



## Dams, Hydropower and Underground Works Profile



We change lives

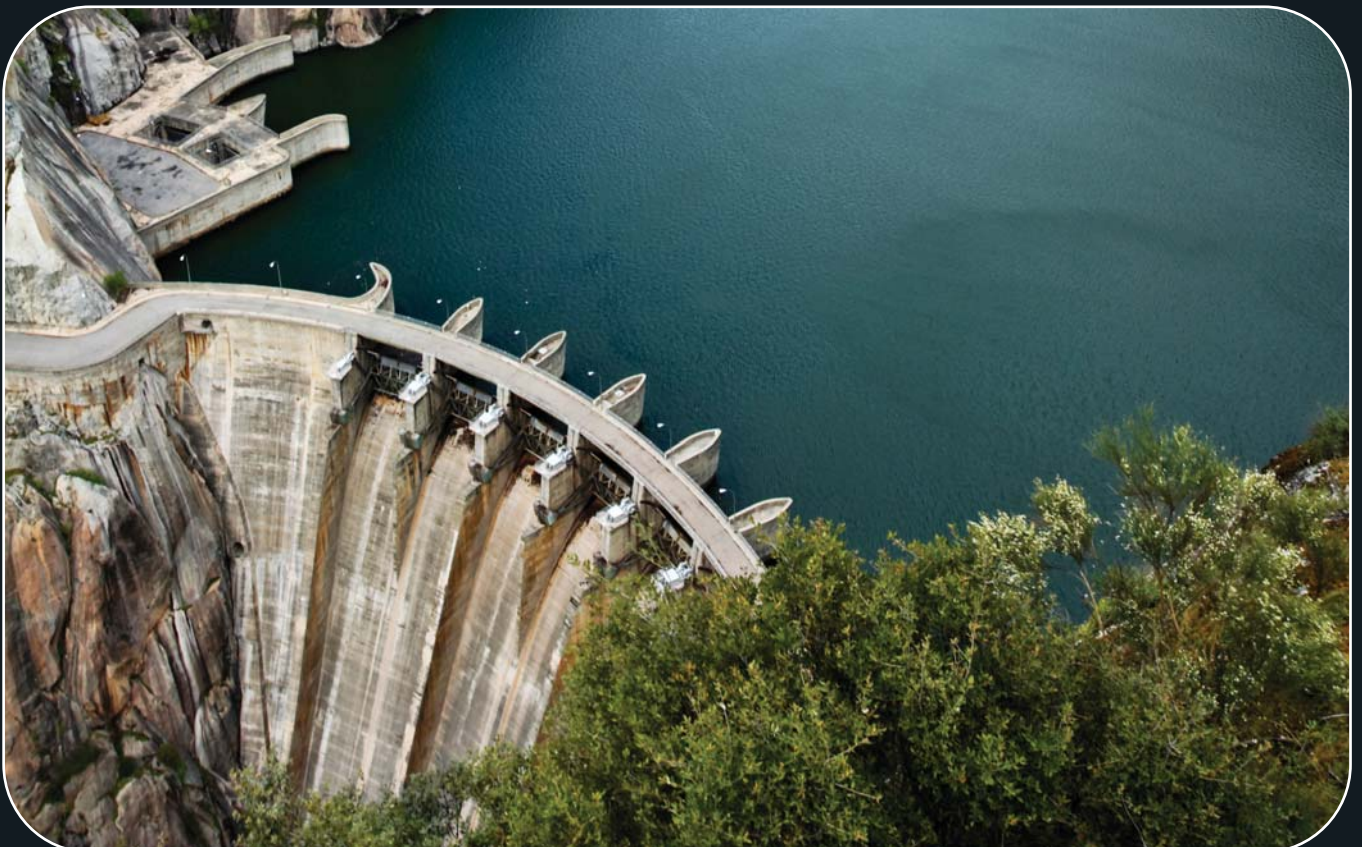
# DAMS, HYDROPOWER AND UNDERGROUND WORKS

## HEAVY ENGINEERING

The Heavy Engineering team at GIBB comprises of highly qualified professionals located in major centres throughout Africa facilitating efficient and cost-effective solutions to complex engineering challenges in the diverse realms of heavy engineering.

Our reputation has been built upon technical excellence combined with total commitment to the highest standard of client care. The Heavy Engineering team is well placed to partner you through each stage of project development, offering a fully comprehensive service that includes:

- Dam engineering
- Diversion structures
- Geotechnical and underground engineering
- Hydropower plants and pumped storage schemes
- Management and programming of multi-disciplinary projects
- Model studies
- Project costing and financial modelling
- Tunnel engineering
- Water engineering and hydrological studies





## **Dam engineering**

See detailed capability description overleaf.

## **Hydroelectric engineering**

See detailed capability description overleaf.

## **Diversion structures**

GIBB has planned, designed and supervised the construction of a range of diversion structures and has executed projects involving hydraulic and structural design as well as complex model studies to evaluate the performance of various functional elements of each system.

## **Management and programming of multi-disciplinary projects**

We have the expertise to programme and manage large multi-disciplinary projects where interfaces are critical to the successful completion. These services include the planning, scheduling, contract management, directing and controlling of resources for the completion of specific goals and objectives.

## **Model studies**

GIBB has taken the lead in a variety of assignments in hydro, thermal and water supply fields, where rigorous hydraulic model studies have resulted in cost-effective solutions. We have developed models for mass oscillations in water conduits and pressure surges in various hydropower stations and pumping mains, the most complex of such models being for pumped storage schemes.

## **Project costing and financial modelling**

We offer services in the accurate pricing of engineering solutions as well as the representation of key financial and operational relationships. To this end we analyse the effects of varying economic climates and estimate the outcome of financial decisions before the commitment of any significant funds is required. This includes cash flow projections, depreciation schedules, debt service, inventory levels, rates of inflation, financial and economic feasibility studies.

We also offer resource-based, analytical estimating services where multiple levels of composite bill items are generated, giving parties a full understanding of price make-ups. Both direct and indirect cost rates are split into user-defined components such as labour, plant and materials.

## **Geotechnical engineering and tunnelling**

See detailed capability description overleaf.

## **Water resources**

See detailed capability description overleaf.

# DAM ENGINEERING

GIBB has been involved in all stages of the life-cycle of dam projects from inception through feasibility to design and construction and on to inspection, monitoring, risk evaluation, refurbishment and remedial works design. GIBB has worked both in the traditional role as consultant to the government or private developer, or as advisor to financiers such as banks and as consultant/designer to the Contractor as part of a design and building project.

## Services offered:

- Hydraulic analysis and design
- Seismic risk analysis
- Geotechnical and geological analysis and modelling including: foundation treatment, materials selection and processing, curtain and consolidation grouting
- Structural analysis and design including: finite element analysis, concrete and steelwork design and architectural input
- Hydrological analysis including: hydrological data generation, reservoir flood routing and dam-break analysis
- Topographic modelling
- Value engineering
- Economic evaluation including: construction cost estimation and cash flow estimation
- Hydraulic equipment design including: spillway gates, control valves, gates, and intake works
- Instrumentation and monitoring systems
- Contract documentation and administration including: pre-qualification, selection of and writing of conditions of contracts, specifications, bills of quantities
- Construction supervision
- Rehabilitation and remedial works
- Environmental impact assessment

## Selected projects:

**Bedford Dam, South Africa:** Design and site supervision of a 50m high concrete faced rockfill dam.

**Braamhoek Dam, South Africa:** Design and site supervision of a 30m high Roller Compacted Concrete (RCC) dam.

**De Hoop Dam, South Africa:** Site supervision of an 80m high RCC dam.

**Thune Dam, Botswana:** Design and site supervision of a 35m high embankment dam with a RCC spillway.

**Kabompo Gorge Dam, Zambia:** Feasibility study and design of a 55m high concrete arch dam.

**Metolong Dam, Lesotho:** Design and construction supervision of a 73m high RCC dam.

**Katse Dam, Lesotho:** Design and site supervision of a 185m high double curvature arch dam and a 35m high roller compacted concrete upstream cofferdam.

**Kariba Dam, Zimbabwe:** Design, construction supervision, ongoing monitoring and inspections.

**Maguga Dam, Swaziland:** Feasibility study for a 105m high clay cored rockfill, concrete faced rockfill or RCC dam.

**Roseires Dam, Sudan:** Feasibility, planning, design and construction supervision of original construction and dam heightening and refurbishment.

**Koudait Rosfa Dam, Algeria:** Design review, detailed design and construction supervision of a 57m high embankment dam.





# HYDROELECTRIC ENGINEERING

GIBB has been involved in hydroelectric development for over 50 years and has developed a depth of experience in all phases of the work, from power sector studies through feasibility studies to the detailed design and supervision of construction of major schemes.

**GIBB has played a leading role in a diverse range of hydroelectric power stations including:**

- Over 100 projects around the world
- Surface power stations
- Underground power stations
- 0.2 MW to 1200 MW
- Heads up to 650m

## Services offered:

- Economic and financial evaluation
- Integrated power planning
- Scheme optimisation
- Environmental impact assessment
- Hydraulic analysis and design
- Structural analysis and design including: finite element analysis, concrete and steelwork design and architectural input
- Seismic risk analysis
- Geotechnical and geological investigations, analysis and modelling
- Hydrological analysis including: hydrological data generation
- Value engineering
- Hydraulic equipment design including: spillway gates, control valves, gates and intake works
- Risk assessment
- Instrumentation and monitoring systems
- Contract documentation and administration including: pre-qualification, selection of and writing of conditions of contracts, specifications, bills of quantities
- Tunnel and cavern design and supervision

## Selected projects:

**Ingula Pumped Storage Scheme, South Africa:** Design and construction supervision of a 1332 MW installed capacity scheme including a concrete faced rockfill upper dam, a roller compacted concrete lower dam, waterway and access tunnels and a powerhouse cavern housing 4 x 332 MW Francis Turbines.

**Kabompo Gorge Hydroelectric Project, Zambia:** Feasibility study and design of a 35 MW hydroelectric scheme.

**Lower Magaduzza Hydroelectric Project, Swaziland:** Feasibility study for a 20 MW hydroelectric scheme.

**Lesotho Highlands Water Project, Lesotho:** Planning, design and construction supervision of a 185m high arch dam, a 46km long, 4.96m diameter headrace tunnel, supplying a 72 MW power station.

**Owen Falls, Uganda:** Rehabilitation, design and supervision of a 180 MW hydropower station with a 30m high gravity dam.

**Kariba North, Zambia:** Study, planning, and design of refurbishment of the 600 MW hydropower station.

# WATER RESOURCES

Ever increasing demands on limited water resources necessitate the accurate assessment of both the quantity and quality of water resources in river catchments in South Africa. This is underlined by the National Water Act (Act No 36 of 1998) which requires the quantification of existing water resources to allow for the determination of water allocation schedules as prescribed for the compulsory licensing of all existing and new water users in water-stressed catchments.

Water resources planning uses the knowledge obtained from climatology and river basin studies to establish the run-off for particular areas and the associated drought and flood probabilities. In addition, planning defines the parameters for water apportionment and detail design by taking into account the overall water needs.

Water resources planning for the sustainable optimal future management of water resources on a catchment basis encapsulates a wide range of water resource modelling activities.

## **GIBB has the expertise for:**

- Water demand forecasting
- Surface runoff hydrological studies to determine the water yield potential of catchments, including the modelling of streamflow reduction activities, eg afforestation, irrigation, farm dams and reservoirs
- Reservoir yield determinations and yield risk assessments for existing and proposed future reservoirs
- Modelling of existing and proposed flow diversion schemes and weirs
- System yield analyses, system yield risk assessments and determination of optimal operating policies for inter linked inter-basin bulk water supply schemes
- Preparation of hydrological data required as input for the compulsory ecological reserve determinations as stipulated by the National Water Act
- Hydro-salinity modelling of total dissolved salts concentrations in surface water
- Project management and administrative support for integrated multi-discipline reconnaissance, pre-feasibility and feasibility catchment hydrological and development studies

A wide range of computer based models, including the application of geographic information system tools are used, depending on the requirements and aims of projects.

## **These include:**

- Water situation assessment model decision support tool for desktop reconnaissance level water resource planning
- WRSM2000 rainfall-runoff and land use water requirements model
- Water resources yield model
- Water resources planning model
- ACRU model
- WQT hydro-salinity model

## **Water engineering and hydrological studies**

GIBB has been instrumental in the development of accurate water resource models. We provide a range of services across the entire water cycle to support development and environmental improvement including allowances for climatic change. These services cover water resources, water supply and flood risk management systems.





# GEOTECHNICAL ENGINEERING AND TUNNELLING

Members of GIBB's geotechnical team have gained a wide range of tunnelling and geotechnical experience having worked in southern Africa on projects such as the 83km long Orange-Fish Tunnel, 90km of tunnelling for the Lesotho Highlands Water Project, and 30km of service tunnels in Gauteng, and Kwa-Zulu Natal. Key members of the team have also worked overseas on tunnelling projects in countries such as the UK, China, and Taiwan.

## Geotechnical and underground engineering

The GIBB Geotechnical and Underground team can provide a wide range of services for:

- Cut and cover tunnels
- Engineering audits
- Site investigations
- Site supervision
- Slope stability
- The design of tunnels, shafts and caverns in hard and soft ground conditions
- The use of Tunnel Boring Machines (TBMs)

## Services offered:

- Planning, design, bid documentation, project management and site supervision of:
  - Tunnels, shafts and caverns in rock and soft ground conditions constructed using conventional, Sequential Excavation and Support (NATM), TBM or raise boring techniques
  - Cut and cover tunnels
  - Slope stability of surface excavations
  - Site investigations
  - Test pitting, profiling and soil analysis
- Design of caverns and tunnel design facilitated by the use of state of the art geotechnical software which includes:
  - FLAC 2D, and Phase 2
  - FLAC 3D
  - UDEC and UNWEDGE
- NTNU Fullprof software modelling and other prediction methods for predicting the performance of hard rock TBMs
- Resource based costing and programming for reliable cost estimates and project schedules
- Engineering audits of designs and construction

## Selected recent projects:

**Ingula Pumped Storage Scheme, South Africa:** Design and construction supervision of a 1332 MW installed capacity scheme including a powerhouse cavern, transformer cavern, waterways, access tunnels, ventilation shaft and surge chamber.

**Kabompo Gorge Hydroelectric Project, Zambia:** Feasibility study and design of a 35 MW installed capacity scheme.

**East London: Umtata railway line, South Africa:** Preliminary designs and cost estimates for 35 tunnels.

**N3 de Beers Pass, South Africa:** A desk study informing the feasibility and preliminary costing of twin three lane road tunnels for the re-alignment of the N3 over de Beers Pass.

**Gautrain: 15km of Underground Works:** Planning, procurement, design review, site monitoring, auditing, project and contractual management.

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