

REPORT

Volume 4: Cost Estimate

Kalpasar Closure Dam Cost Estimate

Client: India Ministry of Earth Sciences, National Centre for Coastal Research (NCCR)

Reference: DI1578-101-100-RHD-ZZ-XX-RP-Z-0005

Status: Draft/01

Date: 21 April 2023

HASKONINGDHV CONSULTING PVT. LTD.

Platinum Techno Park 502-505
5th floor Plot No. 17 & 18
Sector 30 A Navi Mumbai 400 703
Maharashtra
Water & Maritime
Trade register number: 56515154

+91 22 4161 5000 **T**
+91 22 4161 5050 **F**
info.india@rhdhv.com **E**
royalhaskoningdhv.com **W**

Document title: Volume 4: Cost Estimate

Subtitle: Kalpasar Closure Dam Cost Estimate
Reference: DI1578-101-100-RHD-ZZ-XX-RP-Z-0005
Status: 01/Draft
Date: 21 April 2023
Project name: Kalpasar dam project
Project number: DI1578-101-100
Author(s): Satyanand Kunta

Drafted by: Shashank K Pal

Checked by: Robert Jacobs

Date: 21 April 2023

Approved by: Satyanand Kunta

Date: 21 April 2023

Classification

Project related

Unless otherwise agreed with the Client, no part of this document may be reproduced or made public or used for any purpose other than that for which the document was produced. HaskoningDHV Consulting Pvt. Ltd. accepts no responsibility or liability whatsoever for this document other than towards the Client.

Please note: this document contains personal data of employees of HaskoningDHV Consulting Pvt. Ltd.. Before publication or any other way of disclosing, this report needs to be anonymized, unless anonymisation of this document is prohibited by legislation.

Table of Contents

1	GENERAL	1
1.1	Introduction	1
1.2	Overview of scope of assignment	2
1.3	Guidance for the reader	2
2	Cost Estimate	4
2.1	Introduction	4
2.2	Exclusions from CAPEX	4
2.3	CAPEX Summary	5
2.4	Annual Operations and Maintenance Costs	7

Table of Tables

Table 1	Block Cost Estimate for Alternative-1 & Alternative-2	5
Table 2	Cost Estimates for Alternative-1 & Alternative-2	6
Table 3	Summary of Operations & Maintenance Cost Estimates	7

Table of Figures

Figure 1.1	Selected alignment of the KALPASAR dam in the Gulf of Khambhat	1
------------	--	---

1 GENERAL

1.1 Introduction

Identified first in the 1970's for its tidal power resource and having been considered in different configurations over the years, at present the KALPASAR dam aims to provide a reliable source of fresh water for the drought-stricken state of Gujarat (Saurashtra in particular) by means of a 60 km dam between Bhavnagar and Paniyadra of which the centre 30 km concerns a closure dam in the Gulf of Khambhat (Figure 1.1). A reliable source of fresh water is established once the closure dam is constructed and the transition from sea water reservoir to freshwater reservoir has occurred. From earlier studies it was found that the construction of the closure dam and the saltwater transition will require 10 to 15 years before fresh water is available, pending further analysis beyond the scope of this assignment.

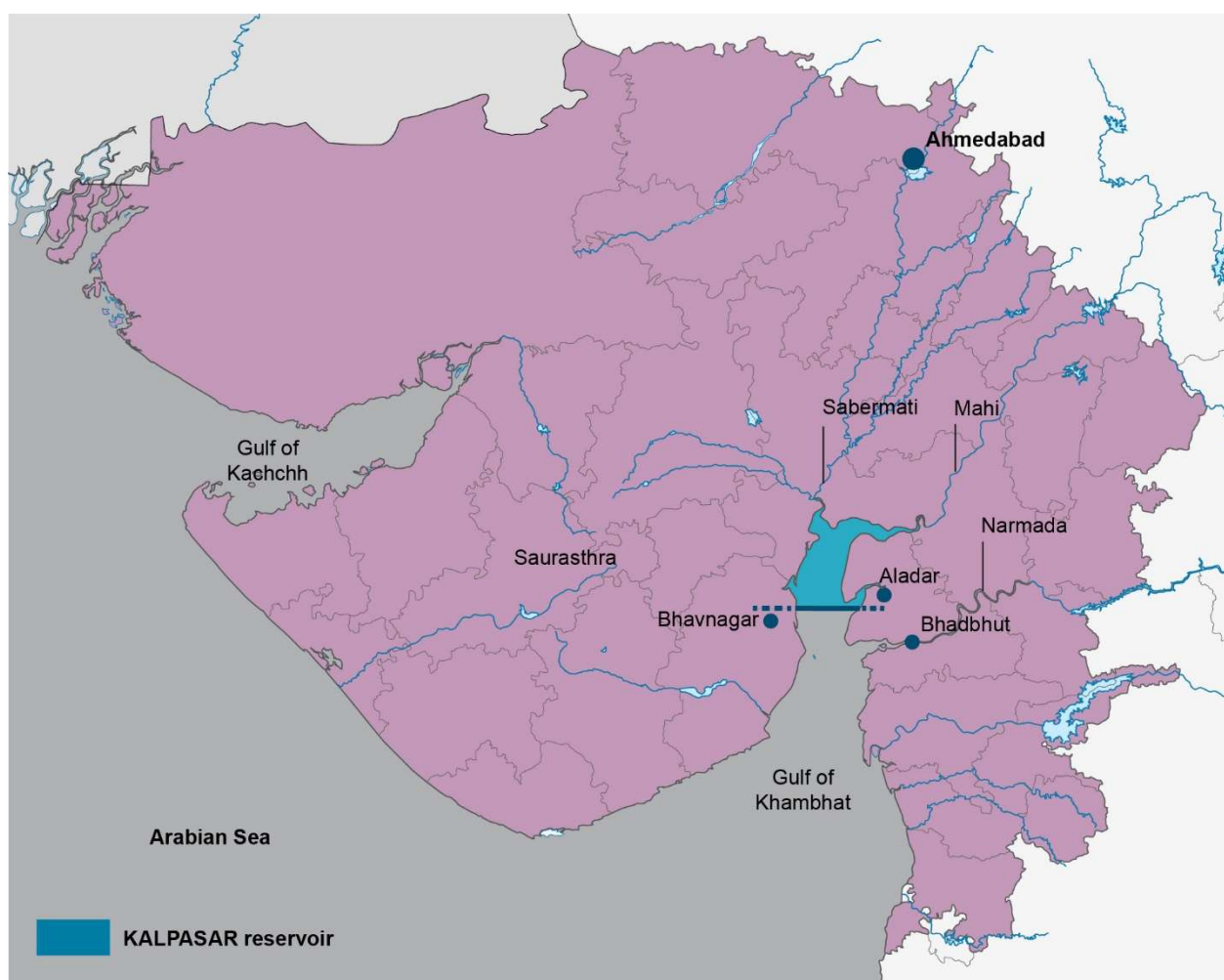


Figure 1.1 Selected alignment of the KALPASAR dam in the Gulf of Khambhat

In its present form, the KALPASAR project includes the 60 km dam connecting the Bhavnagar and Bharuch districts and a road/rail corridor, a freshwater reservoir of 7.800 million m³ and a spillway to divert floods from the three major rivers flowing into the freshwater reservoir (Sabarmati, Mahi and Dhadhar). Once completed, a diversion from the Bhadbhut Barrage in the Narmada by means of a canal towards

the freshwater reservoir is also considered by Narmada Water Resources, Water Supply and KALPASAR Department (NWRWS).

The KALPASAR dam is a huge undertaking considering the sheer volume of work and associated cost alone. Considering that during construction, severe site conditions must be accounted for such as, (i) 25 m water depth on average, (ii) a tidal range of 4 m to 10 m at Bhavnagar, (iii) poor soil conditions and (iv) monsoon seasons that take out 3 months of working time each year, makes the project even more challenging and costly. A delay in its completion – if construction risks are not appropriately mitigated – is likely to occur. Given the anticipated high cost of construction, the risk of delay before fresh water becomes finally available results in a viability gap that is difficult to mitigate, if at all. As such, KALPASAR dam is an unprecedented project.

The construction of the KALPASAR dam consists of two main stages: (i) the construction of the closure dam and (ii) the upgrading of the closure dam to the final (permanent) dam. The present feasibility study considers the feasibility of the closure dam only. This is the first and probably most important step in de-risking KALPASAR project. After all, once the closure dam is erected, the construction risk associated with upgrading it to its desired final form is dramatically lower, although still significant for the overall size of the project.

1.2 Overview of scope of assignment

The scope of the present assignment consists of two aspects, namely (i) the Design of Closure Methodology for KALPASAR closure dam, consisting of review of existing closure methodology reports and study various options for closure of the Gulf of Khambhat and an optimised closure methodology and design the same and (ii) the design of gate and hydraulic mechanical system. This scope has been executed and documented as described in the following sub-chapter.

1.3 Guidance for the reader

The execution of the study is documented in a Detailed Project Report with four supplementary Technical Volumes as annexures, structured as follows:

Detailed Project Report (DPR)

The Detailed Project Report (DPR) or Main Report takes the results from the technical report on the KALPASAR closure dam feasibility (VOLUME 2) to assess and evaluate risks to account for when considering the alternatives identified. Risks addressed are amongst others volume risks, price risks, time related risks and the failure mode analysis as (key) technical risks and mitigated in their respective designs. The DPR includes an executive summary, key issues and risks to consider and recommendations on the way forward.

VOLUME 1: Technical Report on Hydrodynamic Modelling of KALPASAR Dam Closure

Volume 1 introduces the closure methods and strategies, and describes the hydraulic analysis based on thousands of simulations with the one-dimensional model hydraulic model, conducted to determine current velocities occurring during the closure for different closure options.

VOLUME 2: Technical Report on Closure Dam Feasibility

From a thorough analysis of site conditions, a design basis for KALPASAR closure dam is determined to provide an unequivocal and solid basis for (i) development of distinct and feasible alternatives and (ii) risks to account for in the feasibility analysis presented in the Main Report. Gradual and sudden closure components are designed according to the design basis and used as building blocks allowing for evaluation of different closure scenarios in a construction model that provides insight into cost and duration

of construction. From the evaluation of scenarios, the distinct closure strategies are derived and evaluated for input the feasibility analysis. The construction model used results in a theoretical design that is subsequently translated into a practical design for (i) illustrative purposes and (ii) to serve as a basis for the Bill of Quantities and Cost Estimates in Volume 4.

VOLUME 3: Technical Report on Design Review of Permanent Structures KALPASAR Dam and Design of Spillway Gates

Volume 3 contains the identification and assessment of options for the spillway gates, concluding in a conceptual design of the preferred option, a cost estimate and an operations and maintenance plan. In addition, a review of the KALPASAR dam structures in their permanent form, including the spillway, is provided as additional feedback on the designs by other consultants provided by the client.

VOLUME 4: Technical Report on Cost Estimate for KALPASAR Closure Dam (THIS REPORT)

Volume 4 contains a Bill of Quantities (BOQ) and an associated cost estimate for the KALPASAR closure dam alternatives.

2 Cost Estimate

2.1 Introduction

A preliminary CAPEX (Capital Expenditure) estimate has been prepared for Kalpasar Dam development. Actual costs may vary from the provided cost estimates, depending on the construction timeline, changed market conditions, availability of materials, change of policy and other unlisted factors.

The cost is divided into major components such as Project Preliminaries & Site Development, Construction pit for casting caisson, Gradual closure/construction of rock bund, Caisson construction, Utilities, and contingency. Cost Estimation for Caissons has been arrived by considering the preliminary engineering and environmental conditions. Capital expenditure has been arrived based on unit rates taken from below mentioned data.

- Central Public Works Department (CPWD) Schedule of Rates (SOR).
- Gujarat Maritime Board's (GMB) Schedule of Rates (SOR).
- Current market rates obtained from ongoing projects and vendors.
- Rates from past projects carried out by RHDHV in India.

The following assumptions were used during the development of these estimates:

The capital cost estimates are based on the project descriptions and drawings which were prepared after carrying out basic engineering of various components of the project. These will need to be developed, revised, and refined during the detailed design phase, and therefore some quantities shown in the cost estimates may undergo revision.

- All cost estimates are represented in INR
- All mobilization costs are included in respective entities.
- A construction methodology has been assumed based on experience of similar structures and utilized for costing provided in this section.
- Lumpsum amount has been assumed for certain entities.

Note that in the Main Report and Volume 2, costs were determined on a parametric basis for purposes of comparison between alternatives. Whereas the cost estimate in this report has been developed bottom-up by means of unit rates applied to a bill of quantities. As such, some minor differences between costs can be found between the reports; the costs in this Volume 4 prevail for purposes of future budgeting and planning.

2.2 Exclusions from CAPEX

The following exclusions were used during the development of these estimates:

- The tapered ends (west and east ends) of the closure dam are excluded as these were outside of the physical scope of the assignment. The extent of the closure dam thus included for is the 31,000m length reflected in the drawings in **Volume 3 Appendix A1**;
- Cost towards rock at quarry is excluded (i.e. suitable rock is considered to be provided free of charge to the quarry gate);
- Cost towards any special equipment to cast the caissons;
- Risk costs associated with the risks described in the **Main Report** Chapters 4-7;
- Costs of the Spillway Gates are excluded. These are provided separately in **Volume 3**;

- Cost of the permanent Kalpasar dam is excluded;
- Upgradation of external road and rail connectivity, as this is the responsibility of Central and State Government (these upgradations shall be done in coordination with National Highway Authority of India (NHAI) and Indian Railways (IR));
- Costs for environmental and social studies with potential mitigation measures, as these must be estimated by Environmental and Social consultant as part of the EIA & SIA studies;
- Cost towards Land Acquisition is excluded;
- Cost towards project financing is excluded;
- No taxes such as Service Tax, GST etc. are included.

2.3 CAPEX Summary

The cost estimates have been summarized in Table 1. The below cost provides basic cost of the infrastructure and includes cost towards contingency, PMC and other costs. Refer Table 2 for detailed breakup of the quantities.

Table 1 Block Cost Estimate for Alternative-1 & Alternative-2

S.No.	ITEM		Alternative 1 (Scenario 14: 10 km of sudden closure structure)		Alternative 2 (Scenario 16: 20 km of sudden closure structure)	
			INR (Cr. ₹)	EURO (Million €)	INR (Cr. ₹)	EURO (Million €)
1	Project Preliminaries and Site Development		348	39	645	72
2	Construction Pit for Casting Caisson		2,882	320	3,475	386
3	Gradual Closure / Construction of Rock Bund		23,026	2,558	13,741	1,527
4	Sudden Closure Structures (Caissons)		19,400	2,156	37,044	4,116
5	Utilities		460	51	690	77
6	Miscellaneous & Contingency	15%	8,647	961	10,424	1,158
	Engineering and PMC Cost	5%	2,882	320	3,475	386
Project Cost + Engineering & PMC Cost			57,644	6,405	69,494	7,722

Table 2 Cost Estimates for Alternative-1 & Alternative-2

S. No.	ITEM	UNIT	RATE (Rs.)	Alternative 1 QUANTITY	Alternative 2 QUANTITY	Alternative 1 Cr.	Alternative 2 Cr.
1.0	PROJECT PRELIMINARIES AND SITE DEVELOPMENT						
1.1	Project Studies and Surveys	LS	40,00,00,000	1	1	40.0	40.0
1.2	Land Acquisition	LS	0	0	0	-	-
1.3	Site Clearing and Site Development	LS	20,00,00,000	1	1	20.0	20.0
1.4	Internal Road	sqm	25,000	112500	225000	281.3	562.5
1.5	Ground Improvement	sqm	600	105000	375000	6.3	22.5
	Total (1)					347.6	645.0
2.0	Construction Pit for Casting Caisson						
2.1	Assumed as 5% of project cost	LS				2882.2	3474.7
	Total (2)					2882.4	3474.7
3.0	Gradual Closure / Construction of Rock Bund						
3.1	Rock Quarry						
	a Placing Rock Quarry in 1 year	cum	4,950		2,61,47,705	-	12,943.1
	b Placing Rock Quarry in 2.5 year	cum	4,950	4,47,86,546		22,169.3	-
3.2	Geotextile	cum	225	2,08,71,019	2,14,19,757	469.6	481.9
3.3	Sand	cum	270	1,43,29,656	1,17,12,778	386.9	316.2
	Total (3)					23,025.8	13,741.3
4.0	Sudden Closure Structures (caissons)						
4.1	Concrete	cum	14,000	29,20,000	58,40,000	4,088.0	8,176.0
4.2	Reinforcement	MT	1,00,000	6,42,400	12,84,000	6,424.0	12,848.0
4.3	Steel Gate	MT	2,50,000	1,00,000	2,00,000	2,500.0	5,000.0
4.4	Caisson Placement						
	a Special Purpose Vessel	Nos	17,55,00,00,000	1	1	1,755.0	1,755.0
	b Operating Special Purpose Vessel Per day	Nos.	1,90,00,000	200	400	380.0	760.0
	c Tugboat Rent Per Day (4 Tugs per day)	days	8,00,000	800	1,600	64.0	128.0
4.5	Backfill	cum	285	1,00,00,000	2,00,00,000	285.0	570.0
4.5	Mechanical & Electrical (30%)	LS				3,903.6	7,807.2
	Total (4)					19,399.6	37,044.2
5.0	Utilities						
5.1	Electrical and Power Distribution	LS	2,00,00,00,000	1	1.5	200.0	300.0
5.2	Comm, Data and Security	LS	10,00,00,000	1	1.5	10.0	15.0
5.3	Firefighting	LS	1,00,00,00,000	1	1.5	100.0	150.0
5.4	Potable water distribution	LS	50,00,00,000	1	1.5	50.0	75.0
5.5	Storm Drainage, Effluent and Sewage	LS	1,00,00,00,000	1	1.5	100.0	150.0
	Total (5)					460.0	690.0
	Total (1+2+3+4+5)					46,115.2	55,595.2

Note: Cost of Construction Pit for Casting Caisson (under serial number 2.0 in the above table) is assumed as 5% of the total project cost. This percentage is based on RHDHV experience on various projects involving caissons and/or tunnel elements.

2.4 Annual Operations and Maintenance Costs

The annual operation and maintenance cost for Kalpasar Dam project are provided in table below. The O&M for construction is calculated on prorata basis.

Table 3 Summary of Operations & Maintenance Cost Estimates

S.No.	Particulars	Alternative 1 (Cr.)	Alternative-2 (Cr.)
1	Year – 1	2000	3500
2	Year – 2	2000	3500
3	Year – 3	2000	3500
4	Year – 4	2000	3500
5	Year – 5	2000	0
6	Year – 6	2000	0
	Total	12,000	14,000