Terms of Reference

For Feasibility Study, Detail Design and Tender Document Preparation of Rift Valley Lake Basin for Flood Risk Reduction Investment

September 2024

Addis Ababa

Ethiopia

Contents

1 Context 3

2 Purpose 5

3 Introduction 6

3.1 Geomorphology of the Basin 8

3.2 Hydrological Dynamics: 11

4 Rationale of the Project 12

5 Scope of Work 12

6 Duration of Contra and Deliverables 25

7 Roles and Responsibilities 27

8 Manning Schedule 28

9 Man power requirement 28

9.1 Evaluation, Selection and Award 31

10 Team Composition 31

11 Review of the Global Experience on Similar Lake Basin Food risk Management Projects 40

List of Figure

Figure 1: Map of Rift Valley Basin, Ethiopia 3

Figure 2: Lake cross section along the lakes 7

Figure 3: Overview of the strategic flood risk reduction investment framework recently developed for the GoE 22

List of Tabel

Table 1: Characteristics of Rift Valley lakes (Source: Halcrow, 2009) 7

Table 2: Duration and deliverables 25

Table 3: Consultant key expert requirement 29

1 Context

The Rift Valley Lake Basin (RVLB) is a region of immense ecological significance and socio-economic importance, encompassing a series of lakes and their tributaries. However, the basin faces critical challenges related to flooding, affecting communities, infrastructure, and the overall environmental health of the area. In response to these challenges, a comprehensive project is proposed to undertake a Feasibility Study, Detail Design, and the preparation of Tender Documents for Flood Risk Reduction Investments in selected prioritized flood prone area of the Rift Valley Lake Basin.

The Government of Ethiopia has a pipeline of flood risk reduction projects in the Rift Valley Lake Basin. These projects include the Lake Hawassa flood protection document, Sego drainage work project, central Rift valley master plan project, and Bilate flood protection works. These projects aim to protect areas across several Woredas and involve the construction of river dikes as a primary element for reducing flood risk

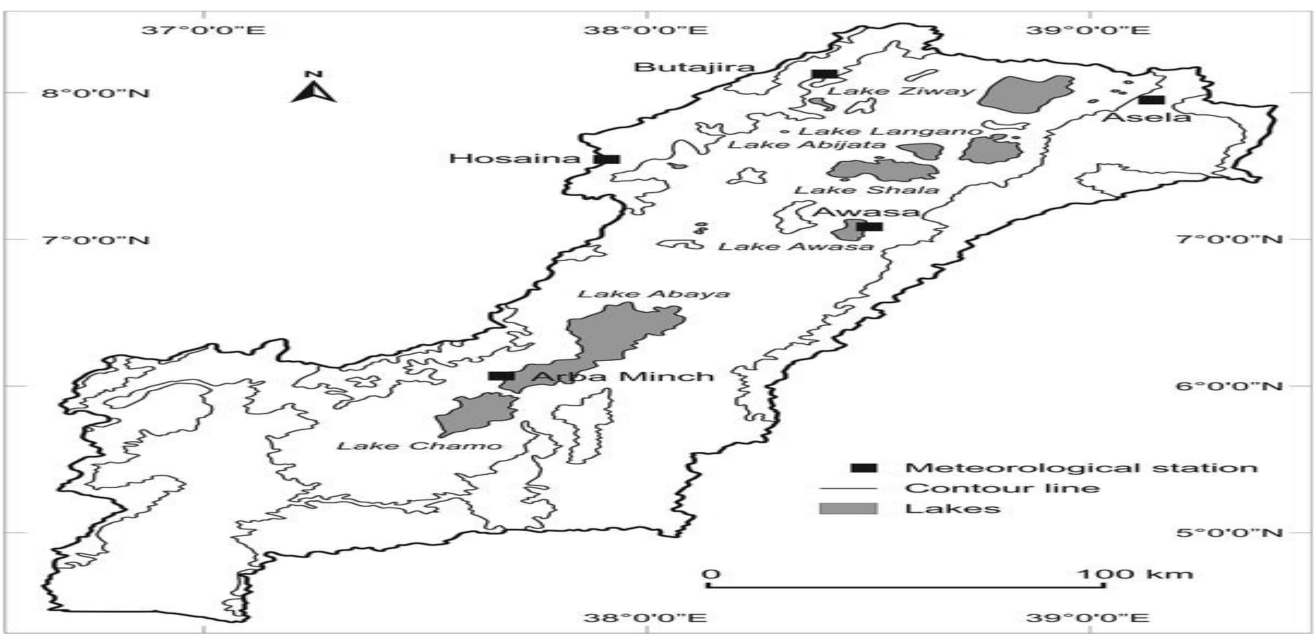

Figure 1: Map of Rift Valley Basin, Ethiopia

Areas benefitting

A technical review of the hydrological and hydraulic analysis underpinning these projects highlighted several aspects that would require further consideration before a detailed design of flood risk reduction and associated infrastructure can be finalized, including:

1 Additional data collection - Site-specific data collection, including terrain data, appears not be sufficiently detailed (based on the reports made available). Additional field surveys and observations may be needed to strengthen the data basis for further detailed studies.

2 Additional feasibility design exploration - At this point the design details can be described as at the level of pre-feasibility. As such, the design of the flood risk reduction infrastructures is conceptual, consisting of a generalised dike alignment within the priority areas. There may be opportunities to optimise of selection of flood risk reduction options including attenuation schemes, and the route and alignment of the dike (where selected) and ensure the design concept takes account of best practice principles that can then be carried forward to detailed design stages.

3 Additional supporting hydrological and hydraulic analysis – The existing hydrological analysis is deemed reasonable for a pre-feasibility. Further detail on design rainfall estimation, critical storm duration, rainfall-runoff model development, calibration and method selection, as well as extreme value analysis and flow reconciliation will be required to support a more robust feasibility stage assessment. If necessary, associated hydraulic modelling to determine the areas benefiting from the scheme and the standard of protection afforded.

4 Consolidated and auditable reporting trail - Reporting did not provide a conclusive audit trail of some key aspects of the analysis, including:

- the treatment of observational data used as inputs, including gap filling techniques
- justification of model parameters, including more robust and rigorous calibration and sensitivity testing
- A lack of direct explanation of how rainfall-runoff models were used for the analysis and how the inflows to any hydraulic models were derived from the hydrological results.

5 Inclusion of climate and other future changes into the project feasibility design process - There is no evidence to the consideration of climate change being part of the feasibility studies and the design of hydraulic structures assumes stationary. Risk assessment to determine the likelihood and impacts of drainage exceedance has not been analysed.

Therefore, while a significant volume of project preparation work has been undertaken, any one of several aspects of the analysis carried out to date may include important elements that have been based on questionable input data, statistical analysis or modeling approach, which may undermine the validity of the designs. An audit of the work done to date is required as well as further detailed conceptual design studies to optimize the overall design including the dyke alignment and costing of capital costs and civil works.

2 Purpose

The purpose of the Terms of Reference (ToR) is to invite consultancy firms to submit proposals for the Feasibility Study, Detail Design, and Tender document preparation of the Rift Valley Lake Basin for Flood Risk Reduction Investment Project. The scope of work will focus on refined hydrological and hydraulic analysis to inform a sound scheme design, advance existing feasibility concepts to a greater level of detail and optimization, and address flood risk elements of the seven series lakes and tributaries of rivers projects. Additionally, the ToR emphasizes the importance of utilizing best-practice methodologies in data preparation, hydrological and hydraulic modeling, calibration, and sensitivity testing. It also highlights the capacity-building opportunity for Ethiopian water engineers through practical hands-on training and a training workshop at the conclusion of the technical assistance.

For future flood risk reduction scheme designs, it is important the MoWE/BDO utilizes best-practice methodologies in terms of data preparation, hydrological and hydraulic modeling methodology, calibration, and sensitivity testing. This TA is expected to be delivered in collaboration with MoWE/BDO, responsible for the original work, following best practice approaches. In doing so, practical hands-on training for Ethiopian water engineers will be carried out ‘on-the-job’ by technical staff executing some of the work in parallel with the consultant. This will be consolidated into a training workshop at the conclusion of the TA, to further consolidate and transfer the skills and knowledge needed to execute or review similar analysis to be carried out on future flood risk reduction projects.

The document also provides valuable information about the climate and topography of the Rift Valley, including variations in temperature, rainfall, and potential evapotranspiration across different elevations and regions within the basin. This information is crucial for informing the hydrological and hydraulic analysis and the design of flood risk reduction infrastructure.

The primary objective of this consultancy project is to assess, design, and propose viable solutions for flood risk reduction in the Rift Valley Lake Basin. The project seeks to safeguard communities, critical infrastructure, and the ecological integrity of the lakes while fostering sustainable development.

3 Introduction

The Rift Valley Lakes Basin is located in the South Western part of Ethiopia between 40 21' 54'' N and 8^{0} 28' 9''N latitude, and 36^{0} 45 '4''E and 39^{0} 22' 8.6''E longitude (figure 1). The basin is situated in three Regional States, Sidama, Oromiya and Southern Nations, Nationalities and Peoples Region (SNNPR), has 53,000-km2 area coverage, and has the potential of 5.6 BM3 annual water resource. The basin is sub-divided into four sub-basins, which are endowed with the major seven lakes (hence, it is called the Lakes basin).

There are seven main lakes in the, namely Ziway, Abiyata, Langano, Shala, Hawassa, Abaya and Chamo. Chew Bahir is still often referred to as a lake but is, in fact, a saltpan, which rarely holds any water.

Bathymetric surveys have been carried out on all of the seven lakes at various times. The earliest were Lake Abaya and Lake Chamo, carried out as part of a doctoral dissertation by Dr. Sileshi Bekele at Arba Minch University, both done in 2000. MoWR did Lake Ziway in 2005. Lake Hawassa was done in 2006 by the SNNPRS administration. The data from these surveys was collected and analysed during Phase 1. Surveys for the three other lakes, Abiyata, Shala and Langano, were carried out as part of this current study. The basic characteristics of the lakes are given in Table 1.

Table 1: Characteristics of Rift Valley lakes (Source: Halcrow, 2009)

Lake	Surface Area (km^2)	Max depth (m)	Ave depth (m)	Volume (km^3)
Ziway	423	9	2.5	1.1
Abiyata	132	14.2	7.6	1.61
Langano	247	23	17	5.3
Shalla	302	252	87	36.7
Hawassa	93	23	11	1.3
Abaya	1095	25	7	8.2
Chamo	315	14	6	3.3

The is a hydrologically closed system, with no surface flow from the terminal lake systems. Four of the seven main lakes (excluding Chew Bahir) are terminal in themselves. The others flow into terminal lakes, making all lake systems terminal. The cross section along the lakes is shown in

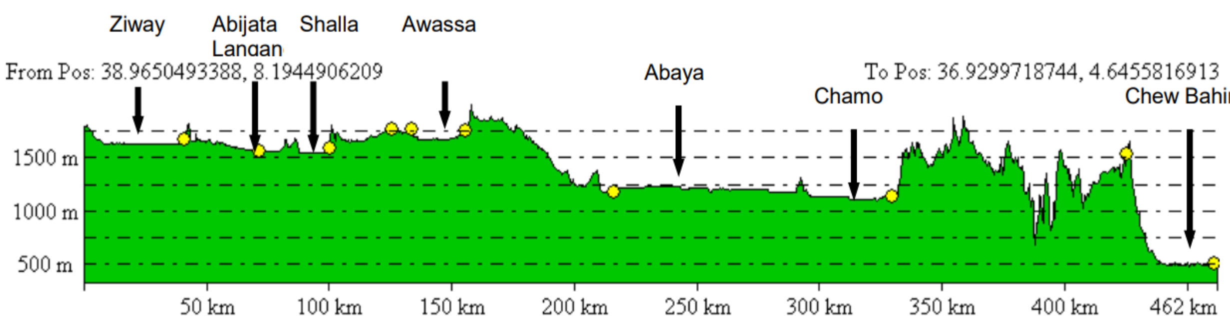

Figure 2: Lake cross section along the lakes

The basin is usually divided into the following four major sub-basins:

1. The **Ziway-Shala** sub-basin (14,477 km^2) which comprises the catchments of Lake Ziway, Lake Langano, Lake Abiyata and Lake Shala. Lake Shala is generally separate but under high flow conditions, some water will transfer to Lake Abiyata.
2. The **Hawassa** sub-basin (1,403 km^2) which is hydrologically separate from the others but includes the former Lake Cheleleka, which is now mainly wetland, with grazing and even agriculture now encroaching.
3. The **Abaya-Chamo** sub-basin (18,118 km^2) which is the catchments of Lake Abaya and Lake Chamo. There has been some flow from Chamo to the Segen River in the past when

lake levels have been extremely high, but it has been so long since this occurred that it is no longer considered one catchment.

4. **Chew Bahir** sub-basin (19,029 km^2) which is the catchment of Chew Bahir, mostly comprising the Weito River and Segen River catchments.

3.1 Geomorphology of the Basin

According to JICA (2012), the Rift Valley Lakes Basin is divided into two areas. The northern portion of the area around the lakes of Ziway to Awasa is almost flat in the valley bed with several mounts of hills in the west. The hills are mostly in the shape of cone or semi-conical crests that leave the traces of past volcanic activity. The eastern terrain shows the stepwise crests bounding the eastern end of the valley. The lineaments of NNE – SSW direction are mostly abundant. In contrast to the northern geomorphological conditions, the southern area, from Lake Abay to Chew Bahir, has relatively precipitous terrain. East of Lake Abay-Chamo is characterized by a continuous range of mountains in a N-S to NNE-SSW orientation, and the lineaments can be tracked up to Lake Hawasa. ENE-WSW oriented lineaments are also abundant in the northern portion. Two major rifts, the Main Ethiopian Rift (MER) and the southwestern Ethiopian Rift (SWR), both of which are encompassed in, characterize the geological structures. The MER extends from the southern Afar margin to the Lake Chamo area, whereas the SWR is located to the west and represents roughly N-S trending basins related to the Kenya Rift. The Gregory rift of Kenya links to the north with Chew Bahir rift.

Hydrological extreme events such as floods and drought are commonly occurring in the Ethiopia Rift Valley lakes basin, which eventually causes environmental hazards (Yishak et al., 2020). Many previous studies have investigated long-term hydrological extreme even related to climate change (Ryu and Kim, 2019). Changes in Earth’s climate system affect the balance of the hydrological cycle and eventually lead to increased occurrence of extreme events such as floods and droughts (Sheffield and Wood, 2007). Recent investigations also show that global climate change will create and intensify even more severe frequent floods and droughts in the region (Birhanu et al., 2016).

According to Mohammed and Yimam (2021), in the lakes’ region of the Ethiopian rift valley the spatial patterns of drought events didn’t exhibit clear patterns, rather a more localized distribution and variability; the frequency of drought incidence became intense from 2008 onwards at all timescales compared to the 1990s, and 2000s; and the increasing tendency of drought in recent years might be the manifestation of borderless global warming. In general, the same study concluded that drought events and their negative effects are highly localized in the lakes basin of Ethiopian Rift valley and provide useful information for local-scale planning for drought management and response.

A. Lake Hawassa Sub-basin

In particular, in the middle part of the rift valley lakes basin, such as in the Lake Hawassa Sub-basin, drought conditions of future periods will increase with respect to the duration, severity, and frequency of the drought. The basin is moderately prone to both mild and moderate droughts, but less prone to severe and extreme droughts. Climate change will largely affect and increase drought duration, frequency, and severity in the basin and subsequently the design of future water resources projects. Thus, sustainable water management measures should be planned to mitigate future impacts of droughts in the basin.

The significant rising trend of Lake Hawassa water level is one of the main environmental threats for the City of Hawassa, which has been established at the eastern shore of the Lake. It is still the subject of concern and center of debate among the stakeholders since the last few decades, especially in the aftermath of the 1998 flood that caused displacement of resident population, destruction of properties and infrastructure by inundating vast areas along the lakeshore. According to WRDB (2007) and WWDSE (2001), the lake level rise and the associated surface expansion affected about 162 urban and 2244 farmers' households, 13 different organizations, water supply schemes, 10 ha of sand quarry, roads, and forestland. In monetary terms, the total physical damage was estimated to be 43,490,524 Ethiopian Birr (about € 5.4 million).

B. Lake Chew Bahir Sub-basin

In the southern part of the Rift valley lakes basin drought is a recurring phenomenon (People in Need, 2018). Previous field observations by various travellers have shown the sensitivity of hydrology of Lake Chew Bahir to even short-term climate variability (Grove et al., 1975). In the late 19th century, the unprecedented drought, which occurred over the whole of East Africa, significantly affected the area during which both people and animals were starved and died; the river no longer reached the Lake Chew Bahir but spread out and disappeared. In recent times too, according to information obtained from local community, availability of pasture in the area is reducing gradually due to drought and shorter rainy season. The dry season is becoming longer contributing to the gradual extinction of indigenous grasses and reducing crop yields and the availability of water in the area. As a result, the community are forced to migrate with their livestock to find pasture.

In Lake Chew-bahir sub- basin, floods occur in the basin because of prolonged heavy rainfall causing rivers to overflow and inundate areas along the riverbanks. Hammer, Bena Tsemay, Buriji, and Konso Zone/Woredas are the most flood prone areas in the basin (Flood alert Report, 2018). Therefore, these issues call for careful disaster preparedness in terms of adapting appropriate response mechanism to hinder and mitigate their catastrophic impact on the society.

C. Abaya-Chamo Sub-basin

In Abaya-Chamo lakes basin flooding is associated with flash flooding from mountain streams and Rivers, which can cause infrastructure damages, loss of life, temporary displacement of large numbers of peoples, and loss of crops. The frequency and extent of out-of-bank flooding will depend on the flow levels and river morphology, while the flood-related damages will depend on the density of population and land use in flood prone areas. The flood prone area assessment report (Flood report, 2008) indicates the high and very high flood hazard threats in the down-stream part of the rivers flowing into lakes Abaya and Chamo. For example, flooding in the lower part of Kulfo River catchment becomes an unbeatable disaster and a challenge for the rural community living around the lower catchment. Farmers in the catchment extensively use Kulfo River for their irrigation, but their crops are affected by flooding each year.

According to MP (2010), flooding is common in Parts of the Middle and lower Bilate River; Middle Gelana; and Lower Kulfo where flooding events affect thousands of people and damages irrigation infrastructure. The most frequently affected Woredas in the Abaya-Chamo Sub-basin includes Shashego Wereda of Hydiya zone; Humbo Wereda of Wolita Zone; Hula, Dale, ShebedinoWereda of Sidama region; AlichWoriro, Dalocha, Lanfaro, Siltee, Sankura in Silite Zone; Halaba special woreda; Galana Woreda of West Guji Zone; and KochoreWoreda of Gedeo Zone. Apart from flooding, as in other parts of the rift valley lakes basin, most parts of Abaya-Chamo Sub-basin are affected by recurrent drought, which results in production failure. In this regard, Halaba-Mareko area, Badawacho, Kedida, Damote Gale, DamotWeyde, Humbo, Amaro, and Derashe Woreda/area are the most affected regions.

The consultant is expected to be very carefully one the methodology selection for this kind of Lake Basin Flood management project. The nature of project consultancy studies for Rift Lake basin and River basin (i.e. every consultant is familiar) flood risk reduction projects is different in several ways due to the unique characteristics of each type of basin. Here are some key differences:

3.2 Hydrological Dynamics:

Rift Lake basins are typically characterized by deep, enclosed lakes with limited outflow, while river basins are characterized by flowing watercourses with varying degrees of connectivity to other water bodies. As a result, the hydrological dynamics of Rift Lake basins can be more complex and require specialized modeling and analysis techniques.

a) **Infrastructure Design:** Flood risk reduction infrastructure in Rift Lake basins may require different design considerations than in river basins due to the unique characteristics of lake basins, such as the potential for standing waves and the need to balance flood control with ecological considerations. River basins may require more traditional infrastructure such as levees, dams, and drainage systems.
b) **Data Availability:** Data availability and quality can vary between Rift Lake basins and river basins, with Rift Lake basins often having limited observational data and requiring specialized surveys and data collection techniques.
c) **Capacity Building:** Capacity building and training programs for local stakeholders and technical staff may differ between Rift Lake basins and river basins, with Rift Lake basins potentially requiring more specialized training in lake basin management and ecology.

Overall, while there may be some similarities in the nature of project consultancy studies for Rift Lake basin and River basin flood risk reduction projects, the unique characteristics of each type of basin can require different approaches and considerations.

The Rift Valley Lakes Basin (RVLB) in East Africa comprises a series of lakes and tributaries of rivers, each with its own unique characteristics. Here are some flood risk elements specific to seven series lakes and tributaries in the RVLB:

4 Rationale of the Project

The rationale of the project is to stimulate sustainable socio-economic development and enhance safety against flood hazards posed by the series lakes and tributary rivers in the Rift Valley Lake Basin. The principal objective of the project is to conduct a feasibility study and detailed design of flood risk reduction and associated infrastructures to protect the assets and lives of the community and business sector that rely on lakes and rivers.

5 Scope of Work

The consulting firm is tasked with carrying out the Feasibility Study and Detailed Design of the Flood Risk Reduction and Associated Infrastructure in alignment with nationally and internationally recognized standards, including those accepted by financial institutions like the World Bank.

The consulting firm shall carry out the following tasks:

- Task 1: Inception
- Task 2: Data Audit, Analysis, and Survey
- Task 3: Update of Hydrological and Hydraulic Analysis
- Task 4: Identify Multiple Options and Select Recommended Option
- Task 5: Hydraulic Modeling and Hazard Mapping
- Task 7: Detailed Design and Tender Documents
- Task 8: Training and Capacity Building

<u>Task 1: Inception</u>

At inception, the following streams of work shall be mobilized:

a) Stakeholder engagement mapping and security planning: Working with the client, a stakeholder map and plan will be developed outlining goals for the engagement and a schedule, including proposed methods. Security concerns must be scoped and addressed in a risk assessment.

Engaging with local communities, government agencies, and other stakeholders to understand their perspectives, gather local knowledge, and ensure that flood risk reduction measures align with community needs and priorities.

b) Thorough technical review of all existing feasibility, modelling, data and detailed design reports for work carried out to date
c) A high-level screening and assessment of available data and refinement of approach: all the main analytical and modeling methods required for studies, the associated data needs and options, and the impact that each will have on accuracy and robustness. To facilitate this, the government of Ethiopia will facilitate a technical workshop between the consultant and relevant technical staff from the government to allow the consultant to familiarize themselves with the data, available models, and key staff.
d) Preparation of a detailed methodology and program for all of following tasks
e) Development of a refined integration and training plan including secondment, workshop and training components, to be implemented through the project in order for the government of Ethiopia (see Task 3 for further details).

Task 1 deliverables:

A draft Inception Report including (1) a stakeholder engagement mapping and an overview of data availability, highlighting key issues and possible data improvement strategy; (2) a detailed review of existing models and suitability for forthcoming tasks, as well as a proposed methodology with suggested additional or change in modelling software to be used; (3) a plan for each of consultation actions, program, risk and data management plans; and (4) a revised integration and training plan summary and actions.

<u>Task 2: Data audit, analysis and survey</u>

Task 2 involves data audit, analysis, and survey activities as part of the consultancy services for the Feasibility Study, Detail Design, and Tender document preparation of the Rift Valley Lake Basin for Flood Risk Reduction Investment Project. The specific tasks under Task 2 include:

a. Evaluating and testing the validity of input data used and assessing the need for data collection and field surveys, particularly regarding observational data sets.

b. Assessing the completeness of terrain data sets, developing, and executing a topographic field survey program to provide terrain data for detailed flood risk and dyke alignment optimization studies.
c. Collecting and organizing information on the storage and operation of relevant existing and proposed reservoirs related to the design of river or lake protection or future operational and irrigation considerations.
d. Revisiting areas of data analysis that require reanalysis,
e. Developing a draft scope for the technical implementation of required field surveys,
f. Conducting additional agreed-upon surveys,
g. Reviewing and ensuring the quality of deliverables from field surveys.

These tasks are expected to be carried out in collaboration with key technical staff from the Ministry of Water, Irrigation, and Energy (MoWE) and the Basin Development Office (BDO) through a mix of secondments, on-the-job training, and workshops.

As noted earlier, the consultant is expected to refine their proposed training and integration plan through the inception phase.

Task 2 deliverables: required outputs include (1) technical scope for required field surveys, (2) results of field survey

Task 3: Update of hydrological and hydraulic analysis and setting target flood events and sites

In general, conducting comprehensive hydrological and hydraulic analyses tailored to the specific characteristics of lake basins, including rainfall-runoff modelling, flood routing, and the assessment of flood hazard and risk.

In order to reassess the existing work, this task is to be commissioned with the full engagement of the MoWE/BDO technical team. This is necessary, given that the report products themselves do not contain important detail on the data and methods used in order for the consultant to replicate the work done. Secondly, this will facilitate the scoping of a capacity building and train task (i.e., Task 7) that will follow.

The analysis done so far is to be used as a basis and additional work on the following aspects is required:

a) Report/provide details on the methodology (including justification) used for the design rainfall depths. Consideration should be given to using a consistent approach to deriving depth duration curves, or intensity duration curves, as this is pertinent to all studies, Uncertainties and limitations need to be acknowledged,
b) Sensitivity analysis to determine critical storm duration for the study catchments,

For the dam studies, this is very important as lag time changes with dams in place and this would need to be explicitly accounted for,

c) Provide detail on rainfall-runoff model development for design flood estimation and dam feasibility. Specific reference to methods selected;
    - In Lake Basin flood risk reduction projects, advanced modelling software technologies to support hydrological and hydraulic analyses, flood risk assessments, and the design of flood risk reduction measures can be used for optimized work of the hydrology and hydraulic analysis. Some of the best recommendable lake basin modelling software technologies include:

- **HEC-HMS**: is a widely used software for hydrological modelling, rainfall-runoff analysis, and the simulation of watershed response to precipitation. It can be valuable for assessing flood risk and designing flood management strategies in lake basins.
- **HEC-RAS**: HEC-RAS is a powerful software for hydraulic modelling and river channel analysis. It can be utilized to simulate flow behaviour, inundation mapping, and the design of hydraulic structures in lake basins and their associated river systems.
- **MIKE SHE:** MIKE SHE is a comprehensive integrated hydrological modelling software that can simulate the movement of water through the landscape, including surface water, groundwater, and interactions with the atmosphere. It is suitable for complex hydrological modelling in lake basins.
- M**IKE 21/3: The MIKE 21/3** software suite, developed by DHI, offers advanced capabilities for 2D and 3D hydrodynamic modelling of lakes, rivers, and coastal areas. It can be used to simulate flooding, sediment transport, and water quality in lake basins.
- **SWMM (Storm Water Management Model):** SWMM is a widely used software for urban drainage and storm water management modelling. It can be applied to assess the impact of urban development on flood risk in lake basins and to design sustainable drainage solutions.

- **TUFLOW:** Tuflow is a hydrodynamic and hydrological modelling software that can simulate flooding, riverine and coastal processes, and the interaction between surface water and groundwater. It is suitable for detailed flood modelling in lake basins.
- **InfoWorks ICM (Integrated Catchment Modelling):** InfoWorks ICM is a comprehensive software platform for integrated catchment modelling, which can be used to simulate the entire water cycle, including rainfall, runoff, flooding, and the performance of flood risk reduction measures in lake basins.
    - ✓ These modelling software technologies offer a range of capabilities for conducting hydrological and hydraulic analyses, flood risk assessments, and the design of flood risk reduction measures in lake basins. The selection of software should be based on the specific needs and complexities of the project, as well as the expertise of the consulting team.

d) Flood frequency analysis: Provide detail/statistical measures of goodness of fit to justify selection of distributions, consider hydro chronology to extend systematic record and carefully approach reconciliation between statistical estimates and design floods derived from the rainfall-runoff models at key locations. Effects of climate change will be considered.

e) Consider using consistent approaches to flow validation for ungauged catchments (consider donors/empirical methods)

f) Consider volume-driven mechanisms of flooding given the size and floodplain in the lower part of the catchment

g) Extend hydrological modelling where appropriate to include additional upstream and downstream areas (e.g., wetlands and reservoirs, including operations of reservoirs both existing and considering proposed dams and reservoirs),

h) PMP analysis: Harsh field method is typically considered a preliminary approach to PMP derivation. Consider using a more comprehensive approach either in conjunction with design rainfall generation for the catchments and/or independently based on international best practice,

i) Consider joint hydrologic-hydraulic modelling calibration or as a minimum validate flows with testing through hydraulic model. There may be a need to check or re-visit the flow estimates after a trial application to the model,

j) Develop baseline 2-dimensional flood maps for return periods from 2- to 1500- years

k) Setting target flood event (e.g. return period) considering balance between urban/rural and consistency among upstream/downstream through consultation with MoWE and WB;

l) Identify/confirm target sites (locations) of flood risk reduction sub-project based on risk information and socio-economic conditions. Target sites of existing studies will be referred appropriately; and

m) Write a report that documents methods, calculations, and decisions made. The work needs to be documented in a manner that is auditable,

The updated hydrological analysis should be linked to a reassessment of the area protected by the proposed project using a suitable hydraulic model and the standard of protection afforded carried forward to update the assessed benefits.

Task 3 deliverables: A complete delivery of the reworked technical report, paying particular attention to the points above. The report should be thorough in its documentation of data treatment, methods, and outputs in manner, which enables future replication of the work.

Task 4: Identify multiple options and select recommended option

The consultant will compare at least three options approximately the target location and recommend the best one based on the interim studies for Detailed Design and cost. The option will be prepared considering multipurpose options infrastructures for long serving (wetland, retention pond, dyke) and suitable, type, site, size, beneficiaries, energy efficiency and other conditions.

The consultant will prepare a set of criteria and a table comparing the options in terms of, including but not limited to flood risk reduction effects(including quantity of beneficiary people and land), multi sectoral co-benefits, adaptation to climate and other changes, O&M, cost benefit analysis, dimensional parameters (height, reservoir area and volume), preliminary cost estimates (investment and O&M), and the environmental and social impacts (including resettlement area and number of population to be relocated). The consultant shall validate the results of conducted studies/investigations/tests. Conducting environmental impact assessments to evaluate the potential ecological consequences of flood risk reduction measures and ensure sustainable and environmentally sensitive solutions is result of the environmental screening process.

This is an opportunity to optimize the project costs and to ensure the design is based on good practice design principles. As a minimum, this task should consider:

General layouts of scheme and alignment of the proposed infrastructure: For example, To ensure (i) the dyke alignment continues to make space for the river where possible (to reduce both the impact on the hydrological processes but also reduce the construction costs) and (ii) the dykes are proposed only where necessary to minimize the over length of the dyke (and reduce cost) without compromising protection (currently dyke alignment is shown as continuous throughout the project area – this may not be necessary).

Design for exceedance: design the dyke to ensure continued performance when loads exceed the design level.

Multi-functionality and co-benefit: plan and design of associated infrastructures such (but not limited to) bridge, road, and irrigation/intake facilities, access routes for pastoralist and public access to rivers, community pond, in consideration of feedback from local government and communities received through existing studies.

Sustainable materials: consider the opportunity to use sustainable material and construction methods that can be sources locally. Provide an initial assessment of the whole life costs of the constructing, maintaining and replacement of the dyke to ensure the project is variable on a whole life perspective.

Climate change influence: explore how the scheme options performance in alterative climate futures, including extreme heat (and the impact on embankment materials) as well as extreme flows (for example).

Consider the morphological processes: Ensure the design appropriately accounts for morphological change, and any issues for attention in the next stage of design flagged (and factored into the cost estimates).

Exploit opportunities to utilize nature-based solutions: Ensure the design appropriately examines and identifies opportunities to incorporate nature-based and hybrid solutions for both flood risk reduction and ecological enhancement, using quantitative assessment where possible to fully account for co-benefits arising for using such design elements.

The assessment should understand these contributions and modify the conceptual design appropriately to reduce project costs whilst continuing to appropriately manage risk. The consultant is encouraged to propose a multi-criteria analysis or similar framework in which to assess the different design considerations in a clear, transparent, and quantitative manner. Any such framework should draw upon the outcomes of stakeholder engagement through the assessment process, with a consultation workshop at the start to determine the design criteria, and co-design workshop to elicit feedback and ideas from basin managers and relevant stakeholders.

<u>Task 4 deliverables:</u> (1) Identification of at least 3 options with clear concept, multi criteria comparison, and rationale for recommended option(2) 2 workshops, first of which to develop assessment criteria and understand constraints and concerns with the second as a co-design session presenting the proposed design concepts and consider feedback, (3) final design concept of recommended option, and (4) recommendations for additional feasibility-level investigations/assessments and detailed design requirements.

<u>Task 5: Hydraulic modelling and hazard mapping</u>

Flood hazard maps will be produced at high a resolution as possible given the modelling output resolution, but as a minimum, will be of sufficiently high resolution to identify hot-spots and understand which areas/communities or specific features of assets will be most affected by floods (expected to be 30m or higher resolution).

The hydrological and hydraulic modelling for the flood hazard and risk assessment must consider the interaction of Main River flooding for the primary flood risk reduction structures. However, pluvial flooding is also expected to be considered with respect to urban and rural areas within the areas benefitting from the primary flood protection structures. The modelling exercise will consider both fluvial in isolation and the joint probabilities of these different sources of flooding, assessing the level of dependence between the flood mechanisms based on available data and the knowledge of the hydrologic/hydraulic system in general. A range of return periods will be modelled, within a range of 2 to at least 1000-years for both pluvial and fluvial flooding (to be finalized during Inception) for all scenarios.

The Consultant must propose an appropriate rainfall-runoff methodology for the various catchment areas to define extreme discharge events. The methodology must address all aspect outlined in Section 1 of this ToR and the consultants' own observations from its own review of previous work. This approach must account for the catchment characteristics, include parameters with a clear physical base in the simulation of soil moisture, and flow routing to allow a straightforward representation of land-use changes and human interventions, as well as applications to ungauged areas. The modelling must be applied to realistically represent variations in rainfall, topography, soil type, land use, and adequately simulate floods' genesis.

Hydrological model must be carried out using industry standard methods and software, and parameters and inputs will be based on and calibrated against the best available information and local data (i.e. flow and rainfall records/statistics). The final values must be discussed and agreed upon with the client and stakeholders. Hydraulic modelling will be carried out using industry standard software, which must be freely available and supported for the near future to allow suitably qualified and experienced personnel to repeat or extend the work carried out under this assignment.

The modelling must be carried out in order to determine the concept designs for the primary flood protection structure, including an optimized dyke alignment. This optimization should significantly improve upon the existing schematic alignment produced by previous studies, and should incorporate design elements (including NBS, etc.) based on the outcomes of Task 4. In the way, the concept dyke design determined by this analysis will consider local-scale terrain, land use, infrastructure, existing wetlands and so on. Opportunities for ecological enhancement and utilization of nature-based solutions should be considered (and will be reviewed in Task 7).

Task 5 deliverables: (1) a draft Hazard modelling and Results Report including an updated understanding of the flood hazard within the study area, providing understandable communication products, such as maps and graphical representations of the current and future hazard for different return periods and under different climate change and land-use scenario and (2) a comprehensive database with all hydrological and relevant modelling data collected or developed during the task, including maps and appropriate metadata; and (3) an optimized infrastructure (dyke, wetland, retention ponds etc..) alignment with sufficient detail to determine high level costing, along with associated concept design drawings; and (4) hazard maps before and after investment of the above infrastructure.

Develop detailed designs for flood risk reduction infrastructure, such as dykes, reservoirs, drainage systems, and other hydraulic structures, taking into account the unique challenges of lake basins.

Task 6 – Application of Flood Risk Reduction Investment Framework

The World Bank recently concluded a consultancy to develop a strategic investment framework for flood risk management in Ethiopia. The use of the framework in this TA is seen as an appropriate application of this new strategic tool. The risk-based framework utilizes a range of qualitative and quantitative appraisal metrics (figure 3) to assess and rank proposed projects to determine a strategic investment plan in a given geographical or administrative area.

The framework can be applied to both a range of proposed flood risk reduction projects, as well as to define the baseline flood risk nationally, at Woreda-level. The framework has been applied to the all over projects, based on the original feasibility studies provided to an earlier consultancy project. The framework is therefore expected to provide both a starting point and a means to execute this flood risk assessment. Based on the new flood hazard modelling, an update to the investment case is to be undertaken.

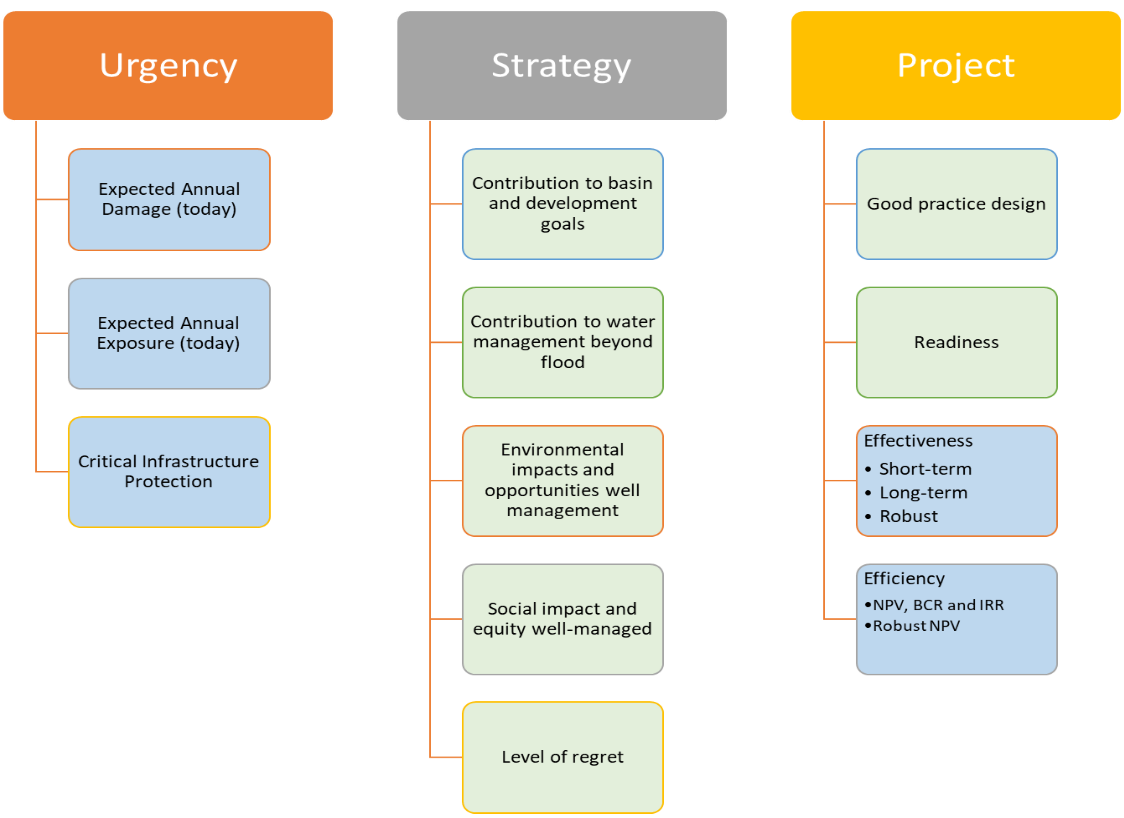

Figure 3: Overview of the strategic flood risk reduction investment framework recently developed for the GoE

Task 6 deliverables: A brief assessment report, utilising the principles, methodology and structure of the Strategic Investment Framework for Flood Risk Reduction in Ethiopia.

Task 7: Detailed Design and Tender Documents

Through Tasks 4, 5 and 6, the concept deign is expected to be refined/completed to a point where optimization of the river protection schemes is achieved, and detailed design can be formalized. The purpose of Task 7 is to support the procurement of design and construction services following World Bank procurement guidelines and utilizing the appropriate templates1. After prequalification, a two-stage bidding process is expected to be the appropriate procurement process for the river protection works proposed given the scale and complexity of the assignment. First, unpriced technical proposals based on a conceptual design or performance specifications are invited, subject to technical as well as commercial clarifications and adjustments, to be followed by amended bidding documents and the submission of final technical and priced bids in the second stage.

To facilitate the procurement process, the consultant is expected to provide bidding documents (including BOQ) to furnish all information necessary for the prospective bidder to prepare a bid for the goods, works, design and other non-consulting services to be provided, including:

1 Invitation to bid and instructions to bidders;

- Contractual terms and conditions
- Specifications and concept drawings based on the refined and optimized design achieved through the design process carried out through Tasks 5, 6 and 7;
- Develop an inventory or relevant detailed technical data (including geological and environmental data, logs and surveys);

Bidding documents shall be worded clearly and precisely. They should state the work to be carried out, the location of the work, the goods to be supplied, the place of delivery or installation, the schedule for delivery or completion, minimum performance requirements, and the warranty and maintenance requirements, as well as any other pertinent terms and conditions.

The documents should encourage both national and international competitive bidding. The bidding documents shall define as necessary the tests, standards, and methods that will be employed to judge the conformity of equipment as delivered, or works as performed, with the specifications.

Task 7 deliverables: A draft set of bidding documents consistent with World Bank procedures and guidelines to be used for international bidding on the proposed river and associated works. Volume of the task is tentatively estimated based on existing two studies described in the context and might be changed upon deliverables of previous tasks.

Task 8: Training and Capacity building

\This will be executed through a policy and gap analysis of existing planning and Integrated Flood Risk Management (IFRM) practices and policies enabling strategic planning. This will include identifying the roles in which institutions play in implementing planning and IFRM in Ethiopia. The project also intends to strengthen Disaster Risk Management (DRM) coordination among federal level agencies and between federal and regional level governments as well as to build the capacities of the DRM offices in regional governments to be able to better implement local level disaster risk management initiatives.

There is a perceived opportunity for strengthening the Government of Ethiopia capacities, knowledge, and skills in executing the risk-based analysis needed to implement IFRM. The content of the training component should focus on contemporary thought with regard to best practice IFRM from hazard mapping, the selection of physical measure options (including Nature Based Solution such as retention ponds, wetland improvement), design standards, O&M considerations, community engagement for physical planning and so on.

The capacity building will then be executed through a series of workshops and training of relevant stakeholders identified in the screening exercise. The workshops are expected to focus on themes identified through the screening exercise and based on the consultant's experience and expertise. At the outset, the content of the workshops is expected to include (though are to be refined or revised under this task):

a) risk-based approaches for flood risk strategic investments – aimed at spatial analysts, geographic information system technicians to imbed hard skills, tools and methodologies behind the strategic investment framework,
b) facilitation workshop among federal level agencies and between federal and regional level governments to build the capacities of the DRM offices and basin management authorities,

Subtasks are therefore:

- Screening of institutional awareness and capacity to utilize risk-based approaches in IFRM and strategic planning,
- Based on this screening, develop stakeholder engagement, and training program, expected to consist of three 3-day workshops,
- Providing training and capacity-building programs for local stakeholders and technical staff to enhance their knowledge and skills in Lake Basin flood risk management and infrastructure design.
- These consultancy activities are crucial for addressing the complex challenges associated with flood risk reduction in lake basins and ensuring the development of sustainable, effective, and context-specific solutions.

Deliver training and capacity building workshops

Task 8 deliverables: Development of draft review report consisting of observations of needs and recommendations to address strengthening (1) institutional technical capacity to utilise risk-based approach to flood risk reduction, (2) developing appropriate training program and materials, and (3) conducting training program in cooperation with the client and producing a report on capacity development activities. The trainees assumed around 60 and the cost of venue covers by consultant.

6 Duration of Contra and Deliverables

The implementation schedule stated in contract agreement the Consultant will be required to submit reports. The following are the deliverables:

Table 2: Duration and deliverables

S.no	Tasks		Deliverables to be submitted to MOWE	Due	Remarks
1	Kick off meeting		-	Within 1 week from signing of the contract	To ensure proper inception
2	Inception Report	✓ Shall include thorough review of existing studies, as well as several dam projects, which is time consuming. ✓ To ensure appropriateness of consultancy's inception works, we could organize kick-off meeting	See detail under task 1	1 month from signing	
3	Data audit, analysis and survey		See detail under task 2	2.5 months from signing	
4	Update of hydrological and hydraulic analysis and setting target flood events and sites		See detail under task 3	4 months from signing	
5	Identify multiple options,	✓ Requires stakeholder consultations	See detail	7 months from signing	

	select recommended option, and conceptual design covering associated infrastructures	including community engagement	under task 4			
6	Hydraulic modeling and hazard mapping		See detail under task 5	8 months	Can be done in parallel	
7	Application of Flood Risk Reduction Investment Framework		See detail under task 6	9 months		
8	Detailed Design and Tender Documents		See detail under task 7	10 months		
9	Training and Capacity building	✓ This task should be conducted throughout the consultancy, in align with each deliverable. ✓ Plan for training and capacity building should be approved at the inception stage, and the consultant should identify several milestones. ✓ Final deliverable is almost at the end of the consultancy	See detail under task 8	Submit training and capacity development plan at inception stage, which identifies milestones. Final report by the end of consultancy (12 months from signing)		

The total duration for completing the Feasibility Study and Detail Design shall be twelve (12) months, which will start from the day the Consultant commenced the services.

7 Roles and Responsibilities

Ministry of Water and Energy has the following responsibilities:

- Provide all reports, data, and maps of relevant previous studies at the beginning of the consultancy;
- Provide access to the project site;
- Schedule and facilitate meetings with partners' organization upon request by the consultant;
- Facilitate the stakeholder participation in situation assessment and preliminary planning and design;
- Pay the consultancy fee according to agreed mode of payment;
- Resolve any social problem whenever it arises;
- Organize a discussion forum among stakeholders and concerned institutions in order to evaluate the proposed planning and detail design;
- Make comments and feedback on design report and check their incorporation or notice of acceptance of justification for rejection;
- Notify the Consultant either to proceed with the subsequent work according to plan or to make modification whenever it deemed necessary;

The Consultant firm has the following responsibilities:

- The consultant shall demonstrate its in depth knowledge, skill understanding and experience of RVLB basin social, economic and environmental context;
- Prepare detail and comprehensive technical proposal indicating overview of the basin situation assessment with regards to this term of reference, approach and methodology of the study, level of investigation and study, sampling and data analysis, schedule of activities and financial plan;
- Undertake desk study (document review), prepare strategic plan, study and analyze information and data, investigation surface and sub-surface condition, and submit feasibility report;
- Submit preliminary planning, design report, draft detail design report, final detail design report, and engineering/construction drawing album.

- Prepare Tender Document and Technical Specification;

8 Manning Schedule

The consultant shall indicate the detail-manning schedule corresponding to the required expert mix.

9 Man power requirement

The consultant must have the following mix of experts and shall establish sub task teams according to the RVLB landform, respectively for effective implementation.

- ✓ Lead flood risk management Expert (Team Leader)
- ✓ Senior Hydraulics Engineer
- ✓ Senior Hydrologist
- ✓ Dam operation Expert
- ✓ Water Resource/Irrigation Engineer
- ✓ Structural Engineer
- ✓ Infrastructure Engineer
- ✓ Environmental safeguards specialist
- ✓ Social safeguard specialist
- ✓ Mechanical Engineer
- ✓ Geotechnical Engineer
- ✓ Geologist
- ✓ surveyor
- ✓ Quantity surveyor
- ✓ GIS expert

Table 3: Consultant key expert requirement

. no	Required Key experts	Required Number	Qualification	Relevant experience
1	Lead flood risk management Expert (Team Leader)	1	BSc or above in flood risk management, hydraulic engineering, hydrology, water resource engineering, Irrigation engineering, soil and water engineering or related field	Minimum 15 yrs working experience in related task including minimum 5 yrs on project coordinating or leading task
2	Senior Hydraulics Engineer	1	BSc or above in hydraulic engineering, water resource engineering, Irrigation engineering, soil and water engineering or related field	Minimum 10 yrs working experience in related task
3	Senior Hydrologist	1	BSc or above in hydraulic engineering, hydrology, water resource engineering, Irrigation engineering, soil and water engineering or related field	Minimum 10 yrs working experience in related task
4	Dam operation Expert	1	BSc or above in hydraulic, civil engineering, water resource engineering, Irrigation engineering, soil and water engineering or related field	Minimum 8 yrs working experience in related task
5	Water Resource/Irrigation Engineer	1	BSc or above in hydraulic engineering, hydrology, water resource engineering, Irrigation engineering, soil and water engineering or related field	Minimum 8 yrs working experience in related task
6	Structural Engineer	1	BSc or above in hydraulic engineering, civil engineering, hydrology, water resource engineering, Irrigation engineering, soil and water engineering or related field	Minimum 8 yrs working experience in related task
7	Infrastructure Engineer	1	BSc or above in hydraulic engineering, civil engineering, hydrology, water resource engineering, Irrigation engineering, soil and water engineering or	Minimum 8 yrs working experience in related task

			related field	
8	Environmental safeguards specialist	1	BSc or above in Environmental engineering, natural resource management or related field	Minimum 8 yrs working experience in related task
9	Social safeguard specialist	1	BSc or above in social science, or related field	Minimum 8 yrs working experience in related task
10	Mechanical Engineer	1	BSc or above in mechanical engineering or related field	Minimum 6 yrs working experience in related task
11	Geotechnical Engineer	1	BSc or above in geology hydrogeology or related field	Minimum 6 yrs working experience in related task
12	Geologist	1	BSc or above in geology hydrogeology or related field	Minimum 6 yrs working experience in related task
13	Surveyor	1	BSc or above in surveying or related field	Minimum 5 yrs working experience in related task
14	Quantity surveyor	1	BSc or above civil engineering, hydraulic engineering or related field	Minimum 8 yrs working experience in related task
15	GIS expert	1	BSc or above in GIS, hydro-informatics, hydrology or related field	Minimum 8 yrs working experience in related task

- The experts must have proven experience in different and diverse projects (design and construction supervision, hydrological analysis, geotechnical study, geological investigation, hydrogeological study, etc.);
- The consultant must have proven track of record for successful implementation of study and design projects. Successful involvement of project in the river basin with reference to flood risk management is a distinct advantage;
- The consultant must have rich experience in study, design and supervision of projects (flood protection, dam, diversion structure, irrigation, water supply, geological and geotechnical investigation, etc.) in the basin;
- The consultant must possess the ability and commitment to execute the work with minimum supervision by the client:

- The consultant shall provide on job technical training and advice Ministry of Water and Energy experts;
- The key experts must be a permanent staff (the consultant shall provide proof of evidence for availability during the project period with hiring contract agreement indicating basic salary);
- The experts must have proven experience in different and diverse projects (design and construction supervision, hydrological analysis, geotechnical study, geological investigation, hydrogeological study, etc.);
- The consultant must have proven track of record for successful implementation of study and design projects. Successful involvement of project in the river basin with reference to flood risk management is a distinct advantage;
- The consultant must have rich experience in study, design and supervision of projects (flood protection, dam, diversion structure, irrigation, water supply, geological and geotechnical investigation, etc.) in the basin;
- The consultant must possess the ability and commitment to execute the work with minimum supervision by the client.
- The consultant must be willing to provide on job technical training and advice Ministry of Water and Energy experts;

9.1 Evaluation, Selection and Award

Ministry of Water and Energy will evaluate all consultancy firms based on technical proposals submitted. The financial proposals will be evaluated for consultants whose technical proposal is accepted. Selection of consultant based on minimum financial proposal will not be considered.

10 Team Composition

✓ **Key Expert 1: Senior Flood Management Expert (Team Leader**

Master‟s degree in Civil Engineering or Engineering Hydrology or equivalent Post GraduateDipl oma closely related with scope of the work and from an accredited College or University andleas t ten (10) years of professional working experience for international organization in flood risk ma nagement and mitigation (soft and Hard Measures). It would be an advantage if consultant has w orking experience in Floodwater Control or similar projects that includes hydraulic and

hydrologic modeling, flood control planning and design of drainage structures.
Must also have working experience in engaging stakeholders in community
base activities. A working knowledge of Arc-GIS software is a plus
The following skills are essential for this work:

Qualifications:

- Academic specialization: Should have Bsc or above in flood risk management, hydraulic engineering, hydrology, water resource engineering, Irrigation engineering, soil and water engineering or related field from a recognized university
- Professional experience: Shall have Minimum 15 yrs working experience in related task on project coordinating or leading task
- Proven experience in managing large-scale flood risk reduction projects
- Strong project management and leadership skills
- Excellent communication and stakeholder management abilities

✓ **Key expert 2: Hydraulic Engineer**

Must have Bachelors or Master's degree in BSc or above in hydraulic engineering, water resource engineering, Irrigation engineering, soil and water engineering or related field from a recognized university at least 10 years working experience in related task, Background in structural and hydraulic engineering, Experience in designing flood risk reduction infrastructure. His/her role is crucial in leading the feasibility study, detailed design, and tender document preparation for the Flood Risk Reduction Investment project in the designated river basin. His/her expertise in hydraulics engineering will be essential for developing effective and sustainable flood risk reduction measures.

The following responsibilities and detailed task assignments are assigned to him/her: Experience with HEC-HMS, HEC-RAS, MIKE SHE, MIKE 21/3, SWMM, TUFLOW, Info Works and ICM, software. Must also have working experience in engaging stakeholders in community base activities. A working knowledge of Arc-GIS software is a plus.

The following skills are essential for this work:

✓ **Key expert 3: Senior Hydrologist**

Must have Bachelors or Master's degree in BSc or above in hydraulic engineering, hydrology, water resource engineering, irrigation engineering, soil and water engineering or related. He has to have Minimum 10 years working experience in related task. His/her expertise is integral to the success of the Flood Risk Reduction Investment project for the designated river basin. His/her responsibilities involve leading hydrological assessments, data analysis, and providing critical insights to support flood risk reduction measures. The following detailed task assignment outlines his/her responsibilities, Proven experience in leading hydrological assessments and modeling projects, in transboundary rivers integrated water resource modeling, Strong analytical and problem-solving skills, Excellent communication and presentation abilities, Experience in climate change impact assessment is desirable, Experience in hydrological assessments, flood modeling, and risk analysis, Proficiency in relevant hydrological software.

Experience with HEC-HMS, HEC-RAS, MIKE SHE, MIKE 21/3, SWMM, TUFLOW, InfoWorks HEC-HMS, HEC-RAS, MIKE SHE, MIKE 21/3, SWMM, TUFLOW, InfoWorks and ICM, software. Must also have working experience in engaging stakeholders in community base activities. A working knowledge of Arc-GIS software is a plus

The following skills are essential for this work:

- ✓ **Key expert 4: Dam Operation Expert**

His/her role is crucial in contributing to the Flood Risk Reduction Investment project for the designated river basin. His/her expertise in dam operation and management will be instrumental in designing and implementing measures to mitigate flood risks. Experience with HEC-HMS, HEC-RAS, and HEC ResSim and ICM, software.

Must also have working experience in engaging stakeholders in community base activities. A wo rking knowledge of Arc-GIS software is a plus

The following skills are essential for this work:

Qualifications:

- Academic specialization: Should have Bsc or above in hydraulic, civil engineering, water resource engineering, irrigation engineering, soil and water engineering or related field from a recognized university
- Professional experience: Shall have Minimum 8 years working experience in related task

- Proven experience in dam operation and reservoir management
- Familiarity with dam operation modeling tools and software
- Strong analytical and problem-solving skills
- Excellent communication and stakeholder engagement abilities

✓ **Key expert 5: Water Resource/Irrigation Engineer**

His/her role is critical in contributing to the success of the Flood Risk Reduction Investment project for the designated river basin. His/her expertise in water resources and irrigation engineering will be instrumental in developing and implementing measures to mitigate flood risks. The following responsibilities and detailed task assignment outline his/her key tasks:

Qualifications:

- Academic specialization: Should have Bsc or above in hydraulic engineering, hydrology, water resource engineering, irrigation engineering, soil and water engineering or related field from a recognized university
- Professional experience: Shall have Minimum 8 years working experience in related task
- Proven experience in water resource management and irrigation system optimization
- Familiarity with hydraulic structure design and modeling tools
- Strong analytical and problem-solving skills
- Excellent communication and stakeholder engagement abilities

✓ **Key expert 6: Structural Engineer**

His/her role is pivotal in contributing to the success of the Flood Risk Reduction Investment project for the designated river basin. His/her expertise in structural engineering will be instrumental in designing and implementing resilient structures to mitigate flood risks. The following responsibilities and detailed task assignment outline his/her key tasks:

Qualifications:

- Academic specialization: Should have Bsc or above in hydraulic engineering, civil engineering, hydrology, water resource engineering, Irrigation engineering, soil and water engineering or related field from a recognized university
- Professional experience: Shall have Minimum 8 years working experience in related task

- Proven experience in structural design and construction oversight for flood risk reduction projects
- Familiarity with geotechnical analysis and seismic design (if applicable)
- Strong analytical and problem-solving skills
- Excellent communication and stakeholder engagement abilities
- Collaborate with the emergency response team to develop plans for rapid structural response during extreme weather events
- Conduct drills and simulations to test the effectiveness of emergency response procedures
- Prepare detailed reports on structural designs, geotechnical findings, construction oversight, and environmental considerations
- Ensure that documentation adheres to industry standards and project requirements

✓ **Key expert 7 Infrastructure Engineer**

His/her role is essential in contributing to the success of the Flood Risk Reduction Investment project for the designated river basin. His/her expertise in infrastructure planning and implementation will be instrumental in developing and implementing resilient infrastructure to mitigate flood risks. The following responsibilities and detailed task assignment outline his/her key tasks:

Qualifications:

- Academic specialization: Should have Bsc or above in hydraulic engineering, civil engineering, hydrology, water resource engineering, Irrigation engineering, soil and water engineering or related field from a recognized university
- Professional experience: Shall have Minimum 8 years working experience in related task
- Proven experience in infrastructure planning and implementation for flood risk reduction projects
- Familiarity with urban planning and sustainable drainage practices
- Strong analytical and problem-solving skills

Excellent communication and stakeholder engagement abilities

✓ **Environmental Safeguards Specialist**

His/her role is vital in ensuring that all project activities adhere to environmental standards, minimizing negative impacts, and promoting sustainability within the designated river basin. The following responsibilities and detailed task assignment outline his/her key tasks:

Qualifications:

- Academic specialization: Should have Bsc or above in Environmental engineering, natural resource management or related field from a recognized university
- Professional experience: Shall have Minimum 8 years working experience in related task
- Proven experience in conducting EIAs and implementing environmental safeguards for infrastructure projects
- Familiarity with national and international environmental regulations
- Strong analytical and problem-solving skills
- Excellent communication and stakeholder engagement abilities

✓ **Social Safeguard Specialist**

His/her role is crucial in ensuring that the Flood Risk Reduction Investment project prioritizes social well-being and inclusivity. You will be responsible for addressing potential social risks and ensuring that project activities align with community needs and expectations. The following responsibilities and detailed task assignment outline his/her key tasks:

Qualifications:

- Academic specialization: Should have BSc or above in social science, or related field from a recognized university
- Professional experience: Shall have Minimum 8 years working experience in related task
- Proven experience in social impact assessments, community engagement, and resettlement planning
- Familiarity with gender equality and social inclusion principles
- Strong analytical and problem-solving skills
- Excellent communication and stakeholder engagement abilities

✓ **Mechanical Engineer**

His/her role is essential in contributing to the success of the Flood Risk Reduction Investment project for the designated river basin. His/her expertise in mechanical engineering will be instrumental in designing and implementing mechanical systems that contribute to flood risk reduction. The following responsibilities and detailed task assignment outline his/her key tasks:

Qualifications:

- Academic specialization: Should have BSc or above in mechanical engineering or related field from a recognized university
- Professional experience: Shall have Minimum 6 years working experience in related task
- Proven experience in the design and optimization of mechanical systems for water management projects
- Familiarity with hydraulic machinery and equipment
- Strong analytical and problem-solving skills
- Excellent communication and collaboration abilities

✓ **Geotechnical Engineer**

His/her role is pivotal in ensuring the stability and integrity of structures within the Flood Risk Reduction Investment project for the designated river basin. His/her expertise in geotechnical engineering will be instrumental in assessing soil conditions, providing foundation recommendations, and contributing to the overall success of the project. The following responsibilities and detailed task assignment outline his/her key tasks:

Qualifications:

- ✓ Academic specialization: Should have Bsc or above in geology hydrogeology or related field from a recognized university
- ✓ Professional experience: Shall have Minimum 6 years working experience in related task
- ✓ Proven experience in geotechnical site investigations, foundation design, and slope stability analysis
- ✓ Familiarity with seismic design considerations
- ✓ Strong analytical and problem-solving skills
- ✓ Excellent communication and collaboration abilities

- ✓ **Geologist**

His/her role is integral to understanding the geological conditions within the Flood Risk Reduction Investment project for the designated river basin. His/her expertise in geological assessments and mapping will play a crucial role in informing project decisions related to infrastructure design and risk mitigation. The following responsibilities and detailed task assignment outline his/her key tasks:

Qualifications

- Academic specialization: Should have Bsc or above in geology hydrogeology or related field from a recognized university
- Professional experience: Shall have Minimum 6 years working experience in related task
- Proven experience in geological assessments, mapping, and risk evaluations for infrastructure projects
- Familiarity with landslide risk assessment and groundwater studies
- Strong analytical and problem-solving skills
- Excellent communication and collaboration abilities

- ✓ **Surveyor**

His/her role is crucial in providing accurate and reliable spatial data for the Flood Risk Reduction Investment project within the designated river basin. His/her expertise in surveying will contribute to precise measurements, mapping, and topographical information essential for project planning and execution. The following responsibilities and detailed task assignment outline his/her key tasks:

Qualifications:

- Academic specialization: Bsc or above in surveying or related field from a recognized university
- Professional experience: Shall have Minimum 5 years working experience in related task
- Familiarity with geodetic control establishment and hydrographic surveys
- Strong analytical and problem-solving skills
- Excellent communication and collaboration abilities

- ✓ **Quantity Surveyor**

His/her role is pivotal in managing the project's cost and ensuring effective financial control throughout the Flood Risk Reduction Investment project within the designated river basin. His/her expertise in quantity surveying will contribute to accurate cost estimations, budget management, and financial reporting. The following responsibilities and detailed task assignment outline his/her key tasks:

Qualifications:

- Academic specialization: BSc or above in civil engineering, Quantity Surveying, hydraulic engineering or related field from a recognized university
- Professional experience: Shall have Minimum 8 years working experience in related task
- Proven experience in quantity surveying for large infrastructure projects
- Familiarity with cost estimation software and project management tools
- Strong analytical and problem-solving skills
- Excellent communication and collaboration abilities

- ✓ **GIS Expert**

His/her role is pivotal in providing geospatial insights and support for the Flood Risk Reduction Investment project within the designated river basin. His/her expertise in Geographic Information System (GIS) will be crucial for data analysis, mapping, and decision-making processes. The following responsibilities and detailed task assignment outline his/her key tasks:

Qualifications:

- Academic specialization: Bsc or above in GIS, hydro-informatics, hydrology or related field from a recognized university
- Professional experience: Shall have Minimum 8 years working experience in related task
- Proven experience in GIS analysis and mapping for large-scale infrastructure projects
- Proficiency in GIS software (e.g., ArcGIS, QGIS) and data visualization tools
- Strong analytical and problem-solving skills
- Excellent communication and collaboration abilities

11 Review of the Global Experience on Similar Lake Basin Food risk Management Projects

It is known that the flood problem in the Rift valley is not new; rather it is common challenge over the entire world physical environment.

The consulting firm can refer to the following international experiences in Lake Flood management as a point of reference for the Feasibility Study, Detail Design, and Tender document preparation of the Rift Valley Lake Basin for Flood Risk Reduction Investment Project:

1) **Lake Constance, Europe:** The management of flood risks in the Lake Constance region involves a combination of structural measures such as dykes and non-structural measures including early warning systems, floodplain management, and community engagement. The firm can study the integrated approach to flood risk reduction in a lake basin context.
2) **Lake Mead, United States:** The management of flood risks in the Lake Mead region involves the operation of reservoirs and dams to mitigate flood events downstream. The firm can study the design and operation of reservoirs for flood control and water storage in a lake basin setting.
3) **Lake Biwa, Japan:** The management of flood risks in the Lake Biwa region involves a combination of traditional and modern flood control measures, including the use of levees, reservoirs, and ecological restoration projects. The firm can explore the integration of nature-based solutions with traditional infrastructure for flood risk reduction.
4) **Great Lakes Basin, United States and Canada:** The Great Lakes, including Lake Superior, Lake Michigan, Lake Huron, Lake Erie, and Lake Ontario, form the largest group of freshwater lakes in the world. Projects in this basin have focused on various aspects of flood risk reduction, water quality management, and ecosystem restoration.
5) **Caspian Sea, Eurasia:** The Caspian Sea, the world's largest inland body of water, has experienced challenges related to flooding and changes in water levels. Projects in the

Caspian Sea region may provide insights into flood risk reduction strategies in internal lake basins.

6) **Lake Tahoe, United States:** Lake Tahoe, situated in the Sierra Nevada Mountain range, has faced issues related to urban development and water quality. Projects in the Lake Tahoe Basin have involved efforts to protect the lake's clarity, manage storm water runoff, and address ecological concerns.

7) **Mekong River Basin, Southeast Asia:** The Mekong River Commission and various international consulting firms have conducted studies and projects related to flood risk management, hydrological modeling, and infrastructure development in the Mekong River Basin. The firm can refer to consultancy studies that address flood management challenges in a large, cascaded river and lake system.

   The Mekong River Basin in Southeast Asia faces various challenges related to flood management, hydrological changes, and infrastructure development. The Mekong River Commission (MRC) and several international consulting firms have indeed been involved in studies and projects to address these issues. Here are some key aspects and examples related to flood risk management in the Mekong River Basin:

   Given the impact of climate change on the region, studies may also explore the potential changes in precipitation patterns, river flow, and flood risks. Strategies for adapting to these changes and building climate resilience may be included in consultancy studies.

   For specific consultancy studies, it is recommended to refer to reports and publications by the MRC, international consulting firms, and relevant government agencies involved in the Mekong River Basin. These documents can provide in-depth insights into the methodologies, findings, and recommendations of studies related to flood risk management in this region.

8) **Lake Titicaca Basin, South America:** Consultancy studies and projects related to flood risk reduction, water quality management, and sustainable development in the Lake Titicaca Basin can provide insights into managing flood risks in a high-altitude lake basin with complex hydrological dynamics.

The Lake Titicaca Basin, situated in the Andean highlands of South America, faces unique challenges related to flood risk reduction, water quality management, and sustainable development. The complex hydrological dynamics of this high-altitude lake basin require tailored approaches to address these issues. While specific consultancy studies and projects may vary, here are some key aspects that could be considered in managing flood risks in the Lake Titicaca Basin:

9) **Lake Baikal Basin, Russia:** While not a cascaded rift lake basin, the experience of consultancy studies and projects related to flood risk reduction, watershed management, and environmental protection in the Lake Baikal Basin can offer valuable lessons for managing flood risks in a large, deep lake basin with unique ecological considerations.

   Lake Baikal, located in Siberia, Russia, is the world's deepest and oldest freshwater lake. While it differs from cascaded rift lake basins, the challenges related to flood risk reduction, watershed management, and environmental protection in the Lake Baikal Basin are significant. Consultancy studies and projects in this region can provide valuable lessons for managing flood risks in a large, deep lake basin with unique ecological considerations.

By referencing these international experiences, the consulting firm can gain valuable insights into best practices, innovative approaches, and lessons learned in Lake Flood management, which can be applied to the specific context of the Rift Valley Lake Basin.