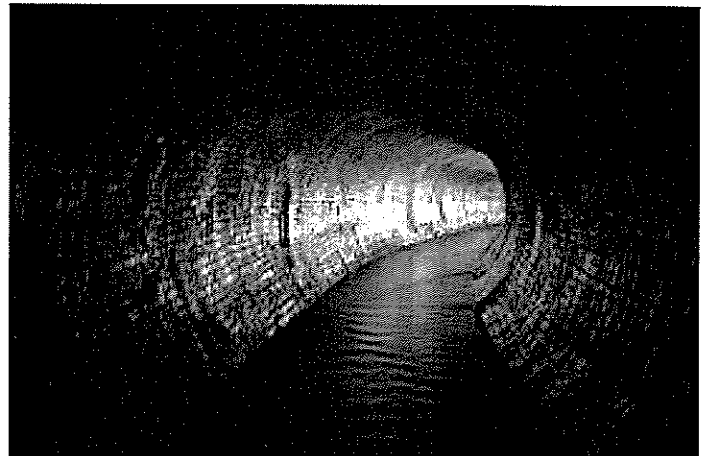
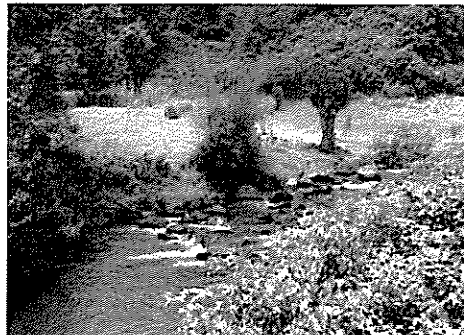




**ENVIRONMENTAL AND SOCIAL IMPACT
ASSESSMENT FOR NORTHERN COLLECTOR
TUNNEL PHASE 1**



FINAL STUDY REPORT

ATHI WATER SERVICES BOARD (AWSB)

I certify that this Environmental and Social Impact Assessment (ESIA) Study Report for the proposed Northern Collector Tunnel Phase 1 was conducted under my direction.

Signature *[Signature]* Date *04/11/2014*

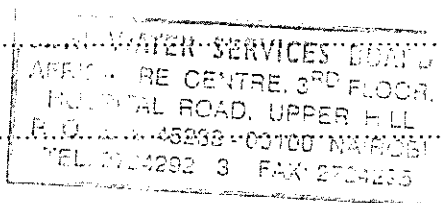
Name *Eng. JOHN M. MUIRURI*

Designation *HEAD CAPITAL PLANNING & ENGINEERING SERVICES*

Address *P.O. Box 45283-00100 NAIROBI*

Telephone *020 2724292/3*

Official Stamp



GIBB AFRICA CERTIFICATION

I certify that this Environmental and Social Impact Assessment (ESIA) Study for the proposed Northern Collector Tunnel Phase 1 was conducted under my direction and that I have reviewed and approved the report.

I hereby certify that the particulars given in this report are correct and true to the best of my knowledge.

Signature *[Signature]* Date *03/11/2014*

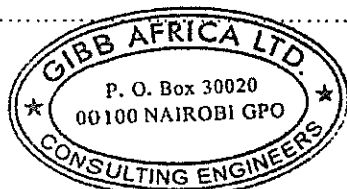
Name : **GEORGE GORO OWUOR**

Designation: **OPERATIONS MANAGER
ENVIRONMENTAL AND SOCIAL SERVICES DEPARTMENT**

Address: **BOX 30020 00100 NAIROBI KENYA**

Telephone : **+254 2 3245000/251880/250577**

Official Stamp



EXECUTIVE SUMMARY

E1 Project background and components

Athi Water Services Board (AWSB) has commissioned GIBB Africa Ltd to prepare an Environmental and Social Impact Assessment (ESIA) and a Resettlement Action Plan (RAP) for the proposed Bulk Water Supply to Nairobi City – Northern Collector Tunnel, a Raw Water Pipeline, and Treated Water Pipeline to Kabete Reservoir.

Following screening and scoping at initial stages, an ESIA Project Report was prepared and submitted to the National Environment Management Authority (NEMA) for review (NEMA Ref: NEMA/PR/5/2/12495). Following the review NEMA recommended wider public consultations and in-depth coverage of the foreseen impacts and proposed mitigation measures. ESIA study TOR were prepared and approved by NEMA in July 2014. This ESIA Study Report covers the ESIA for Northern Collector Tunnel (NCT) Phase 1.

The NCT Phase 1 Project is located in Kangema and Kigumo Sub-Counties of Muranga County. The project is located along the eastern fringe of the Aberdare Conservation Area approximately 60 km north of Nairobi.

The NCT Phase 1 Project consists of a tunnel which will transfer raw water through approximately 11.8 km from intakes at the Maragua, Gikigie and Irati Rivers to an outlet at the Githika River near Makomboki, upstream of the existing Thika Reservoir into which the water will be transferred. The design life of the main tunnel and its associated permanent infrastructure elements will be of 100 years. The principal features of the NCT Phase 1 include the following:

- River diversion weir and related intake hydraulic structures at Maragua River including:
 - 20 m wide, 5 m high weir including trench diversion intake
 - 37 m long, 4 m deep de-silting basin
 - Compensation channel
- River diversion weir and related intake hydraulic structures at Gikigie River including:
 - 14 m wide, 3.3 m high weir including trench diversion intake
 - 17 m long, 2 m deep de-silting basin
 - Compensation channel
- River diversion weir and related intake hydraulic structures at Irati River including:
 - 20 m wide, 4.4 m high weir including trench diversion intake
 - 25 m long, 2 m deep de-silting basin
 - Compensation channel
- Drop shaft and connection gallery connecting the Irati intake to the main tunnel
- River outlet at Githika River including:
 - Cut and cover portal outlet from the main tunnel
 - 20 m long outfall stilling basin structure
- Main Northern Collector Tunnel Phase 1 (main tunnel) including portals, excavation, initial support and permanent concrete lining. The tunnel is approximately 11.8 km long and of 3 m finished internal diameter:
 - Connection adit from Githika tunnel to the main tunnel;
 - Drop Shaft and connection adit at the Irati intake;
 - Access gallery from Kaanja Valley to the main tunnel.

The diversion and intake structures on rivers Maragua, Gikigie and Irati will divert $3\text{m}^3/\text{s}$, $1\text{m}^3/\text{s}$ and $2\text{m}^3/\text{s}$ respectively to the collector tunnel. The weirs and intakes are designed to harness flood flows and allow for compensation flows equivalent to Q95 flows for both Maragua ($Q_{95}=0.481\text{m}^3/\text{sec}$) and Gikigie ($Q_{95} = 0.101\text{m}^3/\text{sec}$) rivers. In the case of the Irati River the estimated compensation flow used is $1.4 \times Q_{95}$ ($0.645\text{m}^3/\text{sec}$) since Q95 flows alone was deemed inadequate.

The operational requirement of the compensation channel is considered in three phases as follows:

- At low river flows, i.e. not exceeding the required minimum compensation flow $Q < Q_c$, the compensation channel gate is fully open and all flows are permitted through the compensation channel gate under free flow condition. The low flows are not permitted through the diversion intake until the required minimum compensation flow is satisfied;
- At higher river flows, i.e. exceeding required minimum compensation flows but excess not exceeding intake diversion capacity ($Q > Q_c$ and $Q - Q_c < Q_d$), the compensation channel gate is partially open to only permit the minimum compensation flow (Q_c) and divert the excess ($Q - Q_c$) to the tunnel intake. The head of water behind the compensation gate contribute to pressure flow through the gate orifice; and
- At river flows exceeding the required minimum compensation plus maximum diversion flows (i.e. $Q > Q_c + Q_d$), the compensation channel gate is fully closed. The excess of diverted flow (i.e. $Q - Q_d$) is passed to the downstream through the main overflow weir, and exceeds the required minimum compensation flow.

The project implementation period is estimated to take about 40 months and on completion will deliver on average 120,000 m³/d to existing Thika dam.

E2 Existing Environment

Ecological survey conducted on the rivers established a total of 77 species of aquatic fauna including 7 fish species. The fishes include Stargazer mountain catfish (*Amphilius uranoscopus*), Pangani Barb fish (*Barbus oxyrhynchus*), Barb fish (*Barbus sp*), *Barbus paludinosus*, Red eye Labeo fish (*Labeo cylindricus*), Athi tilapia (*Oreochromis spirulus*) and Dembea stone lapper (*Garra dembensis*). In addition, some species were not encountered during the study but secondary sources and local knowledge confirmed their presence. These include *Anguilla bengalensis labiata*, Rainbow trout (*Oncorhynchus mykiss*), Salmon (*Salmo gaidneri*) and salmon (*Salmo trutta*). Of particular interest are the *Labeo cylindricus*, *Barbus sp* and the eel *Anguilla* which are migratory species. The *Labeo cylindricus* and *Barbus sp* were recorded at lower river Maragua upwards of the Wanjii Reservoir but were not recorded at the confluence of river Maragua and Sagana although it is known to occur in the middle stream reaches of R. Tana. *Labeo cylindricus* migrate upstream of rivers to spawn and uses the mouth and pectoral fins to climb barrier rocks and weirs. None of the aquatic species recorded is listed in the IUCN Red-list or the Sixth Schedule (Part D) of the Kenya Wildlife Act, 2003 both of which list threatened species.

Natural vegetation in the project area has been significantly modified by settlements and the small holder tea farms. A botanical survey conducted on the reaches of NCT 1 rivers established 279 plant species within the sample points. Of these, 6 species were found to be of special conservation concern. These include *Polyscias kikuyensis*, *Polystachya sp*, *Aerangis thomsonii*, *Prunus africana*, *Rubus keniensis* and *Rubus steudneri*.

There is no gazetted conservation area within the immediate project area. However, the Aberdare Conservation Area (Aberdare National Park and forest reserve) is about five kilometres upstream of the proposed intakes and is the catchment for the Project Rivers. The project is not likely to have impacts on the forest but the project's sustainability will depend on continued conservation of the forest.

E3 Feedback from consultation

During the ESIA study consultations were held through: (1) six (6) general public meetings at location levels within the project area; (2) key informant interviews with civil, government agencies and other institutions in the project area, from both Kigumo and Kangema sub counties as well as with various bulk water service providers; (3) household surveys; and (4) a stakeholders' workshop on 2 October 2014 at Norkas hotel in Murang'a town to disclose findings of ESIA studies. In the workshop, stakeholders' representation was from the local to the national levels and included international financing agencies. A summary of expected benefits and expressed concerns are given below.

i. The Expected benefits include:

- Employment opportunities: community members requested that the proposed project should alleviate unemployment issues by absorbing bulk of the youth in the local area to work in its construction and operation stages;
- Increased sale in crop production especially food products from farmers in Kigumo and Kangema Sub County;
- Increased activities related to trading due to availability of markets;
- Increased reliable water supply in the south of Muranga. Proposed kick-back water supply projects to Muranga; and
- Additional water to Thika Dam thus boosting water supply to Nairobi City (be of great value to the growing demand in the areas).

ii. Expected negative impacts include:

- Vibrations due to underground work activities during construction;
- Reduced river flow/ volumes down stream in Maragua, Gikigie and Irati Rivers;
- Intake structure preventing migratory fish upstream;
- Damage to roads during construction due to heavy equipment;
- Rise in cases of accidents and incidents during construction;
- Community health and increase in disease prevalence and unwanted teenage pregnancies;
- Fear of the possible impact on landslides and earth movements;
- Displacement of farmers paving way for the wayleave for the Tunnel;
- Interruption of school activities: Concerns were raised over the fact that construction might interrupt schooling and education activities in the area;
- Lack of Health Facilities: FDGs raised concerns over the number of health facilities in the area, noting that in some areas far from town centres, women have to travel long distances up- hill to access health care facilities, especially maternity services; and
- Vibrations due to underground work activities during construction.

Through the disclosure workshop, concerns expressed by the participants were addressed by both the consultant and AWSB.

The views of those affected by or interested in the project were also used to inform identification and evaluation of both social and environmental impacts and have been considered in the formulation of mitigation measures and formulation of the environment management plan.

E4 Assessment of Project Impacts

The project will have both positive and negative impacts.

iii. Positive Impacts

The positive impacts include the following:

Improved water supply: Nairobi is experiencing a water crisis with the current demand (750,000m³/day) far much outstripping supply (540, 000m³/day). Most Nairobi residents are therefore accustomed to water rationing. The proposed project will therefore ensure adequate water provision to Nairobi residents and its satellite towns.

Communities in Murang'a County will also benefit through improved waters supply schemes supported by AWSB as part of giving back to the community from where it is drawing its water supplies. AWSB has developed a strategy to complement the efforts of Tana Water Services Board (TWSB) in provision of water to these communities. This will see the Murang'a

communities benefit from development of water projects to the tune of Ksh. 1.270 billion. The key projects to be developed under this arrangement include:

- Muranga W/S (augmentation) – KSh. 800 Million;
- Gatanga W/S (augmentation) - KSh. 300 Million; and
- Gatango W/S (augmentation) – KSh. 170 Million.

Creation of employment opportunities: The construction of the project is anticipated to create numerous direct and indirect employment and economic opportunities through recruitment of significant numbers of people to work with the contractor (s). This will include both skilled and unskilled labour that will be engaged for about 40 months. Man hours to be provided by non technical staff alone have been estimated at 4,100 hours. Indirect economic opportunities will also be created through persons selling different wares to the construction staff domestic requirements. Limited staff will also be required for routine O&M. These will improve economic situation in the project area and partly reduce unemployment levels.

Improved infrastructure: The NCT Phase 1 project design has proposed improvement of access roads within the proposed project area. This will be an advantage to the locals as they will comfortably transport their tea to the buying centres and also facilitate easy transportation of other farm inputs.

Community benefits: AWSB has proposed financial support to implementation of community water projects in the source basin. This will see increased access to piped water supply in the project area.

Other positive impacts anticipated include creation of market for local suppliers of construction materials, opportunities of income generation activities for women in supplying food to project workers, knowledge transfer during the construction period and desirable social change.

iv. Negative Impacts

On the other hand, the proposed project will be associated with a number of negative impacts are discussed below.

Land take and resettlement: Development of the project's infrastructure – weirs, shafts and inlet/outlet portals, Githika outfall and construction camp will entail permanent land acquisition. In addition, a 3m wide wayleave has been proposed right above the 11.8km long tunnel alignment which once acquired will restrict utilization by the current owners. This will affect 177 households (with 657 persons) and 8 institutions.

Hydrology: Specialist hydrological assessment conducted during the ESIA study concluded that the project is not anticipated to have any significant impacts on hydrology. Since the design is based on flood flow of the rivers, no changes on normal flows are anticipated at all. However, frequencies of flood flows downstream will be reduced. The cumulative impacts of the project on downstream hydropower generation schemes at Masinga has also been established to be marginal with an annual average reduction of inflow of 2.32% to Masinga Reservoir, or a reduction in volume of 2.72 m³/s relative to average inflow of 125.51 m³/s (1995-1997).

Ecology: Ecological assessment of project included analysis of impacts of project-induced hydrological changes on downstream ecology of the affected rivers. Habitat requirements for rainbow trout fish *Oncorhynchus mykiss* was used as a benchmark given that they are more stringent than for the rest of encountered aquatic species. The assessment established that the proposed flow release for Maragua intake (Q95=0.481m³/sec) will meet the trout fish requirement (0.259m³/sec). However, for Irati and Gikigie rivers, the proposed downstream releases will be lower than the minimum requirements for the trout species. The proposed design for Irati is 1.4Q95=0.645 m³/sec against calculated rainbow trout fish requirement of 0.989 m³/sec while for Gikigie, the proposed design flow is Q95 = 0.101 m³/sec, against rainbow trout requirement computed to be 0.133 m³/sec. In order to meet the calculated rainbow trout fish minimum habitat requirements, hydrological analysis established that the

design flows at Gikigie and Irati intakes would require upward revisions to $1.32 \times Q_{95} = 1.33 \text{ m}^3/\text{sec}$ and $2.15 \times Q_{95} = 0.991 \text{ m}^3/\text{sec}$ respectively. However, it is notable that the calculated minimum requirements for rainbow trout from this study are higher than the naturalised mean monthly flow e.g. for Irati river and cannot be conclusively used to set the minimum ecological flow requirements. This could also mean that the rainbow trouts species is not distributed throughout all the rivers in all seasons hence the need to ensure that any migration is not impeded for continuous habitats connectivity. The study therefore recommends the implementation of the compensation flow as designed but with strict enforcement of the proposed weir operating principles.

Since the proposed project abstractions will be based on flood flow and not normal flows, there will be no effect at all on the normal flows. The anticipated reduced frequency of low-flows will be associated with some habitat loss for riverine fishes during periods of low-flows with Irati likely to be the most affected. However, no permanent riverine habitat loss is anticipated and there is no species of conservation significance that will be impacted.

Other negative impacts anticipated from the project implementation include

- Loss of vegetation cover;
- Increased demand on utility supplies and Disruption of services;
- Impacts on Soils
 - Soil erosion and increased sedimentation
 - Soil pollution
 - Soil compaction
- Occupational and General public Safety and Health Hazards
- Spread of communicable diseases;
- Pollution of (surface and ground) water resources;
- Changes in groundwater levels and flow;
- Oil spills;
- Shifting of unskilled labour force from agriculture to construction
- Waste Generation;
- Air pollution;
- Geological and seismic hazards;
- Impeded migration of migratory fishes;
- Noise and vibration pollution;
- Social delinquency, HIV/AIDS and other sexually transmitted infections;
- Immigration and emergence of unplanned settlements;
- Impacts of increased traffic volumes and tonnage; and
- Visual impacts on local landscape

Most adverse impacts associated with the project can be readily managed to acceptable levels with implementation of the recommended mitigation measures and ESMP developed in this report. Project such that the overall benefits from the Project will greatly outweigh the adverse impacts. Further, the requisite conditions for most of the mitigations have been incorporated by the proponent on project bidding documents reviewed by the consultant.

E5 Conclusion and Recommendations

This ESIA Study has been prepared to provide sufficient and relevant information on the proposed Northern Collector Tunnel Phase 1, to enable NEMA establish whether activities of the project are likely to have significant adverse environmental impacts. In addition, the report responds to the environmental assessment requirements set by the project financiers: WB and AfD.

In general, the proposed project will result in appreciable benefits to the city of Nairobi, its satellite towns and Kenya at large and bring opportunities for both social and economic development.

It is recommended that the proposed project be implemented in compliance with all the relevant legislation and planning requirements of Kenya at all times. In line with this, the proponent (AWSB) and the contractor (s) must take the legislative framework reviewed in this report into consideration, during and after the implementation of the project, as will be appropriate.

In order to meet the downstream ecological requirements, the following are recommended:

- Ensure the proposed abstraction weirs operation principles are met throughout the operation period for all rivers via continuous monitoring. Reduced abstractions during low-flow seasons achieved by this will help sustain riverine habitats during these periods;
- Construct fish passes as planned and ensure they are regularly maintained to allow safe passage for all identified migratory species;
- Ensure demarcation and protection of riparian reserves of the affected rivers. This will offer favourable cover and temperatures for the rainbow trout; and
- Undertake wet season survey and subsequent annual aquatic fauna surveys for both wet and dry seasons to monitor trends and inform any further management interventions.

Considering the aquatic species documented during this study that is the short distance migratory fish species to feed or spawn such as the *Labeo cylindricus*, *Barbus* spp. and other aquatic invertebrates) and the long distance migratory species (that use the river for feeding and spawning purposes such as the eel *Anguilla bengalensis*, *Oncorhynchus mykiss*, *Salmo trutta*), the proposed Technical fish pass is deemed adequate for this purpose as it allows possibility of migration at weirs for both strongly swimming fish and for bottom oriented and small fish.

The design should adopt a variable abstraction of water based on seasonality of flows.

The Resettlement Action Plan should be implemented before mobilisation of contractor to site. Any additional land requirements by the contractor not covered under the RAP must also be compensated for in full before actual construction begins.