GROUNDWATER RESOURCE DEVELOPMENT

GCS has been involved in various groundwater resource development studies as well as designing abstraction and management programmes for developments ranging from small scale hand pump supplies to large scale mining and irrigation in excess of 4,000 m³/hr. Resource development studies require a broad knowledge of various geological and aquifer types. GCS has extensive in-house experience developed through the implementation of projects throughout Africa.

Potential study areas are identified and assessed for suitability through Aerial Photo Interpretation (API) and remote sensing. Ground geophysical investigations are performed to locate suitable borehole or well positions on site. Various geophysical methods are employed depending on the site specific geology and conditions. Catchment yield potential is evaluated through reserve calculations to determine the sustainability of groundwater abstraction.

During its 25 years of operation in Africa, GCS has established a comprehensive list of drilling and aquifer test contractors who can be employed to install and equip the boreholes. Once installed, aquifer tests can be performed to determine the sustainable yield of the aquifers. GCS performs drilling and aquifer test supervision to ensure optimal design, construction and data collection. Hydrochemistry is determined to ensure water quality suitability for the intended use.

Wellfield longevity is ensured through the development and implementation of sustainable abstraction programmes based on the aquifer test data and reserve calculations. Where necessary, numerical groundwater flow modelling aimed at designing the optimal borehole spatial distribution and abstraction rates is performed to optimise the well field design.

GCS has considerable experience in the development and management of groundwater resources in Africa and offers the following professional services:

- API and remote sensing
- Database development and management
- Geophysical investigations
- Contract management and supervision
- Borehole design and construction
- Resource evaluation (quantity and quality)
- Catchment reserve calculation studies
- Well field design, modelling and optimisation
- Borehole scheme management and monitoring
- Large and small scale irrigation schemes
<table>
<thead>
<tr>
<th>Year</th>
<th>Client</th>
<th>Project name</th>
<th>Services Performed by GCS</th>
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<tbody>
<tr>
<td>2009-2014</td>
<td>Amatheon Agri Zambia (AAZ), Bic Concession</td>
<td>BCA Detailed Hydrogeological study.  Mpongwe Development Company (MDC, Farm formerly ETC Bio, Currently Zambeef)</td>
<td>Characterisation and development of a Carbonate Rock Aquifer for large scale Groundwater abstraction for irrigation development. (1500m³/hour)</td>
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<td>2001-2012</td>
<td>(MDC, Farm formerly ETC Bio, Currently Zambeef)</td>
<td>Liphiring River (Roma University Lesotho emergency supply) Wellfield Development</td>
<td>Development and characterisation of carbonate rock aquifers as part of large scale groundwater abstraction, abstraction scenario modelling and Groundwater Reserve Determinations (4000m³/hour)</td>
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<tr>
<td>2011-2014</td>
<td>Moatize Alluvial Aquifer Assessment</td>
<td>DRA (Global)</td>
<td>Large scale abstraction: Characterisation and development of an alluvial aquifer for large scale Groundwater abstraction. The hydrogeological studies comprised of Electrical Resistivity Geophysical Surveys, Exploration Borehole Drilling, Abstraction Scenario Modelling and feasibility of the demand. (1900m³/hour)</td>
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