2.9 Nepal

1 | Country Information

Table 2.9.1 Basic indicators

Land Area (km^2)		147,181*
Total Population		30.16 million**
GDP (current USD)		31.83 billion (2020)***
GDP per capita (current USD)		1,085 (2020)***
Average Precipitation (mm/year)		1,530 (2014)
Total Renewable Water Resources (km^3)		210.2 (2014)
Total Annual Freshwater Withdrawals (billion m^3)		29.31 (2017)
Annual Freshwater Withdrawals by Sector	Agriculture	98.26% (2017)
	Industry	1.7% (2017)
	Municipal (including domestic)	0.03% (2017)

* The country's official land area is being updated with reference to the new country map approved by the parliament in 2020
(Source: **NPC 2020 (2020 projection), ***GoN 2019, WEPA 2018)

Figure 2.9.1 Trishuli River in Nepal

2 | State of Water Resources

Nepal has abundant water resources. Average annual precipitation is around 1,500 mm, ranging from over 6,000 mm along the southern slopes of the Annapurna Range in central Nepal to less than 250 mm in the north-central portion near the Tibetan plateau. About 10% of total precipitation in Nepal falls as snow, mostly in the 23% of Nepal's total area that lies above the permanent snowline of 5,000 m. There are 3,252 glaciers covering an area of 5,323 km^2 (or 3.6% of Nepal's total area), with an estimated ice reserve of 481 km^3, and 2,323 glacial lakes, covering an area of 75 km^2. The snow-capped Himalayas is the main source of rivers in the country, especially during the dry season.

There are about 6,000 rivers in Nepal, with a total drainage area of 191,000 km^2, 74% of which lies in Nepal. Three categories of river systems predominate, based on their origin. The first comprises four main river systems from east to west, respectively: Koshi, Gandaki, Karnali, and Mahakali river systems, all of which originate from glaciers or snow-fed lakes in the Himalayas. River systems in the second category originate in the Mahabharat range in the mid-hills, and include Babai, West Rapti, Bagmati, Kamala, Kankai and Mechi river systems. River systems in the third category include streams or rivulets from the Chure hills bordering the Terai plain region in south Nepal, the streams and rivulets of which generally cause flash-flood during monsoon rains and remain dry or with very low flow during the dry season.

An assessment has identified 5,358 wetlands in Nepal including high altitude glacier lakes in the Himalayas, natural lakes as well as ponds, dams and other small wetlands (NLCDC 2009). Of these, 329 lakes (including ponds, small wetlands) up to 3,000 m elevation are roughly evenly distributed across seven provinces of Nepal, except in the far west where there are only 21 lakes (Table 2.9.2) (NLCDC 2018).

Table2.9.2 Distribution of lakes in seven provinces in Nepal

Province	Total Lakes
Province No. 1	73
Province No. 2	86
Bagmati Province	36
Gandaki Province	61
Lumbini Province	52
Karnali Province	14
Sudurpashim Province	7
Total	**329**

(Source: NLCDC 2018)

The annual rechargeable groundwater reserve is 8.8 billion m^3, of which less than 2 billion m^3 is currently extracted, mostly for groundwater irrigation in the southern Terai region (WECS 2011). Usually, people living in the Terai (lowland), inner valleys in the hills and mountains extract groundwater for domestic as well as industrial uses.

3 | State of Ambient Water Quality

Water quality of public water bodies is generally considered good. However, urban areas, especially

Kathmandu Valley and Pokhara, suffer from degradation due to direct disposal of huge volumes of untreated or insufficiently treated domestic and industrial wastewater. Solid waste dumped directly into rivers and lakes also negatively contribute to state of water environment.

Increased use of fertilizers and pesticides also impact water quality of surface and groundwater, especially, in peri-urban areas where commercial farming (such as vegetables) is extensive. During the rainy season there are increased incidences of water borne diseases due to unsafe drinking water and sanitation, especially, in rural areas.

3.1 Rivers

Table 2.9.3 and 2.9.4 summarizes the state of water quality in some key locations. Pollution of rivers in urban areas, soil erosion in rural areas, mining of sand and rocks are the three main factors impacting river water quality. Sedimentation in rivers is prominent in the rainy season due to soil erosion and runoff. Development activities such as sand mining, encroachment of river banks and improper river bank protection works have also caused serious sedimentation issues. Over the last decade increased mining of sands, stones by small and medium-sized crusher enterprises have resulted in increased sedimentation in the rivers, with serious turbidity and ecological impacts (such as changing courses of rivers and river bank erosion).

Table 2.9.4 State of water quality in selected river system

Location / River	pH	TDS (mg/L)	DO (mg/L)	BOD (mg/L)
Mechi	8.3	30	8.9	1.8
Kankai	7.7	60	8.7	2
Arun	6.2	200	9.1	2.1
East Rapti (Sauraha)	7.8	213	8.7	2.5
Seti (Ramghat)	8.2	222	9.3	2
Bheri (Chatagaon)	7.8	208	9.3	1.1
Karnali (Chisapani)	7.8	264	10.5	1.5
Mahakali (Pancheswor)	8.8	110	5	2
Desired value	*6.5–8.5**	*<1000**	*>5.0*	*<30*

* NDWQS : National Drinking Water Standard

(Source: Department of Hydrology and Meteorology 2018)

Table 2.9.3 State of water quality in selected rivers across Nepal shown for upstream-downstream sections (2016)

	pH	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TDS (mg/L)	EC (µS/cm)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	TOC (mg/L)	TH (mg/L)	Mg (mg/L)	Fe (mg/L)	TC (MPN/ 100ml)	E-coli (MPN/ 100ml)
Desired Value	6.5–8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100*	<0.3*	0*	0*
Bagmati (Sundarijal-Khokana**)	6.6–7.4**	14.8–1.2	9.6–90.5	24.8–192	380–810	460–970	10–70	0.1–0.3	0.1–0.1	6.8–30	140–90	21.1–10.6	0.5–3.9	500–900	40–50
Bishnumati (Budhanilkantha-Teku Dovan)	7–7.5	12.5–0.9	15.4–167	36.7–178	120–920	187–1360	90–90	0.5–0.5	0.2–0.1	22.6–34.6	160–130	24.5–43.7	0.5–5.7	900–1600	110–170
Nakhu- Saibu	8–8.1	2.1–7.1	40.5–5.4	78–15.9	120–920	650–300	90–30	0.5–0.2	0.13–<0.1	12.1–3.6	100–120	12.3–24.7	4.2 – 2.8	1600–900	110–70
Hanumante (Sallaghari-Thimi)	8.5–7.3	1.8–15.1	33.0–48.9	120–90.7	1530–1290	1800–1600	160–180	2.4–2.7	0.2–0.1	45.6–26.7	80–120	9.8–10.2	6.4–6.5	1600–1600	120–90
Manahara (Pepsikola-Balkumari)	7.4–7.6	7.0–3.9	14.5–23.8	23.7–40.5	620–980	870–1450	60–60	2.3–2.0	0.2–0.2	4.5–12.8	60–80	7.8–11.8	4.9–6.1	1600–500	140–40
Seti Pokhara (Mardi- Dobila)	7.4–7.6	8.1–8.7	1.2–1.3	2.4–2.6	110–150	130–170	1.5–2.8	0.13–0.1	0.05–0.01	2.0–2.0	120–170	9.8–6.9	0.3–3.8	500–500	50–40
Narayani (Bridge-Devghat mixed)	7.3–7.1	11.2–9.7	0.88–1.5	2.5–3.5	170–160	200–180	2.0–1.1	3.5–3.9	0.1 – 0.1	2.0–5.0	340–180	25.6–22.9	0.2–0.3	900–900	60–70
Sirsiya (Parwanipur - Ghadiharwa Pokhara)	6.5–6.6	1.1–1.1	87.3–88.6	123.1–78	390–750	410–710	80.0–90.0	8.9–3.6	0.1 – 0.2	23.0–33.0	300–240	24.6–25.9	3.9–3.7	1600–900	170–110
Tinau (Jhumsa bridge-Radhakrishna Tole)	7.2–7.5	10.4–9.5	1.6–1.5	2.6–3.9	200–220	220–220	0.9–1.0	0.5–0.5	0.02–0.01	4.0–4.0	200–200	14.5–9.8	0.1–0.1	900–500	70–30

* NDWQS : National Drinking Water Standard

** corresponds to upstream and downstream sections of the rivers shown in the table.

(Source: GoN 2016)

3.2 Lakes and Reservoirs

Lake water in the country is generally good. However, some lakes are under pressure from economic development, tourism activities, and population. Table 2.9.5 shows the state of water quality in two lakes, one in Kathmandu and the other in Pokhara. In the Phewa Lake, which a major tourist attraction in Pokhara, there are several hotels and residents established along the lake. Disposal of wastewater into the lake often causes eutrophication and algal bloom at several locations.

Table 2.9.5 State of water quality in the Phewa Lake (Pokhara) and Taudaha (Kathmandu) (2016)

	pH	DO (mg/L)	BOD (mg/L)	COD (mg/L	TDS (mg/L)	EC (µS/cm)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	TOC (mg/L)	TH (mg/L)	Mg (mg/L)	Fe (mg/L)	TC (MPN/ 100m)	E-coli (MPN/ 100m)
Desired Value	6.5–8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100*	<0.3*	0*	0*
Phewa Lake (Halanchowk - Dam site), Pokhara	7.5–7.6	7.9–8.0	2.5–2.1	5.7–5.7	50–50	50–60	1.6–1.6	0.11–0.16	0.07–0.07	5–4	120–120	6.7–11.1	0.1–0.1	900–900	70–70
Taudaha (Locations 1-3), Kathmandu	8.2–8.1	8.9–8.9	17.1–25.9	24.5–33.8	90–85	175–167	50–37.8	0.3–1.0	0.1–0.1	10.1–13.8	160–130	12.8–19.4	0.9–0.8	900–500	70–40

* NDWQS : National Drinking Water Standard

(Source: GoN 2016)

3.3 Groundwater

Groundwater contamination in Nepal is caused by pathogenic bacteria, pesticides, nitrate and effluents from industrial and domestic sources. Unplanned urban development and insufficient waste management facilities are the main causes of groundwater pollution in rural areas. In Kathmandu Valley, long-term deterioration of groundwater quality is continuously being reported such as nitrogen contamination in shallow wells (Shakya et al. 2019). Table 2.9.6 shows groundwater quality at key locations.

Table 2.9.6 State of groundwater quality in selected locations

		Temp. (°C)	pH	EC (µS/cm)	Turbidity (NTU)	Hardness (mg/L)	Cl (mg/L)	Total Alkalinity (mg/L)	Fe (mg/L)	As (mg/L)	F (mg/L)
Desired value		-	6.5–8.5*	<1500*	<5*	<500*	<500*	-	<0.3*	<0.05*	0.5–1.5*
Kathmandu Valley	Shallow Well	18.6	7.1	874.5	45.9	230.7	81.8	366.0	1.47	0.004	0.43
	Tube Well	17.9	7.0	576.8	54.8	218.8	61.1	258.0	1.90	0.003	0.27
	Deep Tube Well	20.3	7.0	704.2	33.2	251.2	59.0	302.7	1.80	0.009	0.74
East Terai (Jhapa, Morang and Sunsari) (2018)**	Groundwater	27	6.9	445	12.7	191.6	17	197.6	1.83	0.005	0.235
Far west Terai (Kailali) (2014)***	Groundwater	25.6	6.96	838.25	22.13	323	24.88	-	2.01	0.01	0.25

* NDWQS : National Drinking Water Standard

(Source: **Mahato et al. 2018, ***Gurung et al. 2015)

4 | State of Wastewater Treatment

Discharge of untreated wastewaters and dumping of septic sludge from on-site sanitation systems into rivers is common due to lack of adequate facilities to treat wastewater. An estimated 876 million liters per day (MLD) of domestic wastewater is generated in Nepal, as shown in Figure 2.9.2 About 70% of this comes from on-site sanitation (faecal sludge) and only 30% of wastewater is collected through sewer networks. However, of the collected wastewater, only around 7% is treated while 93% (i.e. 268 MLD) is disposed of untreated. An estimated 20.1 MLD of wastewater is treated either in centralized WWTP or DEWATS systems.

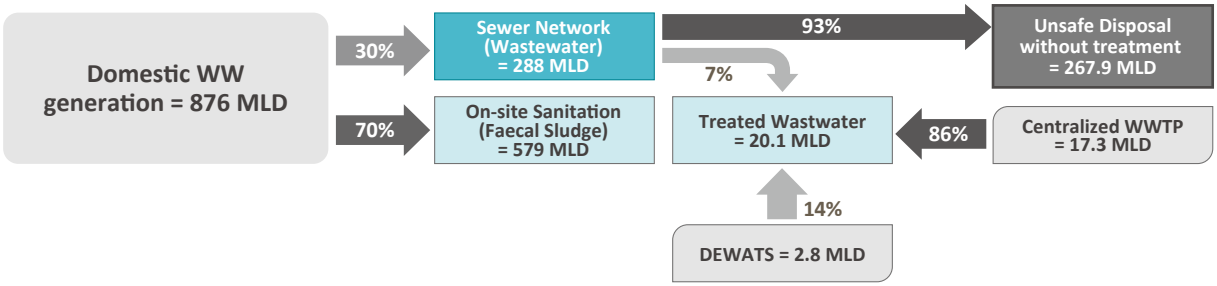

Figure 2.9.2 Domestic wastewater (WW) management in Nepal as of 2017 (Source: GoN 2018)

Septic tanks and pit latrines in urban localities have posed the risk of ground water pollution. Rapid, unplanned urban growth and the lack of adequate investment are responsible for the current poor state of wastewater management in Nepal, especially Kathmandu Valley.

Management of industrial wastewater is largely unknown due to lack of reported data, while the Department of Environment lacks the resources and capacity (human resources for monitoring/sampling and analysis labs) to enforce compliance with existing effluent standards. Industries, especially small and medium-sized enterprises, are unable to invest in costly treatment facilities as relevant acts and regulations on effluent discharge came into effect several years after these industries were established.

The tariff for wastewater in Nepal is based on water consumption either metered (block tariffs) or unmetered (flat rate) according to pipe size. Kathmandu Upatyaka Khanepani Limited (KUKL) tariff for sewer connection (and wastewater treatment, if available) is 50% of the water consumption fee (KUKL 2021).

5 | Frameworks for Water Environmental Management

5.1 Legislation

Nepal has enacted various acts and regulations related to the environment and water since the 1980s such as the Water Resource Act (1992), Drinking Water Rules (1998), Water Resource Strategy (2002), Drinking Water Quality Standards (2005). After Nepal become a federal republic comprising three layers of government (local, provincial and state), the new Constitution of Nepal 2015 (2072 BS) guaranteed the rights to a clean environment, healthcare and conservation, management and use of natural resources. The constitution also ensures the right of access to basic clean drinking water and sanitation services. Several articles of the constitution have provisions on water and the environment, while the government is either revising or in the process of finalizing new acts and regulations as part of legal or institutional reform under the new federal administration (Table 2.9.7). The Environment Protection Act (2019),

Table 2.9.7 Key provisions related to water environment in the new constitution and recent acts and policy documents

Name	Category	Year	Purpose/arrangements
Constitution of Nepal	Constitution	2015	Every citizen shall have the right to live in a clean and healthy environment; victims of environmental pollution shall be entitled the right to compensation from the polluter; right of access to basic clean drinking water and sanitation services; conservation and multiple uses of water resources; use of forests and water resources and management of environment
Environment Protection Act	Act	2019	The umbrella Act governing over all environmental protection issues of the country.
Forest Act	Act	2019	This Act governs all forest and related resources focusing on forest management, while contributing to the conservation of wildlife, environment, and water resources.
National Climate Change Policy, 2019	Policy	2019	Utilizes opportunities for various types of assistance through the framework of conventions for the purpose of climate change management in line with the national priority and local needs while complying with international provisions.
National Environment Policy 2019	Policy	2019	Guides the implementation of environment related laws and other thematic laws, realizes international commitments and enables collaboration between all concerned government agencies and non-government organizations on environmental management actions.
National Water Resources Policy	Policy	2020	The policy aims to cover all aspects of water resources development and management based on the Integrated Water Resources Management (IWRM) principle and newly restructured three tiers of government.
Environment Protection Rules	Rule	2020	This Rule is based on the new Environment Protection Act 2019.
Water Supply and Sanitation Act	Act	Under Parliament	This Act governs all water supply and sanitation protection of the country.
Water Resources Act (Draft)	Act	Under drafting	The draft Act will be the new water resources act for the execution of new policy which covers all aspects of water resources development and management.

National Environment Policy (2019), National Climate Change Policy (2019), and Integrated National Water Resources Policy (2020) are prominent acts/policies issued since adoption of the new constitution. The Water Supply and Sanitation Act is currently awaiting approval in the parliament while the Integrated National Water Resources Act is in the final stage of drafting.

5.2 Institutional Arrangement

The Ministry of Forests and Environment is responsible for environmental protection through managing and coordinating the country's environmental protection policies and measures. The Department of Hydrology and Meteorology (DHM) under Ministry of Energy, Water Resources and Irrigation (MOEWRI) implements and coordinates the monitoring of river hydrology, climate, agro-meteorology, sediment, air quality, water quality, limnology, snow hydrology, glaciology, and wind and solar energy. The Groundwater Resources Development Board monitors the quality of underground as well as surface water. The Water and Energy Commission Secretariat (WECS) has assumed the role of apex body for national planning related to water and energy through the formulation and provision of assistance to water and energy-related policy and strategy development. WECS is also mandated to ensure sustainability by integrating environmental agenda into development policies. Various ministries and line agencies at the national level promote water and environmental management, requiring these ministries to coordinate the work between them (Table 2.9.8).

Table 2.9.8 Key institutions and mandated areas relevant to water environment

Name of the Institution	Level	Mandated Working Area
Ministry of Energy, Water Resources and Irrigation (MOEWRI)	Central	Overall Energy, Hydropower, Irrigation and Water Resources development of the country.
Department of Water Resources and Irrigation	Central	Department of Water Resources and Irrigation is responsible for planning, developing, implementing and monitoring of various central level surface and groundwater irrigation systems by utilizing available surface and ground water resources.
Department of Hydrology and Meteorology (DHM)	Central	DHM is responsible for collecting, processing, publishing and disseminating hydrological and meteorological data and monitoring river hydrology, water quality, sediment, limnology, snow hydrology, glaciology, weather, climate, agro-meteorology, air quality and solar energy in the country.
Water and Energy Commission Secretariat (WECS)	Central	Policy and planning regarding energy and water resources development and management covering all sectors. Advisory role on critical issues related to large water resources projects.
Ministry of Water Supply (MWS)	Central	Water supply, sanitation and hygiene development and management of the country.
Department of Water Supply and Sewerage Management (DWSSM)	Central	The Department of Water Supply and Sewerage Management (DWSSM) is responsible for planning, implementing, operating and maintenance of water supply and sanitation systems throughout the country.
Nepal Water Supply Corporation (NWSC)	National Corporation	NWSC is a public utility organization and autonomous government body, and provides drinking water supply services to the 20 cities within the country.
Ministry of Forests and Environment (MOFE)	Central	Forest resources and environmental development, with a mandate covering environmental management and enforcement.
Department of Environment	Central	Responsible for the implementation and compliance of Environmental Protection Act, and Rule (EPR), and pollution control standard as promulgated by the Government of Nepal.
Ministry of Urban Development	Central	Overall urban planning, development and Management for the development of municipalities in the country.
Ministry of Physical Infrastructure Development	Provincial	Provincial level policy planning formulation and development of various physical infrastructure, and their environmental management.
Ministries of Industry, Tourism, and Forests and Environment	Provincial	Provincial level policy planning formulation and development related to forests, environment, conservation of biodiversity, adaptation to climate change and science and technology.
Kathmandu Upatyaka Khanepani Limited (KUKL)	Kathmandu Valley	KUKL is responsible for the operation and management of water and wastewater services in the Valley, and will assume responsibility for infrastructure built by the Melamchi Water Supply Project.
Local Units	Local	Local level planning and development in close coordination with the province.

5.3 Water Quality Standards

Ambient water quality standards

There are separate standards and guidelines for different uses (drinking water, irrigation, aquaculture, livestock, and recreation) in addition to Nepal Water Quality Guidelines for the Protection of Aquatic Ecosystem (2008).

Monitoring framework

Systematic ambient water quality monitoring is not yet conducted in public water bodies in the country, although water quality is monitored by different ministries and agencies for different purposes. For instance, regular monitoring of the water quality of the Bagmati River in the Kathmandu Valley area is conducted by the High Powered Committee for the Integrated Development of the Baghmati Civilization, which started publishing data for the general public in February 2014. Department of Hydrology and Meteorology under the MOEWRI monitors river and lake water quality. For drinking water, water supply providers are required to monitor different water quality parameters under the surveillance of concerned agencies under the Ministry of Population and Health (Table 2.9.9). Figure 2.9.3 shows the institutional framework of Water Quality Surveillance.

Table 2.9.9 Drinking water quality parameters used in monitoring

No.	Category	Parameters	Monitoring Frequency	Monitoring Institution	Surveillance Agency
1	Physical	Turbidity, pH, Colour, Taste and Odour	Daily	Water Supply Providers	Ministry of Population and Health and its line agencies
2		EC	Monthly		
3		TDS	Quarterly		
4	Chemical	Residual Chlorine	Daily		
5		Ammonia, Chloride, Nitrate, Total Hardness, Calcium	Monthly		
6		Iron, Manganese, Sulphate, Arsenic, Cadmium, Copper, Fluoride, Cyanide, Lead, Chromium, Zinc, Mercury, Aluminum	Yearly		
7	Microbiological	E. coli, Total coliform	Monthly		

(Source: GoN/MoHP 2018)

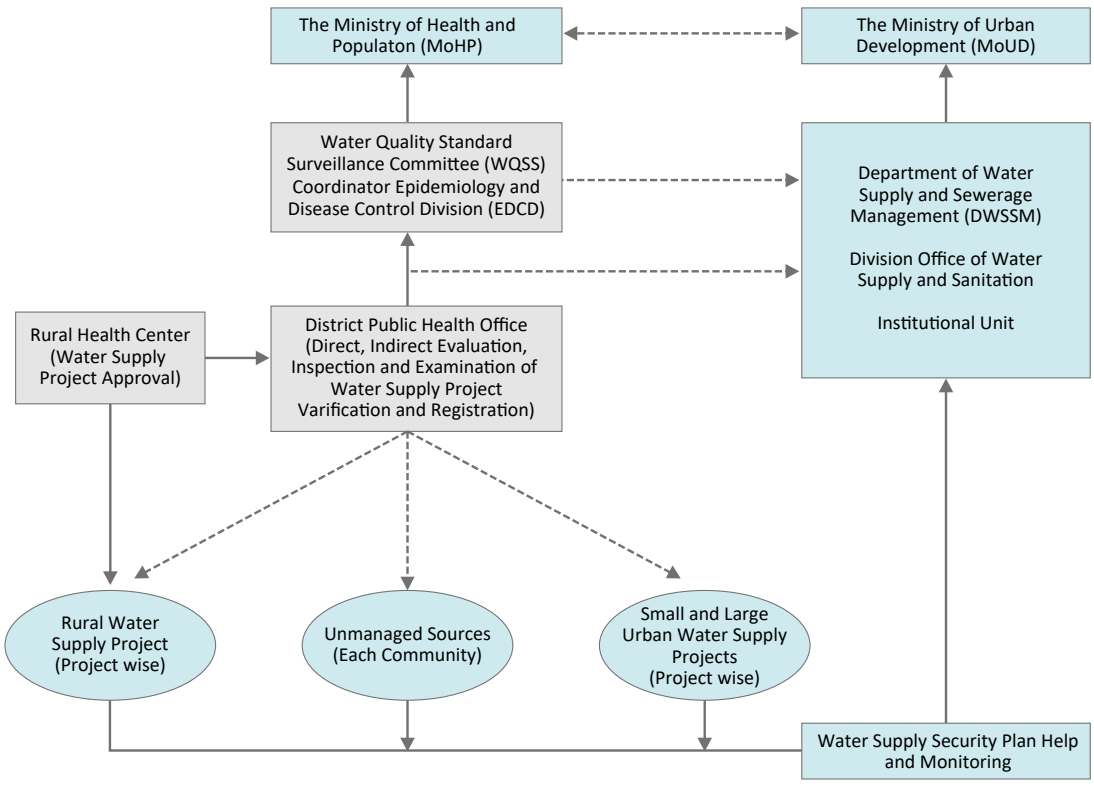

Figure 2.9.3 Institutional framework of national drinking water quality surveillance (Source: GoN/MoHP 2018)

5.4 Effluent Standards

Effluent standards

Effluent standards for different pollution sources are also set up under the EPA as follows:

- Tolerance limits for industrial effluent discharged into inland surface waters (generic)
- Tolerance limits for specific industrial effluent discharged into inland surface waters (tanning, wool processing, fermentation, vegetable ghee and oil, paper and pulp, dairy products, sugar milling, cotton textiles, non-alcoholic beverages, pharmaceuticals, soap, paints, etc.)
- Tolerance limits for industrial effluent discharged into public sewers
- Tolerance limits for wastewater discharged into inland surface waters from combined wastewater treatment plants

Effluent inspection procedure

Inspection mechanisms and procedures are guided by the water quality monitoring framework, guidelines and responsibilities under relevant line ministries or departments dealing with drinking water, industry, and agro-farms.

Measures against non-compliance

Penalties are imposed for non-compliance, although enforcement is sporadic due to gaps in monitoring capacity of the concerned agencies. Instances of enforcement have taken place, such as the MOFE decision in 2019 requesting penalties for non-complying medical institutes.

6 | Recent Developments in Water Environmental Management

The government has substantially strengthened environment-related legislations, acts, policies, and guidelines related to the water environment. Under its federal structure, the government is also revising or drafting acts and legislations and establishing new institutional structures at federal, provincial, and local levels. The establishment of Ministry of Water Supply reflects the government's national and international commitments and increasing prioritization of the water, sanitation and hygiene (WASH) sector together with relevant goals and targets, especially the Sustainable Development Goal on water and sanitation. Nepal has set its national indicators for WASH-related targets, such as ensuring access to piped water supply and improved sanitation by 2030 for 95% of the population.

7 | Challenges and Future Plans

A major challenge for water environment governance in Nepal is the actual implementation of acts, policies, and guidelines to ensure effective monitoring and enforcement at federal, provincial, and local levels. Coordination among line institutes such as water resources (MOEWRI), water supply (MWS), and environment (MOFE) at different levels is a big challenge due to overlapping mandates, resource constraints, multiple sector priorities, and lack of technical expertise or capacity. Although the federal structure grants autonomy regarding power and decision making down to local levels, institutional establishment, allocation of trained staffs, and establishment of monitoring and assessment facilities are still in their infancy.

Nepal is aiming to rapidly develop and transition from Least Developed to Developed status such as through investments in industrialization, construction, tourism, and modernization of agriculture. For instance, rivers in Nepal are under pressure from mining industries (formal and informal), contributing to high levels of sedimentation due to high demand for construction materials. It is thus evident that the water environment will come under greater pressures going forward, meaning the level of water governance capacity of the concerned agencies as well as stakeholders needs to be substantially improved.