

Terms of Reference

Programme Management Services to Oversee the Rehabilitation of the Freetown Water Supply System in Sierra Leone

1. Objectives

The purpose of these terms of reference is to procure the services of a Programme Management Agency to oversee the DFID funded Rehabilitation of Freetown Water Supply Project (205195). The specific objective of the assignment is to manage the project on behalf of the Guma Valley Water Company, in accordance with the NEC 3 Engineering and Construction Contract (Option C).

The main objective of the project is to improve the water situation for 600,000 people in Freetown. Over 90% of the total water supply to Freetown is supplied from Guma Dam and the Guma Water Treatment Plant. A full description of the water supply network is provided at Annex A. In brief it consists of the following main components:

- Guma Dam and Treatment Works
- Bulk Transmission System
- Leakage Detection
- Distribution network – including the Bulk Transfer System and Water Service Reservoirs (WSR).
- Improvements to the Allen Town and Babadori water supply networks
- Spur Road pumps and Wilberforce water supply network.

Guma Dam is sized to provide water reliably to around 800,000 people and the current population is significantly higher than this, estimated to be approaching 2 million. Generally Guma Reservoir fills every year during the rainy season and gradually drains during the dry season. Reservoir 'control rules' dictate how much water can be abstracted depending upon the reservoir water level on any particular day. Over abstraction or a year with low rainfall creates a real risk of emptying the reservoir and leaving Freetown without any supply as occurred in 2006, with dire consequences. Further details regarding network complications and problems are provided at Annex B.

The intended impact and outcome of the project is as follows:

Impact - to reduce morbidity and mortality rates associated with incidences of diarrhoea, malaria and other water-borne and vector-linked diseases.

Outcome - increased sustainable access to safe water in Freetown, the capital city. This will be achieved through rehabilitation of water infrastructure for improved public service delivery of water.

2. The Client

The Client for these services will be the Guma Valley Water Company, which is responsible for the supply of water in Freetown. DFID will be the contracting agency (Employer). The citizens of Sierra Leone are the recipients of the services provided under these terms of reference.

3. Scope of Works

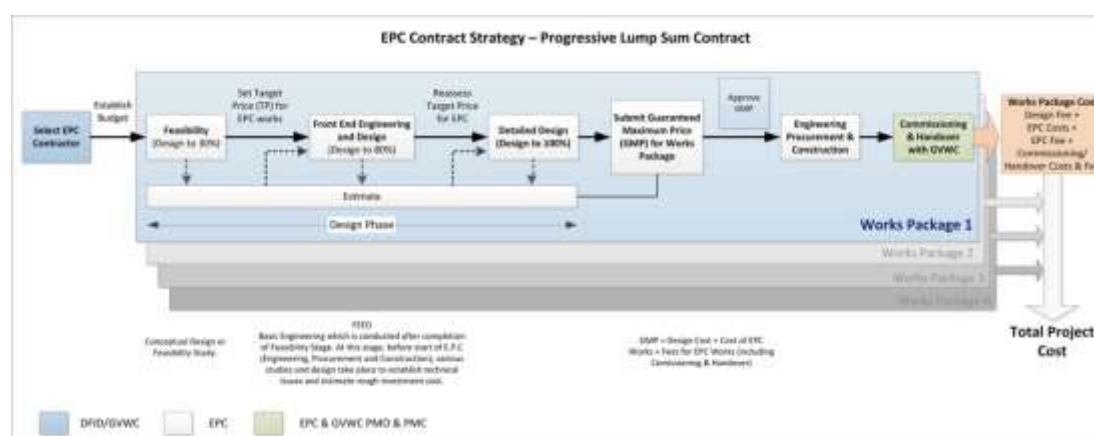
The scope of this assignment will cover all programme management functions required for the successful delivery of the Rehabilitation of Freetown Water Supply Project within time, quality and budget, in accordance with the NEC 3 Contract (Option C).

The project commenced in July 2016 and is expected to end by March 2020. It comprises the design and construction of nine works packages, made up of 62 sub-work items, aimed at reducing leakage and improving the equity of distribution across the existing Freetown water supply system.

Work Package	Name
1	Guma Dam and WTP
2	Construction of Upper Sussex Diversion
3	Rehabilitate the Transmission System
4	Operational Support for the distribution network
5	Distribution Improvements
6	Charlotte to Allen Town
7	Kaningo water supply system
8	Babadori water supply system
9	Pumping Schemes to Wilberforce and other communities

Following a prioritisation exercise during the feasibility phase of the project, works packages 2, 7 and 8 have been de-scoped, and the number of sub-package activities being taken forward reduced to 41, to take account of available funding. An additional package covering the costs of the EPC Programme Management Unit has been added to account for costs that cannot readily be allocated across construction works packages. A full description of the Works Packages and sub-work items can be found in the project Feasibility Report.

The project implementation schedule has been designed using a Progressive Lump Sum approach, broken down into four discrete stages: Feasibility (Stage 1); Front-end Design (Stage 2); Detailed Design (Stage 3) and Construction (Stage 4). A target price for each Stage is agreed before transition from one stage to the next. A Pain / Gain arrangement has also been incorporated to provide an incentive to drive costs down. The project is currently at Stage 3.



DFID has appointed an Engineering Procurement Construction (EPC) contractor to design and build the works under the NEC 3 Engineering and Construction Contract (Option C). A separate Project Management Unit, comprising staff from Guma valley

Water Company has also been assigned to sit alongside the EPC, to ensure that GWWC are involved in day to day decision making.

By July 2018, the project should have reached Stage 4 (Construction) across all works packages. It is envisaged that the construction works can be completed over the next two dry seasons (October to June). The baseline programme is attached at Annex C.

4. Roles and Responsibilities

The Programme Management Agency will fulfil the duties of the Project Manager and Supervisor, as per the NEC 3 Engineering and Construction Contract (Option C). The specific responsibilities will include, but not be limited to:

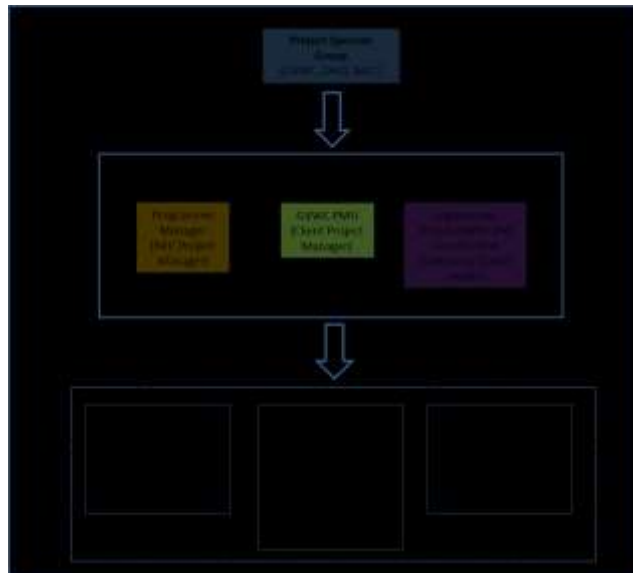
- High level guidance and oversight of the project's objectives and the logframe outputs and outcome, including prioritisation of works packages and investments to achieve maximum impact and value for money, in line with DFID's project cycle management systems and procedures;
- Preparation and implementation of a strategic plan, including the programme brief, activity schedule, finance plan, stakeholder engagement plan, risk management plan, projects dossier, quality plan and environmental and social management plan;
- Accountability to the Project Sponsor Group for physical and financial progress, including requests for expenditure approval (compensation events, target price submissions, etc.), identifying strategic risks and mitigation measures, and raising matters of a strategic nature affecting project delivery;
- Providing training and capacity building support to the GWWC Project Management Unit to assist them with client side project management of the project. Specifically supporting the PMU to ensure environmental issues, resettlement actions plans and stakeholder engagement are addressed to ensure a permissive programme delivery environment.
- Chairing weekly Project Board meetings with the EPC Contractor to review physical progress, identify risks, monitor expenditure, etc., and to provide technical direction and make recommendations on contractual and technical performance;
- Reviewing, approving and monitoring monthly contractual submissions (activity schedule, programme and risk register) provided by the EPC contractor, ensuring compliance with the NEC 3 contract;
- Providing overall project cost control and reviewing, analysing and approving monthly applications for payment, challenging the EPC on variance against monthly forecasts against the project schedule;
- Issuing formal communications (instructions, notifications, compensation events, etc.) to the EPC contractor within the timeframes set out in the NEC3 contract, and providing a comprehensive records management service.
- Reviewing and assessing EPC performance against a set of agreed Key Performance Indicators, in accordance with the contract Pain/Gain mechanism;

- Reviewing and quality assuring EPC technical designs on a proportional basis, including technical designs, drawings, specifications, costs and contract documentation;
- Reviewing and approving procurement applications made by the EPC contractor for materials, equipment and services provided by third party suppliers;
- Monitoring and inspecting progress during construction against the approved works packages, including site visits to oversee execution of the works, management of site quality and rectification of defects, due consideration for health and safety, and public consultation during construction;
- Management of contract variations and any disputes arising due to non-compliance or unforeseen circumstances;
- Conducting snagging inspections, advising the EPC prior to issuing works completion certificates and evaluating invoices submitted to the Employer for payment;
- Keeping records and preparing monthly reports for the Employer on progress of the construction works, including details of delays, drawings received, test results, health or safety issues, environmental issues and other significant events;
- Overseeing the commissioning of works and the smooth hand over of assets from the EPC to GVWC;
- Providing support to the PMU during the 12 months defects liability period.

5. Management and Reporting

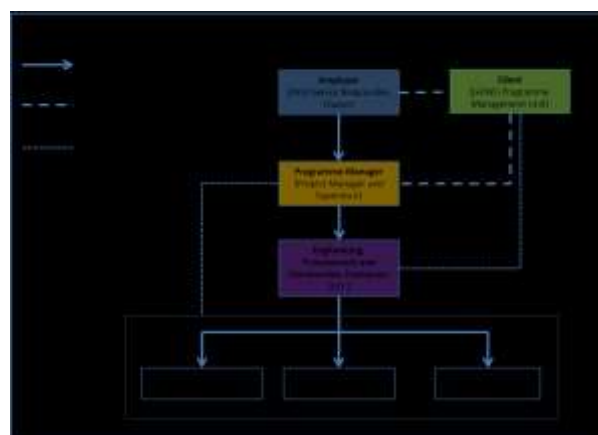
The Programme Management Agency will report directly to DFID's Senior Infrastructure Adviser based in Freetown, who is the Senior Responsible Owner for this project. They will liaise with the GVWC PMU on a day to day basis to promote Client ownership and will convene weekly progress meetings of the Project Board, comprising the GVWC PMU and the EPC. The Programme Manager will also report each month to the Project Sponsor Group. The Sponsor Group comprises members of GVWC's Senior Management team, DFID and a representative from the Millennium Challenge Corporation, which is providing institutional reform support to GVWC.

The Project Governance structure is as follows:



The Programme Manager will have delegated responsibility to manage the EPC contractor in accordance with the Project Manager and Supervisor's roles and responsibilities as per the NEC 3 contract. The PM will certify to DFID that works have been completed to a satisfactory standard and that payment can be made to the EPC.

The Contract Management arrangements are as follows:



The Programme Manager will provide monthly reports to DFID detailing progress against the programme, financial performance and risks arising, plus an activity plan and milestones for the following month. Time sheets for key project staff will accompany the monthly reports.

6. Consultancy Structure, Qualifications and Experience

The Programme Management Agency services will be provided by a consultancy firm with international experience of managing the design, construction and supervision of infrastructure projects, specifically water treatment and reticulated water supply systems in developing countries.

Specifically, the consultant should have a proven track record of administering the NEC 3 engineering and construction contract and have experience of construction contract supervision. The supplier should also be able to demonstrate an appropriate approach to skills and capacity development of the Client in contract planning management. Multi- stakeholder relations and expectation management

will be critical for the success of this role. Prior knowledge of DFID's project cycle management systems and procedures will be a major advantage.

The supplier shall propose a team of professionals, made up of international and local employees, capable of fulfilling the duties outlined under the scope of works. As a minimum, the team should comprise an experienced Project Manager and a lead Supervisor, plus sufficient call-down expertise to quality assure design work and supervise construction on site. The supplier should demonstrate value for money in the composition and structure of its team.

Academic institutions are not eligible to apply for this contract.

7. Timing, duration and location

This assignment will commence in July 2018 and will run until March 2020. Any extension of services required beyond this period will be negotiated between DFID and the supplier for a period of up to 12 months.

The majority of work will be conducted in Freetown. The supplier should demonstrate how the Programme Management team will be deployed to optimally manage the programme work schedule whilst achieving value for money.

8. Cost and Payment

We expect the cost of these services to be in the order of £30,000 to £40,000 per month.

Payment for this contract will be 100% against agreed actual time and expenditure on a monthly basis and acceptance of monthly reports.

The supplier will submit monthly applications for payment in arrears, including all relevant substantiation and evidence to demonstrate achievement of agreed milestone activities.

9. Performance

The performance of the service provider will be managed through a schedule of key performance indicators (KPIs). The KPIs will be agreed during the inception period and the schedule will form part of the Inception Report. Indicative KPIs have been provided by the supplier in the proposal and it is expected that these will be amended/added to in order to reflect this specific programme. Expected results will be set out in the logframe.

This contract will be subject to routine monitoring and independent evaluation. This will be agreed as part of the inception phase.

10. Transparency

DFID requires suppliers receiving and managing its funds to release open data on how this money is spent, in a common, standard, re-usable format and to require this level of information from immediate sub-contractors, sub-agencies and partners. It is a contractual requirement for all Suppliers to comply with this, and to ensure they have the appropriate tools to enable routine financial reporting, publishing of accurate data and providing evidence of this to DFID – further IATI information is available from <http://www.aidtransparency.net/>.

11. Duty of Care

The Supplier is responsible for ensuring that appropriate arrangements, processes and procedures are in place for their personnel, taking into account the environment they will be working in and the level of risk involved in delivery of the Contract. The Supplier is responsible for ensuring appropriate safety and security briefings for all of their personnel working under this contract and ensuring that their personnel register and receive briefing as outlined above. Travel advice is also available on the FCO website and the Supplier must ensure they (and their personnel) are up to date with the latest position.

The Supplier is responsible for all acts and omissions of the Supplier's personnel and for the health, safety and security of such persons and their property. The provision of information by DFID shall not in any respect relieve the Supplier from responsibility for its obligations under this Contract. Positive evaluation of proposals and award of this Contract (or any future Contract Amendments) is not an endorsement by DFID of the Supplier's security arrangements". Note that the term "Supplier's Personnel" is defined under the Contract as "any person instructed pursuant to this Contract to undertake any of the Supplier's obligations under this Contract, including the Supplier's employees, agents and sub-contractors. DFID will share available information with the Supplier on security status and developments in-country where appropriate. Applicant Suppliers must develop their Tender on the basis of being fully responsible for Duty of Care in line with available assessments including the initial risk assessment matrix developed by DFID (See Annex H).

Suppliers must confirm in their tender that:

- They fully accept responsibility for Security and Duty of Care.
- They understand the potential risks and have the knowledge and experience to develop an effective risk plan.
- They have the capability to manage their Duty of Care responsibilities throughout the life of the contract.

Supplier Duty of Care Risk Assessment

Theme	DFID risk score
Overall	3
FCO Travel Advice	3
Host nation travel advice	N/A
Transportation	4
Security	3 ¹
Civil unrest	3 ²
Violence / crime	3
Espionage	1
Terrorism	2
War	1
Hurricane	1
Earthquake	1
Flood	3
Medical services	3 ³

1 Very Low Risk	2 Low Risk	3 Med Risk	4 High Risk	5 Very High Risk
Low		Medium	High Risk	

Last updated: January 2018

¹ Security could shift to 4 during the election period.

² Civil unrest could shift to 4 during the election period.

³ Freetown only. The risk is a 4 outside of Freetown.

12. Environmental and Social (E&S) Safeguards

DFID works to embed environmental and social safeguards predominantly to ensure that our development and humanitarian interventions do no harm. They are also a key part of ensuring that our outcomes are sustainable, that they provide good value for money and that protect the positive results and transformative impacts for poverty reduction and development that we aim to deliver.

DFID needs to understand the scope of safeguard risks that might need to be considered in a given project, to ensure that risks are identified properly analysed and mitigation measures in place, with clear oversight responsibility for example to safeguard those directly or indirectly involved as beneficiaries or community members of DFID interventions.

Further considerations of particular importance to managing the risk of doing unintended harm to people and/or the environment include (but are not limited to)): social and poverty impact, gender equality, resource scarcity and environmental vulnerability, climate change, institutional environment, the political economy, conflict and fragility.

DFID Suppliers are expected to demonstrate;

- **Top-level commitment:** evidence of top-level organisational commitment to implement E&S safeguards, enhance E&S outcomes, and seek continual improvement. This should ideally take the form of a written statement signed by senior management, shared publically.
- **Appropriate systems and processes:** robust policies and systems in place for identifying E&S risks, implementing E&S safeguards, and monitoring performance relevant to this programme or investment, including regular field supervision and spot-checks.
This should include, where relevant, clear policy and strategy and robust processes and documents such as Environmental and Social Impact Assessments (ESIAs), [child] safeguarding policies, Environmental and Social Management Plans (ESMPs), Stakeholder Engagement Plans (SEPs), Resettlement Action Plans (RAPs), Occupational Health and Safety Management Plan (OHSMPs) documentation.
- **Adequate resources:** evidence on adequate financial, professional, and institutional resources in place to implement E&S safeguards, coordinate down-stream partner implementation of E&S safeguards, and seek continual improvement throughout the entire lifecycle of this programme or investment? This should include adequate staff with specialist training and experience (including high-risk issues such as HIV/AIDs, gender based violence, and child protection), and dedicated budgets.
- **Strong track record:** suitability to deliver DFID's contract requirements, including assessment of an organisation's past performances, financial stability and organisational principles and track record of implementing E&S safeguards on similar programming.

13. Background

The water supply to Freetown is in a critical situation. It relies principally on a single source, Guma reservoir built in the early 1960s, which supplies only around half of the city's theoretical demand through a transmission and distribution system that has seen little preventative maintenance or investment in the past five decades. Inadequate and unreliable supply of mains water forces people to fetch water from

unprotected sources, thus seriously increasing the hazard to health and the risk of disease outbreak.

The UK Secretary of State for International Development approved the Rehabilitation of Freetown Water Supply Project in June 2016. The project, valued at £38 million, will improve the water supply situation for 600,000 people in Freetown, including inhabitants of the currently unserved eastern part of the Freetown Peninsula. The main components of the rehabilitation scheme are improvements at the source and the treatment works, replacement of leaking mains, service reservoirs and pumps, and reducing the number of 'spaghetti connections' along the distribution network. These priorities were based on the findings of an engineering review study conducted by WS Atkins in 2016.

In May 2017, DFID awarded an Engineering, Procurement and Construction contract to a consortium, led by IMC Worldwide (Atkins and BAM Nuttall are the other two members of the consortium), to design and build the project. The EPC contract is for a period of 28 months and is valued at £34.7 million. The EPC contract adopted the NEC 3 contract (Option C), with DFID as the Employer and the EPC as contractor (GVWC are the Client but are not a named party in the NEC 3 contract).

To date, DFID has assumed the role of Project Manager, with support from an independent Programme adviser (Advisian) and a Clerk of Works (Mott MacDonald). Both support contracts are due to end in 2018, in March and June respectively. In reassessing the project governance and management arrangements, DFID has taken the decision not to extend these contracts but instead to devolve the functions to a single Programme Management Agency with delegated responsibility to fulfil the NEC 3 Project Manager and Supervisor responsibilities. DFID will remain the Employer but will have less day to day involvement in administering the NEC 3 contract, focussing more on the strategic direction of the project within the project Sponsor Group.

Annex A

Guma Water Supply - Network Description

1 Guma Dam

The existing water supply to Freetown currently relies, to a large extent, on supplies from Guma Dam. Built in the mid-1960s Guma Dam is situated on the coast to the west of the Peninsula Mountains approximately 20 km from Freetown. Its catchment is high in the peninsular forest and is currently protected from development. The dam and treatment works are above 200m elevation, and supplies a deployable output of some 77 Mld. Yield, an increase from the original 69 Mld following the raising of the spillway and diversion of the Little Guma river in 2002. The capacity of the treatment works and transmission systems from Guma are higher at c 90 Mld which allows releases to be maintained above the deployable output of the dam, which have the potential to cause serious dry season shortages if not carefully managed.

2 Guma Water Treatment Plant

The works were initially constructed at the same time as the Guma Dam; the Stage 1 works was commissioned in 1965 with a capacity of 27 Ml/d. The plant was a conventional clarification/filtration/disinfection plant using eight conical upflow clarifiers and six filters. Electrical power was provided by routing the water from the dam through a turbine generator. The works was extended in 1973 and 1983 (Stages 2 and 3) with each extension having a capacity of 27 Ml/d, giving a total capacity of 81 Ml/d. The Stage 2 and 3 extensions both used Degremont pulsators for clarification and Aquazur T filters. There is a total of four pulsators and eight filters in Stages 2 and 3.

In 2000/2002 the Guma plant was extensively rehabilitated and modifications were made. The most significant modification was to convert the Stage 1 filters to Aquazur T filters, fitting them within the original filter structure. This resulted in six Aquazur T filters of a very similar filter area to the filters in Stages 2 and 3. Over 90% of the total water supply to Freetown is supplied from Guma WTP, effective operation of the system is therefore essential for effective water distribution throughout the Freetown area, and any prolonged failure would have immediate and far reaching consequences for public health.

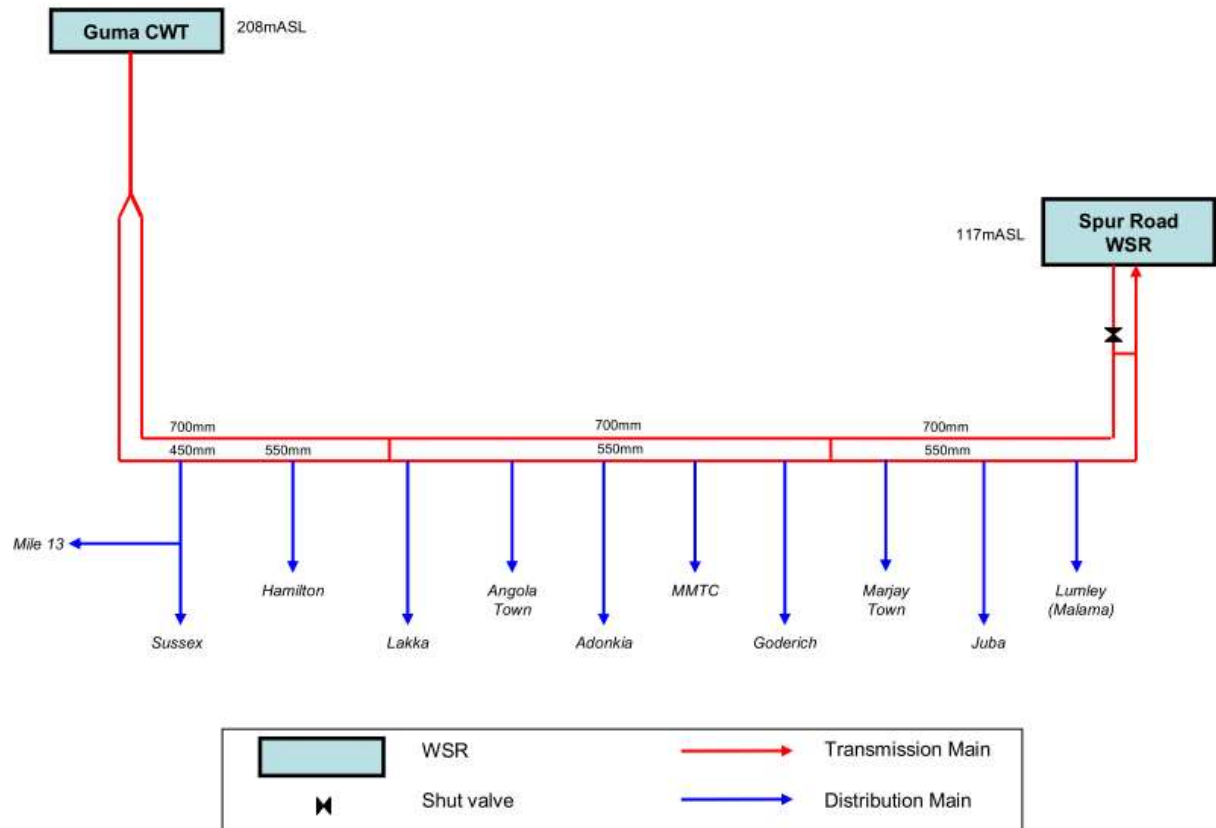
3 Transmission

The Guma transmission main system conveys water using gravity flow over a distance of approximately 16km from Guma Water Treatment Plant to the Spur Road Water Supply Reservoirs (WSR). The transmission system comprises the original 550 mm steel main and a more recent 700 mm ductile iron main. The 550 mm main supplies the communities along the route of the main through a number of takeoffs from air valves and washouts. The mains are cross connected at 2 points along the route and at each end. The theoretical capacity of the pipes is in excess of 90 Mld.

Key elements of the transmission system are as follows:

- A single 800mm main leaves the Clear Water Tank at Guma WTP and runs for approximately 200m, as far as the main outlet meter house for the works. Just after the meter house, the main splits into parallel 450mm and 700mm mains.
- The 450mm main runs northwards for approximately 3.6km before increasing in diameter to 550mm and continuing as far as Spur Road WSR. There are 11 offtakes along the length of the 450/550mm main.

- The 700mm main then runs northwards as far as Spur Road WSR. There are no offtakes from the main, although it is cross-connected to the 450/550mm main at several locations. These cross-connections are non-functional with all cross-connections currently open.



Transmission System

4 Distribution System

The distribution system is divided into the low and high level areas.

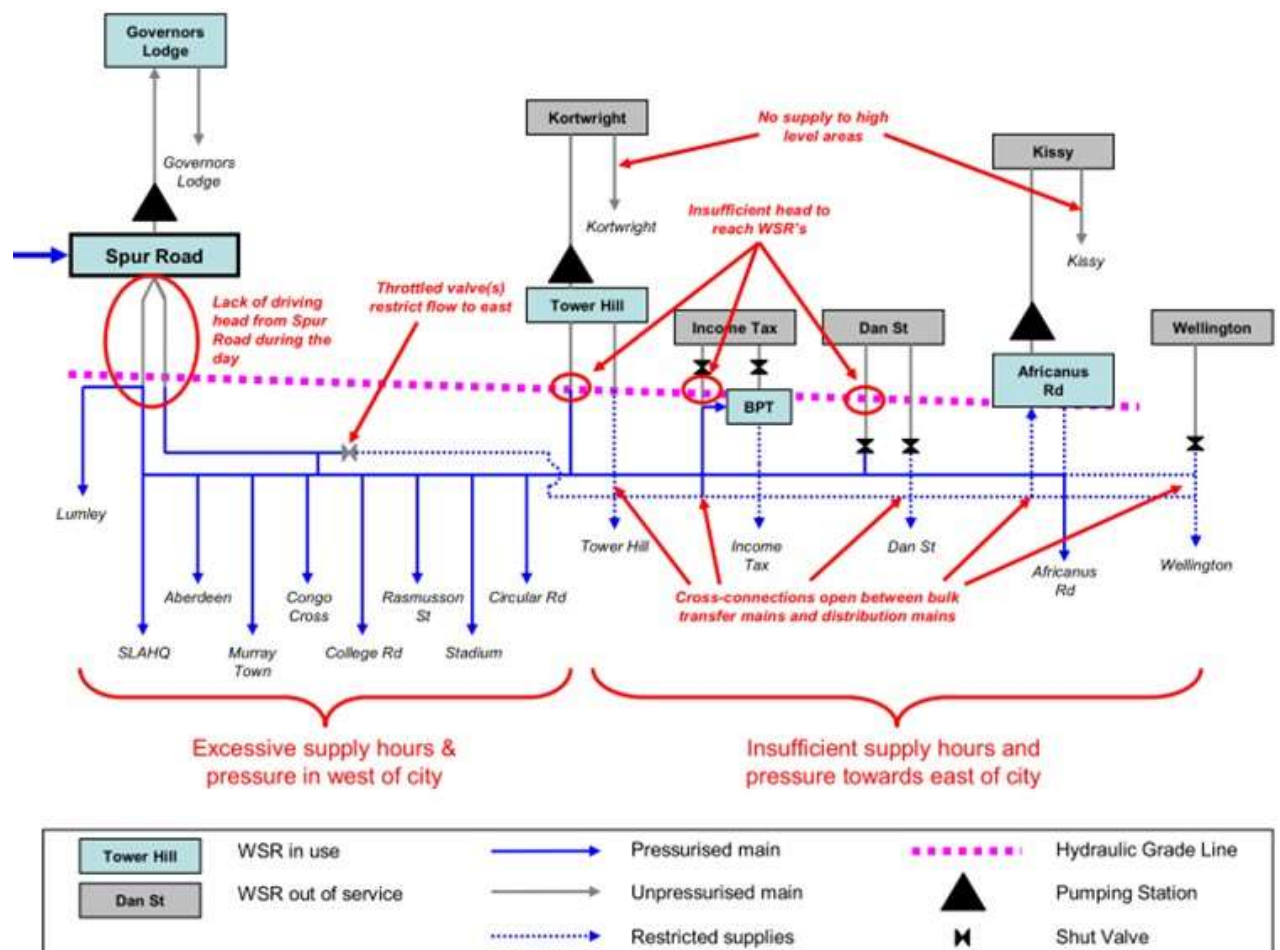
Low Zone

The low level system comprises primarily the water network at or below 100mOD and currently accounts for almost 90% of Freetown's demand. The low zone is fed by gravity from Spur Road reservoir, and incorporates the Bulk Transfer system, which runs as far east as Wellington WSR, as well as local distribution networks that are designed to be fed from the following Water Service Reservoirs: -

- Tower Hill
- Income Tax
- Dan Street
- Africanus Road
- Wellington

Unfortunately, the proposed Bulk Transfer System (BTS) conveying water from west to east through the city is cross connected into the zonal distribution systems, which prevent pressures in the BTS from building up to the level where water will fill the service reservoirs. Bulk Transfer System (BTS) was proposed to create a pipe system to convey water from west to east through the city. The BTS is separate from the distribution network, and should feed water to each of the service reservoirs outlined above. Although there is insufficient water to meet the full demand of the

city, using the BTS it would in theory be possible to equitably supply all parts of the network with water. Formal rationing would be required to overcome the supply demand deficit.



Unfortunately, although the mains were constructed, the system was never properly commissioned. Cross-connections between the distribution network and the bulk transfer system were opened preventing pressures in the BTS from building up to the level where water will fill the service reservoirs, and so the old supply problems were perpetuated.

High Zone

The high level system comprises the mountain region of the Freetown peninsula and it relies primarily on Babadori WTW for its limited supply – via gravity feed. The limited capacity of that source has now been supplemented by pumping systems principally from Spur Road to Governor's Lodge. Recent problems with power supplies have severely limited the pumping in recent times.

Secondary Distribution Network

The secondary distribution network comprises a mixture of formal network as well as 'spaghetti' mains. The spaghetti lines are long surface-laid polythene spaghetti service pipes that connect properties to the network. As a result of a rapid increase in the population of Freetown during the last 10-15 years, and GVWC's shortage of working capital, the distribution network has not been expanded to keep pace with the city's development. A large percentage of customers rely on stand-posts for their water; some 1300 exist throughout the city. Although mechanisms were in place to collect revenue from stand posts these were abandoned some 5 years ago and water is now dispensed free with no control exercised over the stand posts.

Annex B

Freetown Water Supply Complications

1 Overview

The eastern end of the city is particularly poorly supplied with water. High consumption and leakage in the better served western area uses a high proportion of the water before it reaches the city centre let alone the east. The BTS was designed to assist to overcome this deficiency and it needs to be reinstated as soon as practical. However, there is insufficient water to meet the demands of a 24 hour supply so some form of rationing must be adopted. Networks will also need to be expanded into unfed areas.

2 Guma Water Treatment Plant

Intake Tower

Several attempts have been made to seal the ground around the intake tower against the ingress of water, to date all have failed including resin grouting. Following the most recent attempt, contractor submitted a proposal backed by Sika products for sealing the tower but this was not adopted because the cost was considered excessive at some \$350,000 – this proposal has not been located. However, the tower still leaks and corrosion to the ladder and platforms has rendered them unsafe and requiring replacement.

Plant Flow Metering

There is no functioning metering at the water treatment plant, flow control is done by 'rules of thumb' - a concern bearing in mind the importance of controlling reservoir draw-off. 3 new Endress Hauser electro-magnetic meters were purchased under the previous project but not installed, apparently because only the meters were supplied without the necessary flange adaptors and display units. These were for the inlet (2 nr) and outlet. The meters have been stored in the open since they were delivered so their condition is unknown. GVWC have been requested to move them to more protective storage.

Plant Structures

GVWC report problems with some of the launder channels and some filter floors. The filter floors have been problematic since the plant was constructed with leakage between (poorly) precast floor panels and clogging of the filter nozzles. It is difficult to assess the extent of the refurbishment currently required as inspections would require removing filters from service and excavating the media.

Electrical and Control Installations

The observed environment of electric pump/motors within the chemical dosing and stirrer area was of concern. Some pump/motors were not working. Hence we have recommended that all motors in this section be replaced. Regular cleaning of the chemical areas and improved extraction of fumes would also help. Hence new and extra extraction fans are included in the proposed works. The situation in the chlorine room was alarming - corrosion is serious in this room. The chlorine control panel was not functioning, the extractor fan exhibited evidence of extreme corrosion and there are numerous other electrical problems.

Scour Valve

A legacy problem remains from the last DFID project. New Larner-Johnson scour and guard valves were purchased from Blackhall Engineering in UK to replace the existing valves at Guma Dam that are leaking significantly, effectively reducing the deployable output from the dam. The valves were not installed due to the difficulties in sealing the scour pipe safely. Failure of the scour system will empty the dam leaving Freetown with no formal water supply. Losses through the valves have

increased significantly from the estimates made under the Atkins' study. It is now a matter of high priority to stop the leakage from the valves.

3 Transmission System

Current operation and condition of the Guma transmission main system falls well short of what would be required to deliver a satisfactory and equitable water supply to the Freetown area. Firstly, there is no flow metering in place on the transmission main system. Despite detailed data not being available, limited field testing carried out by Atkins in 2008 suggests that water losses between Guma WTP and Spur Road Reservoir are extremely high. Atkins estimated that "nearly 30% (25MI/d) of the water leaving Guma WTP may not reach Spur Road WSR. Consumption of all types, including unauthorised, is considered to account for 8 MI/d, suggesting that real losses could therefore be as high as 17 MI/d". Anecdotal evidence would suggest that this situation has not improved since 2008.

Losses from the 550mm main should be highly visible as it runs above ground for almost its entire length between Guma WTP and Spur Road Reservoir. Two non-exhaustive drive-by inspections of the 550mm transmission main (carried out on 6th April and 8th May 2016) revealed no signs of leakage/seepage from the main (apart from 2 obvious bursts which were repaired on 7th April). The Atkins Report of 2008 came to a similar conclusion, stating that "little loss directly from this main was observed during the project". It therefore concluded that "the great majority of water loss directly from the transmission mains must occur on the 700mm main." Atkins noted that anecdotal evidence suggested "that construction of the final leg of the 700mm main to Spur Road WSR was poorly executed" and that "this may contribute to very high levels of water loss" on the transmission system. However GVWC noted that there is no evidence to support this, with the team saying they have never had an issue with any visible bursts or leakage on this section.

The loss of water between Guma WTP and Spur Road Reservoir appears to be as a result of the following:

- Losses on the distribution network (primarily the spaghettis) from the transmission main offtakes. The pressure at these offtakes is quite considerable in most circumstances. For example if the clear water tank at Guma WTP were full you would expect pressures in excess of 135m at the Sussex, Hamilton, Lakka Hospital and Angola Town offtakes and pressures of approximately 115m at Adonkia, MMTC and Goderich offtakes. Even with the mains exiting the CWT in Guma WTP not running full bore, Atkins found pressures at Sussex and Hamilton of 108m and at Lakka of 120m back in 2008. Most of the offtakes from the 550mm transmission main have had PRVs installed on them but it is understood that none of them are currently functioning/operational. These very high pressures no doubt contribute to significant losses and excess usage in the communities served from these offtakes.
- Loss from damaged valves on the cross connections is also a contributory factor. While bursts identified on the transmission mains are repaired by GVWC, they do not appear to have the expertise/equipment/materials necessary to fix more complicated problems on the cross-connections. Our field visit of 6th April revealed significant losses from 2 valves at either side of the cross-connection near Lakka (see Figure 7). From observation, the losses at this cross-connection are likely to be in excess of 4 litres/sec (350m³/day).
- It is also possible that leakage on the 700mm main as well as the buried section of the 550mm main, contributes notably to the overall losses between

Guma WTP and Spur Road; however no data currently exist to support this theory, although one major leak was visible under the new road near to a bridge.

4 Distribution Network

Due to a severe lack of investment in the water network in recent years and rapid expansion of the city, the current distribution network is in very poor condition with high losses - estimated at round 50% of the water produced. Extensive use of long individual 'spaghetti' connections has occurred due to the lack of proper water mains and losses from such pipe are considerable and these pipes are vulnerable to damage and vandalism.

The Bulk Transfer System (BTS) but has never been operational. While operation of the BTS is dependent on operational procedures such as valve throttling and water rationing, it is made more difficult as a result of the significant leakage losses in the distribution (and transmission) network. Reducing leakage losses in the network should assist in raising the hydraulic gradient downstream of Spur Road and making more water available to supply to the east of the city.

The eastern end of the city is particularly poorly supplied with water. High consumption and leakage in the better served western area uses a high proportion of the water before it reaches the city centre let alone the east. The BTS was designed to assist to overcome this deficiency and it needs to be reinstated as soon as practical. However, there is insufficient water to meet the demands of a 24 hour supply so some form of rationing must be adopted. Networks will also need to be expanded into unfed areas.

Annex C Baseline Programme Workplan (Enclosed)