Rural Water Supply Network

Field Note No 2012-4

Dotun Adekile

2012

Procurement and Contract Management of Drilled Well Construction

A Guide for Supervisors and Project Managers

Summary

The high rate of non-functional boreholes in many parts of the world is attributable, in part, to a lack of professionalism in the drilling sector. In order to increase access to a safe and sustainable water supply, competent and experienced drilling contractors must be engaged. Likewise, suitable equipment is needed and experienced consultants are required to supervise construction.

This guidance note assists project managers involved in the provision of groundwater supplies using boreholes. It sets out procurement and contract management procedures that will lead to the engagement of professional groundwater consultants, drilling contractors and suppliers. The publication will enable clients to ensure that they have the know-how to get the expected results out of drilling contracts.

The publication is primarily about procurement and contract management of multiple boreholes within the context of water supply programmes. However, it also contains advice for institutions, private businesses, householders and communities engaging drilling consultants, contractors and suppliers to drill single boreholes.

The guidance note systematically explains the four stages in borehole procurement and contract management: (1) procurement planning; (2) contract award; (3) contract management and (4) monitoring and reporting. It sets out the actions that need to be taken at each stage by the project manager and supervisors as well as the contractors, consultants and suppliers.

This publication emphasises that objectivity, transparency and integrity are essential in the procurement and contract management process.

Contents

Introduction

"According to the most recent Joint Monitoring Programme (JMP 2012) statistics, 2.3 billion people (one third of the global population) obtain their drinking water directly from groundwater (in the form of springs, hand-dug wells and boreholes), and it is reasonable to assume that at least another 1.7 billion people (one quarter of the world's population) representing 40% of those who enjoy piped water are also supplied from groundwater. Of the 780 million not yet served, the majority of these predominantly rural people will need to be supplied from groundwater" (Carter, 2012).

Humanity relies heavily on sustainable groundwater development. To bridge the gap in water supply coverage, it is crucial that boreholes are delivered in a cost-effective manner. Cost effectiveness does not necessarily mean cheaper boreholes but rather that optimum value is derived over the long term for money invested. This should result in boreholes continuing to function through their designed lifespan of 20 to 50 years.

Presently, in some countries in Africa, 30% to 60% of boreholes are not functional (RWSN, 2009). One reason for this failure rate is poor construction. In turn, this is attributed to a lack of professionalism in the drilling sector. There can be malpractices both in the procurement process and in project implementation. In order to ensure proper construction and cost effectiveness, boreholes have to be properly sited and constructed. The appropriate technology needs to be used, and the consultants and contractors need to be competent and experienced.

In order to achieve this, some countries are regularising the drilling sector. Procurement guidelines are being issued; drilling contractors are being licensed; national codes of practice for borehole drilling are being developed, and drilling contractors are being encouraged to form drillers' associations.

The Rural Water Supply Network (RWSN) has developed *a Code of Practice for Cost Effective Boreholes* based on international best practices (Danert et al, 2010). It focuses on nine principles which should be adhered to (Box 1). The Code of Practice enables international organizations, private enterprises and NGOs to evaluate their approach to borehole delivery in accordance with international best practices.

To support the Code of Practice in practical terms, RWSN is publishing a set of detailed guidance notes which will ultimately cover all the principles. The documents already published are:

- *Costing and Pricing: A guide for water well drilling enterprises* (Danert et al, 2010)
- *Siting of Drilled Water Wells: A guide for Project Managers* (Carter et al, 2012) – addresses principle 2
- *Supervising Water Well Drilling, a guide for supervisors* (Adekile, 2012) – addresses supervision aspects of principle 6

This guidance note, entitled Procurement and Contract Management of Drilled Well Construction, is part of the series. It focusses on principle 4 and the contract management and payment aspects of principle 6 (Box 1). The publication systematically explains each stage involved in the engagement of consultants, contractors, and suppliers. It includes annexes with a form of pre-qualification, a form of agreement and an example of technical specifications.

Box 1: Nine principles of Cost Effective Boreholes

Principle 1:	**Professional Drilling Enterprises and Consultants** - Construction of drilled water wells and supervision is undertaken by professional and competent organisations which adhere to national standards and are regulated by the public sector.
Principle 2:	**Siting** - Appropriate siting practices are utilised and competently and scientifically carried out.
Principle 3:	**Construction Method** - The construction method chosen for the borehole is the most economical, considering the design and available techniques in-country. Drilling technology needs to match the borehole design.
Principle 4:	**Procurement** - Procurement procedures ensure that contracts are awarded to experienced and qualified consultants and drilling contractors.
Principle 5:	**Design and Construction** - The borehole design is cost-effective, designed to last for a lifespan of 20 to 50 years, and based on the minimum specification to provide a borehole which is fit for its intended purpose.
Principle 6:	**Contract Management, Supervision and Payment** - Adequate arrangements are in place to ensure proper contract management, supervision and timely payment of the drilling contractor.
Principle 7:	**Data and Information** – High-quality hydrogeological and borehole construction data for each well are collected in a standard format and submitted to the relevant Government authority.
Principle 8:	**Database and Record Keeping** - Storage of hydrogeological data is undertaken by a central Government institution with records updated and information made freely available and used in preparing subsequent drilling specifications.
Principle 9:	**Monitoring** - Regular visits to water users with completed boreholes are made to monitor functionality in the medium as well as long term with the findings published.

This publication is primarily for government, private sector and NGO staff involved in groundwater development and management of borehole contracts.

The publication will also be useful for institutions, communities, private businesses, householders acquiring boreholes and appointing drilling consultants, contractors, and suppliers. It could be used for the training of new entrants into the groundwater development sector as well.

Overall, it is hoped that the guidance note is another step towards professionalising water well drilling and promoting sustainable groundwater development. The document has been kept brief, touching only the more salient points in borehole procurement and contract management. For more detailed information the reader should consult some of the literature in the bibliography.

Procurement and contract management

Procurement and contract management should ensure that the available resources provide maximum benefits for the end users, with funds judiciously allocated.

Generally, **procurement** is the process of purchasing, hiring or obtaining by contractual means goods, construction works and services following defined procedures. Procurement of boreholes usually involves the appointment of **consultants** for the siting, design and supervision; **contractors** for the drilling of the boreholes; and **suppliers** for the supply of drilling equipment, pumps, tanks, pipes and spare parts.

A **contract** is a legally binding agreement between two parties. The **client** on the one hand seeks value for money and timely delivery of the works. The **contractor** on the other hand seeks work, and timely payment. The public at large desire an efficient service.

Contract management is the process of efficiently managing the contracts made with the consultants, contractors and suppliers. It also involves:

- Negotiating the terms and conditions of the contract to maximize the financial and operational performance of the project and ensuring compliance with the terms and conditions of the contract.
- Documentation and management of the entire contract process and the agreements on any changes or amendments that may arise during the implementation of the contract. Borehole construction contract management extends to data storage and making arrangements for post-construction facility management and monitoring.

The processes of procurement and contract management described in this publication are applicable to the three categories of service providers, i.e. consultants, contractors and suppliers. References to contractors also imply consultants and suppliers. Where there are deviations from the described situation for a particular type of service provider, the distinction is made.

National procurement regulations

Public procurement is undertaken with consideration of economic benefits to the public within national goals. It should be driven by the ethics of public good, which overrides individual interests. Public procurement is expected to be conducted transparently without corruption and discrimination amongst potential consultants, contractors, and suppliers. In all countries, public procurement is subjected to regulation in order to protect the public interest.

In 2003, Ghana and Uganda enacted the *Public Procurement Act* (Government of Ghana, 2003) and *Public Procurement and Disposal of Public Assets Regulation* (Government of Uganda, 2003). Nigeria enacted the *Public Procurement Regulation for Goods and Works* (Federal Government of Nigeria, 2007) four years later. Box 2 provides highlights of the Nigerian regulation. There are serious punishments prescribed (including an up to five-year jail term in Ghana) for contravening the provisions of the regulations, particularly relating to collusion with bidders and alteration of documents with the intent to influence the outcome of the procurement process. The World Bank (2011a) will cancel the loan allocated to a project if it finds that representatives of the borrower are engaged in corrupt, fraudulent, collusive practices in the selection process or implementation of the contract.

Box 2 Highlights of the Nigeria Procurement Act – 2007

- The regulations apply to all procuring entities and participants in public contracts and to all public procurements of goods and works except where a waiver has been obtained.
- The conduct of all persons involved with public procurement whether as government officials, procuring entities, suppliers, contractors or service providers, shall at all times be governed by the principles of honesty, accountability, transparency, fairness and equity.
- All procurements shall be undertaken within the approved budget of the procuring entity and shall be based on a meticulously prepared procurement plan.
- The procurement plan shall provide for grouping of contracts to obtain economies of scale and reduce procurement costs.
- The procuring entities shall maintain records of each procurement process from the date of advertisement through contract signature and for a minimum of ten years thereafter.
- The accounting officer in each procurement entity will establish a procurement unit and a tenders board for the procuring entity.
- Except as otherwise provided in the regulations, all procuring entities shall use open competitive bidding for the procurement of goods and works and related services.
- In all cases of prequalification, only entities prequalified shall be invited to bid.
- Following evaluation, the procuring entity may enter into confidential discussions with responsive bidders, ask for technical clarifications and require necessary adjustments.
- Any payments due for more than 60 days following submission and verification of invoice shall be deemed a delayed payment. The contract document shall specify the rate at which interest shall be paid; interest being penalties for late payments.

Responsibilities of the project manager

It is the primary responsibility of the project manager to be conversant with the national procurement regulations and to manage the contract. The project manager could be a senior government or implementation agency staff with a background in engineering, geology or administration. Sometimes, a consultant is appointed as the project manager to provide technical support.

Other national documents governing borehole procurement

Besides national procurement acts, there are other country governing provisions such as national water policies, strategic frameworks on rural water supply, code of practice for water well drilling and technical guidelines. The project manager needs to be aware of them and abide by them. Such documents may define the roles and responsibilities of the different levels of government in water supply, what contributions are expected from the end users or the service levels for different categories of population settlements (e.g. rural, semi urban and urban).

Some countries have regulations whereby permits must be received before boreholes are drilled. There may be requirements for specific data to be collected and submitted on completion of the boreholes. The project manager must comply with these requirements. Pre-shipment inspection is compulsory for importation of goods in many countries. If this is the case the project manager should alert overseas suppliers. Penalties for non-compliance can be high.

Stages of procurement

Borehole procurement and contract management can be broken into 4 stages (Figure 1). Each stage has a set of required actions by the project manager. The stages and actions are elaborated upon in the rest of the document.

Figure 1 Stages and required actions for borehole procurement and contract management

Stage	Required Actions	Page
Stage 1:	**Procurement Plan**	
	1a Justify the project	5
	1b Define scope of the project	5
	1c Estimate project cost	5
	1d Define procurement process	6
	1e Determine contract packages	7
Stage 2:	**Contract Award** (for multiple boreholes)	
	2a Invite prequalification	7
	2b Evaluate prequalification applicants	8
	2c Prepare contract documents	8
	2d Call for bids	10
	2e Hold pre-bid meeting	10
	2f Open the bids	10
	2g Evaluate the bids	11
	2h Publicise the evaluation result	12
	2i Seek performance bond	12
	2j Sign the contract	12
	for single boreholes, rehabilitation and consultants	
	2k Procurement of single boreholes by institutions, private businesses, communities and households	12
	2l Appointment of contractors for borehole rehabilitation	13
	2m Appointment of consultants	13
Stage 3:	**Contract management**	
	3a Ensure logistics are available	14
	3b Establish administration procedures	14
	3c Hold key meetings	15
	3d Ensure supervision of the works	15
	3e Make payments	16
	3f Ensure data management	17
	3g Hand over boreholes with pumps	17
Stage 4:	**Monitoring and reporting**	
	4a Establish post-construction support and monitoring mechanisms	18

Stage 1: Procurement plan

The procurement process commences with the **procurement plan**. This needs to be approved by the procurement unit or tenders board of the agency doing the procurement. For financial predictability and accounting it is best to have an annual procurement plan or even one spanning several years, which is integrated into the sector expenditure plan. The project manager should liaise closely with the budget office of the agency doing the procurement to ensure that there is provision in the budget for the project and approval received before commencing on the project.

The procurement plan should include:

1a) justification for the project

1b) the scope and duration of the work

1c) the estimated cost of the project

1d) the procurement method and procedure

1e) the contract packaging

All the information collected are presented in the **procurement plan report** for the project and presented to the procurement officer, tender board or committee for approval. The procurement report should also include the criteria for eligibility and state whether domestic preference will apply.

1a Justify the project

In justifying the project, the project manager needs to provide its background, objectives and expected benefits. The required information may be contained in the national water policy, national and local targets and water supply coverage, assessed needs of the project areas and minutes of previous planning meetings. Information may also need to be collated from relevant local government authorities, international non-governmental organisations, academia, institutions, and the private sector.

1b Define scope of the project

The scope of the project refers to the type of facility, the number of boreholes to be drilled and their general locations as well as the hydrogeology. The scope will depend on national targets, programs, assessed needs and availability of funds.

National programs are often guided by policies and requirements that must be adhered to in project implementation. These may relate to environmental protection, participatory approach, cost recovery, operation and maintenance frameworks, supply chain strategies and hygiene and sanitation promotion. The project manager has to be familiar with national programs and policies and ensure that the project has the necessary links to other bodies which may influence its success such as the ministries responsible for finance, health, environment and education.

The scope of the project might have been determined by a committee at the national or local government level or water supply agency. The project area might depend on existing coverage and the assessed need for improved water supplies. However, the specific locations will depend on the geology and hydrogeology, other environmental factors as well as accessibility, community demand response and the community readiness to contribute to the project.

The project hydrogeologist will need to work out the probable drilling depths, preliminary borehole design and the methods of the drilling that will be required. This will need to be fine-tuned when the project commences and more data accrue. All these need to be discussed with the local authorities and taken into consideration in scoping the project.

1c Estimate project cost

The estimated cost of the project would also need to be determined and presented to the tender's committee and budget office. The following cost components will need to be established to arrive at the project cost estimate:

Procurement cost

Some of the costs that may be incurred in the procurement process include the cost of:

- advertising in the media for invitation for prequalification and expression of interest
- pre-bid, evaluation and contract negotiation meetings, attending to queries raised by bidders
- preparation of contract documents and other necessary documentation

Procurement staff salaries and allowances are borne by the client as part of the annual budget, but in some cases, a consultant is employed to carry out the entire procurement process. In such cases the consultant's fees will be part of the procurement cost. This can be estimated from previous jobs or by enquiries from some consultants.

Project management cost

Where the project management will be undertaken by staff of a government or implementation agency, such staff costs must be included as salaries and allowances in the annual budget of the agency. Sometimes however, additional equipment and staff are required such as vehicles, computers and external or contract hydrogeologists. Also, additional field allowances will need to be paid.

Project management costs are governed by the duration of the project and the cost components are time related. So the number of months for which additional salaries and allowances are going to be paid and vehicles run has to be calculated. Where a consultant will be employed, such consultancy fees have to be estimated as suggested above.

Project management may involve overseas travelling, particularly in the appointment of suppliers for drilling and water supply equipment, to inspect the quality of the goods before final agreement and shipment.

Drilling and installations cost – engineers estimate

The RWSN publication *Costing and Pricing – a guide for water well drilling enterprises* (Danert et al, 2010) provides a detailed analysis of costing and pricing of boreholes. The document is targeted at the drilling enterprise, but project managers will also find it useful in determining the engineer's estimate and the evaluation of borehole prices quoted by drilling contractors.

Another method of determining the cost of drilling is by asking for the prices of boreholes, supply and installation of pumps, tanks, pipes from a few drilling contractors and suppliers. This is essentially a market survey from which cost estimates for drilling and installations can be derived. The drillers association (where it exists) may also be consulted to give a fair price for the works. This is useful in that it could prevent a price war which may lead to standards dropping. The drilling cost may include the fee for obtaining a drilling permit in countries where this is the regulation and is the client's responsibility.

The engineer's estimate is used as a benchmark for the bidding. Although the estimate simply indicates the probable order of the cost of the works and is purely a guide to the eventual contract sum of award, it is important for it to be as accurate as possible. It should take into account the distances and different terrains of the project locations, which can be quite variable and have cost implications.

Training/community mobilisation cost

If training of the client's staff is envisaged as part of the project, the cost has to be calculated and included. If the project is going to bear the cost of community mobilization, the cost of the visits, meetings and training material should be calculated.

Supervision cost

The supervision cost will depend on the type of supervision - whether the supervision will be carried out by the client's staff or by a consultant - and whether the supervision will be full time or part time. If it is to be carried out by the client's staff, cost implication will involve cost of the equipment needed, transport and travelling allowance. If supervision is to be carried out by a consultant this too has to be estimated.

Typically, supervision will involve nine steps; pre-mobilisation inspection, siting, mobilisation, drilling, on-site design modification, development, demobilisation, handover (Adekile, 2012). But others creep in which should also be estimated where relevant, such as inspection tours to issue a certificate of substantial completion and another to issue a certificate of final completion (Anscombe, 2012)

On major projects and in remote areas, the contractor may be asked to set up a base camp and the supervising staff are housed and fed in the camp. The contractors are instructed to include this in the preliminaries to the bid price as part of services to the engineer, but first this has to be estimated and included in the construction cost estimate for the procurement plan.

Monitoring and evaluation cost

The cost of post-construction facility management and monitoring (this should not be confused with defects liability period monitoring) should also be included. Since this will go on for several years, it will have to be budgeted for annually by the procurement agency or the district authorities after completion.

Overall communication cost

The cost of installing internet facilities and providing specific staff with allowances for using their mobile phones on the project should be worked out. On bigger projects, radio communication may be required. Postage and courier services cost also need to be estimated.

Contingency

About 10 to 15 % of the total cost of the identified components should be allowed to cover unforeseen items and variations.

1d Define procurement process

The procurement method and procedure has to be stated in the procurement plan. In most countries, the procedure is laid down in the procurement regulations. There are many types of procurement methods, but the two most often used and recommended in borehole construction are **open competitive bidding** and **selective bidding (or request for quotation)** as described in Box 3 and 4 respectively. The choice of the method should support all the parties involved in order to get the optimal result.

Box 3 Open competitive bidding

In open competitive bidding, the contract is advertised, and all companies (even international) that are interested are free to express an interest and to tender. This is the method most often used in borehole works procurement involving more than 5 boreholes.

In the past, international competitive bidding was common for projects supported by international development partners with borehole contracts of the order of 1,000 boreholes. Tenders were invited from all over the world. However, this procurement method was found incompatible with building local capacity and has largely been discontinued. With smaller contracts and the emergence of indigenous drilling contractors in many countries, local competitive bidding has become the norm.

The procurement procedure takes the following steps

- Advertising of the project with invitation for prequalification and request for an expression of interest from interested service providers
- Prequalification
- Short-listing
- Bidding process
- Evaluation
- Contract negotiation and award

Box 4 Selective bidding (or request for quotation)

Selective bidding is used where the value of the contract is small (probably less than 5 boreholes) and the drilling contractors have past working experience with the project planners. The project manager asks for quotation from at least five local contractors. This is also used in procurement of boreholes by institutions, private businesses, households and communities.

For borehole drilling projects, it should also be decided and stated whether a **bill of quantities** will be used or if it will be a **lump sum contract**:

- Bills of quantities are used to set out the stages and quantities of materials to be used in construction against their associated prices. They enable the contractor to price the work for bidding, progress can be monitored and the quantities measured for approval of payment.
- On the other hand, borehole contracts are sometimes awarded as a lump sum where a single price has been negotiated per borehole. The advantage of this method is the

simplicity of its administration over having to complete a bill of quantities for each borehole. Private householders, farmers and others using borehole sources for livelihoods tend to favour this system, which is uncomplicated.

A lump sum contract may curb the practice of over-drilling by unscrupulous drillers but can also encourage under-drilling, with boreholes not being drilled to the required depth. This can result in inadequate yield, leading to an abandoned borehole (section 2d – payment for dry holes discusses this in more detail). Good supervision and contract management are essential, whatever the method. The drilling and casing depth should always be measured.

1e Define contract packages

Reducing the distance and travelling time between borehole sites can save a lot of money. It also makes supervision easier and less hazardous. Further, the contractor works in a terrain of similar geology that will most probably require identical drilling techniques.

As much as possible, where several boreholes are planned, the contracts should be for multi-borehole packages, in a fairly close geographic area with similar depth and hydrogeology. Lots could be for a reasonably high number of boreholes, 100 and above, or small packages of about 5 to 10. Contractors can sometimes be awarded one lot of 5 boreholes, and, on completion, be awarded another lot or two. In this way, contractors may end up constructing 100 boreholes on a particular program.

The appropriate lot size will depend on the need to provide opportunities to smaller drilling companies in order to build in-country capacity. The cost per borehole should decrease as the number per package increases. Some programs simply set a benchmark price based on the engineer's estimate, and all the prequalified bidders below the benchmark are awarded a contract.

Stage 2: Contract award (for multiple boreholes)

The contract award process should follow the method and procedure that has been presented and approved in the procurement plan. In the case of open competitive bidding this starts with prequalification.

Sections 2a to 2j describe the process for the appointment of contractors and suppliers for multiple boreholes. Sections 2k to 2m describe the process for single boreholes by institutions, private businesses, communities and households, borehole rehabilitation and consultants.

2a Invite prequalification

After approval of the procurement plan and budget, the project places an advert in the national newspapers asking interested service providers to prequalify for participation in the project. The **advert** should state:

- the name and address of the procuring agency
- the scope of the project
- project organization, norms and regulations to be followed
- the prequalification requirements
- when and where the prequalification document can be obtained and at what price
- documents required for prequalification
- the place and deadline for submission

Prequalification requirements should include submission of:

- evidence of company registration
- evidence of past contracts of similar nature (with references and previous drilling permits granted where applicable)
- the names, addresses and contacts of 3 referees that may be consulted on performance
- drilling license number (where relevant)
- CV of key staff
- equipment capability
- financial capability (annual audited accounts for the past 3 years and letter of support from bankers)

Some funding agencies such as the World Bank and the African Development Bank have a template for advertising projects which must be followed by borrowers for their projects.

Annex 1 provides a sample prequalification form. Adequate time should be allowed for the submission of the prequalification information, usually about 21 to 28 days from the date of the advert.

Several countries are moving towards licensing of drilling contractors and categorising them according to capacity (e.g. Kenya, Nigeria and Sudan). This actually aids the selection of contractors as there is already some vetting in the licensing process. For a company to obtain a license, there is an appraisal of the drilling rigs, associated equipment and competence. Thus in countries where licensing exists and is a legal requirement, it is useful to ask for evidence when selecting contractors. Besides where there is licensing, the use of licensed drillers is the law. To do otherwise will be contravening the law. Selecting licenced drillers is also a protection against the allegation often heard that public sector contracts are given to "briefcase drillers". Such companies should not hold licences.

Drillers' associations are also being formed in some countries. Evidence of membership is a measure of some level of professionalism and should be asked at the prequalification stage.

Where there is no licensing and no drillers association and there is no previous knowledge of the contractors, it is essential that some of the references given be consulted to provide information on the bidder. In order to ease evaluation and comparison it is useful to send a simple form to the referees to provide the information.

Some rural water supply agencies and local governments have a register of drilling contractors that they use every year. They waive prequalification requirements for such contractors to reduce the bureaucracy. Some agencies combine the prequalification exercise with the bidding process so that a form of qualification as shown in Annex 1 is submitted along with the bid.

In some local governments small contracts are awarded to a small number of known local contractors. In such cases, the invitation for prequalification is only placed on the notice board of the local government to reduce the cost of procurement.

Some projects award separate contracts for the supply of pump and construction of pads, generators and reservoirs. Such suppliers should also be subjected to prequalification. It should be stated whether subcontracting of any part of the project is allowed or not.

Many agencies put the handpump supply and installation within the drilling contract because it reduces the client's input. However, if proper checks are not in place, this can lead to the supply of poor products. Therefore, for quality assurance, it is better to give this as a separate contract.

2b Evaluate prequalification applicants

The prequalification documents submitted are evaluated to determine those who are eligible and those who are not, based on the criteria previously set. The evaluation requires a checklist to see if applicants comply with the requirement. Table 1 provides an example of such a checklist.

Table 1 Sample checklist for eligibility for prequalification of contractors

Requirement	Criteria	Compliance
Company registration	Must be registered in country	Yes
Experience in similar projects	At least 5 similar projects in the last 3 years	Yes
Drilling license	Current	Yes
Referees	Positive response from 2 referees	Yes
CVs of key staff	One drilling manager with minimum 10 years' experience	Yes
	One hydrogeologist with minimum 10 years' experience	Yes
Equipment	One drilling rig, one compressor, 1 mud pump, 1 support truck, 1 water tanker	Yes
Financial capability	Minimum $100,000 annual turnover for the past 3 years.	Yes
	Positive letter from bankers	Yes
Final decision	Eligible	Yes

Once contractors are prequalified, it is assumed that the project is satisfied that they have the technical and financial capacity to carry out the works. In order to do this, it is necessary to verify some of the claims submitted in the prequalification document (Box 5).

It may not be physically possible to visit all the contractors applying for prequalification. However, once a shortlist has been compiled, some of those being considered should be visited. It is good to give prior notice so as to meet and interact with the technical staff. It is also good to see some of the equipment on site. The RWSN guidance note: "Supervising water well drilling" (Adekile, 2012) provides further guidance on prequalification inspection.

Box 5 Case of false prequalification submissions

On a recent project in South Darfur, an NGO had shortlisted five contractors after evaluation of the prequalification submissions, but on physical inspection only one of them was found to be a drilling company with equipment and staff.

2c Prepare contract documents

The contract documents should be kept very simple, clear, and tailored for the requirement. Weighty tomes should be avoided. If possible, the contract documents should not be more than 20 pages in length. However, contract documents should also be robust enough to adequately protect the parties. The contract document should include:

- the form of agreement
- instructions to the bidder
- the general conditions of the contract
- the technical specifications of the works to be provided
- the bill of quantities
- payment schedule
- arbitration clause

If the assignment is not too complex, the contract may consist only of the letter of award, the technical specification, the bill of quantities and the acceptance letter by the contractor. However, every contract should include an agreement signed by both parties and their witnesses.

Form of agreement

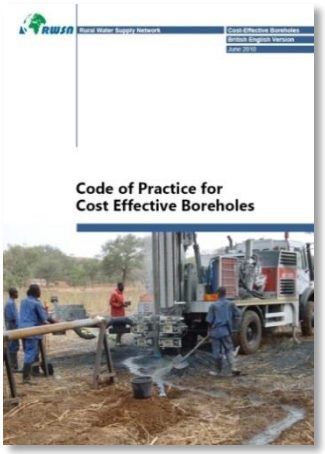
In countries with a procurement law, there are standard forms of contract agreement which can be used. Otherwise, the contract agreement should be a one or two page document stating the names and addresses of parties to the agreement (i.e. the client and the contractor, or supplier) and the responsibility of each party. There should be provision for the agreement to be signed and dated by both parties in the presence of witnesses. A sample form is shown in Annex 2.

Instructions to the bidder

The instructions to the bidder usually contains a brief description of the scope of the project, documents constituting the bid, the deadline and place for submission, mode of clarification of questions on the bid, award criteria and information on the mode of payment. The instruction to the bidder should ask for a **method statement** for the execution of the project based on the technical specification.

General conditions of the contract

The general conditions of the contract cover issues relevant to the contract but not included in the technical specifications. Countries with procurement laws have general conditions of contract applicable to all procurements. For countries without a procurement law, some of the usual issues and how to tackle them are provided in Box 6.



Technical specifications

The technical specifications provide guidelines for physical dimensions of the boreholes and other installations and the technology to be used in the construction and completion of the works. RWSN's *Code of Practice for Cost Effective Boreholes* (Danert et al, 2010) provides guidelines in developing borehole specification.

Box 6 Aspects of General Conditions of Contract

Terms of payment: Payment should be based on actual work completed verified according to the bill of quantities or lump sum contract. If an advance payment is to be made, the percentage and the mode of deduction should be stated. A bank guarantee of the same amount or an insurance bond to cover the advance payment may be required. Payments should be made within 30 days of approval of the completion of works and submission of an invoice. The interest to be paid on delayed payment should be stated (usually at the current bank rate). Where the contractor will not be paid for dry holes, it should be thus stated.

Retention fee: 5%-10% of each stage valuation sum is normally held as retention. Half of the retention fee should be released after practical completion of the works. The balance is released after the defects liability period, which is usually 6 months (12 months in some countries in Southern Africa) after practical completion of the works.

Time of completion: The expected completion time should be based on the program submitted by the contractor and agreed with the client. This will vary according to the size of each lot. By the completion time, the contractor should have completed all the works and remove all his/her material plus any surplus from the site and return the site to normal.

Liquidated damages: In the event of the works specified in the contract not being completed on schedule, the contractors shall be subject to a penalty (of about 0.25% of the price of works ordered per calendar day of delay), except in the case of force majeure (defined below) confirmed by the project manager.

Supervisor's decision: The client will appoint a supervisor who will supervise the drilling operations and certify the completion of items of work for payment. If at any time the supervisor is of the opinion that the contractor is negligent or incapable of delivering the works as designed, he/she has the right to stop the works. The RWSN publication *Supervising Water Well Drilling* (Adekile, 2012) gives the details of the supervisor's responsibility and the role of communities and owners in supervision.

Insurances: The insurances to be taken by the contractor should be stated. The contractor should at all times during the progress of the work keep the works insured in the full value from damage by whatever cause with a reputable insurance company acceptable to the client.

Defects liability period: This is usually 6 to 12 months after the completion and handing over of each borehole. During the period the contractor is obliged to correct any defects on the works at his/her own expense.

Force majeure: refers to circumstances beyond the control of either party, such as war, strikes or unrest, flooding, poor access, that may prevent the performance of its obligations under the contract.

Termination of contract: If there is a breach of the contract, it can be terminated by either the client or the contractor by giving 30 days' notice in writing to the defaulting party. But if the defaulting party amends the breach to the satisfaction of the aggrieved party within 7 days, then the notice can be withdrawn and it is void. However, the client may at any time terminate the contract if he/she] is satisfied that the project is being stalled by the contractor's inability to keep to the required quality or pace of the work.

Arbitration: In case of disputes failing a mutual settlement, it shall be referred to arbitration. Arbitration should consist of three people, one appointed by each of the two parties, and the two arbitrators so appointed will appoint the third person. The three arbitrators will determine the dispute in line with the arbitration laws of the country.

When developing the technical specifications, the project manager needs to be guided by the following principles:

- Ideally, **siting and borehole design** should be carried out independently of the drilling. Geophysics should be used only if it is certain that this will increase the chances of success. In cases where the contractor is to carry out the siting, the risk of drilling a dry borehole should be categorized. RWSN's *Code of Practice for Cost Effective Boreholes* (Danert et al, 2010) provides a model for categorizing the risk of drilling a dry hole. Where the risk of drilling a dry borehole is greater than 50%, the client should always commission an independent consultant to carry out the siting, and the driller should be paid for both dry and wet holes.
- **Borehole dimensions**, i.e. depths and diameter and the lining material, should not be over specified or under specified. The dimensions should be fit for the purpose of the borehole with respect to the expected yield, pump type and use.
- Similarly, the **drilling equipment** should not be over-specified. It should be stated whether rotary drilling or hammer drilling or both are required. Preference should be given to smaller rigs and simpler technology where they work. Unfortunately, it is common for borehole contract documents to be copied from one project to the other without paying attention to the reality of the particular situation. Thus heavy-duty rigs specified for deep drilling terrain in one document are copied and specified for areas where smaller rigs will suffice. The *Code of Practice for Cost Effective Boreholes* (Danert et al, 2010) - Annex B provides a guide for drilling method selection.
- In the case of **part-time supervision** (section 3c), critical milestones for supervision are specified.
- **Bad roads and terrain** requiring 4 x 4 vehicles should be indicated.
- **Borehole development and pumping test** requirements must be stated. They should not be unduly long but fit for the purpose.
- If included in the contract, **head works** should be specified, particularly the type, reinforcing mesh and concrete mix ratio. Likewise, **pump** supplies along with necessary spare parts and tools need to be specified.

Under the conditions of the contract, potential contentious issues (such as if the driller will not be paid for dry holes or a particular minimum yield is expected) should be stated.

Bill of quantities

To enable the contractors to price the works as well as for price evaluation, a bill of quantities has to be prepared. The bill of quantities sets out the estimated quantities of materials, labour, and transportation for completion of each of the items of work described in the technical specifications and the scope of works. The contractor sets out his/her costs against these items. It should include the basic aspects set out in the technical specifications such as casing inside and outside diameter. A sample bill of quantities is provided in Annex 3. Each item of material should be described in the bill of quantities in conformity with the technical specification.

The quantities set out in the bill of quantities should be as realistic as possible. The borehole depths should be based on the hydrogeological appraisal of the sites and existing borehole

data. On crystalline rocks, the depth should ideally be based on depths indicated by the geophysical surveys. Unfortunately, this is not always possible as many projects lump the siting and drilling contracts together. Even on large projects where the client is responsible for siting and it is separate from the drilling contract, the geophysical survey team often only stays slightly ahead of the drilling team. Also, some of the drilling results are required to calibrate the geophysical data and to fine-tune the interpretation from the geophysics.

On motorised schemes it is often not possible to know before the borehole is completed the exact pump, generator, pipeline and storage capacities that will be required. It is therefore advisable to estimate the required capacity as close as possible (or assuming the worst possible scenario) and present it as provisional items. Boreholes to be fitted with motorised pumps should be designed accordingly, with appropriate diameter for the identified provisional pumps and gravel pack thickness, particularly where solar pumps are proposed.

The price for the provisional items should be inserted in the bill of quantities by the project manager from current market prices after allowing a margin for profit and overheads. This is to enable price comparisons between the bidders. If this is not done, some bidders may quote for smaller and cheaper items than others, and it will be difficult to identify the competitive price.

Arbitration and litigation

Where there is a dispute over contractual matters which cannot be resolved by the parties, it is better referred to arbitration rather than going into litigation. In most countries, litigation is time-consuming and costly. Lawyers and judges are not likely to be familiar with the technicalities of borehole drilling. Arbitrators appointed by the parties should be technical people, conversant with drilling so that the dispute can be resolved quickly. Every contract should therefore include an arbitration clause.

2d Call for bids

Once the contract documents are ready, those companies prequalified and short-listed are invited to collect the contract documents and bid for the project. Those not qualified should also be informed and the reasons for not being prequalified stated. The letter of invitation for bidding should state the following:

- the deadline, place and mode for submission
- the required supporting bidding documents (cost and complexity of previous projects, method statement, CV of the project manager and litigation history)
- the deadline for submission of queries
- the address of the person to whom queries can be sent
- the venue and time of the pre-bid meeting
- the duration of the bid validity
- the bid opening date
- the bid security required, the format and preferred issuing entity
- the price of the bid documents (should not exceed the cost of printing, delivery and administration)

The submitted bids should be in sealed envelopes, with the name of the project boldly stated on the envelope. Usually, technical and financial proposals are submitted in separate envelopes. All queries received should be answered and circulated to all bidders.

Bid security

The procuring agency may require bidders to provide a bid security to secure the validity of the bid. This ensures that the bidder will not withdraw the bid within the period specified for acceptance and shall execute the contract within the time specified. To ensure confidentiality, the bid security should be set for all the bidders at not more than 2% of the engineer's estimate.

2e Hold pre-bid meeting

The venue and date of the pre-bid meeting are already stated in the contract documents. All the contractors who collected the contract documents are expected to attend the meeting. A pre-bid meeting is essential particularly on large projects and in those areas with complex geology where non-familiar drilling methods are likely to be required. The project manager should use the pre-bid meeting to brief the bidders on their role (Box 7).

The project manager and hydrogeologist should go through the contract documents with the bidders to ensure a common understanding of all the salient points by themselves and the bidders. The hydrogeologist should explain the geology and the reasons for particular specifications. Where bidders feel an alternative method might work better or is more comfortable with a method other than the one specified, they should be allowed to put in an alternative methodology with justification. The proposed method should be considered objectively. It may mean consulting others in the field to assess its merit and to be able to come to a decision.

The minutes of the pre-bid meeting should be circulated to all bidders, both those in attendance and those not.

Box 7 Bidder's role

Once a bidder receives the prequalification or the bid document, he/she should study the documents carefully to decide if he/she can meet the technical, commercial and contractual conditions, and if so, proceed to prepare his/her. Bidders should critically review the documents to see if there are ambiguities, omissions, contradictions, or any features of specifications or other conditions which are unclear or appear discriminatory or restrictive. If so, they should seek clarification from the procuring agency, in writing, within the time period specified in the bid documents and should use the pre-bid meeting for final clarification.

It is the responsibility of the bidders to ensure the timely submission of fully responsive and compliant bids, including all the supporting documents requested in the invitation to bid and to be present at all meetings regarding the bid.

2f Open the bids

Bid opening should be public. Bidders or their representatives should be present and sign the register of attendance. Each bid envelope should be displayed to show it has not been tampered with, and the price and other documents submitted with the bid announced and recorded in the bid opening minutes. The minutes should be sent to all of the bidders.

2g Evaluate the bids

For the process to be transparent, the bids received should be evaluated by a committee of 3 to 7 persons, including technical staff. The bid evaluation committee members should be drawn from different departments of the procuring agency. In some projects, external people may be invited where there is a shortage of the relevant technical expertise in the procuring agency. The process of evaluation should be confidential until the contract is awarded.

Where bidders have been prequalified, some projects simply award the contract to the lowest bidder. However, it is good at this stage to verify if the information provided in the prequalification document is still valid and to check if the bids comply with all the requirements.

Where some further qualification requirements such as method statement have been asked in the bidding process, a scoring system should be developed for the evaluation of the different aspects of the submission. An example is provided in Table 2.

Table 2 Example evaluation grid

Criteria	Benchmark	Total marks allowed	Marks scored
Cost and complexity of previous projects	Minimum $20,000	15	
Method statement	Shows understanding of tasks	20	
Experience of the project manager	Minimum 10 years	20	
Litigation history	Not more than 2 in the past 3 years	5	
Bid price	Lowest	40	
Total		**100**	

The method statement should be checked to ensure compliance with the technical specifications. A proposal to subcontract more than 25% of the contract indicates a lack of capacity by the contractor to carry out the work and should be deemed unresponsive.

The bill of quantities is checked for arithmetical errors. Where arithmetical errors are found, the bidder should be informed of the correction. If the bidder is not in agreement that there is an error, the bid should be dropped and the bidder informed. In evaluating the bid, the evaluators should watch out for clever attempts by the bidders to circumvent some of the aims of the project (e.g. Box 8). Each committee member does his/her own scoring and the scores are collated and an average found to arrive at the most responsive bid, i.e. the one with the highest score.

In the case of scoring the bid price, the usual practice is for the bidder with the lowest bid price to get the total marks (i.e. 40 in the case of the example given in Table 2). The others are then awarded marks inversely proportional to their bid price. For example, if the bid prices are $20,000, $25,000 and $30,000, the lowest bidder is awarded 40 marks and the others are awarded 32 and 26.7 marks respectively, i.e. 80 % and 66 % of 40.

Box 8 An example of bill of quantities manipulation by a driller

Bill of Quantities						
Item	Description	Unit	Qty	Rate US$	Amount US$	%of Total of Cost
1	Geophysics	LS	1	1,695	1,695	29
2	Mobilisation/ demobilization	LS	1	1,441	1,441	24
3	Drilling basement	M	50	13	636	11
4	Supply and installation of casing	M	41	14	574	10
5	Supply and installation of screen	M	9	16	144	2
6	Gravel packing	No	1	593	593	10
7	Borehole cleaning	No	1	177	177	3
8	Pumping test	No	1	85	85	1
9	Water quality analysis	No	1	232	232	4
10	Sanitary seal	No	1	169	169	3
11	Reporting	No	2	102	204	3
	Total				**5,932**	

The above bill of quantities is from an actual project. In this case, the contractor loaded the items of the contract that are not subject to depth measurement (item 1 - geophysics, item 2 – mobilisation/demobilisation and item 6 – gravel packing), so that even if the depth of drilling was reduced on site by the supervisor, he/she would have earned more than 60% of the contract sum. Yet the pricing was still within the range of the engineer's estimate. The project should have asked for a more realistic distribution of prices.

In some projects where there are several lots and a benchmark has been set for the contract price, based on the engineer's estimate, all bidders below this price are sometimes awarded a contract. Awarding the contract to one single lowest bidder could force prices down, but it may not build local capacity on the scale required. Armstrong (2009) suggests a mechanism for developing in-country capacity of small-scale contractors (Box 9). This may enable better control over the quality of the boreholes.

Even where the procurement procedure is by selective bidding (section 1d) it is still good that all the bidders respond to the same technical specifications. This eases comparison and evaluation. Bid opening and evaluation should follow the same procedure as in open competitive bidding (section 1d). Where only one bid is received and the bid is found to be responsive and within the range of the engineer's estimate, it may be accepted and the contract awarded to the bidder.

Box 9 Developing the capacity of small-scale contractors (Adapted from Armstrong, 2009 and Anscombe, 2012)

Mechanisms for developing the capacity of small scale contractors:

- First prequalify a number of contractors.
- Following a bidding process, some contractors are selected to serve in a driller's pool for a specified term.
- Borehole prices are then negotiated and agreed and set for respective areas to be assigned.
- Subsequently, small roll-over packages of say 20 to 30 boreholes are awarded to individual contractors at the same time.
- As packages are completed, new follow-on packages are awarded depending on satisfactory performance.

With such a system, the contractors are not competing "for" the work but "with" the work; good and timely work can win more work. Contractors with multiple rigs can take on several packages, but the system should not exclude smaller worthy local contractors. It gives the client better control of the works being implemented and limits the risk of poor performance.

An alternative method is the process being followed by the government of Botswana in discussion with the drilling contractors and consultants. The highlights are

- There is plenty of work for all
- Uniform rates apply
- A batch is allocated to each contractor and consultant and then rolled over to a second and third batch on successful completion.

2h Publicise the evaluation result

The result of the evaluation should be made public either by publishing it in the local newspaper or on the notice board of the agency. The format shown in Table 3 could be used.

Table 3 Bid Evaluation Result

Name and address of awarded bidder	Bid price at bid opening	Final bid price
Evaluated responsive bidders		
Names	Bid price at bid opening	Price of evaluated bid
Rejected bids		
Names	Bid price at bid opening	Reasons for rejection

A letter of award is then sent to the successful bidders and invited to sign the contract and commence on the execution of the project. Those not successful are also informed.

2i Seek performance bond

The client may ask the selected bidder to provide a performance security or bond prior to contract signature from an insurance company approved either by the client or a bank. The amount of the security should be between 5% and 10% of the contract value. The performance security is discharged after completion of the contract and expiration of the defects liability period if there is no default.

2j Sign the contract

Two copies of the entire contract document need to be made available for the contract signing. The contract does not differ much in content from the original bidding document unless corrections have been made (e.g. due to discussions at the pre-bid meeting or subsequent clarifications).

The successful bidder should be informed of the date and venue for the contract signing. The venue could be the client's office or some other public venue. As much as possible, the signing should be made public with as many stakeholders as practicable invited, including the press. The ceremony should be presided over by a senior representative of the client.

The contractor's representatives should go through the contract document document and ensure that it represents their understanding of the tasks to be executed and under the conditions for which they bid. The presiding officer should ask the contractor's representatives if they have read and are satisfied with the terms of the contract agreement and are prepared to sign the contract. Responding in the affirmative, the representatives of the two parties and their witnesses then sign the agreement.

Apart from the forms of agreement, each page of the contract documents should be initialled by the representatives of both parties. Each party holds a copy of the signed contract. After signing, representatives of the two parties may address the gathering.

for single boreholes, rehabilitation and consultants

2k Procurement of single boreholes by institutions, private businesses, small communities and households

Heads of institutions, private businesses, small communities and households often have to engage drilling contractors. The cost of a borehole is a major investment for anybody, but more so for householders. Prospective borehole owners should therefore seek advice from relevant institutions and existing borehole owners. They should only deal with reputable drilling contractors. The owners should try as much as possible to have someone competent to supervise the work on their behalf. Drillers working for such clients should carefully explain the drilling process to them and the risks involved.

Although the size of most household plots and business premises does not allow a detailed survey, the surrounding geology and subsurface conditions on the site should still be assessed as much as practicable either by one of the various adaptations of geophysical sounding methods (such as shortening the electrodes array or working outside the premises), or by a geological reconnaissance to ensure that the site is not underlain by barren shallow bedrock.

The risk of drilling a dry hole on crystalline terrains should be explained to the prospective borehole owner. What would happen in such an event in terms of payment needs to be agreed. The driller should ensure that the owner understands that he/she (the driller) will exercise all care and diligence in carrying out the works but that he/she will not be held responsible for the quantity or the quality of the water produced. Only when this has been understood and accepted by the client and the

witnesses and stated in the contract should the agreement be signed. This is very crucial as it is the major cause of conflict between clients and drillers and a source of bad image for the drilling profession.

2l Appointment of contractors for borehole rehabilitation

The appointment of contractors for the rehabilitation of boreholes follows the same procedure as described above (2a to 2g) for new boreholes. The work to be carried out is spelt out in the technical specifications and should include the following:

- A camera inspection of the borehole
- An evaluation of the existing pumps and fittings
- Redevelopment of the borehole by jetting and airlifting
- Pumping test and water quality analysis
- Installation of new pumps and fittings

2m Appointment of consultants

The appointment of consultants follows the same procedure of prequalification and bidding set out in 2a) to 2j). For consultancies, the prequalification advert usually asks for an expression of interest, but the procedure is usually the same as for drilling.

Whereas the bidding documents and contract for a drilling contractor include technical specifications and a bill of quantities, the equivalent for consultancy contracts is a **Terms of Reference (ToR)**. This states the tasks that are expected to be carried out by the consultants. The bidders are asked to respond to the terms of reference by presenting a technical and financial proposal. In the technical proposal, the consultant is expected to present:

- comments on the terms of reference
- experience on similar assignments
- a methodology or strategy of carrying out the work
- a work plan for the project
- the curriculum vitae of key staff and facilities for the work

The financial proposal is a statement of the costs to be incurred by the consultant and the fees for the input. The technical proposal and the financial proposals are submitted in two separate envelopes.

High-quality service is the major consideration in consultancies. Therefore, in consultancy bid evaluation, the technical proposal often carries a higher percentage of the marks, sometimes 80%. Marks are awarded for each of the following assessed points in the technical proposal:

- the consultant's experience on similar assignments
- the methodology
- the workplan
- the key experts' experience and qualifications for the assignment

The evaluation method should be set out in the bidding document. Table 4 shows an evaluation grid from a recent EU sponsored consultancy. The distribution of the scores shows the importance given to expertise and high equality performance in consultancy. On some projects, only those bidders who score 70 - 85% in the technical document are considered. The financial proposals of bidders scoring less than 70% are returned unopened. The successful bidders are then notified and called to the financial bid opening, which is conducted as in contract bid opening (described in 2f). After the opening, the proposals are checked for arithmetic errors. Where bids are in different currencies, they are converted to one currency.

The proposal with the lowest offered price is given a score of 100 and the other proposals scores that are inversely proportional to their price (as described in 2g). These are then added to the technical scores, and the consultant with the highest score is called to negotiation for clarification of any grey areas and an eventual signing of the contract.

In some countries there is a scale of fees payable for consultancies which relate to the magnitude of the project being designed or supervised. There may also be a register of prequalified consultancy firms. In such cases, consultants do not have to submit financial proposals or bids. They may be asked to submit an expression of interest and a technical proposal, which are evaluated (e.g. Box 10).

Table 4 Sample evaluation grid

Input	Maximum score	Actual score
Organization & methodology		
Rationale		
Comments on the ToR	2	
Comments on key issues related to the achievement of programme objectives	2	
Strategy		
Comments on the approach and activities proposed	2	
Description detailing of backstopping facilities	2	
Justification and presentation of support staff team proposed	1	
Timetable of activities	1	
Identification and timing	1	
Total for organisation & methodology	**10**	
Key experts		
Key expert 1 Team Coordinator		
Qualifications and skills	1	
General professional experience	1	
Specific professional experience	8	
Key experts 2 (8 Water and sanitation experts)		
Qualification and skills	8	
General professional experience	8	
Specific professional experience	64	
Total score for key experts	**90**	
Overall total score	**100**	

Box 10 Example of an alternative procurement practice

On an EU-supported small towns borehole project in Nigeria, the client disclosed the budget for the consultancy and asked consultants to put in a proposal for the project. The consultancy that won the project was one of the oldest groundwater consultancies in the country who also offered to do the project for 75% of the budget. Thus there could be some flexibility to use what works best in a particular situation.

Consultants may associate with each other to form a joint venture or sub consultancies to complement their areas of expertise, strengthen the technical proposals and make available a larger pool of experts, better methodologies and sometimes lower prices. However, on any one project, a consultant should be allowed to submit only one proposal either individually or as a joint venture. If a consultancy including a joint venture partner submits or participates in more than one proposal, all such proposals should be disqualified.

Although there should be a professionally qualified and experienced hydrogeologist or engineer directing the drilling project, with drill site supervisors the emphasis should be on experience rather than formal qualification and the modality of how the hydrogeologist/engineer will direct the project. Unlike in the case of drilling contractors, consultants are not usually expected to provide a performance bond.

Selection of individual consultants

Sometimes, an individual consultant is required either to provide advice, carry out a study or an evaluation. Individual consultants are selected on the basis of their relevant experience, qualifications and capability to carry out the assignment. They do not need to submit a proposal but an expression of interest along with their curriculum vitae and relevant experience may be required. This is evaluated in the selection of the consultant. Usually, a minimum of 10 years relevant experience and a master's degree in the field of assignment are the requirements. A financial rate is proposed by the client, and if this is agreeable to both parties, an agreement is signed.

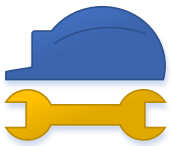
Conflict of interest

Consultants are expected to provide professional, objective, impartial advice to the client. Consultants should not be hired for any assignment that would be at conflict with their prior or current obligation or that may place them in a position of not being able to render their services in the best interest of the client. For instance, a consultant hired for developing the terms of reference or designing a project should not be allowed to bid for the same project or have interests in companies that are bidding for the project

Substitution of experts

During an assignment, if substitution of an expert is necessary by the consultancy firm appointed (for example, because of ill health or because an expert proves to be unsuitable or becomes otherwise ineligible), the consultant shall propose other experts of at least the same level of qualifications for approval by the client.

Stage 3: Contract management



3a Ensure logistics are available

As soon as the contract is signed, the project manager should take action to set up the facilities required for the administration and supervision of the project. Logistics include:

- office space for the number of staff required
- vehicles
- equipment – including Global Positioning System (GPS), maps, dip meters, notebooks and borehole cameras.

3b Establish administration procedures

The project manager should immediately set up a project **filing system**. All communications should be documented and filed. All data and reports from the field also need to be filed. Lack of an efficient filing system often causes long and costly delays in the search for documents at critical moments when procurement or contract management issues arise. There should be a duplicate filing system in which duplicate files are kept for the office or for taking into the field so that one set is labelled office copy and the other field copy.

Notices of meetings should be given with adequate time, at least a week, and circulated to all expected to attend. Minutes of meetings should be filed.

As soon as the contract becomes effective, the contractor should be asked to submit the **program of completion** of the project. This should include a Gantt chart of weekly activities. The contractor should nominate and introduce his/her project manager or responsible person. As much as possible in the tropical regions, it is best to avoid starting a drilling project in the rainy season, when access is poor and drilling can be interrupted by the rains.

Drilling companies tend to be understaffed, sometimes making it difficult to find one particular person that is answerable for all enquiries because they are elsewhere. There should be constant and close liaison between the client's project manager and the contractor's project manager.

Figure 2 Drilling rig ready for action in Malawi (RWSN/Skat)

3c Hold key meetings

Pre-mobilisation

A project start-up meeting should be held to discuss the program of mobilisation and completion. The schedule and venue of project and site meetings should be agreed. The project manager and the supervisor should go over the technical specifications with the driller so that they have a common understanding of the issues. The role of the supervisor should be made clear at the meeting. Any issues requiring clarification should be raised and resolved as early as possible. Safety procedures should be discussed at the meeting.

The contractor is also required to submit the samples of the materials such as casings, drilling fluids, gravel, cement, etc. to be used on the project or confirm the sources of the materials. The format of data collection and site instructions should also be agreed. Furthermore, the contractor will nominate and introduce the record keeper, who will collect all the specified data and information.

The contractor will also ensure that a copy of the project control documents comprising the technical specifications, bill of quantities, all drawings and site instruction book are available on site at all times.

Liaison with communities

In the case of community water supplies, it is essential that the project manager or the supervisor has already had several discussions with the community before mobilization of drilling equipment to each drilling site. The discussions include information about the project, details of the drilling process, the expected obligations and contributions of the community as well as agreement on the main contact persons and community representatives. A date should be set for the introduction of the contractor's representative to the community and the start date agreed.

Site meetings

Site meetings are meant to review the progress of the work, inspect the progress on site and check the quality of the work. The project manager, the supervisor and the driller or the representative should always be present at site meetings. This may be fortnightly or monthly or decided at the end of each meeting, depending on the scope of the project, but should allow a reasonable time for some progress to have been made. At the meeting, the contractor is expected to submit a progress report of the work and detail any challenges that are encountered. Where there are delays in the program, the contractor should be asked to review and update it. Where the completion date is considerably behind schedule the contractor should apply for an extension of the contract with justification within a reasonable time.

3d Ensure supervision of the works

A very crucial aspect of borehole contract management is supervision of the siting, drilling and installation of pumps. High borehole failure rate in Sub-Saharan Africa is partly blamed on poor supervision or lack of supervision.

Whether the contractor carries out the siting or a consultant is appointed to do it, this must to be supervised by competent staff. Supervision is essential to ensure that the driller abides with the specifications, and to guarantee the quality of construction and that all the required information and data are collected and stored.

Supervision is either carried out by the agency staff or by a consultant. Where a consultancy firm is employed, it should be certified that it has capable staff and equipment for the supervision. It is also advisable that some government staff are seconded to work with the consultant as training and capacity development for the staff, monitoring the activities of the consultant and generating institutional memory. However, transport and allowances for this need to be budgeted for at the planning stage (section 1c).

Full-time supervision is the ideal. This means that a supervisor is at the rig with the drilling contractor all the time. Often however, the resources for full-time supervision (i.e. finance, staff and equipment) are not available. Part-time supervision could then be used. This means that the supervisor witnesses and certifies critical aspects of the construction (Box 11). These are stated in the technical specifications. Supervisors should be prompt on site and should not cause undue delays.

Whatever level of supervision is employed, it is essential in rural water supply borehole drilling that **community members** are involved in the entire drilling process to foster the spirit of ownership to encourage post construction-operation and maintenance. The need for this is even greater when part-time supervision is used. Some community members perform certain roles for the supervisor when not on site (Adekile, 2012).

Box 11 Critical aspects of construction for part time supervision

- mobilisation
- depth of termination of drilling
- installation of the casing and screen and gravel pack
- borehole development
- pumping test
- civil works and pump installation
- demobilization

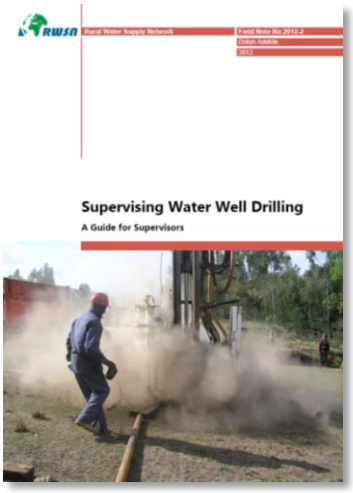
Some other crucial aspects of supervision which should be mentioned here are:

- **Support to junior supervisors** by senior project staff: On public sector projects, supervisors usually tend to be inexperienced young graduates. They need to be trained to know exactly what is expected of them so that they are not bamboozled by experienced drillers. They also need constant support by senior project staff paying visits to the drill site and giving advice.
- **On-site safety**: the supervisor should make sure that the driller takes all actions to minimize the possibility of accident and injuries on site. Even if the borehole is successful, an injury, a limb or life lost on the rig will render the water unpalatable for a long time.
- The **technical specifications** state the criteria for acceptance of a borehole. This will include:
  - depth to static water level
  - yield
  - sand content
  - turbidity
  - water quality
  - finalization of work (including demobilisation)

There will be cases where some of the quantities and values on site may deviate slightly from the acceptable value. Yield, for example, may be 10% below the acceptable limit. The supervisor will have to make a decision to accept the borehole with marginal values or reject it. When such a situation arises and the supervisor feels constrained to make a decision, it is better to refer to a higher authority, such as the project manager. Not all issues can be resolved on site.

The supervisor has great responsibility and is expected to act with professionalism, fairness and honesty at all times.

The RWSN publication *Supervising Water Well Drilling* (Adekile, 2012) is a step by step guide for supervision of borehole construction. The reader is advised to consult it for more details.



3e Make payments

The schedule of payment would have been outlined in the conditions of contract. The contractor may be expected to submit invoices against monthly progress or on the number of boreholes certified completed by the supervisors. For example, some contracts stipulate payment after every batch of 5 boreholes completed.

Daily drilling reports include all drilling details and materials used on the site. Ideally, this should be done by a designated record keeper within the drilling team (Adekile, 2012). They are duly signed by the driller and supervisor and filed. The project manager checks the invoice claims against the reports filed based on the bills of quantities, or, if it is a lump sum, based on the number of boreholes completed. This is used to check that the invoice correlates with the field reports.

Payment in instalments

On other projects, the mobilization payment is taken as part of the total contract sum. A payment is made to the contractor when there is evidence that a substantial part of the contract has been executed. For instance, if an advance of 30% is paid, the contractor may not get another payment until 60% of the works has been completed. The payment could be another 30% of the contract.

Some projects regard mobilization payments as an advance payment loan which has to be deducted from subsequent payments at a rate agreed until liquidated. Mobilisation payments are usually secured either with a bank guarantee or an insurance bond. This should be stated in the conditions of the contract. Where an insurance bond is going to be accepted, it should be from specified reputable firms.

Retention fee – defects liability

A defects liability period refers to the time between the completion of the works and final inspection. During this period the contractor amends defects on the facilities at his/her cost. A defects liability period should be allowed in the contract. It is usually 6 months, although some countries in Southern Africa have a 12-month period. A retention fee, comprising a percentage of the contract (usually 5% or 10%), is retained by the client for the duration of the defects liability period. Borehole contracts are peculiar because each borehole has its own defects liability period. It starts from the moment each borehole is handed over to the client.

The completed works are inspected by a team comprising the client, contractor, and consultant. The contractor is instructed to remedy any defects noted. Shortly before the expiry of the defects liability period, a second visit is made to check if the remedial works has been carried out and that the installation is functioning well. If this is so, a certificate of final inspection is issued. This certificate is then used by the contractor to claim for the release of the retention fee.

Problems encountered on the project and remedied by instruction to the contractor by the supervisor should be documented and filed. Such records may be required in arbitration if the need should arise.

Timely payment

It is essential that contractors be paid on time. Drilling is a highly capital-intensive business, and many drilling companies do not have high levels of cash flow. Long delays in payment can be devastating and even cause a company to go out of business. The project manager should not delay in processing payments. Because of delays in payment on government projects, some drillers in Nigeria and Sudan refuse to work for governments. Even though some country procurement procedures state that contractors should be paid an interest on delayed payment, there is no evidence that this clause has ever been invoked.

Variations and additional works

Sometimes, there are situations in which there is need to alter the design of the works. For example, a decision is made to use steel casing on a borehole that was specified as PVC-lined in the contract. In such a case, the project manager issues a variation order, asking the contractor to provide a price for the new design and if satisfied gives a go-ahead. All variation orders should be numbered and agreed by the client.

Sometimes the project manager issues instruction for additional works where the budget permits. For example, on a World Bank supported borehole project to drill 400 handpump-fitted boreholes in Kaduna State of Nigeria, the contract price was based on an assumed 60 m drilling depth, but the actual drilling depth was an average 35 m. Thus the 400 boreholes were achieved within 60% of the contract price. The client and project manager therefore asked the contractor to drill an additional 300 boreholes to cover the unspent budget.

Payment for dry holes

Some projects and agencies do not pay the contractor for dry holes even though it is generally accepted that a dry hole is not necessarily due to faulty drilling. Participants of the RWSN E-Discussion on Cost-Effective Boreholes agreed that no water no pay contracts cause problems for drillers, and are likely to affect construction quality (Danert and Furey, 2012). Such a policy:

- leads to drilling where water will obviously be struck more frequently than in more difficult areas;
- distorts pricing as drillers compensate for losses
- can encourage low-yielding boreholes to be signed off as productive (supervisor under pressure from driller)
- undermines efforts to collect data and build up hydrogeological understanding, especially in difficult terrains.

Ideally, all drilling should be paid for according to a bill of quantities. Table 5 sets out recommended siting procedures for boreholes of different risk categories.

Table 5 Categorising the risk of dry hole

Category	Success rate	Assumptions
A High Success	>75%	Geophysical survey is not necessary. Drilling at any site has a high chance of success. First preference of the community or owner is likely to be successful.
B Moderate Success	50 – 75%	Survey required and may be done by the contractors within the community or owner-preferred area following guidelines stated above.
C Low Success	<50%	Client to take responsibility for siting according to the above-stated procedure.

3f Ensure data management

Data collection and format

Sustainable groundwater supplies in the future depend on the data and information of the past and present. All the data, including those of dry holes that accrue during the drilling, must be collected. Not collecting the data is a lost opportunity to acquire invaluable information.

The technical specifications in the contract should state all the data to be collected by the consultant and driller during the project from the siting through drilling, development, pumping test, and water quality analysis. The data collection format as well as submission procedure should be specified (in the technical specifications) and followed by the driller.

It is the supervisor's duty to ensure that all the data are diligently collected and submitted. The contract needs to state that the retention fee will only be released when all the required data and records have been submitted in the agreed format. The *Code of Practice for Cost-Effective Boreholes* - Annex E (Danert et al, 2010) provides formats for borehole completion records.

Unique identification number

Every completed borehole should have some form of physical identification marker or plate, with a number which conforms to the national borehole numbering system. Where there is no national numbering system, the project can use a serial system with a prefix of the project or district or local government initials followed by the GPS coordinates or national grid reference and then the serial number, so that when a national numbering system is started the boreholes can be incorporated into the system. The national or district water office should be consulted to find out what, if any, identification standards exist. The identification should be used on all documents relating to the borehole. This will assist with future water point mapping and monitoring.

The borehole number should be stamped into a metal plate on the pump stand. The number should also be embedded in the concrete on the borehole platform along with other data such as the date of completion, depth, static water level, yield and drawdown.

Project report

At the end of the project, a final project report has to be compiled. It should set out all the resources deployed and the outcomes. The report needs to include:

- the organizational structure of the project
- the geology of the project area
- the siting procedure
- the number of boreholes drilled
- the success rate and drilling challenges
- pump types used and sources
- analysis of the expenditure
- details of contractors employed
- trainings provided both to project staff and beneficiaries
- findings of inspection exercise during the defects liability period

The final project report may also include the data on project evaluation, functionality and aquifer monitoring. The project manager should pass all the data generated and report to the central authority responsible for groundwater data storage.

3g Hand over boreholes with pumps

Before handing over the boreholes with the pumps installed to the communities or client, the project manager has to ensure that:

- the driller has complied with all the contract requirements
- the installation is functioning properly
- all the required data has been collected and submitted
- the site has been restored to its former state as much as possible considering there is now a borehole and pump in place.

When the supervisor is satisfied that the borehole is ready for use, a day is set aside for handing over the completed borehole to the community or the client. It is good practice for the handing over certificate to be signed by the supervisor, the contractor's, the community and the client's representatives.

Stage 4: Monitoring and reporting

4a Establish post-construction support and monitoring procedures

In many countries, post-construction monitoring is the responsibility of the district or local government authority, which is expected to support the communities in the maintenance, inspect the facilities and check their functionality, yield and water quality.

Unfortunately, experience has shown that local governments often lack the financial and human resources to support maintenance and undertake adequate monitoring. If this is the case, the project should raise the awareness of what is required amongst entities that could provide the necessary support for the monitoring. Entities include the rural water supply agency, the ministry of water resources, development partners and NGOs.

Ultimately, monitoring should be formalised, with water users visited and facilities inspected twice a year by the designated stakeholder. The report of the inspection indicating functionality and required remedies should be shared with the water users and submitted to the designated authorities and other relevant entities at the national level. The information generated from monitoring is much needed for planning, budgeting and decision-making processes that can ultimately lead to sustainable water supply services.

Figure 3 Celebrating the new water point, North Kordofan, Sudan

Final word

The essence of procurement and contract management is to consistently select the most competent professionals to carry out projects, provide goods and services. Competition at the tendering stage is used to obtain the best value for money invested. This is not necessarily by choosing the cheapest bid.

Procurement of boreholes provides work and income to contractors and consultants whilst providing water supply for the public. It therefore involves a high level of responsibility to society and requires transparency, fairness and accountability on the part of procurement entities. Governments need to continue to strengthen procurement processes and develop the capacities of institutions and individuals involved in procurement and encourage work ethics that promote public good over individual interest.

Annex 1 Form of Pre-qualification

1 Name of Company _____

2 Certificate of Registration

The bidder should attach the certificate of incorporation, driller's license.

Place of registration: _____

Principal place of business: _____

3 Previous Experience

Provide below the details of work performed as prime Contractor on works of similar nature and volume over the last five years. Also list details of work under way or committed, including the expected completion date. Use additional paper in filling in the form.

Project name and country	Name of client and contact person	Type of work performed and year of completion	Function in that project and why reference is relevant	Value of contract
a. b. c. d. e. f. g. h.				

4 Equipment

Major items of Contractor's Equipment proposed for carrying out the Works. List all information requested below. Refer also to Sub-Clause 1.5(c) of the Instructions to Bidders.

Item of Equipment	Description, brand, make, and age (years)	Condition (new, good, poor) and number available	Owned, leased (from whom?), or to be purchased (from whom?)
a. b. c. d. e. f. g. h.			

5 Staff

Provide the qualifications and experience of key staff proposed for administration and execution of the Contract. Attach biographical data.

Position on the project	Name	Years of experience with company	Years of experience (general)	Years of experience in proposed position
a.				
b.				
c.				
d.				
e.				
f.				
g.				
h.				

6 Financial Status

Attach financial reports for the last three years: balance sheets, profit and loss statements, auditors' reports, etc.

7 Evidence of Financial Resources

Provide evidence of access to financial resources to meet the qualification requirements, such as cash in hand or lines of credit. List below and attach copies of support documents.

8 Banker's Address

Provide name, address, and telephone number of banks that may provide references if contacted by the Employer.

9 Current Litigation

Provide information on current litigation in which the Bidder is involved.

Other party(ies)	Cause of dispute	Amount involved
a.		
b.		
c.		
d.		

10 Work Program

Provide proposed Program (work method, risks, and schedule), using descriptions, drawings, and charts, where necessary, to comply with the requirements of the bidding documents.

Annex 2 Form of Agreement

Form of Agreement

This Agreement made the _____ **day of** _____

between the _____ **of** _____

(Hereinafter called the Employer) of the one part, and _____

of _____

(Hereinafter called the Contractor)

(if a joint venture or consortium list the all the partners with the lead partner first)

Whereas the Employer desires that the following works should be provided and executed by the Contractor, i.e.

construction of boreholes, and has accepted a tender by the Contractor for the provision, execution and maintenance of such Works under the direction and to the reasonable satisfaction of the Employer **in the sum of:**

(hereinafter called the Contract Sum)

Now this Agreement is witnessed as follows:

1. In this Agreement, words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to, and they shall be deemed to form and be read and construed as part of this Agreement.

2. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein in conformity in all respects with the provisions of the Contract.

3. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects wherein the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

The parties have therefore caused this Agreement to be executed in the presence of witnesses on the date stated above.

The Common Seal of _____

was hereunto affixed in the presence of: _____

Signed, Sealed, and Delivered by the said _____

in the presence of: _____

Binding Signature of Employer _____

Binding Signature of Contractor _____

Annex 3 Sample Technical Specification for a Borehole Contract

This annex provides an example of Technical Specifications which may be used as a guide. It must be emphasised that technical specifications should reflect the reality of the project requirements and the terrain, a broad brush approach cannot be adopted.

Technical specifications

1. Project description

The project consists of the construction of 100 boreholes in selected communities in 20 local government areas. It shall consist of 80 boreholes on crystalline terrain fitted with handpumps and 20 boreholes on sedimentary terrain fitted with motorised pumps.

The project shall be let under one contract. The drilling is in two geographical areas consisting of Basement Complex rocks in one part and sedimentary formations in the other.

The majority of the boreholes are to be completed with 110 mm diameter PVC casing and screen. Where conditions preclude the use of PVC because of the depth of the boreholes they shall be completed with nominal 150 mm diameter steel casing and screen.

The entire project shall be under the control of the Project Manager appointed by the client. The Project Manager shall be assisted by supervisors who shall be responsible for the management and direction of the project on site and shall approve all materials supplied, works, and measurements carried out by the Contractor and his/her team of workers on the project.

The Contractor shall nominate one key person who shall be responsible for the assignment on behalf of the Contractor and shall be the Contractor's site representative

2. Work schedule

The Contractor, on acceptance of the contract, shall submit a comprehensive work schedule which should fall within the agreed period of contract execution to the Project Manager for approval before mobilization of men, materials and equipment to site. The work schedule shall include setting up the base camp and moving the drilling units and support equipment from one drill site to the next within the area of the project. It shall also include the pre-mobilisation meeting. This schedule shall be subject to the approval of the Project Manager.

Prior to mobilization to the site, the Contractor's representatives shall, in the company of the Project Manager or Supervisor, visit the beneficiary communities to take over the sites and to agree the start-up date of the project.

3. Mobilization

3.1 Base camp

Mobilization shall start with the Contractor establishing a base camp for housing of the Contractor's staff and the Employer's supervising staff, storage and maintenance of plant machinery, supplies and all other equipment required to launch and execute the project. The Contractor shall make his/her own arrangement to acquire or lease the land as necessary for the establishment of the Base Camp and safety for all, the staff and the community. However, the location shall be subject to the approval of the Supervisor.

The Contractor shall submit a plan and layout for the approval of the Supervisor of the proposed base camp with provisions for the following:

- office and residential accommodation and catering facilities for the Contractor's staff and the project staff that shall be deployed for supervision of the project
- sufficient storage for the Contractor's equipment and supplies including handpumps and submersible pumps
  - fuel storage tanks
  - equipment repairs facilities
  - covered storage for PVC casings and screens

3.2 Inspection of materials and equipment

The Contractor shall present to the Supervisor the list of equipment and samples of materials to be used on the project. The Contractor is not allowed to start the work until the Supervisor has checked and approved the equipment and materials.

3.3 Contractor's Staff

The Contractor shall appoint a Project Manager who shall be a hydrogeologist or drilling engineer with at least 10 years of postgraduate experience who shall be responsible for site operations. At each drill site, the Contractor shall also provide a competent hydrogeologist or drilling engineer and other suitable staff to perform the work. Adequate safety equipment such as safety helmets, hard-toed boots and gloves shall be available for the use of the drilling crew while on site.

The Contractor shall be fully operational with the drilling unit and installation crew working within two weeks of commencing borehole construction.

3.4 Contractor's equipment

The Contractor shall provide all plant and equipment, including drilling plant, tools, materials and everything else necessary for the proper completion of the drill holes and collection of the samples. All of the contractor's drilling equipment shall have the capacity to construct 110 mm and 150 mm diameter lined boreholes, including gravel packs to depths of up to 200 m.

The Contractor shall arrange for transportation and security of all equipment and staff as necessary for proper completion of the contract.

3.5 Payment for moving between drill sites

As outlined in the Bill of Quantities, the Contractor shall be paid for preparing all equipment, vehicles, supplies and plant associated with a drilling unit, for a move to the next drill site and for setting up at the next drill site. However, there shall be no payment for moves within each community from one borehole site to the next one. Movement between sites shall be subject to the approval of the supervisor.

3.6 Site instruction

The Supervisor shall from time to time issue instructions to the Contractor through the driller or the Contractor's site repre-

sentative. The instruction shall be in writing and shall be signed as received by the Contractor's representative, who shall, without any delay, carry out the instruction issued.

4. Borehole siting

The Contractor shall be responsible for carrying out geophysical surveys on the sites located on the basement complex areas and some sedimentary areas as directed by the Supervisor. The Contractor shall thus have competent staff, equipment and software for carrying out the surveys and interpreting the data. The siting of the boreholes shall be carried out in the following stages:

- Desk study involving the review of existing data and information on the geology and hydrogeology of the locations, interpretation of remote sense data collated from aerial photographs, satellite imagery, topographical and geological maps
- Hydrogeological reconnaissance involving determination of the rock types underlying the locations, their structural disposition, the weathering products and water-bearing potential; identification of areas suitable for geophysical survey. Care shall be taken to ensure that such areas are away from potential sources of pollution and other existing groundwater sources.

The electromagnetic (EM) conductivity meter will be used, followed by vertical electrical depth soundings (VES). The Contractor's staff, the Supervisor and the community representatives shall jointly carry out a reconnaissance survey of the community and identify potential areas and preferred locations for the borehole in each community. The Contractor will then proceed to carry out geophysical measurements in the areas identified. At least two perpendicular EM traverses will be carried out across the settlement and across observed lineaments. Locations for conducting vertical electrical soundings shall depend on anomalies detected or readings obtained on the EM traverses. All data will be analysed by appropriate software. The Contractor will be required to locate at least three probable sites in each community and number them in order of priority. All measurements and interpretations are subject to the approval of the Supervisor.

Payment for the geophysical survey shall be based on the unit rate in the bill of quantities (BoQ).

5. Drilling

The Contractor shall ensure that the rig is set up at the exact point indicated by the Supervisor. he/she shall also take all precautions to ensure the safety of all staff, community members and equipment deployed to the project.

The Contractor shall be responsible for selecting the appropriate drilling procedure for the geology of each of the project locations. The diameter of the drill hole must be adequate to accommodate the final borehole casing diameter as instructed by the Supervisor plus a minimum annular space of 50 mm. The Contractor may choose to either drill a hole of adequate diameter on the first pass or to drill a small diameter test hole, then ream to the desired size. Regardless of the procedure adopted by the Contractor, payment shall only be for the drilled hole at the appropriate size, i.e. additional payment for reaming shall not be allowed.

5.1 Penetration rate

The Contractor shall equip each rig with a time depth recorder which gives a continuous record of the penetration rate. The Contractor shall maintain the time depth recorders in operating condition at all times. The Contractor shall note on the record, the type and size of bit used in each interval, the weight on the bit and the depth at which drill stem is added.

5.2 Drill site access

The Contractor shall be responsible for improving access where necessary to enable his/her equipment to reach each drill site. The Contractor shall not be compensated for time lost while access improvements are being made or for any access improvements required while his/her equipment is bogged down.

5.3 Drilling technique

The drilling method, drilling plant, drilling fluids and fluid additives are subject to approval of the Supervisor or as stated in the tender documents or national standards. The Contractor may use any drilling technique he/she considers suitable to achieve the depth and diameter required, provided that the techniques used are those specified in his/her tender or are approved by the Supervisor.

It is the responsibility of the Contractor to start drilling at a diameter which will allow the hole to be completed at the specified diameter. Extra casing of a larger diameter to achieve the depth is considered to be part of the Contractor's equipment and shall not be reimbursed for its use.

Temporary steel casing shall be installed in every borehole where needed to protect the walls from caving, either suspended by a ground bearing bracket or correctly anchored in the underlying hard rock.

5.4 Drilling fluids and additives

The drilling fluids and additives shall consist of water, biodegradable drilling mud, weight materials (barite or equivalent), fluid loss control materials, and foam. The selection, supply and use of drilling additives shall be the responsibility of the Contractor. Where there are national standards guiding the use of drilling materials, this should be followed. Toxic or dangerous substances that may adversely affect the quality of the water shall not be added to the drilling fluid.

The Contractor shall be responsible for maintaining the quality of the drilling fluid to assure the protection of the aquifer and other potential water bearing formations and ensure that good representative samples of the formation material are obtained.

5.5 Collection of drill cuttings

The Contractor shall collect representative samples of the formation penetrated at 2.0 m intervals. Samples shall be caught in a bucket placed in the drilling fluid return at the top of the surface casing and the sample allowed to settle out.

The penetration of the bit shall stop when the bottom of the sampling interval (that is every 2.0 m) is reached for such time as is required for all the cuttings to move from the last drilled section of the hole to the sampling point. Drill cuttings shall be placed in containers provided by the Contractor as approved by the Supervisor. Sample containers shall be steel boxes, divided into compartments approximately 100 mm by 100 mm square and 100 mm deep. At each drill site, the Contractor shall have sufficient sample containers to accommodate all of the samples

collected in a hole, and they shall be kept available for inspection until the Supervisor agrees they can be disposed of.

5.6 Driller's daily report

During the drilling, completion and development of each borehole, the Contractor shall maintain a detailed driller's report. The report shall give a complete description of all formations encountered, number of metres drilled, number of hours spent drilling, shutdown due to breakdown, length and type of casing and screen set, and such other pertinent data as requested by the Supervisor. The Contractor shall provide to the Supervisor a copy of the daily driller's report duly signed by both the driller and the Supervisor.

In addition, the Contractor shall measure and monitor during the drilling:

- the depth of the borehole as it progresses
- the static water or mud level in the borehole
- the different depths of water strikes and aquifers
- the penetration rates at various strata or change of tools

The data shall be presented in a format previously approved by the Supervisor and provided as they become available. A sample format is provided in *RWSN Code of Practice for Cost Effective Boreholes* – Annex E (Danert et al, 2010).

5.7 Payment for drilling

The Contractor shall be paid unit prices per metre in accordance with the depth drilled as set out in the Bill of Quantities. The unit prices per meter shall include all costs associated with the drilling, drilling water, drilling additives, surface casing, collection of drill cuttings, gravel packing and development, and preparation of daily drilling reports. The Contractor shall be paid in accordance with the actual depth drilled on the rates set out in the Bill of Quantities. The depths given in the Bill of Quantities are indicative only.

6. Borehole

The final depth of the borehole and all other relevant depths involved in the design of the borehole shall be determined from measurements made by the Contractor and the Supervisor. The Supervisor shall instruct the Contractor on the depth at which to terminate the hole, the intervals to be cased and screened, the appropriate screen slot opening, and the formation stabilizer or gravel pack size if required, to ensure completion of a sand-free borehole. Two main designs based on the geology are envisaged.

Borehole Design No. 1 - Basement Complex boreholes

This design will consist of PVC casing and screen. The casing and screen shall have an inside diameter of 103.4 mm and an outside diameter of 110 mm and a wall thickness of 3.3 mm. The casings and screens shall be joined by threaded joints. The bottom of the casing columns shall be closed with a bail plug.

Borehole Design No. 2 - Sedimentary formations

The borehole shall be lined with threaded steel casing and continuous wire wound stainless steel screen. The casing shall be nominal 150 mm diameter. The screen shall be 150 mm diameter connected to the casing. The slot size of the screens shall be determined after a sieve analysis of the aquifer sand. The bottom of the screen shall be fitted with a minimum length of 3 m of 150mm diameter steel casing. The screen will be joined to the casing by an adaptor and the assembly lowered into the drilled hole. The entire casing and screen assembly shall be installed straight and vertical in the borehole. A maximum deviation of 0.5% will be allowed.

All permanent borehole casings, screens and fittings shall be new. Payment shall be on a per metre basis for the supply and installation of casing and screen in accordance with the Bill of Quantities.

6.1 Gravel packing

The boreholes shall be developed by natural gravel packing, i.e. allowing the formation material to collapse against the screen, and the fines removed until a filter is formed around the screen. However in fine grained unconsolidated formations where an appropriate screen slot size cannot be found, a filter pack shall be used. The grain size of the filter pack material shall be selected in relation to that of the formation material to ensure that it is coarser and more permeable than the formation sand (nominally 2 mm to 4 mm grain size unless otherwise specified by the Supervisor).

The pack should consist of coarse sand or well-graded river gravel. Under no condition should rock chippings be used. The material should be free from shale, mica, clay, dirt or organic impurities of any kind.

The filter pack should have a minimum thickness of 50 mm and shall cover the entire screen length and rise to a minimum of 6 m above the top of the screen. The filter pack should be carefully introduced into the hole by means of a tremie pipe to avoid bridging.

In crystalline and consolidated formation where the formation is not likely to collapse against the screen, a gravel pack shall be installed in the annulus space around the screen. The gravel pack shall have the same characteristics as the filter pack and shall be installed in the same manner.

In crystalline and consolidated formations where the formation is considered stable and not in need of support, the Contractor, with the approval of the Supervisor may elect to case only the upper part of the borehole, leaving the lower part (aquifer horizon) of the borehole uncased and without gravel packing.

7. Borehole development and site completion

7.1 Development

The Contractor shall develop the borehole by a combination of jetting with water and surging with air, simultaneously rotating the jetting tool and slowly raising and lowering it through the length of all screens. The development shall continue until the borehole is judged by the Supervisor to be free of sand.

The Contractor shall develop the boreholes with great care to avoid any damage to the casings, the screens or the formation resulting from application of excessive pressures or inappropriate techniques during the development.

The Contractor shall be paid the unit price for borehole development as in the Bill of Quantities.

7.2 Backfilling and grouting

The Contractor shall place an impervious clay plug at least 1 m thick directly on top of the gravel or filter pack. The exact level shall be indicated by the supervisor. The annular space on top

of the clay plug shall be backfilled with the drill cuttings up to 6 m below ground level. Surface soil shall not be used for backfilling. The backfill may be placed by pouring the material down from the surface, taking due caution to prevent bridging.

The last 6 m of annular space shall be filled with neat cement grout consisting of Portland cement mixed with not more than 25 l of water per 50 kg of cement.

The Contractor shall be paid the unit price for backfilling and placing the grout seal as in the Bill of Quantities.

7.3 Abandonment of unsuccessful borehole

After the development process, the borehole may be abandoned for reasons not resulting from any action or omission of the Contractor. This may occur because of inadequate yield, unsuitable water quality or excessive depth of the water level. Under these circumstances, the Contractor may attempt to retrieve the casing and screen from the abandoned borehole, but shall do so at his/her own expense.

7.4 Pump testing

The Contractor shall conduct a pumping test on every successful borehole. On the boreholes that are to be fitted with **handpumps**, the test shall be at a constant yield and continuous pumping of 1 m^3/h for a period of 4 hours.

On those boreholes that are to be fitted with **motorised pumps** the pumping test shall be in two stages: a **step drawdown test** followed by a **constant yield** test consistent with the capacity of the borehole. The Contractor shall have available a submersible pump and ancillary equipment capable of a discharge of 5 m^3/h against an anticipated head of 100 m. The step test discharges shall be at 1/3, 2/3, 1 and 4/3 of the yield except otherwise indicated by the Supervisor.

Where there is a possibility of the discharge water circulating back into the aquifer, the Contractor shall provide a minimum of 60 m of flexible hose to carry the water away.

7.4.1 Recovery

Immediately after the constant rate test has been completed, the Contractor shall measure the water-level recovery in the borehole over a minimum period of 1 hour and 8 hours for the handpump fitted boreholes and motorised boreholes respectively, unless the water level has recovered to the original level by that time.

7.4.2 Measuring drawdown and recovery of water level

During the pumping and recovery periods, the Contractor shall measure the water level in the borehole using a **calibrated electronic sensing device**. The water level measurements are to be taken in accordance with the schedule indicated by the Supervisor. The Contractor shall analyse the results of the pumping test for the specific capacity of the borehole and report the results on forms supplied by the Supervisor.

The Contractor shall be paid a lump sum price per borehole for each 6-hour pumping test and 24-hour pumping test in accordance with the Bill of Quantities.

7.5 Water quality analysis

During the pumping test, the Contractor shall collect water samples, securely corked and suitably labelled, from the borehole as indicated by the approved laboratory. The samples shall be collected from the pump flow direct into the container, without being allowed to settle first. Each label shall indicate the name of contractor, borehole number, date and time of sampling. The information shall be entered into a form to be provided by the supervisor

The Contractor shall have test carried out in a laboratory approved by the Supervisor to determine the following parameters:

Colour	Total hardness
Odour	Silica
Electric Conductivity	Chloride
pH	Fluoride
Taste	Nitrate
Turbidity	Sulphate
Temperature	Dissolved gases (CO_2, H_2S, O_2)
Arsenic	
Manganese	

Biological parameters shall comprise faecal coli form counts.

The samples thus collected should reach the authorized water testing laboratory **within 6 hours** from the time of collection from the borehole. Otherwise fresh samples shall be taken.

The contractor shall be paid for each set of samples tested as in the Bill of Quantities.

7.6 Borehole disinfection

Immediately after the pumping test has been completed, the Contractor shall undertake final disinfection of the borehole by introducing sufficient chlorine compound into the borehole to achieve a concentration of 20 mg/l of free chlorine in the water i.e. 0.2% chlorine is used for every 100 litres of water in the borehole column.

The chlorine shall be applied uniformly throughout the entire depth of water in the borehole. The chlorine solution shall be introduced into the borehole through a tremie pipe extending to the bottom of the borehole and the pipe raised and lowered to achieve uniform distribution of the solution. All accessible portions of the borehole above the water level shall also be wetted with a chlorine solution.

The cost of borehole disinfection shall be included in the Contractor's unit price for borehole development.

7.7 Criteria for successful boreholes

Boreholes meeting the following criteria shall be accepted as successful and those not meeting them declared abortive and abandoned. The Contractor may be requested to re-drill abortive boreholes if the reasons for being abortive are due to actions or inactions of the Contractor.

7.7.1 Borehole minimum yield

Unless otherwise agreed by the Supervisor, the minimum acceptable yield on the project from a borehole to be fitted with a handpump shall be **1 m^3/hour** sustained over the 6-hour pumping test period, and for a motorised borehole **4 m^3/hour** sustained over the 24-hour pumping test period.

Providing the Contractor has followed the appropriate procedures in the geophysical survey and the completion of the borehole, and having been so certified by the Supervisor, the Contractor shall not be held responsible for the abandonment of a borehole because of inadequate yield. However, if failure to obtain an adequate yield is caused by actions or inactions on the part of the Contractor, he/she will be responsible for recon-

structing the borehole in the proper manner at his/her own cost.

Where possible, the Contractor shall endeavour to maximize the yield from the boreholes. Failure to properly exploit the aquifer potential through, for example, insufficient development or inadequate aquifer penetration and screening even when the yield of the completed borehole exceeds the minimum may be cause for rejecting the borehole and requiring the Contractor to reconstruct the borehole at his/her own cost.

7.7.2 Sand content

The sand content of the water shall not be more than 10 ppm by volume. The Contractor shall be responsible for ensuring that the borehole meets the criteria for sand content. If a borehole must be abandoned because of excessive sand content, the Contractor shall be responsible for constructing another borehole at his/her own cost.

7.7.3 Turbidity

The Contractor shall measure the turbidity of the water for each borehole. The turbidity of the water shall not exceed 25 NTU. In some circumstances, excessive turbidity may be due to the characteristics of the water-bearing formation and thus beyond the control of the Contractor. Where excessive turbidity is caused by actions or inactions by the Contractor, he/she will be responsible for reconstructing the borehole in the proper manner at his/her own cost.

7.7.4 Alignment and plumbness

The Contractor shall continuously monitor the weight on the drilling bit to ensure that the boreholes are drilled and cased straight and vertical. The Contractor shall furnish all labour, tools and equipment to carry out a test for verticality as may be instructed by the Supervisor. Payment shall be on the unit rate as in the Bill of Quantities.

7.7.5 Chemical and bacteriological water quality

The Supervisor shall determine whether or not the chemical and bacteriological quality of the water is adequate to serve as a potable water supply. The Contractor shall take due caution to prevent contamination of the borehole. If the borehole has become contaminated because of an action or inaction on the part of the Contractor, the Contractor shall bear the responsibility for disinfection of the borehole and, if necessary, the construction of a new borehole at his/her own cost.

7.8 Temporary capping

Prior to leaving a borehole unattended at any time, the Contractor shall place a temporary cap on the borehole casing which shall consist of a purpose-made pipe screwed or welded to the top of the casing.

7.9 Construction of concrete pad

The Contractor shall construct a concrete pad around the borehole casing sticking above the ground and continuous with the underlying 6 m cement grout in the borehole annulus described in 6.3. The pad shall be 1 m by 1 m. The concrete shall be cast over a layer of compacted hard core with a minimum thickness 200 mm above the ground and continuous with the underlying cement grout. The drainage channel shall be 6 m long, sloping away from the pad. The Contractor shall ensure that the sides of the pad are straight by properly anchoring the forms. Straightness shall be determined by running a stringline from one corner to the next and measuring the deviation of the pad from the line. Deviations greater than 12.5 mm shall not be acceptable. The top of the pad shall be trowelled to a smooth surface. Edges shall be used to ensure smooth, rounded edges to the pad.

7.9.1 Concrete mix

The concrete used for the pad shall be prepared by mechanical mixers capable of pouring a pad in a single batch using normal Portland cement with a mixture of coarse and fine aggregate.

Water used for mixing concrete and for curing shall be obtained from a borehole source and shall be equal to potable water in physical and chemical properties.

The fine aggregate shall consist of sand having clean, hard, strong, durable, uncoated grains free from dust, soft or flaky particles of shale, alkali, organic matter, loam, or other deleterious substances. Fine aggregate shall be well-graded and have grain sizes within the range of 0.15 mm to 9.5 mm.

The coarse aggregate shall consist of crushed rock or other approved materials of similar characteristics having clean, hard, strong, durable, uncoated particles free from soft, friable, thin, elongated or laminated pieces, alkali, organic or other deleterious matter. Coarse aggregate shall be well graded and shall consist of grain sizes in the range 2.4 mm to 40.0 mm.

Because high temperatures prevail in the Contract area, the Contractor shall keep the surface of the concrete pad moist for a period of 72 hours after the concrete has been placed or use a curing compound approved by the Supervisor.

Payment for each pad shall be as provided for in the Bill of Quantities.

8. Demobilization, handing over & defects liability

8.1 Handing over

On completion of the works at each site, the Contractor shall remove all his/her equipment and materials from the site, cover all settlement pits, seal all abandoned boreholes and as much as possible restore the site to what it was like originally before construction started. An inspection of the works shall be carried out by the Supervisor and the community representative in the presence of the Contractor's representative. On being satisfied that the works carried out are in accordance with the contract agreement and technical specification, a completion certificate shall be issued and signed by the Supervisor and community representative, and the site handed over to the community.

8.2 Defects liability

The defects liability period shall be 6 months from the date of handing over. During this period any defects on the functioning of the works shall be put right by the Contractor at his/her own expense. 10% of the total contract sum shall be retained by the Client until the defects liability period is over, after which the Contractor shall be paid the amount retained. If, however, the Contractor fails to put right any defects on the works as instructed by the Supervisor, he/she shall forfeit the amount retained.

9. Bill of Quantities

All the quantities in this Bill of Quantities are provisional. The contractor shall be paid for actual quantities used.

Item	Description	Unit	Quantity	Rate	Amount
1	**Mobilisation**				
1a	Mobilisation and demobilisation of men, equipment and material				
	for the entire borehole works	No	1		
1b	Movement between drill sites	No	99		
2	**Borehole siting**				
2a	Carry out geophysical survey on the basement complex	No	80		
2b	Carry out hydrogeological survey of the sediments	No	20		
3	**Borehole Drilling**				
3a	Drilling overburden on the basement complex for the				
	installation of 110 mm dia. PVC casing (provisional)	m	1600		
3b	Drilling in crystalline rock for installation of 110 mm dia. PVC screen	m	1600		
3c	Drilling in sedimentary rocks for installation of 150 mm dia. casing & screen	m	2400		
4	**Borehole Completion**				
4a	Supply and install 103.4 mm ID and 110 mm OD threaded PVC casing	m	2240		
4b	Supply and install 103.4 mm ID and 110 mm OD threaded PVC screen	m	960		
4c	Supply and install 150 mm dia. steel casing	m	2160		
4d	Supply and install 150 mm dia. stainless steel screen	m	240		
4e	Supply and install gravel pack as specified for the basement complex	no	80		
4f	Supply and install gravel pack as specified for the sediments	no	20		
4h	Backfill the borehole annulus	no	100		
4j	Supply cement, mix and place grout as specified	no	100		
4k	Develop borehole by jetting, surging and airlifting	no	100		
5	**Pumping Test**				
5a	Carry out pumping test as specified on the basement complex	no	80		
5b	Carry out pumping test as specified on the sediments	no	20		
6	**Backfill abortive borehole**				
6a	Backfill and seal abortive boreholes as specified by the Supervisor	no	5		
7	**Water quality test**				
7a	Collect water samples and carry out water quality				
	analysis as specified	no	100		
8	**Construction of concrete pad**				
8a	Construct concrete pad around well-head casing as specified	no	100		
9	**Disinfect borehole**				
9a	Disinfect borehole as specified	no	100		
10	**Borehole cap**				
10	Supply and install borehole cap as specified	no	100		
11	**Subtotal carried to summary**				

References and Bibliography

ADEKILE, D. (2012) *Supervising Water Well Drilling. A guide for Supervisors*, Rural Water Supply Network (RWSN), St Gallen, Switzerland.

AfDB (2000) *Guidelines for Procurement Under Community Based Investment Projects,* Procurement Monitoring Unit, September 2000, African Development Bank, Tunis, Tunisia.

ANSCOMBE, J.R. (2012) Final Report Consultancy Services for Assessing the Sustainability of WASH Services in Masaiti, Mpongwe, Lufwanyama , Petauke, Katete, Nyimba, Choma, Kazungula and Mazabuka Districts. Contract reference: 43121679.

ANSCOMBE, J.R. (2011) Final Report Consultancy Services: Quality Assurance of UNICEF Drilling Programmes for Boreholes in Malawi. For the Ministry of Agriculture, Irrigation and Water Development. Agreement Number: SA/MLWB/2011/00001996-0.

ARMSTRONG, T. (2009) *Code of Practice for Cost-Effective Boreholes: Zambia Country Status Report 2009.* Final Report 1st November 2009, Rural Water Supply Network (RWSN), St Gallen, Switzerland.

CARTER, R., CHILTON, J., DANERT, K. & OLSCHEWSKI, A. (2010) *Siting of Drilled Water Wells - A Guide for Project Managers.* RWSN Field Note 2010-5, Rural Water Supply Network (RWSN), St Gallen, Switzerland.

CARTER, RC (2012) *Rural Water Supply Network Newsletter – October 2012*, Rural Water Supply Network (RWSN), St Gallen, Switzerland

DANERT, K., ARMSTRONG, T., ADEKILE, D., DUFFAU, B., OUEDRAOGO, I. & KWEI, C. (2010) *Code of Practice for Cost Effective Boreholes.* British English Version, June 2010, Rural Water Supply Network (RWSN), St Gallen, Switzerland.

DANERT K. and FUREY S (2012) *Groundwater Matters: Drinking Water for Rural People*, Three week E-discussion from 10th to 28th September 2012 on http://next.dgroups.org/rwsn/groundwater, Rural Water Supply Network (RWSN), St Gallen, Switzerland.

DANERT, K., LUUTU, A., CARTER, RC., OLSCHEWSKI, A (2010) *Costing and Pricing - A Guide for Water Well Drilling Enterprises.* RWSN Field Note 2010-6, Rural Water Supply Network (RWSN), St Gallen, Switzerland.

FEDERAL GOVERNMENT OF NIGERIA (2007). *Public Procurement Act 2007 for Goods, Works and Services in the Public Sector*, Official Gazette No. 109, Vol. 94, Federal Government of Nigiera. Available on http://www.bpp.gov.ng

GOVERNMENT OF GHANA (2003). *Public Procurement Act 2003.* Available on http://www.ppbghana.org

GOVERNMENT OF UGANDA (2003) *The Public Procurement and Disposal of Public Assets Act,* 2003. Available on http://www.ppda.go.ug

JMP (2012) *Progress on Drinking Water and Sanitation: 2012 Update,* UNICEF/World Health Organisation, Available on http://www.wssinfo.org

ODHIAMBO, W. & KAMU, P. (2003). *Public Procurement: lessons from Kenya, Tanzania and Uganda* OECD Development Centre Working paper 208.

RWSN (2009) *The Myths of the Rural Water Supply Sector,* Rural Water Supply Network (RWSN), St Gallen, Switzerland.

WORLD BANK (2011a) *Guidelines Procurement of Goods, Works and Non Consulting Services, Under IBRD Loans and IDA Credits & Grants By World Bank Borrowers* The International Bank for Reconstruction and Development, The World Bank, Washington, USA.

WORLD BANK (2011b) *Guidelines Selection and Employment of Consultants, Under IBRD Loans and IDA Credits & Grants By World Bank Borrowers* The International Bank for Reconstruction and Development, The World Bank, Washington, USA.

All RWSN publications are available on http://www.rural-water-supply.net

About the Author

Dotun Adekile is a Nigerian consultant with over 30 years of experience in siting and supervising borehole construction, as well as training field geologists and technicians. He has contributed to developing the Code of Practice for Cost Effective Boreholes in three countries as well as the preparation of several guidance notes.

Contact

The Rural Water supply Network (RWSN) is a global knowledge network for promoting sound practices in rural water supply.

RWSN Secretariat
SKAT Foundation
Vadianstrasse 42
CH-9000 St.Gallen
Switzerland

Phone: +41 71 228 54 54
Fax: +41 71 228 54 55
Email: ruralwater@skat.ch
Web: www.rural-water-supply.net

Support and Acknowledgement

The author gratefully acknowledges the helpful comments from Funmi Ademoye, Robin Hazell, Andre Olschewski, Sean Furey, Jim Anscombe and Kerstin Danert in the review and production of the field note.

This document was supported by UNICEF, Skat Foundation and the Swiss Agency for Development and Cooperation.

Layout was undertaken by Martin Laeng.

Photo Credits: The author, Richard Carter, Hazel Jones, WEDC and Jim Anscombe.

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

unicef

skat_foundation

ISBN: 978-3-908156-44-4