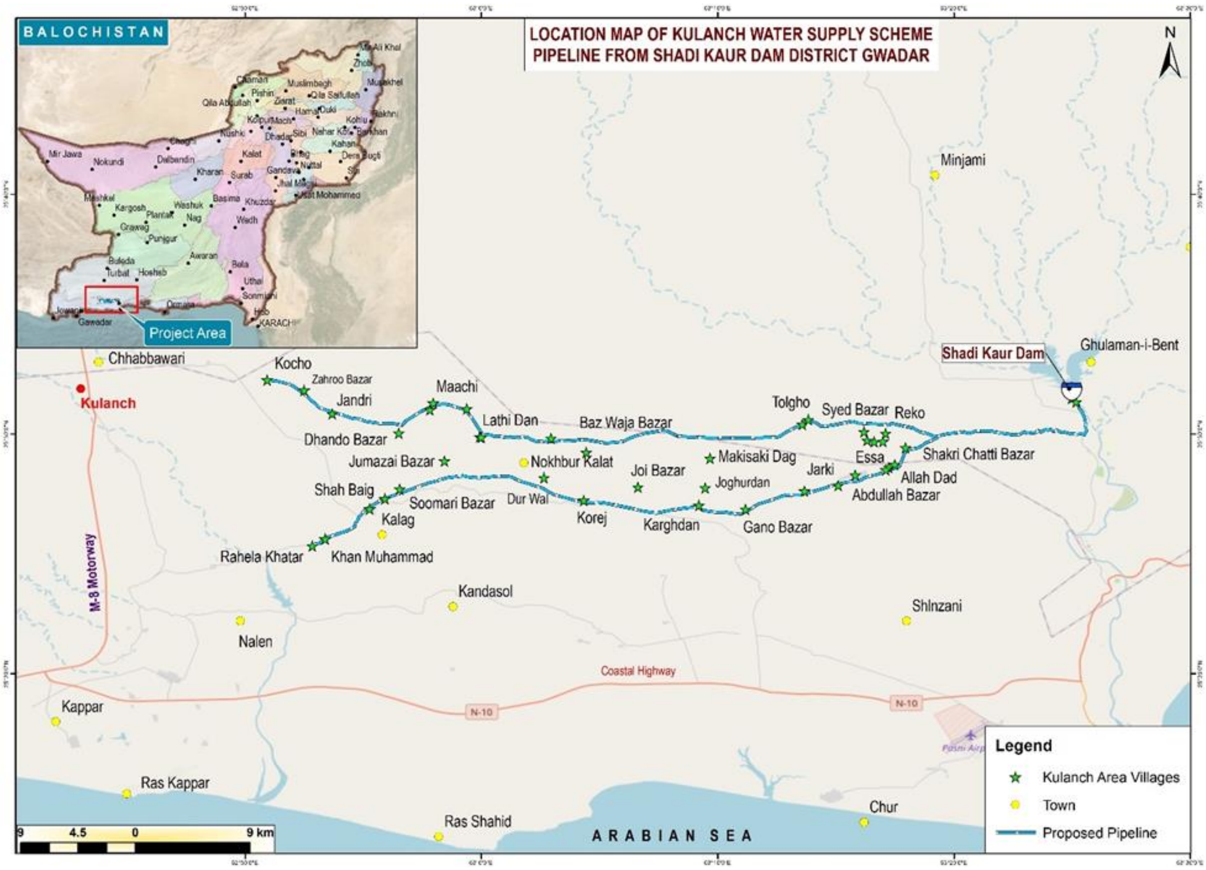
Box 4: Kulanch Valley Water Supply Project

The Kulanch Valley Water Supply Project aims to convey water from Shadi Kaur Dam to Kulanch Valley, located approximately 72 km northeast of Gwadar. With a total estimated cost of Rs. 2,427 million as per Public Sector Development Programme (PSDP) 2025–26, the project represents a critical intervention to improve water access across 52 villages in predominantly rural and underserved areas of Gwadar District.

By June 2025, implementation progress remains limited, with approximately 13 km of pipeline laid and about 21 per cent of the total project cost utilised. While initial groundwork has been established, continued and timely financial allocations are essential to sustain progress and prevent implementation delays.

Upon completion, the project is expected to significantly enhance water availability for both domestic and agricultural use, thereby reducing reliance on informal and high-cost water sources. Given its strategic importance, there is a need to prioritise sustained funding and expedite implementation, with a targeted completion timeline of June 2027.

Figure 5: Location Map of Kulanch Valley Water Supply Project



Overall, Gwadar’s water supply challenge is not solely a matter of aggregate production deficits, but also one of system functionality, spatial equity and long-term demand planning. Addressing current gaps will require operationalizing existing infrastructure, expanding service coverage to underserved settlements, strengthening source diversification and incorporating future demand from port operations, the international airport, industrial estates and other CPEC-linked growth corridors into long-term water resource planning and investment decisions.

4.3.2 Comparative Cost Assessment of Water Supply Sources

A comparative assessment of water supply options in Gwadar District, based on the Feasibility Study on Gwadar Water Supply Issues (2025), highlights significant variation in both capital investment requirements and operational sustainability. Water supply from Shadi Kaur Dam through transmission pipelines entails high upfront capital costs, with operation and maintenance expenses ranging between Rs. 0.7 and 0.9 per gallon due to pumping requirements. Evidence from Key Informant Interviews (KIIs) with GDA further indicates that actual pumping costs are approximately Rs. 0.65 per gallon.

In comparison, the 1.2 MGD desalination plant at Gwadar Port involves relatively lower capital investment than large-scale dam-based conveyance systems but incurs substantially higher operating costs, estimated at around Rs. 1.50 per gallon, primarily due to its energy-intensive processes. Groundwater abstraction from Suntsar wells emerges as the most cost-effective option in the current context, with low capital requirements and operation and maintenance costs of approximately Rs. 0.15 per gallon. However, this option remains constrained by limited availability and variability in groundwater quality.

Water supply through bowsers from Mirani Dam does not require fixed capital infrastructure but represents the least efficient option in economic terms, with operational costs reaching approximately Rs. 4.50 per gallon. This makes it both financially burdensome and unsustainable over the long term.

The analysis demonstrates that no single water source provides a complete or sustainable solution for Gwadar. Lower-cost options are typically constrained by resource limitations or quality concerns, while more reliable sources such as desalination and surface water systems require substantial capital investment and recurring expenditure. This underscores the need for a diversified, integrated and financially viable water supply strategy that balances cost, reliability and long-term sustainability.
While conventional water supply options such as surface water conveyance, desalination and groundwater abstraction remain central to Gwadar's water strategy, their financial, technical and environmental limitations highlight the need to explore complementary, decentralised and climate-resilient solutions.

Box 5: Transforming Access to Safe Drinking Water through Technology and Community-Based Models (India)

Piramal Sarvajal, established in India in 2008, has developed a decentralised model for safe drinking water delivery through community kiosks and automated Water ATMs. Designed for water-stressed and underserved areas, the model operates across 20 states, serving over 765,000 people daily through more than 1,965 water access points. (Piramal Sarvajal, 2026)

The system combines source-specific water purification technologies with solar-powered dispensing units and IoT-based remote monitoring. This enables real-time tracking of water quality, system performance and usage, improving reliability and reducing operational downtime. A key feature is its franchise-based approach, where local entrepreneurs manage water kiosks, creating community ownership and supporting livelihood generation while improving service sustainability.

For Gwadar, this model does not replace large-scale supply systems such as dams or desalination. However, it offers a practical complementary solution for peri-urban and underserved areas where conventional infrastructure is limited or delayed. The key lesson is that climate-resilient water supply requires decentralised, technology-enabled and community-driven service models alongside conventional infrastructure.

Box 6: Majik Water, Atmospheric Water Generation as a Climate-Resilient Niche Option

Majik Water, a social enterprise founded in Kenya in 2017, has developed solar-powered atmospheric water generators that harvest drinking water directly from air. The technology is designed for drought-prone and off-grid settings where conventional water systems fail. Unlike boreholes, dams or piped systems, atmospheric water generation does not depend on rainfall, rivers or aquifers. Instead, it uses a desiccant-based process to capture moisture from the atmosphere, powered entirely by solar energy, with integrated filtration and IoT monitoring. (Majik Water Africa, 2026)

The model has been deployed in schools, clinics, refugee camps and water-stressed communities in Kenya, South Africa and India. Its significance lies not only in the technology itself, but in its broader operational design: it is off-grid, modular, low-emission, and can be linked to local entrepreneurship through pay-as-you-go water sales and community kiosks.

For Gwadar, atmospheric water generation is not a substitute for large-scale supply systems such as dams or desalination. However, it offers a complementary and climate-resilient solution for decentralised service delivery, particularly in contexts where conventional infrastructure is delayed, unreliable or economically unviable. Its relevance is strongest for niche applications, including health facilities, schools, remote coastal settlements and emergency response settings. The key lesson is that climate resilience in water supply requires diversification, including the development of decentralised and climate-independent water sources alongside conventional infrastructure.

4.3.3 Challenges Affecting Water Resources in Gwadar

According to Feasibility study on Gwadar Water Supply Issues, 2025, the water supply system in Gwadar District is affected by a range of interrelated financial, technical, institutional and infrastructural challenges. These issues collectively constrain the effective delivery of water services and hinder the operationalization of existing and planned infrastructure. The key challenges are categorized below:

4.3.3.1 Financing and Funding Constraints

- **Delayed Funding for Operationalization of Shadi Kur Dam Pipeline:** Following the depletion of Sawad Dam, water supply to Gwadar is planned through the Shadi Kaur Dam via a contingency pipeline. However, the operationalization and maintenance of this pipeline require Rs. 288.16 million annually. Despite formal requests submitted by GDA to the Chief Minister’s Secretariat (April 2025), the required funds have not yet been released, delaying the functionality of a critical water supply source.

- **Partial Funding for Nigore–Airport Pipeline (Jiwani WSS):** With the drying of the Ankara Dam, water supply to Jiwani has been disrupted. A 9 km pipeline from Nigore to Airport Pumping Station has been proposed as an alternative. While Rs. 200 million was requested, only Rs 80 million has been released to date.

- **Lack of Funds for O&M of Distribution Network:** Although pumping stations and 148 km of distribution network have been constructed for Gwadar city, approximately Rs. 646 million is required to operationalize these systems, which has yet to be allocated.

- **Delays in Akra–Jiwani Pipeline Project:** Initiated in 2022 and scheduled for completion in 2024, this project remains only 60 per cent complete due to funding delays, limiting water supply improvements for Jiwani.

4.3.3.2 Underutilization of Existing Resources

- **Non-Energization of Pumping Stations:** Four major pumping stations (Old Airport, GDA Park, City Works and Koh-e-Bun) remain partially non-functional due to the absence of essential electrical components, including cables, panels and accessories.

- **Low Household Connectivity:** Out of approximately 24,541 households in Gwadar city, a large proportion remains unconnected to the new distribution network due to low willingness to pay connection (Rs. 1,200) and monthly service fees (Rs. 300), delaying system utilization.

- **Severe Power Shortages and Load Shedding:** Frequent electricity outages significantly disrupt pumping operations. Currently, households receive water for only 2 hours every 10–20 days, severely affecting service reliability and forcing reliance on alternative sources.

- **Non-utilization of Dosi and Shinzani Dams:** Despite their substantial storage capacities (16,000 and 17,800 acre-feet, respectively), these dams remain unused due to the absence of transmission and distribution pipelines. Feasibility for laying of pipelines for both the dams has been prepared.

- **Underutilization of Suntser WSS:** The Suntser WSS, established in 1979, remains underdeveloped despite being one of the few sources of potable groundwater. Its expansion could provide critical support to Gwadar and Jiwani, particularly during drought conditions. The scheme is proposed to be extended to Pallery Station to address water shortages in Jiwani and surrounding areas, with an expected supply of approximately 0.4 MGD. The existing conveyance system includes 30 km of concrete pipeline and 22.5 km of newly laid pipeline; however, inefficiencies in routing highlight the need for a shorter and more direct pipeline to improve transmission efficiency. According to PHED Gwadar, the proposal has been submitted under the Omani Grant Project and is expected to be finalised in the near future.

- **Lack of Integration Between Mirani and Ankara Dams:** Mirani Dam, located on the Dasht River in Kech District, is the largest reservoir in the region, with a storage capacity of approximately 302,000 acre-feet. It is fed by the Kech and Nihing rivers, which converge to form the Dasht River. Despite its substantial capacity and strategic importance, Mirani Dam has not been integrated into the water supply system of Gwadar through linkage with Ankra Dam. This lack of connectivity represents a significant missed opportunity to augment water supply and enhance regional water security, particularly during periods of acute water scarcity.

4.3.3.3 Challenges Related to Dams and Water Supply Infrastructure

- **Design and Implementation Issues in Shehzanik Dam:** The Shehzanik Dam project has been delayed due to inadequate geological surveys, design revisions and alignment changes. The estimated cost has increased from Rs. 2,630 million to Rs. 7,500 million and conveyance infrastructure to Jiwani has not been included in the project scope.

- **Incomplete Development of Basol Dam:** Although the pipeline connecting Basol Dam to Ormara has been laid, the dam remains non-operational due to delayed completion and lack of water storage, primarily caused by insufficient rainfall.

- **Reduced Capacity of Ankara Dam:** Originally designed with a capacity of 17,000 acre-feet, Ankara Dam has been reduced to 8,000 acre-feet due to silting and prolonged drought, significantly limiting its contribution to water supply. To address this, the Irrigation Department has initiated a project to raise the dam, with an estimated cost of Rs. 1.56 billion. Upon completion, the project is expected to enhance water storage capacity, ensuring a more reliable supply of drinking water to Gwadar and surrounding areas, while also supporting irrigation and agricultural productivity. The tendering process is being conducted through the BPRA e-bidding system to ensure transparency[11].

- **Absence of Dedicated Power Supply for Ankara Dam:** Ankara Dam currently lacks a dedicated electricity feeder and shares supply with nearby communities. Due to irregular electricity availability caused by non-payment issues on feeder, pumping operations are frequently disrupted.

The challenges identified above highlight that Gwadar’s immediate priority is not necessarily the construction of additional infrastructure, but the full utilization of existing assets. A "Fix First" approach should therefore guide short-term sector investments by prioritising the energization of

[11] https://quettavoice.com/2025/12/05/tender-invited-for-historic-raising-of-ankara-dam-in-gwadar/

pumping stations, completion of unfinished transmission and distribution pipelines, operationalisation of existing treatment and storage infrastructure, and expansion of household connections to already-developed networks. This approach offers the fastest and most cost-effective pathway for improving service levels before major capital expansion is undertaken.

4.3.4 System Performance, Reliability and Strategic Outlook

Gwadar's water supply system demonstrates a clear disconnect between infrastructure development and actual service delivery. While significant investments have been made in dams, pipelines, pumping stations and distribution networks, these have not translated into reliable, sufficient and equitable water access for households. The contrast between high reported access to piped water and the much lower proportion of households reporting sufficient water availability underscores that the core challenge is not access alone, but the reliability, continuity and adequacy of supply. Intermittent service limited operational hours and dependence on tanker supply indicate that the system is functioning below its intended capacity, particularly in peri-urban and remote areas.

At a structural level, the system remains fragmented and highly dependent on climate-sensitive sources, with limited integration between major water assets such as dams, transmission systems and distribution networks. Operational inefficiencies, including non-energized infrastructure, incomplete schemes and weak cost recovery mechanisms, further constrain performance. The persistence of a significant demand–supply gap across all tehsils reflects both resource limitations and governance challenges, including delayed financing, weak coordination among agencies and inadequate operation and maintenance arrangements.

Looking ahead, improving water supply performance in Gwadar requires a shift from infrastructure creation to system functionality and service delivery outcomes. This entails prioritising the operationalisation of existing assets, strengthening energy reliability for pumping systems, completing unfinished transmission infrastructure, expanding household connections and improving cost recovery mechanisms to sustain operations. Without addressing these systemic constraints, continued investments in infrastructure alone are unlikely to yield improvements in water security or service equity across the district.

Future water supply investments should also be prioritised according to their contribution to strategic economic assets, including Gwadar Port, the New Gwadar International Airport, industrial zones and associated CPEC-related development corridors. Reliable water services are essential not only for households but also for sustaining industrial productivity, logistics operations and long-term urban growth.

Performance monitoring should progressively shift from infrastructure-based indicators toward service-level indicators, including hours of water supply, population coverage, continuity of service, non-revenue water, water quality compliance, customer satisfaction and equity between urban, peri-urban and rural communities. These indicators should form the basis of future performance management and investment decision-making.

4.4 Water Quality

Gwadar's water quality situation reflects a complex interaction of natural constraints, infrastructure limitations and institutional gaps. The district's dependence on saline groundwater, climate-sensitive surface water sources and tanker-based supply systems, combined with the absence of functional treatment infrastructure and weak monitoring mechanisms, has resulted in widespread concerns regarding the safety of drinking water. These challenges are further compounded by rapid urban expansion, increasing demand and limited regulatory enforcement, making water quality not only an environmental issue but a critical public health concern.

4.4.1 Institutional Capacity for Water Quality Monitoring

The degradation and depletion of water quality have become significant global challenges, with direct impacts on public health (Rezaie-Balf, et al., 2020) (Egbuikwem, Obiechefu, Hai, Devanadera, & Saroj, 2020). Poor-quality water affects the health of communities that rely on it, both directly and indirectly, often leading to public health risks and increased costs for water treatment (He & Wu, 2019).

Under the Balochistan Environmental Protection Act 2012, B-EPA is responsible for enforcing drinking water quality standards. However, limited laboratory facilities and technical resources constrain its ability to conduct regular monitoring and enforcement, resulting in continued reliance on service providers and research institutions for water quality testing.

Currently, water quality testing in Gwadar is extremely limited and Pakistan Council of Research in Water Resources (PCRWR) does not have a regional office in the city. In 2016, a water testing laboratory was reportedly established by Pakistan Council of Scientific & Industrial Research (PCSIR) at PNS Akram Gwadar to ensure quality of drinking water. All technical expertise, equipment and necessary chemicals and bio-chemicals for testing key microbiological and chemical parameters were provided by PCSIR Labs Complex, Lahore and PCSIR Labs, Karachi. Hands-on training for four personnel in water testing was also conducted[12]. This technical support by PCSIR was expected to play a vital role in ensuring safe drinking water for the armed forces stationed in Gwadar. However, there have been no updates regarding the laboratory's operations and Gwadar was not mentioned in the PCSIR annual report for 2022–23, leaving its current status unclear.

The absence of a functional district-level water quality laboratory remains one of the most critical institutional gaps affecting water safety management in Gwadar. Water samples currently require testing outside the district, limiting the frequency of surveillance, delaying corrective actions and reducing the effectiveness of routine regulatory oversight. Establishing a dedicated district water quality laboratory in Gwadar, equipped for microbiological, chemical and residual chlorine testing, should therefore be treated as a priority investment to support regular monitoring, regulatory compliance, outbreak prevention and evidence-based water quality management.

Box 7: Senate Fact-Finding on Gwadar Water Crisis – Key Lessons

In 2017–2018, a Senate Standing Committee conducted a fact-finding inquiry into the failure of water infrastructure in Gwadar, particularly the performance of Akra Dam and the non-operational 2 MGD desalination plant at Karwat. The inquiry was initiated in response to acute water shortages affecting Gwadar and concerns regarding the use of public funds.

The investigation found that Akra Dam, commissioned in the 1994-1995 with a storage capacity of 17,025 acre-feet and a yield of 1.62 MGD, had dried (in May 2017) due to prolonged drought and severe siltation. Silt levels had reached near dead storage level, significantly reducing functional capacity. No timely desilting or rehabilitation measures had been implemented despite visible sediment accumulation.

The Committee also examined the 2 MGD Karwat desalination plant, completed in 2013 at a cost of Rs. 984.59 million. The plant had operated for only 43 days since commissioning. The failure was attributed primarily to design flaws, including inadequate intake pipeline length (insufficient offshore extension), improper intake diameter, failure to manage silt density and flawed brine disposal placement. Rehabilitation was estimated at Rs. 800 million, with annual O&M costs projected at Rs.

[12] https://www.pcsir.gov.pk/?Page=News&pg=24

500 million. Concerns were raised regarding weak technical oversight, poor procurement processes and lack of international technical expertise.

During the crisis period (2017), Gwadar relied almost entirely on tanker-supplied water transported from Mirani Dam, delivering approximately 1.3–1.8 MGD at a cost of roughly Rs. 220 million per month. The water quality was acknowledged to be substandard, with contamination concerns and the supply method was deemed financially unsustainable. Delays in tanker payments also caused periodic supply disruptions.

At the time of review, Gwadar's water requirement was estimated at 6 MGD, projected to rise to 12 MGD by 2020, 30 MGD by 2035 and potentially above 100 MGD in the longer term, driven by CPEC-related expansion and urban growth.

The Committee concluded that Gwadar's water crisis was the result of:

- Over-reliance on rainfall-dependent dams in an arid zone
- Failure to maintain and desilt storage infrastructure
- Poor technical design and oversight of desalination facilities
- Lack of long-term, diversified water planning
- Weak institutional coordination and accountability

Key directions emphasized the need for:

- Immediate short-term water treatment for tanker supply
- Desilting and rehabilitation of Akra Dam
- Transparent international procurement for desalination rehabilitation
- Diversification of supply sources (including larger river-based storage such as Dasht River)
- Regular monitoring and reporting on water supply conditions
- Integrated, long-term planning aligned with projected urban expansion

Relevance for Climate-Resilient WASH Planning:

This episode illustrates the risks of infrastructure-led expansion without parallel investment in maintenance, technical due diligence, energy reliability and institutional accountability. It underscores the importance of climate-informed design, diversified water portfolios, lifecycle cost planning and governance reforms in building resilient urban WASH systems in arid coastal contexts such as Gwadar (https://senate.gov.pk/uploads/documents/1521094191_205.pdf).

4.4.2 Drinking Water Quality Status in Gwadar

(PCRWR, 2022) also covered a water quality assessment. Due to the unavailability of the testing facilities in the district, all water samples were analysed in the field for microbial parameters and in PCRWR Karachi laboratory for chemical testing. All results were compared with the permissible limits of the National Drinking Water Quality Standards of Pakistan (NDWQS) to evaluate the degree of fitness of water sources for drinking purposes.

Results from eight samples obtained from dam, storage tanks, pumping stations, water supply distribution network and consumer's end showed that 6 (75 per cent) water sources were contaminated and unsafe for the drinking purpose due turbidity beyond the safe limits. While all the sources (100 per cent) were microbiologically contaminated and unsafe for human consumption.

Table 7: Major Contaminants Exceeding the NDWQS-PCRWR 2022

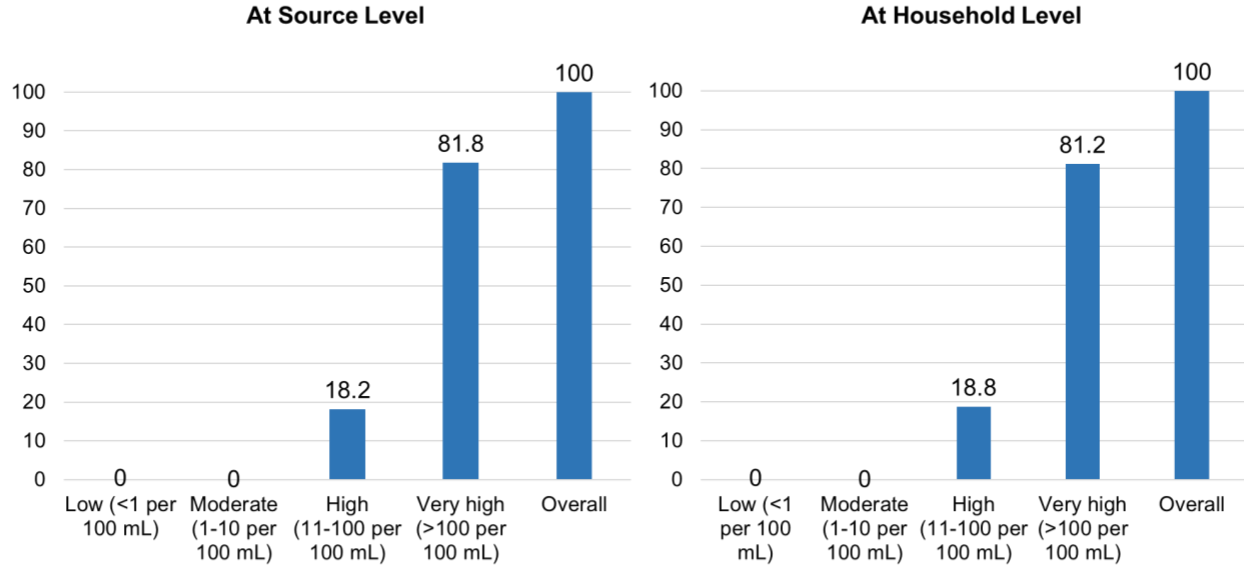
Water Quality Parameter	Unit	Total No. of Samples Analysed	Number of Contaminated Samples	% of Contaminated Samples
Turbidity	mg/l	08	06	75%
Total Coliforms	CFU/100 ml	08	08	100%
E. coli	CFU/100 ml	08	08	100%

Infrastructure-related failures further exacerbate water quality risks. The water treatment system at Akra Dam, including sedimentation and filtration units, which was the main source of water for Jiwani (previously the source of water supply for Gwadar city) is currently non-operational due to maintenance issues. As a result, approximately 0.3 MGD of water is directly pumped to Jiwani for human consumption without any treatment. In addition, old and damaged pipeline sections contribute to substandard water quality. Proper treatment of the water supply is essential to prevent potential outbreaks of water-borne diseases in the future (PCRWR, 2022).

Key informants reported significant concerns regarding water and sanitation at the hospitals. Hospitals majorly receive water supply from contaminated supply lines. The sanitation facilities are inadequate, with toilets improperly designed. Waste disposal is inconsistent, with incinerators available in some areas but absent in others, highlighting serious gaps in hygiene and infection control.

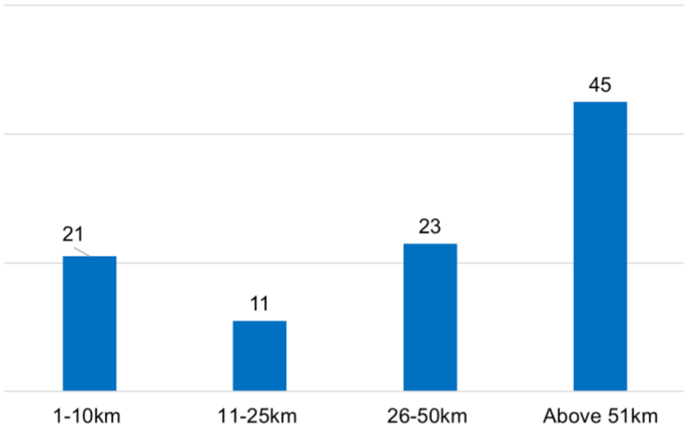
Also, Balochistan MICS 2019-20 indicate that *E. coli* contamination remains a critical concern in Gwadar at both the source and household levels. Water samples classified under low and moderate contamination categories at source level indicate the absence of *E. coli*. However, at the source level, 18.2 per cent of drinking water sources are identified as highly contaminated, while a dominant share 81.2 per cent falls in the very high contamination category. Overall, 100 per cent of source water is contaminated with *E. coli.* The same situation is at the household level, where none of the tested water samples meet the low or moderate contamination thresholds. About 18.8 per cent is highly contaminated and 81.2 per cent highly contaminated. Overall, water at the consumer level is also reported to be 100 per cent contaminated with *E. coli.*

Figure 6: Per centage of E. Coli in Drinking Water in Gwadar (%) - MICS 2019-20



Balochistan Mouza Census Report 2020 indicates that only 9 per cent of mouzas report sweet underground water, whereas 91 per cent report brackish water, making local groundwater largely unsuitable for drinking. Consequently, communities must depend on distant sources of potable water. Among the mouzas which have brackish underground water, 45 per cent of mouzas located 51 km or more from a sweet water facility. An additional 23 per cent are situated 26–50 km away, while only 21 per cent fall within 1–10 km and 11 per cent within 11–25 km. This can create substantial financial, logistical and time burdens, while also increasing vulnerability to supply disruptions and emergencies.

Figure 7: Average Distance to Access Sweet Water (%) (Balochistan Mouza Census 2020)



The most concerning point related water management in Gwadar is that there is no functional public filtration plant. The old central water tank (Aaf Tanki) of the town had one water filtration plant which lies idle at the moment, with taps either broken or stolen (Humza & Rahman, 2023).

Overall, Gwadar's water quality crisis extends beyond a technical challenge and represents a systemic public health risk. Widespread microbiological contamination, non-functional treatment infrastructure, deteriorating distribution systems and limited household-level treatment practices collectively increase vulnerability to water-borne diseases. The situation is further exacerbated by weak monitoring, regulatory enforcement gaps and reliance on unsafe alternative sources. Without urgent and coordinated interventions across treatment, infrastructure rehabilitation, institutional strengthening and community awareness, the risks associated with unsafe drinking water are likely to persist and intensify, particularly in the context of climate variability and urban expansion.

Box 8: Draft Gwadar Water Policy 2020

A draft Gwadar Water Policy 2020, developed by GDA but not officially approved yet, highlights that groundwater quality is under serious threat due to over-extraction, declining water tables and seawater intrusion, while surface water sources are largely non-perennial and highly vulnerable to contamination (Gwadar Development Authority, Government of Balochistan, 2020). As a result, the policy emphasises preventive water quality protection rather than reliance on corrective treatment measures alone.

According to the policy, all natural water sources, including groundwater, stored surface water and desalinated seawater, are to be protected from pollution through strict regulation of abstraction, land use controls in watersheds and the prohibition of contaminating activities in sensitive recharge areas. The policy further stipulates that groundwater extraction must be regulated through permits, continuous monitoring and groundwater budgeting, recognising that contamination of aquifers is often irreversible.

With respect to desalination, the policy underscores the need for careful management of seawater intake and brine disposal processes to prevent marine pollution and ecological damage. It mandates that water supplied for domestic use must consistently meet prescribed quality standards, without compromise, while industries are required to treat wastewater in accordance with National Environmental Quality Standards (NEQS) prior to disposal. The policy also promotes the recycling and reuse of treated effluents as a strategy to reduce pollution loads and alleviate pressure on limited freshwater resources.

The policy further emphasises wastewater treatment and reuse from both domestic and industrial sources as a key measure for protecting water quality and improving resource sustainability. In addition, it highlights that urban water supply systems must address transmission-related risks, including system losses, illegal connections and poor maintenance practices that can lead to secondary contamination.

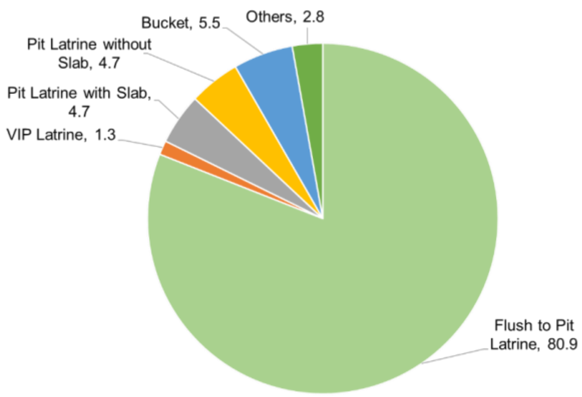
4.5 Sanitation and Wastewater in Gwadar

Sanitation conditions in Gwadar present a structurally imbalanced scenario. While a significant proportion of households have access to sanitation facilities, critical gaps persist across the sanitation service chain, particularly in wastewater collection, treatment, sludge management and final disposal. These deficiencies create substantial environmental and public health risks, exacerbated by Gwadar’s coastal location, shallow groundwater conditions and rapid urban expansion.

4.5.1 Household Sanitation Access

Sanitation estimates for Gwadar vary across datasets but consistently indicate a disparity between access and safe service delivery. According to MICS Balochistan 2019–20, approximately 80.9 per cent of households use flush toilets connected primarily to pit latrines. An additional 1.3 per cent rely on ventilated improved pit latrines, while 4.7 per cent use pit latrines with slabs and another 4.7 per cent use pit latrines without slabs. Bucket latrines are used by 5.5 per cent of households, with the remaining 2.8 per cent comprising other arrangements, including flush systems connected to sewer networks, septic tanks, open drains and other informal options.

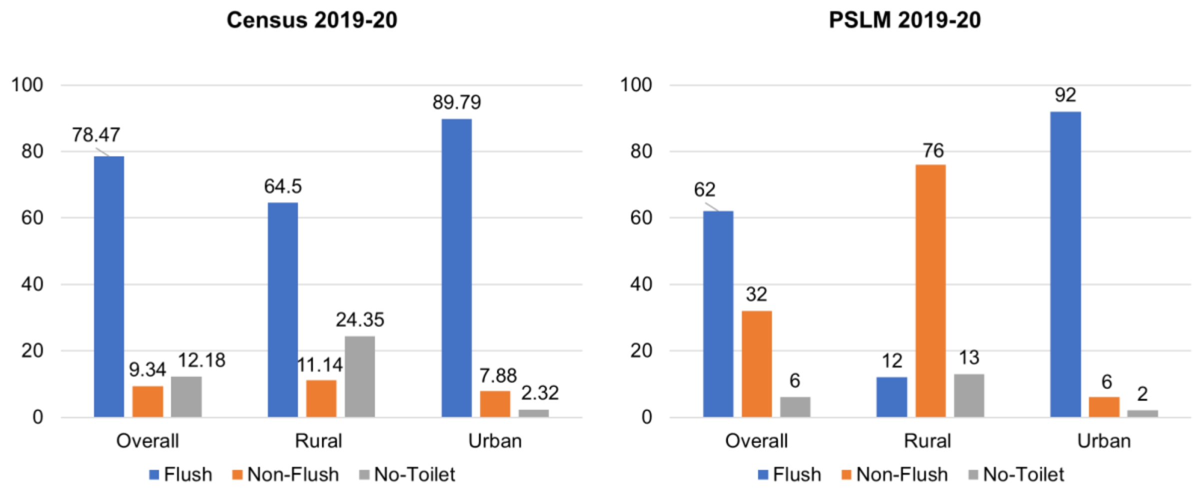
Figure 8: Source of Sanitation Facilities in Gwadar - MICS 2019-20



The Pakistan Social and Living Measurement Survey (PSLM) 2019–20 reports relatively lower sanitation coverage, showing that only 62 per cent of households had access to flush toilets, with urban coverage at 92 per cent compared to 12 per cent in rural areas. The survey further indicates that 32 per cent of households relied on non-flush sanitation facilities, while 6 per cent had no toilet facility.

More recent data from the Population Census 2023 indicates that overall, 78.47 per cent of households reported using flush toilets, with higher coverage in urban areas (89.79 per cent) compared to rural areas (64.5 per cent). Meanwhile, 9.34 per cent of households relied on non-flush facilities and 12.18 per cent had no toilet.

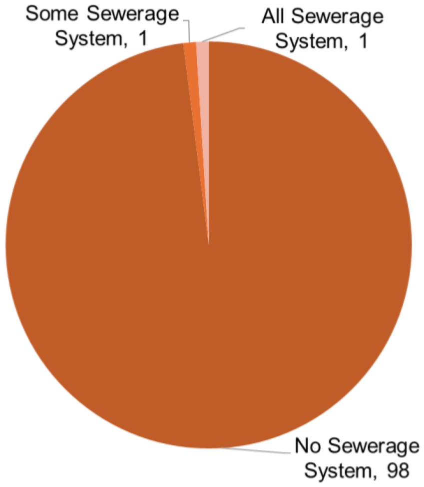
Figure 9: Source of Sanitation Facilities in Gwadar - PSLM 2019-20 & Census 2023



When viewed together, these datasets suggest a gradual improvement in overall sanitation access over time. However, differences in methodologies and indicators used between sources highlight the need for cautious interpretation. Importantly, even where flush toilets are widely reported, evidence from MICS indicates that most are connected to on-site containment systems rather than a centralized sewer network. In the absence of adequate systems for regular desludging, safe disposal and wastewater treatment, reliance on on-site sanitation can lead to leakage, groundwater contamination, overflow during high water table conditions and unsafe sludge disposal practices. This highlights persistent challenges related to the quality, safety and overall management of sanitation services in Gwadar.

These service gaps are further reflected in broader district-level conditions. According to the Balochistan Mouza Census 2020, drainage infrastructure is largely underdeveloped, with 98 per cent of mouzas reporting that drains are not paved or concrete and only 2 percent have any form of lined drainage. Similarly, 98 percent of mouzas have no sewerage system, indicating almost an absence of formal wastewater management across the district. Only 1 percent report partial sewerage coverage and another 1 percent report complete systems. This widespread lack of drainage and sewerage infrastructure increases exposure to stagnant wastewater, environmental contamination and public health risks, while also increasing the likelihood of groundwater pollution.

Figure 10: Sewerage Systems in Mouzas (%) (Balochistan Mouza Census 2020)



4.5.2 Planned Sewerage and Wastewater Management Framework

The Gwadar Smart Port City Master Plan 2017–2050 (revised in 2019) envisions a decentralized and phased sewerage system aligned with the city's functional zoning and projected growth. Under this framework, each zone or development area is to be provided with its own wastewater collection, treatment and disposal arrangements. Sewage treatment plants (STPs) of appropriate capacity are to be developed at strategic locations to meet stage-wise urban expansion, reduce the need for long trunk sewers and improve operational efficiency. A key feature of the planned system is the reuse of treated wastewater for landscaping, greening and urban environmental management. The plan also emphasizes that provision of sanitation infrastructure should guide planned urban development, support environmental protection and enable the government to capture the benefits of infrastructure-led growth.

4.5.3 Current Status of Sewerage Infrastructure and Treatment

Information collected from GDA's Environment Department (2025) indicates that the city's sewerage network currently covers approximately 22,657 running meters (RM). This includes 9,213 RM in Zone-1B covering nine wards[13], 6,422 RM in Zones-2 and 3 covering six wards and 7,200 RM in Zone-4 serving Dhore Ghatti and ECHS Colony. These sewerage lines represent the primary existing network infrastructure within Gwadar's urban service area.

[13] A ward represents a small administrative unit, typically comprising a limited number of households and a relatively small population. A Union Council comprises of many wards.

Figure 11: Sewerage Line of Old Town, Gwadar City

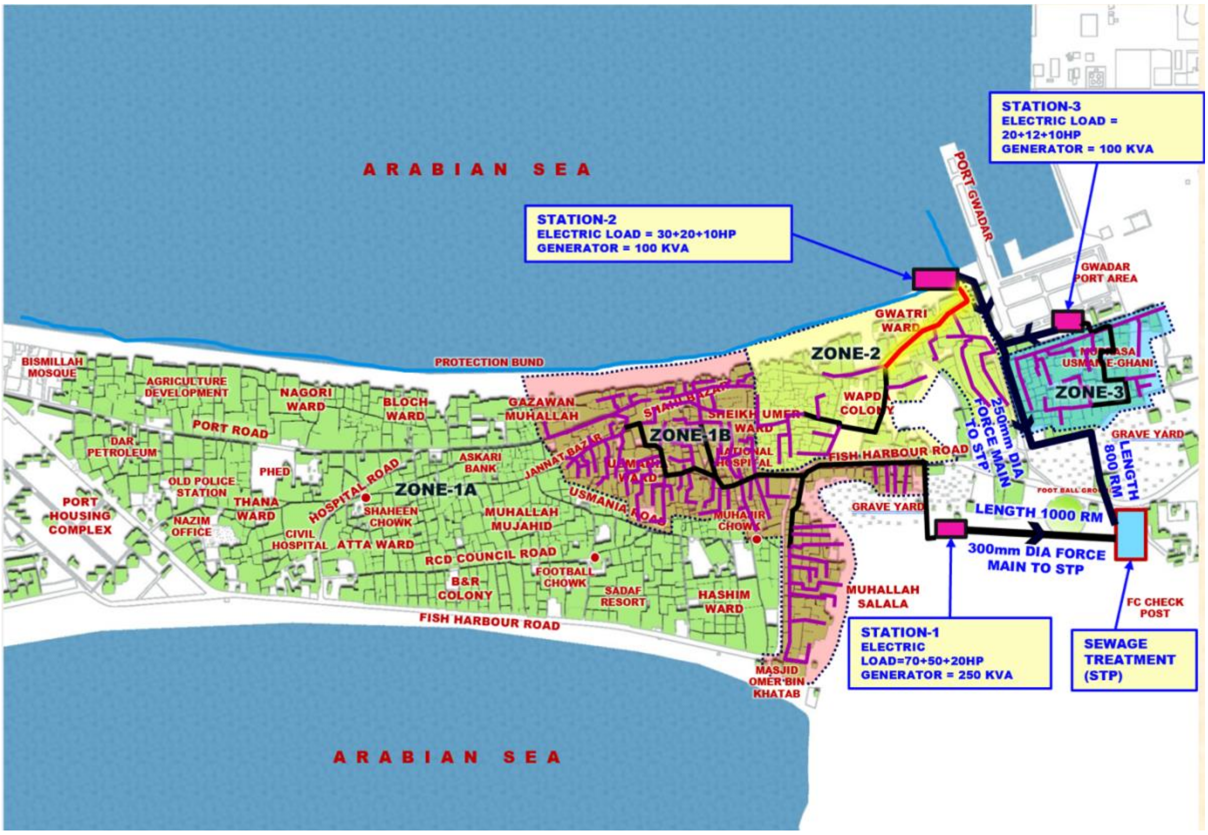
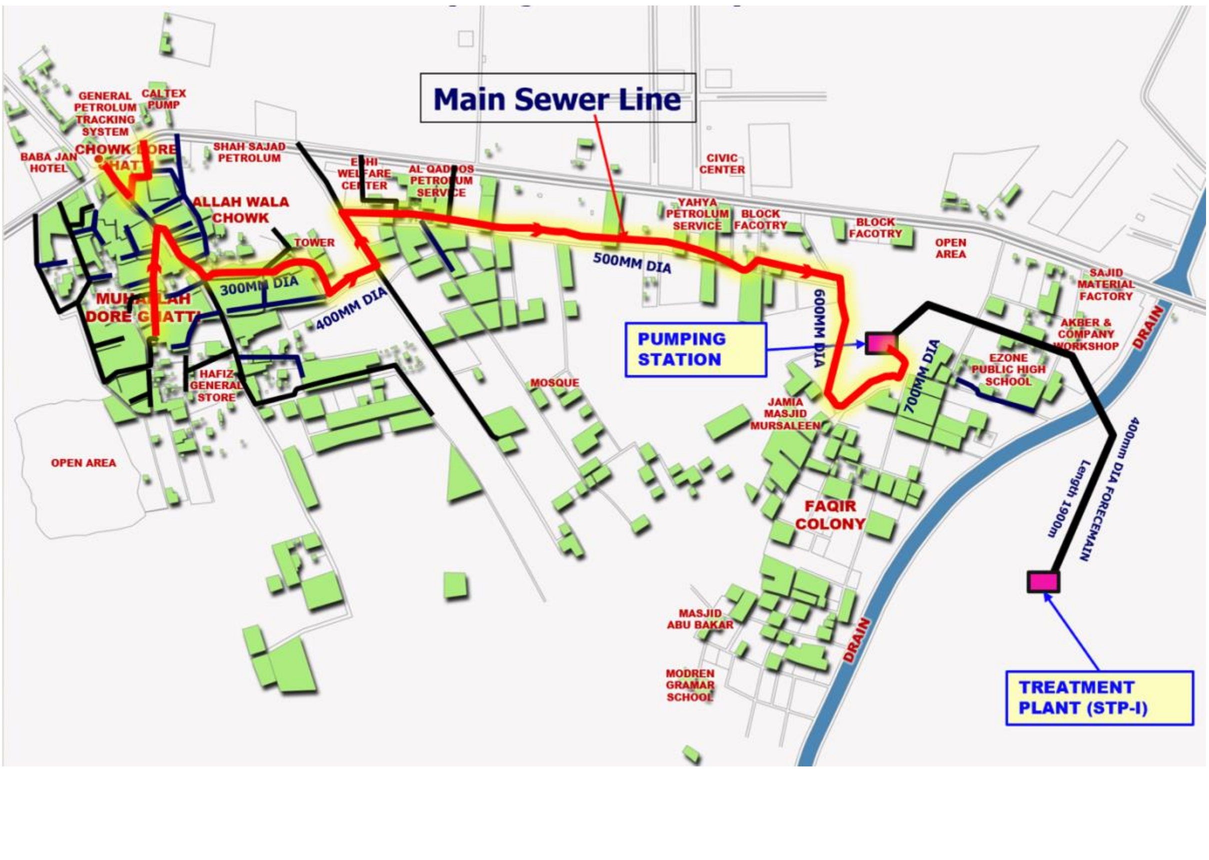


Figure 12: Sewerage Line of Dore Ghatti



Based on the (PCRWR, 2022), wastewater treatment and recycling present significant potential for addressing water shortages in the city. Currently, the city operates two STPs. The first plant (STP-I), located at GDA Park, has a treatment capacity of approximately 0.04 MGD (around 35,000–40,000 gallons per day) and was established during 2014–15. The second and larger facility (STP-II) is located at Kohban near the Senator Ishaque Cricket Stadium and has a design capacity of 0.4 MGD (400,000 gallons per day). Treated wastewater from these plants is reused for landscaping and irrigation of public green spaces in the city.

Operational information from the GDA's Environment Department (2025) indicates that STP-I currently produces only about 16,000 gallons of treated water per day, significantly below its design capacity. The plant serves catchment areas including Dhore Ghatti, ECHS Colony, the GDA Grand Masjid and the GDA School sewerage lines. The treated water is mainly used for plantation within GDA Central Park. The facility operates using Quetta Electric Supply Company (QESCO) power supply and is staffed by one operator and one helper. However, operational challenges persist, as five of the seven installed pumps are currently non-functional and the plant requires maintenance and machinery overhauling. An extension project is currently under construction at the same site to expand the plant's capacity to 0.4 MGD.

The second facility, STP-II, was established during 2016–17 and currently treats approximately 100,000 gallons of wastewater per day, which is also below its design capacity of 0.4 MGD. The plant receives wastewater primarily from the older parts of Gwadar city, covering roughly 35 per cent of the old town population from the port area to Jannat Market. Treated water from STP-II is reused for plantation and landscaping at several public locations, including the cricket ground, Ghous Bux football stadium, Padizer Park, Beach Model Park and roadside green belts. The plant operates with both QESCO grid electricity and an alternate generator supply. However, several operational issues affect its efficiency, including the malfunctioning of four out of nine pumps and the need for repairs to the 200 KVA backup generator.

Figure 13: Locations of STPs in Gwadar

The sewerage system also includes four wet wells that function as sewerage collection points, of which three discharge wastewater to STP-II and one to STP-I. Each wet well is equipped with both grid electricity and alternate generator power and staffed by one operator and one helper. However, several mechanical issues persist within these facilities, including malfunctioning pumps, transformer maintenance requirements and generators requiring repair or servicing.

According to (PCRWR, 2022), the connection of sewerage lines to the STPs was expected to be completed by the end of 2022. However, as reported by a GDA representative in 2026, only 25–30 per cent of the total area is currently connected. Consequently, not even 70,000 gallons per day of sewage actually reaches the STPs.

Operational assessments from the GDA’s Environment Department (2025) further highlight several technical and infrastructure challenges affecting sewerage service delivery. These include frequent power fluctuations and low voltage at STPs and wet wells, which cause pump failures and damage to electrical panels. Additionally, dumping of solid waste and trash into manholes by residents has resulted in frequent sewer line blockages and pump faults. The absence of emergency bypass lines or additional holding tanks also creates risks of overflow during peak flows or system failures. Procurement of replacement pumps has also been challenging due to limited availability of compatible equipment in local and national markets.

Considering current water consumption and projected future demand, it is recommended that the sewerage collection system be developed according to the Gwadar Smart Port City Master Plan 2017–2050 (revised in 2019), while existing sewerage lines are optimized. Additional STPs may be needed to ensure adequate operation and maintenance as urbanization progresses.

Municipal infrastructure assessments further indicate operational constraints related to limited logistical resources and workforce support. The Municipal Wing of the Environment Section currently has approximately 29 staff working across sewerage operations, wet wells, road maintenance and machinery operations. However, field operations are constrained by limited transportation resources (e.g., only one motorcycle allocated for multiple supervisors), inadequate worker safety equipment and insufficient maintenance vehicles. Existing machinery includes one truck-mounted road sweeping machine, one combined suction and jetting truck (with the jetting unit currently non-functional), two tractors and one water bowser.

4.5.4 Sludge Management and Environmental Concerns

(PCRWR, 2022) indicates that STP sludge is disposed of on nearby land, which risks degrading the recreational and environmental value of the port. It is therefore recommended that sludge management, including utilization or digestion, be incorporated into STP operational plans. A dedicated and properly designated site for sludge disposal should also be identified and managed according to standard operating procedures.

The Environment Section of GDA highlighted operational issues within the sewerage network that also pose environmental risks. These include missing or damaged manhole covers, leveling faults in sewer lines, partially blocked or raised manholes, pipe diameter limitations in certain sections of the network and theft of manhole covers. While some corrective actions have already been undertaken, such as such as covering 92 manholes, recovering 82 missing manholes and installing approximately 100 reinforced polymer concrete (RPC) manhole covers, further rehabilitation is required. Estimates indicate that approximately 300 additional manholes require proper covers, around 100 manholes need to be raised to address backflow issues and roughly 200 meters of sewer pipeline require rehabilitation due to pipe size constraints.

In some locations, particularly in Padizer West Bay, sewerage connections have reportedly become disconnected from drainage lines. These issues are exacerbated by infrastructure layout conflicts where drainage channels pass through roadways or run in close proximity to water pipelines, gas lines, fibre optic cables and sewerage pipes. Such overlapping infrastructure corridors create operational and maintenance challenges and increase the risk of service disruptions.

With the development of Gwadar Industrial Zones, adopting wastewater recycling and zero liquid discharge policies for industrial, domestic and municipal wastewater will be critical to alleviate pressure on freshwater resources and safeguard the coastal ecosystem. Installing a citywide sewerage network may reduce available land for soakage pit recharge, highlighting the need to carefully balance sanitation infrastructure expansion with groundwater management. STP rehabilitation, wastewater reuse and sludge management should also be packaged as bankable projects, including PPP options, with treated wastewater reuse prioritised for landscaping, construction, industrial estates and CPEC-related economic zones where feasible.

4.5.5 Planned Solid Waste Management System

The Gwadar Smart Port City Master Plan 2017-2050 (revised in 2019) assigns responsibility for solid waste management to Gwadar Municipality and calls for substantial improvements across the entire service chain, including primary collection, transportation, processing and final disposal. It emphasizes the need for organized household-level collection, development of community storage facilities, establishment of garbage transfer stations and transportation of waste to properly designed sanitary landfills.

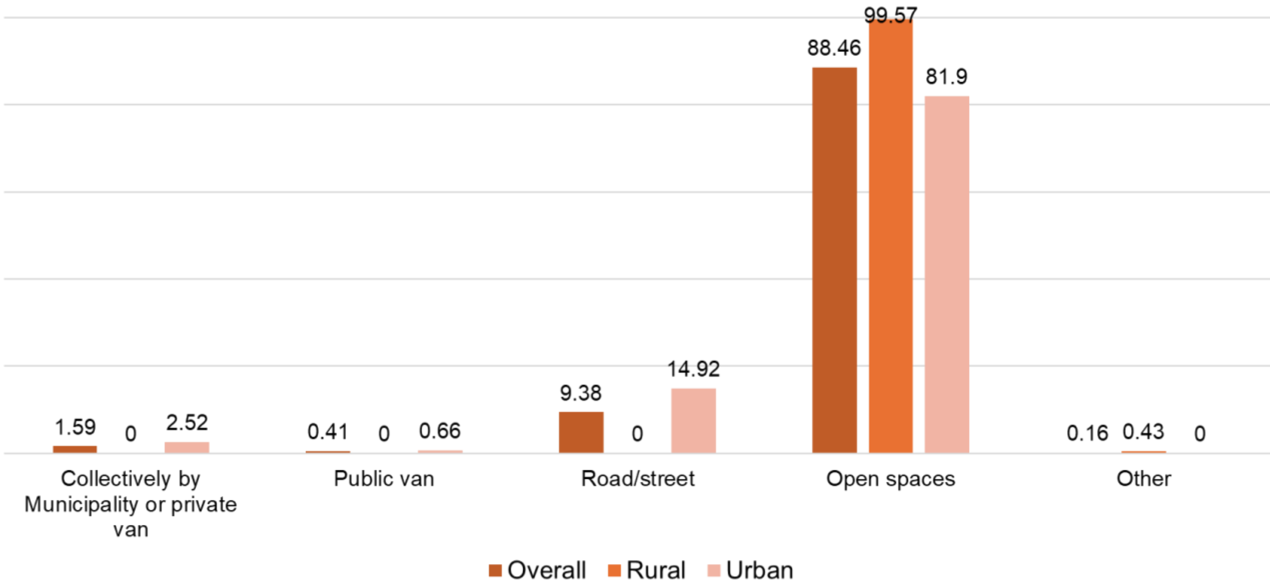
It also proposes future development of engineered disposal facilities, including sanitary landfills and waste incineration plants, based on spatial characteristics, prevailing wind directions and projected waste volumes. In addition, resource recovery options such as composting, biogas generation and methane recovery from landfills are identified as technically feasible, given the organic nature of waste and favourable climatic conditions.

4.5.6 Current Solid Waste Management Practices

In contrast to the planned system, current solid waste management practices remain largely informal and environmentally unsound. According to the PSLM 2019-2020, solid waste disposal data shown for Gwadar demonstrates extremely limited waste collection coverage and heavy reliance on open dumping practices. Only 1.59 per cent of households in Gwadar report waste collection by municipality or private van, while 0.41 per cent dispose of waste in public bins. A further 9.38 per cent dispose of waste on roads or streets. Critically, the overwhelming majority 88.46 per cent of households dispose of waste in open spaces, with 0.16 per cent using other methods.

The urban-rural breakdown further highlights structural weaknesses. In urban Gwadar, 2.52 per cent of households receive municipal or private collection services, 0.66 per cent use public bins, 14.92 per cent dispose on roads/streets and 81.90 per cent dispose in open spaces. In rural areas, formal collection and bin usage are virtually non-existent and 99.57 per cent of households dispose of waste in open spaces, with only 0.43 per cent using other methods.

Figure 14: Solid waste Management in Gwadar (%) – PSLM 2019-20



KIIs with the GDA representatives also revealed that the city currently lacks a properly designated and engineered dumping site. As a result, waste is disposed of at unapproved and unplanned locations, contributing to environmental degradation, public health risks and deterioration of the urban landscape. Recognizing these challenges, the Government of Pakistan has allocated Rs. 200 million under the CPEC to initiate the Gwadar Smart Environment Sanitation System and Landfill Project. Approved under the PSDP and endorsed by the Central Development Working Party, the project includes finalized technical plans (PC-1) and a comprehensive feasibility study, for a comprehensive solid waste management system have been prepared, with a total estimated project cost of approximately Rs. 3,277 million.

The proposed project aims to introduce modern waste management systems in the city, including improved waste collection, storage and transportation infrastructure, environmentally controlled landfill sites, low-carbon waste treatment technologies and smart monitoring systems. In view of Gwadar's rapidly growing population and its strategic role within the CPEC the initiative is intended to improve environmental standards, reduce pollution and support sustainable urban development. In addition, Gwadar's favourable climatic conditions provide opportunities for adopting advanced waste treatment technologies in the future, including composting, biogas production and methane gas recovery from organic waste. These interventions are expected to help establish a more sustainable and climate-resilient waste management system while improving environmental quality and public health outcomes in the city (GDA 2025)[14].

Given Gwadar's strategic role as a port city under CPEC, the landfill and resource recovery project should be fast-tracked to support port city cleanliness standards, environmental compliance for industrial and special economic zones and long-term urban sustainability.

4.5.7 Planning–Implementation Gap for Sanitation

Taken together, the evidence highlights a significant gap between the long-term infrastructure vision outlined in the Gwadar Smart Port City Master Plan 2017-2050 (revised in 2019) and the current level of service delivery. While the planning framework emphasizes decentralized treatment, wastewater

[14] https://gda.gov.pk/news/goadr-smar-anoayrmnl-synyyshn-mnsob-ky-mnthory-200-mlyn-rob-mkhts-shr-my-maholyaty-trky-ky-nyy-ray-kly-gy-syf-all-kytran

reuse, scientific waste management and resource recovery, existing systems remain characterized by limited network coverage, underutilized treatment capacity, reliance on on-site disposal and widespread open dumping of solid waste.

While key components of the sewerage and treatment infrastructure exist, the system faces significant operational challenges related to equipment failure, power instability, limited maintenance capacity, inadequate network coverage and operational resource constraints.

Given the mixed sanitation context in Gwadar, the city should formally adopt a Citywide Inclusive Sanitation (CWIS) approach as the guiding framework for future sanitation planning. This would enable different sanitation service models to be planned as complementary components of a single, integrated service chain, ensuring that technologies are matched to settlement characteristics and service needs rather than applying a uniform solution across the district. Such an approach is particularly relevant for Gwadar, where full sewerage coverage may take time, while immediate risks from unsafe containment, sludge disposal, shallow groundwater and coastal pollution require practical and phased solutions. As the city continues to expand under major development initiatives, CWIS provides a framework for ensuring that sanitation services keep pace with urban growth while minimizing environmental and public health risks.

Accordingly, future sanitation planning should adopt a differentiated service model. Dense urban areas should be prioritised for sewer networks with centralised or semi-centralised wastewater treatment where these are technically and economically viable, while peri-urban, rural and dispersed settlements should be served through decentralised treatment systems, improved on-site sanitation and regulated faecal sludge management. Technology selection should be based on settlement density, groundwater conditions, land availability, operation and maintenance capacity, lifecycle costs and opportunities for the safe reuse of treated wastewater. Detailed feasibility studies should also review successful and operationally proven sanitation models from Pakistan and assess their applicability to Gwadar's climatic, geological and settlement conditions before large-scale implementation.

Box 9: CWIS for Sanitation Planning in Gwadar

CWIS is an approach that ensures safe and equitable sanitation services for all residents, where human waste is managed safely across the entire service chain, from containment and collection to treatment, reuse and disposal. It promotes resource recovery and reuse and recognizes that no single system fits all. CWIS encourages a mix of sanitation solutions, combining on-site and sewered systems within both centralized and decentralized frameworks. This flexible and incremental approach is designed to suit the realities of rapidly growing cities, particularly in developing countries. It also emphasizes the need for cities to adopt long-term planning, institutional strengthening, technical innovation and sustainable financing mechanisms. Successful implementation requires strong political commitment, effective management capacity and innovative approaches to financing and service delivery to ensure lasting improvements in sanitation outcomes.

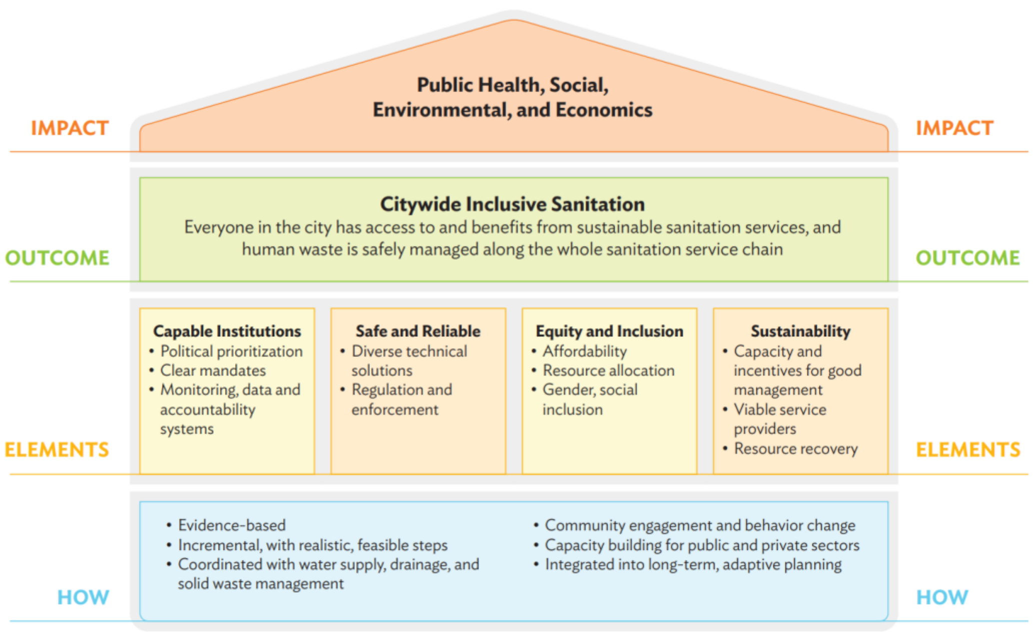
In Gwadar, current sanitation conditions highlight a clear gap between reported access and actual service safety. While a large proportion of households report the use of flush toilets, most are connected to on-site containment systems rather than a functional sewer network. At the same time, only 25–30 per cent of the city is connected to sewerage infrastructure and existing treatment plants are operating significantly below capacity due to limited inflows, operational inefficiencies and infrastructure constraints. The absence of a formal faecal sludge management system further compounds risks, leading to unsafe disposal practices, groundwater contamination and environmental degradation, issues that are particularly critical in Gwadar’s coastal and high-water table context.

A conventional, fully centralized sewerage approach is unlikely to be feasible in the short to medium term, given the high capital costs, energy requirements and time needed for network expansion across a rapidly growing and spatially dispersed urban area. In contrast, a CWIS approach offers a more pragmatic and systems-based pathway by building on existing infrastructure while addressing critical service gaps. It enables the integration of sewered areas with improved on-site sanitation and structured sludge management, supports decentralized treatment where network expansion is constrained and improves the overall performance and utilization of existing assets such as STPs.

Importantly, CWIS aligns closely with the Gwadar Smart Port City Master Plan (2017–2050), which already proposes a decentralized, zonal wastewater management system with reuse components. By adopting a CWIS framework, Gwadar can transition from partial and fragmented sanitation services to a comprehensive, efficient and environmentally responsible system, ensuring that sanitation investments translate into safe outcomes while keeping pace with urban growth and resource constraints.

CWIS comprises four elements, capable institutions, safety and reliability, equity and inclusion and sustainability, with associated actions to achieve the desired outcome.

Figure 15: Conceptual Framework of Citywide Inclusive Sanitation



4.6 Operational Efficiency

Water supply operations in Gwadar District are managed primarily by two public sector service providers, GDA) and PHED, alongside informal providers, including private tankers. GDA's operations are concentrated within Gwadar city, where it supplies water to 12,072 domestic and commercial connections, in addition to three bulk consumers, Gwadar Garrison, Gwadar Airport and GIEDA. PHED operates across rural areas of Gwadar sub-division and other tehsils, including Pasni, Jiwani, Ormara and Suntser, serving a cumulative 10,500 domestic and commercial consumers.

4.6.1 Non-Revenue Water

The assessment of Non-Revenue Water (NRW) in Gwadar is constrained by the absence of a formal metering system and reliable monitoring data. However, indicative estimates based on available administrative and demographic data provide important insights into system inefficiencies and distribution imbalances.

Currently, a total of 22,572 registered domestic and commercial consumers are connected to the water supply network managed by GDA and PHED. Based on an average household size of 6 persons per connection (Census 2023), the total served population is estimated at approximately 135,432 individuals. Using a consumption benchmark of 25 gallons per capita per day, the total water demand of connected consumers is estimated at approximately 3.4 MGD.

In comparison, the total water supplied across the system is estimated at around 7.1 MGD. This indicates an apparent surplus of approximately 3.3 MGD within the system. However, this surplus does not represent actual excess availability but rather reflects system inefficiencies, including physical losses, leakages, unaccounted consumption, and inequitable distribution, which collectively constitute non-revenue water.

A closer examination at the tehsil level reveals significant variation. Gwadar Tehsil shows the largest imbalance, with a demand of 1.8 MGD for connected consumers against a supply of 3.7 MGD, indicating a surplus of 1.5 MGD. Similarly, Jiwani and Ormara demonstrate substantial surpluses relative to their connected demand, receiving 0.8 MGD and 0.7 MGD respectively against minimal estimated demand. In contrast, Pasni shows a comparatively balanced situation, with a demand of 1.0 MGD and a supply of 1.5 MGD. In Suntser, demand estimation is constrained by the absence of formal household connections, as communities rely on direct collection from PHED reservoirs.

It is important to note that this analysis is limited to connected consumers, who represent only about 41 per cent of the district's total population. When assessed against universal service coverage, total district water demand is estimated at 8.2 MGD, indicating that the system is simultaneously characterised by apparent surplus within the network and an overall supply deficit at the district level. This paradox highlights structural inefficiencies in water allocation, limited network coverage and inequitable distribution of available resources.

Table 8: Water Demand and Supply Analysis Based on Existing Consumers

Tehsil/ Sub-Tehsil	Service Provider	Number of Consumers	Served Population (@estimated 6 persons per connection)	Demand of Water Consumers (MGD)	Water Supplied by GDA and PHED(MGD)	Surplus/ Deficit Water Supply (MGD)
Gwadar	GDA	12,072	72,432	1.8	3.7	1.5
		3 bulk water consumers		0.1		
	PHED	2,227	13,362	0.3		
Pasni	PHED	6,525	39,150	1.0	1.5	0.5
Jiwani	PHED	869	5,214	0.1	0.8	0.7
Ormara	PHED	879	5,274	0.1	0.7	0.6
Suntser[15]	PHED	No household Connections	-	-	0.4	-

[15] Given the absence of household-level connections in Sub-Tehsil Suntser, it is not feasible to accurately estimate consumer water demand or assess the extent of surplus or deficit in water supply.

Total		**22,572**	**135,432**	**3.4**	**7.1**	**3.3**

4.6.2 Integrated NRW Reduction and System Efficiency

Estimated NRW levels, approximated at around 25 per cent based on indicative calculations, represent a significant loss of already scarce water resources in Gwadar. Reducing NRW is therefore not only an operational priority but also a critical component of climate resilience, financial sustainability and improved service delivery.

An integrated NRW reduction strategy should combine technical, commercial and digital interventions. Technical measures should prioritize leakage detection and repair, pressure management, network rehabilitation and the establishment of District Metered Areas (DMAs) to improve control over water flows. Commercial interventions should focus on progressive introduction of metering, strengthening billing systems and improving customer management practices to enhance accountability and cost recovery.

To support these measures, GDA and PHED should adopt a phased digital transformation approach. This includes the introduction of Supervisory Control and Data Acquisition (SCADA) systems, bulk water metering at source and transmission levels, and GIS-based asset management systems and pilot DMAs within the core urban areas of Gwadar city. These tools will enable real-time monitoring of production and distribution, facilitate early detection of losses and support data-driven operational decision-making. Lessons from pilot DMAs can subsequently inform phased expansion across other service areas. Implementation should prioritize high-loss and high-demand zones, while aligning with institutional capacity and resource availability.

NRW reduction should be treated not only as a technical objective but also as a financial sustainability measure. Savings generated through reduced physical and commercial losses should be quantified and partially reinvested into network rehabilitation, metering expansion, digital monitoring systems and service coverage improvements, creating a self-reinforcing cycle of efficiency gains, improved cost recovery and enhanced service delivery.

Box 10: District Metered Approach - Learning from Dhaka WASA[16]

Dhaka, capital of Bangladesh, with a population of more than 21 million people, and 36,941 residents per square kilometre, is the fourth-most densely populated city in the world. Around 80 per cent Dhaka's Water Supply and Sewerage Authority (DWASA) water supply relies on groundwater sources. DWASA's distribution network was divided into 10 zones which were difficult to manage, as individual or collective entity, by virtue of varied geographical sizes and population density. DWASA adopted a sectioned approach by splitting the large citywide distribution network into isolated, pressurized clusters, known as DMAs.

A DMA is a hydraulically isolated and completely metered section of the complete water network. If any particular network cluster faces a problem in water supply, that cluster can be isolated to solve the issue without affecting the water supply in other clusters. This also makes it simpler to monitor the amount of water supplied and consumed, and to detect any leakages or illegal connections within the network (water loss) more effectively. In addition, this enables DWASA's field staff to conduct maintenance activities without interrupting (shutting down) the water supply of the whole network especially when city is being shifted towards surface water supply. It is pertinent to mention that DMAs are tools rather than a complete solution to all distribution problems, they require efficient management and careful maintenance in order to remain effective.

16 https://wopbangladesh.com/introducing-model-district-metered-areas-dmas-to-improve-operational-excellence-a-case-study-from-dhaka-wasa/

Key limitations of DMA in Dhaka include: i) Extreme constructions and high population density in Dhaka made it very difficult to construct standardized DMA sizes with "natural" boundaries, ii) Integration of informal /illegal settlements that generally resort to illegal connections causing damage to water supply infrastructure and resulting in NRW, and iii) Required new ways of working to remain vigilant for O&M and optimum utilization of water infrastructure along with ensuring strategic assets management.

4.6.3 Cost Recovery and Tariffs Structure

Cost recovery within Gwadar's water supply system remains extremely limited, reflecting both institutional constraints and the absence of fully operational tariff and billing mechanisms. At present, PHED does not operate under a defined tariff structure and relies entirely on annual budgetary allocations from the provincial government to finance both O&M of existing schemes and the development of new infrastructure. This model limits financial sustainability and reduces incentives for efficiency, cost control and service improvement.

Historically, GDA's cost recovery has also been minimal, limited primarily to one-time connection charges for domestic users at a rate of Rs. 1,850 per connection, without any recurring service charges. In March 2026, GDA formally notified a revised tariff structure introducing differentiated flat monthly rates across various user categories. These include Rs. 300 per month for domestic users, Rs. 5,000 for small commercial establishments such as barber shops and restaurants, Rs. 10,000 for hotels, car wash services and block factories, Rs. 12,000 for RO plants and Rs. 20,000 for fish processing units. While this represents an important policy shift towards cost recovery, the absence of consumer metering, billing systems and enforcement mechanisms means that these tariffs have not yet translated into consistent or predictable revenue streams.

Table 9: New Tariff Rates of GDA for Domestic and Commercial Consumers

Category	Tariff Rates
Domestic	300
Hotels	10,000
Barber Shops	5,000
Car Wash Services	10,000
Block Factories	10,000
Restaurants	5,000
Fish Factories	20,000
RO Plants	12,000

In addition to connection fees, GDA generates revenue through bulk water supply to three major institutional consumers, Gwadar Garrison, Gwadar Airport and GIEDA, based on volumetric billing. During FY 2024–25, total revenue collected by GDA amounted to approximately Rs. 45.9 million, comprising Rs. 25.5 million from Gwadar Garrison, Rs. 18.6 million from Gwadar Airport, Rs. 0.74 million from GIEDA and Rs. 1.05 million from domestic connection fees.

A comparison across years indicates that revenue increased from Rs. 29.5 million in FY 2023–24 to Rs. 45.9 million in FY 2024–25, reflecting improved billing performance and/or increased supply to bulk consumers. For FY 2025–26, revenue from water bills has reached Rs. 12.2 million as of April 2026. This figure is expected to increase during the remaining two months of the financial year, May and June, although it currently indicates a slower revenue trajectory compared to the previous year.

Table 10: GDA's Revenue from Bulk Water Supply and Connection Charges- FY 2024-25

Area	Category	Revenue (in Rs.) 2023–24	Revenue (in Rs.) 2024-25	Revenue (in Rs.) 2025-26
New Gwadar International Airport	Bulk Water Supply-Volumetric billing	14,877,431.00	18,595,174.72	8,222,500.00
Gwadar Garrison	Bulk Water Supply-Volumetric billing	14,594,030.00	25,514,751.00	3,597,265.00
GIEDA	Bulk Water Supply-Volumetric billing	-	736,780.00	-
Gwadar House Connection Fee	House Connection Fee	-	1,052,400.00	424,800.00
	Total	**29,471,461.00**	**45,899,105.72**	**12,244,565.00**

Despite these efforts, overall cost recovery remains critically low. In FY 2024–25, total revenue of Rs. 45.9 million represents approximately 18 per cent of total water-related operational expenditure of Rs. 253.8 million. This reflects a substantial financing gap, with the majority of operational costs, particularly electricity expenses, continuing to be subsidised through public funding.

The structure of revenue generation also highlights systemic limitations. Bulk water supply to a limited number of institutional consumers constitutes the primary source of income, while domestic revenue mobilisation remains minimal and is currently limited to one-time connection charges. The tariff regime is only partially operationalised and lacks comprehensive volumetric coverage across all domestic and commercial user categories. This limits incentives for efficient water use, particularly among high-consumption domestic and commercial users, and constrains revenue expansion.

Overall, the cost recovery framework in Gwadar remains at an early stage of development. Strengthening financial sustainability will require a phased and structured approach, including full operationalisation of the notified tariff regime, expansion of metering systems, establishment of systematic billing and collection processes and gradual transition towards a consumption-based pricing model. These reforms will be critical to improving cost recovery, reducing reliance on government subsidies and enabling reinvestment in system operations, maintenance and service improvements.

4.7 Energy Efficiency

Sawad Dam, located approximately 6 km from Gwadar city, serves as the primary source of drinking water. An additional source, Shadi Kaur Dam, is situated approximately 167 km away. Between these sources lies Chawar Dagar, which functions as a central ground reservoir and distribution hub. Water conveyed from the dams is stored and distributed through a system of six interconnected reservoirs, each with an approximate storage capacity of 0.25 million gallons.

The system is supported by two main pumping stations at Sawad Dam and Chawar Dagar, with an integrated feeder system facilitating water transfer. Electricity billing for both pumping stations is consolidated under Sawad Dam. Accordingly, the energy efficiency analysis is based on total electricity consumption recorded under this account over a 12-month period from March 2025 to February 2026.

Due to data limitations, the analysis is restricted to GDA operations in Gwadar city. Comparable assessments for PHED-managed systems in other tehsils could not be undertaken.

GDA supplies an average of 3.5 MGD, equivalent to approximately 1,277.5 million gallons annually. Based on total annual electricity consumption of 2.4 million kWh, the system delivers approximately 531 gallons of water per kWh. This indicates a moderate level of operational efficiency, particularly given the long-distance conveyance and reliance on energy-intensive pumping.

Table 11: Annual Electricity Consumption by Sawad Dam-March 2025 to Fe 20262

Month	kWh Units
March, 2025	220,360
April, 2025	255,000
May, 2025	231,960
June, 2025	266,080
July, 2025	245,200
August, 2025	282,840
September, 2025	255,520
October, 2025	222,080
November, 2025	77,120
December, 2025	101,280
January, 2026	109,440
February, 2026	138,080
Total	**2,404,960**

As the analysis is based on aggregated electricity consumption, the calculated efficiency represents a system-wide average. In practice, efficiency is likely to vary significantly depending on the source and season. Energy efficiency is expected to be higher when supply is sourced from nearby systems such as Sawad Dam and lower during drought periods when reliance shifts to distant and energy-intensive sources such as Shadi Kaur Dam.

4.7.1 Energy and Carbon Footprint of WASH Service Delivery in Gwadar

Electricity consumption associated with water distribution contributes directly to greenhouse gas emissions. Using an indicative grid emission factor of 0.45 kg CO_2 per kWh, the estimated annual carbon footprint of GDA's water supply operations is presented below.

Table 12: Estimated Annual Carbon Emissions from Water Supply Operations

Parameter	Value
Annual electricity consumption	2.4 million kWh
Emission factor (indicative)	0.45 kg CO_2 per kWh
Estimated annual emissions	approximately 1,082 tonnes CO_2
Emissions per million gallons	approximately 0.85 tonnes CO_2

These results indicate that water supply operations constitute a significant source of service-related emissions in Gwadar, with energy demand structurally embedded in the current supply model.

Key Implications for Planning

The analysis highlights several strategic implications for improving energy efficiency and sustainability:

- Energy consumption and carbon emissions are directly linked to water supply service delivery.
- System performance is constrained more by asset-level inefficiencies than overall capacity.
- Improving the performance of energy-intensive systems, particularly desalination and long-distance pumping, offers the greatest potential for efficiency gains.
- Strengthening monitoring systems, including automated metering, is essential for performance benchmarking and optimisation.
- Transitioning towards renewable energy solutions, particularly solar and hybrid systems, provides a viable pathway to reduce both operational costs and emissions.

The energy and carbon footprint assessment demonstrates that GDA's water supply system is both energy-intensive and operationally uneven, with significant scope for improvement. A transition towards energy-informed system management, focusing on performance optimisation, enhanced monitoring, and gradual integration of renewable energy, is critical to reducing costs, lowering emissions, and strengthening the long-term sustainability of WASH service delivery in Gwadar. PHED has already initiated the solarisation of selected water supply schemes, providing an operational basis for wider adoption of renewable energy within the sector. Experience from these schemes should be systematically documented through energy audits, lifecycle cost analyses and performance monitoring to inform the phased solarisation of additional pumping stations, remote water supply schemes and future desalination facilities.

Beyond improving system efficiency, energy transition also presents a strategic investment opportunity for Gwadar. The large-scale solarization of pumping stations and future desalination facilities should be prioritized to reduce long-term operating costs, improve energy security and support the transition towards a low-carbon and climate-resilient WASH sector. Future desalination feasibility studies should evaluate dedicated solar photovoltaic systems, solar-grid hybrid configurations, battery storage and water-storage options, together with associated land requirements. Renewable energy integration should be incorporated from the initial design stage rather than added after construction, as energy system configuration will directly influence water production costs, operational reliability and long-term financial sustainability. Given China's extensive experience in renewable energy deployment and green infrastructure development, these investments could also be positioned within broader CPEC-related green development and climate cooperation initiatives.

4.8 Human Resource

The staffing profile of the two key WASH service providers in Gwadar District, GDA and PHED, reflects contrasting institutional capacities with important implications for service delivery. PHED, which operates across multiple tehsils and predominantly rural areas, faces significant human resource gaps, particularly in technical, supervisory and financial management positions. These shortages constrain operational oversight, planning, monitoring and effective implementation of water supply schemes.

In contrast, while GDA has an established overall staffing structure across its departments, the water and sanitation function is a relatively recent mandate and is currently being managed as a nascent wing under the Engineering Department. Following an official notification issued by the Chief Minister of Balochistan on 25 September 2025, the responsibility for water supply and sanitation within the Gwadar Master Plan area has been formally delegated to GDA. However, institutional arrangements, systems and dedicated staffing for this function are still evolving. As a result, despite

GDA's broader organizational capacity, the operational effectiveness of the water wing remains limited at this stage.

4.8.1 Current Staffing of PHED

PHED Gwadar has a total sanctioned strength of 586 positions, of which 408 are currently filled while 178 remain vacant, resulting in an overall vacancy rate of approximately 30 per cent. Although the department maintains a functional workforce across key operational areas, the distribution of staff across cadres reveals critical gaps, particularly at technical and supervisory levels.

At the gazetted and senior technical level (BPS 16–18), 6 out of 8 sanctioned posts are filled, indicating a vacancy rate of 25 per cent. More significantly, at the tehsil level, one out of five sanctioned Sub Divisional Officer (SDO) positions remain vacant. This gap directly affects field-level supervision and limits effective monitoring, coordination and implementation of water supply and infrastructure projects. In addition, the Divisional Accounts Officer position is entirely vacant, which has serious implications for financial management, including budgeting, accounting and fund utilisation.

At the non-gazetted technical and supervisory level (BPS 11–14), 6 out of 27 sanctioned posts are vacant, reflecting a vacancy rate of 22 per cent. Notably, 4 out of 9 Sub-Engineer positions remain unfilled, further constraining technical oversight and field supervision. These gaps are particularly critical given the department's reliance on technical staff for scheme operation, maintenance and quality control.

At lower grades (BPS 5–9 and BPS 1–4), vacancy rates are comparatively lower at around 5 per cent in each cadre. However, while staffing at these levels is relatively stable, overall operational effectiveness remains constrained due to shortages in higher technical and supervisory positions.

To partially address these gaps, the department has created 149 contract-based positions on fixed pay during FY 2023–24, covering a range of operational support roles, including Beldar, Chowkidar, Electrician, Engine Driver, Helper, Operator, Petroller, Pump Driver, Plumber and Valve Man. However, these positions currently remain unfilled, limiting their intended contribution to strengthening field operations and service delivery. Further details on PHED staffing are provided in the Annex I.

Table 13: Cader-wise Staffing at PHED Gwadar

Sr.#	Staffing Cadres	Grade (Basic Pay Scale)	Sanctioned Posts	Existing Staff	Vacant Posts	Percentage of Vacant against Sanctioned Posts
1	Gazetted Officers	16-18	8	6	2	25%
2	Non-Gazetted Officers	11-14	27	21	6	22%
3	Lower Grade Officials	5-9	76	72	4	5%
4	Class 4 Workers	1-4	326	309	17	5%
5	Fixed pay		149	0	149	0%
	Total		**586**	**408**	**178**	**30%**

4.8.2 Current Staff of GDA

GDA has a total sanctioned strength of 311 positions across various departments and grades; however, this staffing largely pertains to the overall institutional structure and not specifically to the water and sanitation function. The water wing, which operates under the Engineering Department, is at an early stage of development and does not yet have a fully established sanctioned staffing structure aligned with its newly assigned mandate.

Currently, the water wing is being operated through a limited workforce of 91 contractual staff, primarily engaged in Class IV cadres. These include operational roles such as pump operators, valve men, plumbers and other field-level support staff. While these positions are essential for basic system operations, they do not provide sufficient technical, managerial or supervisory capacity required for comprehensive planning, operation and management of urban water and sanitation systems.

At present, there is no dedicated cadre of gazetted officers or structured technical hierarchy exclusively assigned to the water wing. Instead, oversight and strategic direction are being provided through the broader Engineering Department of GDA, which includes positions such as Chief Engineer, Superintending Engineer and Executive Engineers. However, these roles are not exclusively dedicated to water supply and sanitation and are responsible for a wider portfolio of infrastructure functions. Further details of GDA staffing are provided in the Annex II.

Table 14: Cader-wise Staffing at GDA

Sr. #	Staffing Cadres	Grade (Basic Pay Scale)	No. of Post
1	Gazetted Officers	16-20	16
2	Non-Gazetted Officers	11-14	26
3	Lower Grade Officials	5-9	101
4	Class 4 Workers	1-4	168
	Total		**311**

4.8.3 Organizational Structure of GDA

The GDA operates under a hierarchical governance structure led by the Governing Body, followed by the Chairman and Director General, under whom all administrative, technical and regulatory functions are organised. At the institutional level, GDA's structure is broadly divided into Corporate Support Functions and Technical and Regulatory Functions, reflecting a typical development authority model focused on planning, regulation and infrastructure oversight.

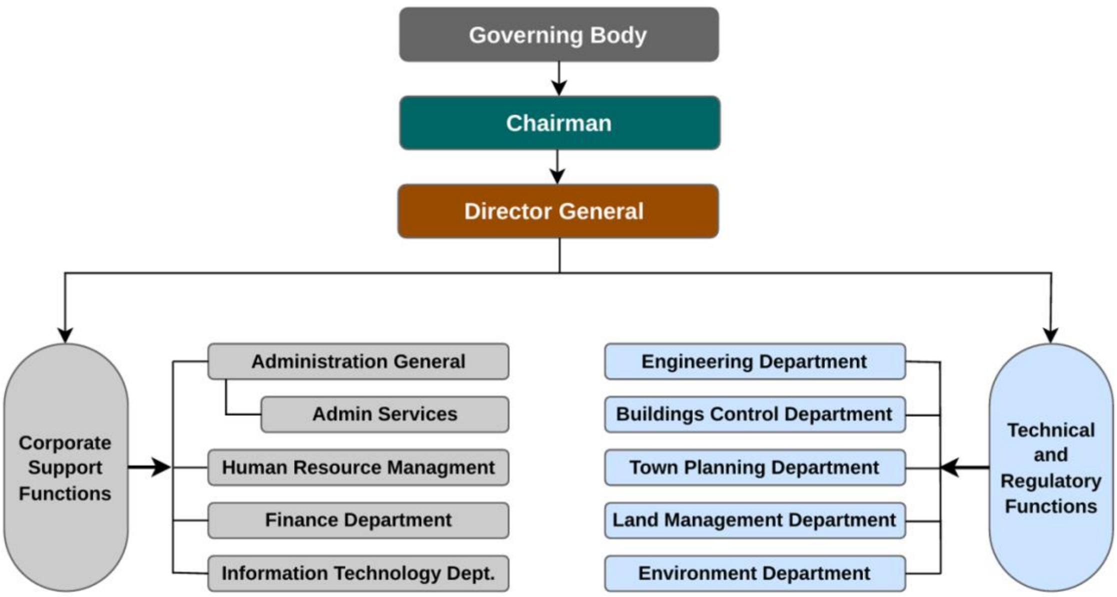
Corporate support functions include Administration General, Admin Services, Human Resource Management, Finance and Information Technology, which collectively ensure internal coordination, personnel management, financial planning and operational support. These functions are adequately structured to support institutional operations; however, they are not specifically aligned to the requirements of utility-style service delivery.

On the technical side, the Engineering Department functions as the central implementation arm, alongside other departments such as Buildings Control, Town Planning, Land Management and Environment, which primarily focus on regulation, planning and compliance. Within this structure, the water and sanitation function has recently been placed under the Engineering Department. However, unlike other established departments, this function does not yet exist as a fully institutionalised unit and remains at a nascent stage.

This structural placement highlights a critical institutional gap. While GDA's existing framework is well-suited for urban planning, land development and regulatory oversight, it is not inherently designed to manage continuous, service-oriented functions such as water supply and sanitation. These services require dedicated operational units, specialised technical cadres, customer management systems and round-the-clock service delivery mechanisms, which are currently not embedded within the existing structure.

Given the scale, complexity and essential nature of water and sanitation services, their current positioning as a sub-function within the Engineering Department is insufficient. There is a strong case for elevating this function into a dedicated and fully resourced entity, either through the creation of an independent Water and Sanitation Department or by establishing a semi-autonomous utility structure within GDA. Such a structure should include clearly defined operational, technical, commercial and maintenance units, supported by an appropriate staffing hierarchy.

Figure 16: Organizational Structure of GDA



4.8.4 Organizational Structure of PHED

The PHED operates as a provincial line department under the administrative control of the Government of Balochistan, with a mandate to provide safe drinking water and sanitation services, particularly in rural areas, in accordance with the Balochistan Rules of Business 2012. As per the recent institutional arrangements and notifications, PHED retains responsibility for water supply and sanitation services in the rural areas of Gwadar District, while urban areas under the Gwadar Master Plan have been assigned to GDA.

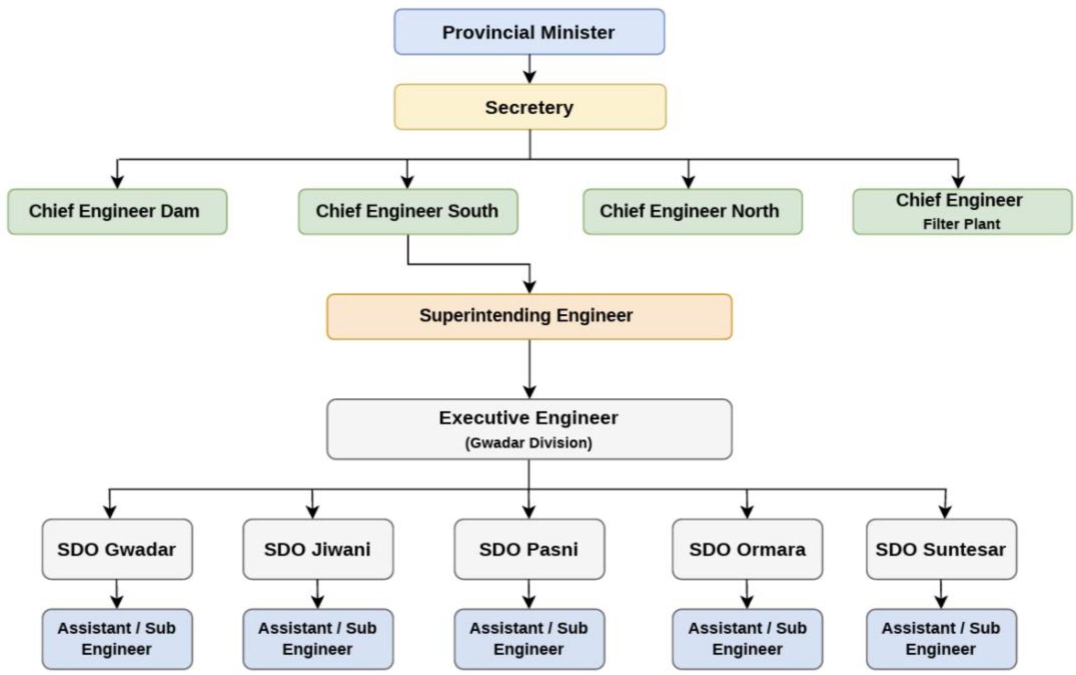
At the provincial level, PHED follows a hierarchical administrative structure led by the Provincial Minister, with oversight provided through the Secretary of the department. Technical leadership is anchored at the level of the Chief Engineer (South), under whom regional operations are managed by the Superintending Engineer.

At the district level, service delivery is coordinated through the Gwadar Division Office, headed by an Executive Engineer, who is responsible for planning, implementation and oversight of water supply schemes across the district. This divisional structure is further decentralised into Sub-Divisional Offices at the tehsil level, each led by a SDO, including Gwadar, Jiwani, Pasni, Ormara and Suntsar. These sub-divisions are responsible for day-to-day operations, including supervision of schemes, routine maintenance, community coordination and response to operational issues.

This multi-tiered structure allows PHED to maintain a field presence across geographically dispersed and often hard-to-reach rural areas. However, while the organisational design provides a clear administrative and technical chain of command, its effectiveness is constrained by significant human resource gaps, particularly at technical and supervisory levels, as highlighted in the previous section.

Furthermore, the current structure is largely engineering-driven and project-oriented, with limited integration of modern utility management functions such as customer services, financial sustainability, asset management and climate-resilient planning. As a result, while PHED remains the primary service provider in rural Gwadar, there are systemic limitations in transitioning from scheme-based implementation to sustainable service delivery.

Figure 17: Organizational Structure of PHED Gwadar



4.8.5 Performance Management and Career Development Systems

Both GDA and PHED have undertaken initial steps towards formalising performance management systems within their respective institutional frameworks. Job descriptions exist for a range of sanctioned positions, particularly within PHED, while GDA maintains role definitions within its broader administrative and engineering structure. Annual performance appraisals are conducted in accordance with the Government of Balochistan's Annual Confidential Report (ACR) system, which remains the primary mechanism for assessing staff performance and informing promotion decisions.

While this appraisal system ensures administrative compliance, it remains largely procedural and does not function as a strategic management tool. The current framework does not systematically link individual performance outcomes with structured capacity development plans or continuous professional development pathways. Performance assessments are not utilised to identify competency gaps, guide targeted training interventions or strengthen institutional capacity in critical areas such as urban utility management, groundwater sustainability, non-revenue water reduction, financial management, digital systems or climate resilience.

Moreover, there is no consolidated institutional mechanism within either GDA or PHED to aggregate appraisal findings into an organisation-wide capacity development strategy. As a result, professional development remains largely promotion-driven rather than aligned with evolving service delivery needs, particularly in the context of Gwadar's rapid urbanisation and climate vulnerability.

Strengthening performance management systems through the introduction of competency-based assessments, measurable service delivery indicators and structured training follow-up mechanisms would enable both institutions to transition from compliance-based appraisal systems to performance-oriented management frameworks. Linking annual appraisals with formal Training Needs Assessments (TNA) and continuous professional development plans will be essential for enhancing accountability, improving workforce productivity and supporting sector reform.

4.8.6 Institutional Implications for Climate-Resilient WASH

The current staffing profiles of both GDA and PHED reveal structural mismatches between evolving service delivery requirements and existing human resource composition. In PHED, while operational cadres are relatively stable, there are significant gaps in technical, supervisory and financial management positions. In GDA, the situation is more pronounced within the water and sanitation function, which is still in its early stages and relies primarily on limited contractual operational staff without an established technical and managerial structure.

This imbalance reflects an institutional orientation towards routine operations rather than strategic, climate-resilient service delivery. The absence of adequately staffed professional and technical roles constrains institutional capacity in key areas such as water resource planning, groundwater management, infrastructure optimisation, energy efficiency and system resilience.

These limitations reduce the ability of both institutions to respond effectively to emerging challenges, including groundwater depletion, climate variability, increasing service demand and infrastructure stress. Addressing these human resource gaps through targeted recruitment, capacity development and institutional restructuring will be critical to strengthening governance, improving financial sustainability and ensuring long-term, climate-resilient WASH service delivery in Gwadar. Given the growing scale and complexity of water and sanitation services in Gwadar, there is also a strong rationale for gradually transitioning towards a semi-autonomous utility model capable of operating on commercial, performance-based and customer-oriented principles. Such a model would facilitate dedicated staffing, strengthen accountability, improve financial sustainability and support specialized technical functions, including desalination operations, SCADA systems, NRW management, water quality surveillance and wastewater reuse.

4.8.7 Operational Systems and Digital Capacity Gaps

Operational systems within both GDA and PHED remain fragmented and predominantly manual, limiting their ability to function as modern, performance-driven service providers. There is no centralised operational or performance monitoring system within either institution. Data related to water production, service coverage, complaint management, tariff collection, non-revenue water, asset management and staff deployment are dispersed across departments without integration into a unified platform.

This fragmentation restricts the ability of management to monitor performance trends, identify inefficiencies and undertake timely, evidence-based decision-making. In GDA, these challenges are further compounded by the nascent stage of the water and sanitation wing, where systems for operational monitoring and service management are yet to be fully established.

The absence of digital systems also affects internal accountability. Human resource management processes, including attendance and field staff deployment tracking, remain largely manual. This limits transparency and affects operational efficiency, particularly for field-based functions such as pump operations, network maintenance and emergency response.

Strengthening digital infrastructure, establishing integrated management information systems and introducing automated monitoring tools will be essential for improving operational efficiency, enhancing revenue collection and enabling data-driven decision-making across both institutions. The introduction of SCADA and other digital monitoring systems should follow a phased implementation approach. Initial investments should prioritise major bulk water systems, key dams, reservoirs, transmission pipelines and principal pumping stations, where real-time monitoring can deliver the greatest operational and energy efficiency benefits. The initial system should capture key operational parameters, including reservoir levels, water flows, pumping hours, energy consumption, system pressure, selected water quality indicators and equipment status. Expansion to distribution networks, district-metered areas, smaller water supply schemes and other operational assets should be undertaken progressively after institutional capacity, data management protocols, cybersecurity measures and long-term operation and maintenance arrangements have been established.

4.8.8 Health, Safety, Regulatory and Environmental Capacity

Health, Safety and Environment (HSE) practices within both GDA and PHED remain underdeveloped. Staff are routinely exposed to high-risk operational environments, including electrical systems, pumping infrastructure, wastewater handling and extreme climatic conditions, yet formal HSE training and protocols are limited.

Standardised procedures for reporting and responding to contamination incidents, system failures or environmental hazards are not systematically embedded within operational frameworks. Strengthening HSE systems, including emergency response protocols and staff training, is essential for improving occupational safety, ensuring environmental compliance and protecting public health.

Regulatory oversight also presents challenges. While the B-EPA holds statutory authority for environmental monitoring and compliance, its capacity to enforce water quality standards, wastewater discharge regulations and environmental safeguards remains limited. This underscores the need for stronger inter-agency coordination between GDA, PHED and regulatory bodies to improve environmental governance within the WASH sector.

4.8.9 Training Systems and Institutional Learning Constraints

There is currently no dedicated provincial or institutional training mechanism to support continuous technical capacity development for staff within GDA and PHED. In addition, there is no formal TNA process in place to systematically identify and address skill gaps.

Existing training opportunities, particularly for officer-level staff, are largely administrative in nature and do not adequately address technical competencies required for modern WASH service delivery. Critical areas such as groundwater management, digital systems, non-revenue water reduction, climate resilience and utility operations remain insufficiently covered.

In the case of GDA, these gaps are more pronounced due to the recent establishment of its water and sanitation function, which currently lacks institutionalised training and capacity development systems. Similarly, PHED’s training approach remains ad hoc and not aligned with evolving sector demands.

There is a strong need to establish structured and continuous capacity development systems, including the development of in-house or shared training facilities. These should focus on practical, field-oriented skills such as leak detection, pump operations, electrical maintenance, safety protocols, GIS applications and digital monitoring systems.

Institutionalising structured learning and capacity development will be critical for enabling both GDA and PHED to transition towards efficient, data-driven and climate-resilient service delivery models in Gwadar.

4.9 Sector Coordination, Governance and Monitoring Framework

4.9.1 Institutional Roles in Water Supply and Sanitation

The institutional landscape for water supply, sanitation and municipal services in Gwadar is characterised by a multi-agency framework involving provincial, federal and local entities, each with distinct but at times intersecting mandates. While the allocation of responsibilities has evolved in recent years, effective coordination across these institutions remains a key challenge for service delivery.

Following recent government decisions, the responsibility for water supply and sanitation has been spatially delineated, with GDA responsible for services within the Gwadar Master Plan area and PHED responsible for rural areas across the district. This functional separation reflects an effort to streamline service delivery; however, coordination between the two institutions remains essential, particularly in peri-urban zones and shared infrastructure systems.

GDA, established under the Gwadar Development Authority Act 2003, serves as the primary agency for urban planning, infrastructure development and service provision within the Master Plan area. In addition to its planning and regulatory functions, GDA is now assuming an operational role in water supply and sanitation, which requires strengthened institutional capacity and coordination mechanisms.

PHED, as a provincial line department, continues to play a central role in the provision of water supply and sanitation services in rural areas. Its decentralised structure enables field-level implementation; however, coordination with urban systems and evolving service boundaries requires clearer operational linkages with GDA.

The GPA, operating under the Ministry of Maritime Affairs, manages port-related infrastructure, including desalination plants that contribute to the city’s water supply. Given the strategic importance of these facilities, coordination between GPA and GDA is critical to ensure alignment in water distribution, infrastructure planning and long-term resource management.

At the local level, Municipal Committees continue to perform essential service delivery functions, particularly in solid waste management and emergency response. Their role remains important for maintaining frontline municipal services and supporting urban operations during crises.

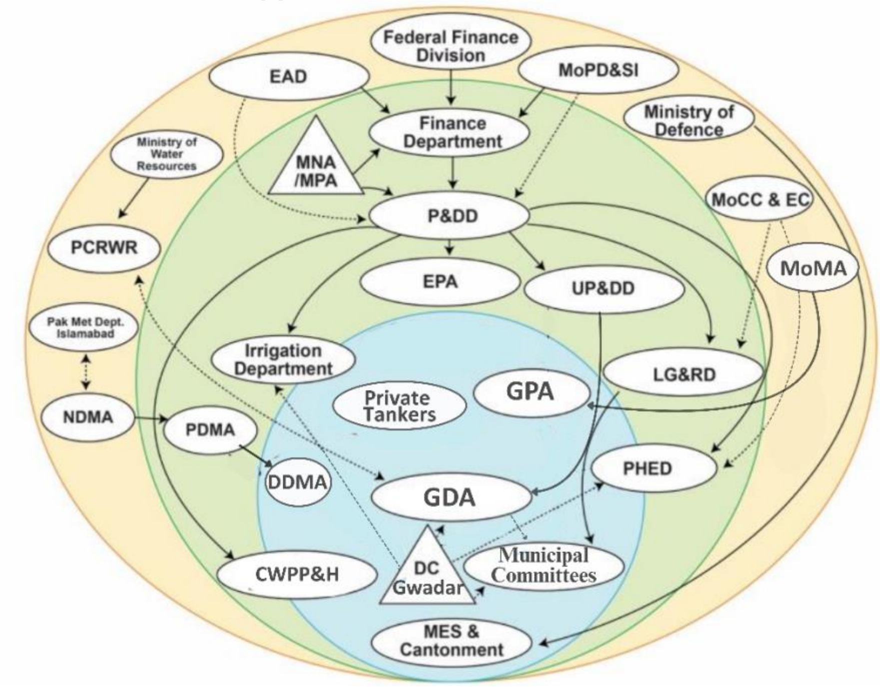
Additional provincial departments contribute indirectly to the sector. The Irrigation Department supports water resource sustainability through the construction of small reservoirs and recharge structures. B-EPA provides environmental oversight, while the P&DD plays a role in development planning and project approvals. The Finance Department manages budget allocations to sector institutions.

Disaster management authorities, including National Disaster Management Authority (NDMA) and PDMA, become operationally relevant during emergencies such as floods and droughts. While a District Disaster Management Authority (DDMA) structure exists within the Deputy Commissioner's office, it is not fully operational as a standing coordination mechanism. The Deputy Commissioner continues to play a central role in facilitating inter-agency coordination, particularly during crises and in resolving administrative bottlenecks.

Other provincial entities, including Local Government and Rural Development Department (LG&RDD), Urban Planning and Development Department (UP&DD), and Communication, Works, Physical Planning and Housing Department (CWPP&H), contribute to infrastructure development and municipal services. However, overlaps in jurisdiction and project implementation responsibilities occasionally create coordination challenges, particularly in areas where urban expansion intersects with district-level service delivery.

At the federal level, institutions such as the Ministry of Planning, Development and Special Initiatives, Economic Affairs Division and Federal Finance Division influence the sector through development financing, fiscal transfers and external funding coordination. Technical and policy support is also provided by entities such as the Ministry of Water Resources, PCRWR, Ministry of Climate Change and Environmental Coordination, and the PMD.

Figure 18: Institutional Arrangement for Water and Sanitation Services in Gwadar and Administrative Support from Provincial and Federal Government



4.9.2 Institutional Coordination Challenges

Key informant interviews with key stakeholders highlighted persistent coordination challenges and institutional tensions among departments. These challenges arise partly from overlapping functions and partly from institutional sensitivities, where technical advice or operational feedback from one department is sometimes perceived by others as interference. Such dynamics have affected the timely resolution of operational issues and contributed to fragmented service delivery.

Although multiple agencies are involved in infrastructure development and service provision, the Municipal Committee remains the most visible and accessible institution for the public. As a result, community complaints and grievances related to water supply or sanitation are often directed to the Municipal Committee regardless of which agency is operationally responsible. Instances were reported where public protests over water shortages occurred at municipal offices, even when the issue originated outside the Municipal Committee's jurisdiction.

Operational coordination gaps also affect infrastructure management. In one reported case, repeated water leakage damaged a road due to a buried pipeline belonging to another department. Municipal staff carried out repeated temporary measures, but the issue could only be permanently resolved once the responsible department intervened. Such situations result in reactive "firefighting" responses rather than coordinated problem resolution.

Given the increasing complexity of WASH service delivery in Gwadar, there is a need to establish a formal Gwadar WASH Coordination Unit bringing together GDA, PHED, GPA, Municipal Committee and other key stakeholders. Such a platform would support integrated planning, infrastructure coordination, data sharing, investment prioritization and resolution of cross-jurisdictional operational issues, particularly in rapidly expanding peri-urban areas. By providing a structured mechanism for inter-agency coordination, the platform would help reduce institutional fragmentation and enable more proactive and efficient service delivery.

4.9.3 Institutional Jurisdiction and Revenue Authority Issues

Institutional overlaps in Gwadar also extend to taxation authority, property regulation and revenue collection, reflecting broader ambiguities in the division of powers between the GDA and the Municipal Committee. Under the Balochistan Local Government Act 2010, Municipal Committees are authorized to collect certain local taxes and fees. However, in practice, the exercise of these powers has often been contested.

Further coordination challenges were reported in relation to profession and trade taxes. Following administrative discussions convened by the Deputy Commissioner, stakeholders including financial institutions were advised that municipal taxation would be limited to a defined share, with fixed amounts to be determined through the council to simplify implementation. Initial resistance was reported by some institutions, which argued that since they managed their own sanitation and cleanliness services, municipal charges were not justified.

4.9.4 Operations, Maintenance and Sustainability Challenges

Stakeholders emphasized that development initiatives in Gwadar have primarily focused on infrastructure construction, while O&M arrangements remain weak. Facilities are often treated as completed development outputs without adequate planning for long-term management, financing and institutional responsibility. This gap between asset creation and operational sustainability presents a significant risk for service continuity as the city expands.

Policy discussions have also highlighted the need for a clear sectoral roadmap to guide future service expansion and institutional roles. Without such a framework, planning for Gwadar’s rapid urban growth remains fragmented and reactive.

4.9.5 Governance, Public Engagement and Institutional Ownership

Institutional effectiveness is further influenced by limited public ownership and trust in development processes. Stakeholders noted that policies and projects implemented without adequate involvement of elected local bodies or community consultation do not generate local ownership. Over time, a perception has developed among residents that their views are not adequately considered in planning and decision-making. This has contributed to public reservations and resistance toward several development initiatives.

At present, the complaint management system remains manual, handling approximately 4–5 complaints per day. While these complaints are addressed and no backlog exists, the system lacks the scale to accommodate broader public engagement.

Strengthening public engagement and creating platforms for community participation were identified as critical for improving institutional legitimacy and facilitating implementation. Stakeholders emphasized that meaningful development in Gwadar will require stronger involvement of local institutions and communities to rebuild confidence and ensure shared ownership of urban transformation. Community consultation and participation should therefore be institutionalised throughout the WASH investment cycle, including needs identification, feasibility studies, infrastructure siting, detailed design, implementation monitoring, operation and maintenance, and post-completion performance assessment. Participation mechanisms should include representative community forums, consultations with women and underserved groups, public disclosure of proposed investments and service commitments, accessible grievance mechanisms and community-based monitoring of water supply, sanitation services and infrastructure performance. Community feedback should be formally documented and linked to institutional decision-making through management responses, corrective actions and public reporting, ensuring that participation contributes directly to the prioritisation, implementation and monitoring of WASH investments rather than being limited to information sharing or complaint registration.

4.9.6 Monitoring, Data Systems and Key Performance Indicators

Monitoring and evaluation systems for WASH services in Gwadar are extremely limited. There is no integrated Management Information System that consolidates operational, financial, technical and service delivery data. Currently there are no defined Key Performance Indicators (KPIs) for WASH service delivery.

A future integrated MIS platform should consolidate operational, financial, water quality, NRW, customer service and infrastructure performance data across GDA, PHED and other relevant service providers. Integration with GIS, SCADA and digital monitoring systems would enable near real-time performance tracking, strengthen accountability and support evidence-based planning, investment prioritization and reporting requirements for development partners, regulators and private investors.

Adopting a structured system aligned with Pakistan Water Operators Network standards would enable consistent tracking and annual reporting across key operational, service delivery and financial indicators, including coverage, production, non-revenue water, efficiency and sustainability, while also incorporating Gender Equality, Disability and Social Inclusion (GEDSI) through disaggregated data to assess equitable access and service outcomes across different population groups.

Table 15: Proposed Key Performance Indicators for WASH Service Delivery

Sr.	Performance Indicators	Unit
1	**Service Coverage**	
1.1	*Water Services*	*Number of Connection*
1.2	*Sewerage Services*	*Number of Connection*
1.3	*Water Services Coverage*	*Percentage of Gwadar Population Served*
1.4	*Sewerage Services Coverage*	*Percentage of Gwadar Population Served*
1.5	*Average Hours of water Supply per Day*	*Hours per Day*
2	**Production and Consumption**	
2.1	*Fresh Water Production*	*In MGDs*
2.2	*Fresh Water Consumption*	*In MGDs*
2.3	*Wastewater Produced*	*In MGDs*
2.4	*Wastewater Treated*	*In MGDs*
2.5	*Treated Wastewater Reused*	*In MGDs*
3	**Non-Revenue Water**	
3.1	*Non-Revenue Water*	*Percentage of total water production*
3.2	*Un-Accounted for Water*	*Percentage of total water production*
4	**Metering Practices**	
4.1	*Consumer Level Metering*	*Percentage of total water connections*
4.2	*Bulk water Metering*	*Percentage of total water production*
4.3	*Metered Water Sold*	*Percentage of total water production*
5	**Network Performance**	
5.1	*Pipe Breaks / Burst*	*Breaks Per Kilometre*
5.2	*Sewerage System Blockages*	*Blockage Per Kilometre*
5.3	*Replacement of Manhole Covers*	*Percentage of total manholes*
5.4	*Pipe Leakages*	*Leakage Per Kilometre*
5.5	*Cleaning/ Desilting of Manholes*	*Percentage of total manholes*
5.6	*Cleaning / Desilting of Sewers*	*Percentage of total sewer network*
5.7	*Storm Water Drain Used as Sludge carriers*	*Percentage of total storm water network*
5.8	*Sewer collapse / Crown Failure*	*Percentage of total sewer network*
6	**Cost and Staffing**	
6.1	*Unit Operational Cost - Water Sold*	*Rupees per cubic meter of water sold*
6.2	*Unit Operational Cost - Water Produced*	*Rupees per cubic meter of water produced*
6.3	*Water & Sewerage Staff/1000 Water & Sewerage Connections*	*Ratio*
6.4	*Water Staff /1000 Water Connections*	*Ratio*
6.5	*Sewerage Staff/ 1000 Sewerage Connections*	*Ratio*
6.6	*Salary Costs as a proportion of Total Operating Cost*	*Percentage of total operating cost*
6.7	*Power/Electricity Costs as a proportion of Total Operating Cost*	*Percentage of total operating cost*
6.8	*Maintenance Costs as a proportion of Total Operating Costs (non-contracted)*	*Percentage of total operating cost*
6.9	*Contracted-out Costs as a proportion of Operating Cost*	*Percentage of total operating cost*
7	**Water Quality**	

7.1	*Total source level water quality test conducted*	*Number of water quality tests*
7.2	*Total consumer level water quality test conducted*	*Number of water quality tests*
7.1	*Chemically fit water samples at source*	*Percentage of water quality tests conducted at source level*
7.2	*Biologically fit water samples at source*	*Percentage of water quality tests conducted at source level*
7.3	*Chemically fit water samples at consumer level*	*Percentage of water quality tests conducted at consumer level*
7.4	*Biologically fit water samples at consumer level*	*Percentage of water quality tests conducted at consumer level*
7.5	*Required residual chlorine test*	*Number of tests required as per standards*
7.6	*Residual chlorine test conducted*	*Number of tests conducted*
7.7	*Samples passed for residual chlorine test*	*Percentage of residual chlorine test conducted*
8.	**Quality of Services**	
8.1	*Water supply complaints received*	*Number of complaints received*
8.2	*Water supply complaints readdressed*	*Percentage of complaints received*
8.3	*Sewerage complaints received*	*Number of complaints received*
8.4	*Sewerage complaints readdressed*	*Percentage of complaints received*
8.5	*Revenue / billing complaints received*	*Number of complaints received*
8.6	*Revenue / billing complaints readdressed*	*Percentage of complaints received*
9	**Billings and Collections**	
9.1	*Average revenue of water*	*Rupees per cubic meter of water sold*
9.3	*Billing Efficiency*	*Percentage of total bills generated against total water connections*
9.4	*Collection Efficiency (Physical)*	*Percentage of total bills paid against the total bills issued*
9.5	*Collection Efficiency (Financial)*	*Percentage of total billing amount collected against the total amount of issued bills*
10	**Financial Performance**	
10.1	*Operational cost versus coverage*	*Rupees operational cost per connection*
10.2	*Working Ratio*	*Ratio of total operating expense and total revenue collected*
10.3	*Debt service ratio*	*Percentage of debt servicing cost against total revenue collected*
11	**GEDSI**	
11.1	*Grievances disaggregated by gender and vulnerability*	*Number of complaints*
11.2	*Disability-inclusive access to water points (PWD accessible)*	*Percentage of water points*
11.3	*Service satisfaction among women, elderly and vulnerable groups*	*Percentage (surveys)*
11.4	*Time spent by women/households in water collection*	*Hours per day*
11.5	*Inclusion of marginalized settlements in service coverage*	*Percentage of settlements served*

4.10 Sector Financing

4.10.1 Development Budget

The development budget for water and sanitation in Gwadar is distributed across multiple provincial and federal institutions, underscoring a fragmented institutional landscape for sector planning and delivery. Water supply schemes are primarily implemented by the PHED, while the LG&RDD undertakes local water supply, sewerage and drainage interventions. Groundwater recharge and related water resource measures fall under the Irrigation Department and city level spatial and infrastructure planning functions are led by the UP&DD. In addition, Gwadar receives federally funded projects, typically financed through the PSDP.

For FY 2024-25, the total development allocation for Gwadar was Rs. 2,209 million, against which reported expenditure reached Rs. 2,804 million, equivalent to 127 per cent of the approved budget, indicating overall over-expenditure. PHED was allocated Rs. 925 million and spent Rs. 1,066 million, reaching 115 per cent of its allocation. The Irrigation Department received Rs. 524 million but incurred expenditure of Rs. 970 million, representing 185 per cent of the approved budget and the largest proportional variance among departments. LG&RDD had a modest allocation of Rs. 10 million but recorded expenditure of Rs. 18 million, equivalent to 180 per cent of its allocation. Urban Planning did not receive an allocation in FY 2024-25 and reported no expenditure. Federally funded projects recorded both allocation and expenditure at Rs. 750 million, indicating full utilisation.

For FY 2025-26, the total development allocation for Gwadar is Rs. 1,737 million. Department-wise allocations include Rs. 1,028 million for PHED, Rs. 479 million for the Irrigation Department, LG&RDD received no budget and Rs. 10 million for Urban Planning, while federally funded projects account for Rs. 220 million. At this stage, the absence of reported expenditure figures for FY 2025-26 limits comparative assessment of budget execution performance and the extent to which prior year over-expenditure trends are being addressed.

Table 16: Allocation & Expenditure of 2024-25 & 2025-26 (Rs. Million)

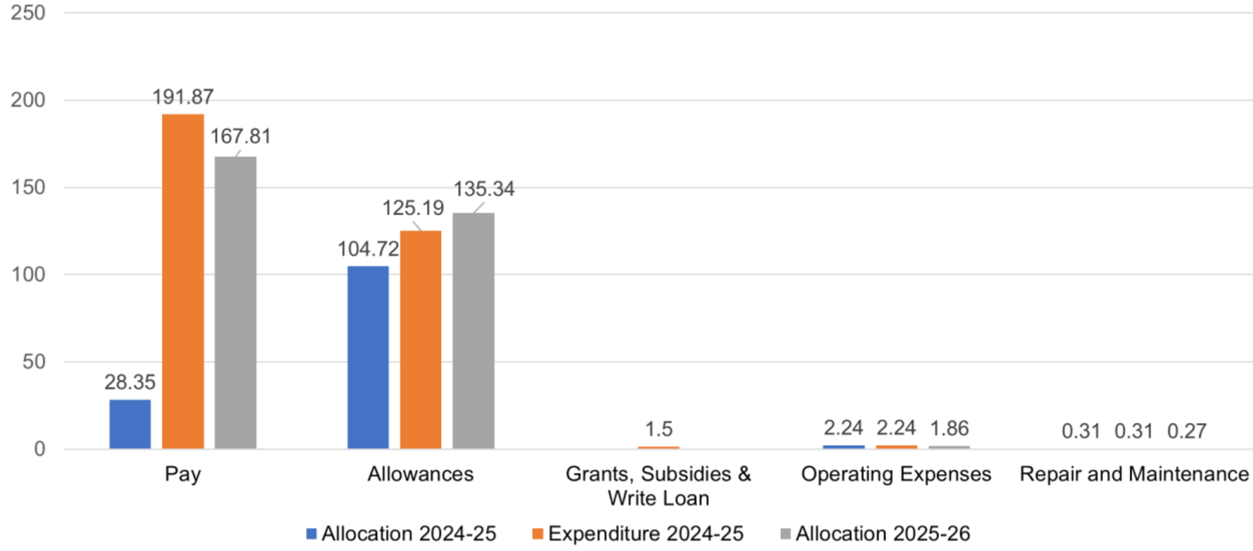
	Allocation 2024-25	Expenditure 2024-25	Allocation 2025-2026
PHED	925	1,066	1,028
Irrigation	524	970	479
LG&RDD	10	18	0
UP&DD	0	0	10
Federally funded projects	750	750	220
Total	**2,209**	**2,804**	**1,737**

4.10.2 Current Budget for PHED Gwadar

For PHE, the allocation for 2024-25 was 135.64 million but the expenditure for 2024-25 was 321.13 million. For the current year, the allocation was 305.3 million which included 303.16 million for salary and 2.13 million for non-salary expenses. The allocation for total employee expenses in 2024-25 was 133.08 million while expenditure for 2024-25 increased to 317.06 million. Within this, allocation for 2024-25 for pay was 28.35 million. But expenditure for 2024-25 rose sharply to 191.87 million. For current year, the allocation for pay is 167.81 million.

For total allowances, allocation for 2024-25 was 104.72 million and the expenditure for 125.19 million. For 2025-26, the allocation is 135.34 million. For operating expenses, both the allocation and expenditure for 2024-25 were 2.24 million. However, for 2025-26 allocation decreased slightly to 1.86 million. For Grants, subsidies and Write Off Loans, the expenditure for 2024-25 was 1.5 million. For repairs and maintenance, both allocation and expenditure for 2024-25 were 0.31 million. While allocation for 2025-26 is slightly lower at 0.27 million.

Figure 19: Allocation and Expenditure for PHED (2024–26) (in Rs. million)



4.10.3 Current Budget for Water Wing GDA

Over the past three years, the GDA has consistently faced a structural financing gap between its operational requirements for water supply and the budget approved by the Government of Balochistan. While the annual demanded budget remained constant at Rs. 287.6 million, the approved allocation was limited to Rs. 182.4 million each year, creating an inherent resource shortfall in sustaining water supply operations.

In FY 2023–24, total expenditure stood at Rs. 184.9 million for water supply, closely aligning with the approved budget and resulting in a marginal deficit of Rs. 2.5 million. However, this balance was not sustained. In FY 2024–25, expenditure increased sharply to Rs. 253.8 million, significantly exceeding the approved allocation of Rs. 182.4 million and resulting in a substantial deficit of Rs. 71.4 million. This escalation reflects growing operational pressures, particularly linked to energy consumption and system expansion. In contrast, projected expenditure for FY 2025–26 declines to Rs. 177.8 million, slightly below the approved budget, indicating possible cost containment measures or operational adjustments, although this may also reflect deferred expenditures rather than sustained efficiency gains.

Electricity consumption for water supply remains the dominant cost driver across all years. Expenditure on electricity increased from Rs. 153.8 million in FY 2023–24 to Rs. 191.8 million in FY 2024–25, before declining to Rs. 135.4 million in FY 2025–26. This consistently high expenditure underscores the energy-intensive nature of pumping water from Shadi Kaur and Sawad Dam to Gwadar City. In response to this burden, the Government of Balochistan provided a one-time subsidy of Rs. 100 million to support electricity costs along the Shadi Kaur–Sawad–Gwadar transmission system. While this intervention provided temporary fiscal relief, it does not address the underlying structural dependence on high-cost energy sources.

Other expenditure categories for water supply also show notable trends. Pay and allowances increased significantly from Rs. 10.3 million in FY 2023–24 to Rs. 18.9 million in FY 2024–25, approaching the annual demand of Rs. 21.0 million, before slightly declining to Rs. 17.0 million in FY 2025–26. POL expenditures rose from Rs. 18.9 million to Rs. 40.9 million between FY 2023–24 and FY 2024–25, followed by a sharp reduction to Rs. 8.8 million in FY 2025–26, suggesting fluctuations in operational intensity or fuel usage patterns. Repair and maintenance costs remained minimal in earlier years but are projected to increase substantially to Rs. 16.5 million in FY 2025–26, indicating anticipated system rehabilitation needs. Notably, allocations for sodium hypochloride remain unutilised across all years, signalling potential gaps in water treatment and quality assurance practices.

Table 17: Salary Charges and Operation Cost of Water Wing-GDA for Water Supply from Shadi Kaur and Sawad Dam to Gwadar City (in Rs Million)

Particulars	2023-24		2024-25		2025-26	
	Total Demanded Budget	Expenditure	Total Demanded Budget	Expenditure	Total Demanded Budget	Expenditure
Pay & Allowances	21.0	10.3	21.0	18.9	21.0	17.0
Electricity Charges	183.5	153.8	183.5	191.8	183.5	135.4
POL	60.3	18.9	60.3	40.9	60.3	8.8
Sodium hypochloride	22.7	-	22.7	-	22.7	-
Repair & Maintenance	-	1.9	-	2.3	-	16.5
Total	**287.6**	**184.9**	**287.6**	**253.8**	**287.6**	**177.8**
Budget Approved by GoB		182.4		182.4		182.4
Deficit		(2.5)		(71.4)		4.6

The above budget analysis highlights broader concerns regarding the long-term financing of WASH infrastructure in Gwadar. The scale of future investment requirements, as presented in Chapter 5 (approximately Rs. 36,628 million for water supply and Rs. 247.27 billion for sewerage and drainage systems by 2050), far exceeds the capacity of traditional public-sector financing alone. Given Gwadar's strategic importance under CPEC and its high climate vulnerability, future WASH investments will require a blended financing approach combining provincial and federal government resources, CPEC-related and Chinese financing, climate finance facilities, development partner support, PPP arrangements and private-sector investment. Developing a structured blended financing framework will be critical for mobilizing resources for desalination, renewable-energy water systems, wastewater reuse and smart utility infrastructure.

5 Investment and Sustainability Case for Gwadar District

Achieving climate-resilient WASH services in Gwadar District will require sustained investment across infrastructure, institutional systems and service delivery. Priorities include strengthening bulk water supply systems, expanding distribution networks, improving sanitation and wastewater infrastructure and enhancing energy efficiency of operations.

Given Gwadar's rapid urbanisation, climate vulnerability and fragmented service delivery between GDA and PHED, investment planning should follow a phased approach. Short-term investments should focus on operationalising existing infrastructure and addressing critical service gaps, while medium- to long-term investments should support system expansion, climate resilience and improved service efficiency.

5.1 Investment Needs for Water Supply Improvement

Anticipating rapid urban expansion and migration driven by CPEC-related development, the Gwadar Water Policy (2020) adopts a forward-looking planning approach, projecting a system capacity requirement of 16.5 MGD to meet long-term demand. While a standard per capita consumption benchmark of 25 gallons per day would suggest lower immediate demand, the policy scales projections upward to account for accelerated population growth, economic activity and future urbanisation pressures.

For the present analysis, population projections are based on the 2023 Census, with water demand estimated using a consumption benchmark of 25 gallons per capita per day. Water supply figures are based on data provided by PHED and GDA, with 2026 taken as the baseline year. A unit capital cost of Rs. 4,580.57 million per MGD, derived from the Gwadar Water Policy (2020), has been applied to estimate investment requirements for incremental supply expansion. The costing framework also considers phased infrastructure development over the period 2026–2050, aligned with projected demand growth. As the average cost per MGD derived from the Policy already incorporates inflation assumptions, no additional inflation adjustment has been applied in these investment estimations.

As of 2026, total water demand is estimated at approximately 8.23 MGD, while available supply stands at 7.1 MGD, resulting in an immediate shortfall of around 1.1 MGD. To address this gap, the investment strategy adopts a front-loaded approach, with accelerated capacity additions during the period 2027–2029. Annual supply augmentation during this phase ranges between 0.57 and 0.66 MGD, enabling the system to reach demand–supply equilibrium by 2030.

This initial phase requires relatively higher annual investments, increasing from approximately Rs. 2,602 million in 2027 to Rs. 3,035 million in 2029. These investments are critical to achieving basic service adequacy and eliminating the existing supply deficit within a short time horizon.

Following this stabilisation phase, investment requirements transition to a more gradual and predictable trajectory. From 2030 onwards, additional supply is aligned with population growth, with annual increments ranging between 0.17 and 0.38 MGD. Correspondingly, annual investment requirements stabilise at lower levels initially, before gradually increasing from approximately Rs. 761 million in 2030 to Rs. 1,726 million by 2050.

Over the long term, water demand is projected to increase steadily, reaching approximately 15.1 MGD by 2050. The cumulative investment requirement over the planning horizon is estimated at approximately Rs. 36,628 million. This reflects a structured transition from an initial phase of deficit reduction to a sustained programme of incremental capacity expansion aligned with demographic growth.

This two-phase investment approach ensures that immediate service gaps are addressed while maintaining long-term system scalability. However, infrastructure expansion alone will not be sufficient to ensure sustainable service delivery. In parallel with these investments in water production, attention must also be given to improving operational efficiency, reducing system losses, strengthening cost recovery mechanisms and ensuring reliable financing for operation and maintenance.

Table 18: Financial Forecasting for Improvement of Water Supply Services

Year	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
Population	329,201	337,629	346,272	355,137	364,228	373,553	383,115	392,923	402,982	413,298	423,879	434,730	445,859
Water demand in MGDs	8.23	8.44	8.66	8.88	9.11	9.34	9.58	9.82	10.07	10.33	10.60	10.87	11.15
Water supplied in MGDs	7.10	7.67	8.28	8.94	9.11	9.34	9.58	9.82	10.07	10.33	10.60	10.87	11.15
Additional water added (in MGDs)	-	0.57	0.61	0.66	0.17	0.23	0.24	0.25	0.25	0.26	0.26	0.27	0.28
Per MGD Cost (in Rs. Million)	4,581	4,581	4,581	4,581	4,581	4,581	4,581	4,581	4,581	4,581	4,581	4,581	4,581
Annal Investment Need on Water (in Rs. Million)	-	2,602	2,810	3,035	761	1,048	1,095	1,123	1,152	1,181	1,212	1,243	1,274
Cumulative Investment Need on Water (in Rs. Million)	**-**	**2,602**	**5,412**	**8,446**	**9,207**	**10,255**	**11,350**	**12,473**	**13,625**	**14,807**	**16,018**	**17,261**	**18,535**

Year	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
Population	457,273	468,979	480,985	493,299	505,927	518,879	532,162	545,785	559,757	574,087	588,784	603,857
Water demand in MGDs	11.43	11.72	12.02	12.33	12.65	12.97	13.30	13.64	13.99	14.35	14.72	15.10
Water supplied in MGDs	11.43	11.72	12.02	12.33	12.65	12.97	13.30	13.64	13.99	14.35	14.72	15.10
Additional water added (in MGDs)	0.29	0.29	0.30	0.31	0.32	0.32	0.33	0.34	0.35	0.36	0.37	0.38

Per MGD Cost (in Rs. Million)	4,581	4,581	4,581	4,581	4,581	4,581	4,581	4,581	4,581	4,581	4,581	4,581
Annal Investment Need on Water (in Rs. Million)	1,307	1,341	1,375	1,410	1,446	1,483	1,521	1,560	1,600	1,641	1,683	1,726
Cumulative Investment Need on Water (in Rs. Million)	**19,842**	**21,183**	**22,558**	**23,968**	**25,414**	**26,897**	**28,418**	**29,978**	**31,578**	**33,219**	**34,902**	**36,628**

5.2 Investment Needs for Sewage System Improvement

The estimation of investment requirements for the sewerage system is based on the Gwadar Water Policy (2020), adopting its phasing, cost assumptions and calculation methodology. At present, the sewerage network in Gwadar is extremely limited, covering only small and fragmented areas of the city, with an estimated network length of approximately 148 km. Given this limited baseline, the expansion of the sewerage system is driven primarily by area-based coverage rather than individual consumption patterns. Accordingly, the planning framework assumes universal coverage across Gwadar District, consistent with the approach adopted in the Policy.

The overall investment profile comprises capital expenditures for sewerage distribution networks, STPs and irrigation reuse systems, along with recurring costs, including O&M and staffing. The Policy identifies an initial investment requirement of approximately Rs. 16.38 billion for the period 2020–2026 to establish core infrastructure, including primary collection systems, treatment capacity and associated support systems. However, limited progress has been made in implementing these investments during this period. As a result, a substantial portion of this initial investment requirement remains unmet and continues to represent an immediate financing need.

From 2026 onward, investment requirements follow a phased and incremental trajectory, driven primarily by network expansion, system scaling and increasing O&M requirements. During the early expansion phase (2026–2034), annual investment requirements range between approximately Rs. 2.5 billion and Rs. 3.3 billion. These investments are largely associated with the gradual extension of sewerage distribution networks and irrigation systems, alongside rising operational costs as service coverage expands.

Significant spikes in investment occur in years where major sewage treatment plants are constructed. These include 2034–35 (Rs. 8.28 billion), 2036–37 (Rs. 13.25 billion), 2039–40 (Rs. 15.28 billion), 2043–44 (Rs. 17.73 billion), 2046–47 (Rs. 19.77 billion) and 2049–50 (Rs. 21.80 billion). These increases are driven by the capital-intensive nature of treatment infrastructure, with costs rising in line with the required treatment capacity and the volume of wastewater generated over time.

O&M costs for sewerage networks, irrigation systems and treatment plants show a steady upward trend across the planning horizon, reflecting the increasing scale and complexity of the system. Similarly, staffing costs expand in phases, corresponding to the commissioning of new infrastructure and the need for additional technical and operational personnel, particularly during later stages when treatment capacity is significantly expanded.

By 2050, Gwadar District is projected to require an estimated Rs. 247.27 billion for the development of a comprehensive sewerage and drainage system. This represents an investment requirement nearly ten times higher than that of the water supply sector. While substantial, this level of investment is critical in the context of Gwadar’s transformation into a major economic and commercial hub. Without timely development of sewerage and drainage infrastructure, the city faces significant risks of environmental degradation, public health challenges and unsustainable urban growth.

However, given the scale of required investment and the current absence of a comprehensive sewerage system, achieving universal coverage will require sustained financial commitment, strong institutional coordination and phased implementation aligned with urban growth patterns.

Table 19: Financial Forecasting for Improvement of Sewage Systems

Sr. No	Phase	Sewerage Distribution Network Construction Cost (in Rs. Million)	Sewage Treatment Plant Construction Cost (in Rs. Million)	Irrigation Network Construction Cost (in Rs. Million)	Sewerage System O&M Cost Incremental (in Rs. Million)	Irrigation Network O&M Cost Incremental (in Rs. Million)	O&M for Sewage Treatment Plant (in Rs. Million)	Staff Cost (in Rs. Million)	Total (in Rs. Million)
1	2020-2026	4,322.62	2,640.00	2,248.65	3,228.34	2,510.85	1,138.76	288.50	**16,377.74**
2	2026-2027	399.57		66.7	912.38	463.08	569.38	88.15	**2,499.26**
3	2027-2028	399.57		66.7	1,012.61	476.42	569.38	88.15	**2,612.83**
4	2028-2029	399.57		66.7	1,112.83	489.76	569.38	88.15	**2,726.39**
5	2029-2030	399.57		66.7	1,213.06	503.1	569.38	88.15	**2,839.96**
6	2030-2031	399.57		66.7	1,313.28	516.44	569.38	88.15	**2,953.52**
7	2031-2032	399.57		66.7	1,413.50	529.78	569.38	88.15	**3,067.09**
8	2032-2033	399.57		66.7	1,513.73	543.12	569.38	88.15	**3,180.65**
9	2033-2034	399.57		66.7	1,613.95	556.46	569.38	88.15	**3,294.22**
10	2034-2035	399.57	4,070.00	66.7	1,714.18	569.8	1,371.17	88.15	**8,279.58**
11	2035-2036	1,937.07		429.59	2,043.36	655.72	1,371.17	203.48	**6,640.39**
12	2036-2037	1,937.07	5,400.00	429.59	2,372.54	741.64	2,161.73	203.48	**13,246.05**
13	2037-2038	1,937.07		429.59	2,701.73	827.55	2,161.73	203.48	**8,261.15**
14	2038-2039	1,937.07		429.59	3,030.91	913.47	2,161.73	203.48	**8,676.25**
15	2039-2040	1,937.07	5,400.00	429.59	3,360.10	999.39	2,952.29	203.48	**15,281.91**
16	2040-2041	1,937.07		429.59	3,689.28	1,085.31	2,952.29	203.48	**10,297.02**
17	2041-2042	1,937.07		429.59	4,018.46	1,171.22	2,952.29	203.48	**10,712.12**
18	2042-2043	1,937.07		429.59	4,347.65	1,257.14	2,952.29	203.48	**11,127.22**
19	2043-2044	1,937.07	5,400.00	429.59	4,676.83	1,343.06	3,742.85	203.48	**17,732.88**
20	2044-2045	1,937.07		429.59	5,006.02	1,428.98	3,742.85	203.48	**12,747.98**
21	2045-2046	1,937.07		429.59	5,335.20	1,514.89	3,742.85	203.48	**13,163.08**
22	2046-2047	1,937.07	5,400.00	429.59	5,664.38	1,600.81	4,533.41	203.48	**19,768.74**

23	2047-2048	1,937.07		429.59	5,993.57	1,686.73	4,533.41	203.48	**14,783.85**
24	2048-2049	1,937.07		429.59	6,322.75	1,772.65	4,533.41	203.48	**15,198.95**
25	2049-2050	1,937.07	5,400.00	429.59	6,651.94	1,858.56	5,323.97	203.48	**21,804.61**

5.3 Return on Investment and Financial Sustainability Framework

At present, revenue generation from water supply services in Gwadar remains extremely limited. Total annual revenue is primarily derived from bulk water supply to three institutional consumers, Gwadar Garrison, Gwadar Airport and GIEDA, with negligible recovery from domestic and commercial users. In FY 2024–25, total revenue amounted to approximately Rs. 45.9 million.

This level of cost recovery is highly inadequate when compared to the projected investment requirement of approximately Rs. 36.63 billion for water supply and Rs. 247.27 billion up to 2050. The existing revenue stream is therefore structurally insufficient to finance either capital expansion or sustained operation and maintenance. Without substantial reform, the gap between required investment and internal revenue generation will continue to widen, increasing dependence on government subsidies and external financing.

5.3.1 Structural Revenue Constraints

Currently, only 22,572 domestic and commercial consumers are formally connected to the water supply system. Even within this limited customer base, systematic billing and collection mechanisms are not operational. The recently notified tariff structure, which includes a flat domestic tariff of Rs. 300 per month and commercial tariffs ranging from Rs. 5,000 to Rs. 20,000 depending on business type, has not yet been effectively implemented.

The Gwadar Water Policy (2020) envisages a total revenue potential of approximately Rs. 444.90 billion, including Rs. 416.55 billion from volumetric water charges and Rs. 28.36 billion from connection fees. However, in the current context, these projections appear highly optimistic. The absence of metering systems, weak customer databases and high levels of non-revenue water result in substantial unaccounted and unbilled consumption across the system, significantly limiting revenue realisation.

As a result, financial sustainability remains unattainable under the existing operational model. In this context, a more realistic revenue framework is required. While universal volumetric charging is not currently feasible due to the absence of consumer metering systems, a phased approach can be adopted. Initial implementation should focus on bulk consumers, industrial users, special economic zones and other large commercial customers where metering and monitoring can be introduced more rapidly. This would improve cost recovery, promote efficient water use and provide an operational foundation for the gradual expansion of volumetric tariffs over the longer term. Accordingly, this proposal adopts an equity-based tariff model combined with a flat-rate approach in the short to medium term, reflecting current institutional capacity and the absence of metering systems.

5.3.2 Revenue Potential under Universal Service Coverage

If universal service coverage is achieved by 2030, in line with the investment framework for water supply, Gwadar has significant potential to expand its revenue base. Under this scenario, the number of domestic consumers is projected to increase from 22,572 in 2026 to 60,705 households by 2030, and further to 100,643 households by 2050 based on population growth.

To support financial sustainability while maintaining equity, a transition from the current flat tariff structure to an equity-based slab system is proposed. Under this approach, households are distributed across four economic categories, each representing 25 per cent of the total consumer base. Tariff levels increase progressively across slabs, ensuring affordability for low-income households while enabling higher cost recovery from upper-income groups.

Table 20: Proposed Tariff Slabs for Domestic Connections of Gwadar

Sr. #	Economic Class/ Service Area Profile	Estimated Households in 2026	Proposed Monthly Tariff rate for 2026
1	Poor	5,643	500
2	Lower Middle	5,643	1,000
3	Upper Middle	5,643	2,000
4	Rich	5,643	3,000

Based on this model, total annual revenue is projected to increase from approximately Rs. 535 million in 2026 to Rs. 1,980 million by 2030, and further to Rs. 21,761 million by 2050. The cumulative revenue generated over the period 2026–2050 is estimated at approximately Rs. 180,850 million.

These projections are based on the following assumptions:

- Domestic tariffs increase at an annual rate of 10 per cent to reflect inflation and gradual tariff rationalisation.
- Bulk water revenues are projected based on FY 2024–25 collections, with a 10 per cent annual growth rate.
- Due to limited data on commercial connections, commercial revenue is conservatively estimated as 10 per cent of domestic revenue, serving as a proxy indicator.

While these assumptions provide a structured basis for revenue estimation, actual revenue realisation will depend on effective implementation of tariff reforms, expansion of service coverage and improvements in billing and collection systems.

5.3.3 Strategic Reform Imperative

To achieve financial sustainability, Gwadar's water supply and sanitation system requires comprehensive operational and financial reform. This includes transitioning from a grant-dependent model to a performance-oriented service delivery framework with strengthened governance, transparent billing systems and enforceable tariff mechanisms.

These reforms must be embedded within a broader institutional strengthening framework, including improvements in service reliability, operational efficiency and customer engagement. The proposed tariff restructuring should be viewed not only as a revenue measure, but as a strategic instrument to improve accountability, promote efficient water use and ensure long-term sustainability.

At the same time, to diversify financing sources, Gwadar should develop bankable investment projects aligned with CPEC Phase-II, climate finance opportunities and international investment mechanisms. Priority projects include desalination clusters, solar-powered pumping systems, wastewater reuse infrastructure, smart WASH monitoring systems and other climate-resilient water security investments. Standardized project preparation, feasibility studies and investment packaging will be essential to attract public, private and international financing partners and translate strategic priorities into implementable projects.

If accompanied by improvements in service quality and reliability, these reforms have the potential to significantly enhance financial resilience and reduce dependence on public subsidies.

Table 21: Potential for Revenue Collection

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Population	329,201	337,629	346,272	355,137	364,228	373,553	383,115	392,923	402,982	413,298	423,879	434,730	445,859
Total Household	54,867	56,271	57,712	59,189	60,705	62,259	63,853	65,487	67,164	68,883	70,646	72,455	74,310
Domestic Consumers	22,572	29,344	38,147	49,591	60,705	62,259	63,853	65,487	67,164	68,883	70,646	72,455	74,310
Households in Slab 1	5,643	7,336	9,537	12,398	15,176	15,565	15,963	16,372	16,791	17,221	17,662	18,114	18,577
Households in Slab 2	5,643	7,336	9,537	12,398	15,176	15,565	15,963	16,372	16,791	17,221	17,662	18,114	18,577
Households in Slab 3	5,643	7,336	9,537	12,398	15,176	15,565	15,963	16,372	16,791	17,221	17,662	18,114	18,577
Households in Slab 4	5,643	7,336	9,537	12,398	15,176	15,565	15,963	16,372	16,791	17,221	17,662	18,114	18,577
Slab 1 Tariff (in Rs.)	500	550	605	666	732	805	886	974	1,072	1,179	1,297	1,427	1,569
Slab 2 Tariff (in Rs.)	1,000	1,100	1,210	1,331	1,464	1,611	1,772	1,949	2,144	2,358	2,594	2,853	3,138
Slab 3 Tariff (in Rs.)	2,000	2,200	2,420	2,662	2,928	3,221	3,543	3,897	4,287	4,716	5,187	5,706	6,277
Slab 4 Tariff (in Rs.)	3,000	3,300	3,630	3,993	4,392	4,832	5,315	5,846	6,431	7,074	7,781	8,559	9,415
Monthly Domestic Revenue (in Rs Million)	37	52	75	107	144	163	184	207	234	264	298	336	379
Annual Domestic Tariff (in Rs Million)	440	629	900	1,287	1,733	1,955	2,206	2,489	2,807	3,167	3,573	4,031	4,548
Annual Commercial Tariff in Rs	44	63	90	129	173	196	221	249	281	317	357	403	455

Million (Considering 10% of domestic revenue)													
Annual Bulk Tariff in Rs Million (Considering revenues of 2024-25 with 10% annual growth)	50	56	61	67	74	81	89	98	108	119	131	144	158
Total Annual Tariff (in Rs Million)	535	748	1,051	1,483	1,980	2,232	2,516	2,836	3,196	3,603	4,061	4,578	5,161
Cumulative Total Revenue (in Rs Million)	**535**	**1,283**	**2,334**	**3,817**	**5,797**	**8,029**	**10,545**	**13,381**	**16,577**	**20,180**	**24,242**	**28,820**	**33,981**

Year	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
Population	457,273	468,979	480,985	493,299	505,927	518,879	532,162	545,785	559,757	574,087	588,784	603,857
Total Household	76,212	78,163	80,164	82,216	84,321	86,480	88,694	90,964	93,293	95,681	98,131	100,643
Domestic Consumers	76,212	78,163	80,164	82,216	84,321	86,480	88,694	90,964	93,293	95,681	98,131	100,643
Households in Slab 1	19,053	19,541	20,041	20,554	21,080	21,620	22,173	22,741	23,323	23,920	24,533	25,161
Households in Slab 2	19,053	19,541	20,041	20,554	21,080	21,620	22,173	22,741	23,323	23,920	24,533	25,161
Households in Slab 3	19,053	19,541	20,041	20,554	21,080	21,620	22,173	22,741	23,323	23,920	24,533	25,161
Households in Slab 4	19,053	19,541	20,041	20,554	21,080	21,620	22,173	22,741	23,323	23,920	24,533	25,161
Slab 1 Tariff (in Rs.)	1,726	1,899	2,089	2,297	2,527	2,780	3,058	3,364	3,700	4,070	4,477	4,925

Slab 2 Tariff (in Rs.)	3,452	3,797	4,177	4,595	5,054	5,560	6,116	6,727	7,400	8,140	8,954	9,850
Slab 3 Tariff (in Rs.)	6,905	7,595	8,354	9,190	10,109	11,120	12,232	13,455	14,800	16,281	17,909	19,699
Slab 4 Tariff (in Rs.)	10,357	11,392	12,532	13,785	15,163	16,680	18,348	20,182	22,201	24,421	26,863	29,549
Monthly Domestic Revenue (in Rs Million)	428	482	544	614	693	781	881	994	1,122	1,266	1,428	1,611
Annual Domestic Tariff (in Rs Million)	5,131	5,788	6,530	7,367	8,311	9,376	10,578	11,933	13,463	15,188	17,134	19,330
Annual Commercial Tariff in Rs Million (Considering 10% of domestic revenue)	513	579	653	737	831	938	1,058	1,193	1,346	1,519	1,713	1,933
Annual Bulk Tariff in Rs Million (Considering revenues of 2024-25 with 10% annual growth)	174	192	211	232	255	281	309	340	374	411	452	497
Total Annual Tariff (in Rs Million)	5,818	6,559	7,394	8,335	9,397	10,594	11,944	13,466	15,183	17,118	19,300	21,761
Cumulative Total Revenue (in Rs Million)	39,799	46,357	53,751	62,087	71,484	82,078	94,022	107,488	122,671	139,789	159,089	180,850

6 Strategic Reform Framework

Gwadar's transition into a strategic port city presents both a transformative opportunity and a systemic challenge for WASH and environmental service delivery. Rapid urban expansion, increasing economic activity under CPEC and heightened climate vulnerability are placing unprecedented pressure on already constrained systems. At present, service delivery is characterized by fragmented infrastructure, underutilised assets, high dependence on energy-intensive water supply systems and limited institutional coordination.

These structural constraints are further compounded by the absence of integrated data systems, weak cost recovery mechanisms and reliance on climate-sensitive water sources. As a result, Gwadar faces a dual challenge: expanding services to meet future demand while simultaneously improving the performance, efficiency and sustainability of existing systems.

In this context, traditional infrastructure-led planning approaches are insufficient. There is a clear need to transition toward a systems-based, adaptive and performance-oriented model, where water resources, service delivery, sanitation, energy, governance and financing are addressed in an integrated manner.

This Strategic Reform Framework provides a structured, phased and cross-sectoral pathway for transforming Gwadar's WASH and CEE systems. It is organized around six interlinked pillars that collectively address resource security, service efficiency, sanitation, resilience, governance and financial sustainability. The framework prioritizes operationalisation of existing assets, institutional strengthening and gradual system expansion, while embedding climate resilience and long-term sustainability into all interventions. It further positions WASH and environmental services as strategic enabling infrastructure for Gwadar Port, Special Economic Zone (SEZ), industrial development and broader economic growth under CPEC Phase-II, while supporting Gwadar's transition toward a climate-resilient and low-carbon coastal development model.

Vision

To transform Gwadar into a climate-resilient coastal district with reliable, efficient and inclusive water and sanitation systems, supported by sustainable resource management, strong institutions and financially viable service delivery models.

Mission

To enable the transition from fragmented and infrastructure-driven systems to integrated, climate-resilient and performance-oriented WASH and CEE services through strengthened governance, improved operational efficiency, diversified water resources and sustainable financing mechanisms, while enhancing water security and environmental sustainability for communities, industries, Gwadar Port and emerging economic zones.

Core Principles

1. **Systems-Based Approach:** Addressing water resources, service delivery, sanitation, energy and governance as interconnected components of a unified service system rather than isolated sectors.
2. **Climate Resilience First:** Prioritizing infrastructure and systems that can withstand climate variability, including droughts, flooding, saline intrusion and coastal risks, through risk-informed planning, climate adaptation measures and resilient infrastructure design.

3. **Operational Efficiency Before Expansion:** Maximizing the performance and utilisation of existing infrastructure before undertaking large-scale capital investments.
4. **Diversification of Water Resources:** Reducing reliance on single sources through integration of surface water, desalination, rainwater harvesting and wastewater reuse.
5. **Phased and Adaptive Development:** Implementing incremental and flexible interventions that can evolve with population growth, technological advancements and improved data availability.
6. **Equity and Inclusion:** Ensuring fair and inclusive access to services across urban, peri-urban and rural areas, with attention to vulnerable and underserved populations, while reducing disparities between rapidly developing urban centres and surrounding rural communities.
7. **Financial Sustainability:** Strengthening cost recovery, efficiency and investment planning to reduce long-term dependence on public subsidies.
8. **Data-Driven Decision Making:** Building robust monitoring, digital systems and performance frameworks to support evidence-based planning and adaptive management.
9. **Low-Carbon and Resource-Efficient Development:** Promoting renewable energy-powered water systems, wastewater reuse, resource recovery, energy efficiency and environmentally sustainable technologies that contribute to Gwadar's long-term low-carbon development pathway.

Institutional Values

- **Accountability and Performance Orientation:** Clear roles, measurable performance indicators and results-based management systems.
- **Coordination and Integration:** Strong collaboration across GDA, PHED, Municipal Committees, GPA and other stakeholders to reduce fragmentation and improve service delivery outcomes.
- **Technical Excellence and Innovation:** Adoption of modern utility practices, including digital systems, energy-efficient technologies and climate-resilient solutions.
- **Responsiveness and Adaptability:** Capacity to respond to system failures, climate shocks and evolving urban demands through proactive and flexible management.
- **Transparency and Public Engagement:** Open communication, accessible information systems, structured grievance mechanisms and active citizen participation in planning, monitoring and service improvement processes to build trust and institutional legitimacy.
- **Sustainability-Oriented Governance:** Long-term planning that balances economic growth with environmental protection, resource conservation and climate resilience.

Strategic Objectives

1. **Strengthen Water Resource Security and Diversification**: Develop a resilient and diversified water resource base through optimized use of surface water, desalination, groundwater management, rainwater harvesting and wastewater reuse, while strengthening climate adaptation and long-term water security for communities, industries and economic development corridors.

2. **Improve Service Delivery, Operational Efficiency and Energy Performance:** Enhance system performance through reduction of non-revenue water, improved asset management, energy-efficient operations and digital monitoring systems, including SCADA, GIS, MIS and smart monitoring platforms.

3. **Develop Climate-Resilient and Inclusive Sanitation Systems:** Transition toward Citywide Inclusive Sanitation by integrating sewered and on-site systems, strengthening wastewater treatment and establishing safe sludge management.

4. **Strengthen Water Quality, Public Health and Climate Resilience:** Ensure safe water supply and sanitation through improved treatment systems, water quality monitoring, public health integration and climate-resilient infrastructure.

5. **Strengthen Governance, Institutional Capacity and Service Accountability:** Improve institutional coordination, clarify roles between GDA and PHED, strengthen urban and rural service delivery systems, build technical capacity and establish performance-based management, digital monitoring and community engagement mechanisms.

6. **Achieve Financial Sustainability and Investment Efficiency:** Develop sustainable financing models through improved cost recovery, efficient expenditure management, diversified funding sources and private sector participation, supported by a rolling Gwadar Climate-Resilient WASH and CEE Investment Plan, blended financing mechanisms and preparation of bankable projects for strategic investment under CPEC Phase-II, climate finance and PPP frameworks.

6.1 Strategic Roadmap

Short Term (1–3 years)	Medium Term (4–6 years)	Long Term (7–10 years)
Pillar 1: Secure and Diversify Water Resources		
Conduct unified technical audit of all water sources (dams, desalination, groundwater, transmission systems) and prepare an integrated water resource portfolio and source sequencing plan for Gwadar District	Establish integrated water resource management system linking GDA, PHED and key stakeholders	Develop a fully regulated, climate-resilient water resource governance framework
Complete technical and operational audits of existing desalination plants, rehabilitate priority desalination facilities and restore functionality of key surface water systems (Sawad, Shadi Kaur).	Transition toward decentralized desalination infrastructure based on demand clusters and establish a district-wide desalination development programme with common technical, environmental and operational standards	Expand desalination capacity through PPP and renewable energy integration aligned with green investment and climate adaptation objectives
Establish a Desalination Programme and Technical Coordination Unit within GDA and PHED to prepare a district-wide desalination strategy, standardize technical specifications, assess priority sites and develop PPP/BOT investment models, including standard technical, environmental and operation and maintenance	Pilot modular solar-powered or solar-hybrid desalination systems in selected locations before wider expansion, supported by solar/hybrid energy solutions, international technical partnerships and environmental compliance measures including brine management	Institutionalize a climate-resilient desalination programme as a core component of Gwadar's water security strategy, supported by renewable energy integration, private-sector participation, environmental safeguards and long-term asset management systems

requirements for future desalination plants		
Protect existing groundwater sources, initiate groundwater monitoring (levels, salinity and abstraction), undertake hydrogeological assessments before additional tube-well development and identify priority locations for managed aquifer recharge, recharge wells, check dams and watershed restoration.	Implement priority watershed management, managed aquifer recharge and catchment protection measures for major dams, while strengthening groundwater monitoring systems	Establish groundwater protection and abstraction control policies integrated with coastal planning
Identify alternative water sources and reduce reliance on single supply systems	Develop multi-source water supply system (surface, desalination, limited groundwater, reuse)	Maintain a balanced and climate-resilient water resource portfolio comprising dams, bulk surface water, protected groundwater, desalination, rainwater harvesting and wastewater reuse, with periodic review based on climate conditions, population growth, water quality, operating costs and system performance.
Initiate rainwater harvesting pilots in public buildings and water-scarce settlements	Scale up urban runoff collection and local storage systems	Integrate rainwater harvesting into urban planning regulations and building codes
Initiate feasibility for wastewater reuse	Develop pilot reuse systems for irrigation and industry	Scale wastewater reuse as a core water resource component for water security, industrial use and climate resilience
Undertake feasibility assessment of the Mirani Dam–Gwadar bulk water connection, including technical, financial, environmental and institutional considerations	Complete priority Mirani Dam bulk water infrastructure, subject to feasibility, water availability and Government approval	Periodically review and optimise the district's water source portfolio to strengthen long-term climate resilience and water security
Pillar 2: Improve Service Delivery, Efficiency and Energy Performance		
Operationalize existing infrastructure through a "Fix First" programme focused on energizing pumping stations, completing unfinished transmission and distribution pipelines, restoring non-functional assets and	Restore full functionality of systems and improve network connectivity	Ensure all infrastructure operates at design capacity with preventive maintenance systems

expanding household connections		
Conduct NRW assessment and initiate leakage reduction in high-loss zones	Pilot DMAs in Gwadar city core and high-loss zones, followed by phased expansion of DMAs, bulk and zonal metering and pressure management systems across the district	Achieve continuous supply with optimized, low-loss distribution system
Introduce basic monitoring of production vs distribution and initiate billing systems	Expand metering to bulk and high-consumption users and strengthen billing and collection systems	Implement universal metering and fully automated billing linked to consumption
Conduct energy audits of pumping systems (Sawad, Chawar Dagar)	Replace inefficient pumps, document and assess the performance of PHED's existing solarised water supply schemes and prepare a phased renewable energy programme covering pumping stations, rural schemes, treatment facilities and future desalination systems	Transition to low-carbon, renewable energy-based water systems including large-scale solarization of pumping and desalination infrastructure
Introduce preventive maintenance and basic asset tracking systems	Develop GIS-based asset management and introduce SCADA initially for major dams, bulk transmission systems, strategic reservoirs and principal pumping stations. Following successful implementation and institutional capacity development, progressively expand SCADA to treatment facilities, distribution networks, district-metered areas and smaller water supply schemes	Institutionalize predictive maintenance with integrated digital systems
Improve supply distribution to underserved areas through interim allocation mechanisms	Expand network connectivity and increase population coverage	Achieve universal and equitable service coverage across Gwadar
Pillar 3: Develop Climate-Resilient Sanitation and Wastewater Systems		
Rehabilitate existing sewerage systems, STPs and wet wells to restore functionality	Expand conventional sewerage networks in high-density areas where technical and financial feasibility is	Scale up the most effective combination of centralised sewerage, decentralised treatment and improved on-site sanitation, aligned with the Gwadar Master Plan and based

	established, and improve connectivity to STPs	on settlement characteristics and operational performance
Operationalize and rehabilitate STPs, improve treatment performance, prepare reuse-linked wastewater projects for landscaping, construction and industrial demand, and review operationally proven decentralised and nature-based wastewater treatment models for application in Gwadar	Upgrade STPs to design capacity and improve energy reliability	Establish decentralized and centralized treatment systems with reuse integration, including supply options for industrial estates and CPEC-related development zones
Introduce interim sludge management practices, designate disposal sites and undertake a citywide sanitation assessment identifying areas suitable for conventional sewerage, decentralised treatment, improved on-site sanitation and faecal sludge management	Develop scheduled desludging services, regulated faecal sludge collection and treatment arrangements, and pilot decentralised wastewater treatment systems in selected peri-urban and dispersed settlements	Establish regulated sludge treatment and resource recovery systems
Promote safe on-site sanitation practices at household level	Standardize and regulate on-site sanitation systems	Formally adopt CWIS as Gwadar's sanitation planning framework, integrating sewered systems, FSM, decentralized treatment and improved on-site sanitation
Clear drains and address critical overflow and blockage points	Upgrade drainage systems to reduce flooding and contamination	Develop integrated drainage and sewerage systems for climate resilience and urban flood resilience requirements, including elevated and flood-resilient sanitation infrastructure in vulnerable areas
Control solid waste dumping into sewer systems	Establish formal waste collection systems at neighbourhood level	Fast-track integrated solid waste management, sanitary landfill and resource recovery systems aligned with CPEC port city cleanliness and SEZ environmental compliance requirements

Map sanitation infrastructure and service gaps	Develop GIS-based sanitation monitoring systems	Institutionalize CWIS-based planning and monitoring systems
Pillar 4: Strengthen Water Quality, Public Health and Climate Resilience		
Introduce chlorination at key supply points and deploy field testing kits	Establish district-level laboratory and strengthen water quality surveillance systems and pilot IoT-based smart water quality monitoring sensors in major transmission pipelines, storage facilities and strategic supply nodes through national and international technical partnerships	Institutionalize continuous water quality monitoring through integrated digital surveillance platforms, smart sensors and automated alert systems linked to utility operations and public health surveillance.
Initiate water safety plans for major water supply system in accordance with WHO/ UNICEF guideline	Implement and institutionalize water safety plans across major urban and rural water supply schemes, integrating risk assessment, monitoring and corrective action procedures	Institutionalize risk-based water quality management through utility-wide water safety plans and continuous compliance monitoring
Repair damaged pipelines and control contamination risks	Replace ageing pipelines and improve distribution safety	Develop climate-resilient water distribution networks using corrosion-resistant materials and designs suitable for coastal and saline environments.
Introduce basic regulation of tanker water quality and supply	Formalize tanker operations through licensing and standards	Reduce dependence on tanker supply through regulated piped systems
Conduct public awareness on safe water handling and hygiene	Integrate water quality monitoring with health surveillance systems	Establish preventive public health systems linked with WASH
Introduce simple early warning systems and community preparedness	Develop formal disaster response protocols for floods, droughts and cyclones	Integrate early warning systems into digital platforms with PDMA/PMD
Initiate drainage clearing and flood risk mitigation measures	Upgrade drainage systems and introduce stormwater management	Develop integrated drainage systems aligned with climate projections
Pilot nature-based solutions, including rainwater harvesting, managed aquifer recharge and mangrove restoration, in climate-vulnerable areas	Scale ecosystem-based coastal protection, mangrove restoration, watershed rehabilitation and groundwater recharge systems	Integrate nature-based solutions, including mangrove protection and coastal ecosystem restoration, into urban planning and climate systems, supporting Gwadar's long-term low-carbon and

		climate-resilient development vision.
Pillar 5: Strengthen Governance, Institutions and Human Capacity		
Document and formalise the current allocation of urban and rural WASH responsibilities between GDA and PHED, including asset ownership, operational responsibilities, source management, revenue authority, water quality monitoring, operation and maintenance financing and coordination arrangements. Recognise the current institutional arrangement as transitional pending completion of a long-term institutional options assessment	Undertake an independent institutional options assessment for long-term urban WASH service delivery in Gwadar, evaluating WASA-type, ring-fenced, municipal, provincial, corporate and other semi-autonomous utility models	Implement the utility-based institutional model approved by the Government of Balochistan following completion of the institutional options assessment, ensuring clear separation of policy, regulation, asset ownership and service delivery functions
Clarify institutional mandates and formally demarcate urban and rural WASH service areas, with PHED leading rural water supply, bulk water systems and climate adaptation functions and GDA leading urban utility service delivery within the Master Plan area	Establish formal coordination mechanisms and operational protocols	Develop unified WASH governance framework supporting climate-resilient urban growth, port operations and SEZ development through a permanent multi-agency WASH governance platform
Establish a Gwadar WASH Coordination Unit under the Deputy Commissioner bringing together GDA, PHED, GPA, Municipal Committee and key provincial agencies for joint planning, monitoring and issue resolution	Institutionalize inter-agency planning, data sharing and decision-making systems across urban and rural service providers	Integrate the coordination platform into a permanent multi-agency WASH governance framework
Establish dedicated water and sanitation unit within GDA	Develop structured technical and managerial cadre for WASH	Transition the GDA Water and Sanitation Unit into a semi-autonomous Gwadar Water and Sanitation Utility
Fill critical technical vacancies including sub-engineers, plant operators, electricians, SCADA technicians, planners and water quality specialists, while	Implement competency-based HR systems and structured training programs	Institutionalize professional, performance-based utility workforce

strengthening the field workforce		
Introduce basic digital systems for HR, monitoring and reporting	Develop integrated MIS and real-time WASH performance monitoring systems covering service levels, NRW, water quality, sanitation, energy efficiency, financial performance and KPI reporting	Establish fully integrated digital utility platform
Establish structured community participation mechanisms covering WASH needs assessment, project prioritisation, feasibility studies, infrastructure design, implementation monitoring, operation and maintenance arrangements, customer feedback and service performance monitoring, ensuring meaningful participation of women, persons with disabilities, fishing communities and other underserved groups	Develop integrated community engagement and complaint management systems that document community feedback, institutional responses, agreed corrective actions and follow-up status, and integrate findings into annual planning and management reviews	Implement real-time digital citizen engagement systems
Initiate KPI-based monitoring framework covering hours of supply, service coverage, NRW, water quality, customer complaints and urban-rural service equity	Standardize service-level KPI reporting and benchmarking across institutions through annual performance reviews	Institutionalize performance-based planning and management
Introduce basic HSE protocols and training	Develop standardized safety and environmental systems	Institutionalize comprehensive HSE and regulatory compliance frameworks
Conduct capacity needs assessment and establish technical cooperation partnerships with national and international institutions, including Chinese utilities, universities and technology providers	Implement specialized training and certification programmes in desalination, SCADA, NRW management, wastewater reuse, PPP management, asset management and utility performance improvement through national and international partnerships	Institutionalize continuous professional development, technical exchange programmes and utility leadership development systems
Pillar 6: Achieve Financial Sustainability and Investment Efficiency		

Prepare the Gwadar Climate-Resilient WASH and CEE Investment Plan, including project prioritization, climate-risk screening, infrastructure readiness assessments and preliminary economic and climate-benefit analysis of major investments.	Operationalize and periodically update the Investment Plan while introducing sector-wide investment prioritization frameworks incorporating climate-risk screening, green investment criteria and low-carbon WASH objectives, and preparing a pipeline of bankable and flagship projects for desalination clusters, solar-powered pumping systems, wastewater reuse, NRW reduction and smart WASH systems linked to CPEC, Chinese cooperation mechanisms and international financing opportunities while strengthening industrial water security, SEZ development and investor confidence in Gwadar	Institutionalize a rolling multi-year Gwadar Climate-Resilient WASH and CEE Investment Plan supporting Gwadar's transition as a climate-resilient and low-carbon demonstration city under CPEC Phase-II through integrated public, private and climate-finance investments
Create dedicated O&M and energy budget lines for water systems	Develop sustainable O&M financing models	Institutionalize lifecycle-based asset financing
Operationalize tariff structures and initiate billing systems, including volumetric metering and charging for bulk consumers, industrial users and major institutional customers	Expand volumetric metering and tariff systems to commercial and high-consumption users while improving collection efficiency and tariff equity	Transition to volumetric, cost-reflective tariff systems
Strengthen financial tracking and reporting systems	Develop integrated financial management systems	Institutionalize digital financial systems with real-time monitoring
Mobilize external funding through PSDP, CPEC Phase-II programmes, climate finance facilities, development partners and private investment mechanisms	Develop blended financing strategies combining public funding, CPEC/Chinese financing, climate finance, PPPs and private investment, aligned with the Pakistan Green Taxonomy	Establish diversified financing model combining public, private and climate funds
Initiate PPP opportunities in desalination and wastewater reuse and renewable-energy water infrastructure	Develop structured PPP frameworks and pilot projects for desalination, wastewater reuse and climate-resilient urban infrastructure	Scale private sector participation in service delivery while leveraging climate and green financing opportunities

Initiate financial baseline and cost analysis	Develop medium-term financial planning frameworks	Achieve financially sustainable WASH system with reduced subsidy dependence
Establish NRW baseline and quantify financial losses associated with physical and commercial water losses	Create a NRW reduction investment mechanism that reinvests verified savings from leakage reduction, metering and efficiency improvements into network rehabilitation and service expansion	Institutionalize performance-based financing where NRW reduction savings support continuous infrastructure renewal and service improvements

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8 Annexure

8.1 Annex I: Sanctioned Posts, Existing Staff and Vacant Post at PHE Gwadar

Sr. No.	Nomenclature of Post	BPS	Total Sanctioned Strength	Working Strength	Vacant Position
1	Executive Engineer	BPS-18	1	1	0
2	Sub Divisional Officer	BPS-17	5	4	1
3	Divisional Accounts Officer	BPS-17	1	0	1
4	Community Dev. Officer	BPS-16	1	1	0
5	Head Draftsman	BPS-13	1	1	0
6	Steno Typist	BPS-12	1	0	1
7	Sub Engineer	BPS-11	9	5	4
8	Head Clerk	BPS-14	1	1	0
9	Draftsman	BPS-11	2	2	0
10	Community Dev. Worker	BPS-11	1	1	0
11	Senior Accounts Clerk	BPS-11	1	1	0
12	Sub Divisional Clerk	BPS-14	5	5	0
13	Junior Clerk	BPS-11	3	3	0
14	E/M Supervisor	BPS-11	1	1	0
15	Mechanic	BPS-8	2	2	0
16	Supervisor Mechanic	BPS-9	1	1	0
17	Supervisor	BPS-9	1	1	0
18	Assistant Store Keeper	BPS-6	1	1	0
19	Electrician	BPS-8	3	3	0
20	Engine Driver	BPS-5	13	12	1
21	Foreman	BPS-11	2	1	1
22	Operator	BPS-4	14	14	0
23	Pipe Fitter	BPS-5	6	6	0
24	Pump Driver	BPS-5	34	33	1
25	Tanker Driver	BPS-5	6	5	1
26	Tracer	BPS-5	2	2	0
27	Truck Driver	BPS-5	1	1	0
28	Dozer Driver	BPS-7	1	1	0
29	(Driver)	BPS-4	7	6	1
30	Camel Man	BPS-5	1	1	0
31	Cleaner	BPS-5	4	3	1
32	Mate	BPS-2	4	4	0
33	Patroller	BPS-1	45	42	3
34	Valveman	BPS-2	96	95	1
35	Barkandaz	BPS-1	4	4	0
36	Beldar	BPS-1	19	19	0
37	Chowkidar	BPS-1	53	50	3

38	Cook	BPS-1	1	1	0
39	Coolly	BPS-2	14	14	0
40	Daffedar	BPS-1	1	1	0
41	Dak Runner	BPS-1	3	3	0
42	Fero Printer	BPS-1	1	0	1
43	Gauge Reader	BPS-1	3	2	1
44	Helper	BPS-2	32	29	3
45	Mali	BPS-1	2	1	1
46	Naib Qasid	BPS-1	12	11	1
47	Plumber	BPS-4	5	4	1
48	Sweeper	BPS-1	3	3	0
49	Water Carrier	BPS-1	4	3	1
50	Helper Contract	BPS-2	1	1	0
51	Chowkidar Contract	BPS-1	2	2	0
52	Beldar Contingent (Fixed)	Fixed	21	-	21
53	Chowkidar Contingent (Fixed)	Fixed	25	-	25
54	Electrician (Fixed)	Fixed	2	-	2
55	Engine Driver (Fixed)	Fixed	4	-	4
56	Helper Contingent (Fixed)	Fixed	12	-	12
57	Operator Contingent (Fixed)	Fixed	4	-	4
58	Petroller Contingent (Fixed)	Fixed	23	-	23
59	Pump Driver Contingent (Fixed)	Fixed	17	-	17
60	Plumber Contingent (Fixed)	Fixed	5	-	5
61	Valveman Contingent (Fixed)	Fixed	36	-	36
	Grand Total		**586**	**408**	**178**

8.2 Annex: Current Staffing in the GDA

Sr. No.	Designation	BPS	No. of Post
1	Chief Engineer	20	1
2	Superintending Engineer (Water Wing)	19	1
3	Executive Engineer (Transmission)	18	1
i.	Assistant Engineer	17	2
ii.	Sub-Engineer	11	2
iii.	Supervisor	9	2
iv.	Electrician	8	4
v.	Generator Operator	5	12
vi.	Pump Operator	5	18
vii.	Mechanical Technicians	8	4
viii.	Plumber	4	4
ix.	Fitter	5	6
x.	Helper	2	8
xi.	Valve man	2	16
xii.	Security Guard / Chowkidar	2	14
xiii.	Patroller (Line Watchman)	2	12
4	Executive Engineer (Distribution)	18	1
i.	Assistant Engineer	17	2
ii.	Sub-Engineer	11	2

iii.	Supervisor	9	2
iv.	Electrician	8	3
v.	Generator Operator	5	10
vi.	Pump Operator	5	20
vii.	Mechanical Technicians	8	2
viii.	Plumber	4	4
ix.	Fitter	5	4
x.	Helper	2	10
xi.	Valve man	2	50
xii.	Security Guard / Chowkidar	2	10
xiii.	Patroller (Line Watchman)	2	12
5	Executive Engineer (Billing)	18	1
i.	Assistant Engineer	17	1
ii.	Sub-Engineer	11	2
iii.	Account Officer	17	1
iv.	Recovery Officer	16	1
v.	Assistant Recovery Officer	14	3
vi.	Social Mobilizer	9	1
vii.	Operation Manger	9	1
viii.	Meter Reader	5	6
ix.	Meter Inspectors	5	3
x.	Bill Distributer	2	6
xi.	Meter Repair and Calibration Staff	2	5
6	Ministerial Staff		
i.	Office Superintendent	17	1
ii.	Office Assistant	11	3
iii.	Senior Clerk	14	6
iv.	Junior Clerk	11	6
v.	Store Keeper / Verifier	14	2
vi.	Store Issuer	8	2
vii.	Telephone Operator	5	1
viii.	Computer Operator	16	3
ix.	Sweeper	2	4
x.	Peon	2	4
xi.	Cook	2	3
xii.	Drivers	4	6
	Total		**311**