

**WATER RESOURCES DIVISION (WRD)
MINISTRY OF WATER (MoW)**

**GROUNDWATER DEVELOPMENT AND MANAGEMENT
CAPACITY DEVELOPMENT PROJECT
IN THE UNITED REPUBLIC OF TANZANIA**

FINAL REPORT

March 2016

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

EARTH SYSTEM SCIENCE CO., LTD.

GE
JR
16-061

Contents

CHAPTER 1 INTRODUCTION.....	1
1.1 Background of the Project.....	1
1.2 Purpose of the Project	2
1.3 Project Area.....	2
1.4 Persons Concerned with the Project.....	3
1.4.1 Project Director and Manager	3
1.4.2 Project Members (Counter Part).....	3
1.4.3 Japanese Expert.....	4
1.5 Project Design Matrix (PDM).....	4
CHAPTER 2 PROJECT CONTENTS AND BACKGROUND OF TERMINATION OF THE PROJECT	9
2.1 Work Flow of the Project	9
2.2 Summary of Activities.....	9
2.3 Project Input.....	12
2.3.1 Subcontract, Procurement and Dispatch of Experts	12
2.3.2 Assignment Schedule	12
2.4 Activities Related to Planning and Management of the Project.....	13
2.4.1 Formulation of Work Plan and Counterparts Meetings.....	13
2.4.2 Joint Coordinating Committee (JCC) Meetings	14
2.4.3 Procurement of Equipment.....	14
2.4.4 Result of Sub-Contracting of Local Consultants.....	14
2.5 CIRCUMSTANCES OF TERMINATION OF THE PROJECT.....	15
CHAPTER 3 ACTIVITIES TAKEN AND OUTPUTS OF THE PROJECT.....	16
3.1 Output 1: Enhancement of DDCA's Ability to Impart Techniques and Skills regarding Water Well Drilling to Private Drilling Sector	16
3.1.1 Baseline Survey related to Entire Groundwater Development Sector and to Private Drilling Companies	17
3.1.2 DDCA's capacity development support plan and technical instruction system for private drilling companies.....	46
3.2 Output 2: Enhancement of DDCA's Capacity in Groundwater Development Required to Provide Technical Instructions	64
3.2.1 Baseline Survey related to Organization and Institution of DDCA, Educational System related on Drilling Technique, and Drilling Work Process in DDCA	65
3.2.2 Formulation of Technical Support Plan for Drillers in DDCA and Provision of Technical Instruction and Support.....	83
3.2.3 Well Information Database.....	97

3.3	Output 3: Establishment of Equipment Hiring System	101
3.3.1	Needs Assessment of Private Sector on Hiring of Drilling Equipment and Machinery and Baseline Survey on Maintenance System of Drilling Equipment	103
3.3.2	Establishment of the Operation System of the Equipment Hiring Service	104
CHAPTER 4	RESULTS, RECOMMENDATION AND LESSONS	120
4.1	Results of the Project.....	120
4.2	Present situation and the evaluation of project activities	121
4.3	Recommendation related to project outputs	123
4.4	Lessons learnt from the project implementation	124

Tables

Table 1	Project Design Matrix 1(PDM ₁).....	5
Table 2	Plan of Operation.....	7
Table 3	Contents and Results of the Activities of the Project	9
Table 4	Result of Sub-Contracting Work	15
Table 5	Baseline Survey and its Purposes (Output 1)	17
Table 6	Method of Procurement for WSDP works.....	19
Table 7	Composition of SBD for Medium and Large Works	20
Table 8	Procurement Stage and Progress of Contract under RWSS Component	25
Table 9	Actual Contract of Well Drilling Works under the RWSS Component of WSDP (Phase I).....	26
Table 10	Distribution of Target Companies by Status of the Survey and Business Operation in Drilling Works	28
Table 11	Number of Contracts Awarded in the Past 3 Years per Company.....	32
Table 12	Categorization of Well Specifications	34
Table 13	Average Days Required for Drilling Works.....	34
Table 14	Distribution of Companies by Type of Working Experience.....	35
Table 15	Contract Value and Number of Wells Drilled per Contract	36
Table 16	Hiring Cost of Drilling Equipment.....	38
Table 17	Contents of DDCA's Capacity Development Support Plan and Technical Instruction System for Private Drilling Companies.....	46
Table 18	Classification of Private Drilling Companies	47
Table 19	DDCA's Hiring Equipment and Disposition of Drilling Sites	48
Table 20	Numbers of Support Equipment of Companies Belonging to Group A and B	49
Table 21	Average Numbers of Investigation Equipment of Companies Belonging to Group A and B.....	49

Table 22	Expected Contents of Hydrogeological Information to be provided from DDCA ..50
Table 23	Numbers of Drilling Staff by One Rig of the Private Companies51
Table 24	Demand of Private Drilling Companies for Enhancement of Technological Capabilities52
Table 25	Classified Groups of Private Drilling Companies and Project Effect Potential level55
Table 26	Composition of Teaching Guidance58
Table 27	Internal Certification System of Technical Instructors61
Table 28	On-site Checklist of Drilling Technical Level (Draft).....62
Table 29	Technical Instruction Review62
Table 30	Baseline survey and its Purposes (Output 2)65
Table 31	Number of Staffs by Duty in Drilling Project Department DDCA68
Table 32	Qualification of NTA, Certificate Award and Competence Level71
Table 33	Number of Staffs by Qualification72
Table 34	Contents of Short Courses Provided by WDMI74
Table 35	Modules on Hydrogeology and Water Well Drilling for Technician and Diploma .74
Table 36	Modules on Short Courses related to Drilling75
Table 37	Visited Drilling and Pumping Test Sites.....76
Table 38	Operational Drilling Rigs of DDCA.....77
Table 39	Annual Number of Borehole by Type of Rig in 2011/201278
Table 40	Number of Boreholes Drilled by Area in 2011/2012.....78
Table 41	Average Drilling Depth by Area in 2011/201279
Table 42	Maximum Yield by Diameter of Casing Screen Pipe79
Table 43	Number of Wells Drilled in 2011/2012 and Average Depth by Casing Diameter ...80
Table 44	Diameter of Casing and Screen Pipes and Drilling Diameter by Drilling Method .80
Table 45	Formulation of Technical Support Plan for Drillers in DDCA and Contents of Activities for Technical Instruction and Support.....83
Table 46	Classification of Drillers.....84
Table 47	Contents of the Competence Test84
Table 48	Accuracy Rate by Area and Item.....85
Table 49	Distribution of Number of Senior Drillers by Accuracy Rate86
Table 50	Test Result by Technical Area87
Table 51	Technical Enhancement Measures for each Technical Area.....91
Table 52	Data Item of Database97
Table 53	Number of Business Entities in Water Well Drilling Sector in Tanzania103
Table 54	Baseline Survey on Maintenance System of Drilling Equipment104
Table 55	Activity of Establishment of the Operation System of the Equipment Hiring Service104

Table 56	List of Equipment to be Hired	108
Table 57	Roles of DDCA Staff to be Attached to the Hired Equipment	110
Table 58	Management Indicator	112
Table 59	Contents of the Guideline on Hiring of Drilling Equipment	116
Table 60	Contents of the Manual on Hiring of Drilling Equipment.....	117
Table 61	Contents of Documents for Maintenance System.....	118
Table 62	Progress of project purpose and outputs.....	121

Figures

Figure 1	Project Area.....	3
Figure 2	Flow Chart of the Project.....	11
Figure 3	Guidelines, Plans and Manuals of the Project.....	12
Figure 4	Assignment Schedule until interruption of the Project	13
Figure 5	Result of Activities for Output 1	16
Figure 6	Trend of Number of LGAs already engaged by fiscal year	25
Figure 7	Geographical Distribution of Office and Project Location	29
Figure 8	Year of Establishment and Start of Business Operation in Drilling Works.....	30
Figure 9	Distributions of Companies Awarded Contracts for Drilling Works in RWSSP/WSDP by Year of Experience of the Organization	30
Figure 10	Distribution of Companies by Status of Registration at CRB and MoW	30
Figure 11	Clients for Water Well Drilling (multiple answers)	31
Figure 12	Proportion of Drilling Works Awarded by the Government in Number of Contracts and Contract Values	31
Figure 13	Total Number of Contracts Awarded to and Wells Drilled by the Surveyed Companies in the Past 3 Years	32
Figure 14	Distribution of Companies by Number of Contracts Awarded for Drilling of Deep Wells per Annum.....	33
Figure 15	Distribution of Companies by Number of Wells Drilled per Annum.....	33
Figure 16	Distribution of Wells Drilled per Annum by All the Surveyed Companies	34
Figure 17	Distribution of Companies by Number of Rigs Owned.....	36
Figure 18	Distribution of Owned Rigs by Drilling Capacity	37
Figure 19	Distribution of Companies by Number of Owned Rigs in Each Type.....	37
Figure 20	Possession of Supporting and Survey Equipment.....	38
Figure 21	Workshop Equipment and Tools Owned (multiple options).....	39
Figure 22	Type and Level of Periodical Maintenance of Drilling Equipment the Company can Perform (multiple options)	39
Figure 23	Distribution of Companies by Size of Staff.....	40

Figure 24	Areas of Capacity Development Needs of Technical Staff (multiple options)	41
Figure 25	Capacity Development Measures (multiple options)	41
Figure 26	Needs of Procurement of New Drilling Equipment (multiple options)	42
Figure 27	Demand for DDCA's Hiring Service of Drilling Equipment	43
Figure 28	Demand for Hiring Supporting Equipment (multiple options)	43
Figure 29	Distribution of Companies by Demand for Different Types of Private Sector Support Services by DDCA	44
Figure 30	Type of Technical Staff Required for Technical Instruction (multiple options).....	44
Figure 31	Contents of Hydrogeological Information Required (multiple options).....	45
Figure 32	Structure of Training System of the Instructor.....	61
Figure 33	Progress of Activities for Output 2	64
Figure 34	DDCA Organizational Structure	67
Figure 35	General Education System in Tanzania.....	70
Figure 36	Annual Number Boreholes Drilled by DDCA in Past 10 Years (2002/03 to 2011/12)	77
Figure 37	Process of Drilling Works	81
Figure 38	Computer Network.....	100
Figure 39	Progress of Activities for Output 3	102
Figure 40	Roadmap for Establishment of the Equipment Hiring System	106
Figure 41	Status of Registration at CRB and MoW by Classification of the Surveyed Companies.....	108
Figure 42	Geographical Distribution of Private Drilling Companies and RWSS Coverage by Provinces.....	110
Figure 43	Business Cycle for the Hiring Business.....	114
Figure 44	Process Flow of Hiring Business	115
Figure 45	Guideline, Plan and Manuals prepared in the Project.....	120
Figure 46	Concept of Achievement of Project Purpose	120

ABBREVIATIONS

BICO	Bureau of Industrial Cooperation
BWO	Basin Water Office
CBET	Competency Based Education and Training
CEO	Chief Executive Officer
CD-PLAN	Capacity Development Plan
CRB	Contractors Registration Board
DAT	Drillers Association of Tanzania
DDCA	Drilling and Dam Construction Agency
DTH	Down-the hole-Hammer
FTC	Full Technician Certificate
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
LGA	Local Government Authority
MCDGC	Ministry of Community Development Gender and Child
MDGs	Millennium Development Goals
MKUKUTA	Mkakati wa Kukuza Uchumi na Kupunguza Umaskini Tanzania (National Strategy for Growth and Reduction of Poverty)
M/M	Minute of Meeting
MIS	Management Information System
MoFEA	Ministry of Finance and Economic Affairs
MEVoT	Ministry of Education and Vocational Training
MoW	Ministry of Water
NACTE	National Council for Technical Education
NGO'	Non-Governmental Organisations
NWSDS	National Water Sector Development Strategy
OJT	On the Job Training
OPRAS	Open Performance Review and Appraisal System
PDM	Project Design Matrix
PO	Plan of Operation
PO-PSM	Prime Minister's Office-Public Service Management
R/D	Record of Discussion
RWSS	Rural Water Supply and Sanitation
SWAp	Sector Wide Approach to Planning
TIC	Tanzania Investment Centre
VET	Vocational Education Training

VETA	Vocational Educational Training Authority
WB	World Bank
WBS	Work Breakdown Structure
WDMI	Water Development and Management Institute
WRD	Water Resources Division
WRMA	Water Resource Management Act
WSDP	Water Sector Development Programme

Appendices

Appendix 1

Assignment Schedule	A1-1
---------------------------	------

Appendix 2

Review of PDM ₁ and Revision to PDM ₂	A2-1
---	------

Appendix 3

Minutes of Meeting of the 1 st JCC (Joint Coordinating Committee) Meeting.....	A3-1
---	------

Appendix 4

Minutes of Meeting of the 2 nd JCC (Joint Coordinating Committee) Meeting.....	A4-1
---	------

Appendix 5

List of Equipment Procured in the Project	A5-1
---	------

Appendix 6

Report of Baseline Survey of Private Drilling Companies under DDCAP	A6-1
---	------

Appendix 7

Capacity Development Support Plan for Private Sector (draft) (cover and ToC).....	A7-1
---	------

Appendix 8

Teaching Guidance for Capacity Development Support Plan for Private Sector (draft) (cover and ToC)	A8-1
--	------

Appendix 9

Technical Support Plan for the Drillers in DDCA (cover and ToC).....	A9-1
--	------

Appendix 10

Technical Manual for Drilling Works for Technical Support Plan for the Drillers in DDCA (cover and ToC).....	A10-1
--	-------

Appendix 11

Technical Manual for Tool Fishing and Well Rehabilitation for Technical Support Plan for the Drillers in DDCA (cover and ToC)	A11-1
---	-------

Appendix 12

12-1 Well Database (MS-Excel datasheet excluding scanned data of well completion report is	
--	--

submitted by CD-ROM)

12-2 Well Database Report (cover and ToC)..... A12-1

Appendix 13

Guidelines on Hiring of Drilling Equipment and Machinery (cover and ToC)..... A13-1

Appendix 14

Manual on Hiring of Drilling Equipment and Machinery (cover and ToC) A14-1

Appendix 15

Maintenance Guideline (cover and ToC) A15-1

Appendix 16

Maintenance Plan (cover and ToC)..... A16-1

Appendix 17

17-1 Maintenance Manual for OWNER (DDCA) (cover and ToC)

17-2 Maintenance Manual for HIRER (Private Drilling Company) (cover and ToC)..... A17-1

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND OF THE PROJECT

The Government of the United Republic of Tanzania (hereinafter referred to as “the Government of Tanzania”), set the development of rural water supply as direct strategy for the poverty reduction, and made a political target by revised National Water Policy (2002), and National Strategy for Growth and Reduction of Poverty (2005 - 2010).

According to the Policy, the government target was for “every person should get water within 400 meters distance by 2025”. Furthermore, as a reform of the operation system of the water supply projects, the measures consisting 1) community-owned management of the scheme, 2) participation of private sector organizations for the operation and maintenance of the scheme, 3) integrate water supply into the strategy for national hygiene promotion, 4) strengthening decentralized planning, project implementation and management through local government were promoted. Under the policy, the Ministry of Water (MoW) had been trying the strengthening of the implementing system of water supply services.

Based on the Policy, the MoW had finalized preparation of the National Water Sector Development Strategy (NWSDS), for implementing National Water Policy and National Strategy for Growth and Reduction of Poverty (2003). Following preparation of the Strategy, the Ministry had launched a Water Sector Development Programme (WSDP) in February 2007, in order to realize these policy and strategy. The Programme was designed under Sector Wide Approach to Planning (SWAp) to address shortfalls in urban and rural water supply infrastructure, to improve water resource management primarily through upgrading the country’s nine Basin Water Offices (BWOs), and to strengthen the sector institutions and their capacities.

Under the Rural Water Supply and Sanitation (RWSS) component of WSDP, it was aimed that 79,754 water supplying facilities shall be constructed until 2025 for the 34.5 million people with unsupplied water. According to the plan, 91 percent of the planned facilities rely on the groundwater. For achieving the goal, 1,200 wells in average per year are required to be drilled. The main actor¹ of the RWSS works of the WSDP including the well drilling would be private sector. However, there were some gaps seen between demands and actual number of wells drilled since the capacity of the private sector was only 600 wells in average per year.

In 2006, MoW formulated the “Strategy for Strengthening Water Well Drilling Industry in Tanzania”² for the purpose of capacity development of private well drilling sector. Drilling and Dam Construction Agency (DDCA), sole national drilling agency, was mandated to launch the hiring equipment business and technical instruction to the private sector. Under such circumstance, the Government of Tanzania requested the Government of Japan to implement the technical cooperation project, in order to strengthen the capacities of DDCA for establishment of the hiring equipment system and technical instruction to the private sector.

In response to the request of the Government of Tanzania for the technical cooperation for the Groundwater Development and Management Capacity Development (DDCAP) Project, the Government of Japan decided to conduct the Project in accordance with the Minutes of Meeting and the Record of Discussion agreed upon between MoW, DDCA and Japan International Cooperation Agency (JICA).

The project commenced in March 2012, and scheduled to complete in March 2016. However, the interruption of the project was decided in 2nd JCC meeting held on 13th February 2013 due to the delay of the procurement of drilling equipment and machinery for hiring. Eventually, the main project activities were discontinued from the end of March 2013, while the activity of Well Information Database which was completed in July 2013.

¹ DDCA is not eligible to bid the WSDP works due to the World Bank rule.

² Ministry of Water, 2006

CHAPTER 1 INTRODUCTION

During the interruption, JICA Tanzania office and the Expert Team have requested DDCA to take any actions for resumption of the project. No clear indications have been given to the project, however. Subsequently, MoW requested to terminate the project by the official letter signed by the Permanent Secretary on 6th May 2013. They declared that support of the water well drilling industry by establishment of equipment hiring system would not be implemented for the time being because of the change of the policy.

This Final Report summarizes the activities and results for the commencement of the project up to the interruption of the project (March 2012 to July 2013).

1.2 PURPOSE OF THE PROJECT

The purpose of the project was to enhance the DDCA's capacity to support the private water well drilling sector by strengthening of DDCA's techniques and skills for groundwater development and their capacity of technology transfer toward private drilling companies, and by establishing an equipment hiring system in DDCA. The achievement of the following overall goal and project purpose were expected.

Overall goal: The number of wells necessary to achieve the target of WSDP is drilled.

Project purpose: DDCA's capacity to support the water well drilling industry is enhanced.

The following outputs were required to achieve the overall goal.

Output 1: DDCA's ability to impart techniques and skills regarding water well drilling to private drilling sector is enhanced.

Output 2: The capacity of DDCA in groundwater development, which is required to provide technical instructions, is enhanced.

Output 3: A system to hire drilling equipment and machinery is established.

1.3 PROJECT AREA

The project targeted the whole country except Zanzibar.

DDCA, the targeted organization of the Project, had its headquarters in Dar es Salaam and five (5) zonal offices of Northern Zone in Arusha, Lake Zone in Mwanza, Central Zonal in Dodoma, Eastern Zone in Dar es Salaam and Western Zone in Rukwa. Also Six (6) offices of Drilling Project Officers (DPO) were located in Mwanza, Arusha, Dodoma, Sumbawanga and Dar es Salaam to support zonal offices in the activities of drilling business and supervision of drilling works. The locations of the Headquarters and Zonal offices are shown in *Figure 1*.

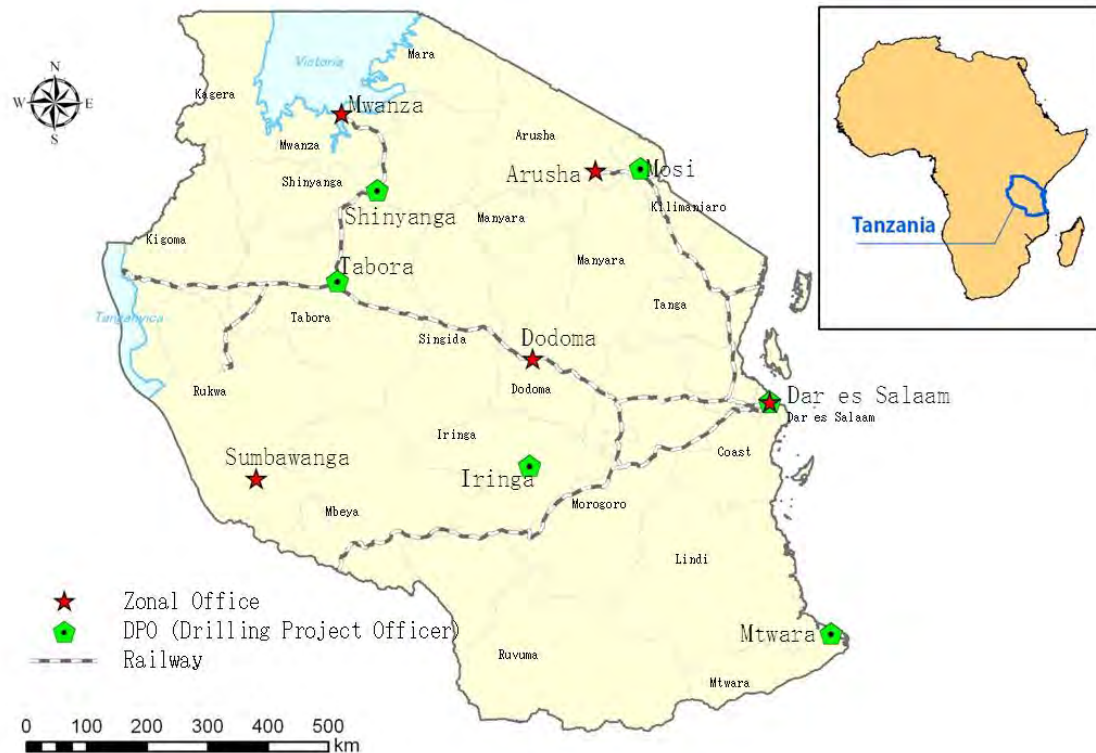


Figure 1 Project Area

1.4 PERSONS CONCERNED WITH THE PROJECT

1.4.1 PROJECT DIRECTOR AND MANAGER

- Project Director: The Permanent Secretary of Ministry of Water (MoW)
- Project Manager: Chief Executive Officer (CEO), DDCA

1.4.2 PROJECT MEMBERS (COUNTER PART)

(1) Water Resources Division (WRD)

Mr. Peter B MDALANGWILA	Hydrogeologist	Coordination with MoW and other relevant organizations
Ms. Mariam HASSAN	Hydrogeologist	Coordination with MoW and other relevant organizations

(2) Drilling Dam and Construction Agency (DDCA)

Mr. Jonathan MGAIWA	CEO	Project Manager, overall management of the Project
Mr. David B. SONGEA	Drilling Project Manager	Deputy Project Manager, overall technical matter related to the Project
Mr. Ezei MAKASO	Zonal Manager of Eastern Zone / Head of Drilling Operation Section	Technical training and guidance of drilling works
Ms. Domina MSONGE	Ag. Business Support Manager	Overall organizational and institutional matter related to the Project
Mr. Nungu EGWAGA	Marketing and Public Relation Officer	Capacity development of private sector
Mr. George BERNARD	Head of Workshop	Equipment maintenance system
Mr. Kulwa THOMAS	Surveyor/Logger Operator	Well logging and database

Ms. Maureen KUNAMBI	Survey Section Data Entry, Drilling Project Department	Well Database
Mr. Obadia KIBONA	Head of Monitoring and Environmental Protection	Groundwater resources management aspect of the Project

1.4.3 JAPANESE EXPERT

Dr. Yuichi HATA	: Chief Advisor / Groundwater Development Expert
Mr. Masakazu SAITO, Eng.	: Deputy Chief Advisor / Drilling Expert
Mr. Yoshimi HIDA, Eng.	: Field Technique Training Expert
Ms. Mikiko AZUMA, MSc	: Operation Management / Organizational and Institutional Development Expert
Ms. Chiaki TAMEKAWA, BSc.	: Training Planner / Private Sector Development Expert
Mr. Koji UZAWA, Eng.	: Machinery and Equipment Maintenance Expert
Mr. Tatsuya SUMIDA, MSc	: Geophysicist / Well Database Specialist
Ms. Aya Kadokami, MSc	: Well and Groundwater Resources Management Expert

1.5 PROJECT DESIGN MATRIX (PDM)

1.5.1 PROVISION OF PDM

PDM₁ was formulated and agreed between Ministry of Water and Japanese Detailed Planning Survey Team with the Record of Discussions signed 14th December, 2011. PDM₁ was used for the management, monitoring and evaluation of the Project.

1.5.2 REVIEW OF PDM₁ AND PREPARATION OF PDM₂

The first version of PDM, namely PDM₁ was provided and agreed through Minute of Meeting signed on 15th November 2011 and Record of Discussion (R/D) signed on 24th December 2011 among MoW, DDCA and Japanese Preparatory Study Team. Considering findings from baseline surveys conducted for capacity assessment of DDCA and private drilling companies, the project team observed necessity of revision of PDM₁, particularly on overall goal, activities, important assumptions, and indicators. The revised version was prepared and proposed as PDM₂. After examination and approval from JICA, PDM₂ would be presented for approval at 3rd coming JCC meeting. However, due to the termination of the Project, this revision was not conducted. The proposal of revisions of PDM₁ is attached to the Appendix in this report.

PDM₁ together with PO₁ are shown in *Table 1* and *Table 2*, respectively.

Table 1 Project Design Matrix 1(PDM 1) (1/2)

Project Title: Groundwater Development and Management Capacity Development Project in Tanzania
 Implementation Organizations: Ministry of Water (MoW) and Drilling and Dam Construction Agency (DDCA)
 Target Groups: DDCA

Period (Tentative): March 2012 – March 2016
 Project Sites: Tanzania mainland

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal The number of wells necessary to achieve the target of WSDP is drilled.	1. The number of successful wells drilled by the drilling industry, per year, increases from XX in year 2010/2011 to XX by 2018/2019.	1. Statistics records of MoW	
Project Purpose DDCA's capacity to support the water well drilling industry is enhanced.	1. The number of wells drilled using the hired drilling equipment reaches to XX. 2. More than XX registered companies utilise some form of service provided by DDCA. 3. More than XX % of private drilling companies, which used services provided by DDCA, consider that the services they received helped their business activities.	1. DDCA's record for hiring drilling equipment and machinery 2. DDCA's record for provided services and baseline / end-line survey 3. DDCA's record for provided services and end-line survey	The Government of Tanzania and the DDCA secure necessary budget and personnel to continue activities. The plan of RWSS component of WSDP does not change dramatically, and the projects of RWSS make progress largely as planned.
Outputs 1. DDCA's ability to impart techniques and skills regarding water well drilling to private drilling sector is enhanced. 2. The capacity of DDCA in groundwater development, which is required to provide technical instructions, is enhanced. 3. A system to hire drilling equipment and machinery is established.	1-1. DDCA staff gain confidence in providing technical instructions to private drilling companies. 1-2. The number of drilling supervisors certified by the project team reaches XX. 1-3. The technical instruction system of the groundwater development for private drilling companies is standardized in DDCA 2-1. DDCA staff gain advanced ground water development techniques. 2-2. The number of drilling supervisors certified by the project team reaches XX. 3-1. Total number of hires reaches XX per year. 3-2. Drilling equipment and machinery are hired in accordance with the procedure established, such as the tariff and contract agreement. 3-3. All drilling equipment and machinery for hiring are maintained in accordance with guidelines and maintenance manuals. 3-4. Internal management accounting document for hiring is reported periodically to the management.	1-1. Project reports and end-line survey report 1-2. Project reports 1-3. DDCA's record and end-line survey report 2-1. Project reports and end-line survey report 2-2. Project reports 3-1. DDCA's record for hiring 3-2. DDCA's record for hiring 3-3. DDCA's maintenance record 3-4. DDCA's report for hiring	The government mandate to DDCA does not change significantly. The hiring business environment, such as expectation to the services provided by DDCA and business conditions of private drilling companies, does not change dramatically.

Project Design Matrix 1(PDM₁) (2/2)

Activities	Inputs	
1-1. To conduct a baseline survey to assess the capacity and needs of private drilling companies. 1-2. To formulate a capacity development plan for private drilling companies. 1-3. To establish a technical instruction system of the groundwater development for private drilling companies. 1-4. To support the DDCA in carrying out technical instruction for private drilling companies. 1-5. To conduct an end-line survey to collect information and to evaluate the effect of the project on private companies. 2-1. To identify areas necessary to be enhanced at DDCA in ground water development capacity. 2-2. To provide technical training and guidance for the DDCA towards strengthening capacity for drilling wells. 2-3. To provide technical training and guidance for DDCA towards strengthening capacity for special techniques such as rehabilitation and fishing wells. 2-4. To support the establishment of a database of wells drilled by DDCA. 3-1. To conduct a baseline survey to collect information and investigate regarding the hiring of drilling equipment and machinery. 3-2. To assist the establishment of the operations for hiring drilling equipment and machinery. 3-3. To assist the establishment of maintenance systems for hiring drilling equipment and machinery. 3-4. To conduct trial hiring and to review the system. 3-5. To conduct an end-line survey to collect information regarding the use of the hiring drilling equipment.	1. Tanzanian side Counterparts for the Project Project Director: Director of Water Resource Division, MoW Project Manager: Chief Executive Officer, DDCA Counterparts 2. Office with necessary equipment for the Project (including utilities such as communications, internet connectivity, electricity, and water etc.) 3. Running expenses necessary for the implementation of the Project 4. Other facilities, equipment and materials mutually agreed as necessary. Japanese side 1. Experts - Chief Advisor / Groundwater Development - Drilling Expert - Business and Operation Management / Organization and Institutional Management - Project Coordinator / Training Planner - Machinery and Equipment Maintenance - Geophysicist - Well Database Specialist - Other necessary fields 2. Equipment - PC and software for database establishment - Necessary equipment identified in the Project 3. Trainings in Japan / third countries - Necessary training(s) as identified in the Project 4. Other expenses necessary for the implementation of the Project which are not covered by Tanzanian side	Provision of drilling equipment for hiring is available by Project commencement. Trained counterparts do not resign, or are transferred, too frequently. . Preconditions No significant changes are made in policies related to groundwater development.

*1Some Objectively Verifiable Indicators are tentatively set as XX. That will be determined at JCC during the course of the Project Implementation.

Table 2 Plan of Operation (1/2)

Process			Baseline survey / Development of the systems of equipment hiring services and technical instructions												Commencement of the hiring services and technical instructions												Implementation of the hiring services and technical instructions and improvement the systems												Implementation of the hiring services and technical instructions and improvement the systems /Project evaluation																																																																																			
Time Schedule			1st year												2nd year												3rd year												4th year																																																																																			
			2012												2013												2014												2015												2016																																																																							
			3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3																																																																							
Overall activities	[0-1] Preparation of Work Plan	Plan																																																																																																																								
	[0-2] Baseline Survey	Actual																																																																																																																								
		Plan																																																																																																																								
	[0-2-1] Private sector	Actual																																																																																																																								
		Plan																																																																																																																								
	[0-2-2] DDCA	Actual																																																																																																																								
		Plan																																																																																																																								
	[0-2-3] Other related areas for PDM indicators	Actual																																																																																																																								
		Plan																																																																																																																								
	[0-3] Review of PDM1 and Preparation of PDM2	Actual																																																																																																																								
		Plan																																																																																																																								
		Actual																																																																																																																								
	[0-4] End-line Survey	Actual																																																																																																																								
		Plan																																																																																																																								
		Actual																																																																																																																								
[0-4-1] Private sector	Actual																																																																																																																									
	Plan																																																																																																																									
	Actual																																																																																																																									
[0-4-2] DDCA	Actual																																																																																																																									
	Plan																																																																																																																									
	Actual																																																																																																																									
[0-4-3] Other related areas for PDM indicators	Actual																																																																																																																									
	Plan																																																																																																																									
	Actual																																																																																																																									
[0-5] Preparation of Progress Report (1 to 7)	Actual																																																																																																																									
	Plan																																																																																																																									
[0-6] Preparation of Final Report	Actual																																																																																																																									
	Plan																																																																																																																									
[0-7] Collaboration with Project Mid-Term / Terminal Evaluation	Actual																																																																																																																									
	Plan																																																																																																																									
[0-8] JCC (Joint Coordination Committee) meeting	Actual																																																																																																																									
	Plan																																																																																																																									
Output 1 DDCA's ability to impart techniques and skills regarding water well drilling to private drilling sector is enhanced.	[1-1] Survey on the capacity and needs of private sector	Actual																																																																																																																								
		Plan																																																																																																																								
	[1-2] Formulation of a CD plan for private drilling companies	Actual																																																																																																																								
		Plan																																																																																																																								
	[1-2-1] Analysis of private sector's deficient abilities	Actual																																																																																																																								
		Plan																																																																																																																								
	[1-2-2] Formulation of DDCA's capacity develop policy for each target areas	Actual																																																																																																																								
		Plan																																																																																																																								
	[1-2-3] Formulation of a capacity development plan for private sector	Actual																																																																																																																								
		Plan																																																																																																																								
	[1-3] Establishment of a technical instruction system for private drilling companies	Actual																																																																																																																								
		Plan																																																																																																																								
	[1-3-1] Formulation of a teaching guidance	Actual																																																																																																																								
		Plan																																																																																																																								
	[1-3-2] Establishment of a certification system for trainers in DDCA	Actual																																																																																																																								
		Plan																																																																																																																								
	[1-3-3] Establishment of an instruction system for technical trainers in DDCA	Actual																																																																																																																								
		Plan																																																																																																																								
	[1-3-4] Establishment of a certification system for engineers in private sector	Actual																																																																																																																								
		Plan																																																																																																																								
[1-3-5] Accumulation, share and organization of results of teaching instructions	Actual																																																																																																																									
	Plan																																																																																																																									
[1-4] Support DDCA in carrying out Technical Instructions for private drilling companies	Actual																																																																																																																									
	Plan																																																																																																																									
[1-4-1] Assistance of DDCA's technical instructions toward private sector	Actual																																																																																																																									
	Plan																																																																																																																									
[1-4-2] Assistance of DDCA's technical instructions toward drillers in private sector	Actual																																																																																																																									
	Plan																																																																																																																									
[1-4-3] Evaluation of instructors' teaching skills in DDCA	Actual																																																																																																																									
	Plan																																																																																																																									
[1-4-4] Evaluation and improvement of technical instruction systems	Actual																																																																																																																									
	Plan																																																																																																																									
[1-5] Evaluation of effect of the project on private sector	Actual																																																																																																																									
	Plan																																																																																																																									

Plan of Operation (2/2)

[illegible]

CHAPTER 2 PROJECT CONTENTS AND BACKGROUND OF TERMINATION OF THE PROJECT

2.1 WORK FLOW OF THE PROJECT

The Project commenced in March 2012 and was supposed to continue up to March 2016. The activities of the Project were composed of three following stages.

- 1st Year (March 2012 to February 2013): to conduct Baseline Survey, and preparation of the establishment of equipment hiring and technical instruction system.
- 2nd Year (March 2013 to February 2014): to commence the equipment hiring business and technical instruction.
- After 3rd Year (March 2014 to March 2016): to continue and improve the equipment hiring business and technical instruction

However, the project activities were interrupted in the middle of 2nd year due to the request to terminate the project from MoW. The contents and procedure of the activities are shown in *Figure 2*.

2.2 SUMMARY OF ACTIVITIES

After commencement of the project, baseline survey on DDCA and private sector were conducted. The Private Sector Support Plan was formulated based on the result of baseline survey on private sector regarding the capacity and resources the private sector owns. On the other hand, the equipment hiring needs were also collected in the survey. It was utilized for establishment of the business model for equipment hiring. As the baseline survey on DDCA, the competence test was conducted to the DDCA drillers in order to assess the current competence level of drilling works and identify the technical area to be strengthened. Based on the result, the initial version of the Technical Support Plan and the manuals were formulated for drillers of DDCA. The result of the competence test was also utilized in the selection and classification of the target drillers for establishment of technical instruction system including instruction from senior to middle drillers and its certification system in DDCA. For the establishment of equipment hiring operation system, the business model was proposed and the initial version of the guideline and procedure were formulated. Furthermore, the baseline survey on the existing equipment maintenance system in DDCA was conducted. The findings were to be reflected to the system of hiring equipment maintenance. The initial version of the guideline, plan and manuals for the equipment maintenance system were prepared. Apart from these activities, well database has been established by converting the paper based drilling record into electrical data in order to enhance the capacity of DDCA to provide the hydrogeological information to the private sector.

Table 3 shows the work items and the work completed. *Figure 3* summarizes guidelines, plans and manuals which were formulated in the Project.

Table 3 Contents and Results of the Activities of the Project

No.	Activity	Completed activities	
		(2012/03-2013/02)	(2013/03-2013/07)
Overall Activity			
[0-1]	Preparation of a Work Plan	Completed in April 2012	
[0-2]	Baseline survey related to [1-1] [2-1] [3-1]	Completed in September 2012	
[0-3]	Review of PDM1 and preparation of PDM2	Completed in February 2013	
[0-5]	Progress Reports	Progress Report 1 submitted in September 2012 Progress Report 2 submitted in February 2013	
[0-6]	Final Report	This report	

CHAPTER 2 PROJECT CONTENTS AND BACKGROUND OF TERMINATION OF THE PROJECT

No.	Activity	Completed activities	
		(2012/03-2013/02)	(2013/03-2013/07)
Output 1 : DDCA's ability to impart techniques and skills regarding water well drilling to private drilling sector is enhanced.			
[1-1]	Survey on the capacity and needs of private sector	Completed in September 2012	
[1-2]	Formulation of a CD support plan for private drilling companies	Completed in January 2013	
[1-3]	Establishment of a technical instruction system for private drilling companies		Completed in March 2013
Output 2: The capacity of DDCA in groundwater development, which is required to provide technical instructions, is enhanced.			
[2-1]	Identification of areas necessary to be enhanced at DDCA	Completed in January 2013	
[2-2] [2-3]	Technical training and guidance for DDCA (for drilling wells, rehabilitation and fishing wells)	Completed in September (formulation of initial plan and manuals)	Completed in June (borehole logging seminar)
[2-4]	Support establishment of a database of wells drilled by DDCA		Completed in July 2013
Output 3: A system to hire drilling equipment and machinery is established.			
[3-1]	Investigation regard to the hiring of equipment and machinery	Completed in September 2012	
[3-2]	Establishment of the operation system of the hiring of drilling equipment and machinery		Completed in July 2013
[3-3]	Establishment of maintenance system for the hiring equipment	Completed in September 2012 (formulation of initial plan and manuals)	

CHAPTER 2 PROJECT CONTENTS AND BACKGROUND OF TERMINATION OF THE PROJECT

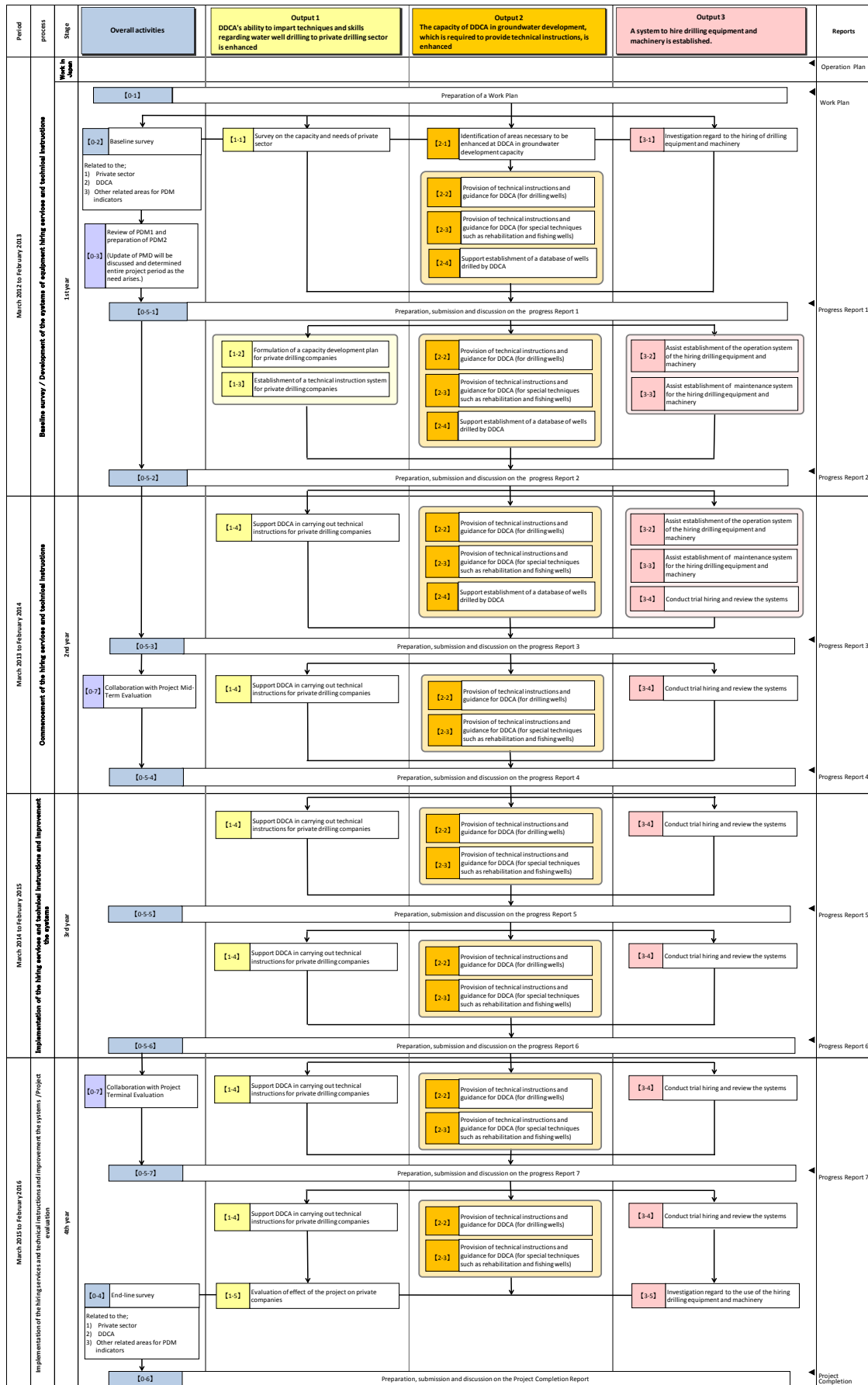


Figure 2 Flow Chart of the Project

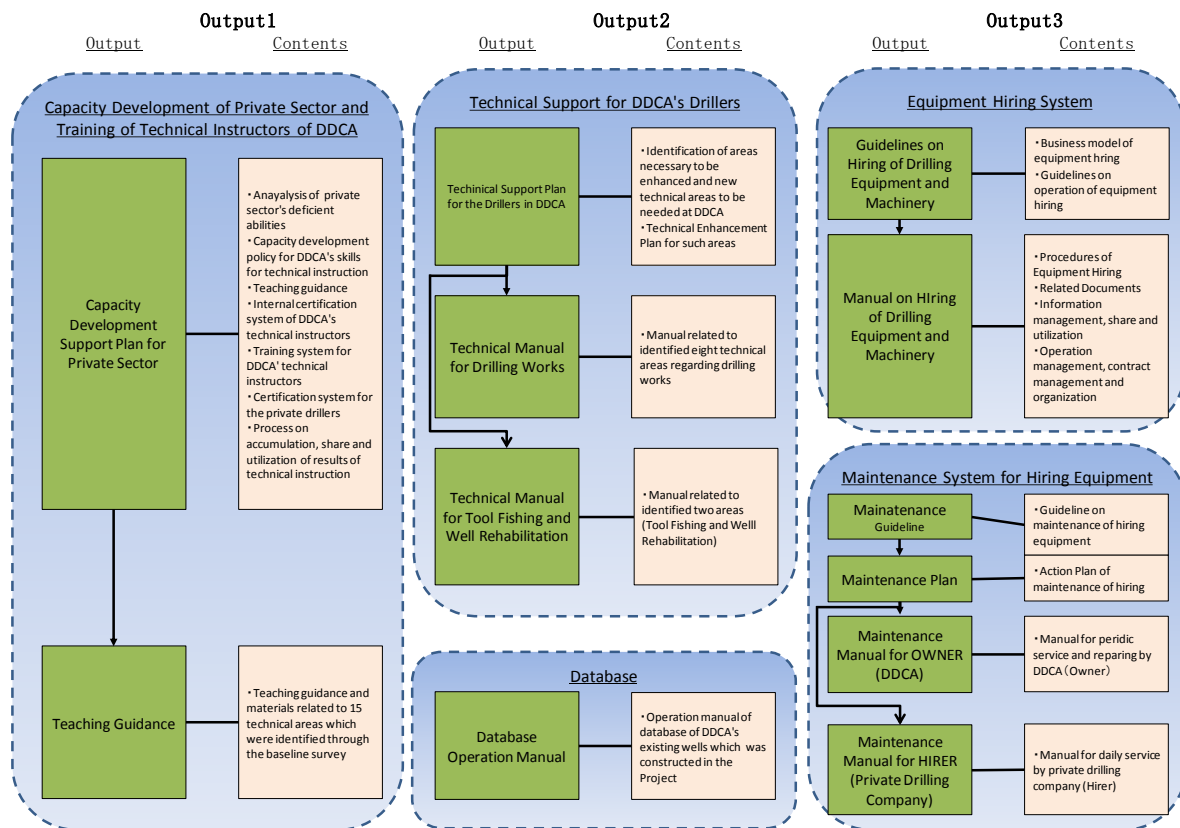


Figure 3 Guidelines, Plans and Manuals of the Project

2.3 PROJECT INPUT

2.3.1 SUBCONTRACT, PROCUREMENT AND DISPATCH OF EXPERTS

The necessary project inputs planned by PDM₁ were executed by the Project. These include dispatch of Japanese Expert and procurement of equipment and local contractors. Japanese Experts dispatched are shown in **Figure 4**. The duration dispatching eight (8) Japanese Experts was 40.54M/M in total.

2.3.2 ASSIGNMENT SCHEDULE

The assignment schedule of Japanese Experts until interruption of the project is shown in **Figure 4**. The assignment schedule of the whole Project is shown in **Appendix-1**.

CHAPTER 2 PROJECT CONTENTS AND BACKGROUND OF TERMINATION OF THE PROJECT

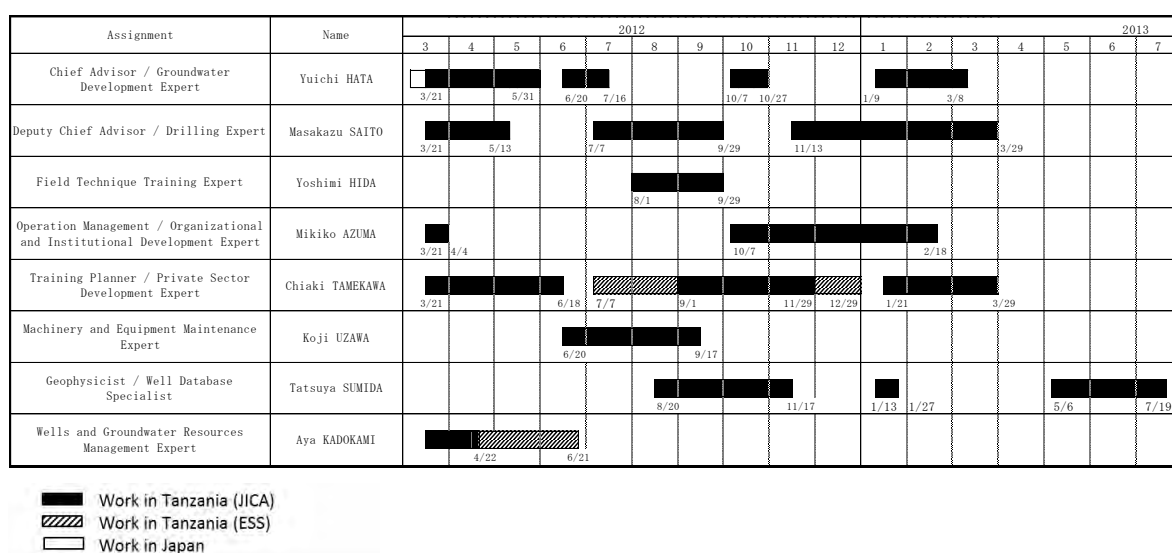


Figure 4 Assignment Schedule until interruption of the Project

2.4 ACTIVITIES RELATED TO PLANNING AND MANAGEMENT OF THE PROJECT

2.4.1 FORMULATION OF WORK PLAN AND COUNTERPARTS MEETINGS

The JICA Expert Team grasped the overall picture of the Project by examining the existing materials including the preparatory survey report of the Project. The principles, methodology and project schedule were examined and compiled in the draft work plan. Starting from the discussion on this draft work plan, the JICA Expert Team and counterparts had a series of discussion on the concrete project activities at each step of the Project, through the following counterpart meetings:

1st Counterparts Meeting (on 3rd April, 2012)

After the commencement of the project activities in Tanzania, the contents of the Draft Work Plan were explained to counterparts of MoW and DDCA and were discussed between the counterparts and the JICA Expert Team. In this meeting, the participants came to principal agreement with the contents of the Draft Work Plan

This 1st Counterpart Meeting was held as the “Kick-off Meeting of the Project”. Besides the discussion on the contents of the Draft Work Plan, the concept and the use of the PDM were explained using the PDM of the Project. Through this explanation, the counterparts came to realize the concept of the PDM and the necessity of the indicator setting and the revision of the PDM.

The Draft Work Plan was finalized and approved after reflecting the comments from the participants of the 1st JCC (Joint Coordination Committee). It was distributed to all the members of JCC on 27th April, 2012.

2nd Counterparts Meeting (on 23rd July, 2012)

In this meeting, the progress of the activities which had already launched such as Baseline Survey, Well and Groundwater Resources Management Survey, Technical Support Plan for DDCA’s Drillers and Establishment of Hiring Equipment Maintenance System was reported and the coming schedule for the activities were discussed.

3rd Counterparts Meeting (on 25th September, 2012)

Prior to this meeting, the Draft Progress Report 1 was distributed to the participants. The contents of the Draft Progress Report 1 were reported from the counterparts in charge of each activity in this meeting.

It was agreed that the Draft Progress Report 1 shall be revised and approved after a week of grace period to accept the further comments from the participants.

4th Counterparts Meeting (on 25th October, 2012)

In the meeting, the schedule of the review and revision of PDM₁ were confirmed so that the revised PDM, namely PDM₂ shall be agreed in the coming JCC Meeting. Also the progress of the procurement of hiring equipment was discussed, and agreed to share the information until handover of the equipment.

5th Counterparts Meeting (on 17th and 23rd January, 2013)

PDM₁ was reviewed and discussed on the points to be revised. Based on the result of the baseline survey, the indicator, activities and logicity between outputs and the project goal were made review and revision. The revised PDM, namely PDM₂ was agreed between Counterparts and Japanese Experts. The draft PDM₂ was to be proposed in the coming JCC Meeting for the official approval.

2.4.2 JOINT COORDINATING COMMITTEE (JCC) MEETINGS

1st Joint Coordinating Committee (JCC) Meeting (on 12th April, 2012)

The project opening ceremony was held at the conference room of MoW. This ceremony was opened with the remarks of Mr. Christopher Sayi, Permanent Secretary of MoW and Mr. Yukihide Katsuta, Chief Representative of JICA Tanzania Office, announcing the official opening of the Project to the JCC Members and to the press.

After this ceremony, the 1st JCC Meeting was held, chaired by Ms. Naomi Lupimo, Assistant Director of Water Resources Management, MoW. In this meeting, the contents of the Draft Work Plan was explained and discussed. The participants came to the principal agreement with the contents of the Draft Work Plan. The Chairperson proposed that the Draft Work Plan shall be revised and approved after a week of grace period to accept the further comments from the participants.

The minutes of meeting of 1st JCC Meeting is attached in *Appendix-3*.

2nd Joint Coordinating Committee (JCC) Meeting (on 13th February 2013)

In the meeting, it was confirmed that how DDCA manage to implement the existing plan and Project activity for capacity development. The contents of business model for equipment hiring and future schedule for the Project activities were also discussed. The trial operation of equipment hiring has been planned to start from April 2013. Since the delivery schedule of supply of equipment was lag behind, it was agreed that the Project would be suspended if it would not be ready for use until April 2013.

The Minutes of Meeting (M/M) for JCC Meeting is shown in *Appendix-4*.

2.4.3 PROCUREMENT OF EQUIPMENT

After the commencement of the Project, necessary equipment for the Project activities was procured both in Japan and Tanzania. The equipment included the ones for the field survey, the database construction, equipment maintenance, and office equipment for the activities of Japanese experts. The list of equipment is shown in *Appendix-3*.

2.4.4 RESULT OF SUB-CONTRACTING OF LOCAL CONSULTANTS

As for the sub-contracting works, the two (2) contracts of Baseline Survey on Private Drilling Company and Construction of Well Information Database were concluded. The Baseline Survey on Private Drilling Company was completed in September 2012. The Construction of Well Information Database was completed in July 2013. The progress of the above sub-contracting works is shown in *Table 4*.

Table 4 Result of Sub-Contracting Work

Contract	Contractor	Progress
Baseline Survey on Private Drilling Company	Bureau for Industrial Cooperation (BICO), College of Engineering & Technology, University of Dar es Salaam	Completed in September 2012
Construction of Well Information Database	Locaidas General Supply Ltd.	Completed in July 2013

2.5 CIRCUMSTANCES OF TERMINATION OF THE PROJECT

It was planned that the Project would establish the drilling equipment hiring system and provide the support for implementation of the system by using the drilling equipment and machinery to be procured by WSDP fund (8 drilling rigs of 2 large size drilling rigs up to 300m and 6 medium size drilling rigs up to 200m) together with DDCA's existing supporting equipment and vehicles.

However, the procurement process of the equipment and machinery under the procurement management by MoW and DDCA were drastically delayed and there found concerns about the quality of the equipment. Therefore, the Project Team, JICA, donors such as WB requested MoW and DDCA to take appropriate measures to solve these issues. However, since no effective action had been provided for this issue, interruption of the Project was agreed in 2nd JCC meeting in February 2013. After this agreement, though the Project Team and JICA continued to request MoW to improve the situation, concrete measures were not showed by MoW.

In December 2014, the change of the policy that DDCA would not proceed with the equipment hiring business for private sector was informed by MoW to JICA. Subsequently, MoW requested to terminate the project by the official letter signed by the Permanent Secretary on 6th May 2013. As the Project got lost its aims, JICA decided to receive the request and terminate the Project.

CHAPTER 3 ACTIVITIES TAKEN AND OUTPUTS OF THE PROJECT

3.1 OUTPUT 1: ENHANCEMENT OF DDCA'S ABILITY TO IMPART TECHNIQUES AND SKILLS REGARDING WATER WELL DRILLING TO PRIVATE DRILLING SECTOR

Output 1 was “DDCA’s ability to impart techniques and skills regarding water well drilling to private drilling sector is enhanced.”, and the following activities were planned.

[1-1] Survey on the capacity and needs of private sector (Baseline Survey)

[1-2] Formulation of a CD support plan for private drilling companies

[1-3] Establishment of a technical instruction system for private drilling companies

[1-4] To support the DDCA in carrying out technical instruction for private drilling companies.

[1-5] To conduct an end-line survey to collect information and to evaluate the effect of the project on private companies.

In the activity [1-1], the baseline survey related to the entire groundwater development sector and private drilling companies were conducted. The answers from 94 private drilling companies were obtained and analysed. In the activity [1-2], the drilling companies were grouped according to their capacity and the capacity development support plan was formulated according to the characteristics of each group. In the activity [1-3], DDCA’s technical instruction system for private drilling company was formulated, by utilizing the results of the baseline survey on DDCA’s organization for drilling works. Only a part of activities of the support to DDCA in carrying out technical instructions for private drilling companies ([1-4]) were conducted, due to the termination of the Project. Activity [1-5] was not conducted as well.

The activities for output 1 and the results are shown in **Figure 5**.

Activity	Year	2012										2013						
	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
1-1 Survey on the capacity and needs of private sector																		
		A local consultant conducted a baseline survey. Final results were compiled in 3.1.																
1-2 Formulation of a CD support plan for private drilling companies																		
		Analysis of private sectors deficient ability, formulation of DDCA’s capacity development policy and formulation of DDCA’s capacity development support plan for private sector were conducted.																
1-3 Establishment of a technical instruction system for private drilling companies																		
		Teaching guidance was prepared. Certification system for trainers in DDCA, instruction system for technical trainers in DDCA and certification system for engineers in private sector were formulated. Technical guidance was conducted.																
1-4 Support DDCA in carrying out technical instructions for private drilling companies		The activities were planned to be continuously implemented from the 2 nd Year of the Project (March 2013). However, only a part was conducted, due to the termination of the Project.																
1-5 Evaluation of effect of the project on private sector		The activities were planned to be conducted in the 4 th Year of the Project (November 2015). However, it was not conducted due to the termination of the Project.																

Figure 5 Result of Activities for Output 1

The following Section 3.1.1 describes the activities of baseline survey related to the entire groundwater development sector and to private drilling companies. Section 3.1.2 describes the activities of the formulation of DDCA’s capacity development support plan and the establishment of technical instruction system for private drilling companies.

3.1.1 BASELINE SURVEY RELATED TO ENTIRE GROUNDWATER DEVELOPMENT SECTOR AND TO PRIVATE DRILLING COMPANIES

In order to grasp the situation of the private drilling companies in Tanzania and to formulate a proper capacity development support plan for the private sector with consideration of their resources and business policies, a baseline survey related to entire groundwater development sector by JICA Expert Team and a baseline survey related to private drilling companies by hiring a local consultant were conducted. The results of these baseline surveys were utilized also for the development of the equipment hiring system for Output 3.

Table 5 shows the contents and purposes of baseline survey for Output 1.

Table 5 Baseline Survey and its Purposes (Output 1)

Baseline Survey	Content	Item	Purpose
Baseline Survey related to Entire Groundwater Development Sector	Laws and Regulations related to Procurement of Drilling Contractors under WSDP	1) WSDP Procurement Manual 2) The Regulation of PPRA 3) Water Resources Management Act (WRMA) 4) The Governmental Specification and Regulation on Well Drilling and Installation of the Materials	To grasp the system of public procurement in WSDP and in Tanzania in order to examine the conditions on which the private drilling companies join the works of WSDP.
	Permit and Registration Required for Contractors	1) Drilling Permit Issued by MoW 2) Contractors Registration Board (CRB) 3) Business Registration Licensing Authority (Brela)	To grasp the company registration system in Tanzania in order to evaluate the operation of the private drilling companies.
	Current Situation of Well Drilling Work under Rural Water Supply and Sanitation Component (RWSS) of WSDP	1) Progress of Procurement for 10 Village Project under the RWSS Component 2) Actual Contract of Well Drilling Works	To grasp the progress of the rural water supply component of WSDP and evaluate the market in which the private drilling companies shall join. In addition, by analysing the contract amount, utilize for calculation of equipment hiring tariff.
Baseline Survey on Private Drilling Companies	Business Establishment	1) Geographical Distribution 2) Year of Establishment and Experience in Drilling Works 3) Registration to Regulatory Bodies	To grasp geographical distribution, experiences, situation of company registration etc. of the private drilling companies.
	Clients for Water Well Drilling		To grasp the clients of private drilling companies such as the government, private companies etc.
	Performance in the Past Three Years	1) Number of Contracts Awarded 2) Number and Type of Wells Drilled 3) Size of a Contract for Deep Well Construction	To grasp the annual work amount, type of works, experience of drilling works in WSDP etc. of private drilling companies
	Possession of Equipment	1) Drilling Equipment 2) Supporting and Survey Equipment 3) Maintenance of Drilling Equipment	To grasp the owned equipment in order to examine the needs for equipment hiring and for capacity development.
	Human Resources	1) Staffing 2) Working Experience and Qualification of Technical Staff 3) Capacity Development of Technical Staff	To grasp the numbers, experiences and qualifications of company's staff in order to examine the needs for technical instruction service.

Baseline Survey	Content	Item	Purpose
	Interest in Business Opportunities in WSDP		To grasp whether or not private drilling companies are interested in joining the drilling works in WSDP.
	Investment for New Drilling Equipment		To grasp the intention to invest for increase of drilling equipment
	Demand for Private Sector Support Services of DDCA	1) Hiring Service of Drilling Equipment 2) Other Forms of Private Sector Support Services	To grasp the needs for DDCA's private sector support services

(1) Baseline Survey related to Entire Groundwater Development Sector

1) Laws and Regulations related to Procurement of Drilling Contractors under WSDP

The prequalification of private tenderers (consultancy service, contractors and suppliers etc) including tendering process for WSDP works is stipulated in the WSDP Procurement Manual issued in 2006 by MoW. The procedures are prepared based on the Public Procurement Act enacted by the Tanzanian government, the Public Procurement Regulation prepared by the Public Procurement Regulatory Authority (PPRA) and other regulations stipulated by World Bank.

On the other hand, the MoW obliged to the contractors which conduct drilling work in Tanzania to acquire the drilling permit. The drilling permit is a requirement indispensable for the private drilling companies to participate in the WSDP works.

The details of WSDP Procurement Manual, Public Procurement Regulation and the drilling permit are described in the following sections.

WSDP Procurement Manual

The WSDP Procurement Manual is the reference document for the procurement organizations in order to conduct the procurement management in a uniformed manner. The Procurement Management Unit (PMU) of each organization is responsible for the procurement of construction, non-consultancy service and consultant so that they refer to the Manual when they supervise the entire process of the procurement. The Manual includes the contents of the regulations of PPRA and World Bank since the regulation of the WSDP works is followed by these. The Manual includes on the procurement of the works of installation of the equipment, training, transport service and maintenance of the facility. The procurement management includes preparation of tender, evaluation, signing contract, payment, contract management and documenting. According to the Manual, the types of procurement are classified to the four followings.

Procurement of Goods: Installations of goods, training on how to use it, transport service of goods, operation and maintenance of the goods. Goods are defined as pumps, water meters, generators, motors, machinery, water chemicals, transportation equipment, tools and equipment.

Procurement of works: Construction and rehabilitation of water works sewerage systems and sanitation facilities. Water works includes the construction of wells, water tanks, dams, water treatment plants, distribution systems and drilling of boreholes. Wastewater works include construction and rehabilitation of sewage treatment plants, sewer networks and pit latrines.

Non-Consultancy Services: Training, communication services, cleaning services, security service, information dissemination, and awareness creation campaigns and Maintenance services.

Consultancy Services: Studies, preparation of detailed designs and tender documents, and supervision of construction services.

The different procurement method is applied for the above four categories of works based on the scale and characteristics of works. **Table 6** shows the five methods of procurement, the characteristics of each method and applied condition. In case of International National Competitive Bidding (NCB), the procedure might be followed by the guideline of World Bank.

Table 6 Method of Procurement for WSDP works

Method	Characteristics	Applied Condition
International Competitive Bidding (ICB)	The tenders shall be advertised nationally and internationally, and anyone can equally participate in the tender regardless of nationality. The preference to the local tenderers shall be applied in the evaluation if required in the solicitation document.	<ul style="list-style-type: none"> - The estimated cost of the goods or works exceeds the threshold value. - The experts with high knowledge are needed for tenders from widest range.
National Competitive Bidding (NCB)	The tenders shall be advertised nationally and internationally, and anyone can equally participate in the tender regardless of nationality. The preference to the local tenderers shall be applied in the evaluation if required in the solicitation document.	<ul style="list-style-type: none"> - The contract value is small and does not exceed the threshold. - The duration of tender does not exceed three months. - The goods or works are available locally at prices below the international market. - The works are scattered geographically or spread over time. - The works are intensive to the physical labour.
Restricted Bidding (RSB)	A PE might restrict the issue of tender documents to a limited number of specified suppliers, contractors, or service providers. The justification for restricting procurement must be shown in the record of procurement proceedings. If the suppliers, contractors or service provider have already pre-qualified, a PE shall seek tenders from the list of potential bidders	<ul style="list-style-type: none"> - The suppliers, contractors or service providers have already pre-qualified in the previous assignment. - The goods, works or services required come up with the specialized specification. - The estimated contract values are within the limit for restricted threshold - There is an urgent need such that there would be insufficient time for the PE to proceed ICB or NCB.
Shopping or Competitive Quotations (CQ)	The price quotations obtained from at least three different suppliers or contractors which provided the estimated value of the contract within the threshold are compared. The quotation that tenderer with the lowest evaluated cost provided but meeting the quality shall be successful. A list of suppliers to submit quotations shall be approved by the tender board.	<ul style="list-style-type: none"> - The desired goods are readily available off-the-shelf, or goods are of standard specification - The estimated cost of goods is small, or civil works which is simple and small cost. - The applicable goods includes handpump, office stationery, motor vehicle/motorcycles/bicycles, tools and materials, office rehabilitation, information dissemination/awareness campaign, simple and small rehabilitation works and construction of some sanitation facilities.
Single Source Procurement (SSP)	Only one contractor or supplier is available (sole sourcing)	<ul style="list-style-type: none"> - There is a need for continuity for on-going contract. - Emergency procurement is needed. - An on-going project, additional items need to be purchased for completion of implementation. - Any mitigating factors might be approved by respective Tender Committee.

In the Rural Water Supply and Sanitation (RWSS) component of WSDP, the PE, that is LGA, applies the procurement method of NCB and RSB to procure the consulting and construction works.

The annexes of the WSDP Procurement Manual include the time schedule. Also these include the list of document required to submit (pre-qualification, expression of interest, technical proposal & financial proposal), evaluation items, format of progress report for contract management. The procurement is processed by each procuring organization with referred to the WSDP Procurement Manual. When the further information is needed, the regulation of PPRA is also referred. The details of the regulation are describes in the following section.

The Regulation of PPRA

As mentioned in the above, the procedure of WSDP procurement is followed by the Public Procurement Act (2004) and Public Procurement Regulations (2005) issued by PPRA.

The procurement of drilling works is classified to the type of works. Two types of works are categorized by PPRA to Smaller Works, and Medium and Large Works. The ten village projects of RWSS Component under WSDP are categorized to Medium and Large Works based on the scale of work. User Guide for Medium and Large Works, which is one part of the guideline called as Procurement of Medium and Large Works, includes the regulation and format of the tender documents which is Standard Bidding Document (SBD).

User Guide is the manual explaining on the tendering process and how to use the SBD. The procurement of Medium and Large Works is suitable for the lump sum contract for a fixed period. ICB, NCB and RSB are mainly applied for the procurement of Medium and Large Works. The composition of the SBD is shown in **Table 7**.

Table 7 Composition of SBD for Medium and Large Works

Section No.	Section Title
I)	Invitation for Bids
II)	Instruction to Bidders
III)	Bid Data Sheet
IV)	General Condition of Contract
V)	Special Condition of Contract
VI)	Specification and Statement of Requirements
VII)	Activity Schedule
VIII)	Forms of Bid
IX)	Security Forms
X)	Undertaking by Bidder on Anti-Bribery Policy/Code of Conduct and Compliance Programme

In **Table 7**, the general requirement for all tenderers is stipulated in the II) Instruction to Bidders. The contents include the basic information on the tenderer, the scale of company or evidence of legal company such as company registration, contractor registration to the regulatory body, past annual contract value, condition of contract and owned equipment. The requirement to be specified in III) Bid Data Sheet, IV) General Conditions of Contract and V) Special Condition of Contract shall be set by each procuring organizations. The contents to be inserted into III) include the implementing capacity of the tenderer such as contract value of a certain threshold, experienced year of the project manager, number and type of owned equipment. The prospective personnel resources is mentioned in IV), while specific qualifications such as educational level, certificate held and experienced year are described in V).

The sample requirement for pre-qualification which was employed by LGA for ten village projects of WSDP RWSS component is shown as below. This work was drilling of six preliminary testing boreholes including well development and pumping test.

- The tenderer registered to the Construction Registration Board (CRB)
- The tenderer acquired the drilling permit issued by MoW
- The annual value of contract awarded in the past two years reaching Tsh 1,000,000
- The experience of the project taken as a prime at least once
- The clarification on the way of procurement of the equipment (own or lease) shall be given. The equipment includes drilling rig with the capacity of more than 200m depth, compressor, pumping test unit, two trucks (one supporting truck and one water tanker) and well development unit.
- The drilling supervisor should have an experience on relevant area more than five years.
- The allocation of the personnel who satisfies the requirement shall be proposed. It includes drilling supervisor equivalent to civil engineer who holds BSc and has the experience of supervision more than five years, hydrogeologist who holds BSc in geology

and has the experience of related area more than five years, technician who holds Full Technician Certificate (FTC) in hydrogeology and operator equivalent to technician level who has the experience of related work.

Water Resources Management Act (WRMA)

The Water Resource Management Act (WRMA) enacted in 2009 aiming at sustainable water resources management. The roles of the implementers, who take in charge of water resources management such as MoW, Basin Water Office (BWO) and stakeholders, are mentioned in the WRMA. Also law and regulation related to water resources management are stipulated. The regulation related to the user of the groundwater including well drilling is described in the section of groundwater permit and water use permit in the WRMA.

Anyone who commences the well drilling or expansion of the well is required to acquire the groundwater permit. For the drilling or expansion of well, the deepest water level, expanding range, well depth shall be referred to the regulation stipulated in another statement. The groundwater data such as yield shall be submitted to the BWO. Also consideration to avoid the contamination of groundwater such as sealing shall be reported to BWO. Furthermore, the security measures shall be taken to prevent injury and accident during the drilling work. In case the default to these duties is revealed, the groundwater permit could be cancelled. BWO is responsible for determination of the safe yield and amount of intake from aquifer, and setting of the intake limitation. Also the regulation on the artesian well to prevent contamination, waste of water and drop of water pressure shall be prepared.

On the other hand, anyone who diverts, stores and intakes water from surface or underground and the land owners who contain the intake point in their land are required to hold the water use permit. Water use permit shall be granted by BWO. Before grant or renew of the water use permit, BWO investigates if the contamination of water or water source and drainage are within the standard level and also if the appropriate environmental flow is sustained.

In the Baseline Survey on Private Drilling Companies, 49 percent of the companies among the target 94 companies replied that the application of the groundwater permit is supposed to do by the drilling companies. The remaining 47 percent of the companies replied that the well owner would be responsible for the application of the permit while 4 percent were not aware of the permit. On the other hand, regarding the water use permit, 74 percent of the companies replied that application shall be done by well owner, while 14 percent of the companies do it by themselves. 11 percent of the companies are not aware of the permit. Regarding the groundwater permit, as the Act mentions, anyone who commences the well drilling or expansion of the well for water intake is required to acquire the groundwater permit. It means that the application might be done by either well owner or drilling companies. According to the result of baseline survey, it is revealed that the application is only done by about the half target companies. The private drilling companies need to obtain not only proper knowledge on groundwater exploration but also the understanding on procedure of the groundwater permit. It is the obligation for the private drilling companies to apply the groundwater permit for themselves or explain to the well owners on the need of holding the groundwater permit.

The Governmental Specification and Regulation on Well Drilling and Installation of the Materials

The Water Resources Division (WRD) of MoW provides the specification and regulation on well drilling and installation of the materials to all private companies and non-governmental organizations. The regulation mentioned that all companies who conduct the drilling work shall acquire the drilling permit to be granted by MoW. Apart from the permit, the followings related to the drilling work are stipulated.

- All companies who conduct construction works shall submit the hydrogeological survey report to BWO and MoW before commencement of the works. Within seven days BWO shall grant the clearance permit to the companies. The companies are prohibited to commence the work until clearance permit issued.
- The recording of the coordination at drilling point by Geophysical Positioning System

(GPS) is obliged for the drilling of new borehole.

- The companies which conduct the drilling work shall install the casing pipe, do cementing and sealing to the drilled borehole to prevent the contamination.
- The casing screen shall be installed in the right position and the appropriate amount of gravels shall be filled.
- The constant discharge test, step pumping test and water quality analysis shall be conducted.
- The well completion report shall be prepared and submitted to the WRD, BWO and well owner.
- The backfilling for the unsuccessful well shall be done.

At the time of baseline survey, WRD of MoW was preparing of Groundwater (Exploration and Drilling) Licensing Regulations in order to regulate groundwater development. This regulation shall include the contents mentioned above.

2) Permit and Registration Required for Contractors

Drilling Permit Issued by MoW

As above mentioned, MoW obliged the contractors for drilling to acquire the drilling permit. The required documents for the application are shown below. The submission of the documents is required not only for the new application but also renewal one.

- Application letter addressing Permanent Secretary of MoW
- Copy of company's registration
- Copy of certificate of Tax payer
- Details of owned equipment (drilling rig, compressor, pumping test unit etc)
- CV for employees
- Company profile
- Copy of work permit of employees in case of foreigner

The provisional grant for six months is given to the new applicant of drilling permit. After six months are passed without any problems, one year valid permit shall be granted. The renewal of the permit shall be done based on the investigation of the performance conducted by the companies in a past year, in addition to the submission of the required documents.

At the time of the baseline survey, 126 private drilling companies had been registered to the MoW. As mentioned above, as the result of the baseline survey on private companies, it was revealed that there were some existing companies out of 126 companies which had not updated the permit, as well as the companies unknown about their existence and being out of business.

Contractors Registration Board (CRB)

As mentioned in the section of "PPRA", one of the requirements for pre-qualification of the tenderers for WSDP work is to register the regulatory body. Since drilling works are taken regarded as a part of the construction, the registration to the Contractors Registration Board (CRB) is required for the drilling companies. The Contractor Registration Act was enacted by the Tanzanian government in 1997. The Ministry of Works, which was mandated to supervise and regulate all construction works, established the CRB responsible for registration, regulation and development of contractors. According to the Contractor Registration Act, the registration shall be done by any person, developer or investor who carries out any construction work of two types shown as below. The construction work include fixing, installation and alternation for any structure situated below, on or above the ground or water bodies and other work.

- Anyone to supply the material necessary for the work or is authorized to exercise control over the type, quality or the use of material supplied by any other person.
- Anyone to supply the labor necessary for the work or is authorized on behalf of the person for whom the work is undertaken or any other person, to employ or select for employment

workmen to assist him in the execution of the work.

The type of contractors is categorized into five, which are building contractors, civil works contractors, mechanical contractors, electrical contractors and specialist contractors. The drilling work is included into the specialist contractors. Also specialist contractors include demolition, construction of water supplying or wasting facilities, plumbing, construction of sanitation facilities, fixing of air conditioner and elevator, assembly of a car body, installation of the electric communication network or security system and so on. Each of five types has seven classes of registration except specialist contractors which has only three classes. The registration class is determined by various factors showing the capacity of the companies or their work. Those factors include contract value per work or financial status of the company, number of the staff by qualification, type and number of equipment owned, detention of the workshop, tenant and office, type, number of safety equipment and experienced work of the company etc. The requirement of each factor is set per class so that the company applies for it according to the requirement. Normally, the registration fee and annual subscription fee are differed by the class. For the foreign company, those fees are also different. In case they come to the country to conduct only specific work, the temporary registration shall be applied.

The submission of the following documents shall be needed for the evaluation of new applicant. In the process of the evaluation, the officers of the Board shall visit and inspect the offices, workshops, yard properties and projects executed or other facilities of the applicant. After the approval of the application, the registration shall be completed upon the payment of registration fee and annual subscription.

Dully signed and stamped application form which include the financial status of the company, office facilities, staff qualification, plant and equipment owned, hand tools and testing equipment owned and references.

- Certificate of incorporation or registration
- Proof of ownership of office
- CV's of shareholders/partners each with certified copy of share certificate and certified academic/professional certificate for qualified shareholder/partner
- CV's of key personnel & certified copy of academic/professional certificate with perspective employment contracts for each staff
- Passport size photo of the technical director endorsed at the back by advocate
- Certified true copies of registration cards/proof of ownership of plant and equipment
- Certified current bank statement
- Proof of fixed asset ownership of any
- Dully filled and signed anti-bribery pledge
- Company memorandum and articles of association or extract from registrar of Business Registration licensing Authority (Brela)

CRB shall provide for the registered contractors the advice on the safety in the site, the inspection of the project, training on the contract management and techniques, examination and award, conducting of the workshop and conference, and review of the registration regulation.

There were 25 companies among the 126 companies which were registered the drilling permit of MoW. The reason assumed is that some of the companies which were not registered didn't fulfill the requirement such as the number of the staffs, equipment and financial status and so on. Also it might not be necessary for some other companies to register it since most of their clients were the individual ones and had never asked about the permit. Otherwise, the registration might be invalid due to the unsettlement of the annual subscription.

Business Registration Licensing Authority (Brela)

The register of the company or incorporation shall be a requirement for every application to the public registration body such as the drilling permit of MoW, CRB and others.

The register of the companies are taken in charge of Brela under the Ministry of Industry, Trade and Marketing. The National Industries (Licensing and Short title Registration) Act was made in 1967 by the government of Tanzania. After that, the Business Licencing Act was enacted in 1972 and all companies which execute industrial activities are obliged to register their companies.

According to the Companies Act established in 2002, “company” is defined as the four followings.

- Private Company: The Company is owned and operated by the individuals who have a special relationship (family, friend etc). The number of staffs is the range between 2 to 50. The share trading is limited according to the company regulation. The registered company shall submit the report of annual return and legal documents.
- Public Company: The number of minimum staff is seven, and no limitation is in the maximum number. It is possible for the share trading to do trading stock freely. The consolidation of the company shall be determined based on the purpose of the company, share capital, source of fund and prospectus. The private company can be changed to the public company if the company does the modification of the memorandum, increase the number of staffs more than seven and issuance of the prospectus. The memorandum shall mention on the regulation of the share trading between the company member and director, the company and broker in case of listed company.
- Foreign Affiliate Company: The company has the branch office of the firm whose headquarter is located out of the country though the investor and shareholder are local ones. The memorandum, information on the headquarters, the list of the directors, the representative of the branch office and special registration and application fee are required for the register of the company.
- National Company: The private company receiving subsidy from the government more than half of the capital.

The register of the company shall be obliged to the four above companies. The registration fee, application fee, stamp tax of the memorandum shall be needed for the registration. The registration fee and type of the registration shall be determined by the capital cost. The type of the registration is categorized to two of Certificate of Registration and Industrial License. Also the registration office shall be differed according to the type. In case of Industrial License, the application would be done at Tanzania Investment Centre (TIC) or Industrial Licensing Board under the Industrial Licensing Section, while the applicant for Certificate of Registration is supposed to go to the registrar of Brela. The documents such as the dully filled application form, a copy of business name certificate or certificate of incorporation, a copy of feasibility study etc are supposed to submit.

Among the 126 companies registered to MoW, 27 companies had been registered to Brela. The register of the Brela would be valid permanently until the company informs the change of the business or company name and close of the business. At least 126 companies which were the target of baseline survey should have been registered to Brela since the registration to Brela was one of the requirements for the application to the drilling permit in MoW. However, it was confirmed that the companies registered were only 27 through searching of the registered companies on the web site of Brela. The reasons why the other companies were not found were assumed as deletion of the registration due to the close of business, change of the name of companies and use of the different name for application of registration.

3) Current Situation of Well Drilling Work under Rural Water Supply and Sanitation Component (RWSS) of WSDP

Progress of Procurement for 10 Village Project under the RWSS Component

The procurement process of consulting service (stage 1) for 1st cycle of 10 village project under the RWSS component started from 2007/2008. As shown in **Table 8**, the services and works of this project were procured by the sequence from 1) to 4). Out of 123 target LGAs, 47 had already engaged the contract of the construction work of water supply facility. At the same

time, the consultant who would work on the supervision of the construction work (stage 2) was under procurement process. Soon after the engagement of the contract, the work was to be commenced. For the other districts, the status was still under bidding process for either construction or designing of the well/facility for the water sources. There were still two LGAs which had not yet completed the procurement of consultant to conduct the survey and design in the stage 1.

Table 8 Procurement Stage and Progress of Contract under RWSS Component

Procurement Stage		No. of LGA already engaged
1)	Consulting Service: scoping survey, formulation of sub-project plan, detail design, preparation of bidding document, supervision of work (stage 1) ³	130
2)	Well drilling	109
3)	Consulting service: Supervision of water facility construction, operation and maintenance support (stage 2)	31
4)	Water facility construction	47

(Source: compiled based on the data from Water Sector MIS)

As shown in **Figure 6**, most of the LGAs had procured the consultant for stage 1 the period between 2008/2009 to 2009/2010. In case the groundwater was determined as water source, the well drilling work was conducted after 2009/2010 by the supervision of consultants. For the sub-project which the water source was secured, facility design and preparation of bidding document were conducted. Then, the construction work should be started after the bidding and the engagement.

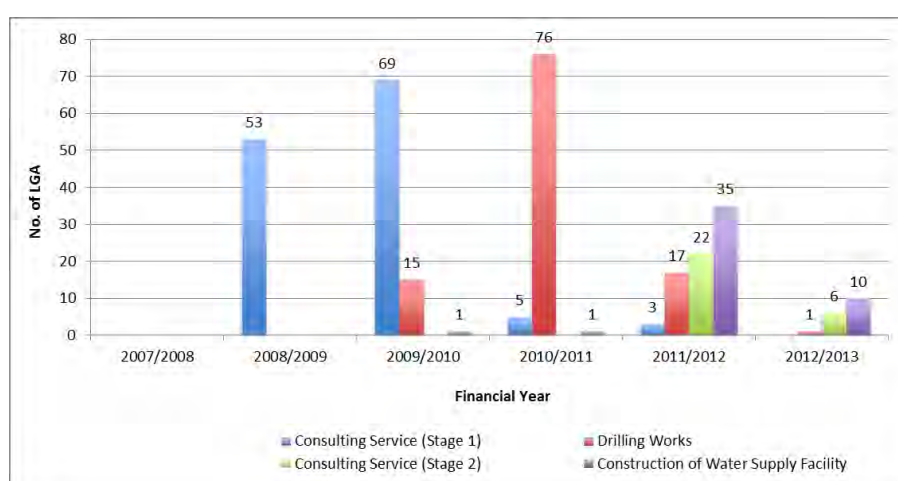


Figure 6 Trend of Number of LGAs already engaged by fiscal year

In the initial plan, it was estimated to take two to three years in stage 1 for the consultant from the engagement to the completion of the facility construction. In fact, however it took three to four years to conduct the half scale of the initial plan. In such context, it would take around five years until the 1st cycle of RWSS component would be completed in all target LGAs because of the fact that progress of the project was differed in LGA, and there were still a few LGAs which had not completed the procurement.

Contract of Well Drilling Works

Number of Contract

As of December 2012, out of 132 LGAs, 121 contracts of well drilling works were engaged in 109 districts⁴. For the rest of 23 LGAs, 5 LGAs determined to use only surface water and 3 LGAs are under the procurement of consultant for stage 1, and also 15 LGAs were under either

³ MoW applies the term of “Phase I”, “Phase II” in the contract. For avoiding the confusion with the WSDP phase as a matter of convenience, the term of “stage 1”, “stage 2” are used in the report.

⁴ The number of district and contract is not corresponded since some districts engaged the contract by dividing to lot.

designing or bidding for the well drilling work.

Number of Well

Out of 121 engaged contracts, number of planned wells were 1,127 in total, namely, the total number of drilled wells were 1,095 including the 764 of successful wells (69.8 % of success rate). Accordingly, 67.8 percent of wells were completed to the plan. Except for 8 contracts, the number of successful wells was 731 out of planned 1,043 wells (92 contracts). The remaining 312 wells were dealt as unsuccessful wells in the contract.

Within the contract of well drilling work under the RWSS component, the contractor conducted the drilling work with only limiting to the planned number of wells. It meant that the compensation of the drilling for unsuccessful wells was not required for the contractor. The drilling work included two stages of 1) test well drilling with 4" diameter, 2) reaming to the required diameter and installation of the casing if the test drilling was resulted in successful well. In case of unsuccessful well, the payment for 1) should have been done. Only one time of drilling was allowed for one well, that is, alternative site was not be allocated. Accordingly, as long as unsuccessful wells were come out, it would be impossible to achieve 100 percent to the plan under the current condition of contract.

MoW was planning that for the sub-project which was failed to conduct the facility construction due to the unsuccessful well, the drilling would be brought over the WSDP Phase 2.

Well Specification

According to the actual work result, the average depth of well was in between 78 to 114 m. For the diameter of well, 95 percent of contract stipulated as 6 "(150 mm). The ratio by the facility type determined in Phase I was the piped scheme with the submersible pump (53.4 %), gravity flow piped scheme (41.5 %) and hand pump well (5.1 %)⁵. Therefore, the ratio of the construction of piped scheme well was occupied high.

Number of Contractor and Contract Value

The number of the contractor who engaged 121 contracts including joint venture was 23, namely, 21 companies have taken in WSDP drilling works. Most of the companies engaged one to two contracts, though the average number of contract per company was five. On the other hand, three companies engaged more than 15 contracts as a prime (maximum 28 contracts), whose contracts covered the half number of wells to the plan. *Table 9* shows the actual condition of the contract.

Table 9 Actual Contract of Well Drilling Works under the RWSS Component of WSDP (Phase I)

No. of LGAs already engaged well drilling work		109 / 132 LGAs	
Number of contract ^{*1}		121	
Planned and actual No. of wells ^{*2}	Planned No. of well for Phase I	1,119	
	No. of drilled well	1,089	
	No. of successful well	760	
	Attainment rate (successful well/planned)	67.9%	
	Success rate	69.8%	
No. of contract stipulating required casing diameter	100mm	1	1.3%
	120mm	1	1.3%
	150mm	75	94.9%
	200mm	2	2.5%
	Total (valid case)	79	100%
	(exceptional case: diameter unknown)	42	
Depth of well per contract	Average maximum depth (m)	114.2	(valid case 79)
	Average minimum depth (m)	78.3	(valid case 65)

(Source: compiled based on the data from Water Sector MIS and Rural Water Supply Division)

Note:

1: One LGA engaged the multiple contracts

2: Actual results as of Dec 2012 are shown since drilling work is on going

⁵ Ministry of Water (2011) Water Sector Development Programme: Restructuring Plan for Phase I, Ministry of Water, Dar es Salaam, 103p

Scale of Plan for WSDP Phase II (2013/2014-2017/2018)

According to Rural Water Supply Division (RWSD) of MoW, the scale of plan and details of RWSS components under WSDP Phase II had not yet been decided. Regarding the well drilling works, the drilling work of which was resulted in unsuccessful would be included, and the construction of the water source in new candidate village for 2nd cycle of RWSS component as well.

Under the Water Sector Support Project (WSSP) which was one of the components for supporting WSDP with initiative of World Bank (WB), a mission would be dispatched in February 2013 to support formulating the project of Phase II. The outline of the plan shall be decided through the discussion between the mission and stakeholders. Also the proposal from the programme evaluation of Phase I, which was under implementing, shall be reflected to the formulation of the plan.

Regarding the 2nd cycle of sub-projects, though the scale of plan and details were not yet decided, the period from 1st year to 2nd year would be taken for survey and formulation of plan and design in order to work on the procurement of the consultant according to the project implementation schedule. Therefore, the bidding for well drilling work was expected to be started from 2014/2015 at the earliest, or 2015/2016.

It was needed to confirm continuously to MoW if the well drilling works brought from the Phase I was conducted earlier by the same contractor engaged in Phase I with applying the method such as private contract.

(2) Baseline Survey on Private Drilling Companies

This section describes salient points of findings from detailed analysis on capacities of private drilling companies and their needs for private sector support from DDCA based on results of the baseline survey conducted by a consultant who was assigned by the project team. This serves as the final results of analysis on the baseline survey on private drilling companies.

As it was reported in the Progress Report 1, the consultant, Bureau for Industrial Cooperation (BICO) of University of Dar es Salaam, completed interviews with the targeted private drilling companies and submitted the first draft of the preliminary analysis report in the end of September 2012. As a result of verification of the survey data and report submitted by the consultant, the project team observed that the consultant would countercheck missing information and inconsistency in the collected data to further elaborate the survey results in the report. The project team received a final version of the preliminary analysis report and the dataset from the consultant in the end of November 2012 after several improvements.

1) Methodologies of the Survey

The survey employed structured interviews with all the business entities which are registered as the water well drilling permit holders at MoW. After establishing a contact with them, the survey team sent a questionnaire to each organization in advance of the interview so that the companies would be able to fill in the form beforehand. The survey team made an interview with the management of the organization to have complete information on the questionnaire as much as possible. Information collected from the survey was processed with MS Excel for data compilation and further analysis.

For identification of the target group of the survey, the project team referred to a list of the water well drilling permit holders registered at MoW as of March 2012. A total of 126 business entities were identified from the list as the target of the survey. In addition, another 27 companies that had not been on the list of MoW were found from other sources. The number of the targeted companies, therefore, counted 153 in total. The survey team finally collected questionnaires from 99 out of 153 companies, which made the response rate 64.7%. The rest was either not located due to unavailability of information on their physical addresses, no longer in drilling works, or against providing information on their business operation. **Table 10** shows distribution of the targeted companies by status of the survey and their business operation. For

those which were not interviewed, a breakdown of the companies is also shown by reasons why the survey could not be conducted.

Table 10 Distribution of Target Companies by Status of the Survey and Business Operation in Drilling Works

Status of Business in Drilling Works	Surveyed	Not Surveyed				Total
		Not located	No longer in business	Refused survey	Sub-Total	
Currently in business	94	1	0	1	2	96
No longer in business	5	1	10	0	11	16
Status is unknown	0	31	0	10	41	41
Total (N)	99	33	10	11	54	153
Total (%)	64.7	61.1	18.5	20.4	35.3	100

(Source: Results of the baseline survey)

Analyses were made on 94 out of 99 questionnaires collected which excludes survey results of five companies that were considered to be rendering services for groundwater exploitation survey only or no longer in business of drilling works.

2) Limitations of the Survey

Identification of Business Entities in Water Well Drilling Industry

It was found in the process of the survey that the list of the drilling permit holders of MoW had not been fully updated to provide basic information such as office locations, contact numbers and status of their business operation with accuracy. It hindered the project team from not only reaching the target companies for interviews but also identifying the total number of business entities which are actually involved as contractors in the water well drilling industry.

Updated information on the number and distribution of the business entities in drilling industry provides DDCA with an overall picture of potential clients of the private sector support services. The project team made an effort to obtain supplementary information on existing business entities in the drilling industry from other sources such as the Contractors Directory of CRB and Water Sector MIS. These sources of information brought names of another eight companies which render drilling works although they were not included in the original list of the registered companies at MoW.

By adding these eight companies as well as two entities which could not be interviewed to 94 respondents, a total of 104 organizations can be considered as the population of the business entities in drilling works which are identifiable at present. Survey results of 94 cases analyzed here still provide information and data which would represent these 104 business entities.

Operation of the Field Survey

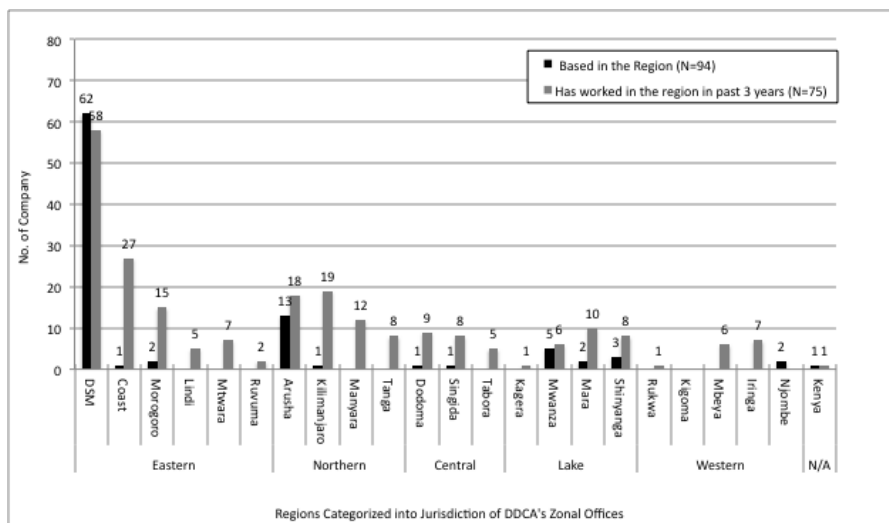
The survey team had difficulty in conducting interviews as per schedule since the management staff of most of the targeted companies were in small numbers, one or two on average, and was too occupied in their business operation to bear time for preparation of answers to questionnaires and for attending the interview. The team had to make several visits and follow-up by telephone communication for these respondents in order to collect questionnaires with valid answers as much as possible.

The other limitation faced in the operation of the field survey is that numbers of the companies are not willing to disclose the financial performance such as sales and profit/ loss as well as contract values, which made the response rate of the related questions lower than other items. Although the survey team explained confidentiality of collected information and data to the respondents, these companies were reluctant to respond to the questions. It is partly considered that these companies do not keep accurate financial records or they are afraid to state their income for taxation purposes. Bearing this limitation in mind, the project team utilized other source of information such as the Water Sector MIS for verification of financial performance of the private drilling companies, especially contract values of the works they provided in WSDP.

3) Business Establishment

Geographical Distribution

The majority of the organization surveyed is established as private companies limited by shares while six of them are formed as NGOs or religious organizations. Offices of these companies⁶ are concentrated in major cities in the country. **Figure 7** shows distribution of the companies by locations of their offices and project sites where they have worked in the past three years. Regions are grouped into five zones where DDCA operates through its Zonal Offices. 62 companies (65.9%) are based in Dar es Salaam, which is followed by Arusha and Mwanza. Projects the companies have worked in the past three years are located in most of the regions although there are several areas such as Ruvuma, Kagera, Rukwa and Kigoma where few companies have working experience in the same period. Half of the borehole drilling works performed by the companies is located in districts with basement rock-dominant areas or combination of basement rock and other types of geological formation.



Note: The number of companies which have worked in the region indicates cumulative figures consolidated from 75 valid cases.

Figure 7 Geographical Distribution of Office and Project Location

It is observed that the companies in each zone have geographical advantage in performing works in the area where they are based. Those which are operating from regions in Eastern Zone have obtained more business opportunities in the same area than the companies in other zones. The same tendency is seen in Northern and Lake Zones, too.

Year of Establishment and Experience in Drilling Works

Half of the private drilling companies surveyed are relatively new as they were established after 2006, which coincides the launch of WSDP (**Figure 8**). The number of companies which start business operation in drilling works doubled in 2009-2011 compared to the preceding period. In these three years, 10-13 companies a year started drilling works as (a part of) their business while there were maximum 7 entities per annum from 1985 to 2008. Nearly 60% (56 nos.) of the companies have fewer than six-year experience in operation of the drilling works.

In comparison of years of experience of the company in drilling works with the number of contracts awarded in WSDP, there is no clear correlation between these two factors. A total of 21 companies were involved in the drilling works as the contractors for 10-village sub projects in RWSS Component of WSDP (Phase 1). Among these organizations, 16 companies are included in the respondents of the baseline survey. As **Figure 9** indicates, relatively new companies are awarded contracts more than the ones that have longer experience in operation of drilling works. It implicates that there is possibility for the companies with a few experience in the drilling industry to have business opportunities in WSDP in case that other factors such as experience of key personnel in similar works, arrangement of drilling equipment to be used in

⁶ The word "private drilling companies" or "companies" refer to all the organizations interviewed in this baseline although the respondents include NGOs and religious organizations.

the works, and financial status satisfy requirements in evaluation of bidding.

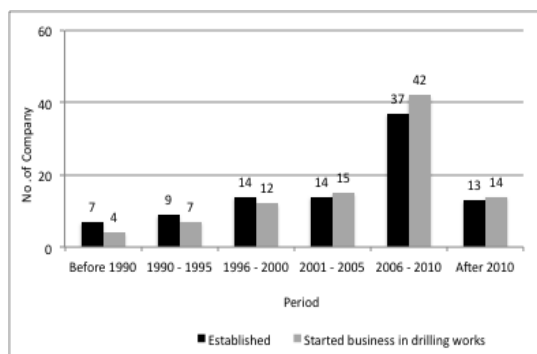


Figure 8 Year of Establishment and Start of Business Operation in Drilling Works

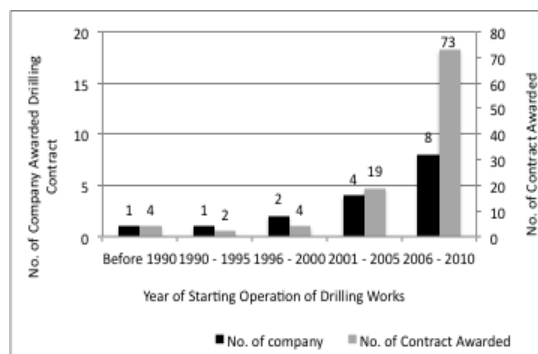
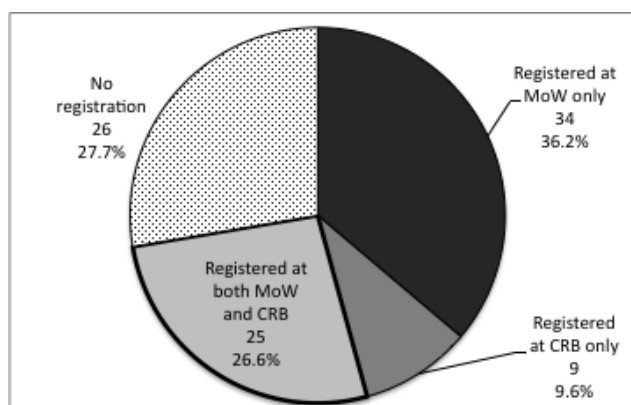


Figure 9 Distributions of Companies Awarded Contracts for Drilling Works in RWSSP/WSDP by Year of Experience of the Organization

Registration to Regulatory Bodies

34 companies are registered at CRB while the number grows to 59 in case of those which are regulated by MoW as the holder of valid water well drilling permit⁷. Of these entities, there are 25 companies (26.6%) which have registration at both CRB and MoW as shown in **Figure 10**.



Note: Each label in the figure shows category name, number of the case, and its proportion in the total number of the valid cases.

Figure 10 Distribution of Companies by Status of Registration at CRB and MoW

The specialist contractors in drilling works (28 nos.) occupy the majority in the surveyed companies which are registered at CRB. Others, however, possess registration in the areas of civil works, building or electricity only which are not included in the conditions of eligible bidders of drilling works in WSDP.

Attention should be paid to a fact that about 15% of the permits are not renewed annually as per requirement although three fourth of the surveyed companies have once obtained the water well drilling permit from MoW, according to findings from the interviews. This also suggests that MoW should update information on the water well drilling permit holders annually.

Also, one fourth of the companies were registered neither of the authorities, which would hinder these organizations from participating in tendering of drilling works in WSDP. Even if they show high interest in DDCA's hiring business of drilling equipment, possibility of this group to utilize the equipment in WSDP would remain low unless they register themselves at CRB and MoW to satisfy the eligibility.

⁷ The validity of the drilling permit is one year. The companies which updated the permit in 2011 or 2012 were counted as the holders of the valid permits in this analysis.

4) Clients for Water Well Drilling

The major clients for water well drilling for the surveyed companies were individual households (90.4%), followed by private companies (81.9%), government (71.3%), and donor/NGO(57.4%) according to **Figure 11**. 27 companies had never worked for borehole drilling funded by the government.

Figure 12 shows the distribution of the number of companies by the proportion of the government client concerning the number of the awarded contract and contract value. The companies of which numbers of the governmental contract were less than 40% was 66.1% (41.5%+24.6%) of the surveyed companies. Regarding the contract value, the companies of which the governmental contract values were less than 40 % was 58.7% (31.7%+27%). Consequently, the proportion of governmental work for approximately 60 % of the surveyed companies is less than 40 %. Meanwhile, the contractors which have been awarded the contracts in WSDP concentrate in the groups that have more than 60% of sales from the contracts with the government. 12 companies out of 21 contractors for drilling works in RWSSP/WSDP (Phase 1) are categorized into these groups. This situation indicates that the companies which regularly work with the government are in the minority while the rest usually deal with demand of the private sector and individual households.

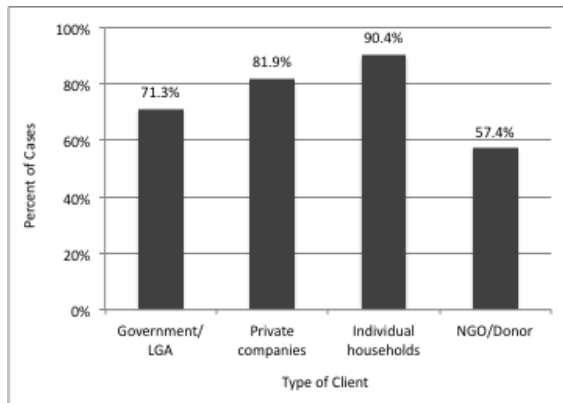
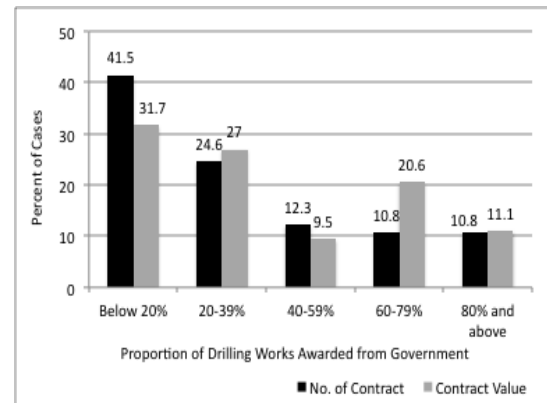


Figure 11 Clients for Water Well Drilling (multiple answers)



Note: No. of valid cases is 65 for the variable of “No. of Contract” and 63 for “Contract Value”.

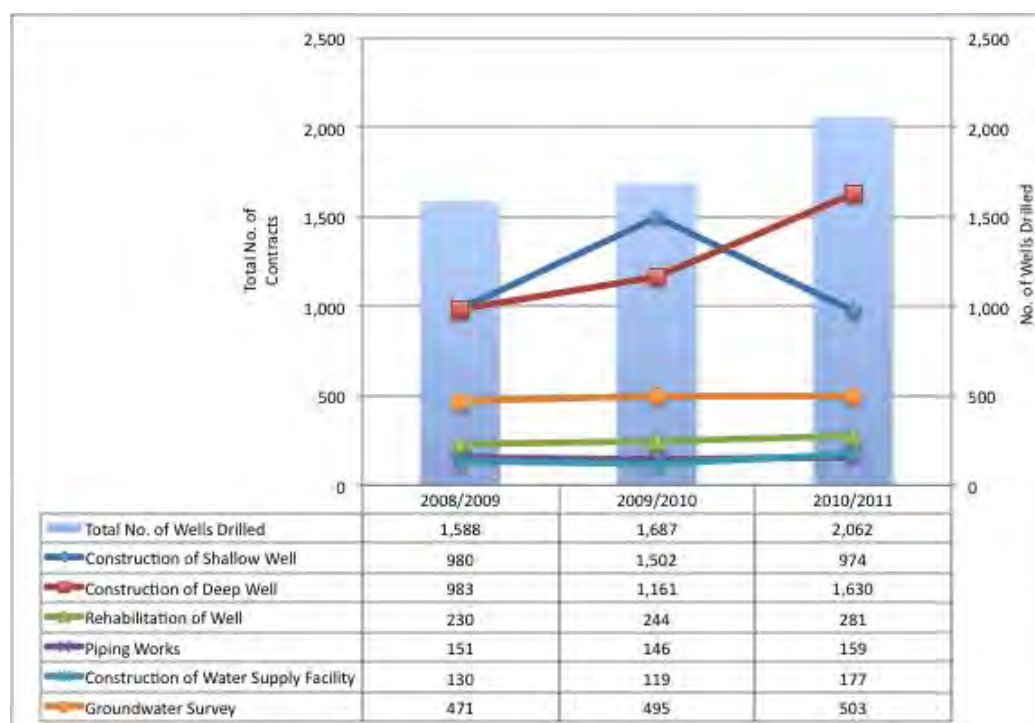
Figure 12 Proportion of Drilling Works Awarded by the Government in Number of Contracts and Contract Values

5) Performance in the Past Three Years

This subsection describes the performance of the companies in drilling works from viewpoints of the number of contracts awarded, number of boreholes drilled, and amount of contract value in the past three years from 2008/2009 to 2010/2011.

Number of Contracts Awarded

In terms of the number of the contracts, the borehole drilling occupies the majority of works awarded to the surveyed companies as a whole. **Figure 13** shows an aggregate of number of contracts awarded to the companies for each type of work annually. Information of the graph also includes the grand total of boreholes drilled by the surveyed companies. It indicates that the greater number of the contracts is for drilling of wells, followed by groundwater survey. Works for borehole construction increased steeply in the period while contracts for other works reduce or remained at the same level. As the number of contracts for deep well construction grew, the total of wells drilled also rose accordingly. The increase of the contracts for borehole construction coincides with growth of the numbers of business entities which started the operation of drilling works as well as procurement of contractors for exploratory drilling in RWSSP/WSDP in the same period.



Note: Total number of wells drilled contains both successful and unsuccessful boreholes.

Figure 13 Total Number of Contracts Awarded to and Wells Drilled by the Surveyed Companies in the Past 3 Years

The median of the number of contracts awarded to a company is eight to nine a year in case of drilling of deep wells (*Table 11*). Among 75 companies which provided valid answers on the number of the contracts for drilling of deep wells, approximately 60% (48-54 companies) worked for less than 20 contracts a year (*Figure 14*). Those which had more than 120 contracts a year are contractors which have participated in the drilling works for RWSSP/WSDP (Phase 1).

Table 11 Number of Contracts Awarded in the Past 3 Years per Company

Type of Works	Valid N	Number of Contracts by Fiscal Year					
		2008/09		2009/10		2010/11	
		Mean	Median	Mean	Median	Mean	Median
Constructon of shallow well	23	40.8	2.0	65.3	2.0	42.4	6
Construction of deep well	75	13.7	8.0	15.9	9.0	21.7	9
Rehabilitation of well	23	10.5	7.0	11.1	9.0	12.2	8
Piping works	27	5.8	2.0	5.4	3.0	5.9	3
Construction of water supply facility	14	9.3	3.5	8.5	5.5	12.6	7
Groundwater survey	31	15.2	10.0	16.0	15.0	16.2	12

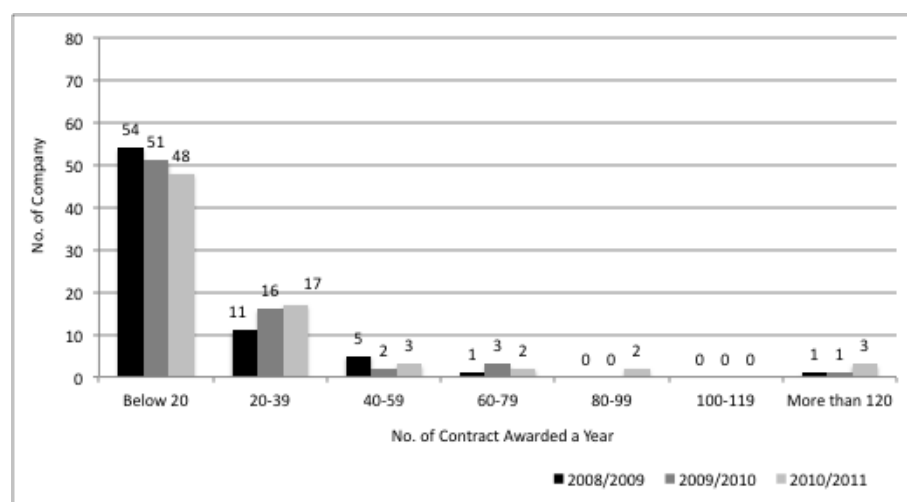
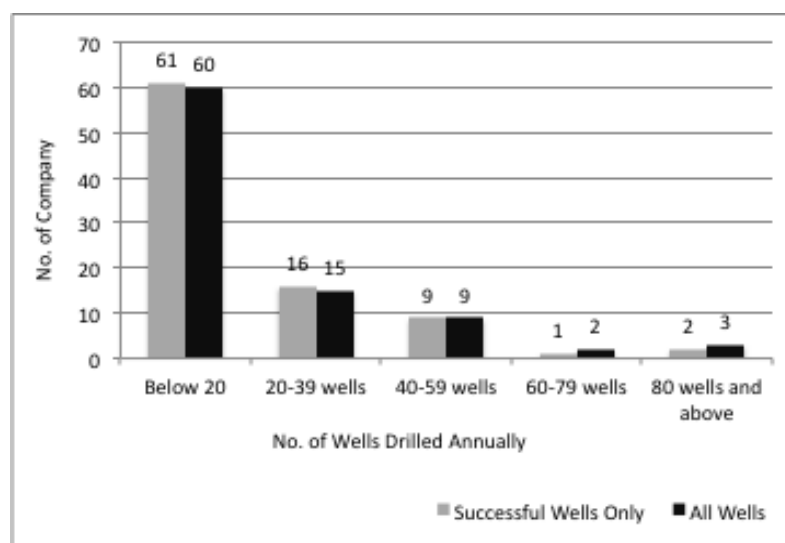


Figure 14 Distribution of Companies by Number of Contracts Awarded for Drilling of Deep Wells per Annum

Number and Type of Wells Drilled

From the valid data obtained from 89 companies, it is estimated that one company drilled 10-13 wells⁸ including unsuccessful ones as the median per annum in the period of 2009-2011. Approximately 68% (61 nos.) of the companies drill less than 20 successful wells a year (**Figure 15**). This proportion remains almost the same even in case including unsuccessful ones.



Note: The number of valid cases is 89.

Figure 15 Distribution of Companies by Number of Wells Drilled per Annum

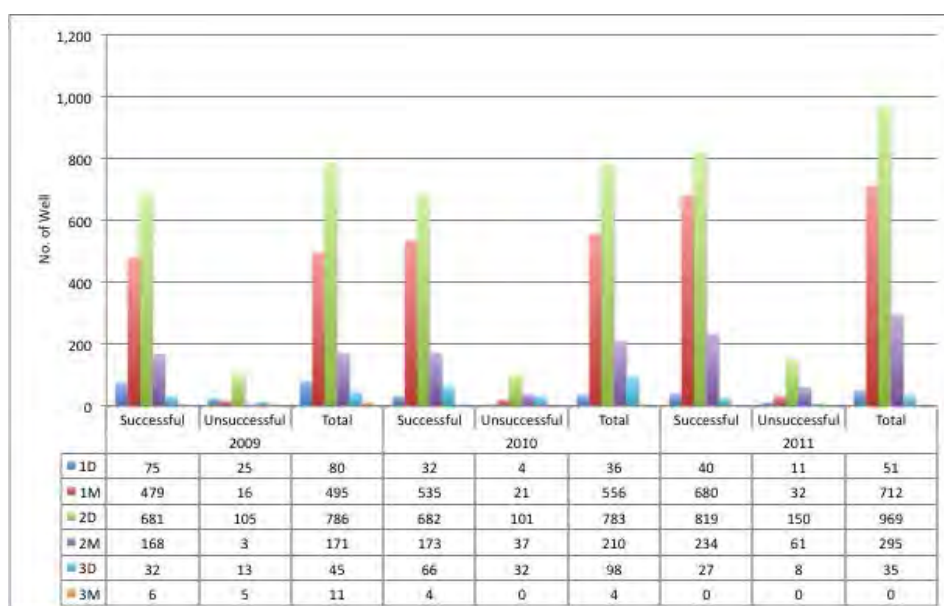
Distribution of these drilled wells was also obtained by type of wells categorized according to use and depth of the well, size of casing pipe, and drilling method as listed in

Table 12. The biggest number of wells constructed in the period is Type 2D which is drilled with DTH method and mainly meant for the medium-scale piped water schemes (Note: The number of valid cases is 89) (**Figure 16**). The second largest number is Type 1M constructed with mud rotary drilling method for hand pump water facilities. The number of borehole drilled in the past three years was 5,337. Therefore, the average annual number of borehole drilled is 1,779.

⁸ This number includes the wells drilled with hired equipment. Information could not be obtained from the respondents on the proportion of wells constructed with the drilling equipment owned by the company and those which were drilled with the hired rigs.

Table 12 Categorization of Well Specifications

Type	Use of Well	Well Depth	Size of Casing Pipe	Drilling Method
1D	Hand pump	30-100m	4" or 5"	DTH
1M	Hand pump	30-100m	4" or 5"	Mud rotary
2D	Small or Medium-scale piped scheme	30-200m	6"	DTH
2M	Small or Medium-scale piped scheme	30-200m	6"	Mud rotary
3D	Large-scale piped scheme	30-200m	8" to 10"	DTH
3M	Large-scale piped scheme	30-200m	8" to 10"	Mud rotary



Note: The number of valid cases is 89.

Figure 16 Distribution of Wells Drilled per Annum by All the Surveyed Companies

These water sources constructed in each year vary in depth depending on type of wells. Type 1D and 1M have approximately 90m with 4 to 5 inches diameter depth while 2D and 2M are more or less with 100m depth with 6 inches diameter on average. The depth of wells in Type 3D and 3M is in almost the same range with those of 2D and 2M. There are no marked changes in the average depth of each type of wells in three years.

The average days required to drill a successful well is five to eight days depending on type of well. Working days involved is relatively smaller in case of use of DTH method, as shown in Type 1D, 2D and 3D, in comparison with the period taken for mud drilling (Type 1M, 2M and 3M) in **Table 13**. It takes another one or two days in case that pump installation is included in the works.

Table 13 Average Days Required for Drilling Works

Type of Work	No. of Working Days Required per Each Type of Well					
	1D	1M	2D	2M	3D	3M
Drilling a successful well including drilling, development and pumping test	5	6	5	7	7	8
Drilling an unsuccessful well excluding PVC installation, development and pumping test	3	3	2	3	4	4
Pump Installation (hand pump or submersible pump)	2	1	1	1	2	2

Note: The number of valid cases is 93.

Based on information on the type of wells drilled, the proportion of the companies by drilling methods they have experienced is 36.9% with mud rotary drilling only, 35.7% with DTH method only, and 27.4% with both DTH and mud rotary drilling (**Table 14**). This means that approximately 63% of the companies have experience in using DTH drilling method.

With regard to type of water supply facilities, 45.2% of the companies worked for borehole construction for piped schemes only in these three years and 34.5% was involved in drilling works for hand pump water facilities only. The remaining 20.2% has experience of drilling works for both hand pump and piped schemes. From the survey results mentioned above, it is observed that about two third of the companies possess working experience in drilling works with DTH method to construct wells which can be served for the medium-scale piped schemes.

Table 14 Distribution of Companies by Type of Working Experience

Drilling Method	N	%	Valid %
Mud drilling only	31	34.8	36.9
DTH only	30	33.7	35.7
Both DTH and mud drilling	23	25.8	27.4
Total	84	94.4	100
NA	5	5.6	
Total	89	100	

Type of Facility	N	%	Valid %
Piped scheme only	38	42.7	45.2
HP only	29	32.6	34.5
Both HP and piped scheme	17	19.1	20.2
Total	84	94.4	100
NA	5	5.6	
Total	89	100	

Note: NA (Not applicable: no drilling works were conducted in the period.)

Size of a Contract for Deep Well Construction

The drilling works accounts for approximately 80% of the sales of the surveyed companies. Average size of a contract for deep well construction is analyzed in terms of the contract value and number of wells drilled. Valid data was obtained from 59 companies on variables of the number of contract, contract values and number of drilled wells per annum for three successive financial years from 2008/2009 to 2010/2011. The median of a contract value is within a range of Tsh 7million – 8million in these three years, which covers construction of one well (**Table 15**). The unit cost of drilling per meter was ranged between Tsh 70,000 and Tsh 80,000 since the average depth drilled between 2008/2009 and 2010/2011 was approximately 100 meter. The number of wells drilled per contract appears small as the major clients for drilling works for the companies are individual households and private sector. In case of the works in WSDP, one contract is made for construction of an average of nine wells.

The contract value awarded by those which have participated in drilling works in WSDP appears relatively larger than the ones without experience in the same programme. The difference becomes much more significant, especially in 2010/2011. With considering that the procurement of contractors for drilling works in RWSSP/WSDP (Phase 1) reached a peak in 2010/2011, the contract value of the companies with experience in WSDP seems to be pushed up by the contracts awarded from the programme.

This finding is also supported by the fact that the average value of a contract of drilling works in RWSSP/WSDP (Phase 1) is approximately Tsh 20 million per well, which was obtained from calculation of actual contract prices of the works conducted by all the 23 contractors involved in the programme, as explained in Section 3.1.3. The average depth per well was approximately 95.9 m and the unit cost of drilling per meter was Tsh 209,000 based on the result of drilling works in RWSS component in 1st Phase. The drilling works in WSDP provide the contractors with opportunities to have larger size of the contract in terms of its value and the number of boreholes required than those of clients in the private sector.

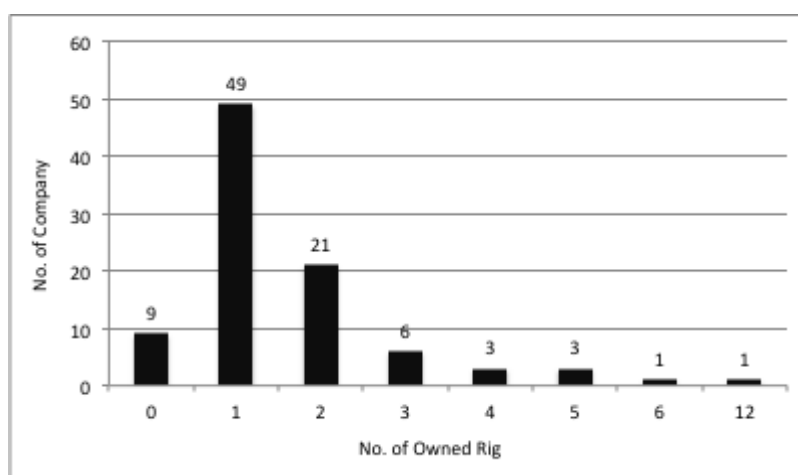
Table 15 Contract Value and Number of Wells Drilled per Contract

Category of Company		Contract Value (Tsh)			No. of Wells Drilled		
		2008/09	2009/10	2010/11	2008/09	2009/10	2010/11
Whole Cases (N=59)	Mean	21,978,884.91	18,105,406.38	19,030,230.28	1.91	3.56	2.75
	Median	7,000,000.00	8,000,000.00	7,729,312.50	1.00	1.00	1.00
Has experience in WSDP (N=13)	Mean	42,495,047.87	50,896,878.47	56,275,838.09	3.72	4.19	3.50
	Median	8,650,000.00	11,834,734.85	14,935,483.87	1.00	1.00	1.00
No experience in WSDP (N=46)	Mean	16,180,838.85	8,838,251.22	8,504,297.64	1.40	3.38	2.54
	Median	6,733,333.33	6,000,000.00	6,333,333.33	1.00	1.00	1.00

6) Possession of Equipment

Drilling Equipment

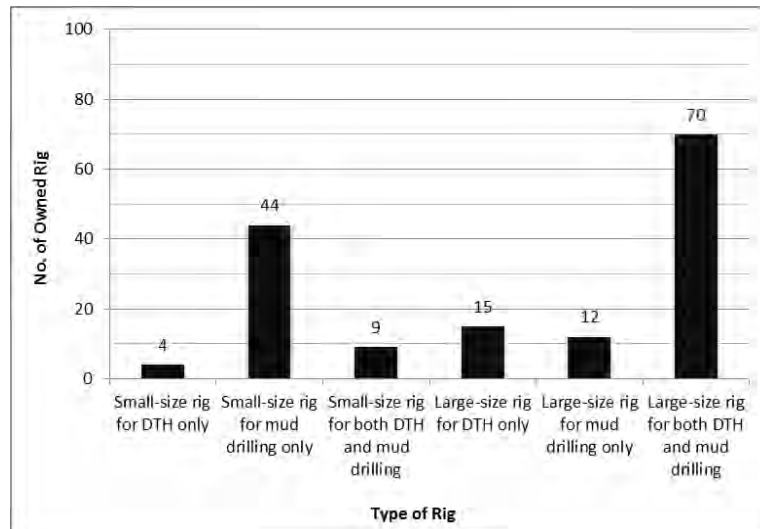
The number of drilling rig owned by a company is one on average. **Figure 17** indicates that the capacity of the private companies is relatively small in terms of possession of drilling rigs as 75% of the companies have only one or two sets of the machinery. There is only one entity which owns more than 10 rigs although it is far below the number of drilling equipment that DDCA possesses. Meanwhile, nine organizations have no rigs at all. They hire drilling equipment from others or contract out the whole scope of drilling works to specialized companies.



Note: The number of valid cases is 93.

Figure 17 Distribution of Companies by Number of Rigs Owned

The survey found a total of 156 drilling rigs owned by 84 companies among the surveyed. The average number of borehole drilled per rig was 11.4. This came from the calculation by dividing 1,779 boreholes annually drilled in average (refer to 3.1.4 (5) 2)) in the past three years from 2009 to 2011 by 156. As a result of categorization of these rigs by capacities, 45.5% (70 nos.) is classified into the large-size rig which can perform both DTH and mud rotary drilling methods (**Figure 18**). The second largest proportion is the small-size rig for mud drilling only with 28.6% (44 nos.). The definition of large-size rig refers to the one that has capacities to drill up to maximum 150m depth and 12-inch diameter.



Note: The number of valid cases is 154. For the remaining 2 rigs, there is no information which can be used to identify specifications and capacity of the equipment.

Figure 18 Distribution of Owned Rigs by Drilling Capacity

Further analysis in **Figure 19** shows distribution of companies by the number of owned rig according to the capacities. The proportion of companies which owns more than two units of large-size rigs for both DTH and mud rotary drilling accounts for less than 20% (15 nos.) of the surveyed companies.

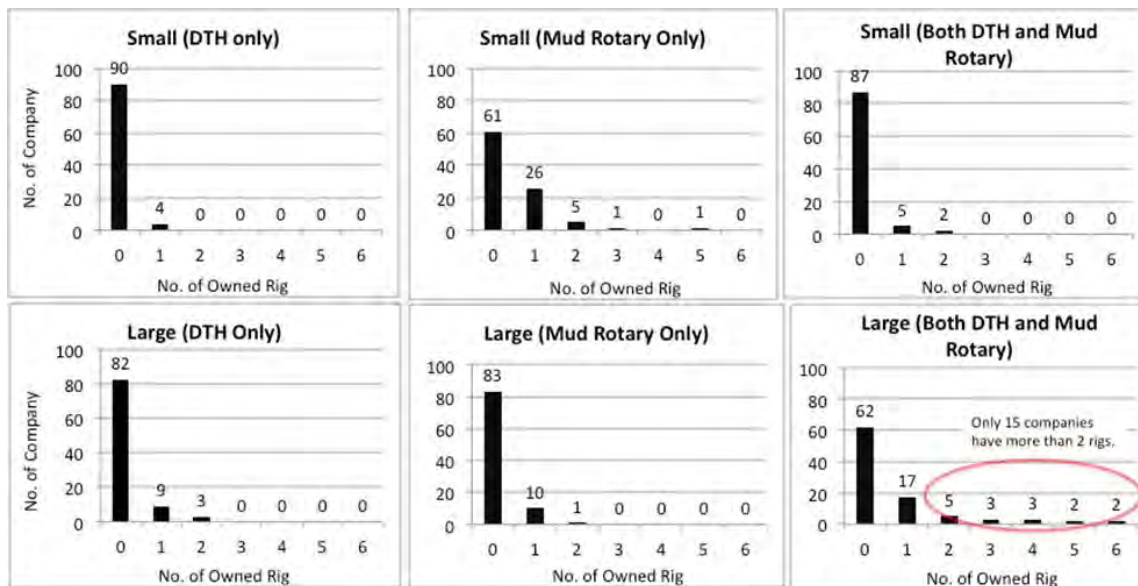


Figure 19 Distribution of Companies by Number of Owned Rigs in Each Type

In order to supplement shortage of the required number of rigs for particular works, 51% of the companies have ever hired drilling rigs from other business entities. This includes 13 companies which have used rigs owned by DDCA. There are more than 30 entities listed as the lender of the rigs. Almost all of these lenders operate drilling works as their business and hire out the equipment to others when it is available.

The cost for hired equipment is mainly charged either by meter or well. Table 16 shows the median of the hiring costs which were actually charged to the respondents. The figures are compared between the small-size drilling rigs which are mostly dominated with PAT model and other types of equipment. The median of the hiring cost is Tsh 80,000 per meter and Tsh 2

million per well for all types of the equipment. The hiring cost for PAT is cheaper than large-size equipment.

Table 16 Hiring Cost of Drilling Equipment

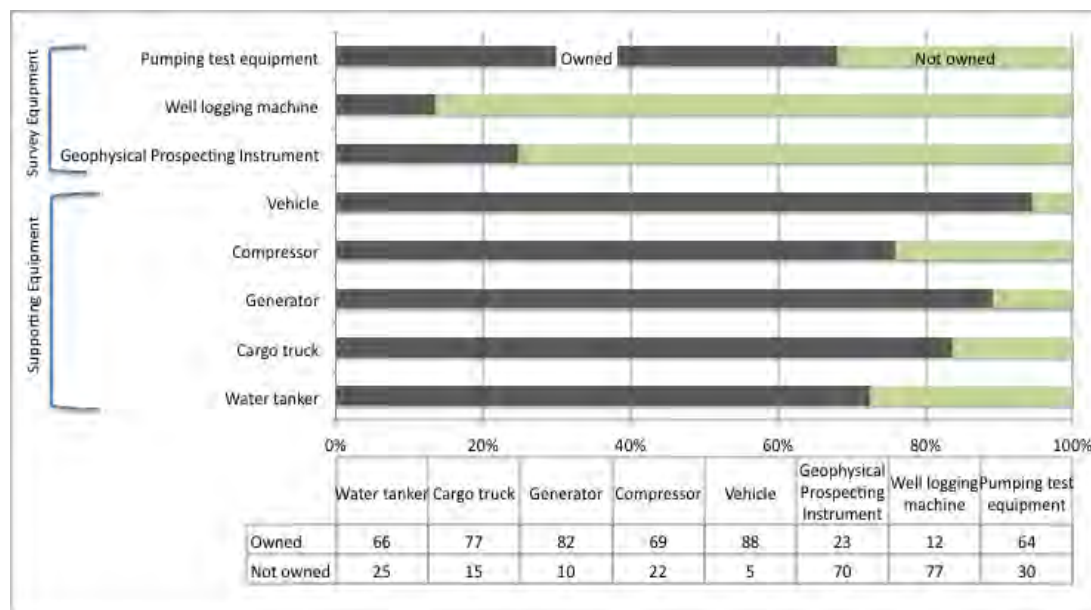
Charging Method	Type of Rig	N	Median of Hiring Cost (Tsh)
per meter	Small-size (PAT)	6	50,000
	Large-size (Excluding PAT)	19	110,000
	All types	25	80,000
per well	Small-size (PAT)	20	1,500,000
	Large-size (Excluding PAT)	18	6,000,000
	All types	38	2,000,000

PAT: Small rotary rig used by many drilling companies in Tanzania for drilling of boreholes less than 80 m with small diameter in the sedimentary rock areas.

Supporting and Survey Equipment

More than 60% of the companies own each type of supporting equipment consisting of water tanker, cargo truck, generator, compressor and vehicle (**Figure 20**). An average of one or two units of each type of the equipment is available in an entity. Meanwhile, the companies which have survey equipment are in small number except for the pumping test unit.

In case that the supporting equipment is not available at the company, the majority utilizes hiring service of those items. In contrast, the proportion of sub-contract becomes larger than use of the hired equipment in case of pumping test unit, well logging machine and geophysical prospecting instrument.



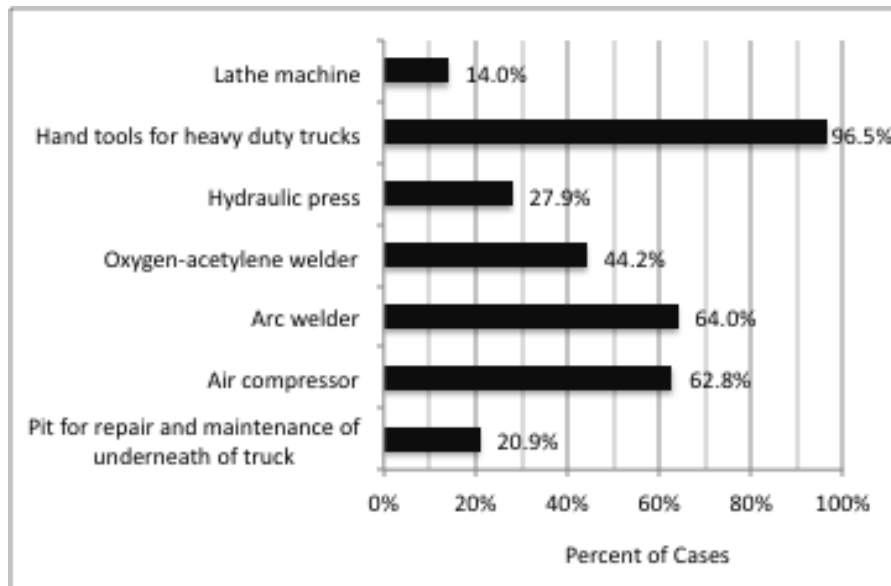
Note: Figures in the table above indicate number of companies while the graph shows its proportion.

Figure 20 Possession of Supporting and Survey Equipment

Maintenance of Drilling Equipment

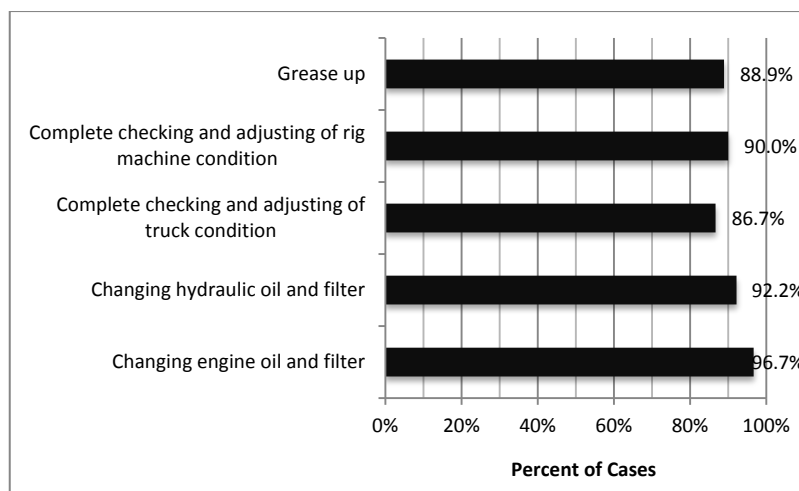
The majority of the companies attend the maintenance of the owned drilling equipment either at their workshops or on site. Only eight companies do not have workshop facilities with them while the rest installs equipment and tools as listed in **Figure 21**.

With regard to the type and level of routine maintenance of the owned rigs, more than 80% of the companies assess that they can attend all necessary works such as greasing up, checking and adjusting of condition of rigs and trucks, and changing hydraulic oil, engine oil and filters (**Figure 22**).



Note: The number of valid cases is 86.

Figure 21 Workshop Equipment and Tools Owned (multiple options)



Note: The number of valid cases is 90.

Figure 22 Type and Level of Periodical Maintenance of Drilling Equipment the Company can Perform (multiple options)

8) Human Resources

Staffing

The median number of the staff in one company is 15 in total including non-regular workers. The largest proportion of the companies has 10-19 employees followed by those with below 10 members (**Figure 23**). These groups account for 70% of the surveyed companies.

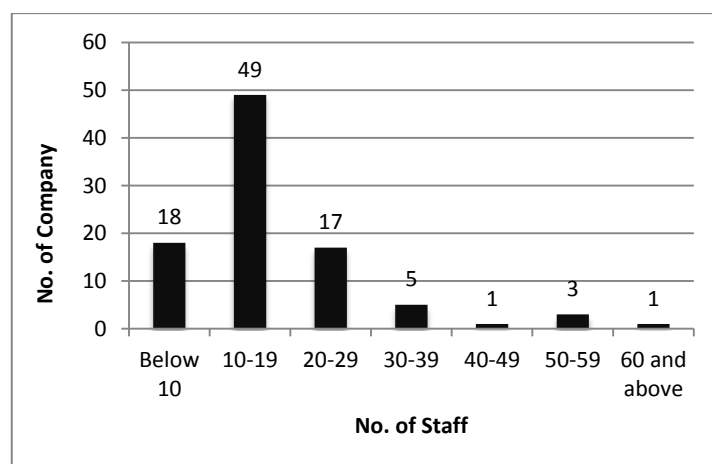


Figure 23 Distribution of Companies by Size of Staff

Drilling staff employed in an entity consists of one drilling supervisor, one driller (rig in charge), one assistant driller, and two workers on average. More than 60% of the companies also have staff in expertise as the engineer or hydrogeologist.

It is observed that the management staff serves as an engineer, hydrogeologist or drilling supervisor in several organizations as they have limited number of human resources. Staff at other position also makes similar arrangement to supplement shortage in staffing.

Working Experience and Qualification of Technical Staff

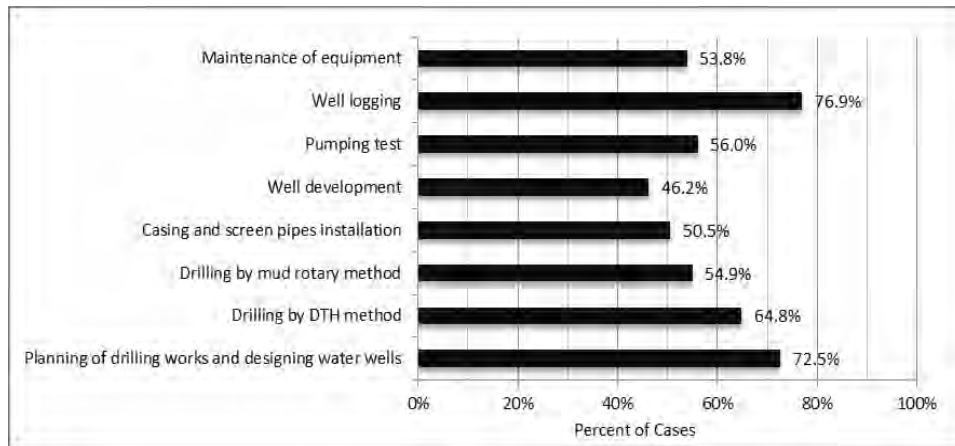
As to working experience of these staff members, the management has the longest period of experience in the drilling industry. The average period of their working experience is 14 years, followed by the engineer, hydrogeologist, drilling supervisor, and driller with 10-12 year career on average. Other employees such as assistant drillers, drilling workers (helpers and assistant technicians), mechanics, welders and plumber have been in the drilling industry for an average of five to eight years.

The majority of the engineers possess bachelor degrees, whereas most of the hydrogeologists and the drilling supervisors possess diplomas. The drillers (rig in charge) and assistant drillers are holding Form IV certificates, whereas the drilling workers are STD VII leavers. STD VII certificate holders are the majority of the workers in the surveyed drilling companies followed by the Form IV certificate holders. It is observed that the proprietors of the drilling companies call some of their staff engineers or hydrogeologists while they only possess FTC, Form VI, Form IV or Basic Certificates which are not qualified for those positions.

Capacity Development of Technical Staff

Of all the companies surveyed, the respondents at 91 entities expressed capacity development needs of their technical staff. The highest proportion of the companies see necessity of strengthening of knowledge and skills of the staff on well logging (76.9%), followed by planning of drilling works and designing of water wells (72.5%), drilling by DTH method (64.8%) as shown in **Figure 24**. Another one case is no answer and two cases are not applicable as the respondents do not see necessity of capacity development of their technical staff. Approximately 30% (29 nos.) of the respondents chose all the areas listed in the same graph as their needs for capacity development of the technical staff.

Only two organizations answered that they did not require capacity development of the technical staff as they have enough skills necessary for drilling works. One of them was a private drilling company which had the largest share in the contracts for drilling works in RWSSP/WSDP (Phase 1) and the other was a charitable organization providing support for water supply projects.

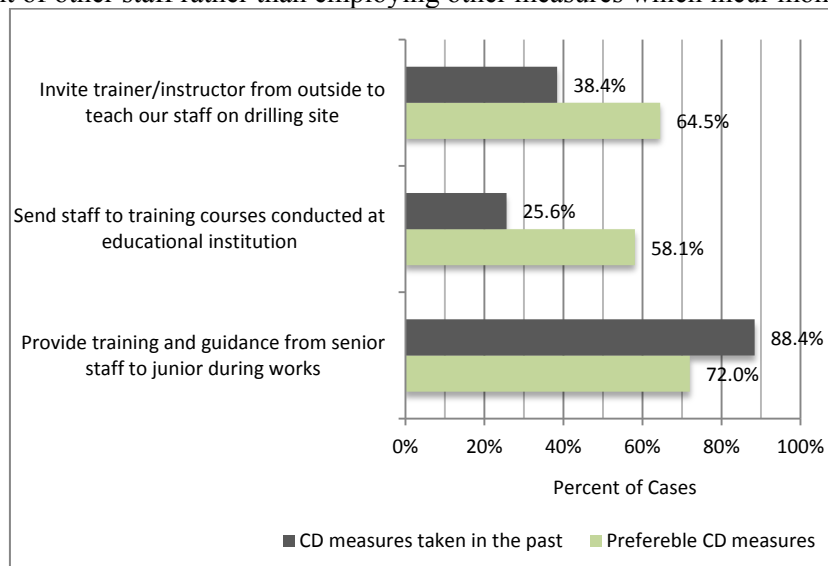


Note: The number of valid cases is 91. Another one case is no answer and two cases are not applicable as the respondents do not see necessity of capacity development of their technical staff.

Figure 24 Areas of Capacity Development Needs of Technical Staff (multiple options)

Aiming at the human resources development of their staff, 89 companies have conducted some forms of the training or sent the selected staff to Water Development and Management Institute (WDMI). **Figure 25** shows type of capacity development activities the companies have ever employed as well as their preferable measures for the same. Provision of On the Job Training (OJT) from senior staff was most widely practiced among the companies (88.4%). Less than 40% of the companies have also organized training on drilling site by trainers invited from outside and/or sent the staff to educational institutions in contrast to relatively high preference to these measures.

In most cases, the company bore the costs for these capacity development measures. There are only three cases that the staff member paid the cost. It is observed that the companies show tendency to rely on utilizing the experienced personnel in their organizations for capacity development of other staff rather than employing other measures which incur monetary burden.



Note:

1. The number of valid cases for the variable "CD measures taken in the past" is 86. The remaining eight cases are not applicable as the companies have never conducted capacity development for their technical staff.
2. The number of valid cases for the variable "Preferable CD measures" is 93. Another one case has no answer.

Figure 25 Capacity Development Measures (multiple options)

9) Interest in Business Opportunities in WSDP

As mentioned earlier, 16 companies among the surveyed have worked as the contractors for

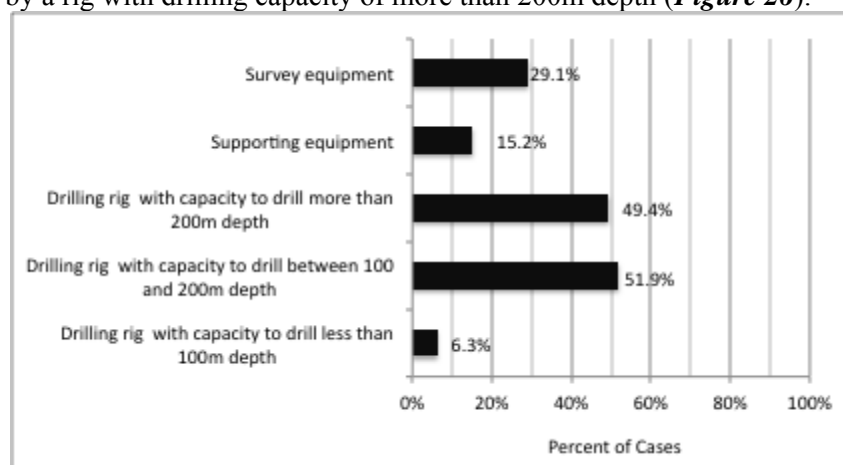
drilling works in 10-village subprojects in RWSSP/WSDP (Phase 1). The interviewed companies including the contractors which already had experience in the programme expressed high interest in participating in drilling works in WSDP. Almost all the companies (93 nos.) showed their interest in the programme. The remaining one is a charitable organization which does not operate the drilling works at commercial basis.

78.7% (74 nos.) perceives that there are some obstacles to participate or expand business opportunities in drilling works in WSDP while the rest does not see any such difficulties. Of those obstacles raised by the respondents, the biggest proportion of opinions goes to concern on high requirements in procurement rules for drilling works in WSDP (43.2%). Delay in payment of the contract amount is also pointed out as one of the obstacles. Except for these difficulties related to the implementation procedures of the programme, 36.5% expressed hardships to source sufficient investment fund for the business operation as part of problems in the organizations. The companies which have worked or are working in WSDP also pointed out difficulty in hydrogeological conditions of project areas more frequently than the group without experience in the programme.

10) Investment for New Drilling Equipment

Nearly three third of the companies only rely on personal funds of proprietors when new investment is required in their business. One third also borrows money from friends, relatives and/or banks.

For those which consider new investment for the drilling equipment, demand for large-size rigs is especially high. 79 companies answered that they had investment plans to purchase new drilling equipment. This number includes the entities which have experience in drilling works in WSDP. The highest demand goes to a drilling rig with capacity to drill 100-200m depth, followed by a rig with drilling capacity of more than 200m depth (*Figure 26*).



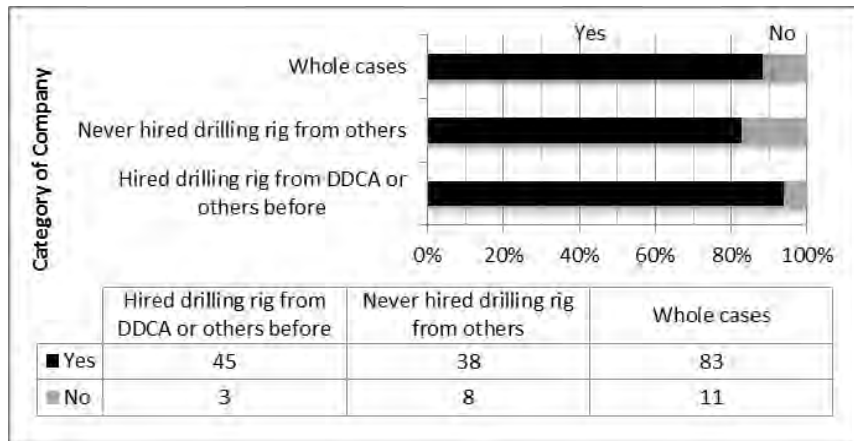
Note: The number of valid cases is 79. Another 11 are not applicable as they do not have any investment plan for new equipment and four have no answer.

Figure 26 Needs of Procurement of New Drilling Equipment (multiple options)

11) Demand for Private Sector Support Services of DDCA

Hiring Service of Drilling Equipment

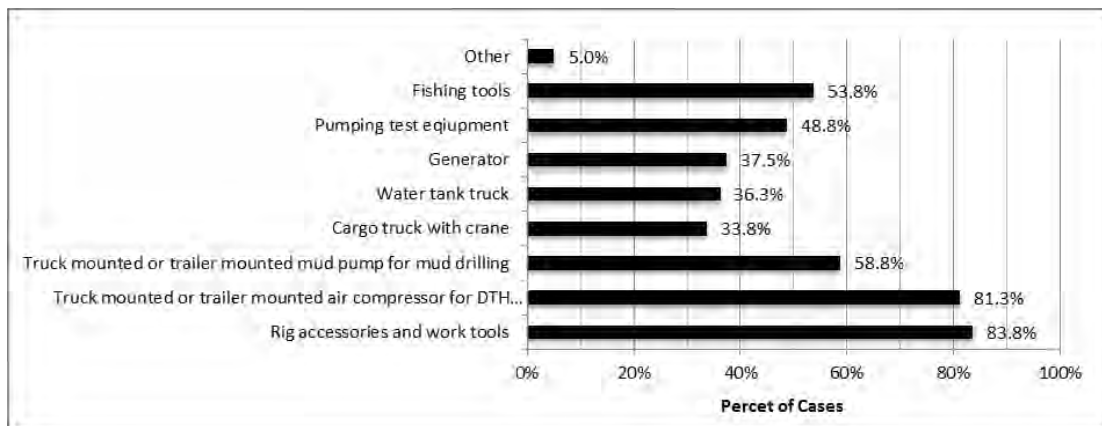
Of 94 companies interviewed, 88% (83 nos.) showed interest in using the hiring service of drilling equipment from DDCA. These companies expect increase of contracts to be awarded in WSDP (85.5%), acquisition of eligibility to participate in tendering in the same programme (62.7%), and reduction of investment costs for the equipment (47.0%) as major benefits from using drilling rigs hired by DDCA. High expectation to expand business opportunities in drilling works in WSDP is observed on both the companies which already have experience in the programme and those which are interest to participate newly. Regardless of possession of past experience in using hired drilling equipment, needs for DDCA's hiring service is high as shown in *Figure 27*.



Note: Figures in the table indicates the number of companies while the graph shows its percentage distribution.

Figure 27 Demand for DDCA's Hiring Service of Drilling Equipment

As to options of the hiring service, these companies much prefer to have hired rigs accompanied with technical staff from DDCA (81.5%) rather than use the equipment only (25.9%). The survey results also shows high demand of the companies to hire truck/ trailer mounted air compressor for DTH drilling as well as rig accessories and work tools (**Figure 28**) together with the drilling machine. Fishing tools, pumping test equipment and mud pump are also selected by half proportion of the companies as items which they would like to hire from DDCA according to their necessity. Meanwhile, generator, water tanker or cargo truck are not in acute needs compared with other supporting equipment. It seems to be due to wide availability of these items for hiring in the market.



Note:

1. The number of valid cases is 80. Another three cases have no answer and 11 cases are not applicable as they are not interested in the hiring service.
2. "Other" includes a flow meter, logging machine, and survey equipment.

Figure 28 Demand for Hiring Supporting Equipment (multiple options)

11 companies which did not show interest in hiring the equipment explained the reasons that they have enough number of drilling rigs. The number of rigs owned by these companies varies from one to six, which implicates that they do not intend to scale up their drilling works by hiring equipment from others.

Other Forms of Private Sector Support Services

Besides the demand for the equipment hiring services, the surveyed companies also showed high demand for other forms of the private sector support services of DDCA, that is, the technical support services including the technical advice for drilling works on site from the staff of DDCA and provision of hydrogeological information on project areas where DDCA drilled wells in the past. The percentage of the companies expressing their interest in the technical support service

is 95.7% (90 nos.) from 94 companies surveyed as baseline, bigger than demand for the hired equipment. 90 companies (95.7%) of surveyed companies expect to access to hydrogeological information kept at DDCA while the number of companies which are interested in receiving technical advice is counted 65 in total (**Figure 29**). 92.5% of the companies are willing to pay for the private sector support services to be provided by DDCA.

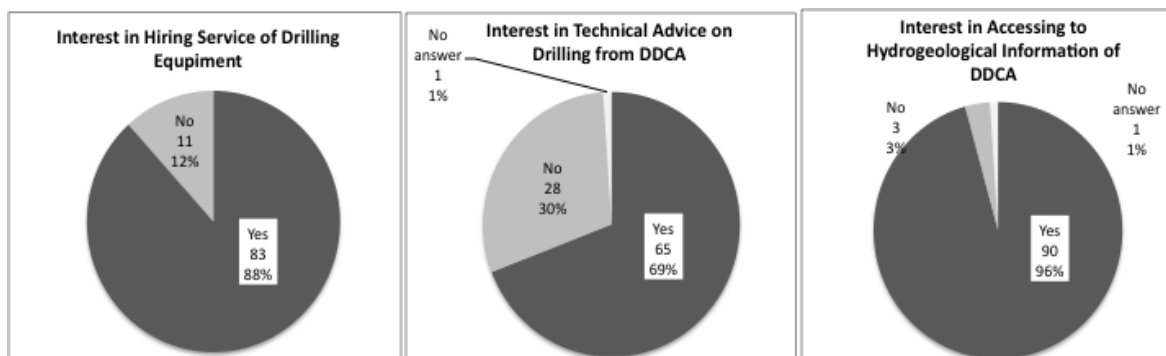
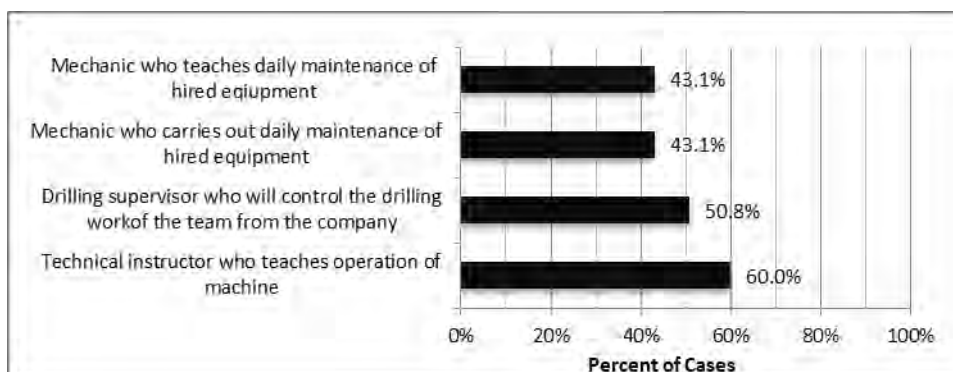


Figure 29 Distribution of Companies by Demand for Different Types of Private Sector Support Services by DDCA

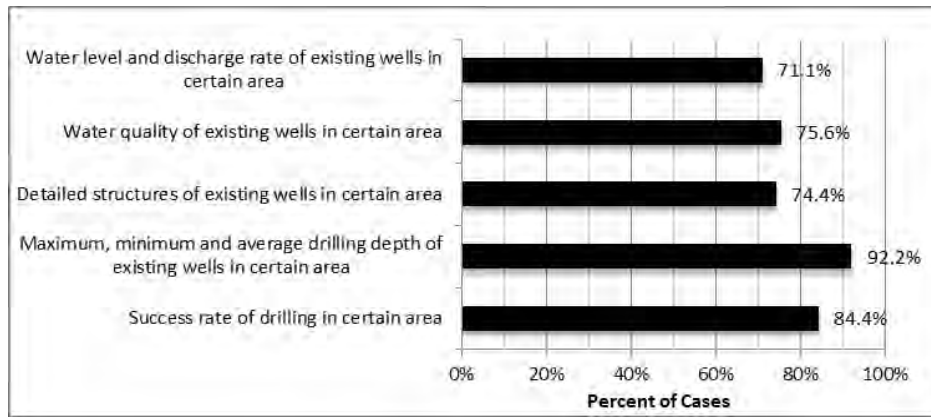
With regard to the technical advice, skilled and experienced instructors are mostly needed by the companies, followed by drilling supervisor who will control drilling works to be conducted by the team from the lessee (**Figure 30**). Some companies also raised necessity of mechanics who will conduct daily maintenance of hired equipment and/or teach the lessee on required maintenance procedures.



Note: The number of valid cases is 65. Another one case has no answer and 28 cases are not applicable as they do not require technical advice from DDCA's staff.

Figure 30 Type of Technical Staff Required for Technical Instruction (multiple options)

As to access to the hydrogeological information kept by DDCA, the respondents are mostly interested in drilling depth of existing wells and success rate of drilling in the areas where they are going to work (**Figure 31**). Other types of information such as discharge rate, water quality and detailed structure of wells are also with high demand.



Note: The number of valid cases is 90. Another one case has no answer and three cases are not applicable as they are not interested in accessing to hydrogeological information at DDCA.

Figure 31 Contents of Hydrogeological Information Required (multiple options)

The survey revealed high demand of the private companies for hiring service of drilling equipment as wells as the technical support services of DDCA. 63.8% (60 nos.) of the surveyed companies had also experience in use of such services provided by DDCA in the past although DDCA had not developed procedures for service provision in formal manner. In most cases, these companies requested DDCA for hydrogeological information and/or technical advice for drilling works while 13 companies have hired drilling rigs from DDCA. Conclusion was drawn from these facts that provision of private support services by DDCA was not quite new in the drilling industry in Tanzania. Rather, private companies were keeping expectation that DDCA should play such roles to support strengthening of capacities of the private sector.

The half among the surveyed 94 companies was established after 2006. The increase of the private drilling companies coincided in the commencement of WSDP in 2007. It was assumed that many companies were established expecting the demand of WSDP. However, the companies participated in the drilling works in WSDP Phase 1 was only 23 (16 of 23 were included in 94 surveyed companies). The procurement of drilling works for Phase 2 would be commenced from 2014/2015 though the RWSS component of WSDP was lag behind to the initial schedule. Capacity enhancement in private groundwater development sector was urgent since the delay of schedule in Phase 1 was needed to be recovered.

The lack of investment fund, the shortage of experienced drilling engineers, procurement rule of WSDP drilling works and hydrogeological condition in the target area etc. were raised as the reason why many companies could not participate in the WSDP drilling works though 99% of 94 surveyed companies showed the interest in the WSDP drilling works. 84 companies among the surveyed companies owned the drilling rigs. However, many companies did not own the large and DTH type of drilling rigs to accommodate the specification of WSDP. High cost for investment to purchase the large size drilling rigs was an obstacle for the private drilling companies. However, even if they could manage to purchase the large size rigs, the challenge on shortage of the drillers to operate them properly would remain. Many private drilling companies were aware of the necessity on the enhancement of the techniques related to the entire areas of drilling works. Especially the companies which neither owned the large drilling rigs nor had experienced DTH drilling strongly desired the enhancement of such techniques to participate in the WSDP drilling works.

The private sector supports including equipment hiring, technical instruction and provision of hydrogeological information to be provided in the Project were necessary for capacity enhancement in the private groundwater development sector since the challenges of the participation in WSDP for the private drilling companies were mitigated for them to expand their business to the WSDP.

3.1.2 DDCA'S CAPACITY DEVELOPMENT SUPPORT PLAN AND TECHNICAL INSTRUCTION SYSTEM FOR PRIVATE DRILLING COMPANIES

DDCA's Capacity Development Support Plan for Private Drilling Companies and Capacity Development Policy for DDCA's Skills for Technical Instruction were formulated based on the analysis of the baseline survey results. These activities were conducted according to the contents and the order shown in *Table 17* below.

Table 17 Contents of DDCA's Capacity Development Support Plan and Technical Instruction System for Private Drilling Companies

Activity	Item
Analysis of Status of Ability of Private sector	1) Classification of Private Drilling Companies 2) Priority Issue on Capacity Development of the Private Sector
Formulation of Capacity Development Policy for DDCA's Skills for Technical Instruction	1) Acquisition of Theoretical Knowledge of Drilling Mechanism 2) Standardization of Techniques 3) Technical Instruction of Entire Drilling Process by DDCA's Instructors 4) Unified and Commoditized Techniques of Well Rehabilitation and Tool Fishing
Formulation of DDCA's Capacity Development Support Plan for Private Drilling Companies	1) Evaluation of Project Effect Potential of Classified Groups of Private Drilling Companies 2) Capacity Development Support Plan for Private Drilling Companies 3) Technical Instruction Structure

The results of the activities above are described below.

(1) Analysis of Status of Ability of Private sector

1) Classification of Private Drilling Companies

99 % of 94 target private drilling company surveyed show their interest in the drilling works under RWSS (Rural Water Supply and Sanitation) component of WSDP. However, only 16 of 94 companies had experiences of the works of WSDP. The following issues were pointed out as obstacles for the participation in WSDP:

- Lack of investment fund
- Lack of qualified and skilled drillers
- Strict procurement rules of drilling under WSDP
- Difficult hydrogeological conditions for drilling

In order to support private drilling companies in their capacity development to cope with their challenges related techniques and equipment, DDCA was planning to provide their technical support services. Different contents of technical support services would be provided by DDCA according to the challenges, ability and interests of the companies. In order to classify the private drilling companies, the following three criteria were selected.

The reasons of selection of above criteria are described below:

To own large-capacity drilling rig and experience of DTH drilling

In order for the participation in WSDP, the private drilling companies need drilling equipment and techniques which correspond to well specifications of WSDP. According to the results of drilling works in 1st phase of RWSS component of WSDP, drilling depth of one borehole was 114 m in maximum, 78 m in minimum and 96 m in average. Diameter of casing and screen pipes were not less than 150 mm in 97 % of drilled boreholes⁹. Furthermore, most of the location of the drilling sites is hard rock areas. Therefore, DTH method should be used for drilling. In order to correspond to these conditions, large-capacity drilling rigs and technique of DTH drilling are required. The companies which fulfill these conditions are regarded to be

⁹ Calculated from Water Sector MIS and records of Rural Water Supply Directorate of Ministry of Water

capable for the drilling under WSDP in both respects of equipment and techniques.

To be interested in DDCA's equipment hiring services

DDCA would conduct private sector support services, mainly by hiring equipment and technical instruction. In this reason, this criterion was selected as the second one. 83 companies showed their interest in DDCA's equipment hiring services. The other companies had a purchase plan of new equipment with their own investment fund or they already owned enough number of equipment.

To be interested in DDCA's technical support services

Some of companies were not interested in equipment hiring but were interested in technical instructions and provision of hydrogeological information. This criterion was selected in order for the examination of support measures.

With the above three criteria, the private drilling companies were classified in five groups between A to E, as shown in **Table 18**. The characteristics of companies which belong to each group are described below, without equipment hiring.

Table 18 Classification of Private Drilling Companies

Group	Number of Companies	Classification Criteria		
		1) Large-Capacity Drilling Rig and Experience of DTH Drilling	2) Interest in Equipment Hiring Services	3) Interest in Technical Instruction and Provision of Hydrogeological Information
A	23	23	17	22
B	60	0	60	58
C	3	3	0	3
D	7	0	0	7
E	1	1	0	0
Total	94	37	83	90

● **Group A**

The companies which belong to Group A has large-capacity drilling rig and the technique of DTH drilling. A total of 23 companies belong to this group, the Group A is the second rank group in company numbers. Among 16 companies which have experiences of participation in WSDP, 11 companies belong to this group. Therefore, this group is regarded as a high capacity group among all. Companies of this group have drilling techniques to correspond to drilling works under WSDP. As 17 companies of this group have a purchase plan of new large-scale drilling rigs. It is evaluated that the Group A has an intention to positively expand their business by measures of their own investment and/or DDCA's equipment hiring services. 22 companies also show their interest in technical support services.

● **Group B**

The companies which belong to Group B have either not owning large-capacity drilling rig or no experience of DTH drilling. However, they are interested in equipment hiring services. A total of 60 companies are referred to the group, and it is in the first rank group in company numbers. Three companies of 60 have experiences of participation in WSDP, though the numbers of contract which they obtained were only one or two. 52 companies of 60 have a purchase plan of drilling rig capable for not less than 100 m in depth. It is presumed that the Group has intention to expand their business. 58 companies show their interest in technical support services. This proves that they are highly motivated for the capacity development of drilling techniques. In case companies of this group participate in WSDP, they are required to acquire the techniques of the operation of large-capacity drilling equipment and DTH drilling.

● **Group C**

The companies which belong to Group C have both large-capacity drilling rig and the technique of DTH drilling. They are not interested in equipment hiring, however, are interested in technical instruction and hydrogeological information. Three companies belong to Group C

and is the fourth rank group in company numbers. One company of three has experiences of drilling work under WSDP. This group is regarded as a capable group in the respects of equipment and techniques, as well as Group A.

● Group D

The companies which belong to Group D have neither large-capacity drilling rigs nor the technique of DTH drilling. They are not interested in DDCA's service of equipment hiring. However, they are interested in technical instruction and hydrogeological information. Seven companies belongs Group D, and is the third rank group in company numbers. Provision of technical support services should be differed according to the needs of each company of this group.

● Group E

As well as Group C, the companies which belong to Group E have both large-capacity drilling rigs and the technique of DTH drilling. They are not interested in both equipment hiring and technical instruction. Only one company belongs to Group E. This company is situated in Morogoro and conducts their business exclusively for drilling of large diameter wells for urban water supply. Therefore, they are highly capacitated in respects of both equipment and techniques. Accordingly, this group is excluded from the target of technical support services.

As a result of the above analysis, 83 companies which belonged to Group A and B were the potential target of DDCA's technical support services. These groups were mainly supported with the combination of equipment hiring and technical instruction. Regarding companies which belonged to Group C and D were the potential target only for the technical instruction and hydrogeological information. A company which belonged to Group E, though it was only one company, was excluded from the target of technical support services.

2) Priority Issue on Capacity Development of the Private Sector

In order for private drilling companies to newly participate in WSDP, capacity development both equipment and techniques aspects were required. The Project plans to capacitate DDCA to support private drilling companies by providing equipment hiring, use of well database information and technical instruction. The objectives of these three services would contribute to expansion of equipment resources, hydrogeological information and enhancement of drilling techniques.

Priority Issue related to Equipment Resources Expansion

In order to conduct drilling works under WSDP, private companies need large-capacity drilling rigs which are capable of drilling of 100 m in depth with 8" in diameter. MoW was procuring the drilling equipment for DDCA. This equipment consisted of large-capacity drilling rigs and supporting equipment which fulfilled such conditions. The DDCA's hiring services of the equipment would enhance the capacity in equipment resources of private drilling companies. **Table 19** shows the use of each equipment and the disposition to drilling sites.

Table 19 DDCA's Hiring Equipment and Disposition of Drilling Sites

Equipment	Qty.	Use	Disposition to Drilling Sites
Truck mounted drilling rig (Maximum Depth 150 m)	6 units	Drilling, nesessarry for all construction process.	One drilling rig/site.
Trailer mounted air compressor	5 units	For DTH drilling and well development.	Sharing by several sites
Trailer mounted mud pump	5 units	For complementary mud drilling	Sharing by several sites
Rig accessories and work tools	6 units	Drilling, nesessarry for all construction process.	One set/site.
Trailer mounted pumping test unit	5 units	Pumping test	Sharing by several sites

In addition to the above equipment, support vehicles such as cargo trucks, water tank trucks etc.

are needed for drilling works. Furthermore, geophysical prospecting instruments and/or borehole logging instruments are also needed, in case the contract conditions require them.

As shown in **Table 19**, rig and rig accessories should be exclusively disposed to one site, but others can be shared among several sites. The numbers of support equipment for one rig differs according to work specifications and scale. **Table 20** shows average numbers of support equipment owned by companies of Group A and B.

The companies of Group A own 2.70 units of rig, of which approximately 2.4 times larger than that of by Group B (1.01 rigs) companies. Situation of use of support equipment analyzed from is described below.

- **Cargo Truck:** Numbers of cargo truck by company are respectively 2.74 (Group A) and 0.98 (Group B). Regarding numbers by rig, they are 1.01 (Group A) and 0.88 (Group B). The companies of Group A own almost same numbers of cargo truck as those of rig. On the other hand, numbers of cargo truck owned by the companies of Group B are slightly fewer than those of rig. Upon use equipment hiring services, Group A companies are possible to use their cargo trucks for the transport to both the drilling site for hiring equipment and sites of their own equipment. However, Group B companies need certain measure of transport such as DDCA's transport service or hiring of cargo trucks from hiring companies.
- **Generator:** Generators are used for the machinery works at drilling sites and stock yards. This equipment is shared by several drilling sites and does not stay at site during all the period of the drilling work. An average numbers of generators by rig of Group A companies are 0.9, and 1.23 of Group B companies. It is approximately one generator by one rig. The companies belonging to Group B owns 1 rig out of 1.2. Since the generator is used for drilling sites and workshops, the generators for more than the number of rigs are needed to be owned. However, the numbers of generator by rig by company can be reduced if the allocation and the use is effectively organized.
- **Air Compressor:** The companies which belong to Group B do not have experience of DTH drilling. Therefore, their air compressors are small capacity, and are used only for well development. Therefore, they need to hire large capacity air compressor for DTH drilling, upon the use of equipment hiring services. Companies which belong to Group A own air compressors for DTH drilling. The average numbers of air compressor by rig is 0.89. This means that they share an air compressor among several drilling sites. Group A can select one of two cases upon the use of equipment hiring. The first case is to use own compressor and the second is to hire it from DDCA when theirs is not available.

Table 20 Numbers of Support Equipment of Companies Belonging to Group A and B

Item	Group	Rig	Cargo Truck	Generator	Air Compressor	Vehicle
Numbers by Company	A	2.70	2.74	2.57	2.39	4.70
	B	1.12	0.98	1.38	0.82	2.47
Numbers by Rig	A	-	1.01	0.95	0.89	1.74
	B	-	0.88	1.23	0.73	2.21

In most of cases, drilling of shallow depth with small diameter boreholes does not require investigation. Companies of Group B principally conduct such small scale drilling works. Therefore, the companies who own the investigation equipment are very few. **Table 21** shows that companies of Group B has less numbers of investigation equipment comparing to companies of Group A, in all three types of investigation equipment.

Table 21 Average Numbers of Investigation Equipment of Companies Belonging to Group A and B

Group	Geophysical Instrument	Borehole Logging Instrument	Pumping Test Equipment
A	0.82	0.45	1.91
B	0.27	0.07	0.66

The above analysis proves that Group A companies are possible to conduct drilling works with the combination of their own equipment and the equipment to be hired from DDCA. In most of companies, the equipment related to the pumping test and has drilling consumable tools such as drag bits, tricone bits, DTH bits etc. are available.

On the other hand, the resources of Group B companies, is not corresponding to DTH drilling. Therefore, the companies need to hire a complete set of hiring equipment from DDCA. The supporting equipment such as cargo truck is also necessary in case of Group B companies. Therefore, the companies need to procure such equipment by hiring from other companies and/or purchase by their own fund. Alternatively, there is a room of examination to provide transport service by DDCA, in case the company has difficulty to arrange the cargo track. Regarding drilling consumables, there are two options i.e. the hiring and the purchase from DDCA. For both options, it is important for DDCA to keep stocks for the smooth provision of services.

As described above, the priority issue was the establishment of flexible equipment hiring system which corresponds to various conditions of private companies. Detailed contents of equipment hiring system was described in the guideline of equipment hiring system which was formulated in the course of activities related to Output 3.

Priority Issue on Use of Hydrogeological Information

Degree of difficulty and the cost of drilling works vary depending on hydrogeological conditions of drilling site. For example, hardness of the strata and/or bore wall collapse causes unexpected increase of drilling period. The wrong estimation of success rate of drilling may bring unnecessary stock or additional purchase of drilling materials, and/or the deviation from the initial budget plan. Therefore, hydrogeological information is important for all the drilling companies. In the baseline survey, expected service by DDCA was inquired. About 58.8 % of 94 respondent companies answered to expect the provision of hydrogeological information. The other service expected by the companies is technical advice. About 37.9 % of the companies were expecting the technical advice.

A total of 45 companies of 94 (36.3 %) had experiences of provision of hydrogeological information from DDCA. DDCA had been providing such information upon the request from the private companies. However, the provision of hydrogeological information by DDCA in the past had been conducted mainly by verbal explanation of drillers. Well completion reports were stored separately in Dar es Salaam and Dodoma by hard copy. Therefore, it was not easy to find the target completion reports of the well. This situation was attributable to lack of use of hydrogeological information both DDCA and private companies. In the Project, database of existing well completion reports of DDCA for the purpose of the effective search and data provision was constructed.

Table 22 shows the results of baseline survey related to the demand on hydrogeological information to be provided by DDCA.

Table 22 Expected Contents of Hydrogeological Information to be provided from DDCA

Type of Hydrogeological Information	Percentage of Companies	
	Expecting Provision of Information	(%)
Successful Rate of Drilling in Certain Areas		20.9
Maximum, Minimum and Average Depth of Existing Well		22.8
Detailed Structure of Existing Well		18.4
Water Quality of Existing Well		18.7
Water Level and Yield of Existing Well		17.5

As shown in **Table 22**, there was no significant difference in the demand on each information type. Proposed methodologies for the provision of information of each type are described below:

● **Successful Rate of Drilling in Certain Areas**

It is possible to provide pumping test data of existing wells in the range of village or ward. The

pumping test data includes discharge rate of wells. It is therefore, easy to identify the dry well. On the other hand, it is not easy to identify the unsuccessful well in terms of water quality aspect. This is because such judgment regarding the usage of the well is normally done by the client. However, in case water quality analysis is conducted, the record is attached to well completion report. Whether or not the well is usable can be judged from it. Water quality analyses are conducted according to Tanzanian drinking water standard.

- **Maximum, Minimum and Average Depth of Existing Wells**

Drilled depth and thickness of each stratum are recorded in well section drawings. The drilling depth of specific well can be provided from section drawing of each well. In case a private drilling company requires information of well depth in certain areas for a new drilling project, maximum, minimum and average drilling depth of existing wells in these areas can be calculated by the range of village or ward.

- **Detailed Structure of Existing Wells**

The information of well structure such as casing installation depth, position of screen pipes, depths of back-filling, gravel packing and surface cementing etc. can be provided from well section drawings.

- **Water Quality of Existing Wells**

In case water quality analysis was conducted according to the contract requirement, the results are attached to well completion report. A water quality analysis includes four bacteriological parameters and approximately 24 physical and chemical parameters based on Tanzanian drinking water quality standard.

- **Water Level and Yield of Existing Wells**

The availability of such information produced by the pumping test depends on the contract requirement. However, if the pumping test was conducted, the records were stored with well completion reports. Therefore, information of yields and variation of water level in accordance with pumping time can be provided. The priority issue on enhancement of use of hydrogeological information is to establish user-friendly database system which enables easy search and extraction of the above information. The database system was established in the course of the activities related to Output 2.

Priority issue on Enhancement of Drilling Techniques

As described in the section 3.1.2 (1) 2) Priority Issue on Capacity Development on the Private Sector, lack of skilled and qualified drillers was one of obstacles for private drilling companies to participate in drilling works under WSDP. 37.9 % of 94 respondent companies expected technical advice from DDCA according to the baseline survey. It proved that there were considerable needs of technical instruction among private drilling companies.

Table 23 shows numbers of drilling staff by rig of companies of Group A to E. A standard drilling team of DDCA contains one rig in charge, one assistant rig in charge, two to three assistant drillers. Organization of a drilling team of private drilling companies is almost same. However, number of rig in charge of companies of Group A to D is less than one. It shows the insufficiency of skilled drillers comparing of numbers drilling rig. In case of use of hiring equipment from DDCA, it was required to organize appropriate drilling team by educated drilling staffs.

Table 23 Numbers of Drilling Staff by One Rig of the Private Companies

(unit: person)

Group	Rig in Charge	Assistant Rig in Charge	Assistant Driller	Total
A	0.9	0.9	1.7	3.5
B	0.9	1.4	2.6	4.9
C	0.7	1.3	2.7	4.7
D	0.8	1.4	2.2	4.4
E	1.2	1.2	2.3	4.7

Table 24 shows the demand of private companies of Group A to D for enhancement of technological capabilities. Among the technical area, “Borehole Logging (74.2 %)” and “Drilling Plan and Well Design (69.9 %)” showed high demand. For companies of Group B, the highest percentage is 73.3 % in “DTH Drilling”. It proved that companies of Group B recognized the importance of acquiring of techniques of DTH drilling in order to participate in drilling works under WSDP.

Table 24 Demand of Private Drilling Companies for Enhancement of Technological Capabilities

Group	Numers of Company	Technical Area which are demanded to be enhanced								
		Drilling Plan and Well Design	DTH Drilling	Mud Drilling	Installation of Casing, Screen Pipes	Well Development	Pumping Test	Borehole Logging	Equipment Maintenance	Others
A	23	69.6	47.8	47.8	34.8	39.1	47.8	73.9	56.5	8.7
B	60	71.7	73.3	58.3	56.7	48.3	61.7	76.7	53.3	3.3
C	3	66.7	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
D	7	57.1	57.1	42.9	42.9	57.1	42.9	71.4	42.9	14.3
All Groups	94	69.9	63.4	52.7	48.4	45.2	54.8	74.2	51.6	5.4

Note) Figures of each technical area is percentage of the numbers of company of each group which answered to wish to enhance the technical area to 94 respondent companies.

The priority challenges on enhancement of drilling techniques were as follows.

- **Formulation of Proper Teaching Guidance and Training of Technical Instructors**

The technical instruction to the driller of private companies would be provided by DDCA’s technical instructors who accompany hiring equipment. Such instruction should cover all the technical area shown in **Table 24**. Basically, the drillers in DDCA had the techniques to complete a well. However, they were lack in experience as technical instructor. In addition, no materials were developed for the enhancement of technological capabilities such as teaching guidance. Formulation of teaching guidance covering entire drilling process was important, as well as mastering of instruction methods by using teaching guidance by DDCA’s technical instructors. The baseline survey for DDCA proved that lack of sufficient knowledge in certain technical areas such as drilling control, gravel packing, pumping test etc. A care shall be taken for the technical enhancement in such areas during the training activities for the technical instructors.

Mastering techniques of “Fishing” and “Well Rehabilitation” by DDCA’s drillers were also important, in addition to areas in entire drilling process. 46.8 % of 94 respondent companies expected to hire fishing tools. Being not limited to fishing techniques, many requests for technical advice from DDCA also contained those for well troubles. These two technical areas were identified as those to be newly acquired by DDCA. Therefore, DDCA’s technical instructors needed to acquire the related knowledge.

- **Evaluation of Technical Level of Private Drilling Companies**

For efficient drilling works and technical instruction, continuous use of equipment hiring services was preferable. In order to enhance techniques of private drillers step-by-step, DDCA’s technical instructors needed to evaluate technical level of private drillers who receive technical instruction. For the purpose of on-site technical evaluation, technical level checklist should be prepared and be included in teaching guidance.

- **Provision of Technical Support Services without Equipment Hiring**

The numbers of DDCA’s hiring equipment were limited (only six drilling rigs and equipment). The service was therefore, suspected not to cover the all of demanded companies of Group A and B. Furthermore, companies of Group C and D were interested only in technical instructions,

but were not in equipment hiring. Such companies which do not use equipment hiring services can be supported with other types of technical support services, such as dispatch of technical instructor or the provision of advices. These technical support services can cover larger target groups and contributes to capacity development of entire private drilling sector. Furthermore, numbers of company who participate in drilling work under WSDP was expected to be increased. Effects of public relations of DDCA's equipment hiring business were also expected.

DDCA's technical instruction to private drilling companies was conducted in the course of activities related to Output 1. The concrete plan is described in the section 3.1.2 (3) Formulation of Capacity Development Support Plan for Private Drilling Companies.

(2) Formulation of Capacity Development Policy for DDCA's Skills for Technical Instruction

In order to enhance drilling techniques of private drilling companies, DDCA was required to facilitate technical instructors capable to instruct work contents of entire drilling process and well rehabilitation techniques. Furthermore, necessary structure for technical instruction needed to be established. The results of baseline survey for the DDCA proved that there was lack of experience on technical instruction. Based on these survey results, development policies of DDCA's ability of technical instruction were formulated.

The challenges of DDCA related to technical instruction to private drilling companies were summarized into four issues of 1) lack of theoretical knowledge of drilling mechanism, 2) technical transfer based on the experimental rule, 3) division of the works and 4) well rehabilitation and tool fishing. In this section, policies on enhancement of skills to provide technical instruction to correspond to these challenges are described.

1) Acquisition of Theoretical Knowledge of Drilling Mechanism

DDCA's drillers had work experiences and basic knowledge necessary to conduct and complete drilling works. However, many drillers relied on their experimental rule rather than theoretical knowledge, as following examples.

- During DTH drilling, hydraulic force of swivel should be controlled by checking weight indicator so as not to load too much weight on DTH and bit. However, the weight control was conducted by driller's experience without using weight indicator on drilling sites. Excessive load on DTH may cause damage of drill pipe and DTH and/or deviation of a hole.
- Gravel volume was calculated based on the past experiences instead of calculation. Miscalculation of gravel volume may bring about interruption of works due to the necessity of additional procurement. Furthermore, well troubles such as sand producing may occur due to the insufficient gravel packing.

It was possible to complete the works based on the experimental rule. Actually DDCA was completing more than 200 boreholes per year. However, in order to enhance the capacity of DDCA, and to provide technical instructions to inexperienced private drillers, DDCA's technical instructors needed to acquire necessary theoretical knowledge for technical instruction. In November 2012, a competence test was conducted for the purpose to evaluate the level of theoretical knowledge. A total of 66 DDCA's drillers participated in this test. As a result, "Drilling Tools and Equipment", "Drilling Control", "Borehole Logging", "Well Development", "Back-Filling and Surface Cementing", "Pumping Test" and "Water Quality Analysis" were identified as eight technical areas which are necessary to be enhanced. "Tool Fishing" and "Well Rehabilitation" were identified as two technical areas which are necessary to be newly acquired.

Capacity development policy for DDCA's skill for technical instruction was to enhance drilling techniques of candidates of technical instructors especially in the above areas. At the same time, it was necessary to facilitate them to acquire theoretical knowledge of drilling mechanism in entire drilling process.

2) Standardization of Techniques

DDCA did not have any written technical standards which had been accumulated by DDCA's drillers, and then it may cause a technical gap among drillers. Thus, technical standardization was required to conduct technical instruction as a part of new DDCA's services and internal technology transfer.

The baseline survey proved that DDCA had sufficient resources such as modern techniques and equipment. However, there was a room for improvement such as an institutional supervision and operation aspects, in order to develop DDCA's ability of technical instruction. The formulation of teaching guidance by standardize the existing techniques of DDCA was one of policies to develop DDCA's ability of technical instruction.

Teaching guidance shall include technical areas to be enhanced (activity 2-2) and technical areas to be newly acquired (activity 2-3), which were identified in the course of activities related to Output 2. Reduction of gap of technical level among drillers in order to provide technical instruction in uniform quality shall be also one of the policies to develop DDCA's capacity of technical instruction.

3) Technical Instruction of Entire Drilling Process by DDCA's Instructors

It was estimated that the technical instruction would be provided by only one instructor at most of case. In that case, the instructor accompanying with hiring equipment should conduct technical instruction of entire drilling process on site.

As a result of competence test of DDCA's drillers, the areas of "Drilling Tools and Equipment", "Drilling Control", "Borehole Logging", "Well Development", "Back-Filling and Surface Cementing", "Pumping Test" and "Water Quality Analysis" were identified as technical areas necessary to be enhanced. As for DDCA's organization structure, drilling, pumping test and borehole logging were conducted respectively by the drilling teams under the drilling section of the drilling department, pumping test teams under the same section and department and the borehole logging technician under the survey section of the technical support department. Three processes of drilling i.e. 1) drilling, 2) borehole logging and 3) pumping test, were specialized to three different working teams. Therefore, it was natural that drillers who were in charge of drilling showed low level of comprehension in technical areas of "Borehole Logging" and "Pumping Test". This was institutional characteristics of DDCA and was not a challenge of DDCA for the implementation of drilling works.

However, as described above, it was expected that the technical instructions should be conducted by only one instructor at most of case. In this respect, low level comprehension of the drilling techniques such as borehole logging and pumping test was regarded as a challenge of technical instruction ability. There were unique techniques in the fields of drilling, borehole logging and pumping test, respectively. However, these areas had an intimate relationship one another from the view point of entire drilling process. For the determination of the casing program, the logging result shall be comprehensively interpreted with the consideration of the result of cutting analysis and the drillers' log including water strike, lost circulation and collapse of borehole etc. Furthermore, the implementation and the interpretation of the pumping test requires various drilling information such as drilling depth, water level, positions and specifications of screen pipes etc. Therefore, if a driller who was familiar with such drilling information conducted the works of entire drilling process including borehole logging and pumping test, it was regarded to be very effective and ideal.

Therefore, mastering borehole logging and pumping test by drillers was important in both respects of a good workmanship of well construction and a technical instruction to private drilling companies. Actually, due to the lack of sufficient human resources, it was not possible for private drilling companies to divide the work process to different team like DDCA. In many cases, private drillers conducted the works of entire drilling process. Consequently, technical enhancement of DDCA's drillers who would be technical instructors in borehole logging and pumping test shall be one of the policies to develop DDCA's capacity of technical instruction.

4) Unified and Commoditized Techniques of Well Rehabilitation and Tool Fishing

DDCA had a challenge that techniques of well rehabilitation and tool fishing had not yet been unified and commoditized, comparing to those of drilling and pumping test. One of major reasons was insufficiency of tools and equipment. Different tools from tools for drilling were required for well rehabilitation and tool fishing. However, number and variety of such tools owned by DDCA were limited. Thus, each drilling team modified and/or manufactured them in respective manner on drilling site, according to the specific situations. In such reasons, there were not unified and commoditized techniques throughout drillers.

Other techniques related to well rehabilitation and tool fishing such as double-casing method or well fracturing etc. had not been established in DDCA. Mastering of such new technology was also important for DDCA's drillers. A well camera was being procured by basket fund of WSDP. Well diagnosis using well camera would contribute much to the effectiveness and the success of the works. This was another important technique to be acquired.

Consequently, formulation of manual of well rehabilitation and tool fishing and technical enhancement of DDCA's drillers in these technical areas shall be ones of the policies on capacity development to provide technical instruction.

(3) Formulation of DDCA's Capacity Development Support Plan for Private Drilling Companies

As described in (1) 2) Priority Issue on Capacity Development of the Private Sector of Section 3.1.2, DDCA's capacity development support plan for private drilling companies included three options i.e. equipment hiring, provision of hydrogeological information and technical instruction. Among them, activities of equipment hiring and provision of hydrogeological information were related to Output 1 and Output 2 respectively. Their concrete contents were stipulated in the equipment hiring guideline and the manual of well information database. The capacity development support plan for private drilling companies clarified the concrete plan of the following activities:

- Establishment of a technical instruction system
- Formulation of teaching guidance
- Training of DDCA's technical instructors
- Technical instruction to private drillers

This section describes contents of capacity development support plan for private drilling companies.

1) Evaluation of Project Effect Potential of Classified Groups of Private Drilling Companies

As a result of the baseline survey, private drilling companies were classified into five groups of A to E. In order to formulate a capacity development support plan for private drilling companies, group-wise project effect was considered. **Table 25** shows numbers of company by classified group. The parameters of situation such as availability of equipment, interest in DDCA's services and experience of drilling under WSDP were applied to each group for measuring the impact to achieve the necessary number of borehole to be drilled in WSDP. Each group was given the evaluated potential level from one to five. The large number indicates the higher impact.

Table 25 Classified Groups of Private Drilling Companies and Project Effect Potential level

Group	Numbers of Company	Large machine and DTH Drilling Experience	Interest in DDCA's Service		Experience of Drilling under WSDP	Project Effect Potential Level
			Equipment Hiring	Technical Instruction and Provision of Hydrogeological Information		
A	23	23	23	22	11	4

Group	Numbers of Company	Large machine and DTH Drilling Experience	Interest in DDCA's Service		Experience of Drilling under WSDP	Project Effect Potential Level
			Equipment Hiring	Technical Instruction and Provision of Hydrogeological Information		
B	60	0	60	58	3	5
C	3	3	0	3	1	3
D	7	0	0	7	1	2
E	1	1	0	0	0	1

Note) Figures show numbers of company

Group B was a largest group and 60 companies belong to the group. The DTH drilling equipment to correspond to basement rock drilling was not available in the companies of Group B. However, almost all of them were interested in both equipment hiring and technical support. On the other hand, only three companies of 60 had experiences of drilling under WSDP. Consequently, Companies of Group B had the largest potential to use DDCA's equipment hiring and technical support services and participate in WSDP. Therefore, the potential of project impact was evaluated to be level 5 which is the highest rank.

A total of 23 companies belonged to Group A. All of them owned DTH drilling equipment and were also interested in DDCA's equipment hiring and technical instruction services. In addition, 11 companies of 23 had experiences of drilling under WSDP. This group was evaluated to be potential in the respect of their intention to the business expansion. Therefore, level 4 was given to this group as a result of evaluation.

Three companies of Group C owned DTH drilling equipment therefore, were not interested in equipment hiring services. It meant their intention of the business expansion was smaller than that of companies of Group A. However, they were interested in technical instruction and hydrogeological information. Their potential for the participation in WSDP could be expected, if the proper approach of technical instruction was taken. As the potential of project impact was in some extent limited, level 3 was given to this group, which was a middle potential level.

Seven companies of Group D neither owned DTH drilling equipment nor were interested in equipment hiring services. However, they were interested in technical instruction and hydrogeological information. The characteristics of Group D were similar to Group C. However, their intention of the business expansion and the participation in WSDP was evaluated to be lower than the one of Group D, because they were not interested in equipment hiring services even though they did not own DTH drilling equipment. Therefore, the potential of project impact was evaluated to be considerably limited. Level 2 was given to this group, which was a lower rank in potential levels.

A company of Group E already owned DTH drilling equipment. On the other hand it was interested in neither equipment hiring nor technical support services. Only one company belonged to this group. Consequently, very low project impact potential was expected to this group. Therefore, the lowest level of Level 1 was given to this group.

2) Capacity Development Support Plan for Private Drilling Companies

The capacity development for private drilling companies was conducted with the measures of three options, i.e. equipment hiring services, technical instruction and provision of hydrogeological information. The combination of these options became a support plan which was based on the situation and needs of private drilling companies. This was a major component of the plan. The proposed capacity development support plan for private drilling companies is summarized as below, with consideration of characteristics of classified groups of private drilling companies and potential of project impact.

Plan for Introduction of DTH Drilling

(Target: Group B Companies [Project Effect Potential – Level 5])

This plan targeted Group B of which project impact potential was evaluated to be highest level

of 5. This group had the largest numbers of the companies among all the groups. Companies which belonged to this group were interested in both equipment hiring and technical instructions, as they had no experience of the DTH drilling at basement rock area. The major component of support plan was the combination of the hiring of DTH drilling equipment and instruction of drilling techniques. Further capacity development was expected by the provision of hydrogeological information as a supplementary support measure. Many companies classified to Group B were not registered to both MoW and CRB. In addition to the technical support, and the support for promoting the registration shall be provided to those companies in order to enhance their capacities to participate in WSDP.

Business Expansion Support Plan

(Target: Group A Companies [Project Effect Potential – Level 4])

Companies which belonged to this group already owned DTH drilling equipment and approximately a half of them had experiences of drilling under WSDP. They were interested in both equipment hiring and technical instruction. Thus the potential of project impact was evaluated to be Level 4. The combination of equipment hiring and technical support services (technical instruction and provision of hydrogeological information) were the major component of this plan. However, some of companies of this group were expected to expand their business, as they had already owned DTH drilling equipment.

Technical Instruction Plan

(Target: Group C, D, E Companies [Project Effect Potential – Level 3,2,1])

Only 11 companies belonged to these groups. This plan targeted to companies which were not interested in equipment hiring, notwithstanding whether or not they owned DTH drilling equipment. Therefore, the major component of the plan was a combination of technical instruction and provision of hydrogeological information.

Three companies of Group C were interested in only the provision of hydrogeological information. Among seven companies of Group D, only three companies were interested in technical instruction. On the other hand, all seven companies of Group D were interested in provision of hydrogeological information. Consequently, two cases can be expected. One was the support by the combination of both technical instruction and provision of hydrogeological information and another was the support only by provision of hydrogeological information.

3) Technical Instruction Structure

The technical instruction would be carried out by the drillers accompanying the hiring equipment. DDCA was required to conduct proper technical instruction which corresponded to capacity and needs of each private company. Basic contents and the structure of technical instruction to the companies of each classified group are described below. Using this structure, specific contents of technical instruction was determined according to types of contract with each private drilling company.

● Technical Instruction to Group A Companies

The companies of this group already had experiences of DTH drilling with large-capacity drilling equipment. The basic idea was dispatch of only one technical instructor, as they can organize a drilling team with a required technical level. The work of the technical instructor was to explain the specific operation of equipment hiring, checking of technical level through entire drilling process and instruction for proper work implementation in each technical area.

● Technical Instruction to Group B Companies

The companies of this group did not have experience of DTH drilling with large-capacity drilling equipment. They needed to acquire techniques in entire drilling process. Among such techniques, DTH drilling techniques were especially important. A technical instructor needed to conduct technical instruction in entire drilling process. Furthermore, on the job training to private drillers by the instructor was required, in case private drillers did not have sufficient technical level. Therefore, another option of field OJT including dispatch of one or two drillers

would also be prepared.

● Technical Instruction to Group C,D Companies

Companies of these groups were interested in technical support services. However, they were not interested in equipment hiring. Furthermore, each company had different expectation of technical areas to be instructed. The basic idea was dispatch of one technical instructor for specific technical areas according to needs of each company. Several options were supposed, such as dispatch of technical instructors for borehole logging, pumping test, DTH drilling etc. The tariff of dispatch of technical instructors was stipulated in the equipment hiring guideline.

4) Technical Instruction System

As described in (2) Formulation of Capacity Development Policy for DDCA's Skills for Technical Instruction of Section 3.1.2, capacity development policies of DDCA's ability of technical instruction were "acquisition of theoretical knowledge of drilling mechanism", "standardization of techniques", "technical instruction of entire drilling process by DDCA's technical instructor" and "unified and common techniques of well rehabilitation and tool fishing". Based on these policies, a technical instruction system was established through activities of 1) formulation of teaching guidance, 2) establishment of certification system for the instructor, 3) establishment of training system for the instructor and 4) establishment of certification system for engineer in private sector and 5) preparation of process on accumulation, share and utilization of results of technical instruction. Contents of these activities are described below.

Teaching Guidance

DDCA's technical instructors needed to acquire theoretical knowledge and teaching method in technical areas of entire drilling process. The Project Team was conducting the listing-up of items of technical instruction and preparation of teaching guidance. A teaching guidance contained "Objective", "Contents", "Teaching Method" and "Materials". General books of drilling techniques which were used in DDCA, manuals which were prepared in the projects, catalogs and/or manuals of suppliers of drilling materials and equipment were used as materials for the teaching guidance. **Table 26** shows composition of teaching guidance.

Table 26 Composition of Teaching Guidance

Technical Area / Item	Objective
1 Site Mobilization	
1-1 Site Preparation and Drilling Machine Setting-Out	To be able to explain and advise proper site preparation and drilling machine installation on site.
2 Drilling Tools and Equipment	
2-1 Selection of drilling bit and drilling method	To be able to explain and advise differences between drilling methods and how to select them according to geological conditions.
2-2 Rotary Bits	To be able to explain and advise type, structure and use of rotary bits for mud drilling.
2-3 DTH and DTH Bit	To be able to explain and advise type, structure and use of DTH and DTH bits for DTH drilling.
2-4 Rig Accessory	To be able to explain and advise necessary contents and specifications of rig accessory such as drill pipe, drill collar etc.
2-5 Casing Tools	To be able to explain and advise specifications of steel casing pipes to be used as surface and conductor casing.
2-6 Drilling Equipment	To be able to explain and advise specifications of major drilling equipment such as drilling rig, mud pump, compressor, supporting truck etc.
2-7 Drilling Calculation	To be able to explain and advise necessary calculation for drilling work such as unit conversion, calculation of discharge rate, annular volume etc.
2-8 Weight of drilling tools	To be able to explain and advise unit weight and total of drilling tools weight which shall be balanced with rig capacity during drilling.
2-9 Rotary bit rotation speed and weight on bit	To be able to explain and advise suitable bit rotation speed and weight on bit so as to use them effectively and safely during mud drilling.
2-10 DTH Bit rotation speed and weight on bit	To be able to explain and advise suitable DTH bit rotation speed

CHAPTER 3 ACTIVITIES TAKEN AND OUTPUTS OF THE PROJECT

Technical Area / Item	Objective
3 Drilling Drawbacks	
3-1 Countermeasures against lost circulation during mud drilling	To be able to explain and advise how to prevent from lost circulation and countermeasures against it during mud drilling.
3-2 Countermeasures against lost circulation during DTH drilling	To be able to explain and advise how to prevent from lost circulation and countermeasures against it during DTH drilling.
3-3 Countermeasures against bore wall collapse during mud drilling	To be able to explain and advise how to prevent from bore wall collapse and countermeasures against it during mud drilling.
3-4 Countermeasures against bore wall collapse during DTH drilling	To be able to explain and advise how to prevent from bore wall collapse and countermeasures against it during DTH drilling.
3-5 Countermeasures against jamming of drilling tools	To be able to explain and advise how to prevent from jamming of drilling tools and countermeasures to recover it.
4 Drilling Control	
4-1 Mud control	To be able to explain and advise rolls of mud fluid to conduct effective drilling and how to keep condition of mud.
4-2 Mud Pump Operation	To be able to explain and advise how to operate mud pump for effective use.
4-3 Casing for mud drilling	To be able to explain and advise specifications of surface and conductor casings and procedure to install and remove them.
4-4 Drilling operation for mud drilling	To be able to explain and advise how to control various parameter of drilling and procedures of each work such as pipe connection, cleaning hole etc.
4-5 Bit control and repairing for mud drilling	To be able to explain and advise how to control and repair bits for effective use.
4-6 Air control for DTH drilling	To be able to explain and advise rolls of air and how to control pressure and delivery for effective DTH drilling.
4-7 Air compressor operation	To be able to explain and advise how to operate air compressor for effective use.
4-8 Casing for DTH drilling	To be able to explain and advise specifications of surface and conductor casings and procedure to install and remove them.
4-9 Drilling operation for DTH drilling	To be able to explain and advise how to control various parameter of drilling and procedures of each work such as pipe connection, cleaning hole etc.
4-10 Bit control and repairing for DTH drilling	To be able to explain and advise how to control and repair DTH bits for effective use.
5 Borehole Logging	
5-1 Borehole logging instruments	To be able to explain and advise principles, measuring items and operation procedures of borehole logging.
5-2 Interpretation of borehole logging results	To be able to explain and advise how to determine screen position from borehole logging results.
6 Casing Program / Installation	
6-1 PVC casing, screen pipe	To be able to explain and advise specifications of PVC casing, screen pipe.
6-2 Casing Program	To be able to explain and advise how to determine casing size, borehole size and how to prepare casing program.
6-3 Role of centralizer	To be able to explain and advise use of centralizer and how to determine its installation depth.
6-4 Casing, screen pipe installation	To be able to explain and advise preparation and procedures of installation of casing, screen pipe.
7 Gravel Packing	
7-1 Determination of gravel size	To be able to explain and advise how to determine gravel size suitable to well structure and aquifer formation.
7-2 Calculation of gravel volume	To be able to explain and advise how to calculate gravel volume for the proper preparation on site.
7-3 Gravel packing	To be able to explain and advise gravel packing procedures and precautions to prevent from failure of packing.
8 Well Development	
8-1 Well cleaning after drilling	To be able to explain and advise several well cleaning methods to be selected according to well conditions, such as bailing, swabbing, air-lifting etc.

CHAPTER 3 ACTIVITIES TAKEN AND OUTPUTS OF THE PROJECT

Technical Area / Item	Objective
8-2 Single-tube method air-lifting	To be able to explain and advise single-tube method air-lifting which is popular method.
8-3 Double-tube method air-lifting	To be able to explain and advise double-tube method air-lifting which is more safe methods than single-tube one.
9 Back-Filling & Surface Cementing	
9-1 Back-filling	To be able to explain and advise procedures of back-filling.
9-2 Surface cementing	To be able to explain and advise how to calculate mixing of cement and water and how to place it.
10 Site Demobilization	
10-1 Precautions upon site demobilization	To be able to explain and advise precautions upon site demobilization to prevent from damage to third parties and environment.
11 Well Investigation for Well Rehabilitation	
11-1 Necessary information of well rehabilitation plan	To be able to explain and advise information about well, pump and water supply facility is necessary to formulate rehabilitation plan.
11-2 Well rehabilitation plan	To be able to explain and advise necessary contents of well rehabilitation including data provision and work contents.
12 Tool Fishing	
12-1 Tool fishing plan	To be able to explain and advise necessary contents of tool fishing including down-hole investigation and work plan.
12-2 Fishing tools	To be able to explain and advise type of several fishing tools and their use.
13 Well Rehabilitation	
13-1 Phenomena and causes of well deterioration	To be able to explain and advise several type of well deterioration such as incrustation on screen, sand production etc. and their causes.
13-2 Methods of well rehabilitation	To be able to explain and advise several methods of well rehabilitation such as mechanical and chemical cleaning, sedimentation removal etc.
13-3 Usage of well camera	To be able to explain and advise usage of well camera to observe inside conditions of well.
14 Pumping Test	
14-1 Purpose and methods of Pumping Test	To be able to explain and advise purpose of pumping test and major pumping test methods.
14-2 Pumping test equipment	To be able to explain and advise necessary equipment to conduct pumping test.
14-3 Selection of Submersible Pump	To be able to explain and advise how to select suitable submersible pump according to capacity of well.
14-4 Interpretation of test results	To be able to explain and advise interpretation of step drawdown test and constant discharge rate test and recovery test in order to determine well capacity and select proper pump.
15 Water Quality Analysis	
15-1 Purpose of Water quality analysis	To be able to explain and advise purpose of water quality analysis as a general knowledge.
15-2 Item of water quality analysis	To be able to explain and advise items analysed for groundwater and their effect on human health.

Internal Certification System of the Instructors

Prior to the commencement of equipment hiring business, technical instructor were certified by the Project. As six drilling rig were being procured for hiring, at least six technical instructors were to be certified. With consideration of retirement of staffs and activities of internal training of DDCA's drillers, another six technical instructors were expected to be certified by the year of 2013. An instructors' seminar was held in March 2013 for the purpose to explain how to conduct technical instruction by using teaching guidance. This seminar targeted 14 candidates of technical instructors who were selected from 35 senior drillers of DDCA according to the evaluation by the drilling project operation department of DDCA. Upon the completion of the seminar, comprehension of each candidate was measured by an intelligibility test. All the 14 candidates achieved required intelligibility level and were certified as technical instructors. Technical guidance on technical transfer to the private companies was planned to be implemented by Japanese expert for these certified instructors. However, it was not conducted due to the termination of the Project.

Table 27 summarizes this internal certification system.

Table 27 Internal Certification System of Technical Instructors

Activity	Contents
Selection of Candidates of Technical Instructors	Among senior drillers who were selected based on evaluation by the drilling project department of DDCA, candidates of technical instructors are selected, with the consideration of technical level and DDCA's personnel assignment plan.
Instructors' Seminar	An instructor's seminar is held for candidates of technical instructors for the purpose to explain how to conduct technical instruction using teaching guidance. Participants of the seminar is 12 persons in maximum and the period is one day.
Intelligibility Test	Confirmation of comprehension of participants of the instructors' seminar related to teaching guidance, by mean of an intelligibility test.
Certification of Technical Instructors	Candidates of technical instructors who fulfill the following conditions are certified by DDCA as technical instructors. <ul style="list-style-type: none"> - To have attended the instructors' seminar - To have achieved not less than 80 % in the intelligibility test

Training System for the Instructors

In order to keep necessary number of technical instructors i.e. 12 persons, supplementation of the instructor is required according to the necessity. The various outputs from the Project were to be utilized for the training of the instructor. In the stage of initial certification of technical instructors, outputs such as competence test, technical instruction, intelligibility test and internal certifications are produced. Furthermore, technical instructors will be a trainer for the other drillers. Through activities of capacity development of DDCA's senior drillers related to Output 2, outputs such as manuals and intelligibility test regarding technical areas to be enhanced are produced. By using such outputs, the continuous training activities of DDCA are materialized. Furthermore, certified technical instructors internally conduct training of DDCA's drillers in technical areas of entire drilling process. The results of intelligibility tests and training, which were produced during the capacity development activities, can be used as the basic data for the selection of candidates of supplementation of technical instructors. The system was designed so that all the above outputs constituted the training system of the instructors.

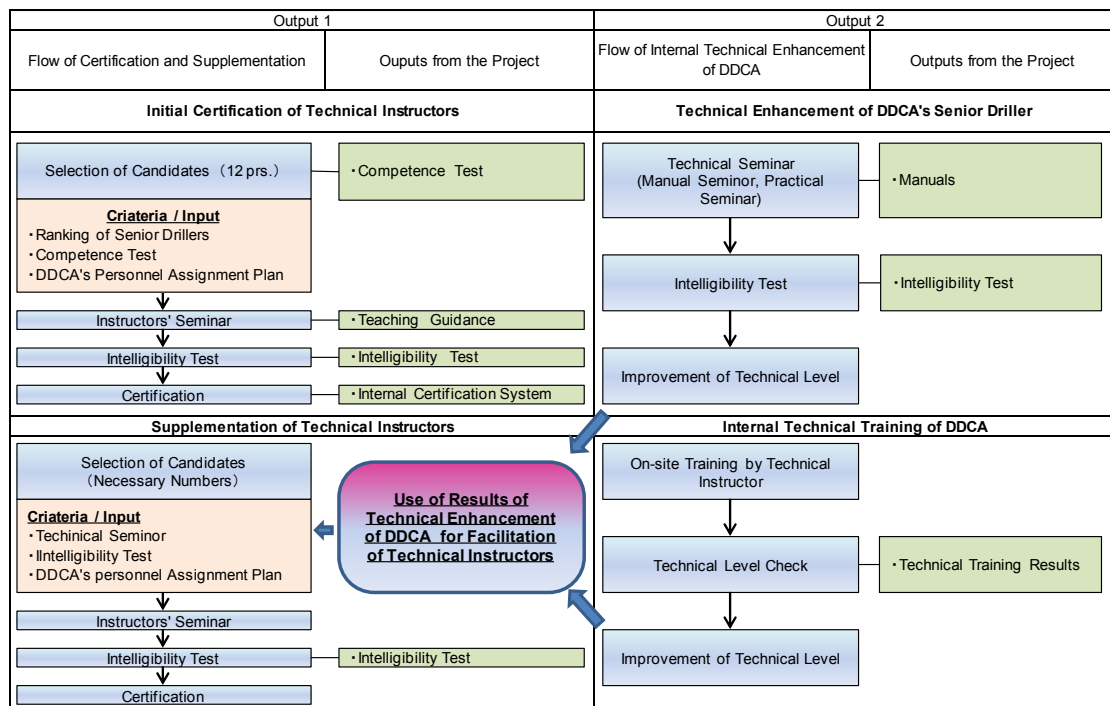


Figure 32 Structure of Training System of the Instructor

Certification System for the Engineer in Private Sector

In order for private drilling companies who use the equipment hiring services to acquire

necessary drilling techniques, continuous use of equipment hiring was required for a step-by-step improvement. For the efficient technical instruction, technical instructors were required to evaluate the impact to instructed private drillers. In this purpose, on-site checklist of drilling technical level as shown in **Table 28** was prepared. In drilling sites for technical instruction, technical instructors check the technical level of the instructed driller who is the rig in charge of the drilling team of the company. One of three technical levels is to be given to each technical area, that is, A: To have sufficient knowledge to complete works, B: To have knowledge of works, however there is still room for improvement and C: Lack of necessary basic knowledge for works. The entry column on checklist for remarks on technical instruction is filled with challenges on technical instruction, advices from experts, proposals for improvement of teaching method and so on. After the completion of technical instruction, the checklist is submitted to the drilling project operation department. The instructed drillers who achieved required drilling technical level is certified by DDCA, with the approval of CEO. The drilling project department keeps checklists as basic data for the next technical instruction.

Table 28 On-site Checklist of Drilling Technical Level (Draft)

On-site Checklist of Drilling Technical Level			
Name of Trainee :		Ref. No. :	
Position :		Date :	
Company Name:		Borehole Number :	
		Location / Areas :	
Name of Technical Instructor of DDCA:			
Technical Area	Technical Level	Items of which challenges were observed	Observation
1 Site Mobilization			
2 Drilling Tools and Equipment			
3 Drilling Drawbacks			
4 Drilling Control			
5 Borehole Logging			
6 Casing Program / Installation			
7 Gravel Packing			
8 Well Development			
9 Back-Filling & Surface Cementing			
10 Site Demobilization			
11 Well Investigation			
12 Tool Fishing			
13 Well Rehabilitation			
14 Pumping Test			
Remarks on Technical Instruction:			

Preparation of Process for Accumulation, Share and Utilization of Results of Technical Instruction

Technical instruction methods and contents of teaching guidance were required to be improved through the implementation of technical instruction. In this purpose, results of technical instruction are periodically reviewed by the drilling project operation department, by using checklist which was described in Clause 4). The results of technical instruction are annually reviewed. Technical instruction methods and contents of teaching guidance are revised based on the results of review of technical instruction. **Table 29** summarizes these contents of technical instruction review.

Table 29 Technical Instruction Review

Activity	Contents
Preparation of Materials for Review	Based on technical level checklists, necessary data such as results of technical instructions, numbers and specifications of boreholes drilled and improvement of technical level of instructed drillers etc., are summarized by the drilling project operation manager.
Review Meeting	Based on the prepared materials, the drilling project operation department holds a review meeting in order to examine the following issues: - Results of technical instructions (numbers and technical areas)

CHAPTER 3 ACTIVITIES TAKEN AND OUTPUTS OF THE PROJECT

Activity	Contents
	<ul style="list-style-type: none">- Improvement of technical level of instructed private drillers- Proposal for revision of technical instruction methods and contents of teaching guidance with consideration of the results of implementation of technical instructions- Preparation of technical instruction review report <p>A reveiew meeting is held once a year.</p>
Revision of Technical Instruction System	The technical instruction system is revised according to the review report. Contents of revision are disseminated to all technical instructors.

3.2 OUTPUT 2: ENHANCEMENT OF DDCA'S CAPACITY IN GROUNDWATER DEVELOPMENT REQUIRED TO PROVIDE TECHNICAL INSTRUCTIONS

Output 2 was “The capacity of DDCA in groundwater development, which is required to provide technical instruction, is enhanced”, and the following activities were planned.

[2-1] Identification of areas necessary to be enhanced at DDCA

[2-2] Technical training and guidance for DDCA for drilling wells

[2-3] Technical training and guidance for DDCA for rehabilitation and fishing wells

[2-4] Establishment of a database of wells drilled by DDCA

The activities taken for Output 2 included identification of areas necessary to be enhanced at DDCA in groundwater development capacity, provision of technical training and guidance for the DDCA toward strengthening capacity for drilling wells and the techniques such as well rehabilitation and tool fishing and, establishment of a well database at DDCA. The activity of [2-1] identification of areas necessary to be enhanced at DDCA was conducted through baseline survey on DDCA and competence test for DDCA's drillers. For the activities of [2-2] and [2-3] which provided the technical training and guidance on drilling, well rehabilitation and tool fishing, were started on site and seminar, in accordance with preparation of technical support plan and manuals were prepared with focus on the area identified in the activity [2-1]. However, due to termination of the Project, only a part of the planned activities were implemented.

In the activity of [2-4] a well information database was constructed and the basic guidance was conducted. Due to termination of the Project, the planned activities of the guidance on the updating and the utilization of database from the 2nd Year of the Project were not implemented.

The activities conducted for output 2 is shown in **Figure 33**.

Activity	Year	2012										2013						
	Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
2-1 Identification of areas necessary to be enhanced at DDCA																		
		Throught survey on drilling sites, interview to DDCA, workshops, competence test of DDCA's drillers, the technical level of DDCA's drillers and the areas to be enhanced were identified.																
2-2 Technical training and guidance for DDCA for drilling wells																		
		Technical manuals were prepared and the technical support such as seminars were started. Though it was planned to conduct the continuous activities of technical support and guidance by the Project from the 2 nd Year, they were not conducted due to termination of the Project.																
2-3 Technical training and guidance for DDCA for rehabilitation and fishing wells																		
		Technical manuals were prepared and the technical support such as seminars were started. Though it was planned to conduct the continuous activities of technical support and guidance by the Project from the 2 nd Year, they were not conducted due to termination of the Project.																
2-4 Establishment of a database of wells drilled by DDCA																		
		Paper based well reports of DDCA were digitized and well information database was constructed. Though it was planned to conduct the continous guidance on the utilization of the database, it was not impletemented due to termination of the Project.																

Figure 33 Progress of Activities for Output 2

3.2.1 BASELINE SURVEY RELATED TO ORGANIZATION AND INSTITUTION OF DDCA, EDUCATIONAL SYSTEM RELATED ON DRILLING TECHNIQUE, AND DRILLING WORK PROCESS IN DDCA

Related to the Output 2, Technical Support Plan for Drillers was prepared for DDCA. The purpose of the plan was to enhance the capacities of DDCA in terms of organization and institution, human resource and training system for drillers in order to provide the technical support to the private drilling companies. To make an appropriate plan, the baselines survey was conducted by the JICA experts to identify the situation of DDCA's organization and institution, educational system for well drilling works and DDCA's drilling works. The results of the baseline were used for the activity of output 1 in establishment of technical instruction system for the private drilling companies. The purpose and contents of each baseline survey is summarized in *Table 30*.

Table 30 Baseline survey and its Purposes (Output 2)

Baseline Survey	Content	Item	Purpose
Baseline Survey related to Organization and Institution of DDCA	Organizational Settings in DDCA		To grasp the organization setting of DDCA, technical level of mobilization of staff, activities of capacity development, personnel rating system in order for the formulation of technical support plan
	Personnel Setting in Drilling Project Department and Technical Support Department		
	Capacity Development of Drillers in DDCA		
	Personnel Rating System in DDCA		
Baseline Survey on Educational System Related on Drilling Technique	General Education System in Tanzania		To grasp general education system in Tanzania, technical education system and system of WDMI in order for the formulation of technical support plan
	Technical Education System	1) Institute Providing Vocational Training 2) Vocational Education Training Authority (VETA) 3) Higher Educational Institutions 4) Qualification Possessed by DDCA Staffs	
	Technical Educational Institute Providing Drilling Course (WDMI)	1) Outline of WDMI 2) Courses on Higher Education 3) Courses on VET 4) Courses on Water Well Drilling Attaining Technician and Diploma 5) Modules on Water Well Drilling Provided by WDMI 6) General Education System for Drillers Provided by WDMI	
Baseline Survey on Drilling Work Process in DDCA	Field Survey at Drilling and Pumping Test Sites		To grasp technical level of staff, work quantities and specifications, challenges on drilling technics and technical instruction, through the site investigation at drilling sites and interview to DDCA, in order for the
	Annual Number of Drilled Boreholes		
	DDCA's Organization for Drilling Works	1) DDCA's Drilling Rigs 2) Organization of Drilling Teams 3) Annual Number of Boreholes Drilled by Rig Type	

Baseline Survey	Content	Item	Purpose
		4) Usage of Rig by Area	formulation of technical support plan
	Well Specifications		
	Issues on Technical Instruction	1) Drilling Work 2) Borehole Logging 3) Well Completion 4) Pumping Test and Water Analysis 5) Well Rehabilitation	

(1) Baseline Survey related to Organization and Institution of DDCA 1) Organizational Settings in DDCA

DDCA was established under the Executive Agency Act enacted in 1997 by the Government of Tanzania and came into operation in 1999. It was consolidated by the former Drilling Section under the Water Resource Department and the Dam Construction Section under the Construction Department in the Ministry of Water (MoW). Since then, DDCA was mandated by MoW to undertake the drilling and dam construction works. When DDCA was established, approximately 260 employees in DDCA were involved in MoW. They were shifted to the DDCA with holding the previous working condition. Almost all of them were drilling technicians and engineers so that the staffs in charge of management, administration and account were newly employed. The same working condition with shifted staffs was adapted to those new employees.

As of January 2013, there were in total 226 staffs including permanent, contract basis and branch staffs. The breakdown of 226 staffs was one CEO, two internal auditors, 99 in Drilling Project Department, 17 in Earthworks Project Department, 62 in Technical Support Department and 45 Business Support Department. The Drilling Project Department had a largest number of staffs in all the departments.

In July 2011, DDCA revised the two working conditions for their staffs. The staffs shifted from MoW become employer of DDCA. Another revision was that out of 226 staffs the wage of 163 who are employed in a permanent basis got to be borne by the President Office Public Service Management (PO-PSM)¹⁰. Others were employed as contract basis and paid directly from DDCA.

Headquarters of DDCA was located in Dar es Salaam. The organization consisted of four departments of Drilling Project, Earthworks Project, Technical Support and Business Support Department, and an Internal Audit Unit (refer to **Figure 34**). Each department consisted of several sections. There were 12 sections in total under four departments. Each department was operated by a manager who was a head of department. At that time, managers in Technical Support, Business Support and Earthworks Project Department were vacant.

The drilling works, which was main task of DDCA, were conducted by drillers belonging to the department of Drilling Project and Technical Support. In total 74 drillers were composed of 68 from Drilling Project Department and 6 from Technical Support Department. 35 senior drillers among them (34 from Drilling Project Department and 1 from Technical Support Department) were the target of activity to support the enhancement of their capacities related to output 2. The technical instructors related to output1 were nominated among the senior drillers based on the evaluation in Drilling Project Department. The technical instructor's seminar was provided to them. If they take the seminar and pass the intelligibility test, they would be certified as technical instructor.

The main duty of Drilling Project Department was to conduct the drilling works, and also pump installation works though the number was quite a few. The Technical Support Department was responsible for the drilling technique and dam construction such as geological survey, prospecting exploration and equipment maintenance. In principle all drillers were supposed to belong to the Drilling Department. However, some of the drillers remained in Drilling

¹⁰ The governmental organization responsible for personnel issues of government officials.

Department since the drivers originally employed as the drivers were changed to the drillers.

Apart from the headquarters, there were six Drilling Project Officer's offices (DPO) located under the Drilling Department for supervising the drilling works and providing the assistance on the procurement of equipment and materials in case drilling works were conducted in the upcountry. Under the Technical Support Department, there were five zonal offices for supervising the DPOs and promoting the business activities of DDCA.

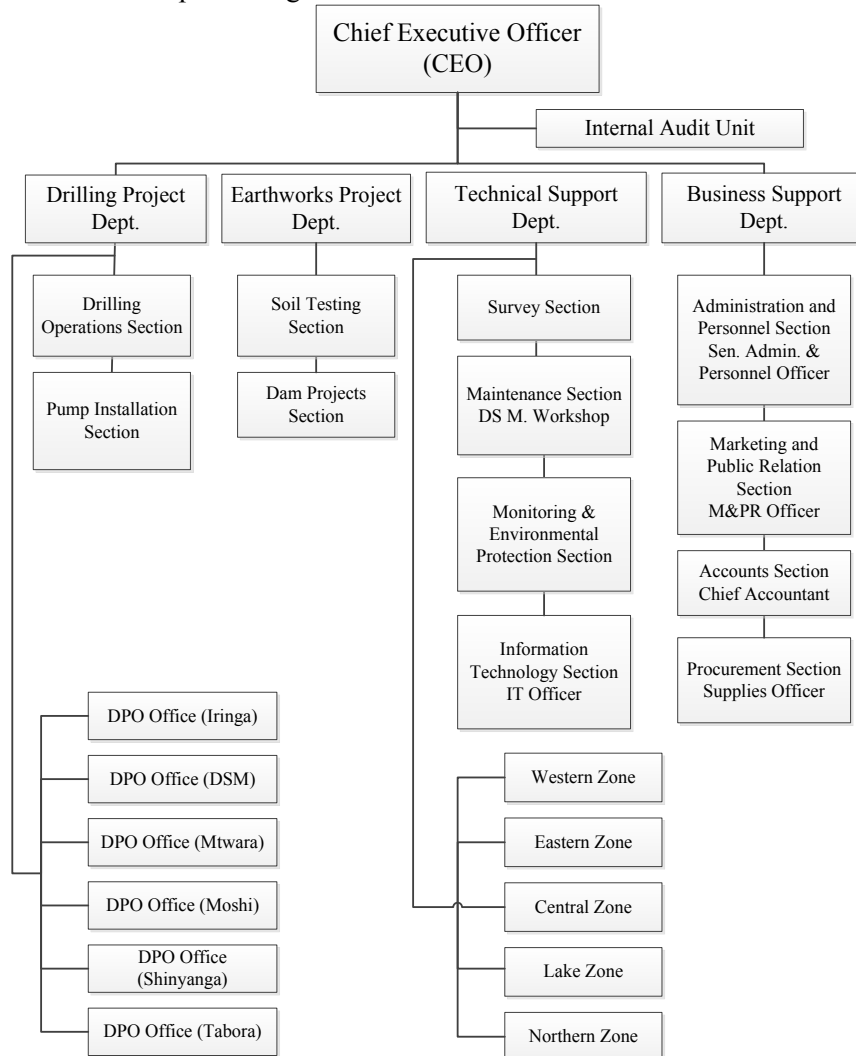


Figure 34 DDCA Organizational Structure

2) Personnel Setting in Drilling Project Department and Technical Support Department

The staffs involved in the drilling work belonged to the Drilling Project Department and Technical Support Department. Most of those staffs were graduated from Water Development and Management Institute (WDMI). They obtained the certificate or diploma in drilling or other areas. As above mentioned, in the Drilling Project Department, 84 staffs of 99 were permanent basis employer and 15 were employed in contract basis, while 28 were permanent and 34 were contract basis in the Technical Support Department out of 62.

In many cases, the position of the new staffs were started with the lowest one of Assistant Technician, and orderly promoted to the Technician II, Technician I, Senior Technician and Principal Technician. According to the PO-PSM, the chance of promotion was given in every three to five years. Experience and educational level of the staffs were considered for the

promotion as the evaluation criteria (PO-PSM, 2002)¹¹.

The duties which were internal professional categorization were assigned to each staff based on their knowledge, skills and experiences. **Table 31** shows the number of staffs by duty in Drilling Project Department and Drilling Project department.

Table 31 Number of Staffs by Duty in Drilling Project Department DDCA

Duty	Drillin Project Dep.	Technical Support Dep.
Manager	1	1
Zonal Manager	4	0
Drilling Project Officer	4	0
Driller	2	0
Rig in Charge	16	0
Assistant Rig in Charge	9	1
Operator	20	1
Assistant Driller	15	1
Mechanics	9	7
Flushing	2	0
Pumping Test	9	0
Electronics	0	3
Plant Operator	1	2
Drawing	1	1
Stock keeper	1	0
Surveyor	2	13
Autoelectrician	1	1
Drawing	0	1
Office Attendant	0	1
Panel Beating & Spray	0	2
Quarryman	0	5
Hydrogeologist	0	2
Environment	0	1
IT Computer	0	1
Transport & Logistics	0	2
Driver	2	17
Pump Installation	1	2
	99	62

There were 16 drilling teams which are organized by a rig. A team was composed of Rig in Charge, an Assistant Rig in Charge, Operators and Assistant Drillers. Sometimes, a Mechanic was included. Also some team member came from the Technical Support Department. On the other hand, the staffs in charge of well development and pumping test, who were from the Drilling Department, conducted a specific works of well development and pumping test for the well drilled in Dar es Salaam, while the team itself did well development and pumping test in case of drilling work outside of Dar es Salaam.

68 staffs of DDCA were the member of the drilling team or other drilling related staffs, while 6 staffs in the Technical Support Department were involved in drilling. These 74 staffs were defined as “Driller” in this Project.

3) Capacity Development of Drillers in DDCA

There was no system established in DDCA for capacity development of drillers. However, an

¹¹ Scheme of Service, PO-PSM, Tanzania, 2002

exceptional case occurred when the Drilling Project Department and Human Resources Section made a discussion and determination in case drillers voluntarily asked for the possibility of the participation to the training courses including financial assistance. In another case, drillers just asked for the permission when they decided to attend the training courses in their own charge. Many drillers desired to go further study for acquiring the diploma, degree and masters in the area of drilling or hydrogeology.

In 2010, MoW facilitated the formulation of CD plan to the implementing organizations of WSDP. As one of those organizations, DDCA had formulated the CD plan. However, the implementation had not yet been done due to the budget limitation.

At that time, PO-PSM (Prime Minister's Office Public Service Management) had obliged all the governmental organizations including ministries and agencies to set aside the opportunities in order for their employees to participate in the training courses. Therefore, each organization was supposed to submit their training plan for three years to PO-PSM. The budget for the implementation shall be secured by each organization, while each organization was supposed to report the progress of implementation to PO-PSM. DDCA conducted the training needs assessment (including concrete training course, institution, course expense and duration) to the heads of departments and each personnel in November 2012. As the result, the training plan for 2013 to 2015 was formulated and submitted to the PO-PSM.

4) Personnel Rating System in DDCA

There was no periodical rating system for employees in DDCA except when there was a need to consider on the personnel to be posted into the vacant position.

As mention in (1) 1) Organizational Settings in DDCA of Section 3.2.1, the most of DDCA staffs became the government officials. Under such case, their promotion and rise in wage shall be processed according to the regulation of PO-PSM. So far, DDCA had only made rise of the constant rate in wage once a year.

PO-PSM had adopted the Open Performance Review and Appraisal System (OPRAS) for all government officials. Therefore, the competent organizations were supposed to introduce the system for their employees. In the system, the employees and their superiors reviewed the actual plan of the work which was made at the commencement of the fiscal year, and appraise the performance to the plan at the end of the year, though only superiors had confidentially done it before. There was an advantage to adopt the system since it would make possible for the employees to recognize the objective appraisal on their work performance. Each organization shall submit the result of appraisal based on the OPRAS when the organization desired to apply the promotion of their employees once in three to five years. PO-PSM would approve it in case the budget was allowed. DDCA had already introduced OPRAS. It was expected for the staffs to fill their form quarterly within this fiscal year.

(2) Baseline Survey on Educational System Related on Drilling Technique

1) General Education System in Tanzania

In Tanzania, primary education is started from 7 to 13 year's old and it takes seven years to complete it. After the completion (Standard VII), the graduates proceed to the secondary education ordinary (O) level which is completed after four years. In the fourth year, national qualifying test examination is given to all students for them to acquire certificate of secondary education (Form IV). Only the graduates passed through the Form IV are allowed to apply for the secondary education advanced (A) level (Form V-VI). Generally, the eligibility to enter the university is given to the graduates of Form VI.

When it comes to the vocational and technical education, there are vocational education training institute and higher educational institute which provide them. Normally, the persons who completed Form IV are allowed to apply for them. Some institutes set the requirement or restrictions on the attainment of Form IV. Regarding vocational education, some institutes offer the admission even to the graduates of Standard VII. Regarding the entry to university, the persons who completed the Diploma in the higher educational institutes are also allowed as same as the graduates of Form VI. **Figure 35** shows general education system in Tanzania.

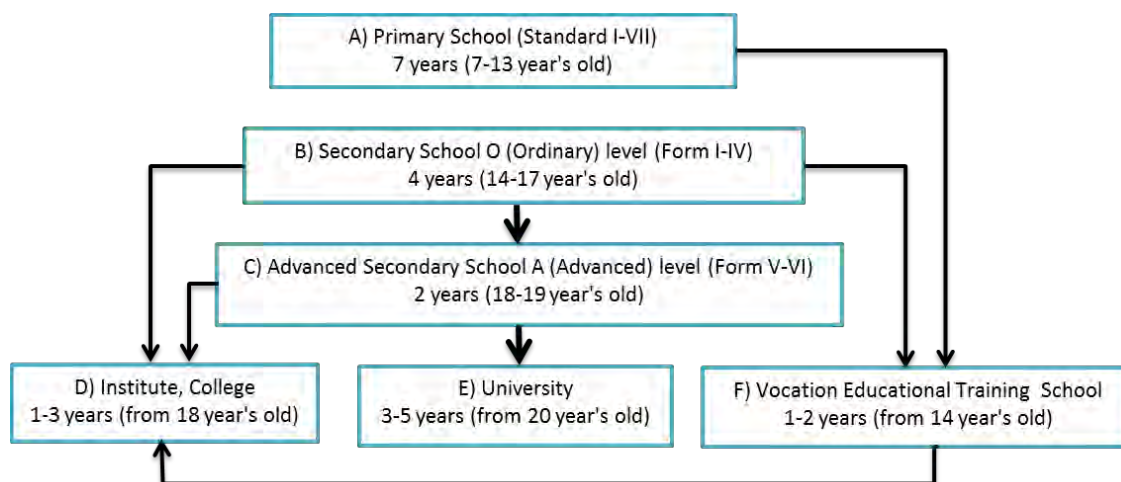


Figure 35 General Education System in Tanzania

2) Technical Education System

Institute Providing Vocational Training

As above mentioned, some of vocational education training institute and higher educational institute provide the vocational and technical education. The owners of these institutes include the ministries, local government, private and NGOs. In 1994, Vocational Education Training (VET) Act was enacted and Vocation Education Training Authority (VETA) was established under the Ministry of Education and Vocational Training (MEVoT) as a regulatory body of VET. VETA is responsible for the registration and authorization of all institutes. As of January 2013, VETA was operating 22 vocational institutes in the country. The target applicants were those who had completed Form IV. 8,000 people in average had been entering VETA every year¹².

Apart from VETA, Folk Development College (FDC) also provides the VET in the country. It was established in 1975 under the Ministry of Community Development, Gender and Child (MCDGC). FDC aims to offer the education to the young people with provision of the assistance for their self-help. Therefore, the education on know how to solve the problem in the society are included into the training. The vocational technique on agriculture, architecture, electric work, sewing, cooking and others are provided by FDC. As of January 2013, there were 55 FDCs in the country. The Standard VII graduates were also allowed to attend FDC¹³.

Regarding the higher educational institutes, there were approximately 300 institutes in the country¹⁴. The half of them was operated by the governmental organizations.

Vocational Education Training Authority (VETA)

In 1988, VETA adopted the Competency Based Education and Training (CBET) to make the students equipped with the technical knowledge and skills required in the labor market upon completion of the courses. CBET aimed to acquire the competence so as students to perform the daily duty as demanded in the industrial market. Based on the fluid needs in the market, VETA set the attaining goal of the technical competence. Then, the curriculum, evaluation criteria and contents of the test to measure the attainment were prepared. Normally, the contents taught in the classes are mainly focused on the practical training. VETA provided approximately 20 courses for the long period of one to two years. The subjects included electronics, mechanics, civil engineering, information technology and sewing. Also around 50 courses including driving, haircut, administration, plumbing and installation of the mechanical instrument were provided as the short term courses, which were completed in several months.

In order to measure the attaining level of the competence, VETA imposed the students various periodic examinations such as CBET Test (National Competency Based Education and Training

¹² VETA official website

¹³ MCDGC official website

¹⁴ National Council for Technical Education (NACTE) official website

Examination) level I to III, Trade Test level I to III and National Business Examination stage I to III. At the end of the course, the Certificate of Competence (level I to III) was determined and given in consideration of the previous test results together with the other criteria including qualification of National Vocational Awards (NVA) (level 1 to 3).

Higher Educational Institutions

Higher educational institutions include technical school and college. One to two years are taken for acquiring the certificate, and three years for diploma. Some institutions offer the courses acquiring VET and degree. The National Council for Technical Education (NACTE)¹⁵ is a regulatory body of those institutions and responsible for the registration and authorization once in five years. They also conduct authorization for teachers and curriculum to be used in the institute. The criteria for the authorization of the institutions includes number of facilities equipped, teachers qualified and curriculum authorized. Each institute determines to qualify the students based on the result of periodic examination together with other evaluation criteria including the qualification of National Technical Awards (NTA) level 1 to 10. Each institution and NACTE work together on determination of the qualification. Normally, the semester¹⁶ examination is prepared by each institute and submitted to NACTE. The modification and setting of the marking standards are done by the person of NACTE who is specialized in the relevant technical area. After the feedback, each institute conducts the examination and evaluation¹⁷ on their own schedule¹⁸. **Table 32** shows the kind of NTA qualification, certificate award and competence level.

Table 32 Qualification of NTA, Certificate Award and Competence Level

S/N	Qualification ¹⁹	Certificate award	Competence level
1.	NTA Level 1	Certificate of Competence Level I	The holder of the qualification will be able to apply “basic craft knowledge and skills”
2.	NTA Level 2	Certificate of Competence Level II	The holder of the qualification will be able to apply “intermediate craft knowledge and skills”
3.	NTA Level 3	Certificate of Competence Level III	The holder of the qualification will be able to apply “full / higher craft knowledge and skills”
4.	NTA Level 4	Basic Technician Certificate	The holder of the qualification will be able to apply skills and knowledge at routine level
5.	NTA Level 5	Technician Certificate	The holder of the qualification will be able to apply skills and knowledge in a range of activities, some of which are non-routine and be able to assume operational responsibilities.
6.	NTA Level 6	Ordinary Diploma	The holder of the qualification will be able to apply skills and knowledge in a broad range of work activities, most of which are non-routine.
7.	NTA Level 7	Higher Diploma	The holder of the qualification will be able to apply knowledge, skills and understanding in a broad range of complex technical activities, a high degree of personal responsibility and some responsibility for work of others
8.	NTA Level 8	Bachelors Degree	The holder of the qualification will be able to apply knowledge, skills and understanding in a wide and unpredictable variety of contexts with substantial personal responsibility, responsibility for the work of others and responsibility for the allocation of resources,

¹⁵ The council was the governmental body established under the National Council for Technical Education Act, 1997

¹⁶ Many institutions divided the academic year two semesters, first semester starts from July and second semester starts from February.

¹⁷ The result of marking and evaluation shall be sent to NACTE for verification of the reliability and reasonability.

¹⁸ Regarding the course for degrees, the procedure is needed between institution and TCU (Tanzania Commission for Universities) which is a governmental regulatory body for the university education.

¹⁹ NTA1 to 3 is equivalent to NVA 1 to 3 qualified by VETA

S/N	Qualification ¹⁹	Certificate award	Competence level
			policy, planning, execution and evaluation.
9.	NTA Level 9	Masters Degree	The holder of the qualification will be able to display mastery of a complex and specialised area of knowledge and skills, employing knowledge and understanding to conduct research or advanced technical or professional activity, able to work autonomously and in complex and unpredictable situations
10.	NTA Level 10	Doctorate Degree	The holder of the qualification will be able to apply knowledge and understanding and do advanced research resulting into significant and original contributions to a specialised field, demonstrate a command of methodological issues and engaging in critical dialogue with peers, able to work autonomously and in complex and unpredictable situations.

(Source: NACTE official website)

Qualification Possessed by DDCA Staffs

As mentioned in (1) 1) Organizational Settings in DDCA of Section 3.2.1, DDCA had 226 staffs in total at that time. A detail of those staffs are shown in **Table 33**. According to **Table 33**, the number of the certificate holders was largest, followed by the diploma holders. Certificates were uniquely given by the institutions according to the NVA or NTA qualified by VETA or NACTE. The areas qualified in the certificate included drilling, mechanics, electronics, driving and computer. For the diploma holders, the areas qualified included drilling, marketing and mechanics. Many staffs possessed the certificate and diploma in drilling area. Normally, the duties were given to the staffs according to the specialized area qualified in the certificates. For the staffs who completed Form VI and Standard VII, many of them were assigned as driver, drilling worker and quarryman for the gravel.

Table 33 Number of Staffs by Qualification

Qualification	Masters	Degree	Diploma	Technician	Certificate	Form IV	Standard VII	Total
No.	10	13	31	6	146	1	19	226

(Source: The Project Team prepared according to the staff list provided by DDCA)

3) Technical Educational Institute Providing Drilling Course (WDMI)

Outline of WDMI

WDMI was the only institute in the country which provided the VET and higher education specialized in water. WDMI was authorized by NACTE and operated by MoW. As a higher educational institute, WDMI provided five relevant courses attaining technician and diploma for maximum three years, and course of Water Resources and Irrigation Engineering attaining degree²⁰ for four years. WDMI aimed at making students become water experts and technicians through training, consultancy and research under the guidelines of MoW.

Courses on Higher Education

There were five courses attaining the technician and diploma, which were Water Supply and Sanitation Engineering, Hydrology and Meteorology, Hydrogeology and Water Well Drilling, Water Laboratory Technology and Irrigation Engineering. According to the NTA, NTA 4 level

²⁰ WDMI provided only certificate and diploma courses up to three years. From July 2013, Degree course would be started up to four years.

attaining basic technician was completed within a year, NTA 5 level attaining technician took two years and NTA 6 level for ordinary diploma takes three years. On the other hand, NTA 6 equivalent to the higher diploma and NTA 7 equivalent to degree were possible to be attained only in Water Resources and Irrigation Engineering course, which took three to four years. The details of the courses are described as below.

Water Supply and Sanitation Engineering: The course provides the subjects of civil engineering, leveling, hydrogeology, sanitation engineering required for feasible study on water supply facilities, design and construction. The graduates could be employed by water supply department of local government implementing the many construction works of water supply facilities, private contractors and consultants.

Hydrology and Meteorology: The course provides the techniques on survey and interpretation of the hydrological and meteorological data required for water resources development and management.

Hydrogeology and Water Well Drilling: The course provides the subjects of basic geology, hydrogeology, geophysical prospecting and water well drilling required for groundwater resources development and management.

Water Laboratory Technology: The skills on scientific evaluation required for water quality analysis is provided in the course. The course aims to train the students to be the experts on evaluation of water resources and environmental conservation.

Irrigation Engineering: The course provides the subjects of civil engineering, coil mechanics, leveling, hydrology, geomorphology required to conduct survey, design and construction of irrigation facilities.

Water Resources and Irrigation Engineering: The course provides the subjects of geology, water quality analysis, civil engineering, hydrogeology and environmental studies required for the construction of water supply facilities, water treatment facilities and irrigation facilities in consideration of the water resources management and environmental conservation.

There were 56 staffs in WDMI including 36 lecturers²¹. The number of the students in 2011/2012 was 221 for diploma courses, 60 for technician courses, 300 for certificate of short courses²².

Courses on VET

WDMI also provided the VET programmes attaining the vocational (artisan) qualifications. As same as VETA, Certificate of Competence level I to III equivalent to NVA level 1 to 3 was possible to be acquired within two years. At that time, four courses of construction engineering, water science and technology, mechanics and electronics were provided. Water science and technology course included water well drilling, construction of facilities, hydrogeology, hydrology, meteorology and water quality analysis. However, the course of water science and technology was hardly conducted due to the lack of lecturers. Provision of the VET programmes was going to be terminated for this fiscal year.

Also there are short courses on VET uniquely provided by WDMI, which was completed within maximum two months. **Table 34** shows the contents of short courses provided by WDMI. As the completion of each course, grade certificate III to I in relevant area shall be given to the students based on the result of the examination (Draughting and Deep well drilling courses provide only Grade I and II). At least one year experience in drilling site was required for the applicants to participate in the water well drilling course.

²¹ 2011, 2012/2013 Prospectus, WDMI, 128pp

²² 2011, Preliminary Survey Report, JICA, 174pp

Table 34 Contents of Short Courses Provided by WDMI

No.	Courses
1	Pump mechanics
2	Shallow well drilling
3	Deep well drilling
4	Masonry water tank
5	Topographical survey
6	Pipe fitting
7	Draughting

(Source : WDMI, Craft Syllabus, 46pp)

Courses on Water Well Drilling Attaining Technician and Diploma

Most of the staffs who belonged to the Drilling Department in DDCA were graduated from WDMI. There were large number of the diploma holders in the area of hydrogeology and water well drilling, and grade certificate holders in drilling, while some of the staffs held the diploma and grade certificate in other area such as mechanics, electronics and civil engineering.

Following sections describe the modules on water well drilling, and general education system for drillers provided by WDMI.

Modules on Water Well Drilling Provided by WDMI

Table 35 shows the modules on hydrogeology and water well drilling for technician (including basic technician) and diploma level. The students attaining Technician were supposed to complete the modules on Basin Technician. Also the students attaining Diploma shall complete those of Basic Technician and Technician beforehand.

Table 35 Modules on Hydrogeology and Water Well Drilling for Technician and Diploma

Module Title	Basic Tech	Tech	Diploma
Fundamental Modules			
Sequences & series, Binomial, Polynomial & Rational functions	○		
Physics	○		
ICT Essentials	○		
Trigonometry, complex numbers and Boolean Algebra	○		
Communication skills	○		○
Establishment of small business	○		
Vectors, Metrics and Differentiation		○	
Chemistry		○	
Office Applications		○	
Integration, Differential equations and Linear Programming		○	
Technical Writing		○	
Business opportunities and environment		○	
Advanced mathematics			○
Physical sciences			○
Entrepreneurship and development			○
Basic computer applications			○
Core Modules			
Shallow Well Surveys	○		
Shallow Dug Ring Well Construction	○		
Introduction to Hydrogeology	○		
Health Sanitation and Water	○		
Technical Drawing	○		
Plumbing	○		
Shallow tube well construction	○		
Maintenance of drilling equipment	○		
Levelling and applications	○		
Civil Eng. Drawing	○		
Construction Technology	○		
Industrial Practical Training	○		○
Groundwater Prospecting		○	
Introduction to well drilling		○	
Introduction to Engineering		○	
Introduction to quantity surveying		○	

Module Title	Basic Tech	Tech	Diploma
Introduction to geophysical instrument		○	
Geophysics; investigation for groundwater occurrence		○	
Construction Management		○	
Groundwater Exploration			○
Analysis and interpretation of hydrogeological data			○
Introduction to engineering geology			○
Well construction and rehabilitation			○
Maintenance of hydrogeological instrument			○
Measuring and monitoring groundwater			○
Rig maintenance and pumps installation			○
Documenting drilling information			○

The core modules for Basic Technician level (first year) mainly includes on the drilling techniques of shallow well, the drilling equipment and basic maintenance. For Technician level (second year), the drilling technique of boreholes, and skills of the hydrogeological and geophysical investigation to effectively conduct the drilling work are provided. For diploma level (third year), the modules are focused on the technique and supervision needed for entire drilling work including pump installation, interpretation of hydrogeological data and monitoring. WDMI owned the drilling rig only for the shallow well so that the practical training of borehole drilling shall be conducted out of institutes such as in drilling site of DDCA or private drilling companies.

On the other hand, the modules on the short courses related to the drilling are shown in **Table 36**. In Shallow Well Drilling course, certificate of grade III to I were possible to be acquired while only grade II and I were to be given in Deep Well Drilling course. The module on technique of drilling was provided for the grade II of Shallow Well Drilling course and grade I of Deep Well Drilling course. Since WDMI had no large scale rig for deep well drilling, the students were sent to DDCA or private drilling companies for the practical training.

Table 36 Modules on Short Courses related to Drilling

Grade	Module for Shallow Well Drilling	Module for Deep Well Drilling
III	Constructing a well slab	-
	Installing a hand pump	-
II	Preparing Investigations	· Pump Test
	Test hole drilling	Dismantling the rig tools and equipment
	Drilling a shallow supply well	-
I	Origin, Occurrence and Movement of Groundwater	Setting up drill rigs
	Locating a well site	Drilling a borehole
	Installing filter pipes and gravel pack	-
	Quantity and quality of groundwater	-
	Maintenance and operation of pumps and wells	-

(Source : WDMI, Craft Syllabus, 46pp)

General Education System for Drillers Provided by WDMI

The above mentioned education systems of drillers are summarized below.

- The graduates of Form IV²³ attend to study for attaining Technician or Diploma at WDMI.
- The graduates of Form IV attend to major in relevant technical courses at VETA for acquiring NVA 3. After the completion, they attend to study at WDMI for attaining Technician or Diploma.
- Every person who has experiences in drilling site at minimum one year is allowed to attend to take the grade certificate of short courses at WDMI.

As above mentioned, most of DDCA drillers were holders of grade certificate. At that time, no

²³ There are requirement of Form IV attainment in the subjects of physics/engineering, science, chemical, biology and mathematics for application.

one was allowed to apply for higher education in WDMI without Form IV certificate even if he/she had already acquired the grade certificate in short courses. It meant that the chances of learning on the drilling mechanism in the form of lecture were limited to the duration taken in the short courses. On the other hand, school expenses were expensive for many students to bear it on their own.

In order to develop the technical level of DDCA drillers, the acquirement of knowledge and skills on drilling mechanism was important as same as accumulation of the practical experience in the drilling site. As mentioned in (1) 3) Capacity Development of Drillers in DDCA of Section 3.2.1, there was no training system in DDCA. Therefore, it was needed that the project provides the support for DDCA to establish the system such as provision of the instruction from the senior drillers to middle drillers, and offers of the opportunities to DDCA drillers to attend the training courses which might be held outside. For achieving them, the collaboration with WDMI was effective since WDMI was the only institute which possesses the know-how on education of drilling technique.

(3) Baseline Survey on Drilling Work Process in DDCA

1) Field Survey at Drilling and Pumping Test Sites

Ten drilling sites and one pumping test sites of DDCA were surveyed by the JICA experts of drilling and of field technique training expert together with the counterparts. The objective of this survey was to investigate drilling techniques currently applied by DDCA. Various sites in terms of location and rig were selected in order to observe different types of drilling work depending on well type, drilling method and rig type. Visit to one site of Mwanza in April 2012 and nine sites of Kilimanjaro, Coast and Dar es Salaam including one pumping test site was done between August and September 2012.

Table 37 Visited Drilling and Pumping Test Sites

Region	District	Location	Drilling Type	Rig No.	Rig Name	Rig Type
Kilimanjaro	Moshi	Moshi	DTH Drilling	82	BPVL	Rotary (Large Capacity)
Coast	Kibaha	Mitamba	Mud Drilling	46	Schramm	Rotary (Large Capacity)
		Misugusugu	Mud Drilling	81	Sankyo	Rotary (Large Capacity)
Mwanza	Mwanza	Maliza	DTH Drilling	78	Koken	Rotary (Large Capacity)
Dar es Salaam	Kinondoni	Kibamba	Mud Drilling	44	Schramm	Rotary (Large Capacity)
		Bunju A	Mud Drilling	44	Schramm	Rotary (Large Capacity)
		Msakuzi	Mud Drilling	46	Schramm	Rotary (Large Capacity)
		Vikuruti	Mud Drilling	46	Schramm	Rotary (Large Capacity)
		Sinza	Mud Drilling	14	PAT301A	Rotary (Small Capacity)
	Temeke	Kijichi	Pumping Test	-	-	-
Lindi	Lindi	Kingurungundwa	DTH Drilling	42	Schramm	Rotary (Large Capacity)

In Tanzania, mud drilling is mainly applied for sedimentary rock deposit along the coast and in a part of inland area, while DTH drilling is applied for basement rock areas which cover most of the inland area. DDCA corresponds to both of these drilling methods. DDCA's drilling equipment is classified into cable and tool type and rotary type. Moreover, rotary type consists of large capacity type and small capacity type. Large capacity rigs are capable to drill more than depth of 150 m while the small capacity rigs are for drilling boreholes of less than 100 m in depth with small diameter. The field survey revealed the status of the use of the equipment and contents of drilling works at several sites of which equipment type and drilling methods are different. The identified situation of DDCA's drilling work is summarized below.

2) Annual Number of Drilled Boreholes

Figure 36 shows the annual number of boreholes drilled in 10 years since 2002/03 to 2012. Over 400 boreholes were drilled in the period of 2002/03 to 2008/09. However, the number was decreased to the level of 200 in recent three years since 2009/10 to 2012. The major reason of decrease is insufficient number of the drilling rigs due to their aging. Approximately 30 drilling rigs were operated in early 2000's. Then, the number of drilling rigs went on decreasing year after year. 17 rigs were operated in 2011/12. However, in 2012/13, only 15

rigs are operational since two rigs were ceased to be used. The increase of drilling depth is another reason of the decrease of the annual number of drilled boreholes.

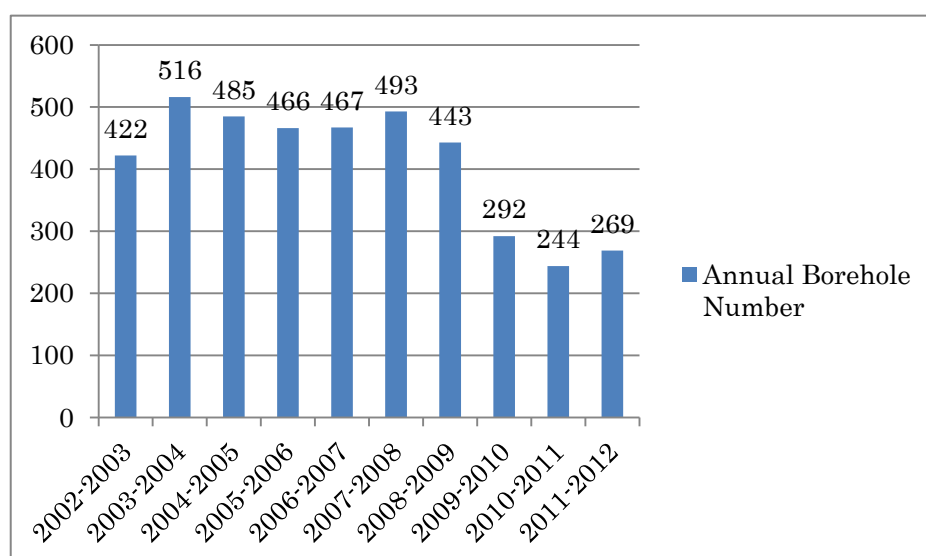


Figure 36 Annual Number Boreholes Drilled by DDCA in Past 10 Years (2002/03 to 2011/12)

3) DDCA's Organization for Drilling Works

DDCA's Drilling Rigs

As of 2012, DDCA owned 15 operational rigs consisting, which were 4 cable tools and 11 rotary (9 large and 2 small). **Table 38** shows model, type, year of purchase and capacity (diameter and depth) of 15 operational rigs of DDCA.

Table 38 Operational Drilling Rigs of DDCA

No.	Rig No.	Model	Rig Type	Year of Purchase	Drilling Diameter	Max. Drilling Depth (m)
1	1	PERCUSSION	Cable/Tool	1930	6"-10"	150
2	16	PERCUSSION		1965	6"-10"	180
3	17	PERCUSSION		1961	6"-12"	200
4	60	PILCON		1984	6"-8"	80
5	42	SCHRAMM	Rotary (Large)	1974	6"-12"	300
6	44	SCHRAMM		1974	6"-12"	300
7	46	SCHRAMM		1974	6"-12"	300
8	49	SCHRAMM		1974	6"-12"	300
9	50	SCHRAMM		1974	6"-12"	300
10	78	KOKEN		1997	6"-12"	200
11	81	SANKYO		2004	6"-12"	300
12	82	BPVL		2007	6"-12"	150
13	83	BPVL		2007	6"-12"	150
14	77	PAT	Rotary (Small)	1997	5"-8"	80
15	78	PAT		2004	5"-8"	100

Organization of Drilling Teams

As shown in **Table 38**, DDCA had 15 drilling teams for each rig under the Drilling Project Department. Normally, a team consisted of four to five members of one rig in charge, one assistant rig in charge, two to three operators and drilling workers. Since cable and tool rigs were rarely used, three staffs shared four rigs and other necessary staffs were temporarily employed for the necessary.

Apart from the 15 drilling teams, DDCA had two pumping test teams in Dar es Salaam and one team in Sumbawanga (Rukwa region). Normally, a team consisted of four members of one

pumping test in charge, one assistant pumping test in charge and two pumping test assistant for each team. Only drilling team of KOKEN rig (Rig No. 78) was furnished with the pumping test equipment. Accordingly, there were four pumping test teams in total in DDCA.

Also, DDCA had one flushing team in Dar es Salaam, which conducted well development works. The flushing team transported the air compressor by their truck, and develops wells by air lifting. In upcountry, development was mainly conducted with air compressor for DTH drilling, as most of well were drilled by DTH drilling method. In Dar es Salaam and Coast area, where mud drilling was major method, air compressor for the development shall be brought to the site since air compressor was not used for mud drilling. In these areas, the flushing team conducted the development work at each drilling site.

Annual Number of Boreholes Drilled by Rig Type

Table 39 shows the annual number of boreholes drilled by rig type in 2011/2012. 19 rigs were used at the point of the survey. Among 19 rigs, two rigs (one cable and tool rig and one large rotary rig) came to be unused as of 2011/12 and two rigs were hired from other companies. The total number of boreholes drilled by 19 rigs is 269, namely 14 boreholes per rig. The number of boreholes drilled by rotary was 234 in total (178 for large and 56 for small one), which occupied 87 percent of the total number of wells per annum drilled by DDCA. It meant that approximately 20 boreholes per each of 12 rotary rigs were drilled annually. Therefore, rotary rig was regarded as the major type of rig for DDCA.

Table 39 Annual Number of Borehole by Type of Rig in 2011/2012

Rig Type	No. of Rig	No. of Well by Rig Type	No. of Average Well per Rig
Cable/Tool	5	29	6
Rotary (Large)	10	178	18
Rotary (Small)	2	56	28
Hired Rig	2	6	3
Total	19	269	-
Average	-	-	14

Usage of Rig by Area

The areas around Dar es Salaam (Dar es Salaam and Coast Region) and the coastal areas are covered by sedimentary deposit. The drilling works for these areas are conducted by small rigs for mud drilling. On the other hand, drilling works in the inland areas requires large rigs corresponding to DTH drilling, since these areas are covered by basement rock. Thus, different drilling methods shall be used for these two types of geological condition. The analysis on the usage of rig by area is described as follows.

Table 40 shows the number of boreholes drilled by rig type and area. 263 boreholes were drilled by 17 rigs of DDCA in 2011/12. By the cable and tool rigs, 72 percent of the boreholes were drilled around Dar es Salaam. The geological conditions to the application of the cable and tool rigs were limited. In this reason, three rigs out of five were used in Dar es Salaam and other two rigs were used in certain areas where the conditions match. On the other hand, 72 percent of boreholes were drilled in inland area by the large rotary rigs. 129 (94 %) out of 137 boreholes drilled in this area were drilled by this rig type. The small rotary rigs were applicable only for mud drilling with small diameter so that they were used only around Dar es Salaam.

Table 40 Number of Boreholes Drilled by Area in 2011/2012

Rig Type	No. of Rig	Number of Boreholes			
		Around Dar es Salaam		Inland Area	Whole Country
Cable/Tool	5	21	(72%)	8 (28%)	29 (100%)
Rotary (Large)	10	49	(28%)	129 (72%)	178 (100%)
Rotary (Small)	2	56	(100%)	0 (0%)	56 (100%)
Total	17	126	(48%)	137 (52%)	263 (100%)

Note 1) 17 rigs do not include 2 hired rigs and include one cable and tool rig and one large rotary rig which were ceased to be used since 2012/2013.

Note 2) The figures in parentheses show the ratio of number of boreholes by area to the total number in whole country.

Table 41 shows the average drilling depth by area for the boreholes drilled in 2011/2012. This data was compiled from the drilling records in 2011/2012, as well as the one in **Table 40**. The average drilling depth by cable and tool rigs in whole country was 30.3 m. It showed that rigs of this type were used shallower boreholes than those of other rig types. On the other hand, the average drilling depth by large rotary rigs in whole country was 96.9 m, which was the deepest among three types of rig. The average drilling depth around Dar es Salaam of large rotary rig was 110.0 m. The average drilling depth of small rotary rigs was 70.0 m. The maximum capacity of the depth for this type of rig was 80.0 m. In this reason, the small rotary rigs were used for boreholes whose depths were less than 80.0 m.

Table 41 Average Drilling Depth by Area in 2011/2012

Rig Type	No. of Rig	Average Drilling Depth (m)		
		Around Dar es Salaam	Inland Area	Whole country
Cable/Tool	5	25.3	43.6	30.3
Rotary (Large)	10	110.0	91.9	96.9
Rotary (Small)	2	70.0	-	70.0
Average	17	78.1	89.0	83.8

4) Well Specifications

More than 80 percent of wells drilled by DDCA were ordered by private customers. They were used for drinking water, industry, irrigation etc. The water demand and the diameter of casing and screen pipes differ by the uses of well. This is because the maximum yield of pump to be installed differs in accordance with the diameter of casing and screen pipes. **Table 42**, shows that the more discharge rate is required, the larger diameter of casing and screen pipes are needed.

Table 42 Maximum Yield by Diameter of Casing Screen Pipe

Casing Diameter	Applicable Pump	Maximum Discharge Rate (m ³ /h)	Use
4" or 5"	Handpump	0.7	Rural water supply, private households etc
	Submersible Pump	15.0	
6"	Submersible Pump	40.0	Rural water supply, small scale urban water supply, industrial water etc
8"	Submersible Pump	70.0	Large scale urban water supply, irrigation, industrial water etc
10"	Submersible Pump	120.0	

Apart from the drilling depth, well specifications such as the type and diameter of casing and screen pipes etc. are to be determined prior to the drilling work. As the result of the baseline survey, the specifications of the wells of DDCA were identified as described in the followings.

● Type of Casing

DDCA employed the PVC (polyvinyl chloride) casing and screen pipes. Steel casing and screen pipes were used until the end of 1990s. Subsequently, the usage of PVC casing and screen pipes got increased. At the time of survey, PVC casing and screen pipes were employed for almost all drilling works. Compared to the steel casing and screen pipes, those of PVC have advantages such as resistance to oxidation, good workability because of their light weights and so on. On the other hand, they are easily damaged by physical impact. Moreover, the maximum installation depth is around 250 m, because of limitation of strength, though it does not matter in Tanzania since most of wells are of not more than 200 m in depth. Consequently, steel or stainless steel casing and screen pipes were rarely being used in Tanzania.

● Water Consumption of Well and Diameter of Casing and Screen Pipes

Table 43 shows the number of wells drilled by DDCA in 2011/2012 average drilling depth by casing diameter. 23 wells without casing were judged unsuccessful before the installation of

the casing and screen pipes. The wells with 4" and 5" casing diameter occupies 64 percent to total, which is a highest demand. This shows that many clients of DDCA have demand of wells for small scale water facilities with hand pump or small submersible pump. Regarding hand pump wells, 5" casing and screen pipes instead of 4" were mainly used at the point of the survey for the purposes of the prevention of well trouble and the future extension to submersible pump. The 4" casing wells drilled in 2011/2012 were drilled under the special requirement in the Project for Rural Water Supply in Mwanza and Mara regions funded by Japanese Government. The number of wells with 6" casing and screen pipes occupies 26 percent to the total number. This is the most general diameter for the wells for piped schemes in rural water supply and industrial usage. The wells with 8" casing and screen pipes contributes just small number, i.e. only one percent to the total. This type of well is rarely demanded except when very large discharge rate is required.

The average depths were 81 m for the diameter of 4" or 5", 99 m for 6" and 124 m for 8". As the diameter becomes larger, the deeper drilling and larger capacity rigs are needed.

Table 43 Number of Wells Drilled in 2011/2012 and Average Depth by Casing Diameter

Casing Diameter	Number of Wells	Percentage (%)	Average Depth (m)
4"	9	3	81
5"	163	61	
6"	70	26	99
8"	4	1	124
Without casing	23	9	94
Total	269	100	85

Note) : Compilation from the drilling record in 2011/2012

● Drilling Diameter

Generally, mud drilling method is applied for soft sedimentary rock while DTH drilling method is applied for hard basement rock. Even if the casing and screen pipes of same diameter are used, the drilling diameter differs in accordance with drilling methods and geological conditions. The drilling diameter is selected so that sufficient annular space between the hole and casing and screen pipes is secured. Insufficient annular space will cause the trouble on casing and screen installation and gravel packing. Not less than 13 mm in one side is necessary for DTH drilling, while not less than 50 mm in one side is needed for mud drilling.

Mud is not used for DTH drilling because the strata are consolidated. Therefore small annular space is enough for installation of casing and screen pipes and gravel packing. However, more space is needed for mud drilling since sand and clay in the mud disturb of the gravel packing. DDCA used the drilling diameter shown in **Table 44** in accordance with the drilling method and diameter of casing and screen pipe.

Table 44 Diameter of Casing and Screen Pipes and Drilling Diameter by Drilling Method

Drilling Method	Casing, Casing Screen Pipe Diameter	Drilling Diameter
DTH	4" or 5"	6-1/2"
	6"	8"
	6" or 8"	10" – 12"
	4" or 5"	8"
Mud	6"	9-7/8" – 10"
	6" or 8" PVC	10" or 12"

5) Issues on Technical Instruction

Contents of drilling works, technical level of DDCA's drillers in each technical areas and issues on technical instructions were identified through the field survey and interview to DDCA. **Figure 37** shows the process of drilling works of DDCA. Though there are slight differences of drilling method and diameter in the wells of DDCA, the process of drilling works is almost same. However, the large rig and higher technical level are needed for the drilling of larger

diameter and deeper wells. Issues on technical instruction on each drilling process are described as follows.

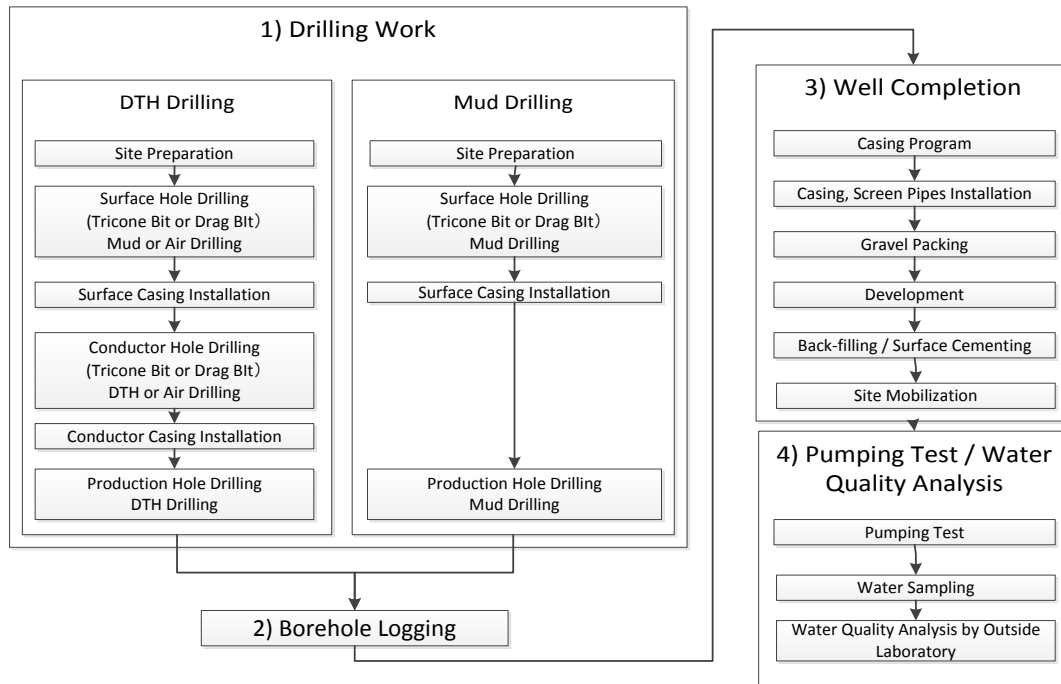


Figure 37 Process of Drilling Works

Drilling Work

DDCA's drillers were confirmed to have basic techniques to conduct drilling works by using drilling equipment. Whereas, the following issues on efficiency of the work were observed

- Regarding the site preparation, it was observed that the equipment was put in place without leveling the ground. The leveling is necessary for keeping the equipment and machinery stable.
- The solid separation was observed to be ineffective due to too short drain canal and its slope. This may cause the low penetration and the rapid wearing of the drilling equipment. The meaning of mud control shall be properly understood by drillers so that the mud control is to be done in appropriate manner.
- There was no check list prepared for the equipment and materials to be brought into the site. It helps to prevent from suspending the work due to running out of the equipment and materials.
- The capacity of the drilling equipment (maximum lifting load of rig, discharge rate and pressure of mud pump, unit weight of drilling pipe etc.) was not comprehended properly. Also sometimes the weight indicator or pressure gauge was not being used during the drilling works.
- Neither Marsh funnel (viscosimeter) nor mud balance was used for mud control.

Most of drillers were observed to rely on their past experience rather than measured figure such as machinery capacity and value of discharge and pressure. Accordingly, it took a time to transfer the knowledge and technique to other drillers. This was regarded as an issue on provision of technical instructions.

Borehole Logging

Currently DDCA has one technician who is in charge of the borehole logging. He was confirmed to be competent for borehole logging work and interpretation of the result. An issue on data management observed is that the borehole logging technician does not have enough knowledge on how to transfer the data into the computer and how to make a logging chart.

Accordingly, the borehole logging results were not properly stored by DDCA.

DDCA realized the importance of the logging. They intended to implement the borehole logging for as many wells as possible. In order to respond the increasing demand, DDCA regarded it necessary to allocate drillers who knew the operation of the borehole logging instrument to each drilling team. Also it was necessary for drillers to acquire the usage of a logging machine which was remained unused since purchased in 2012. The issue on technical instruction was that there were few drillers who had already known about the usage. Accordingly, transference of the experience and knowledge on logging to drillers was required.

Well Completion

It was confirmed that after drilling DDCA conducted the installation of the casing and screen pipe, gravel packing, development with air lift, backfilling, cementing and site demobilization without any problem. The points to be considered were observed as below.

- The amount of gravel is determined by not calculation but experience. The work would be happened to suspend due to the shortage of gravel.
- Regarding the air lift, usually single pipe is used in air lift and double pipe is rarely used. Air lift by single pipe can damage the casing. Accordingly, drillers are required to acquire the work process of air lift by double pipe and the selection standard of air lift.

The issues on technical instruction was to make them enhance the calculation on installation depth of casing and screen pipe, and method of development by air lift in order to provide the instruction for others.

Pumping Test and Water Analysis

The pumping test was done by the pumping test team. As only a few drillers had knowledge of pumping test., it was necessary for drillers to impart the technique and knowledge on pumping test. Regarding the water quality analysis, only those who had experienced the pumping test know about it. Therefore, the drillers were required to acquire the knowledge on sampling and basic water quality items.

Well Rehabilitation

Well rehabilitation was not major works for DDCA. However, the techniques on taking measure of sand rush and falling pump were indispensable for drillers and there were demand to such techniques from private companies. It was confirmed that at least DDCA drillers had technique on flushing and fishing through drilling works. As issues on the technical instruction, the techniques were not shared and standardized in DDCA. Therefore the manuals on well rehabilitation were thought to be useful for imparting and sharing the technique.

3.2.2 FORMULATION OF TECHNICAL SUPPORT PLAN FOR DRILLERS IN DDCA AND PROVISION OF TECHNICAL INSTRUCTION AND SUPPORT

In addition to the analysis result of the baseline survey, technical areas necessary for capacity development were identified through evaluation of the technical level of the DDCA's drillers. Based on the identified technical areas, Technical Support Plan for Drillers in DDCA was formulated and technical instruction and support were commenced. These activities were conducted according to the contents and items shown in *Table 45*

Table 45 Formulation of Technical Support Plan for Drillers in DDCA and Contents of Activities for Technical Instruction and Support

Contents	Items
Identification of the technical areas necessary for capacity development of DDCA	1) Evaluation of technical level of DDCA's drillers 2) Identification of areas necessary for enhancement and newly development based on the intelligibility test
Provision of technical instruction and support to DDCA	1) Target for technical instruction and support 2) Technical areas necessary for technical instruction and support 3) Method of capacity development 4) Formulation of Technical Support Plan for Drillers in DDCA to enhance the capacity of drilling works 5) Preparation of manuals for capacity development of drilling works 6) Preparation of manuals for capacity development of well rehabilitation and fishing 7) Provision of technical instruction and support (1 st year) 8) Provision of technical instruction and support (2 nd year)

The results of each activity are shown below.

(1) Identification of Technical Areas Necessary to be Enhanced at DDCA

1) Evaluation of Technical Level of DDCA's Drillers

The findings of baseline survey on drilling works in DDCA were compiled in (3) Baseline Survey on Drilling Work Process in DDCA of Section 3.2.1. It was confirmed that the drillers of DDCA had basic technique on the drilling. However not all drillers had the techniques on further drilling work such as logging and pumping test. The technical instructor to private sector had to acquire the entire process of the drilling works. Moreover, in the technical areas where the shortage of basic knowledge was identified, the drillers' capacity had to be enhanced intensively. In addition to the baseline survey on the drilling work in DDCA, more details on the technical area necessary to be enhanced had to be clarified. Therefore, the competence test to the drillers was conducted in November 2012 in order to measure the technical level of drillers.

Purpose of the survey

The purpose of the survey is as follows.

- To identify areas necessary to be enhanced and new technical area at DDCA for the technical instruction to the private sector,
- To identify the technical level of each driller and utilize these basic information for selecting the candidate of technical instructor.

Target Group of Survey

There were 74 drillers in DDCA. Out of 74, 68 belonged to the Drilling Project Department and 6 were from Technical Support Department. They were members of the either drilling team or pumping test team which was involved in drilling works. The target drillers were classified to the four levels of S, A, B and C in order to select the candidates of technical instructors to the private drilling companies. The drillers classified to level S was defined that they had experienced and acquired high drilling knowledge and technique and they were in position to provide the instruction to others. Regarding level A, they were competent in doing

the drilling work as a supervisor. The drillers classified to level B had a relevant experience to do the work according to the instruction from the supervisor, while those of level C who had a skill to do the supporting work under the instruction from supervisor. This classification was determined by the evaluation of supervision of the Drilling Project Department through observation of their daily work performance and the achievement of the work. The number of the drillers and those who had taken the competence test by classification is shown in **Table 46**.

The drillers who classified to S and A level were almost senior drillers, who shall be a candidate of the technical instructor. The activities enhancing the capacity of DDCA were targeted for these senior drillers. Though the middle drillers, who classified to B and C, were not targeted in this Project, they would be senior driller in the near future as the result of capacity development through the daily work. The competence test was conducted to both senior and middle drillers in total 66 drillers in order to identify the entire technical level of drillers. Out of 66 drillers, 35 were senior and 39 are middle drillers. The number of senior and middle drillers who taken the competence test were 29 and 37, respectively. Some drillers missed to take a test since they were involved in their own task and some others had already been positioned to provide the instruction.

Table 46 Classification of Drillers

Technical Level	All Drillers			Competence Test Respondents			Reference
	Drilling Project Dep.	Technical Support Dep.	Sub total	Drilling Project Dep.	Technical Support Dep.	Sub total	
S	9	0	9	5	0	5	1)
A	25	1	26	23	1	24	2)
B	18	3	21	17	3	20	3)
C	16	2	18	16	1	17	4)
Sub total S, A	34	1	35	28	1	29	5) = 1) + 2)
Sub total B, C	34	5	39	33	4	37	6) = 3) + 4)
Total	68	6	74	61	5	66	7) = 5) + 6)

Note : Technical level S. and A are classified to senior driller while B and C are classified to middle driller

Venue and Data of the Survey

The questionnaire was filled in 1st November 2012 from 9:00 to 11:30 at Water Resources Management Institute (WDMI) and DDCA zonal office in Mwanza.

Contents of the Competence Test

The 15 technical areas shown in **Table 47** were covered in the competence test. Each technical area is consisted of several items and each item has several questions. **Table 48** shows the number of item and question. In total 68 questions were asked in the questionnaire.

Table 47 Contents of the Competence Test

No.	Technical Area	No.	Technical Area
1	Site Mobilization	9	Back-Filling & Surface Cementing
2	Drilling Tools and Equipment	10	Site Demobilization
3	Drilling Drawbacks	11	Well Investigation
4	Drilling Control	12	Tool Fishing
5	Borehole Logging	13	Well Rehabilitation
6	Casing Program / Installation	14	Pumping Test
7	Gravel Packing	15	Water Quality Analysis
8	Well Development		

2) Identification of the Technical Areas to be Enhanced and New Technical Area to be Needed

Method of Markings and Result of Test

Table 48 shows the accuracy rate by each item for whole respondents. The marking was set as 100 percent in case all questions of each item were answered correctly. Then, the accuracy rate was calculated according to the score attained by each respondent. The accuracy rate shown in **Table 48** is the average accuracy rate by item for all respondents. The accuracy rate by area was given by calculating the average accuracy rate of items under each area.

Regarding the accuracy rate of senior drillers by area, areas of logging, gravel packing, pumping test and water quality analysis were resulted in below 30 percent which was the lowest in whole area. The reason assumed was that the drillers who had experienced logging, pumping test and water quality analysis were just a few. Also through the baseline survey it was anticipated that there were many drillers who were not competent in calculation of the gravel. The average rate of whole area was 44.6 percent. Accordingly, the area and item of accuracy rate attained to less than 45 percent was the standard for determination of the area necessary to be enhanced or newly acquired.

Table 48 Accuracy Rate by Area and Item

Technical Area / Item	Accuracy Rate			Numbers of Question
	Senior Drillers	Middle Drillers	All Drillers	
1 Site Mobilization	85.5%	82.6%	80.0%	3
1-1 On-site Drilling Machine Setting-Out	85.5%	82.6%	80.0%	3
2 Drilling Tools and Equipment	35.5%	28.0%	22.2%	4
2-1 Selection of drilling bit and drilling method	30.1%	23.6%	18.6%	4
2-2 Bit rotation speed control	39.5%	30.5%	23.4%	4
2-3 Weight of drilling tools and weight on bit control	36.9%	30.0%	24.7%	3
3 Drilling Drawbacks	58.7%	50.9%	44.5%	2
3-1 Countermeasures against lost circulation (mud and air)	52.5%	45.3%	39.6%	2
3-2 Countermeasures against borehole collaption	70.0%	61.3%	54.1%	3
3-3 Countermeasures against jamming of drilling tools	53.5%	46.0%	39.9%	4
4 Drilling Control	38.4%	34.3%	31.1%	1
4-1 Air control of compressor for DTH drilling	72.3%	65.0%	59.5%	1
4-2 Mud control	26.1%	23.8%	22.0%	3
4-3 Proper mud flow velocity	44.1%	40.0%	36.5%	3
4-4 Control of mud pump operation	20.4%	20.8%	21.2%	3
4-5 Mud control for drilling of clay layer	29.0%	21.8%	16.2%	2
5 Borehole Logging	26.9%	23.9%	21.4%	1
5-1 Borehole logging instruments	21.7%	19.7%	18.0%	1
5-2 Interpretation of borehole logging results	32.2%	28.0%	24.9%	2
6 Casing Program / Installation	45.3%	43.3%	41.4%	1
6-1 Casing Program / Casing Installation	39.0%	35.0%	31.5%	1
6-2 Role of centralizer	51.7%	51.5%	51.3%	2
7 Gravel Packing	23.7%	17.9%	13.5%	1
7-1 Calculation of annular volume	12.2%	6.0%	1.4%	1
7-2 Calculation of gravel volume	13.9%	11.3%	9.4%	1
7-3 Determination of gravel size	45.0%	36.5%	29.7%	1
8 Well Development	43.8%	39.1%	35.5%	1
8-1 Well cleaning after drilling	35.9%	30.6%	26.5%	1
8-2 Single-tube method air-lifting	58.6%	54.5%	51.3%	1
8-3 Double-tube method air-lifting	36.8%	32.3%	28.8%	1
9 Back-Filling & Surface Cementing	44.7%	42.0%	39.9%	1
9-1 Back-filling	55.0%	45.5%	37.9%	1

Technical Area / Item	Accuracy Rate			Numbers of Question
	Senior Drillers	Middle Drillers	All Drillers	
9-2 Surface cementing	34.3%	38.5%	42.0%	1
10 Site Demobilization	69.8%	63.3%	58.1%	1
10-1 Precautions upon site demobilization	69.8%	63.3%	58.1%	1
11 Well Investigation	73.4%	65.3%	58.8%	1
11-1 Necessary information of well rehabilitation plan	73.4%	65.3%	58.8%	1
12 Tool Fishing	41.4%	39.2%	37.4%	1
12-1 Tool fishing plan	36.8%	36.0%	35.1%	1
12-2 Fishing tools	46.0%	42.3%	39.6%	1
13 Well Rehabilitation	34.8%	34.4%	34.0%	1
13-1 Deterioration of casing	46.6%	48.5%	50.0%	1
13-2 Cause of rust-colored water	5.4%	5.5%	5.5%	1
13-3 Cause of sand production	41.5%	39.5%	37.9%	1
13-4 Methods of removal of sand sedimentation	24.1%	32.0%	37.9%	1
13-5 Methods of casing cleaning	29.2%	28.0%	27.1%	1
13-6 Usage of borehole camera	62.1%	53.0%	45.8%	1
14 Pumping Test	27.6%	26.4%	25.5%	1
14-1 Purpose of Pumping Test	35.8%	31.3%	28.0%	1
14-2 Selection of Submersible Pump	17.4%	18.0%	18.9%	1
14-3 Test Method	20.8%	26.0%	29.7%	1
14-4 Interpretation of test results	36.5%	30.2%	25.4%	4
15 Water Quality Analysis	18.9%	22.8%	25.7%	1
15-1 Purpose of Water quality analysis	17.1%	27.5%	35.2%	1
15-2 Item of water quality analysis	20.7%	18.0%	16.1%	1

Table 49 shows the distribution of the number of senior drillers by accuracy rate for whole area, drilling related area and area necessary to be enhanced (accuracy rate below 45 %). The number attained the accuracy rate more than 45 percent was 16 senior drillers for whole area (46 %), 20 for drilling related area (57 %), 3 for area to be enhanced (9 %). The result shows that the technical level of drilling related area involved in daily work was high, whereas the level of the other area was not. That is to say few drillers had acquired the basic knowledge except for drilling area. It was thought to be important for DDCA to enhance their capacity by increasing the number of drillers who acquired the basic knowledge on the area necessary to be enhanced.

The selection of the candidate of technical instructor shall be done comprehensively in consideration of not only the technical level identified by the competence test but also the evaluation of the daily performance from the drilling managers and supervisors, and also the plan of personnel allocation as well. The score of the drilling related area in the competence test was expected to be attained more than 45 percent. Enhancement for the knowledge shorten was possible to be covered during the training of instructors to be conducted for the activity of output 1. The specific activity of the training was included into the Private Sector Capacity Development Supporting Plan.

Table 49 Distribution of Number of Senior Drillers by Accuracy Rate

Accuracy Ratet	Distribution of No. of drillers			Accuracy Ratet	Distribution of No. of drillers		
	All Area	Drilling Related Area	Area Necessary to be Enhanced		All Area	Drilling Related Area	Area Necessary to be Enhanced
Below 5%	0	0	1	40%	2	2	5
10%	1	1	0	45%	6	5	7
15%	0	0	0	50%	7	5	3
20%	0	0	1	55%	4	3	0


Accuracy Ratet	Distribution of No. of drillers			Accuracy Ratet	Distribution of No. of drillers		
	All Area	Drilling Related Area	Area Necessary to be Enhanced		All Area	Drilling Related Area	Area Necessary to be Enhanced
25%	1	0	3	60%	5	6	0
30%	0	1	4	65%	0	6	0
35%	3	0	5				
No. of drillers attaining more than 45 %					16	20	3
Ratio to all senior drillers (35 drillers)					46%	57%	9%

3) Test Result by Technical Area

Table 50 shows the accuracy rate by technical area. The average rate for the whole area and drilling related area is shown at the bottom of the table. The average of senior drillers for whole area was 44.6 percent and 49.5 percent for drilling related area of which their level of understanding was high. Compared between senior and middle drillers for whole area and drilling related area, the accuracy rate of senior drillers was higher than that of middle drillers. This result corresponded to the evaluation of the Drilling Project Department.

Table 50 Test Result by Technical Area

No.	Technical Area	Accuracy Rate			Remarks
		Senior Drillers	Middle Drillers	All Drillers	
1	Site Mobilization	85.5%	80.0%	82.6%	Drilling Related Area
2	Drilling Tools and Equipment	35.5%	22.2%	28.0%	Drilling Related Area
3	Drilling Drawbacks	58.7%	44.5%	50.9%	Drilling Related Area
4	Drilling Control	38.4%	31.1%	34.3%	Drilling Related Area
5	Borehole Logging	26.9%	21.4%	23.9%	Other Area
6	Casing Program / Installation	45.3%	41.4%	43.3%	Drilling Related Area
7	Gravel Packing	23.7%	13.5%	17.9%	Drilling Related Area
8	Well Development	43.8%	35.5%	39.1%	Drilling Related Area
9	Back-Filling & Surface Cementing	44.7%	39.9%	42.0%	Drilling Related Area
10	Site Demobilization	69.8%	58.1%	63.3%	Drilling Related Area
11	Well Investigation	73.4%	58.8%	65.3%	Other Area
12	Tool Fishing	41.4%	37.4%	39.2%	Other Area
13	Well Rehabilitation	34.8%	34.0%	34.4%	Other Area
14	Pumping Test	27.6%	25.5%	26.4%	Other Area
15	Water Quality Analysis	18.9%	25.7%	22.8%	Other Area
Average of All Areas		44.6%	37.9%	40.9%	Other Area
Average of Drilling Related Areas		49.5%	40.7%	44.6%	Other Area

 : Areas attained below 45% by senior drillers

The current situation on the drilling level of senior drillers observed from **Table 49** and **Table 50** is summarized as below.

● Drilling Work

The drilling work included site setting, drilling, installation of surface and middle casing, and casing after drilling and development before installation of the screen pipe, of which these areas are shown in 1 to 4 of **Table 50**. These areas were the major daily task for drillers. However, the score of the area on drilling tools and equipment, and supervision of the drilling was lower than the standard. Therefore, the knowledge of this area needed to be improved. The score for the knowledge on drilling method, bit selection, tools weight and bit injection pressure, and drilling operation management including mud control, mud pump operation and drilling of clay layer was attained by low accuracy rate. It meant that at least drillers conducted the drilling work with using the knowledge acquired by experience. However, the issue would come to the technical instruction providing the knowledge on the drilling work management such as tools weight and bit injection pressure. The utilization of the instruction manuals was thought to be helpful for the technical instructor to enhance them such knowledge.

- **Borehole Logging**

The average accuracy rate of borehole logging was 26.9 percent. Since many senior drillers had just experienced the supporting work for logging, they had only insufficient experience and knowledge. Accordingly, it was thought to be important for the as many as drillers to be given the opportunities of logging work and acquire it by using the technical manual.

- **Casing Programme**

The accuracy rate was 45.3 percent. The conclusion was that they had basic experience and knowledge.

- **Gravel Packing**

The accuracy rate was low, which attained to 23.7 percent. The questions included the calculation of vacancy volume and gravel. The reason of the low accuracy rate was thought to be because, in drilling site, the drillers did not have a theoretical calculation of gravel, but depend on their experience. Regarding the calculation of the annular volume and gravel volume, if the supporting data book was provided and used by each driller at the site, the drillers would mitigate the task of calculation. The data book including the specification of the drilling tools and volume table was thought to be useful tool for drillers.

- **Development**

The activity for the enhancement of the capacity was judged to be necessary since the accuracy rate was 43.8 percent, which was slightly low. The reason attained by low accuracy rate was assumed that the names of method of development such as air lift, bailing and surging were not familiar to them. In the provision of technical instruction, using of uniformed terms was thought to be important. Also the accuracy rate to the question about the air lift was low, especially for the air lift with double tubes. Normally, DDCA used the air lift with single pipe. It was thought to be necessary for the technical instructor to acquire and give the instructions of the knowledge on air lift with double pipe as an option.

- **Backfilling/Surface Cementing**

The accuracy rate was 44.7 percent. Backfilling and surface cementing would be important area in terms of protecting the surface water flowing into the well and also preserving the aquifer. The technical instructor was expected to provide the advice on appropriate method.

- **Site demobilization**

The drillers seemed to have basic knowledge about the site demobilization according to the accuracy rate of 69.8 percent. For site mobilization, there were no complex works needed for the specific skill. At least the drillers were expected to possess the perception on the site recovery and environmental conservation. The appropriate method of demobilization was to be facilitated to the private drilling companies.

- **Well Investigation**

The well investigation included the items such as well depth, screen position and pump type in order to conduct the well rehabilitation. The understanding was relatively high since the accuracy rate was 74.4 percent.

- **Fishing**

The accuracy rate was 41.4 percent which was higher than expected, though the fishing for the well rehabilitation had been an area of which DDCA desired to make the drillers enhance. The fact was that the technique applied for fishing was not shared and unplanned among the drillers. Therefore, it was thought to be useful to prepare the universal manual using uniform terms for the technical instruction on fishing in order to share the technique.

- **Well Rehabilitation**

The accuracy rate was 34.8 percent, which was higher than expected, though DDCA had observed itself that well rehabilitation was the area necessary to be enhanced. On the other hand, the accuracy rate for the question on the cause of rust coloured water was 5.4 percent,

which was quite low. The knowledge on the deterioration of the casing was needed for the diagnosis of well. It was thought to be helpful for them to enhance the knowledge on it from the technical manual.

- **Pumping Test**

The accuracy rate was 27.8 percent, which was low as expected. This was because the pumping test was only conducted by the pumping test team. For the enhancement of DDCA, the knowledge of the pumping test should be acquired with using the technical manual, and the opportunity the pumping test work was supposed to be given to as many as senior drillers.

- **Water Quality Analysis**

The pumping test team was responsible for the sampling of water quality analysis. As same as the pumping test, the accuracy rate was low, which was only attained to 18.9 percent. Actually, the knowledge on detail methodology of the water quality analysis was not necessary for drillers. However, at least basic knowledge on analyzing items and the points to consider in sampling shall be obtained for technical instructor. Transfer of the knowledge with using the manual was thought to be effective for the enhancement of these knowledge.

Identification of the Areas Necessary to be Enhanced at DDCA

Based on the result described in above, the areas necessary to be enhanced at DDCA were concluded as follows.

- **Technical area necessary to be enhanced**

Among the technical areas which DDCA was conducting, it seemed that the basic knowledge and experience were not yet acquired by whole senior drillers. The eight areas of drilling tools and equipment, drilling operation management, logging, gravel packing, well development, backfilling and surface cementing, pumping test and water quality analysis were concluded as the technical areas necessary to be enhanced. For water quality analysis, as the technical instructor, they were supposed to have certain knowledge as a series of the groundwater development process, though there were not so much things to be acquired by them.

- **New technical area to be needed**

Two areas of fishing and well rehabilitation were concluded as the new technical area to be needed. These areas were not major technical area which DDCA was working on. However, the technical instructor shall be competent in these areas since the demand would be increased in the future. Also the accuracy rate was resulted below the standard.

4) Challenges on Daily Work of Drillers

Apart from the competence test, the drillers were asked on the challenges observed in their daily work. According to their response, the followings were collected as the challenges.

Challenges on working environment

- Shortage and delay of wage, travel allowance and extra pay for temporary leave (in case of long term travel) (12 respondents)
- No regular holiday for drillers on site (2 respondents)
- Lack of communication between management and drillers (2 respondents)
- Lack of teamwork (2 respondents)
- Late arrival to work (1 respondent)
- Lack of consideration of welfare for drillers (1 respondent)
- Shortage of opportunities searching for new business market while on rural site (1 respondent)

Challenges on equipment

- Shortage of equipment (rig (ex. PAT Drill, percussion), different size of surface casing, bit, PVC casing, pumping test unit, logging tool, bentonite, gravel, EC meter) (20

respondents)

- Deterioration of the equipment, insufficient maintenance (14 respondents)
- Shortage of safety gear and camping tools (helmet, grove, overall, safety shoes, tent, camping cooking stove) (13 respondents)
- Delay of the work due to the delay of equipment or material supply (8 respondents)
- Water tanker to be allocated to each rig (2 respondents)
- Site visit prior to the drilling (1 respondent)
- Small vehicle to be allocated to each rig (1 respondent)
- Lack of checking necessary equipment and materials before moving site (1 respondent)

Challenges on enhancement of capacity

- Shortage of regular seminar and test for drillers to improve their work quality (4 respondents)
- Insufficient plan to improve the efficiency of work (2 respondents)
- Short in experience of different type of drilling method (1 respondent)
- Shortage of the opportunity to have training on the usage of equipment on site (1 respondent)
- Inappropriate selection of rig and drilling method (1 respondent)
- Lack of experience to entire process of drilling (1 respondent)
- Inappropriate countermeasure for trouble (1 respondent)

The challenges on the equipment were observed during the site visit done by JICA Expert and counterpart. In other word, the drillers themselves also observed the challenge on the equipment. Other challenges include the shortage of seminar and training on site to enhance the capacity of drillers, and experience of pumping test. It was confirmed that drillers desire to enhance their technical capacity. It was expected the project activities would contribute to the enhancement of the technical capacity of drillers.

(2) Technical Guidance and Support for DDCA

During 1st year of the Project, capacity assessment of DDCA was carried out in combination with baseline survey, survey on drilling site and field technique training, competency test and workshops. Based on the results of the capacity assessment of DDCA, Technical Support Plan (TSP) was formulated in order to enhance the capacity of DDCA. Additionally, manuals for relevant areas for conducting the technical training and guidance were prepared. The TSP and manuals included the two areas of well drilling (activity 【2-2】 of PDM) and well rehabilitation and tool fishing (activity 【2-3】 of PDM).

The planned technical training and guidance would carry on until end of the Project, which was 4th year of the Project. The findings and results of the training and guidance needed to be reflected to the revision of plan and manuals. However, these activities were not conducted due to the termination of the project.

1) Target Group of Technical Training and Guidance

As above mentioned in 1) (1) Organizational Settings in DDCA of Section 3.2.1, there were 74 drillers in DDCA. Each driller was classified by Drilling Project Department to four technical level of S, A, B and C. The number of drillers classified to S and A are senior driller were 35, while those who were classified to B and C were 39. The activity on enhancement of the DDCA's capacity related to output 2 shall be targeted to the senior drillers.

2) Technical Area to be Needed for Technical Training and Support

The technical area necessary to be enhanced and new technical area to be needed were compiled in (2) Formulation of Technical Support Plan and Manuals of Section 3.2.2 based on the result of baseline to DDCA. The areas necessary to be enhanced included eight areas of drilling tools

and equipment, drilling control, borehole logging, gravel packing, development, backfilling/surface cementing, pumping test and water quality analysis. The new technical areas to be needed were two areas of fishing and well rehabilitation work.

3) Methodology for Capacity Enhancement

The technical area necessary to be enhanced or new area to be needed were identified through the baseline survey and competence test (described in (2) of section 3.2.2). Moreover, the technical level of senior drillers related to such area was also identified. The learning with using the technical manuals prepared by the Project was thought to be effective for the enhancement of the capacities in each technical area. The on-site training on “Drilling Tools and Equipment”, “Pumping Test” and “Fishing” was planned to be conducted in headquarters in DDCA. The technical instructors certified during the activity related to output 1 would provide the instruction in each area to not only private drillers but also in DDCA. *Table 51* shows measures for technical enhancement in each technical area.

Table 51 Technical Enhancement Measures for each Technical Area

Technical Area	Learning with Manual	Practical Training at the headquarters of DDCA	On-site Technical Instruction by Instructor
Drilling Tools and Equipment	✓	✓	✓
Drilling Control	✓		✓
Borehole Logging	✓	✓	✓
Gravel Packing	✓		✓
Well Development	✓		✓
Back-Filling & Surface Cementing	✓		✓
Pumping Test	✓	✓	✓
Water Quality Analysis	✓		✓
Drilling Tools and Equipment	✓	✓	✓
Drilling Control	✓		✓

4) Technical Support Plan for Enhancement of Drilling Technique

Preparation of manual

The manual was prepared with focused on the eight technical areas necessary to be enhanced. The manual included the procedure of the work for each technical area, the work of listing up the specification of drilling equipment and materials, and data and drilling mechanism necessary for the technical instruction. Also in the manual, the general document on drilling technique and catalog of drilling material maker were attached or referred. The contents and structure are described in the following section.

Technical seminar

The technical seminar were conducted for senior drillers to enhance their capacity. The seminar included on the utilization of the manual and technical training and guidance on site regarding drilling tools, equipment, borehole logging and pumping test. The seminar targeted all 35 senior drillers.

● Seminar on utilization of the manual

The seminar on the manual was conducted in Dar es Salaam in March 2012. The purpose was to make the drillers acquire the contents of the manual and utilization of the manual during the drilling work.

● Technical training and guidance on drilling tools, specification of the equipment and borehole logging

The technical training and guidance on drilling tools, specification of equipment and borehole logging was planned for 2 days in June 2013 by dividing 2 groups. The existing well owned by DDCA would be utilized for the training and guidance on the borehole logging. Also the equipment and materials of DDCA's headquarter would be utilized for the training and guidance on drilling tools and equipment.

In June 2013, the training and guidance on borehole logging was conducted. However, due to termination of the Project, training and guidance on drilling tools and specification of the equipment was not implemented.

Technical training and guidance on pumping test

The technical training and guidance on pumping test was planned for 2 days in September 2013. One day was to be allocated for the training and guidance utilizing the existing well of DDCA, and in 2nd day the seminar was planned at a certain venue. These training and guidance was not conducted due to termination of the Project.

On-site Training and Guidance to Technical Instructors

In July 2013, JICA Expert was supposed to conduct an on-site training and guidance to 12 certified technical instructors during their activities of instructions to other drillers at drilling sites. This training and guidance was planned at four drilling sites of which two of DDCA's site and other two of sites for hiring equipment. At each site three technical instructors were supposed to receive the training and guidance during two days. After this training and guidance, the internal technical instruction activities were planned to be principally conducted by DDCA's self. However, during the Project, JICA Experts needed to provide technical supports at drilling sites and/or in DDCA's office, according to DDCA's requests.

Due to termination of the Project, these training and guidance were not conducted.

Review of Internal Technical Instructions in DDCA

Continuous revision of manuals and instruction methods for technical enhancement of DDCA was required. In this purpose, a technical instruction review meeting was to be held by the drilling project operation department once a year. In this meeting, the technical improvement of senior drillers and the plan of revision of manual and instruction methods were supposed to be examined.

Due to termination of the Project, review was not conducted.

5) Composition of Manuals for Drilling Techniques

The composition of manuals for enhancement of drilling techniques corresponds to those in the teaching guidance shown in *Table 26*. Prepared manuals were used as materials for the teaching guidance as well.

6) Technical Support Plan for Well Rehabilitation and Tool Fishing

● Preparation of Manuals

Manuals for well rehabilitation and tool fishing were prepared in the Project. These manuals contained the necessary knowledge and data such as work procedures, specifications sheet of equipment and materials etc. General technical books of drilling, catalogues of manufacturers of equipment and materials were utilized by annexing or indicating the name and the reference part of each material.

● Technical Seminar

Seminars on utilization of technical manuals and a seminar for practical training of tool fishing was planned to be held in March 2013. The target group was 35 senior drillers.

Seminar for Technical Manual

This lecture-style seminar was held in the venue in Dar es Salaam in March. The objective was to facilitate senior drillers to master the contents of manuals and the utilization of manuals during drilling works. The period of the seminar was one day, together with the seminar on technical manuals for drilling.

Practical Training of Fishing Tool Making

This seminar was planned to be conducted in two days in July 2013 in the headquarters of DDCA. In the first day a practical training of making fishing tools from steel product was to be conducted. In the second day, a lecture was given in a seminar venue in Dar es Salaam. DDCA was required to prepare for necessary steel materials, welding materials and tools.

This training was not conducted, due to termination of the Project.

7) Composition of Manuals on Well Rehabilitation and Tool Fishing

The composition of manuals of well rehabilitation and tool fishing correspond to those in the teaching guidance shown in *Table 26*.. Prepared manuals were used as materials for the teaching guidance as well.

8) Activities Taken in the 1st Year related to the Technical Training and Guidance for DDCA

This section summarizes the activities related to the technical training and guidance for DDCA which was taken in the 1st year of the Project. The major target group of these activities was DDCA's drillers and the actual technical enhancement for them was implemented. Subsequently, these activities aimed at the base construction of another three years' activities of technical training of guidance for DDCA.

Practical Technical Training at Drilling Sites (August to September 2012)

JICA expert team conducted the field survey at drilling sites from August to September 2012. The objective of the survey was to grasp contents of drilling works of DDCA and the technical level of drillers. In case certain challenges on drilling works are found during the survey, the experts conducted technical training and guidance to drillers at each site regarding these challenges. Challenges observed at each site, contents of guidance and considerations for the activities of technical training and guidance of the Project are summarized below.

● **Coast region Mitamba – Mud Drilling Site**

Challenges : Mud pits were too small and they were too closely located. Thus, the mud circulation system was not effective on its solid contents separation function. Due to this situation, recirculation of solid contents in mud was decreasing drilling progress.

Contents of Guidance: It was found that drillers did not sufficiently understand the mechanism of cutting removal function of mud circulation system. Due to the insufficient mud density or velocity, drill cutting retain at the borehole bottom. Retained cuttings are re-drilled and disturb the drilling progress. The expert explained such mechanism of drilling. Furthermore, the importance of proper solid separation system for the prevention of the re-circulation of cuttings was explained, as well.

● **Coast region Misugusugu - Mud Drilling Site**

Challenges: Discharge rate of mud pump was not measured. Accordingly, mud was leaking from pump, because of misjudgment of replacement timing of piston and seals. In addition, pump pressure was not checked with pressure gauge. This may cause an overlooking of the decrease of discharge rate due to the elevation of pressure.

Contents of Guidance: The expert instructed the importance of regular measurement of discharge rate in order for the effective cutting removal by mud circulation. The mechanism of variation of discharge rate due to the pressure increase according to drilling diameter and depth was also instructed. Through the above guidance, the importance of comprehension of mud circulation system for the prevention of drilling drawbacks was emphasized.

● **Mwanza region Maliza - DTH Drilling Site**

Challenges: The drilling team was taking long time to remove the sedimentation from the borehole bottom during DTH drilling.

Contents of Guidance: The guidance of sand removal methods such as mixing water into compressed air, the use of foam agent, etc. were conducted. Other methods such as bailing, reverse circulation were explained as well.

Consideration: Some of these methods are already used by DDCA's drillers. However, DDCA does not have any unified manual for them. It is an effective measure of technical enhancement to familiarize these methods to drillers by formulating unified manuals.

● **Dar es Salaam region Kibamba - Mud Drilling Site**

Challenges: Drill cuttings deposited in mud pits were suctioned by the pump and re-circulated.

Contents of Guidance: As well as the site in Mitamba mentioned-above, drillers' comprehension of functions of mud circulation system was not sufficient. Therefore, the expert instructed the importance of cutting separation and the prevention of re-circulation. He explained that such insufficient comprehension of drilling mechanism would cause the ineffectiveness of the works, as well.

- **Dar es Salaam region Bunju A - Mud Drilling Site**

Challenges: An interruption of drilling work occurred, due to the necessity of transport of additional screen pipes as some of them had been found to be damaged.

Contents of Guidance: The estimation methods of quantities of casing and screen pipes for the site preparation were instructed. The necessity of securing supplementary quantities was explained, as well.

Consideration: As DDCA does not have a manual of procedures of drilling materials preparation, each driller conducts this work in their own way. It is important to include in the manual the procedures of drilling material preparation and quantity check in order to familiarize unified procedures to drillers.

- **Dar es Salaam region Msakuzi - Mud Drilling Site**

Challenges: The spare parts had not been kept at site when the breakdown of hydraulic parts occurred.

Contents of Guidance: The expert instructed the importance of keeping spare parts of which frequent replacement is predicted, in order for the prevention of the interruption of the works. Furthermore, he also explained that the continuing operation of hydraulic system without repairing some of the parts would cause the further breakdown.

Consideration: The daily maintenance manual for hiring equipment was prepared in the course of activities related to Output 3. Even for the equipment used by DDCA, it is important to use this manual for the proper implementation of daily maintenance.

- **Dar es Salaam region Vikuruti - Mud Drilling Site**

Challenges: The drilling team was taking long time to cope with the lost circulation during mud drilling.

Contents of Guidance: Countermeasures against lost circulation such as placing of strong mud, mixing of blocker materials like sawdust were instructed. Furthermore, the importance of the control of mud density and viscosity and the regular measurement of discharge rate and returning rate of mud was explained.

Consideration: In addition to lost circulation, drilling drawbacks such as bore wall collapse, jamming of drilling tools are important technical areas to all drillers. Though senior drillers in DDCA have the basic knowledge about them, unified techniques shall be familiarized to each driller.

- **Dar es Salaam region Sinza - Mud Drilling Site**

Challenges: The diameter of drag bit was found to be smaller than the standard size, due to the friction wear.

Contents of Guidance: JICA expert explained the following obstacles on drilling works caused by diminished bit:

- When the diminished bit is replaced with a new bit, reaming with this new bit is necessary before reaching the drilled depth,
- By pushing the new bit into small sized hole, bit may be stacked,
- Gravel packing work may be disturbed due to insufficient annular space,

Furthermore, he explained the importance of bit control and proper bit repairing.

Consideration: Too long use of bit for the purpose to economization of labor of bit replacement and repairing is not advisable. It may bring about obstacles and ineffectiveness on drilling works. It is important to familiarize the proper procedures of bit control to drillers.

- **Dar es Salaam region Kijichi – Pumping Test Site**

Challenges: The pumping test started before the water had become perfectly clear by air-lifting. In addition, the volume of measuring bucket had not been confirmed with the measurement standard.

Contents of Guidance: The expert instructed the importance of complete the air-lifting with perfectly clean and sand free water. In case of starting pumping test before the perfect well cleaning, an incorrect measurement of pumping test is suspected, due to the change of aquifer conditions during the test. Furthermore, there is a concern of smaller water yield against the expected one, as the cleaning effect by pumping is normally smaller than that of air-lifting.

The importance of the confirmation of bucket volume with a standard was instructed. The pumping test is important to determine the specifications of pump for water supply. Incorrect measurement may bring about the shortage of water supply and/or the breakdown of pump under improper operating conditions after the construction of water supply facilities.

- **Lindi region Kingurungundwa DTH Drilling Site**

Challenges: The drillers did not grasp the correct lifting capacity of rig nor weight of drill pipes. Furthermore, they did not check the weight on bit with weight indicator.

Contents of Guidance: The expert instructed the importance of keeping proper weight on bit with the knowledge of the weight of drill pipes and drill collars, and lifting capacity of rig.

Consideration: With an excess of weight, there is concern over hole deviation and/or damages on drilling tools. Therefore, it is important to keep proper weight by understanding the weight of drilling tools according to the drilling depth. Regarding the lifting capacity of rig, it is important to understand the room of capacity against the tools weight in order to conduct drilling work without causing tool jamming. Learning such drilling dynamics is important for drillers in order to conduct effective works and technical instructions.

Workshop related to Enhancement of Drilling Organization (September 2012)

A workshop related to enhancement of drilling organization was held on 12th September 2012. The participants contained 31 persons in total, of which nine counterparts of the project, 14 drillers of DDCA, three maintenance staffs of the maintenance section of DDCA and five staffs of JICA Expert Team. In the workshop, an interim analysis result of baseline survey on drilling equipment and organization of DDCA was reported. Furthermore, policies of enhancement of drilling organization were discussed. The unification of techniques by formulating manuals and the evaluation system of the technical level of drillers were confirmed to be necessary.

In this workshop, as part of technical support for DDCA's drillers, a seminar of well rehabilitation was held. Well rehabilitation was not major works of DDCA. Consequently, DDCA did not have unified techniques for it. However, as well as tool fishing, this technical area was identified as areas necessary to be newly acquired from the result of the baseline survey. The lectured contents in the workshop were "causes of well deterioration", "importance of well operation history", "well deterioration by incrustation", "well deterioration by iron bacteria", "well deterioration by corrosion" and "well rehabilitation methods".

Technical Seminar of Borehole Logging (November 2012)

A technical seminar of borehole logging for a trainee of borehole logging technician was held on 14th and 15th November, 2012. Contents of the seminar are described as below:

Objective: As of 2012, only one borehole technician belonged to DDCA. Because he had other tasks of hydrogeological survey and drilling supervision, sometimes it was difficult to correspond to the requirement of borehole logging at once. In this reason, DDCA selected one staff as a trainee and was facilitating him to be second borehole technician. Another purpose of the seminar was strengthening the supporting organization for technical enhancement of borehole logging techniques, by increasing the number of borehole logging technicians.

Contents of Seminar: In the first day, a practical training of borehole logging instruments was carried out at actual drilling site at Msoga village in Bagamoyo district. In the second day, guidance for the interpretation and data management was made, using the manuals for

each subject prepared in the Project.

9) Activities of Technical Instruction and Support Conducted in 2nd Year of the Project

In 2nd year of the project, a series of the seminars on technical manual, drilling tools and equipment, borehole logging, fishing tools, pumping test and technical instruction on drilling site was planned to be held based on the Technical Support Plan for Drillers in DDCA. However, only a part of the activities were held due to the termination of the project. The technical instruction and support conducted are described below.

Seminar on Technical Manual (March 2013)

Based on the Technical Support Plan for Drillers in DDCA (draft), two types of manuals of “Technical Manual for Drilling Work” and “Technical Manual for Well Rehabilitation and Tool Fishing” were finalized as the 1st drafts. The seminar on usage of these manuals was held for DDCA senior drillers on 19 March 2013. 31 out of 35 senior drillers attended the seminar. 77 percent of the attendees, which was equivalent to 24 out of 31 attended drillers, attained the standard score (60 out of maximum 100) in the competence test conducted at the end of the seminar.

2nd Seminar on Borehole Logging (18 and 25 June 2013)

1st seminar on borehole logging was held for the staff to be in charge of borehole logging in November 2012. Based on the Technical Support Plan for Drillers in DDCA, the seminar on borehole logging was held on 18 June 2013 for all the senior drillers. 22 senior drillers, 2 middle drillers and 2 WDMI students attended the seminar. The contents of the seminar were principles of each measuring parameter and their application for geological analysis. The field training on how to use the logging machine was held on 25 June 2013 at the actual drilling site.

3.2.3 WELL INFORMATION DATABASE

This activity included review of data of existing wells, design of a database, construction of the database, preparation of a database operation manual and assistance for database operation. The construction of the well database was completed in August 2013 by data-entry of 9,997 out of 12,932 well data, of which the well completion reports were existed.

A seminar on operating manual including the basic usage was held in completion of the well database. The methods of database update and provision of information to the private drilling companies were supposed to be provided from the 2nd year of the Project. However, these activities were not conducted due to the termination of the Project.

The activities implemented until the suspension of the Project are described below.

(1) Review of Existing Data

The review of existing data was completed in September 2012. DDCA had drilled 12,932 boreholes since 1930/1931 to 2011/2022, of which drilling reports had been kept at headquarters of DDCA in Dar es Salaam, at zonal office in Dodoma and in WRD of MoW in Dodoma. Among 12,932 boreholes, drilling reports of 9,997 boreholes had been kept.

Well completion forms consisted of well completion report, borehole section drawing, pumping test report and water quality analysis report. These items were scanned and necessary data was entered into computer. For the effective entry works of huge numbers of data, the contractor of database constructed a system specialized for the data entry works. All the data entry was conducted with this entry system and data was converted to the data sheet in MS-Excel format upon the completion of the data entry.

(2) Database Design

The database was designed based on the following principles:

- The Software shall be MS-Excel as a versatile and popular one. This enables the DDCA staffs to continue the update and maintenance of the database by themselves.
- Too much additional tasks for the updating of new database by DDCA shall be avoided. Therefore, the change from the existing report making system shall be as less as possible. Necessary consideration shall be taken such as the utilization of the typed-up data of handwriting report in existing report as inputs to new database.
- Many data items in the database can be commonly used with the “Well Database in African Countries” of JICA. The database shall be equipped with a function for the easy transferring of data to the “African Countries Well Database” at the same time, shall be added to the database.

Necessary data items were extracted from the forms of well completion reports. They were respectively related to three fields of drilling, pumping test and water quality analysis. **Table 52** shows the list of data items. Most of report forms except for the well section drawing and the water quality analysis results were typed up in the registry room in the DDCA’s head quarter. The use of these data as inputs to database can reduce the burden on data entry clerks of DDCA. Regarding the pumping test result, only representative data was entered in the database. Detailed records such as time and drawdown etc. were entered and saved in a separate data sheet. At that time, the pumping test results were entered in the forms of MS-Word. Converting it to MS-Excel forms encourages the easier interpretation and chart-making works. Technical support to improve the skills in MS-Excel of DDCA’s staff was provided by the contractor of the database and JICA Expert Team, since there was no staff who was sufficiently skilled for the operation and maintenance of the MS-Excel.

Table 52 Data Item of Database

Data Item		
1 Drilling	1-6 DrillingMethod	3 Water Quality
1-1 General Information	GravelType	3-1 WaterQuality
RegionName	SealingPosition	PK WaterQualityId

CHAPTER 3 ACTIVITIES TAKEN AND OUTPUTS OF THE PROJECT

Data Item		
DistrictName	SealingMaterial	FK DBId
WardName	AverageSize	Turbidity
VillageStreetName	InsertedFrom	Colour
SubVillageName	InsertedTo	SettleableMatter
LocationAreaName	NoOfCubicMeterInserted	PH
WorkScope	BottomBackFillingUpTo	Taste
DrilledByRigNo	BottomBackFillingUpMaterial	ConductivityAt25C/Salinity
DrilledByRigType	BottomBackFillingUpMaterialSize	TotalDissolvedSolid
BoreholeNo	GravelFillingUpTo	TotalNonfiltrableResidualAt105C
Zone	GravelFillingUpMaterial	TotalVolatileandFixedResidualat550C
CoordianteX	GravelFillingUpMaterialSize	Alcalinity(asCaCo3)
CoordianteY	SealingAboveGravelUpTo	Phenophthalim
Elevation	SealingAboveGravelUpMaterial	TotalAlcalinity
ApplicantId	SealingAboveGravelUpMaterialSize	Hardness(asCaCo3)
NameOfApplicant	BackFillingUpTo	Carbonate
Address	BackFillingUpMaterial	NonCarbonate
DateOfCommencement	BackFillingUpMaterialSize	TotalHardness
DateOfCompletion	SanitarySealingFrom	Calcium
SurveyRefNo	SanitarySealingTo	Magnesium
Drawing	SanitarySealingMaterial	Sodium
DrillerInChargeName	1-7 Drilling Method	Potassium
Remarks	MethodName	Cadmium
Signature	From	Chromium
1-2 Strata	To	Copper
StrataFrom	2 Pumping Test	Iron
StrataTo	2-1 Pumping Test General Information	Lead
GeneralDescription	Recovery Measuring Time	Manganese
WaterStrike	2-2 Pumping Test Summary Data	Mercury
1-3 Water Strike	ConductedFor	Zinc
StructAtDepthFrom	ConductedBy	TotalNitrogen
StructAtDepthTo	SWLAt	AmonicalNitrogen
Yield	DrawDown	OrganicNitrogen
WLRoseTo	Yield	NitrateNitrogen
YieldTested	TypeOfPumpingTest	TotalPhosphorus
WaterQualityToTaste	NoOfSteps	Orthophosphate
DepthOnCompletion	OutFlowMeasurementWithTankCapacityOf	Sulphate
1-4 DiameterDrilledAndDepth	AirLiftSize	Chloride
DiameterDrilled	ALSPlacedAtDepthOf	Fluoride
DepthDrilled	PumpCylinderSize	PermanganateValueAsmgKMnO/L
1-5 CasingScreenLeftInHole	PCSPlacedAtDepthOf	BOD(5Days)
CasingType	Equipment	OthersTotalColiform
CasingDiameter	PumpModel	FaecalStreptococci
CasingLength	EPMPPlacedAtDepthOf	ChlorineResidual
CasingThickness	2-3 WaterLevelDrawDown	Remarks
ScreenPositionFrom	Date	Note
ScreenPositionTo	TimeHour	ReportingOfficerName
CasingAboveGL	TimeMinute	Signature
TopOfCasingSecured/TopPlug	Meter	Position
TopOfCasingSecured/TopPlugAboveGL	Centmeter	3-2 LaboratoryInformation
BottomEndOfCasingProtectedWith	YieldLPH	PK LaboratoryNo
BottomPlug	DischargeMeasuredUsing	RefNo
HoleUncasedUpTo	Remarks	Telephone, Telegram, Email, FaxNo
BackFilledTo	2-4 WaterLevelRecovery	3-3 OriginOfTheSample
FilledWith	Date	PK OriginId
AverageSize	TimeHour	AnalysisRequestedBy
OtherMethod	TimeMinutes	Dated
Length	TimeDifference	DateReceivedAtLaboratory
ConductorCasingDiameter	WL.RaisedTo	DateCollectedForAnalysis
ConductorCasingGLTo	AdditionalNotes	TimeCollectedForAnalysis
SurfaceCasingDiameter	Remarks	Temperature
SurfaceCasingGLTo		PurposeOfSumpling
DiameterFrom, DiameterTo		PreservativeAdded/TypeOfTreatmentTo WaterBeforeSampling

(3) User Organization

Different staffs of DDCA were involved in the operation of the database. Some were the administrators and others are users. In order for the effective and safe database operation, rolls in the course of the database design, the database related staffs were clarified and disseminated to all staffs. The rolls of each staff are described below.

- **Rig in charge**

Each rig in charge of the drilling team fills in the drilling record form by handwriting at drilling sites and submits it to the zonal managers or DPOs.

- **Zonal Managers and DPOs**

The zonal managers or DPOs receive the drilling record form submitted from the rig in charge and forward it to the head of drilling section of DDCA's headquarters.

- **Pumping test in charge**

Pumping test in charge fills in the form by handwriting on site and submits it to the drilling manager of DDCA's headquarters.

- **Hydrogeologist in Survey Section under the Technical Support Division in DDCA's headquarters**

Hydrogeologist analyses the geological samples and prepare for a casing program. These results are informed the rig in charge. He is responsible for the control of the survey reference numbers and informs the rig in charge of it. He browses the database to check the record of lithology and casing program and to interpret the survey result.

- **Water quality analysis laboratory**

The water samples collected during the pumping test is sent to the water quality analysis laboratory. The report is submitted to the head of drilling section.

- **Head of Drilling Section of the DDCA's Headquarters**

The head of drilling section examines the well completion report forms submitted from each staff in charge. After that, he instructs to the registry room to enter the drilling and pumping test records. The well section drawing is finalized by the drawing room by Auto-CAD. He submits the finalized well completion report to the CEO for his approval before submitting to the client. He is responsible for the supervision of the entire process of report preparation, the update and the information retrieval from the database.

- **Drawing room in the DDCA's Headquarters**

Well section drawings are prepared by Auto-CAD from the handwritten reports examined by the head of drilling section.

- **Registry Room in the DDCA's Headquarters**

After the examination by the head of the drilling section, the handwritten drilling work record form and the pumping test form are transferred to the data entry clerk of the registry room. The finalized forms return to the head of drilling section.

- **Computer room**

The computer room is mainly in charge of the calculation regarding the account issues. This room is not directly related to the data entry. However, the server computer is installed in this room and the staffs in this room are the network administrator.

- **Data entry room**

The data entry room is in charge of the management of the information regarding to the contracts of drilling works. This room browses the database for the purpose of comparing the contents of the contract and work results.

(4) Computer Network

Setting and networking of computers for the database was also examined during the database design. Three computers were procured by the Project for the database. One computer was a server computer while two were the client computers. These computers were connected by wireless LAN. The setting location and the usage of computers were described below.

- **Server computer**

Server computer is installed in the computer room. The staffs in this room are network administrators. The database itself is saved in this server. The data is periodically backed up in both server and client computers.

- **Client computer No.1**

Client computer No.1 is installed in the registry room. Update, maintenance and information retrieval are done in this computer. The staffs in the registry and the head of drilling section use this computer.

- **Client computer No.2**

Client computer No.2 is installed in the Survey Section of Technical Support Department. Hydrogeologists mainly use it for checking the record of strata and casing program, and for interpreting the survey result.

DDCA was planning to procure one client computer for browsing the database to compare the contract conditions and work results. It was to be installed in the data entry room as the Client Computer No.3. **Figure 38** shows the networking of these four computers.

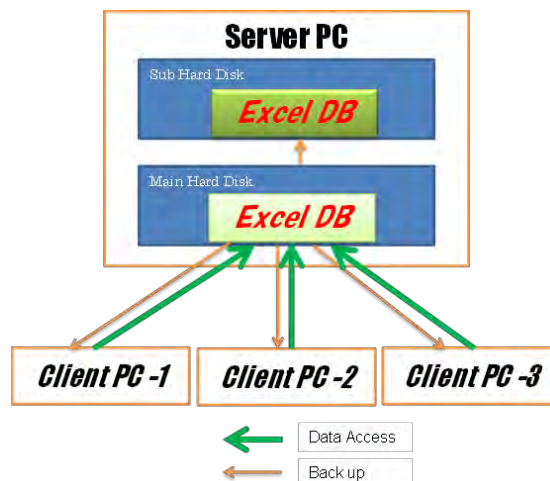


Figure 38 Computer Network

3.3 OUTPUT 3: ESTABLISHMENT OF EQUIPMENT HIRING SYSTEM

Output 3 was “A System to hire drilling equipment and machinery is established”, and the following activities were planned for implementation.

[3-1] Investigation regard to the hiring of equipment and machinery

[3-2] Establishment of the operation system of the hiring

[3-3] Establishment of maintenance system for the hiring equipment

[3-4] Conduct trial hiring and review the systems

[3-5] End line survey regard to the use of the hiring business

Until the termination of the Project, “establishment of the operation system of the hiring” and “establishment of maintenance system for the hiring equipment” were implemented as individual activities. “Establishment of maintenance system for the hiring equipment” was planned to be operated as a backup system of equipment hiring system after the commencement of the business, as it aimed to enable the equipment hiring system smoothly working. However, the Project has not reached up to this operational stage due to the termination of the Project.

[3-1] Investigation regard to the hiring of equipment and machinery was conducted as baseline survey on the private drilling companies. A survey of the needs of the hiring of drilling equipment, and the interview to the DDCA and related organizations in collecting the basic information were conducted in order to specify the legally and administratively procedures needed in establishing the equipment hiring system. In the activity of [3-2], “Equipment Hiring Guideline” and “Manual on Hiring of Drilling Equipment and Machinery Annexes” which included a business model, implementation organization and business procedures were prepared. The detailed contents are describes in 3.3.2.

For the activity of [3-3], maintenance organization for the hiring equipment, maintenance plan and maintenance procedures were proposed as the result of identification of the current maintenance system. They were compiled as “Maintenance Guideline for Maintenance System for Hiring Equipment”, “Maintenance Plan for Maintenance System for Hiring Equipment” and “Maintenance Manual for Maintenance System for Hiring Equipment”. The detailed contents are described in 3.3.3.

Through implementation of the activities of [3-1] to [3-3], all the documents necessary for commencement of the trial equipment hiring were prepared. However, activities of [3-4] and [3-5] has not been implemented due to termination of the Project.

The result of the activities for Output 3 is shown in *Figure 39*.

CHAPTER 3 ACTIVITIES TAKEN AND OUTPUTS OF THE PROJECT

Activity	Year	2012												2013						
	Month	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7		
3-1. Investigation regard to the hiring of equipment and machinery																				
		A baseline survey by local consultant was conducted. The final analysis results were compile in Section 3.3 of this report.																		
3-2. Establishment of the operation system of the hiring of drilling equipment and machinery																				
		The operation system of the hiring drilling equipment and machinery, including business model, guidelines, manual etc.																		
3-3. Establishment of maintenance system for the hiring equipment																				
		Based on the interview survey and field survey, Maintenance Guideline, Maintenance Plan and Maintenance Manuals were formulated. Though continuous activities of technical guidance and support for the equipment maintenance system from the 2 nd Year were planned, they were not implemented due to termination of the Project.																		
3-4. Conduct trial hiring and review the systems		The hiring business did not launch, due to termination of the Project.																		
3-5. End line survey regard to the use of the hiring business		End line survey was not conducted due to termination of the Project.																		

Figure 39 Progress of Activities for Output 3

3.3.1 NEEDS ASSESSMENT OF PRIVATE SECTOR ON HIRING OF DRILLING EQUIPMENT AND MACHINERY AND BASELINE SURVEY ON MAINTENANCE SYSTEM OF DRILLING EQUIPMENT

(1) Needs Assessment of Private Sector on Hiring of Drilling Equipment and Machinery

A needs assessment of private drilling companies was conducted in the baseline survey as explained in Section 3.1. The result proved that there was a strong interest of the private drilling companies in obtaining business opportunities for drilling works in WSDP and utilizing the equipment hiring service of DDCA to supplement drilling rigs they owned.

In parallel with implementation of analysis on results of the baseline survey, the project team also collected information on drilling companies which were not covered in the survey. It was found that some business entities in the drilling industry had not been included in the list of the drilling permit holders of MoW in spite that some of them had been awarded contracts for drilling works in WSDP. Existence of these companies was identified from the Water Sector MIS managed by MoW and the contractors' directory of CRB. Particulars such as office address, contact, registrations at MoW and CRB of all the companies was consolidated as a list of the potential clients of DDCA's private sector support services.

Table 53 shows the total number of business entities involved in drilling works, which were identified through the registrations at MoW and CRB, baseline survey, and the Water Sector MIS. A total of 174 business entities were found from these sources of information. Further examination made it clear that some of the business entities listed had already stopped operation of water well drilling or were specialized in other activities such as soil testing and groundwater exploration. There were also a certain number of organizations which could not be reached due to unavailability of updated information on their contacts. After excluding these organizations, 104 companies were confirmed to be currently involved in water well drilling either by directly conducting drilling works or contracting out the whole works to other specialized contractors. These 104 companies were, therefore, regarded as the potential clients of the private sector support services of DDCA.

Table 53 Number of Business Entities in Water Well Drilling Sector in Tanzania

Category	Total	Breakdown
Total No. of Business Entities Identified	174	126 : Listed in the original list of drilling permit holders of MoW
		27 : Added to the target list of baseline survey
		18 : Registered as specialist contractors (drilling works) under CRB but not on the original list of drilling permit holders of MoW
		3 : Recorded on Water Sector MIS as contractor of drilling works but not on the original list of drilling permit holders or CRB Directory
No. of Entities which are currently involved in drilling works	104	
Interviewed in Baseline Survey	94	
Not interviewed	10	1 : not found
		1 : refused interview
		8 : not on the original list of the registered companies obtained from MoW.
No. of Entities which are not involved in drilling works	18	5 : perform survey works or soil testing only. 13 : stopped drilling works.
No. of Entities which status is unknown	52	Could not confirm current status of the business as some were refused to be interviewed and others could not be located.

Note: The status in the table is as of December 2012.

(2) Baseline Survey on Maintenance System of Drilling Equipment

The baseline survey on existing system of equipment maintenance in DDCA was conducted directly by the JICA expert team in order to establish the appropriate maintenance system for the hiring equipment. The survey consisted of the interview to the DDCA headquarter and field visit to the DDCA zonal offices in Arusha, Mwanza, Sumbawanga and Dodoma. The contents of the survey are shown in *Table 54* below.

Table 54 Baseline Survey on Maintenance System of Drilling Equipment

Content	Item	Purpose
Current maintenance system for workshop in DDCA headquarter	1) Oranization and staffing for maintenance in Technical Support Department 2) Condition of existing maintenance equipment and tools 3) Condition of maitennance works 4) Record of inspection nd maintenance 5) Procurement procedures of spareparts and grease etc.	Identify current maintenance system of workshop in DDCA headquarter (staff, technical level, owned equipment and tools, working environment etc) as a basic data necessary for preparation of the maintenance organization and plan
Current maintenance system in DDCA zonal offices	1) DPO office (Moshi) 2) Zonal office (Arusha) 3) Zonal office (Dodoma) 4) Zonal office (Mwanza) 5) DPO office (Shinyanga) 6) DPO office (Mtwara) 7) DPO office (Iringa) 8) Zonal office (Sumbawanga) 9) BWOs, WASAs etc	Identify the facilities, equipment and human resoure etc for equoipment maintenance in the country as a basic data necessary for establishment of backup system of maintenance activities for equipment hiring business

3.3.2 ESTABLISHMENT OF THE OPERATION SYSTEM OF THE EQUIPMENT HIRING SERVICE

Based on the results of the analysis of the needs for hiring business and the interviews to the DDCA and the related institutions, a maintenance system for the hiring equipment was established and compiled in the document. The contents of the activities are shown in *Table 55*.

Table 55 Activity of Establishment of the Operation System of the Equipment Hiring Service

Content	Item
Roadmap for Establishment of the Equipment Hiring System	
Legal and Administrative Requirements	
Business Model of the Equipment Hiring	1) Conditions Considered in Formulation of the Business Model 2) Potential Clients 3) Scope of the Hiring Service 4) Use of the Hired Equipment 5) Placement of Drilling Rigs 6) Allocation of Staff of DDCA to the Hired Equipment 7) Maintenance of the Equipment 8) Business Promotion 9) Establishment of Hiring Business Unit 10) Operation Management 11) Contract Management 12) Financial Management and Cost Management 13) Information Management on Client 14) Business Flow of Hiring Business 15) Tariff Setting and Formulation of Budget 16) Formulation of a Guideline and Manual on Hiring of Drilling Equipment

The results of each activity are described below.

(1) Roadmap for Establishment of the Equipment Hiring System

Activities to be required for establishment of the hiring service were listed and a roadmap was drawn in order to ensure common understanding among the stakeholders on the process and schedule to be followed. *Figure 40* in the next page shows the roadmap agreed in the project team. It was formulated on the assumption that the trial operation of the hiring service would be started in April 2013.

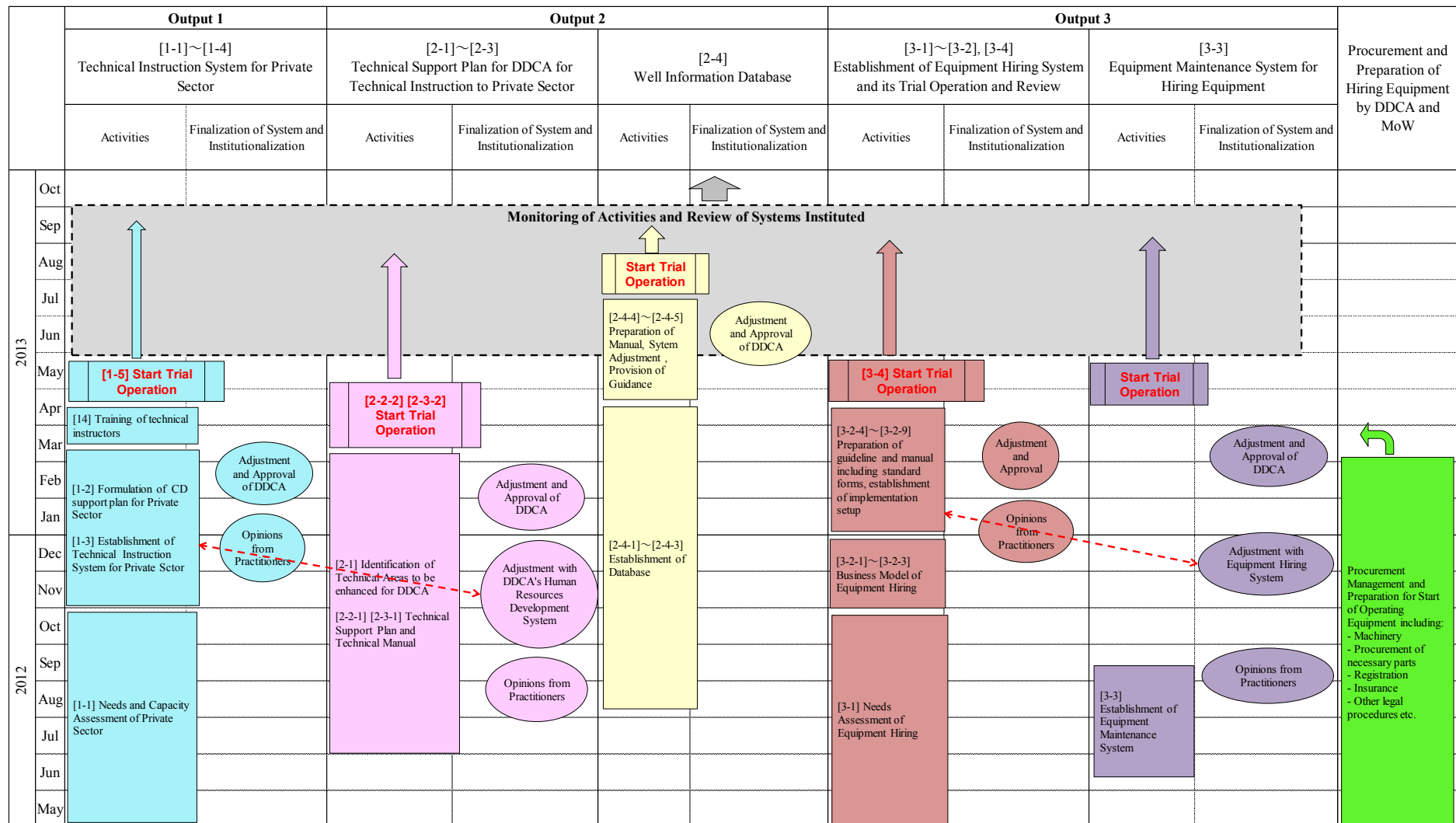


Figure 40 Roadmap for Establishment of the Equipment Hiring System

(2) Legal and Administrative Requirements

The project team asked the acting head of Business Support Department to confirm with legal unit of MoW that there was no particular legal requirement for DDCA to start the hiring service. Hiring of equipment to other organizations is included as the secondary function of DDCA in Clause 1 (iv) hiring of equipment to and from other organizations of the Executive Agencies (Drilling and Dam Construction Agency) Order, 1999, by which DDCA is legally recognized to operationalize such function.

With regard to the administrative procedures, DDCA needed to decide arrangements of insurance for machinery and vehicles to be hired out. All the equipment owned by DDCA belonged to the Government of Tanzania and was insured by Ministry of Finance and Economic Affairs (MoFEA), and the Treasury of MoFEA was responsible for registration and management of all the government-owned vehicles and machinery.

According to a consultation received by DDCA from Legal Unit of MoW, the arrangement of the insurance of the hired equipment varied depending on how the business was going to be operated and what were to be charged as the rental fee to hirers. In case that the equipment hiring was operated as part of the governmental services and to recover operation costs only, MoFEA would insure the equipment in the same manner with other equipment that DDCA uses for its own drilling works. On the other hand, if it pursued profits at commercially viable basis, the responsible party for the insurance needed to be agreed in a contract between DDCA and the hirer. After finalization of the proposed business model of the hiring service, the project team was to have a consultation with the legal officer of DDCA and MoW to receive advice on an appropriate arrangement of the insurance based on the proposed model.

As for the taxation of the hiring service, the Value Added Tax (VAT) would not be charged to the service as DDCA was exempted from taxation of VAT on its sales.

(3) Business Model of the Equipment Hiring

An outline of the business model of the hiring service is as follows;

1) Conditions Considered in Formulation of the Business Model

MoW had a plan to procure a total of 20 drilling rigs for DDCA in WSDP. However, the ministry had not yet concluded a procurement plan of the remaining number of the drilling equipment. MoW was also yet to make it clear how many units of the remaining drilling rigs to be procured were meant for the hiring service. The business model was, therefore, formulated to operate the hiring service with six drilling rigs and supporting equipment which were under procurement in WSDP (Phase 1).

Another condition considered was the progress of procurement of the drilling equipment in WSDP. As the schedule of completion of the procurement process was uncertain, an alternative plan was discussed in the project team to start the hiring service with existing equipment owned by DDCA in the first year. The number of drilling rigs which could be used for the trial run of the hiring service was analyzed with considering the operation ratio of existing rigs and the DDCA's business plan for drilling works in 2013. As the result, it was revealed that it was possible for DDCA to use two existing rigs as hiring equipment according to the current operation rate though it was difficult for them to purchase the rig accessories including steel casing pipes necessary for hiring based on the result of further consideration on technical aspect. Therefore, the business model was formulated not for the operation of the existing rigs but for the operation of new hiring equipment under procurement.

2) Potential Clients

As explained in Section 3.1, segmentation of the surveyed companies identified a total of 83 business entities which were interested in the equipment hiring service. These were further divided into two groups. Group A (23 nos.) already possessed experience in operation of DTH method with a large-size drilling rig. Group B (60 nos.) had no experience in DTH drilling

with large-size rig.

It was expected that the project would create larger effect on Group B than Group A in terms of increase of number of contractors which could perform drilling works in WSDP. In case that DDCA needed to choose hirers among applicants due to limited number of the available rigs, the first priority in selection would, therefore, be given to the companies classified into Group B. The technical support and the advice for promoting the registration would be provided to the companies classified to Group B in order to enhance their capacities to participate in WSDP.

Conditions to be required to an applicant of the hiring service are as follows;

- To possess a valid water well drilling permit issued by MoW.
- To be registered as the specialist contractor at CRB.
- To have at least one permanent employee among the drilling staff to be on site with the hired equipment and to receive the technical instructions from DDCA.

Registrations at MoW and CRB were required by relevant laws, respectively, as the contractors to execute a certain type of works governed by these organizations. MoW was also considering stipulating possession of the CRB registration as one of the conditions to issue a water well drilling permit in the Groundwater (Exploration and Drilling) Licensing Regulations, 2011, which was in the process of formulation. The third condition was set based on intention that the hirer would utilize skills and knowledge acquired from the technical instructors in other drilling works in the future by transferring such skills and knowledge from the trained personnel to others.

According to results of the baseline survey, most of the companies classified into Group A had both valid drilling permit of MoW and registration at CRB (**Figure 41**). In contrast with this situation, Group B was occupied by the companies which had the drilling permit only or no registration at all. If these conditions were applied, around 23 companies in Group A and Group B had higher advantage than others to access to the hiring service. DDCA would update information on status of registration of the potential clients continuously.

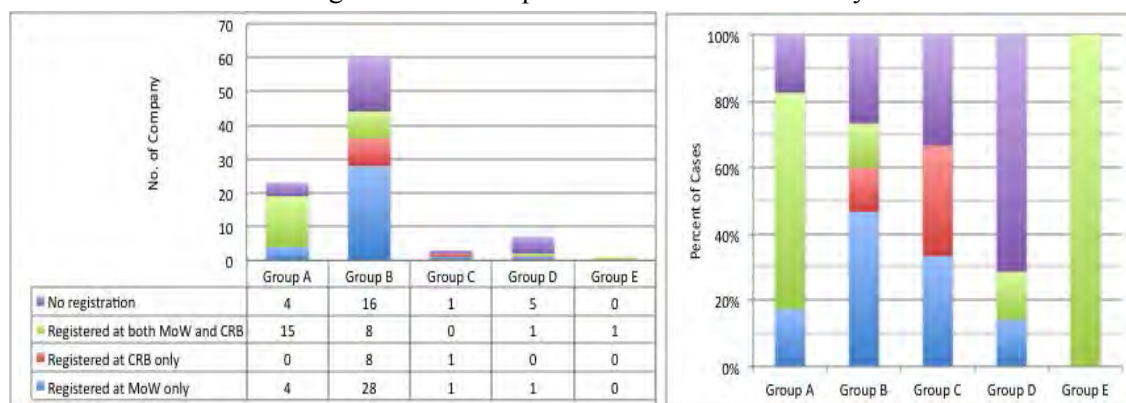


Figure 41 Status of Registration at CRB and MoW by Classification of the Surveyed Companies

3) Scope of the Hiring Service

Table 56 shows items to be made available for hiring to the private companies. Hirers were to choose items necessary to execute contracts with their clients. In case that the hirer needed other equipment which was not listed below, he would procure it in the market or borrow it from DDCA, if available, at cost.

Table 56 List of Equipment to be Hired

Item	Specification	Qty
1. Truck mounted drilling rig	Rotary cum DTH, max. depth 150m	6 units
2. Trailer mounted air compressor	650CFM, 246 psi	5 units

Item	Specification	Qty
3. Rig accessories	Drill pipes, DTH bit, work casing, etc.	1 set for each rig
4. Fishing tools	Tap, jack, etc.	1 set for each rig
5. Trailer mounted mud pump	20kg/cm ² , 600 l/min.	5 units
6. Trailer mounted pumping test unit	Generator, riser pipe, submersible pump	5 units

4) Use of the Hired Equipment

The equipment to be hired should be primarily utilized in drilling works for WSDP in order to contribute for attainment of the programme goal for improvement of water supply coverage in the country. Meanwhile, it was predicted that the number of procurement for drilling works in WSDP would much vary from time to time as the first phase of the programme experienced. The equipment would also be hired for the use in drilling works procured by the private sector including individual households in order to mitigate reduction of operation ratio of the equipment during the period when procurement in WSDP was not concentrated.

DDCA also planned to use the equipment for hiring in its own drilling works. In such cases, Drilling Project Department would bear the rental fee and transfer the fund equivalent to the charges to Hiring Business Unit while the first priority in use of the equipment would be given to applicants from the private companies. Cost management by the department was not conducted at the time of survey, while the sales cost was dealt in the accounting by the item of expenditure (bit expense, pump expense, depreciation, PVC pipe expense, cement expense etc.) called as segment. The finance for the hiring business required to be managed on the separated bank account for the hiring business unit. For receiving order inside DDCA, the item of expenditure for placing the order to the hiring business unit was set by the accounting section to the existing account of DDCA. The original code of work item was set to the account of the hiring business unit based on the cost by the item of expenditure. These items of expenditure were to be set under the discussion with the hiring business unit and the accounting according to the accounting policy of DDCA.

5) Placement of Drilling Rigs

Taking into account of convenience of hirers to access to the equipment, DDCA would decide allocation of the drilling rigs and compressors to be newly procured among its headquarter and zonal offices. The private companies classified in Group A and B mostly concentrated in Dar es Salaam, around 20 companies operated from Northern part of the country such as Arusha, Mwanza and Shinyanga (*Figure 42*). On the other hand, from the viewpoint of demand for improved water supply, regions which water supply coverage was below the national average were Tabora, Singida, and Dodoma in the central part of the country, Shinyanga, Mara, and Kagera in Lake zone, Rukwa in western zone, and Lindi and Mtwara in eastern zone. Based on these points, rigs would be allocated depending on the demand to the specific time (In the commencement of the business, the hiring was expected to conduct in the sites around Dar es Salaam for the easy management.). It also needed to consider capacities of each zonal office in conducting maintenance and repair works of the equipment.

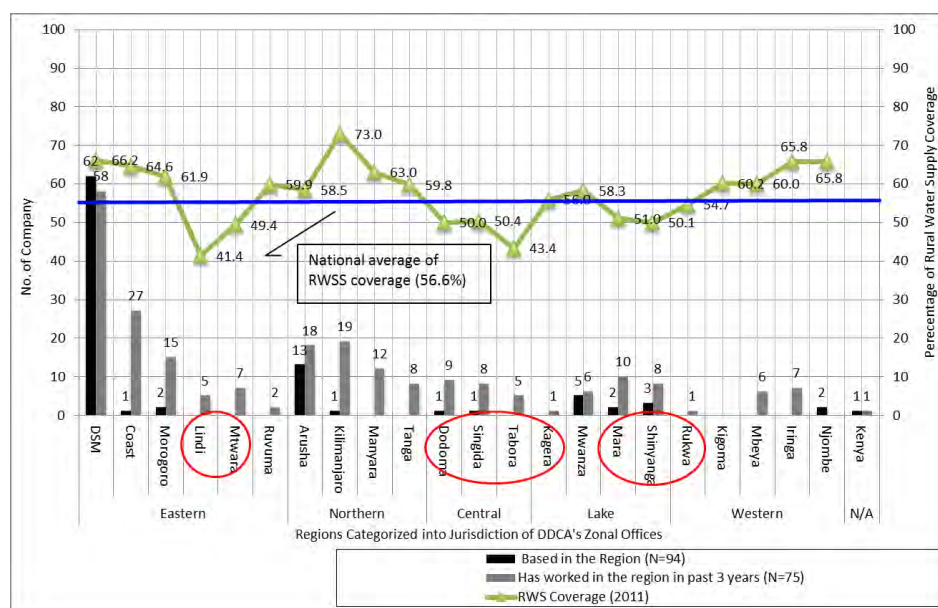


Figure 42 Geographical Distribution of Private Drilling Companies and RWSS Coverage by Provinces

6) Allocation of Staff of DDCA to the Hired Equipment

Integration of two types of service of the equipment hiring service and technical instruction service as one component was thought to be important in order for the effective implementation of the capacity development support for the private sector. As shown **Table 57**, for each contract of equipment hiring, mobilization of an instructor and a truck driver was planned. The clarification of the responsibility on the operation of government's vehicles and equipment was thought to be important, as well.

Table 57 Roles of DDCA Staff to be Attached to the Hired Equipment

Position	Responsibility in Operation of the Hired Equipment	Required No.
Technical Instructor	<ul style="list-style-type: none"> - to teach how to operate the drilling rig. - to provide technical advice on management of the process of drilling works on site. - to supervise and control appropriate use and routine maintenance of the hired equipment. 	1 person/ rig
Driver of carrier truck of drilling rig	<ul style="list-style-type: none"> - to drive trucks owned by DDCA to and from the drilling sites. 	1 person/ truck

7) Maintenance of the Equipment

DDCA would be responsible for preventive maintenance and repair works of the equipment before and after the equipment is hired. On the other hand, the hirer would conduct routine maintenance of the hired equipment on site under supervision and instruction of the technical instructor from DDCA. For any mechanical troubles which cannot be attended by the drilling staff from the hirer or technical instructor, DDCA would send a mechanic to the site either from the headquarters or the nearest zonal office. The contract would specify demarcation of responsibilities between two parties on maintenance and repair of the equipment. The format of hiring contract was prepared as the Annex 3 of Manual on Hiring of Drilling Equipment and Machinery.

DDCA would make a plan and implement maintenance of the hired equipment in accordance with the guideline, plan, and manuals for DDCA and private drilling companies on the maintenance system of the hired equipment. The operation of equipment maintenance consists of the periodical maintenance and repairing conducted by DDCA and daily maintenance on site

conducted by hirers who are private drilling companies. The manuals on equipment maintenance mentioned above shall be utilized for the equipment maintenance by DDCA and hirers.

8) Business Promotion

DDCA would promote the launch of private sector support services including the equipment hiring to potential clients. While the priority target was those which were classified into Group A and Group B according to the results of the baseline survey, identification of new potential clients needed to be conducted simultaneously. As mentioned in Section 3.3.3, there were 10 companies which were not interviewed in the baseline survey although it was confirmed that these were also operating drilling works. These companies would also be included in the target of the business promotion.

Means of the business promotion to be employed included mailing a brochure explaining the service contents to identified companies, introducing it to participants in regular and/or extraordinary meetings of Drilling Association of Tanzania (DAT) and CRB, and publicizing newsletters to be issued by CRB for its members. Brochure was to be completed with the specification after the delivery of the equipment for hiring. The sample brochure was prepared as shown in the annex 2 of the Manual on Hiring of Drilling Equipment and Machinery.

9) Establishment of Hiring Business Unit

DDCA would establish the Hiring Business Unit under the Business Support Department in order to manage daily operation of the hiring service. The Unit would be responsible for tasks mentioned below;

- To administer hiring process including appraisal and selection of the qualified hirers, contract management, and customer care.
- To keep and update information of particulars of clients.
- To coordinate with other departments in the organization for arrangement of the technical instructors and other required staff, maintenance of the hired equipment, and procurement of consumables and other materials for the drilling equipment as may be necessary.
- To prepare the budget for operation of the hiring service to be included in annual budget proposals of DDCA.
- To set/review and propose the tariff for approval by the management of DDCA.
- To prepare monthly reports on operational and financial status of the service provision.
- To coordinate with Marketing and Public Relations (PR) Section in preparation of PR materials and communication with potential clients for business promotion.

The Unit would involve the legal officer(s) of DDCA in contract management for the hiring service and seek advice from the Legal Unit of MoW when necessary, and would work closely with the Procurement Section of DDCA to purchase consumables and spare parts of drilling equipment in time for its hiring.

A full-time administration officer and an assistant staff would be required in the Unit to be supervised by the manager of the Business Support Department who would serve concurrently as the head of the Unit. DDCA was planning to reallocate existing staff to fulfill the staffing plan for the Hiring Business Unit instead of recruiting new personnel. The staffing plan would be reviewed from time to time according to volume of works to be involved in the Unit staff. The establishment of Hiring Business Unit would be applied to MoW by DDCA after their making decision based on the evaluation of the sustainability of the business. After the approval of the application by MAB (Ministerial Advisory Board) in DDCA, it was to be approved by PO-PSM (President's Office-Public Service Management).

10) Operation Management

The operation management was to be done by the hiring business unit according to the management indicator shown in **Table 58**. The result of the management was to be reported to DDCA and MAB monthly and annually. The monthly report form attached in the annex 13 of the Manual on Hiring of Drilling Equipment and Machinery would be used for reporting.

Table 58 Management Indicator

Objective	Indicator
1. Process Management	<ul style="list-style-type: none"> – 1-1. The drilling equipment is hired according to the procedure established. – 1-2. The maintenance management of drilling equipment is conducted according to the maintenance management plan. – 1-3. The internal accounting documents for the hiring business is periodically submitted to the management.
2. Service Output Management	<ul style="list-style-type: none"> – 2-1. The annual average operation days of drilling equipment reaches 11 days which is profitable breakeven line of hiring business by 2016. – 2-2. More than 80% of the registered private drilling companies uses the private support services of DDCA by 2016. – 2-3. More than 80% of the private drilling companies using the private support services consider that the service help their business.
3. Reporting Management	<ul style="list-style-type: none"> – 1-4. The private drilling companies which uses the private support services of DDCA participate in the WSDP drilling works reaches 122% by 2018. – 1-5. The number of wells planned for WSDP is drilled by 2015.

11) Contract Management

Contract management includes the following procedures.

- Preparation of the standard contract form
- Preparation of the contract by hiring contract
- Signing of contract
- Billing and collection of payment
- Check of fulfillment terms and conditions by both parties
- Claim on implementation of obligation of the hirer

The sample form of general conditions on the drilling equipment hire contract is prepared as shown in the annex 9 of the Manual on Hiring of Drilling Equipment and Machinery.

12) Financial Management and Cost Management

The accounting service for hiring business was to be provided by the accounting unit under the business support department of DDCA according to the DDCA accounting manual. In addition to the accounting process based on the related regulations, the calculation of the profit and loss and cost management for the business were to be done by the hiring business unit. The result of managerial accounting would be reported monthly to the management of DDCA. The monthly report form was prepared as shown in the annex 13 of the Manual on Hiring of Drilling Equipment and Machinery.

13) Information Management on Client

The proper information of the customers showing as below and feedback on the service provided by DDCA are to be recorded appropriately and updated constantly. For the management of such information, the contact list of private drilling companies shown in the annex 3 and the feedback form shown in annex 12 of Manual on Hiring of Drilling Equipment and Machinery are to be utilized.

- Name, physical address and contact of the organizations
- Name and position of the representative person for contract
- Year of acquisition/renewal of the water well drilling permit issued by MoW
- Registration number of the specialize contractor at CRB
- Records of equipment hired and hiring period
- Contract amount
- Number of boreholes drilled (both successful and unsuccessful with hired equipment, drilling sites)
- Feedback from the customers on technical instruction, condition and capacity of equipment, hiring tariff etc.

14) Business Flow of Hiring Business

The hiring business was to be conducted by the PDCA (Plan-Do-Check-Action) cycle shown in **Figure 43**. The business is commenced with the formulation of the annual operation plan. The budget of the plan is included to the entire annual budget of DDCA. The form for annual plan of operation of hiring service was prepared as shown in the annex 1 of Manual on Hiring of Drilling Equipment and Machinery. The setting of hiring tariff and the allocation plan of the equipment were clarified in this plan. The business cycle included the different processes as shown in **Figure 44**. The procedure to be institutionalized required to be recorded properly for the accountability and transparency.

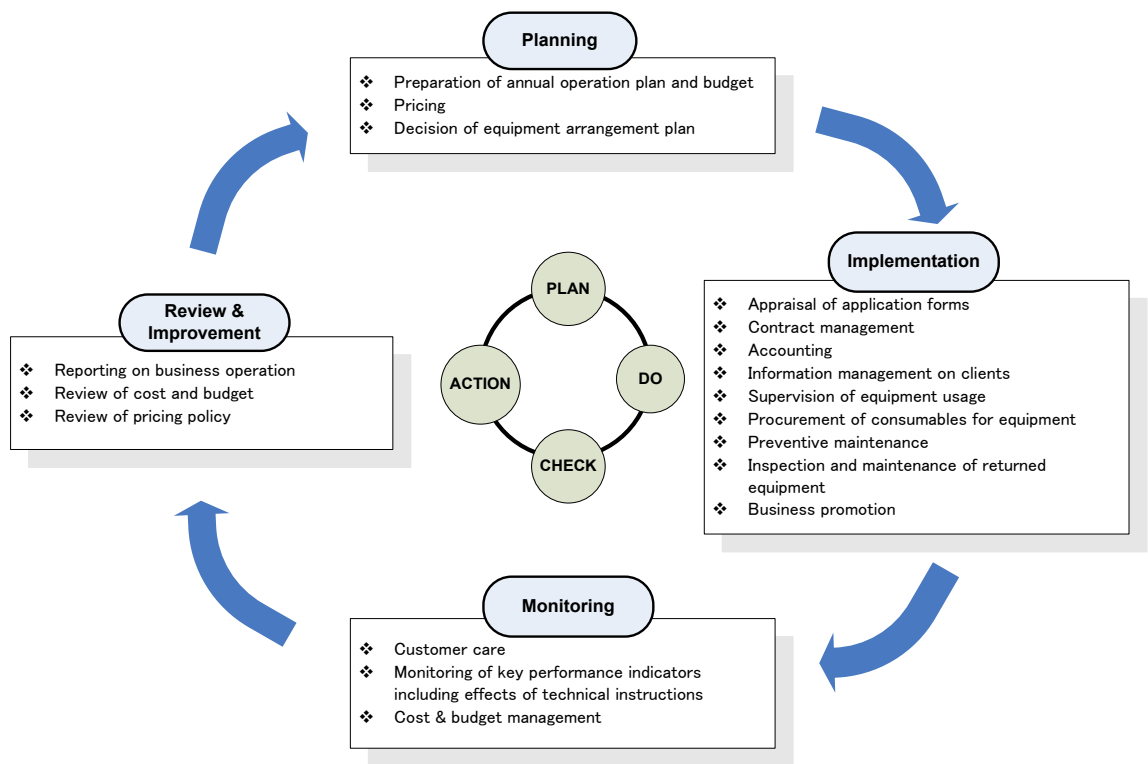


Figure 43 Business Cycle for the Hiring Business

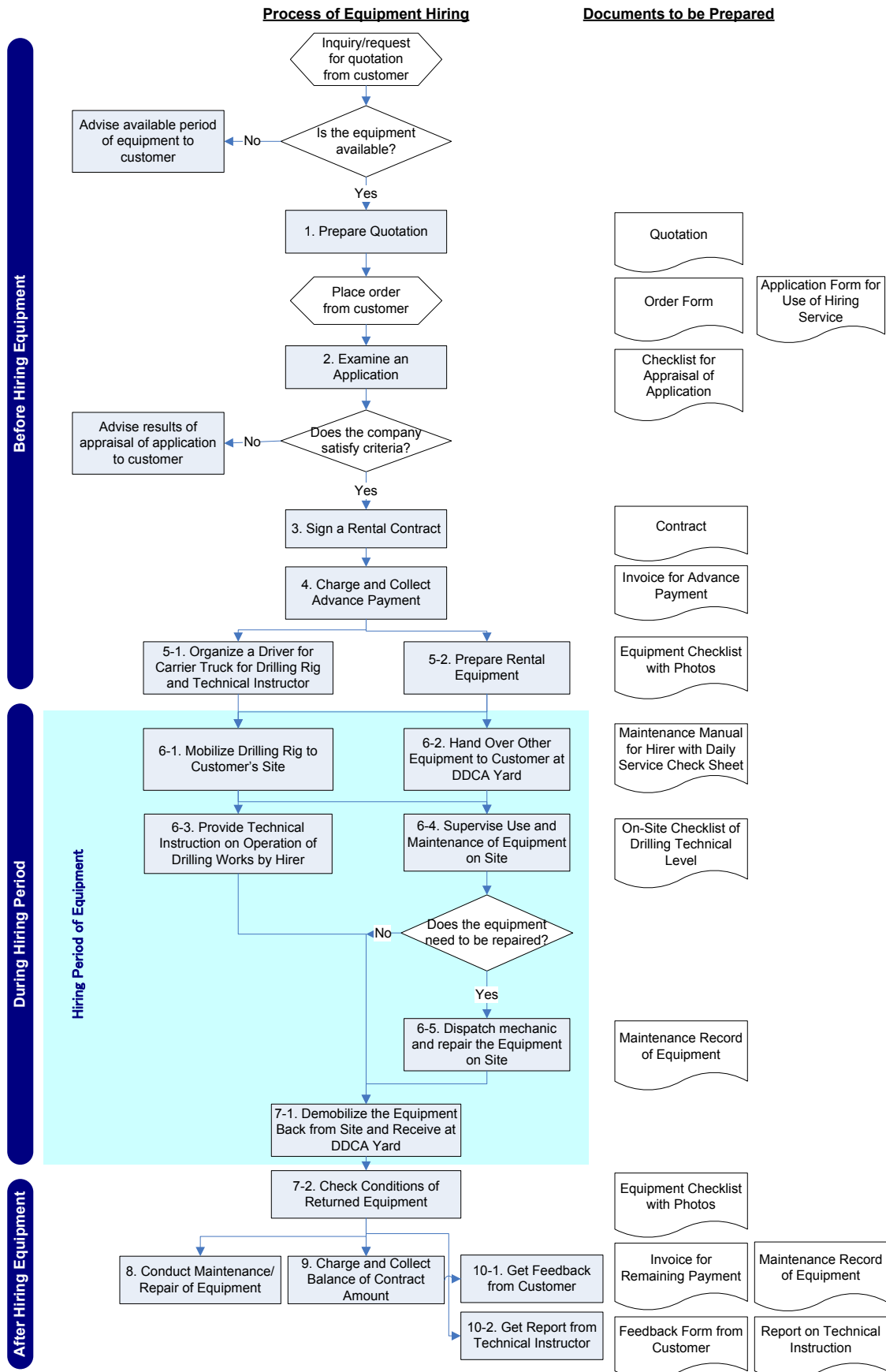


Figure 44 Process Flow of Hiring Business

15) Tariff Setting and Formulation of Budget

The tariff and operation budget of the hiring service are summarized in the Guideline on Hiring of Equipment and Machinery based on the conditions described before. Expenses to be recovered from the rental fee consist of costs for maintenance of the equipment, fuel and lubricants, consumables, allowance, advertisement, stationery, depreciation and other administrative expenses. The operation rate and general condition for drilling were considered for each type of equipment. The rental cost per day was calculated based on the annual operation days. The hiring business would be commenced with the daily basis contract, while the option of the borehole number basis tariff would be considered depending on the customer needs and analysis of actual result. The adapted calculation method can correspond to both daily basis and borehole number basis. The tariff per borehole was calculated to be Tsh 3,433,000. Based on the result of baseline survey, the actual tariff of large rig charged for a borehole was Tsh 6,000,000 (**Table 16**). Accordingly, the hire tariff was cheaper than the actual experienced tariff for the surveyed companies. However, equipment depreciation cost was not included into the hire tariff. It would be discussed between the accounting section and Technical Support Department and decided before the commencement of the business if the hire tariff includes the equipment depreciation cost.

The hire tariff would be revised every year based on the actual result in the previous year, using the form for annual plan of operation of hiring service shown in the annex 1 of Manual on Hiring of Drilling Equipment and Machinery.

16) Formulation of a Guideline and Manual on Hiring of Drilling Equipment

The first draft of the guideline and manual for operation of the equipment hiring business was prepared based on the business model explained in subsection (3). Various forms to be used in administration of the business are attached in the manual (Appendix 5 of this report). **Table 59** and **Table 60** show contents of these guideline and manual.

Although DDCA had experience in hiring the drilling equipment to other organizations in the past, there were no standardized forms for contract and other administrative procedures as it had been operated as ad hoc basis. It was expected that the hiring business would be operated with transparency and accountability by utilizing the guideline and manuals including the standardized formats.

Table 59 Contents of the Guideline on Hiring of Drilling Equipment

	Chapter	Detailed Subject
1.	Objectives of the Hiring Business	
2.	Environemental Scan of DDCA ²⁴	<ul style="list-style-type: none"> - Internal environment (strength, weakness) - External environemnt (opportunities, threat)
3.	Identification of Potential Clients	<ul style="list-style-type: none"> - Geographical distribution - Clients for water well drilling - Equipment owned - Human resources - Demand for hiring of drilling equipment - Demand for technical support services - Classification of the private drilling companies
4.	Scope of Services to be Provided by DDCA in the Hiring Business	<ul style="list-style-type: none"> - Items to be hired - Allocation of staff of DDCA to the hired equipment - Maintenance
5.	Qualification to be Required for Clients and Other Conditions	<ul style="list-style-type: none"> - Registration to CRB and MoW - Use of the Hired Equipment

²⁴ This is used as a method for capacity assessment of the organization. Internal environment is assessed by the strength and weakness while external environment is assessed by the opportunity and threats. The attention for the strategic planning of the business shall be drawn out from the cross SWOT analysis.

	Chapter	Detailed Subject
6.	Legal and Administrative Procedures Required	<ul style="list-style-type: none"> - Liablility of insurance for the hiring equipumnt - Establishment of Hiring Business Department at DDCA - Tax
7.	Establishment of Hiring Business Unit	<ul style="list-style-type: none"> - Job description - Personnel arrangement plan
8.	Performance Management	<ul style="list-style-type: none"> - Key performance indicator - Performance monitoring and reporting
9.	Outline of the Business Flow	
10.	Business Promotion	
11.	Finance	

Table 60 Contents of the Manual on Hiring of Drilling Equipment

	Chapter	Detailed Subject
1.	Purpose and intended users of the manual	
2.	Planning	
3.	Business Promotion	
4.	Identificaiton of Clients	
5.	Process of equipment hiring	
6.	Appraisal of Applications	
7.	Contract Management	
8.	Allocation of Technical Instructors	
9.	Maintenance	<ul style="list-style-type: none"> - Demarkation of responsibilities in maintenance of equipment - Preventive maintenance - Inspection and maintenance of returned equipment
10.	Handling of Accident	<ul style="list-style-type: none"> - Motor insurance - Equipment insurance - Handling of accident cases
11.	Information Management on Client	
12.	Financial Management	<ul style="list-style-type: none"> - Accounting - Reporting
13.	Asset Management	
14.	Performance Monitoring	

Annexes

- | | |
|--|--|
| - 1. Form for annual plan of operation of hiring service | - 8. Checklist for appraisal of application |
| - 2. Sample brochure of hiring service | - 9. Sample contract form |
| - 3. Contact list of private drilling companies | - 10. Form for report on technical instruction |
| - 4. Form for request for quotation | - 11. Checklist of equipmment |
| - 5. Quotation form | - 12. Feedback form from client |
| - 6. Application form for hiring of drilling equipment | - 13. Monthly report form |
| - 7. Order form | - |

3.3.3 MAINTENANCE SYSTEM FOR HIRING EQUIPMENT

Maintenance system for the hiring equipment, maintenance plan and maintenance procedures were considered based on the analysis results of the baseline survey on current maintenance system in the workshop in the headquarter of DDCA and the zonal offices, and examination of the hiring equipment. They were compiled in “Maintenance Guideline for Maintenance System for Hiring Equipment”, “Maintenance Plan for Maintenance System for Hiring Equipment” and “Maintenance Manual for Maintenance System for Hiring Equipment”. The contents are shown in **Table 61**.

Table 61 Contents of Documents for Maintenance System

Content	Item
Maintenance Guideline	
1 Background	
2 Documents for Maintenance System	
3 Precondition of Maintenance Works for Hiring Equipment	3.1 Specification of Wells to be Drilled by Using Hiring Equipment 3.2 Drilling Equipment to be Hired
4 Maintenance Activities in the Process of Hiring	
5 Contents of Maintenance	5.1 Scope of Maintenance - Condition check - Periodic service maintenance - Daily service maintenance - Repairing 5.2 Responsibility of Owner and Hirer - Condition check - Periodic service maintenance - Daily service maintenance - Repairing - Case of loss or damage of equipment - Safety measures
6 Maintenance Organization	
7 Formulation of Maintenance Plan	7.1 Planning 7.2 Contents of Maintenance Plan
8 Revision of Maintenance System	8.1 Monitoring and Evaluation of System 8.2 Procedure for Revision of System
Maintenance Plan	
1 Background	
2 Documents for Maintenance System	
3 Contents of Plan	
4 Annual Action Plan	4.1 Action Plan Intended for Preventive Maintenance 4.2 Details of Annual Action Plan
5 Periodic Service Maintenance Plan	5.1 Management of Periodic Service Maintenance 5.2 Utilization of Periodic Service Manual and Periodic Service Check Sheet
6 Daily Service Plan	6.1 Daily Service Maintenance Management 6.2 Utilization of Daily Service Manual and Daily Service Check Sheet
7 Repairing Plan	7.1 Repairing Work 7.2 Case Necessary for Repairing
8 Spare Parts and Consumable Parts Control and Procurement Plan	8.1 Specification of Spare Parts 8.2 Spare Parts Procurement Plan 8.3 Drilling Consumable Plan
9 Maintenance Equipment Control and Procurement Plan	
10 Personnel Assignment Plan	10.1 Allocation of Hiring Equipment 10.2 Staff Allocation
11 Technical Enhancement Plan	
12 Budget Plan	
Maintenance Manual for OWNER (DDCA)	
1 Documents for Maintenance System	
2 Purpose of Maintenance of Hiring Equipment	

CHAPTER 3 ACTIVITIES TAKEN AND OUTPUTS OF THE PROJECT

Content	Item
3 Condition Check of Hiring Equipment Before and After Hiring	3.1 Hiring Equipment Condition Check Sheet 3.2 Contents of the Hiring Equipment Condition Check Sheet
4 Periodic Service	4.1 Periodic Service Check Sheet 4.2 Contents of the Periodic Service Check Sheet
Maintenance Manual for HIRER (Private Drilling Company))	
1 Documents for Maintenance System	
2 Purpose of the Maintenance Manual of Hiring Equipment	
3 Daily Maintenance of Hiring Equipment by Hirer	3.1 Daily Service Check Sheet 3.2 Contents of Daily Service Check Sheet 3.3 Evaluation of Daily Services
4 Safety Measures Manual	

Maintenance system for the equipment hiring was established until March 2013 for trial operation of the hiring business through preparation of the documents. However, it was not implemented due to termination of the Project. Technical transfer to the DDCA staff who were in charge of the equipment maintenance was neither implemented.

CHAPTER 4 RESULTS, RECOMMENDATION AND LESSONS

4.1 RESULTS OF THE PROJECT

Until termination of the project, activities were implemented based on PDM₁ (refer to **Table 1**), which was agreed on R/D signed on 24th December 2014. The Project was designed to achieve the project purpose of “DDCA’s capacity to support the water well drilling industry is enhanced” by the following steps:

- In the first part of the Project, five systems related to Output 1 to 3, composed of guidelines, plans and manuals) (**Figure 45**) are developed,
- In the remaining period of the Project, the trial operation of the above systems is conducted for the improvement system and for the technical enhancement of DDCA’s staff.

This logic of the Project is shown in **Figure 46** and contents of each system are described below.

System related to Output 1

- 1) Private Sector Capacity Development Support System for the Private Sector: DDCA’s capacity development support system for the private drilling companies, including the training system of DDCA’s instructors.

System related to Output 2

- 1) Technical Support System for DDCA’s drillers: Technical enhancement system of DDCA’s senior drillers, developed based on the results of baselines survey on the technical level of DDCA’s drillers.
- 2) Well Database System: System to enhance the capacity of DDCA on the provision of hydrogeological information to the private sector, by digitizing the DDCA’s existing paper-based well reports

System related to Output3

- 1) Equipment Hiring System : System for the operation of hiring business of equipment and machineries, composed of guidelines and manuals, developed from the results of the baseline survey on the private drilling companies
- 2) Maintenance System for Hiring Equipment and Machineries: System for DDCA to properly maintain drilling equipment for hiring, composed of plan and manuals

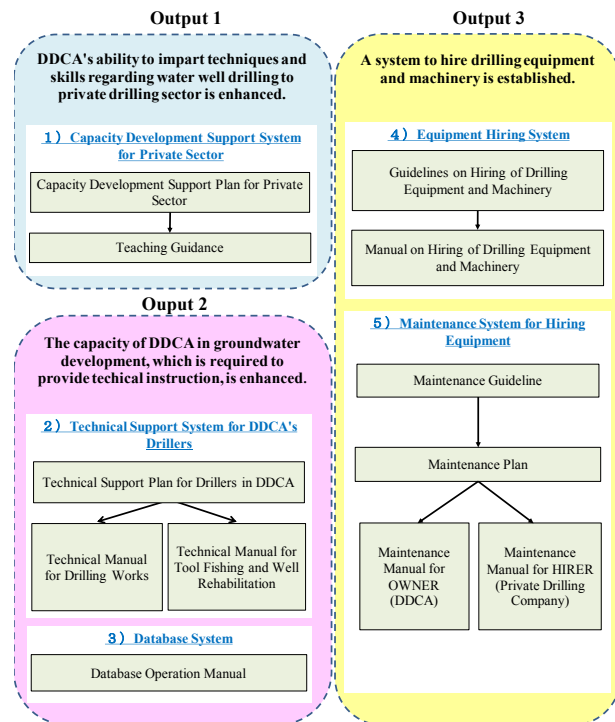


Figure 45 Guideline, Plan and Manuals prepared in the Project

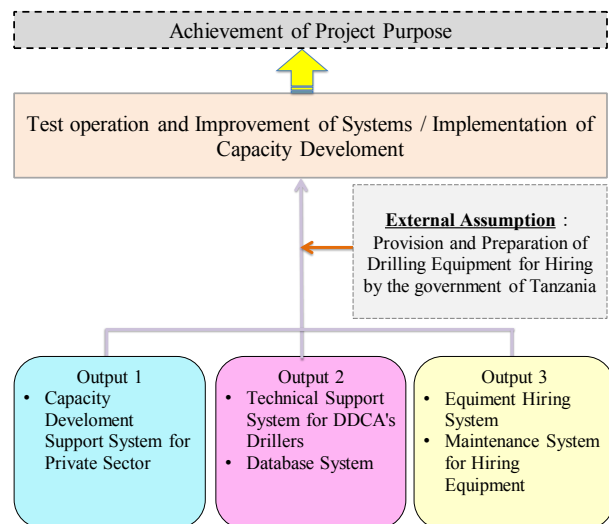


Figure 46 Concept of Achievement of Project Purpose

As described in Chapter 3, the above systems were formulated, and the necessary documents such as guidelines, plans, and manuals were prepared before the suspension of the Project. However, in December 2014, JICA was informed of the change of MoW's policy not to proceed with the launch of DDCA's hiring business to support private sector. According to this change of the policy, MoW requested the termination of the Project and JICA decided the termination.

The progress of project purpose and outputs until project termination are shown in **Table 62**.

Table 62 Progress of project purpose and outputs

Project Purpose and Outputs	Indicator	Progress
Output 1 to 3		
1. DDCA's ability to impart techniques and skills regarding water well drilling to private drilling sector is enhanced.	1-1. DDCA staff gain confidence in providing technical instructions to private drilling companies.	<ul style="list-style-type: none"> Technical instruction system and instruction guideline of DDCA were documented, and seminar for trainers was convened.
	1-2. The number of drilling supervisors certified by the project team reaches XX.	<ul style="list-style-type: none"> Target technical trainers were selected and seminar for trainers was convened.
	1-3. The technical instruction system of the groundwater development for private drilling companies is standardized in DDCA	<ul style="list-style-type: none"> Technical instruction system was documented.
2. The capacity of DDCA in groundwater development, which is required to provide technical instructions, is enhanced.	2-1 DDCA staff gain advanced ground water development techniques.	<ul style="list-style-type: none"> Technical parts to be strengthened were identified, and manuals and the technical support plan were formulated.
	2-2 The number of drilling supervisors certified by the project team reaches XX.	<ul style="list-style-type: none"> Practical training for 31 nominated senior drillers was conducted.
3. A system to hire drilling equipment and machinery is established.	3-1 Total number of hires reaches XX per year.	<ul style="list-style-type: none"> Drilling equipment hiring has not been started.
	3-2 Drilling equipment and machinery are hired in accordance with the procedure established, such as the tariff and contract agreement.	<ul style="list-style-type: none"> Procedures for tariff and contract agreement were documented.
	3-3 All drilling equipment and machinery for hiring are maintained in accordance with guidelines and maintenance manuals.	<ul style="list-style-type: none"> Guideline for equipment maintenance and maintenance manuals were documented.
	3-4 Internal management accounting document for hiring is reported periodically to the management.	<ul style="list-style-type: none"> Internal management accounting documents were developed.
Project Purpose		
DDCA's capacity to support the water well drilling industry is enhanced.	1. The number of wells drilled using the hired drilling equipment reaches to XX.	<ul style="list-style-type: none"> Drilling equipment hiring has not been started.
	2. More than XX registered companies utilise some form of service provided by DDCA.	<ul style="list-style-type: none"> Since drilling equipment hiring has not been started, technical instruction service also has not been started too.
	3. More than XX % of private drilling companies, which used services provided by DDCA, consider that the services they received helped their business activities.	<ul style="list-style-type: none"> The service by DDCA has not been started.

4.2 PRESENT SITUATION AND THE EVALUATION OF PROJECT ACTIVITIES

Output1 : DDCA's ability to impart techniques and skills regarding water well drilling to private drilling sector is enhanced

Based on the results of the baseline survey focusing on 94 private drilling companies, the private sector capacity development support plan was formulated, in order that DDCA shall develop his

organization and capacity for the proper implementation of the support of private company's capacity development. This plan also includes a training plan of DDCA's technical instructors for private sector and the teaching guidance to be used for technical instruction. Activities were completed on planned schedule, including conducting seminar for 14 candidates of technical instructor who were certified as technical instructor after the seminar.

Planned technical guidance on drilling sites was not conducted, due to the project suspension. However, the clarification of measures to facilitate private companies to join the business of WSDP's drilling works, based on the examination of DDCA's cost management system and analysis of private companies' assets and business situation are thought to contribute to the groundwater development sector in Tanzania.

Output 2 : The capacity of DDCA in groundwater development, which is required to provide technical instructions, is enhanced.

(1) Based on the results of the baseline survey on DDCA, the technical support plan and technical manuals for the technical enhancement of DDCA's drillers were formulated. These activities were completed on planned schedule and a technical seminar for 31 senior drillers of DDCA was conducted.

Planned activities of technical support for DDCA's drillers were not completed, due to termination of the Project. However, after receiving seminars, DDCA's administrative department identified a clear behaviour change of DDCA's drillers in their work to carry the distributed manuals to sites and referring to it for the proper implementation of drilling.

Furthermore, following activities are thought to contribute to the evaluation and improvement of the entire field of drilling technics in Tanzania:

- Clarification of DDCA's organization setting and process of drilling works, not only by interview to DDCA, but also by detailed data collection and analysis such as field survey at drilling sites and competence test of drillers, which was the first attempt in this field,
- Collaboration and knowledge sharing with lecturers of WDMI, only an educational institute in the field of drilling works in Tanzania.

(2) 9,997 wells among 12,932, which were drilled by DDCA from fiscal year of 1930/1931 to 2011/2012, were digitized and compiled into a database.

Due to the project termination, the project was not able to instruct the methodology for the proper updating and utilization of the database. However, it is evaluated that, after the completion of the database, the access to DDCA's valuable drilling data was drastically improved, which had been limited to utilization of paper-based data.

Output3 : A system to hire drilling equipment and machinery is established.

Based on the results of the baseline survey focusing on 94 private drilling companies, guidelines, plan and manuals for the proper operation of DDCA's hiring business and equipment maintenance were formulated.

Due to the project termination, the equipment hiring business was not launched. However, during the process of formulation of guidelines, plan and manuals preparation, not only for the equipment hiring business but also with regard to entire drilling business of DDCA, the following operation and management issues were revealed:

- 1) lack of feedback from cost analysis to actual work cost budgeting,
- 2) lack of planning of equipment maintenance, and
- 3) lack of equipment renewal plan based on depreciation of the equipment.

Formulated system documents for the hiring business are useful tools for DDCA's future hiring business, and, at the same time, tools for the improvement of work implementation system and

methods of DDCA's self. Accumulation of know-how of improvement of DDCA's business management will lead to the improvement of his capacity on the technical support to the private sector.

4.3 RECOMMENDATION RELATED TO PROJECT OUTPUTS

With regard to shift in government policy, it seemed that MoW regarded strengthening drilling capacity of DDCA as a more urgent issue than the private sector support by DDCA's hiring business. As mentioned in Section 3.2.1 (3), the number of wells drilled by DDCA had decreased from over 400 to 200 between fiscal years of 2002/2003 to 2008/2009. During this period, the number of functional drilling rigs had decreased from 30 to 15, as well. However, DDCA still now drills over 200 wells every year, and remains to be a core drilling company of groundwater development sector in Tanzania.

The following outputs of the Project can be used as useful tools for enhancement of technical level and business management improvement of DDCA:

- 1) Analysis on drilling work system of DDCA and private drilling companies,
- 2) Development of tools for reinforcement of drilling technics and equipment maintenance,
- 3) Construction of well information database, and:
- 4) Results of financial analysis and equipment planning, implemented through the formulation of equipment hiring system.

The following clauses describe the recommendation on the utilization of the above mentioned outputs of the Project.

Utilization of Output 1

Regarding documents related to Output 1, "Private Sector Capacity Development Support Plan" and "Teaching Guidance" were developed. "Private Sector Capacity Development Support Plan" includes training system of technical instructors of DDCA, and the project implemented the seminar on "Teaching Guidance" for 14 DDCA's senior drillers nominated as candidate technical instructors, all of whom achieved more than criteria score in the comprehension test after the seminar.

The above technical instructor training aimed at the technical instruction to private drilling companies. However, the trained and certified technical instructor can also be trainers for DDCA's middle driller, by measure of which the technical enhancement in drilling works of DDCA and technical inheritance from the senior to the middle will be achieved.

By utilizing the trained technical instructors and "Teaching Guidance", DDCA is expected to conduct the effective and theoretical training to his drillers.

Utilization of Output 2

(1) Regarding the documents related to Output 2, "Technical Support Plan for Drillers in DDCA", "Technical Manual for Drilling Work", and "Technical Manual for Well Rehabilitation and Tool Fishing" were developed by the project. These documents aimed at capacity development of DDCA's senior drillers, and can be directly used for the technical enhancement of DDCA's drillers.

DDCA is expected to utilize the above documents, together with the technical instructors of Output 1, in order to conduct continuous technical enhancement activities on drillers.

(2) For the purpose to construct the well information database, the project digitized DDCA's hand-written well reports. By this digitization of data, accessibility to the hydrogeological information of DDCA was much improved.

However, due to the project termination, technical supports such as technique for Microsoft Excel operation and higher level utilization of the computerized hydrogeological information were not

conducted. Therefore, in order for the more effective use of the database, DDCA is recommended to conduct the technical enhancement activities for his staff on Microsoft Excel operation skills.

Utilization of Output 3

(1) Regarding the documents related to “Systems for hiring drilling equipment and machinery” in Output 3, “Guidelines on Hiring of Drilling Equipment and Machinery” and “Manual on Hiring of Drilling Equipment and Machinery” were developed for the purpose to establish a system for hiring drilling equipment and machinery. During the process of preparation of the above documents, cost structure of the drilling works of DDCA was analyzed and use and mobilization of the equipment for each contract of hiring was planned. The methodologies for these activities can be useful tools to enhance DDCA’s cost and business management. Therefore, DDCA is recommended to utilize such tools in order to cope with the decreasing of sales of drilling works and intensifying competition with private companies.

(2) Regarding the documents related to “Maintenance systems for hiring drilling equipment and machinery” in Output 3, “Maintenance Guideline for Hiring Equipment”, “Maintenance Plan for Hiring Equipment”, and “Maintenance Manuals for Hiring Equipment” were developed for the purpose to conduct effective maintenance of the drilling equipment and machinery for hiring. However, this equipment maintenance system can be used for the maintenance of the drilling equipment of DDCA’s own. DDCA is recommended, under the situation where his drilling equipment is being aging, to utilize these tools for the proper planning and implementation of the equipment maintenance.

4.4 LESSONS LEARNT FROM THE PROJECT IMPLEMENTATION

Lessons related to the delay of equipment to be procured

The Project was decided to be terminated, upon the change of the policy of MoW that DDCA’s equipment hiring business for the support of private sector would not launched. However, the direct reason of the agreement of the suspension of the Project at the 2nd Joint Coordinating Committee (JCC) in February 2013 was the delay of the planned equipment procurement. There were two major reasons of the delay of the procurement, those are, the delay of delivery due to the custom clearance procedures and concern of quality of delivered drilling rigs.

In case equipment procurement by counterparts is an assumption for the Project implementation, there will be a risk to have the same problem. The following counter-measures can be considered.

- 1) In the Project, project activities and the equipment procurement were implemented in parallel. Scheduling such to start the project activities after the completion of the equipment procurement can be considered.
- 2) In the Project, procurement management such as tender document preparation, selection of supplier, progress and quality control was out of scope of the Project. Inclusion of these activities into the Project in order to conduct the procurement control by the experts of the Project and/or provision of technical training for MoW and DDCA on procurement management can be considered.

Furthermore, the following countermeasures against the quality and progress control can be considered.

1) Technical control

In order to ensure the technical quality of the equipment, more detailed descriptions in the tender document are required. Regarding the technical specifications of the equipment, detailed specifications shall be described in the tender document, by the detailed examination of specifications of the products of not less than three major manufacturers.

Inspection items and criteria on the workmanship of welding and painting should be clarified. They shall be inspected in the multiple steps of factory inspection, pre-shipment inspection and

delivery inspection. In order for the proper implementation of the client's inspections, internal and/or external quality control technical auditors shall be ensured.

2) Secure of procurement management technics

As well as the technical control, secure of procurement management technics in order to ensure the supplier's proper implementation of quality control and procurement is required. In the stage of the preparation of tender document, appropriateness of the selection method of supplier who has sufficient capacity and the supplier's responsibility to the quality of the equipment shall be verified to be duly described in the tender document. Regarding procurement period, contract conditions such as progress control without delay, client's obligation of the smooth custom clearance, supplier's obligation to repair and/or replacement in case of defect of the equipment, shall be clearly mentioned in the tender document.

Communication between actors

The Project commenced in March 2012 and was to continue during four years. However, after one year from the commencement, in February 2013, suspension of the Project was agreed, and in December 2014, change of the policy of MoW was informed JICA. Finally, MoW requested the termination of the Project in May 2015.

Change of the policy of the recipient country would bring about the distinct influence on the implementation of projects. As earlier obtaining of such information would enable the prompt countermeasures such as modification or termination of projects, it is important to keep intimate communication with counterparts to grasp movements of recipient country, as well as with JICA to share the information to discuss the measures.

Strengthening the registration system of private drilling company

In the baseline survey focusing on private drilling companies, the project utilized the registration list of private drilling companies of MoW. However, the registration list had not been updated regularly. In order for the proper monitoring and supervision of private drilling companies by MoW, proper system of review of qualification for registration and regular updating is required to be established.

Strengthening the relationship with WDMI (Water Development and Management Institute)

The project developed the "Technical Manual for Drilling Work" and "Teaching Guidance", and conducted a technical seminar in collaboration with WDMI's lecturers in charge of drilling. Even before the launch of the Project, DDCA had a certain relationship with WDMI through participation of DDCA staff in training at WDMI. Furthermore, through the collaborative activities of the Project, relationship between DDCA and WDMI was strengthened. It is thought to be important for DDCA to keep this collaborative relationship with WDMI on revision of technical manuals and formulation of training course based on the feedback from the actual drilling works, in order to accumulate the technical knowledge and instructing capacity as a technical center of drilling works in Tanzania.

Cost management in consideration of the equipment procurement

So far, DDCA has regularly procured the equipment by subsidy from the government and support from development partners. Therefore, estimated budgets by DDCA did not include the equipment depreciation cost, and retained earnings for aged equipment renewal have not been accumulated. The developed documents related to "Hiring of Drilling Equipment and Machinery" and "Maintenance System for Hiring Equipment" can be utilized as tools for proper cost analysis and management. In order to address in issue of equipment aging, it is important that DDCA estimates the competitive cost based on a proper analysis.

For the future technical support for private drilling companies in Tanzania, also obtaining proper drilling cost management skills are important.

Sustainable approach for the capacity development of DDCA's staff

DDCA was reviewing the performance of staff in accordance with the human resource evaluation system authorized by the Government of Tanzania. However, from the perspective of the capacity development of drillers, the performance review and the approach for the capacity development of their staff were insufficient. Thus, by using the evaluation/training system, technical manuals and the teaching guidance developed in the Project, DDCA is recommended to conduct sustainable performance review and capacity development of staff required.

Enhancing the management skills for the drilling equipment procurement

So far, most of drilling equipment of DDCA was provided by development partners, and the procurement process was supported by them. In order to prevent problems such as delay of the procurement, enhancement of the skills for proper procurement planning and preparation of technical specifications is required. Technical documents developed in the Project cover necessary knowledge for the selection of the proper equipment and clarification of detailed technical specifications. It is important that DDCA enhances skills of staff in charge of procurement by using the above documents.































































Enhancing capacity for the hydrogeological information provision

In order for continuous update of the well database constructed in the project, enhancing the capacity of responsible staff is required. Furthermore, compiling of all hydrogeological information in Tanzania by utilizing MoW's well data provided by private drilling companies in addition to DDCA well data is expected. Hydrogeological data collection, analysis of collected data and development of consultancy capacity by utilizing hydrogeological data, will contribute to the support to private sector in the future.

Collaboration with basin offices from the perspective of the water resources management




As a responsible agency for hydrogeological information management, it is important for DDCA to incorporate the perspective of groundwater resource management and protection in the future. Furthermore, groundwater data managed by basin offices is expected to be utilized for groundwater resources management and protection in the areas where DDCA and private drilling companies drill boreholes.

Assignment Schedule

	Assignment	Name	2012												2013												Sub-total①	
			3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	Tanzania	Domestic		
Work in Tanzania	Chief Advisor / Groundwater Development Expert	Yuichi HATA																								5.97	0.10	
	Deputy Chief Advisor / Drilling Expert	Masakazu SAITO																								9.20		
	Field Technique Training Expert	Yoshimi HIDA																								2.00		
	Operation Management / Organizational and Institutional Development Expert	Mikiko AZUMA																								5.00		
	Training Planner / Private Sector Development Expert	Chiaki TAMEKAWA																								8.27		
	Machinery and Equipment Maintenance Expert	Koji UZAWA																								3.00		
	Geophysicist / Well Database Specialist	Tatsuya SUMIDA																								6.00		
	Wells and Groundwater Resources Management Expert	Aya KADOKAMI																								1.10		

Assignment		Name	2014												2015												2016			Total②		Total①+②	
Work in Tanzania	Chief Advisor / Groundwater Development Expert	Yuichi HATA																									0.00		5.97	0.10			
	Deputy Chief Advisor / Drilling Expert	Masakazu SAITO																									0.00		9.20				
	Field Technique Training Expert	Yoshimi HIDA																									0.00		2.00				
	Operation Management / Organizational and Institutional Development Expert	Mikiko AZUMA																									0.00		5.00				
	Training Planner / Private Sector Development Expert	Chiaki TAMEKAWA																									0.00		8.27				
	Machinery and Equipment Maintenance Expert	Koji UZAWA																									0.00		3.00				
	Geophysicist / Well Database Specialist	Tatsuya SUMIDA																									0.00		6.00				
	Wells and Groundwater Resources Management Expert	Aya KADOKAMI																									0.00		1.10				
				Total																												40.54	0.10

Legend

-  Work in Tanzania (JICA)
-  Work in Tanzania (ESS)
-  Work in Japan

REVIEW OF PROJECT DESIGN MATRIX 1 (PDM₁) AND REVISION OF PDM₂

The first version of PDM, namely PDM₁ was provided and agreed through Minute of Meeting signed on 15th November 2011 and Record of Discussion (R/D) signed on 24th December 2011 among MoW, DDCA and Japanese Preparatory Study Team. During the last half of the 1st year, considering findings from baseline surveys conducted for capacity assessment of DDCA and private drilling companies, the project team observed necessity of revision of PDM₁, particularly on overall goal, activities, important assumptions, and indicators. The revised version was prepared and proposed as PDM₂. Currently, JICA headquarters examines proposed PDM₂. After approval from JICA, PDM₂ would be presented for approval at 3rd coming JCC meeting. The following sections describe proposal of revisions of PDM₁.

(1) Super Goal

Details in revision of PDM₁ and formulation of PDM₂, regarding the super goal are explained in **Table 1** with its justification.

Table 1 Addition of Super Goal

PDM 1	PDM 2	Reason for Revision
Narrative Summary: none	Narrative Summary: The number of wells necessary to achieve the target of WSDP is drilled.	In order to contribute for achievement of construction works of the planned number of wells in WSDP, it is necessary that capacities of the drilling industry are strengthened with utilizing the enhanced private sector support services of DDCA. Based on this logic, achievement of construction of the planned number of wells in WSDP is regarded as the super goal of the project.
Indicator: none	Indicator: The number of wells planned in WSDP is constructed by 2025.	
Means of Verification: none	Means of Verification: MoW Annual Water Sector Status Report, Water Sector MIS	

(2) Overall Goal

Details in revision of PDM₁ and formulation of PDM₂, regarding the overall goal are explained in **Table 2** with its justification.

Table 2 Revision of Overall Goal

PDM 1	PDM 2	Reason for Revision
Narrative Summary: The number of wells necessary to achieve the target of WSDP is drilled.	Narrative Summary: The performance of drilling activities in WSDP is improved.	A direct result expected from enhancement of private sector support services of DDCA is set as the overall goal.
Indicator: The number of successful wells drilled by drilling industry, per year, increases from XX in year 2010/2011 to XX by 2018/2019.	Indicator: 1. The number of private companies which use the private sector support services of DDCA and participate in drilling works in WSDP increases by 122% by 2018, compared to the status at the beginning of the project. 2. The operation ratio of drilling rigs used by DDCA is improved from 24.0% (2012) to 36.4% by 2018.	Indicators are set to measure level of improvement in performance of both DDCA and the private drilling companies which use the private sector support services of DDCA.

(3) Indicators of Project Purpose

Details in revision of PDM₁ and formulation of PDM₂, regarding the indicators of the Project purpose were explained in **Table 3** with its justification.

Table 3 Revision of the Indicators of Project Purpose

PDM 1	PDM 2	Reason for Revision
Narrative Summary: DDCA's capacity to support the water well drilling industry is enhanced.	Narrative Summary: No change	-
Indicator: 1. The number of wells drilled using the hired drilling equipment reaches to XX. 2. More than XX registered companies utilize some form of service provided by DDCA. 3. More than XX % of private drilling companies, which used services provided by DDCA, consider that the services they received helped their business activities.	Indicator: 1. The number of wells drilled using the hired drilling equipment reaches to XX <u>per annum on average, which is the breakeven line of the hiring business, by 2016.</u> 2. More than 80% of the registered water well drilling companies utilizes some forms of the private sector support services including provision of hydrogeological information of DDCA by 2016. 3. More than <u>80%</u> of private drilling companies, which used the <u>private sector support</u> services provided by DDCA, consider that the services they received helped their business activities.	1. The original indicator is modified to see if the hiring business as part of the private sector support services is operated in commercially viable manner. 2. The target value is to be indicated in percentage instead of actual number since the total number of the registered companies will change from time to time. 3. Wording is modified to clearly state scope of the services concerned in this indicator.

(4) Indicators of Output

Details in revision of PDM₁ and formulation of PDM₂, regarding the indicators of output are explained in **Table 4** with its justification.

Table 4 Revision of the Indicators of Project Output

PDM 1	PDM 2	Reason for Revision
Output 1 Narrative Summary: DDCA's ability to impart techniques and skills regarding water well drilling to private drilling sector is enhanced.	Output 1 Narrative Summary: No change	-
Indicator: 1-1. DDCA staff gain confidence in providing technical instructions to private drilling companies. 1-2. The number of drilling supervisors who are certified by the project team reaches XX. 1-3. The technical instruction system of the groundwater development for private drilling companies is standardized in DDCA.	Indicator: 1-1. The technical instruction system of the groundwater development for private drilling companies is standardized in DDCA <u>by 2013.</u> 1-2. The number of drilling supervisors ¹ who are certified <u>by the DDCA's internal qualification system of technical instructors</u> reaches <u>12 by 2013.</u> 1-3. The staff of the private drilling companies who received technical instructions by DDCA acquires an average of 80% of the total score of the checklist in the second year after	1-1. The original indicator is removed as it cannot measure degree of change which is to be realized by the project. The Indicator 1-3 in PDM ₁ is now regarded as Indicator 1-1 in PDM ₂ . 1-2. The original Indicator 1-2 is modified as the drilling supervisors who act as the technical instructors to the private drilling companies are supposed to be certified by the DDCA's internal qualification system which is to be established in the Project. 1-3. An indicator is added in order to measure level of improvement of instruction skills of DDCA's drilling supervisor from the aspect of level of understanding of the staff of private companies

¹ Those who will be attached to the hired equipment and provide technical instructions to private companies

PDM 1	PDM 2	Reason for Revision
	commencement of the hiring business.	which receive technical instructions from DDCA.
Means of Verification: 1-1. Project reports and end-line survey report 1-2. Project reports 1-3. DDCA's record and end-line survey report	Means of Verification: 1-1. Project reports 1-2. Project reports 1-3. Project reports	Appropriate means of verification are set in accordance with the modified indicators.
Output 2 Narrative Summary: The capacities of DDCA in groundwater development, which is required to provide technical instructions, is enhanced.	Output 2 Narrative Summary: The capacities of DDCA in groundwater development ² , which is required to provide technical instructions, is enhanced.	Target group of the technical instructions of DDCA is clearly indicated.
Indicator: 2-1. DDCA staff gain advanced groundwater development techniques. 2-2. The number of drilling supervisors who are certified by the project team reaches XX.	Indicator: 2-1. More than 70% of 35 senior drillers pass minimum required score in a test in each training course to be held in accordance with the technical support plan for DDCA. 2-2. The well database is updated annually by DDCA.	2-1. The indicator is modified to be measurable. 2-2. The original Indicator 2-2 in PDM ₁ is removed as it is a duplication of Indicator 1-2. Indicator 2-2 in PDM ₂ is newly added since management of the well database also included in the target areas of capacity development of DDCA in the Project.
Means of Verification: 2-1. Project reports and end-line survey report 2-2. Project reports	Means of Verification: 2-1. Tests in training courses for drillers 2-2. Project reports	Appropriate means of verification are set in accordance with the modified indicators.
Output 3 Narrative Summary: A system to hire drilling equipment and machinery is established.	Output 3 Narrative Summary: No change	-
Indicator: 3-1. Total number of hires reaches XX per year. 3-2. Drilling equipment and machinery are hired in accordance with the procedure established, such as tariff and contract agreement.	Indicator: 3-1. Drilling equipment and machinery are hired in accordance with the procedure established, such as tariff and contract agreement. 3-2. All drilling equipment and machinery for hiring are maintained in accordance with the <u>maintenance plan</u> .	3-1. The original Indicator 3-1 in PDM ₁ is removed as it does not show if the hiring business is established. It only provides information on actual performance of DDCA in the hiring business. Original Indicators 3-2, 3-3, 3-4 in PDM ₁ are maintained in PDM ₂ as these are sufficient to measure establishment of the hiring service. 3-2. The original Indicator 3-3 in PDM ₁ is regarded as Indicator 3-2 in PDM ₂ . Wording is modified as maintenance of the equipment is supposed to be conducted in accordance with annual maintenance plan showing necessary actions based on the maintenance guideline

² It includes capacity to provide hydrogeological information based on the well database as well as technical skills for water well drilling.

PDM 1	PDM 2	Reason for Revision
3-3. All drilling equipment and machinery for hiring are maintained in accordance with guidelines and maintenance manuals.	3-3. Internal management accounting document for hiring is reported periodically to the management.	and manual. 3-3. The original Indicator 3-4 in PDM ₁ is regarded as Indicator 3-3 in PDM ₂ .
3-4. Internal management accounting document for hiring is reported periodically to the management.	-	-
Means of Verification: 3-1. DDCA's record for hiring 3-2. DDCA's record for hiring 3-3. DDCA's maintenance record 3-4. DDCA's report for hiring	Means of Verification: 3-1. DDCA's record for hiring 3-2. DDCA's maintenance record 3-3. DDCA's report for hiring	Appropriate means of verification are set in accordance with the modified indicators.

(5) Activity

Details in revision of PDM₁ and formulation of PDM₂, regarding the activity are explained in *Table 5* with its justification.

Table 5 Revision of Activity

PDM 1	PDM 2	Reason for Revision
1-2. To formulate a capacity development plan for private drilling companies.	1-2. To formulate a capacity development <u>support</u> plan for private drilling companies.	A word "support" is added to since the capacity development plan of private drilling companies is supposed to be formulated by each company. DDCA's role is only to provide private sector support to capacity development of the private sector.
1-4. To support the DDCA in carrying out technical instruction for private drilling companies.	1-4. To conduct training of DDCA's drilling supervisors for enhancement of their skills to provide technical instructions to private drilling companies.	An activity is added as DDCA's drilling supervisors need to make them familiar with the teaching guidance, checklist and methods of technical instructions prior to commencement of actual works on site. Numbering of the Activities 1-4 and 1-5 in PDM1 is therefore to be changed to 1-5 and 1-6 accordingly.
	1-5. <u>To carry out</u> technical instructions for private drilling companies.	Wording is modified since DDCA counterpart personnel and Japanese experts are supposed to jointly conduct this activity as the project team.
2-1. To identify areas necessary to be enhanced at DDCA in groundwater development capacity.	2-1. To identify <u>capacity</u> areas necessary to be enhanced at DDCA <u>for provision of technical support in groundwater development</u> .	Capacity areas of DDCA to be dealt with in this activity are specified.
2-2. To provide technical training and guidance for the DDCA towards strengthening capacity for drilling wells.	2-2. To provide technical training and guidance for the DDCA towards strengthening capacity for drilling wells <u>based on the capacity areas identified in Activity 2-1.</u>	The focus of the technical training and guidance to be provided by the Japanese experts to DDCA is specified.
2-3. To provide technical training and guidance for DDCA towards strengthening capacity for special techniques such as rehabilitation and tool fishing.	2-3. To provide technical training and guidance for DDCA towards strengthening capacity for special techniques such as rehabilitation of wells and tool fishing <u>based on the capacity areas identified in Activity 2-1.</u>	The focus of the technical training and guidance to be provided by the Japanese experts to DDCA is specified.
2-4. To support establishment of a database of wells drilled by DDCA.	2-4. <u>To establish</u> a database of wells drilled by DDCA.	Wording is modified since DDCA counterpart personnel and Japanese experts are supposed to jointly conduct this activity

PDM 1	PDM 2	Reason for Revision
3-2. To assist the establishment of the operations for hiring drilling equipment and machinery.	3-2. <u>To establish</u> the operations for hiring drilling equipment and machinery.	as the project team. Wording is modified since DDCA counterpart personnel and Japanese experts are supposed to jointly conduct this activity as the project team.
3-3. To assist the establishment of maintenance system for hiring drilling equipment and machinery.	3-3. <u>To establish</u> maintenance system for hiring drilling equipment and machinery.	Wording is modified since DDCA counterpart personnel and Japanese experts are supposed to jointly conduct this activity as the project team.

(6) Input

Details in revision of PDM₁ and formulation of PDM₂, regarding the input are explained in **Table 6** with its justification.

Table 6 Revision of Input

PDM 1	PDM 2	Reason for Revision
Japanese Side: 1. Experts Chief Advisor / Groundwater Development Drilling Expert Business and Operation Management / Organization and Institutional Management Project Coordinator / Training Planner Machinery and Equipment Maintenance Geophysicist Well Database Specialist Other necessary fields	Japanese Side: 1. Experts Chief Advisor / Groundwater Development Expert Deputy Chief Advisor/ Drilling Expert Field Technique Training Expert Operation Management / Organization and Institutional Development Expert Training Planner/ Private Sector Development Expert Machinery and Equipment Maintenance Expert Geophysicist/ Well Database Specialist Well and Groundwater Resources Management Expert	The team composition is updated according to the actual staffing plan.

(7) Important Assumption

Details in revision of PDM₁ and formulation of PDM₂, regarding the important assumption are explained in **Table 7** with its justification.

Table 7 Revision of Important Assumption

PDM 1	PDM 2	Reason for Revision
1. Provision of drilling equipment for hiring is available by Project commencement.	1. Drilling equipment for hiring is made available <u>within a year after commencement of the project</u> .	1. The time limit for preparation of the drilling equipment is modified as the hiring business is scheduled to start in the second year of the project.
2. Trained counterparts do not resign, or are transferred, too frequently.	2. No change	-
Assumption on Achievement of Project Purpose		
1. The government mandate to DDCA does not change significantly.	1. No change	-
2. The hiring business environment, such as expectation to the services provided by DDCA and business conditions of private drilling companies, does not change dramatically.		2. Item 2 in PDM1 is shifted to assumptions on achievement of the overall goal.

Assumption on Achievement of Overall Goal

PDM 1	PDM 2	Reason for Revision
1. GoT and the DDCA secure necessary budget and personnel to continue activities. 2. The plan of RWSS component of WSDP does not change dramatically, and the projects of RWSS make progress largely as planned.	1. No change 2. The hiring business environment, such as expectation to the services provided by DDCA and business conditions of private drilling companies, does not change dramatically.	- 2. Item 2 in PDM1 is shifted to assumptions on achievement of the super goal.
Assumption on Achievement of Super Goal		
-	The plan of WSDP does not change dramatically, and water supply projects make progress as planned.	As explained above

PDM₂ together with PO₂ are shown in *Table 8*.

Table 8 Project Design Matrix 2(PDM 2) (1/2)

Project Title: Groundwater Development and Management Capacity Development Project in Tanzania

Period (Tentative): March 2012 – March 2016

Project Sites: Tanzania mainland

Implementation Organizations: Ministry of Water (MoW), Drilling and Dam Construction Agency (DDCA)

Target Groups: DDCA

Prepared on: 24th January 2013

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Super Goal The number of wells necessary to achieve the target of WSDP are drilled.	The number of wells planned in WSDP is constructed by 2025.	MoW Annual Water Sector Status Report, Water Sector MIS	
Overall Goal The performance of drilling activities in WSDP is improved.	<ol style="list-style-type: none"> The number of private companies which use the private sector support services of DDCA and participate in drilling works in WSDP increases by 122% by 2018, compared to the status at the beginning of the project. The operation ratio of drilling rigs used by DDCA is improved from 24.0 % (2012) to 36.4 % by 2018. 	Baseline and end line Surveys, DDCA's record for hiring drilling equipment, Water Sector MIS	The plan of WSDP does not change dramatically, and water supply projects make progress as planned.
Project Purpose DDCA's capacity to support the water well drilling industry is enhanced.	<ol style="list-style-type: none"> The number of wells drilled using the hired drilling equipment reaches to XX per annum on average, the breakeven line of the hiring business, by 2016. More than 80% of the registered water well drilling companies utilize some forms of the private sector support services including provision of hydrogeological information of DDCA by 2016. More than 80% of private drilling companies, which used the private sector support services provided by DDCA, consider that the services they received helped their business activities. 	<ol style="list-style-type: none"> DDCA's record for hiring drilling equipment and machinery DDCA's record for provided services and baseline / end-line survey DDCA's record for provided services and end-line survey 	<ol style="list-style-type: none"> GoT and DDCA secure necessary budget and personnel to continue activities. The hiring business environment, such as expectation to the services provided by DDCA and business conditions of private drilling companies, does not change dramatically.
Outputs <ol style="list-style-type: none"> DDCA's ability to impart techniques and skills regarding water well drilling to private drilling sector is enhanced. The capacities of DDCA in groundwater development³, which is 	<ol style="list-style-type: none"> 1-4. The technical instruction system of the groundwater development for private drilling companies is standardized in DDCA by 2013. 1-5. The number of drilling supervisors⁴ who are certified by the DDCA's internal qualification system of technical instructors reaches 12 by 2013. 1-6. The staff of the private drilling companies who received technical instructions by DDCA acquires an average of 80% of the total score of the checklist in the second year since commencement of the hiring business. 2-3. More than 70% of 35 senior drillers pass minimum required score in a test in each training course to be held in accordance with the technical 	<ol style="list-style-type: none"> 1-4. Project reports 1-5. Project reports 1-6. Project reports 2-3. Tests in training courses for drillers 	The government mandate to DDCA does not change significantly.

³ It includes capacity to provide hydrogeological information based on the well database as well as technical skills for water well drilling.

Project Design Matrix 2(PDM 2) (2/2)

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
required to provide technical instructions, is enhanced.	support plan for DDCA.		
2-4. The well database is updated annually by DDCA.		2-4. Project reports	
3. A system to hire drilling equipment and machinery is established.	3-1. Drilling equipment and machinery are hired in accordance with the procedure established, such as tariff and contract agreement.	3-5. DDCA's record for hiring	
	3-2. All drilling equipment and machinery for hiring are maintained in accordance with the maintenance plan.	3-6. DDCA's maintenance record	
	3-3. Internal management accounting document for hiring is reported periodically to the management.	3-7. DDCA's report for hiring	
Activities	Inputs		
1-1. To conduct a baseline survey to assess the capacities and needs of private drilling companies.	Tanzanian side		1. Drilling equipment for hiring is made available within a year after commencement of the project.
1-2. To formulate a capacity development support plan for private drilling companies.	1. Counterparts for the project		2. Trained counterparts do not resign, or are transferred, too frequently.
1-3. To establish a technical instruction system of the groundwater development for private drilling companies.	Project Director: Director of Water Resource Division, MoW		
1-4. To conduct training of DDCA's drilling supervisors for enhancement of their skills to provide technical instructions to private drilling companies.	Project Manager: Chief Executive Officer, DDCA		
1-5. To carry out technical instructions for private drilling companies.	Counterparts		
1-6. To conduct an end-line survey to collect information and to evaluate the effect of the project on private companies.	2. Office with necessary equipment for the Project (including utilities such as communications, internet connectivity, electricity, and water etc.)		
	3. Running expenses necessary for the implementation of the Project		
	4. Other facilities, equipment and materials mutually agreed as necessary.		
	Japanese side		
2-2. To identify capacity areas necessary to be enhanced at DDCA for provision of technical support in groundwater development.	1. Experts		
2-3. To provide technical training and guidance for the DDCA towards strengthening capacity for drilling wells based on the capacity areas identified in Activity 2-1.	- Chief Advisor / Groundwater Development Expert		
2-4. To provide technical training and guidance for DDCA towards strengthening capacity for special techniques such as rehabilitation of wells and tool fishing based on the capacity areas identified in Activity 2-1.	- Deputy Chief Advisor/ Drilling Expert		
2-5. To establish a database of wells drilled by DDCA.	- Field Technique Training Expert		
	- Operation Management /Organization and Institutional Development Expert		
3-1. To conduct a baseline survey to collect information and investigate regarding the hiring of drilling equipment and machinery.	Expert		
3-2. To establish the operations for hiring drilling equipment and machinery.	- Training Planner/ Private Sector Development Expert		
3-3. To establish maintenance system for hiring drilling equipment and machinery.	- Machinery and Equipment Maintenance Expert		
3-4. To conduct trial hiring and to review the system.	- Geophysicist/ Well Database Specialist		
3-5. To conduct an end-line survey to collect information regarding the use of the hiring drilling equipment.	- Well and Groundwater Resources Management Expert		
	2. Equipment		
	- PC and software for database establishment		
	- Necessary equipment identified in the Project		
	3. Trainings in Japan / third countries		
	- Necessary training(s) as identified in the Project		
	4. Other expenses necessary for the implementation of the Project which are not covered by Tanzanian side		
			Preconditions
			No significant changes are made in policies related to groundwater development.

⁴ Those who will be attached to the hired equipment and provide technical instructions to private companies



UNITED REPUBLIC OF TANZANIA
MINISTRY OF WATER

MINUTES OF THE MEETING
ON
1st JOINT COORDINATING COMMITTEE (JCC) MEETING
BETWEEN
MINISTRY OF WATER (MoW)
AND
DRILLING AND DAM CONSTRUCTION AGENCY (DDCA)
AND
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
FOR
DDCAP PROJECT
(GROUNDWATER DEVELOPMENT AND MANAGEMENT CAPACITY
DEVELOPMENT PROJECT)

Dar es Salaam, Tanzania

16 April, 2012

Mr. Yukihide Katsuta
Chief Representative
JICA Tanzania Office

Ms. Naomi Lupimo
Assistant Director,
Water Resources Division
Ministry of Water
The United Republic of Tanzania

Dr. Yuichi HATA
Chief Advisor
JICA Expert Team

Mr. Jonathan L. Mgaiwa
Chief Executive Officer
Drilling and Dam Construction Agency
The United Republic of Tanzania

The opening ceremony for Groundwater Development and Management Capacity Development Project in the Republic of Tanzania (the Project) was held on 12th April 2012 at Ministry of Water in Ubungu. The Project was officially launched by the statement of Permanent Secretary of MoW and Chief Representative of JICA Tanzania Office.

Following the opening ceremony, 1st JCC meeting was held at the same venue, and JCC members participated in the meeting. Prior to the meeting, the DDCA (Groundwater Development and Management Capacity Development) Project Team (the Team) prepared the Work Plan for the Project. The Work Plan was distributed to the JCC members in advance to go through and prepare for the meeting.

The Team made a presentation and a series of discussion on contents of the Work Plan and matters related to the Project with MoW and other concerned organizations on the 1st Joint Coordinating Committee (JCC) meeting (the Meeting) chaired by Ms. Naomi Lupimo, the Assistant Director, Water Resources Division, MoW. A List of attendants of the opening ceremony and the 1st JCC meeting is shown in the Attachment 1 of these minutes.

As a result of the discussions, JCC members expressed general agreement to the contents of the Work Plan. Major items discussed were as follows:

1. Chairperson suggested establishing a secretariat for this project. The Team confirmed that it would be formed by nominees from both teams of DDCA counterparts and JICA Experts respectively.
2. The Participant inquired about the frequency of JCC meetings during the project. The Team answered it would be held at least once a year and whenever it deemed necessary.
3. The Participant asked whether the certification system to be introduced by this project was different from that of Engineers Registration Board. The Team answered that the purpose of the certification system was to raise trainees' motivation, who received the technical instructions by DDCA. The Team also explained that the system shall be managed within DDCA's mandate and it is neither official nor authorized certification.
4. The Participant asked if the Work Plan should be approved by this JCC meeting. All the Participants confirmed that the approval of the Work Plan should be done by this meeting.
5. The Participant inquired whether the Work Plan is the plan for JICA Expert Team or for the Project. The Team replied that the Work Plan was the plan for the Project. The Participant also suggested



describing counterparts' name of Tanzanian side in the Work Plan if it is for the Project. The Team agreed to the suggestion and to amend the description of composition of team members in the Work Plan.

6. The Participant suggested that the responsible organization for each activity should be indicated in the Work Plan of Operation (PO). The Team agreed to modify it.
7. The Participant suggested that issue on over exploitation of the wells should be considered in the Project, as a part of contribution of the groundwater resources conservation. The Team replied that since such issue is taken as an important aspect, it should be discussed during the course of the Project with the considerations of roles and responsibility of DDCA and BWO.
8. The Participant pointed out that since MoW is currently preparing the regulation for drilling profession, the technical instruction system to be established in the Project is supposed to be harmonized. The Team replied that the Project will collaborate with the preparation of the Regulation and other relevant documents by MoW in the process of establishment of technical instruction.
9. Chairperson suggested that the process and time frame of approval for the Work Plan shall be decided. It was agreed by JCC members that the Team reflect the comments arisen in this meeting by 13th April 2012, and circulate the updated Work Plan to all the members on 16th April 2012. The Work Plan shall be approved by reflecting the further comments which supposed to be feedback by 20th April 2012.



ATTENDANTS LIST OF THE OPENING CEREMONY

TANZANIAN SIDE

Mr. Christopher Sayi	Permanent Secretary, MoW
Mr. Lister Kongola	AG. Director Water Resources, MoW
Ms. Naomi Lupimo	Assistant Director Water Resources, MoW
Ms. Tabu Aron	Director Administration and Human Resources Management, MoW
Mr. John Mukumwa	Director RWSD, Mow
Mr. Jonathan Mgaiwa	Chief Executive Officer, DDCA
Mr. David B.Songea	Drilling Project Manager, DDCA
Mr. Ezei C.Makaso	Zonal Manager (EAST), DDCA
Mr. Nungu Egwaga	Marketing Officer, DDCA
Mr. George Bernard	Head of Workshop, DDCA
Ms. Domina M. Msonge	Ag. Business Support Manager, DDCA
Ms. Mariam Hassan	Hydro geologist, MoW
Mr. Peter Mdalangwila	Hydro geologist, MoW

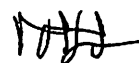
JAPANESE SIDE

Mr. Yukihide Katsuta	Chief Representative, JICA Tanzania Office
Ms. Fumiko Adachi	Chief Programme Officer, JICA Tanzania Office
Mr. Mariango Msuya	In-House Consultant ,JICA Tanzania Office
Dr. Yuichi Hata	Chief Advisor/Ground Water Development Expert , JICA Team
Mr. Masakazu Saito	Deputy Chief Advisor/Drilling Expert, JICA Team
Ms. Chiaki Tamekawa	Training Planner/Private Sector Development Expert, JICA Team
Ms. Aya Kadokami	Well and Groundwater Resources Management Expert, JICA Team
Mr. Cornelius Rwegasira	Hydro geologist/Private Sector Assistant, JICA Team

ATTENDANTS LIST OF THE 1ST JCC MEETING

TANZANIAN SIDE

Ms. Naomi Lupimo	Assistant Director Water Resources, MoW
Mr. Simon S. Nkemyemka	AG.Head of Legal Unit, Mow
Mr. Jonathan Mgaiwa	Chief Executive Officer, DDCA
Mr. David B.Songea	Deputy Project Manager, DDCA



Mr. Ezei C.Makaso	Zonal Manager (EAST), DDCA
Mr. Nungu Egwaga	Marketing Officer, DDCA
Mr. George Bernard	Head of Workshop, DDCA
Ms. Domina M. Msonge	Ag. Business Support Manager, DDCA
Ms. Mariam Hassan	Hydro geologist, MoW
Mr. Peter Mdalangwila	Hydro geologist, MoW

JAPANESE SIDE

Mr. Yukihide Katsuta	Chief Representative, JICA Tanzania Office
Mr. Mariango Msuya	In-House Consultant ,JICA Tanzania Office
Dr. Yuichi Hata	Chief Advisor/Ground Water Development Expert , JICA Team
Mr. Masakazu Saito	Deputy Chief Advisor/Drilling Expert, JICA Team
Ms. Chiaki Tamekawa	Training Planner/Private Sector Development Expert, JICA Team
Ms. Aya Kadokami	Well and Groundwater Resources Management Expert, JICA Team
Mr. Cornelius Rwegasira	Hydro geologist/Private Sector Assistant, JICA Team





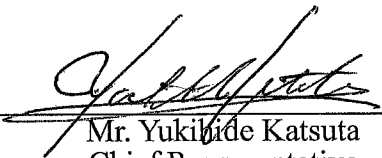


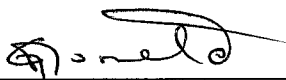

UNITED REPUBLIC OF TANZANIA
MINISTRY OF WATER

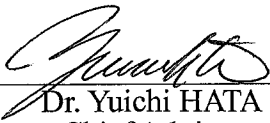
MINUTES OF THE MEETING
ON
2nd JOINT COORDINATING COMMITTEE (JCC) MEETING
BETWEEN
MINISTRY OF WATER (MoW)
AND
DRILLING AND DAM CONSTRUCTION AGENCY (DDCA)
AND
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
FOR
THE GROUNDWATER DEVELOPMENT AND MANAGEMENT
CAPACITY DEVELOPMENT PROJECT (DDCAP)

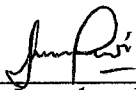
Dar es Salaam, Tanzania

13th February, 2013


Mr. Yukihide Katsuta
Chief Representative
JICA Tanzania Office


Dr. George Lugomela
Assistant Director,
Water Resources Division
Ministry of Water
The United Republic of Tanzania


Dr. Yuichi HATA
Chief Advisor
JICA Expert Team


Mr. Jonathan L. Mgaiwa
Chief Executive Officer
Drilling and Dam Construction Agency
The United Republic of Tanzania

The 2nd Joint Coordinating Committee (JCC) meeting for the Groundwater Development and Management Capacity Development Project (DDCAP) was held on 13th February 2013 at Permanent Secretary's Conference Hall of the Ministry of Water (MoW), and JCC members participated in the meeting. The meeting was chaired by Dr. George Lugomela, the Assistant Director, Water Resources Division, MoW.

Prior to the meeting the Project Team (the Team) distributed the Draft Progress Report 2 for the project to the JCC members for their perusal and preparation for the meeting. Participants of the meeting discussed contents of the Draft Progress Report 2 and matters related to the project based on presentations made by the Team. A List of attendants of the meeting is shown in the attachment of the minutes.

As a result of discussion, JCC members expressed general agreement to the contents of the report. Major items discussed are as follows:

1. Participants asked about implementation of capacity development of DDCA staffs on its drilling works while the project is aimed to strengthen capacities of DDCA in provision of technical support services to private sector. The Team responded that DDCA would continue capacity development of its staffs since drilling is their core activity.
2. Participants suggested that results of the baseline survey should be shared with other stakeholders through the Technical Working Group of WSDP as they are very informative. MoW agreed to this suggestion and promised to put it on the agenda for the Technical Working Group for WSDP Component 1 meeting to be held on 19th February 2013.
3. Participants raised concern on inappropriate development and use of groundwater such as drilling by illegal companies and over pumping by users to result in decline of water level. MoW responded that it is currently preparing the Groundwater (Exploration and Drilling) Licensing Regulations in order to regulate groundwater development.
4. Participants asked how DDCA is going to accommodate the technical support plan formulated by the project in the organization as the Agency already has a capacity development (CD) plan and training plan. DDCA responded that CD plan describes approaches and planned actions of DDCA to enhance organizational capacities including augmentation of equipment and facilities required for its business operation while the training plan formulated with guidance of President's Office-Public Service Management (PO-PSM) is particularly for the human resources development. DDCA further assured that the technical support plan will be incorporated into the training plan as it relates to the human resources development of technical staff of the



organization

5. Participants asked whether the database system being established by the project is compatible to those of Basin Water Boards (BWBs). The chairperson mentioned that BWBs, except for Wami Ruvu Basin which is supported by JICA, have no database system for groundwater. The Team responded that the database system which is under construction will be compatible to those of BWBs.
6. Participants emphasized on importance of establishment of Hiring Business Unit which will be responsible for all hiring activities in DDCA. Participants also suggested the following;
 - Drilling Department should hire equipment from Hiring Business Unit, when necessary, and transfer funds equivalent to the rental fee to an account for the hiring service rather than using it free of charge.
 - Hiring Business Unit should involve a legal officer for the contract management in the hiring service.
7. Participants asked about possibility of allocation of two units of existing drilling machines, as proposed as an option for the hiring service, by procuring necessary accessories and tools with the cost for approximately Tsh330 million per one rig. DDCA explained difficulty to finance this activity and further asked if JICA could assist them in procurement of the accessories and tools. JICA explained that it would not be possible to agree to the request as the issue of preparation of the drilling equipment for hiring is supposed to be solved in the framework of basket-funding of WSDP.
8. The Project team explained two cases for the schedule of the second year of the project as follows;
 - To continue all activities if all equipment for hiring is delivered by April 2013.
 - To suspend activities which are scheduled to be carried out in association with operation of the hiring business in case of delay of delivery of the equipment for hiring, until all the equipment is confirmed to be ready for hiring by both Tanzanian and Japanese sides.JICA informed the participants that the suspension cannot be termless and the maximum of one year period is acceptable at this moment. Tanzanian side understood the time frame.
9. Participants suggested that MoW and DDCA should allocate enough time for careful inspection of the equipment without rushing with the schedule so as to have the equipment of acceptable quality. MoW agreed to take necessary process for the inspection and commissioning in order to receive equipment with required quality.



10. Participants suggested that MoW should involve the legal officer as well as technical specialist in the inspection process so as to properly establish claim on the defects on equipment against the supplier.
11. The Team reported that it had reviewed PDM 1 and prepared proposal of PDM 2 which is in the process of examination at the JICA Headquarters. Proposed PDM 2 will be presented at 3rd JCC Meeting for approval.

ATTENDANTS LIST

TANZANIAN SIDE

Dr George Lugomela	Assistant Director, Water Resources Division, MoW
Ms. Tabu Aron	Director, Administration and Human Resources Management, MoW
Mr. Jonathan Mgaiwa	Chief Executive Officer, DDCA
Mr. David B.Songea	Drilling Project Manager, DDCA
Mr. Ezei C.Makaso	Zonal Manager (EAST), DDCA
Mr. Nungu Egwaga	Marketing Officer, DDCA
Mr. George Bernard	Head of Workshop, DDCA
Ms. Domina M. Msonge	Ag. Business Support Manager, DDCA
Mr. Obadia Kibona	Environmental Officer, DDCA
Ms. Maureen Kunambi	Data Entry, DDCA
Ms. Mariam Hassan	Hydrogeologist, MoW
Mr. Peter Mdalangwila	Hydrogeologist, MoW
Mr. Abdulrahman A.M	Coordinator RWSSP, PCU, MoW

JAPANESE SIDE

Mr. Yukihide Katsuta	Chief Representative, JICA Tanzania Office
Mr. Takanori Obayashi	Representative, JICA Tanzania Office
Dr. Yuichi Hata	Chief Advisor / Ground Water Development Expert, JICA Team
Mr. Masakazu Saito	Deputy Chief Advisor / Drilling Expert, JICA Team
Ms. Mikiko Azuma	Operation Management / Organizational and Institutional Development Expert, JICA Team
Ms. Chiaki Tamekawa	Training Planner/Private Sector Development Expert, JICA Team
Mr. Cornelius Rwegasira	Hydrogeologist/Private Sector Assistant, JICA Team
Ms. Linda Temba	Project Secretary, JICA Team





DDCAP Project
Groundwater Development and Management Capacity
Development Project



Ministry of Water (MoW), DDCA - Japan International Cooperation Agency (JICA)
Project Office: c/o DDCA, P.O.Box 55658 Dar es Salaam
Phone& Fax +255-22-2410299, Mobile: +255-0786-000551

AGENDA

2nd Joint Coordinating Committee (JCC) Meeting
for
Groundwater Development and Management Capacity Development
(DDCAP) Project

13th February 2013, From 10:00am,
at Permanent Secretary's Conference Room,
Ministry of Water, Ubungo

Topic	Time	Presenter
1. Opening of the Ceremony	10:00 – 10:10	Chairman (Director, WRD, MoW)
2. Self-introduction	10:10 – 10:20	All participants
3. Outline of the Project	10:20 – 10:50	Mr. Mgaiwa CEO, DDCA
4. Remarks by JICA	10:50 – 11:00	Chief Representative, JICA Tanzania Office Mr. Yukihide KATSUTA
5. Presentation of Progress Report 2		Project Team
5.1 Progress and products of the activities related to Output 1	11:00 – 11:20	Mr. Nungu Egwaga (DDCA) Ms. Chiaki Tamekawa (JICA)
5.2 Progress and products of the activities related to Output 2	11:20 – 11:40	Mr. David Songea (DDCA) Mr. Masakazu Saito (JICA)
5.3 Progress and products of the activities related to Output 3	11:40 – 12:00	Ms. Domina Msonge (DDCA) Ms. Mikiko Azuma (JICA)
5.4 Discussion of Progress Report 2	12:00 – 12:30	All participants
6. Schedule of Next Project Year	12:30 – 12:50	Dr. Hata (JICA)
7. Discussion	12:50 – 13:10	All participants
8. AOB	13:10 – 13:20	All participants
9. Closing of the Meeting	13:20 – 13:30	Chairman (Director, WRD, MoW)

List of Equipment Procured in the Project

	Items	Purpose of use	Quantity	Status
1	Water Gauge (100m)	For field activities	3	Procured
2	Water Gauge (200m)		3	Procured
3	GPS		4	Procured
4	Multi tester	For workshop	3	Procured
5	Insulation resistance tester		3	Procured
6	Clamp meter		3	Procured
7	Mechanic tool set		3	Procured
8	Maintenance tool set		3	Procured
9	Electric tool set		3	Procured
10	Soldering iron		3	Procured
11	Disc grinder 125mm and cutting machine		3	Procured
12	Disc grinder 180mm and bench grinder		3	Procured
13	Electric drill machine		3	Procured
14	Electric drill bit set		3	Procured
15	Workshop hammer drill machine		3	Procured
16	Workshop hammer drill bit set		3	Procured
17	Extension code		3	Procured
18	Scanner 1	For data processing and construction of the database	1	Procured
19	Scanner 2		1	Procured
20	Desktop personal computer		4	Procured
21	Wireless router		1	Procured
22	Wireless access point		1	Yet procured
23	UPS		4	Procured
24	Stabilizer	For data processing and construction of the database	4	Procured
25	Printer		3	Procured
26	Microsoft Office		4	Procured
27	Anti-virus software		4	Procured
28	Internet modem		4	Procured
29	LAN cable		4	Procured
30	Backup software		1	Yet procured
31	Combined machine		1	Procured
32	Air conditioner	For project office	2	Procured



DDCAP
**Groundwater Development and
Management Capacity Development
Project**

Ministry of Water (MoW), DDCA - Japan International
Cooperation Agency (JICA)



FINAL REPORT

ON

**BASELINE SURVEY ON PRIVATE DRILLING COMPANIES –
UNDER GROUNDWATER DEVELOPMENT AND
MANAGEMENT CAPACITY DEVELOPMENT (DDCAP)
PROJECT IN THE UNITED REPUBLIC OF TANZANIA**

**Submitted by
Bureau for Industrial Cooperation (BICO)**

College of Engineering and Technology
University of Dar es Salaam
P.O. Box 35131
Dar es Salaam
Tel. Direct: +255 (22) 2410113
Tel. /Fax: +255 (22) 2410114
E-mail: bico@udsm.ac.tz



Tuesday, 27 November 2012

Final Report Format for the Preliminary Analysis Report for the Baseline Survey

Table of Contents

1. INTRODUCTION	1
1.1 BACKGROUND OF THE SURVEY	1
1.2 SURVEY OBJECTIVE AND SCOPE OF THE ASSIGNMENT	1
1.2.1 Survey Objective	1
1.2.2 Scope of the Assignment	1
2. SURVEY PROCESS AND METHODOLOGIES	2
2.1 SURVEY PROCESS AND METHODOLOGIES EMPLOYED	2
2.1.1 Structured Interview with the Target Group	2
2.2 TARGET GROUP	3
2.3. SURVEY SCHEDULE	4
2.3.1 Observations	9
2.4. SURVEY TEAM COMPOSITION	10
2.5. LIMITATIONS (FACTORS WHICH AFFECTED IMPLEMENTATION OF THE SURVEY)	11
3. RESULTS OF THE BASELINE SURVEY	12
3.1. BUSINESS ESTABLISHMENT	12
3.2. BUSINESS LOCATION OF THE DRILLING COMPANIES	12
3.3 RENEWAL OF DRILLING PERMIT	13
3.4 CRB REGISTRATION	14
3.5 EQUIPMENT	14
3.5.1 Drilling Equipment	14
3.5.2 Supporting Equipment	17
3.5.3 Survey Equipment	18
3.5.4 Operation and Maintenance	19
3.6. FINANCE	21
3.6.1 Capital	21
3.6.2 Sales and its proportion by services in the past five years	22
3.6.3 Net profit or loss	24
3.6.4 Sources of fund	25
3.6.5 Investment plan for procurement of new drilling equipment	26
3.7. HUMAN RESOURCES	26
3.7.1 Distribution of staff by divisions	27
3.7.2 Distribution of technical staff by position and expertise	28
3.7.3 Years of Experience of the staff	30
3.7.4 Human Resource Development	31
3.7.5 Needs of staff for their capacity development	32
3.7.6 Preferable measures of capacity development	33
3.8. SERVICE MANAGEMENT	34
3.8.1 Clients of the Drilling Water Wells	34
3.8.2 Contracts awarded in the past three years	35
3.8.3 Contracts values awarded in the past three years	44
3.8.4 Proportion of machinery costs to contracts amounts for drilling wells	46
3.8.5 Process Management and Quality Control	48
3.8.6 Business Projections	52
3.9. EXTERNAL ENVIRONMENT	54
3.9.1 Laws & Regulations	54
3.9.2 Relation with DDCA	55
3.10. NEEDS FOR DRILLING EQUIPMENT HIRING SERVICE	58
3.10.1 Availability of Drilling Equipment Hiring Service	58

3.10.2 Needs for Hiring Service of DDCA	60
4. PRELIMINARY ANALYSIS	65
4-1. CATEGORIZATION OF PRIVATE DRILLING COMPANIES BY RESOURCES AND BUSINESS PLAN	65
4-2. CAPACITY DEVELOPMENT NEEDS OF THE PRIVATE DRILLING COMPANIES.....	75
5. CONCLUSION AND RECOMMENDATIONS	80
ANNEXES.....	81
ANNEX 1: TERMS OF REFERENCE	81
ANNEX 2: QUESTIONNAIRE FOR THE STRUCTURED INTERVIEW.....	89
ANNEX 3: MEMBER LIST OF THE SURVEY TEAM.....	104
ANNEX 3: SURVEY ITINERARY.....	107
APPENDIX 4: LIST OF TARGETED COMPANIES FOR INTERVIEW AND LIST OF DRILLING COMPANIES THAT WERE ACTUALLY INTERVIEWED	108

List of Tables

Table 2.1: Distribution of the Surveyed Drilling Companies by Region	4
Table 2.2 Survey schedule 1: week 1 (4 th to 8 th June 2012).....	4
Table 2.3 Second survey schedule (June 11 -15th, 2012)	6
Table 2.4 Confirmed up country companies that were scheduled for visit	8
Table 2.5 Survey team composition	10
Table 3.1: Statistical Data of Companies owning drilling rigs	14
Table 3.2: Number of Rigs owned by Drilling Companies	15
Table 3.3: Type of Drilling Rigs in Surveyed Companies	15
Table 3.4: Workshop Equipment and Facilities possessed by the interviewed companies (multiple response).....	20
Table 3.5: Type and level of periodic maintenance that can be done by the company itself (multiple response)	21
Table 3.6: Sales of Drilling Works as a Proportion of Total Sales.....	23
Table 3.7: Income of the Total Sales Proportion of the Surveyed Drilling Companies	24
Table 3.8: Profit and Loss in Drilling Companies.....	24
Table 3.8b: Profit and Loss in Drilling Companies (after filtering two extremes)	25
Table 3.9 source of funds for new investment (multiple response)	25
Table 3.10 Equipment planned to be purchased by the drilling companies (multiple response)	26
Table 3.11 Staffing Situation in the surveyed in the drilling companies.....	27
Table 3.12: Distribution of staff by position	28
Table 3.13: Level of Education of the staff	29
Table 3.13b: Type of Certificate.....	29
Table 3.14: Years of experience of the staff	30
Table 3:15 Measures taken to improve the drilling technique and skills (Multiple Answers)	31
Table 3.16 Paying for the technical staff to attend training	32
Table 3.17 Capacities Which Needs to be strengthened by the technical staff.....	33
Table 3.18 Preferable measures of capacity development	34
Table 3.19 Clients of the drilling well	34
Table 3.20 Proportion of contract awarded from the government/ local government authorities	35
Table 3.21 Number of Contracts Awarded in the Past Three Years	36
Table 3.22 Distribution of the Companies Surveyed by the Districts Where They have Worked and Type of Works Provided in the Past Three Years.....	38
Table 3.23 Average value of water drilling contracts awarded in past three years.....	44
Table 3.24 a) Number and Depth of Wells Drilled in 2009	44
Table 3.24 b) Number and Depth of Wells Drilled in 2010	45
Table 3.24 c) Number and Depth of Wells Drilled in 2011	45
Table 3.25 Unit Price of Drilling Works and Pump Installation (Median)	46
Table 3.26 Average number of days for drilling a well and pump installation	48
Table 3.27: Backfilling of uncased unsuccessful wells (multiple response)	49
Table 3.28: Backfilling of cased unsuccessful wells (multiple response)	50
Table 3.29: Methods of Covering the Casing Pipes (multiple response)	51
Table 3.30: Warranty Period in the contracts	52
Table 3.31: Obstacles to participate in WSDP (multiple response)	53
Table 3.32: Application for Groundwater Permit (Multiple Responses).....	54
Table 3.33: Application for Water Use Permit (multiple options)	55
Table 3.34: Perception of the Drilling Companies on their relationship with DDCA (multiple response)	56
Table 3.35: Experience in using services of DDCA (Multiple Options)	56
Table 3.36: Contents of Support Services Expected from DDCA (multiple response)	57
Table 3.37: Hydrogeological information requirements by Private Companies Expected from DDCA (multiple response)	58
Table 3.38: List of Companies Offering Drilling Equipment Hiring Services.....	58
Table 3.39: Hiring costs of Drilling Rigs.....	60
Table 3.40: Preferred type of Hiring Services from DDCA (multiple response)	61
Table 3.41: Preferred type of Hiring Services from DDCA (multiple response)	62
Table 3.42: Preferred type of Technical Personnel to accompany drilling rig (multiple response)	62
Table 3.43: Benefits from using the hiring service of drilling rigs from DDCA (multiple response).....	63
Table 4.1 Characteristics of Each Group of the Drilling Companies.....	65
Table 4.2: Assessment of the level of potential of Project Impact following the categorization	66
Table 4.3: Classification of the Interviewed Drilling Companies.....	67
Table 4.4: Grouping of the interviewed companies according to their capacities and interests	72
Table 4.5: Capacity needs for the interviewed drilling companies	75
Table Ap4.1: list of Drilling Companies that were originally targeted	108
Table Ap4.2: List of Interviewed Company.....	112

List of Figures

Figure 3.1: Year of Establishment of the Drilling companies.....	12
Figure 3.2 Location of the Interviewed Drilling Companies	13
Figure 3.3 Latest Year of Renewal of the Drilling Permit.....	13
Figure 3.4 CRB Registration.....	14
Figure 3.5: Capital Investment in Drilling Companies in Tanzania.....	22
Figure 3.6: Staffing situation in drilling companies	27
Figure 3.7: Proportion of contracts awarded by government/local government authorities	36
Figure 3.8: Trend in water drilling contracts	37
Figure 3.9: Proportion of machinery costs to the contract values	48

List of Abbreviation

Adv.	Advanced
BICO	Bureau for Industrial Cooperation
B.Sc.	Bachelor of Science
CCM	Chama Cha Mapinduzi
Coy	Company
CRB	Contractors Registration Board
DDCA	Drilling and Dam Construction Agency
DDCAP	Groundwater Development and Management Capacity Development
Dr.Ing	Doktor der Ingenieurwissenschaft
Eng.	Engineering
FTC	Full Technician Certificates
GPPE	Geophysical Prospecting Equipment
ICT	Information and Communications Technologies
JICA	Japan International Cooperation Agency
MoW	Ministry of Water
M. Dev. Mgmt	Master of Development Management
M.Sc	Master of Science
NACTE	National Council of Technical Education
NTA	National Technical Awards
NWSDS	National Water Sector Development Strategy
PGD	Postgraduate Diploma
Ph.D	Doctor of Philosophy
STD	Standard
SWAP	Sector Wide Approach to Planning
TZS	Tanzanian Shilling
WSDP	Water Sector Development Programme

1. Introduction

1.1 Background of the Survey

The Bureau for Industrial Cooperation (BICO) of the University of Dar es Salaam was awarded a contract by the Earth System Science Co., Ltd, (hereinafter called “the Client”), officially retained by JICA (Japan International Cooperation Agency) as the JICA Expert Team to conduct conducting of baseline survey on private drilling companies – under Groundwater Development and Management Capacity Development (DDCAP) project in the United Republic of Tanzania.

The available information shows that the Ministry of Water (MoW) has been implementing the Water Sector Development Programme (WSDP) since 2007 in accordance with the National Water Policy (2002) and the National Water Sector Development Strategy (NWSDS). WSDP employs the Sector Wide Approach to Planning (SWAP) to implement four programme components, i.e. i) water resources management, ii) rural water supply and sanitation, iii) urban water supply and sewerage, and iv) institutional strengthening and capacity building.

For the rural water supply component, construction of an approximate number of 79,000 water supply facilities is required in order to provide safe water to 34.5 million un-served populations. WSDP estimates that 91% of these planned water supply facilities will rely on groundwater, which requires drilling of 1,200 wells annually. Although private drilling companies are the main actor for groundwater development under WSDP, their current capacity of drilling wells is reported as approximately 600 per annum. In other words, their capacities such as technical skills and resources have a great gap to respond to demands in the water sector.

In order to address this challenge, MoW formulated “the Strategy for Strengthening Water Well Drilling Industry in Tanzania” in 2006. Proposed approaches for capacity development of the drilling industry are, among other things, establishment of hiring business of drilling equipment at Drilling and Dam Construction Agency (DDCA) to make the equipment available to the private drilling companies in association with technical instructions.

1.2 Survey Objective and Scope of the Assignment

1.2.1 Survey Objective

According to the information given the specific objectives of the survey are:

- 1) to identify present level of capacity of the private drilling companies and capacity areas which need to be strengthened in order to increase their participation into WSDP and drilling of water wells in appropriate manner.
- 2) to analyze characteristics and needs of the private drilling companies which are to be potential customers for the equipment hiring service by DDCA.

1.2.2 Scope of the Assignment

According to the Terms of Reference given, the following were the scope of the assignment:

1. Training of survey team and pre-test of survey tools;
2. Structured interview with the target group; and
3. Data entry, analysis and reporting.

2. Survey Process and Methodologies

2.1 Survey Process and Methodologies Employed

In implementing this assignment, the consultant used several approaches in order to obtain better results from the target group. Among the approaches used include the following:

A) Translating the English Version into Kiswahili

The Kiswahili is lingua-franca of Tanzania; therefore if one wants to get better responses from the Tanzanian target group, then the questionnaire should be translated into Kiswahili. Therefore, the first assignment that was done by the consultant was to translate the English version of the Questionnaire into Kiswahili. The consultant knows that the majority of the Tanzanians do not understand well the English language; therefore it was necessary to put the questionnaire into a language that is clear to the target group.

B) Training of Survey Teams

The training of the survey team was conducted on 21st May 2012. The Director of Earth System Science Co., Ltd. and the chief advisor of JICA team, Dr. Yuichi HATA gave the background information regarding the project. After that the Survey Manager, Prof. Mjema, took the survey team throughout the questionnaire to make sure that everyone in the team is clear on each of the question in the questionnaire and what was supposed to be asked.

C) Pre-Test of Survey Tools

On 22nd May 2012 a pre-test of the survey tool was done. The survey teams accompanied by the JICA team, and representatives of MoW and DDCA tested the questionnaire in two firms: Chimba Enterprise (which is a big company) and Lima Economic and Development group (which is a small company). The pre-test of the survey tool helped to confirm the surveyors' skills and secure the accuracy of procedures for the survey.

On 23rd May the survey teams, the JICA team and representatives of MoW and DDCA discussed the experience they obtained from the pre-test of the survey tool. Some corrections were done on the survey tool and suggestion on how to make the survey effective were given out.

On request by the JICA team, a survey was conducted to another company (Aqua Well Drilling Company) on 24th May 2012 to help the JICA visiting mission in Tanzania to get a true picture of the project.

2.1.1 Structured Interview with the Target Group

Confirmation of Contact of Private Drilling Companies

The Survey team made a confirmation of the contact of the private drilling companies before visiting. Each of the company that has a telephone number was contacted and was sent the questionnaire by e-mail, and they were instructed to fill some important areas before the survey teams visited their offices.

Structured Interview with the Target Group

Up to 8th June 2012 afternoon total of 21 companies have been interviewed (see the list of the interviewed companies in appendix 1). To increase the speed of data collection the survey teams hired one more expert in drilling and re-organised its team into 3 teams instead of 2 teams. This re-organisation was prompted by the fact that the logistics of reaching each of the companies are very difficult, and some companies decline their appointments at the last minute (e.g. You make an appointment with company A three days before to visit them on, say Thursday morning, then on Thursday morning when you call again company A that we are coming now to your office, then company A gives an excuse that they have an emergency to attend. This situation has distorted our planned schedule of carrying out of interviews. Therefore, we agreed to have a flexible schedule such that if company A declines on the morning, then call any other company in the schedule who are ready to be visited in that day).

2.2 Target Group

The target group of the survey is all the private drilling companies which possess the water well drilling permit issued by MoW. As of the end of March 2012, a total of 126 private drilling companies are registered at MoW as holders of the water well drilling permit. The survey teams were supposed to make contact with these companies and were also required to make a physical visit to the head office of each company listed and make interviews in accordance with specifications described in this section. The survey teams were able to interview 74 companies out of the 126 targeted companies (about 59% of the target). Some of the identified companies refused to be interviewed, some of the companies are already out of the business and some few companies could not be identified their whereabouts. It was, however, revealed that 3 companies out of the 74 interviewed companies were no longer conducting drilling of water wells, therefore, only 71 companies were considered for further analysis. It was further agreed that in case the Contractor discovers new private drilling companies besides 126 companies registered in MoW through this Work, the survey teams should confirm the contact and should conduct structured interview to them. Through this arrangement, the survey teams were able to identify 25 extra companies, which were not registered with the MoW. It was, however, later on discovered that 2 companies out the 25 “new” companies were not drilling companies, but they were water surveyors only. Therefore, the total number of new companies that were considered for research was only 23. In that case, the total of companies that qualify for this analysis is therefore 94. Table 2.1 shows the distribution of the surveyed companies by region, which shows that 66% of the drilling companies resides in Dar es Salaam, followed by Arusha with 14% of the drilling companies.

In appendix 4 there is a list of the drilling companies, that shows the names of the companies targeted for the survey and the ones actually interviewed

Table 2.1: Distribution of the Surveyed Drilling Companies by Region

REGION	NO. OF DRILLING COMPANIES		% in Regions
	Plan	Actual	
ARUSHA	6	13	13.8
COAST	0	1	1.1
DODOMA	3	1*	1.1
DAR ES SALAAM	51	62	66.0
KILIMANJARO	1	1	1.1
MARA	2	1	1.1
MOROGORO	2	2	2.1
MWANZA	6	6	6.4
NAIROBI	1	1	1.1
NJOMBE	2	2	2.1
SHINYANGA	4	3	3.2
SINGIDA	1	1	1.1
Total	79	94	100%

* The two companies in Dodoma were found that they are not drilling but exploring water

2.3. Survey Schedule

The survey teams were initially composed of two groups. But after carrying out of the preliminary survey, it was observed that there were difficulties of accessing the drilling companies. Due to those difficulties, the survey teams were re-grouped into three survey groups. The survey schedules are as shown in tables 2.2, table 2.3, and table 2.4

Table 2.2 Survey schedule 1: week 1 (4th to 8th June 2012)

Group 1 Technical Supervisor: Dr. Bujulu Lead Surveyor: Ms Kimambo				Group 2 Technical Supervisor: Mr. Songo Lead Surveyor: Mr Melchioly				Group 3 Lead Surveyor: Dr Bwire Surveyor: Mr. Kapoma			
Day	Session	Group 1		Group 2		Group 3					
Monday	Morning	Company Name	BASAT CONTRACTORS LTD	Company Name	MARATA PLUMBER AND DRILLING COMPANY LTD	Company Name	COAST WATER WELL DRILLING				
		Physical Location	Ushirika Building, Lumumba Road	Physical Location	Shekilango Road	Physical Location	Indian Street				
		Contact Name	AH MAVURA	Contact Name	J.E MACHANGE	Contact Name	Hussein Ismail				
		Contact Phone	0713 292655	Contact Phone	0715804666	Contact Phone	0713777877				
	After-noon	Company Name	LYERU WATER WELLS DRILLING COMPANY LTD	Company Name	MASWI DRILLING COMPANY LTD	Company Name	TALHA WATER WELL DRILLERS LTD				

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Day	Session	Group 1		Group 2		Group 3	
Tuesday		Physical Location	42Mbezi beach	Physical Location	Msimbazi	Physical Location	Pugu Road
		Contact Name	William Kaguruki	Contact Name	Maungo Michael	Contact Name	Shaban Khamis
		Contact Phone	0784782452	Contact Phone	0784932228	Contact Phone	0713403121 (022)2181614
	Morning	Company Name	SNUB PRO ENERGY SERVICES INC. AFRICA LTD	Company Name	PP SETTY INTERNATIONAL LTD	Company Name	O.C.I INDUSTRIAL HOLDING LTD
		Physical Location	Sinza kwa Remmy	Physical Location	ZANAKI Street	Physical Location	Mwenge Area
		Contact Name	Abdul Ghafur Abdallah	Contact Name	Vijal Kumar	Contact Name	Dr Kaaya
		Contact Phone	0773 484384	Contact Phone	0784238308	Contact Phone	0713614122
	After-noon	Company Name	STAR WATER PUMP	Company Name	WINAM GENERAL TRADERS LTD	Company Name	DRILL MAT AND GROUNDWATER SERVICES LTD
		Physical Location	Udoe Street-Kariakoo	Physical Location	Tabata Segerea karibu na Bus Stand	Physical Location	Plot 113, 114 Sam Nujoma road, Savei Mlalakua adjacent Mlimani City
		Contact Name	Castor Sanguya	Contact Name	Dano Okay	Contact Name	Hamisi
		Contact Phone	0755434411	Contact Phone	0784363838	Contact Phone	0754619498
		Company Name	WELLS TECHNOLOGY COMPANY	Company Name	SERENGETI LTD	Company Name	AL-WATER WELL DRILLERS
		Physical Location	Sinza area	Physical Location	Serengeti estate block A	Physical Location	Fire-kariakoo
		Contact Name		Contact Name		Contact Name	Mohamed Mbaraka
		Contact Phone	0754495195/ 0713343939/ 0766114881/ 0717423811	Contact Phone	0754444454/ 0754261465	Contact Phone	0713342882/0754383583
Wednesday	Morning	Company Name	EFAM LTD	Company Name	AL-TTAI DRILLING COMPANY	Company Name	ASHRAF WATER WELL DRILLING COMPANY
		Physical Location	Makumbusho	Physical Location	Algeria street	Physical Location	Makongo juu
		Contact Name	Fatma M.Rweyemam	Contact Name	Fahad A. Said	Contact Name	Mustapha Seleman Mtenga
		Contact	0754294596	Contact	0784768076	Contact	0715475600
	After-noon	Company Name		Company Name		Company Name	

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Day	Session	Group 1		Group 2		Group 3		
		Phone		Phone		Phone		
Thursday	Morning	Company Name	HAMDRILLERS	Company Name	WEPMO	Company Name	TRANSFORMER AGR.&CONSTRUCTION	
		Physical Location	Mbezi beach	Physical Location	DDCA-Ubungo	Physical Location	Mikocheni	
		Contact Name	Mohamed A. Hassan	Contact Name	Kasisi	Contact Name	Hong Tai Wu	
		Contact Phone	0715586187	Contact Phone	0716099959	Contact Phone	0784782458	
	After-noon	Company Name	SEBA CONSTRUCTION AND DRILLING COMPANY	Company Name	VICTORIA DRILLING COMPANY LTD	Company Name	WATER HUB (T) LTD	
		Physical Location	Ilala-Amana	Physical Location	Chang’ombe near VETA	Physical Location	Mwalim House-uhuru street	
		Contact Name	Khalid	Contact Name	Babu	Contact Name	Mohamed	
		Contact Phone	0712666666	Contact Phone	0783671669	Contact Phone	0718120083	
	Friday	Morning	Company Name	PIONEER WELL DRILLING LTD	Company Name	BUBUJIKO INTERPRISE	Company Name	LEORNE RESOURCE
			Physical Location	Kinondoni block 41	Physical Location	Mtoni kwa azizi ally-Temeke	Physical Location	Mbezi beach
Contact Name			Bakari	Contact Name	Kheli Osman	Contact Name	Li-Guary	
Contact Phone			0656006113	Contact Phone	0755533921/068 2018207	Contact Phone	0785713218	
After-noon		Company Name	NILE WELL DRILLERS	Company Name	MAVONDA COMPANY LTD	Company Name	PNR SERVICES LTD	
		Physical Location	Ilala,lindi/Arusha street	Physical Location	Sido building block A	Physical Location	Kinondoni-biafra	
		Contact Name	Omary Omary	Contact Name	Abdiel A.Mshana	Contact Name	Mwana	
		Contact Phone	0713 228265	Contact Phone	0713245167	Contact Phone	0712058565	

Table 2.3 Second survey schedule (June 11 -15th, 2012)

Group 1 Technical Supervisor: Dr. Bujulu Lead Surveyor: Ms Kimambo	Group 2 Technical Supervisor: Mr. Songo Lead Surveyor: Mr Melchioly	Group 3 Lead Surveyor: Dr Bwire Surveyor: Mr. Kapoma
---	--	---

Day	Session	Group 1		Group 2		Group 3	
Monday	Morning	Company Name	MAKE ENGINEERS AND WATER WELL	Company Name	MUWANYA WELL DRILLING	Company Name	HOLLAND FARM LTD
		Physical	Shekilango	Physical	Kinondoni-	Physical	Kigamboni,

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Day	Session	Group 1		Group 2		Group 3	
		Location	Road Opp Ubungo NHC	Location	vijana	Location	house No.37 TUAMOYO
		Contact Name	Hennry	Contact Name	Hussein Muwanya	Contact Name	Mohamedi Ally
		Contact Phone	0754312527	Contact Phone	0715462396	Contact Phone	0713565758
	After-noon	Company Name	LUGOBA STONES CONSTRUCTION LTD	Company Name	Mr. WATER DRILLING COMPANY LTD	Company Name	WATER TRANS INTERNATIONAL LTD
		Physical Location	Chang'ombe-Mandela Road	Physical Location	Upanga, block 882 plot No.3	Physical Location	Kigamboni-Mji mwema, plot No. 24 block A
		Contact Name		Contact Name	Abdallah Salehe	Contact Name	
		Contact Phone	0222772823	Contact Phone	0773889888/022 2807843	Contact Phone	0222180383
Tuesday	Morning	Company Name	ARDHI WATER WELLS LTD	Company Name	PUMPS INTERNATIONAL AND SOLAR LTD	Company Name	TACHI INTERNATIONAL DRILLING
		Physical Location	Nkurumah Road, plot No. 80 1 st floor	Physical Location	Nyerere Road	Physical Location	Mwenge, NSSF building
		Contact Name		Contact Name		Contact Name	Antony Swai
		Contact Phone	0222153314	Contact Phone	0222862544/022 2864184	Contact Phone	0222771842/022 2771837
	After-noon	Company Name	SN.TECH(T) LTD	Company Name	GREAT RUAHA DRILLING AND EXPLORATION	Company Name	HYDROTECH (T) LTD
		Physical Location	Nkurumah, plot 2234 block 160	Physical Location	135 Upanga-Aly Khan Road	Physical Location	Mwenge
		Contact Name		Contact Name		Contact Name	Will Mgombela
		Contact Phone	0222028007/0222128006	Contact Phone	0784954067	Contact Phone	0222700590
	Morning	Company Name	KARUMBA DRILLING COMPANY LTD	Company Name	BAHADELE DRILLING COMPANY	Company Name	MM WATER AND ONLAND WORKS COMPANY
		Physical Location	Kinondoni-Mlongoni street	Physical Location	Buguruni Sokoni	Physical Location	Sam nujoma Road
		Contact Name	Onesmo Karumba	Contact Name		Contact Name	
		Contact Phone	0754452704	Contact Phone	0222862427/074 1540283	Contact Phone	0712728030
Wednesday	After-noon	Company Name	UNDERGRO UND WATER WELLS	Company Name	TECHNO DRILLERS	Company Name	MMEKU WATER WELLS DRILLNG

Day	Session	Group 1		Group 2		Group 3	
			COMPANY LTD				COMPANY
		Physical Location	Lumumba-Mkunguni-Kariakoo	Physical Location	Mavuno house 1 st floor No.104 Azikiwe	Physical Location	Algeria street
		Contact Name		Contact Name	A. Keiss	Contact Name	
		Contact Phone	0754311086	Contact Phone	0222134795	Contact Phone	0784229965/022 21219597
Thursday	Morning	Company Name	TWABAHA CONSTRUCTION LTD	Company Name	FUTURE CENTURY LTD	Company Name	PARAMOUNT WATER WELL & DRILL
		Physical Location	Tabata	Physical Location	Cocobeach	Physical Location	Msasani
		Contact Name		Contact Name	Albert Mwanika	Contact Name	Kaheda
		Contact Phone	07857/707-611628	Contact Phone	0222601649/075 4273753	Contact Phone	0687872157/071 8054353

The survey teams did not prepare a specific schedule for the companies that are in up country, but two teams were sent to visit the up country companies that shown in Table 2.4

Table 2.4 Confirmed up country companies that were scheduled for visit

S/ No	Company Name	Physical Address	Region	Tel No.	Contact Person
1.	Maji Tech Engineering Ltd	Usa River-Momella	Arusha	0784667163	Humphrey Bureta
2.	Chemchem Drilling Co.Ltd	Unga LTD Office	Arusha	0783152221	John Frank
3.	Arusha Aggregate Co.Ltd	Majengo Block F	Arusha	0784723456	Jenti Patel
4.	As Drilling Co.Ltd	Njiro town	Arusha	0715269777	Suleyman R. Othman
5.	Oriteti Arusha Co.Ltd	Njiro	Arusha	0783160131	George Angelides
7.	Okuto Drilling Co. Ltd	DDCA	Arusha (but moved to Dar es Salaam)	0784680178	Domina
8.	Ardhi Water Wells Ltd	Nkuruma road, near to tigo customer care	Dar es Salaam	022218312/0 788235420	Babu
9.	Nyakirang'anyi Construction Ltd	Samora, Mkwepu, opposite to the women's bank	Dar es Salaam (They have a branch in Musoma)	0784254012	Mahuza M. nyakirang'anyi
10.	Homepride Construction Co. Ltd	Ilala bungoni	Dar es Salaam (with a branch in Mbeya)	02525861090 717047058	
11.	Society Of The Precious Blood Water Project	Miyuji Area Plot No. 95	Dodoma	026 230 4656	Father
12.	Masochi Water Resources Exploration Co. Ltd	Kigamboni Area	Dodoma	0754 696400	Mr&Mrs Mchome

S/ No	Company Name	Physical Address	Region	Tel No.	Contact Person
13.	The Water Family Company (T) Ltd	Oyster Bay Area	Dodoma	0784 353687 0754353687	Martini Muhile
14.	Kanisa La Kiinjili La Kilutheri	Njombe Town	Njombe (Former Iringa)	0764768944	Briton Kagu
15.	Shipo – Southern Highlands Participatory Organisation	Njombe Town	Njombe (Former Iringa)	(026) 2782989 0767082989	info@shipo-tz.org LYDIA
16.	Drilling Spares And Services	Mombasa Road	Kenya	+254-722204761+254-722881128	Vishal Bhelle (dss@iconnect.co.ke)
17.	Water International Services (Kenya)		Kenya	+254 733750139	info@waterafrica.net
18.	Islamic Foundation	Msanvu - Highway	Morogoro	0784223779	Arif Nahdi
19.	Layne Drilling Tanzania Ltd	Msamvu area, along iringa road,	Morogoro	0784529634/7 or 0767529635/6	
20.	Global Resource Alliance-Tanzania	Baruti	Musoma	02826227870 75443764907 54067584	Enock Ndonondo
21.	Nyakirang'anyi Construction Ltd	Nyakato Industrial Area	Musoma (Head office in Dar es Salaam)	07672619410 71326194107 83261941	Happy
22.	Water Solution Drillig Co. Ltd	New Safari Hotel	Mwanza	0754691256	Vincent Shirima
23.	CMG Construction Co.Ltd	Musoma Road-Sinai	Mwanza	0783654582	Alexander Mabula
24.	Sparr Drilling Co.Ltd	Mabatini-Sinai Area, block8, plot CC Mwanza	Mwanza	0688905510	H.V. Raghavendra
25.	Geweco Ltd	Junction (Nyerere and uhuru road)-Makuni	Mwanza	0784593402	Sangija
26.	Globaltech Drilling And Exploration Ltd	Bwiru near impression press	Mwanza	0762786007	Reddygari sridha reddy
27.	Nyanza Bottling Co.Ltd	Igoma	Mwanza	0784800715 0784800701 0755204965	Malando Wema
28.	Shy Builders Ltd	Mama Karanga Street	Shinyanga	0788038888	Bhiku Damji
29.	Wedecoltd	Matanda	Shinyanga	0713341937	Mwanasha
30.	Nasser General Trader	Bariadi, CCM Sima	Shinyanga	0783532662	Vitalis Lazaro
31.	Shinyanga Maji Office		Shinyanga	028 276066	Gaspar I. Joseph

2.3.1 Observations

1. All of the confirmed companies were sent the interview tools (both the Kiswahili version and the English version) one week before the planned interview day. The survey teams started to

call the companies as from 25th May and made appointment as starting Monday the 4th June 2012. The whole week starting from 28th May to 1st June was left to let the companies fill the questionnaire before the survey teams visited the companies. It was however observed that most of the companies did not fill the questionnaire prior to the survey team's visit. That situation made the exercise to take too long time to respond to the questions and to fill in the questionnaire.

2. It was also observed that most of the companies are not willing to fill section G part of the questionnaire on Finance. Despite that the companies were given the questionnaire almost a week early (which we believe that it is sufficient to fill the required part), most of them still would not fill that part of the questionnaire. The survey teams are just speculating that, most of these companies do not keep correct records on their finances or they are afraid to show their real income for taxation purposes. But this is just speculations – the reasons that make them to abstain from filling the information on their finances is yet to be researched.
3. It was also observed that most of the companies did not keep their promise after making an appointment for interview. This caused the planned interviews to be distorted and not following the planned schedule of interview. The survey teams resorted to confirm each day before going to visit the company instead of making a full week schedule of appointment.

2.4. Survey Team Composition

The survey teams consisted of 8 staffs provided by BICO. Table 2.5 summarises the survey team composition

Table 2.5 Survey team composition

S/ No	Name of Staff	Area of Expertise	Position Assigned	Task Assigned	Academic Background
1	Prof. E.A.M. Mjema	<ul style="list-style-type: none"> • Project Management • Performance Management • Operations Management • Logistics • ICT 	Survey Manager	<ul style="list-style-type: none"> • To oversee planning and progress of works and provide overall quality control of the survey outputs • Communicate with the Client on daily operation of the survey and progress of the works 	B.Sc (Engineering) M.Sc (Engineering Management) Dr.Ing. (Computer Simulation)
2	Dr. P. M. S. Bujulu	<ul style="list-style-type: none"> • Geotechnical eng. • Drilling technology • Hydrogeology, g/water prospecting and well development 	Technical Supervisor 1	To provide technical advice and quality assurance to the works to be conducted by the surveyors with regard to issues related to hydrogeology, drilling of wells and drilling equipment	Ph.D (Geotechnical Engineering) M. Civ. Eng. (Geo-technique) B.Sc. (Eng.) Civil Engineering
3	Mr. M. Songo	<ul style="list-style-type: none"> • Hydrogeology • Geophysics • Water well drilling • Surface water hydrology • Environment • Minerals and rocks 	Technical Supervisor 2	To provide technical advice and quality assurance to the works to be conducted by the surveyors with regard to issues related to hydrogeology, drilling of wells and drilling equipment	B.Sc. (Hons) in Geo-hydrology B.Sc (Hons) Environmental Management Diploma in Water Resources Engineering

S/ No	Name of Staff	Area of Expertise	Position Assigned	Task Assigned	Academic Background
4	Dr. H. Bwire	<ul style="list-style-type: none"> Civil engineer Transportation Planning and Traffic Engineering Highway Engineering 	Lead Surveyor	<ul style="list-style-type: none"> To lead structured interviews with the target group To analyse the survey results and compile the report 	PhD M.Sc(Highway Engineering) B.Sc. (Eng.)
5	Mr. S. Melchiori	<ul style="list-style-type: none"> Groundwater Hydrology Mechanical Engineering 	Lead Surveyor	<ul style="list-style-type: none"> To lead structured interviews with the target group Analysis of survey results and compile the report 	M.Sc Technology (Groundwater Hydrology) M. Dev. Mgmt B.Sc. Eng.
6	Mr. S.Kapoma	<ul style="list-style-type: none"> Hydrogeology Groundwater Prospecting Well Drilling 	Assistant Surveyor	To assist the lead surveyors in structured interviews	Diploma of Hydrogeology and Water well Drilling (Hydrogeology)
7	Ms. H.Kimambo	<ul style="list-style-type: none"> Geotechnic Engineering 	Assistant Surveyor	To assist the lead surveyors in structured interviews and report compilation	B.Sc.Transportation and Geotechnic engineering
8	Ms J.A. Mtana	<ul style="list-style-type: none"> Project Management Data processing 	Data Entry Clerk	To prepare excel database and to manage the data entry	MEM (Project Management) PGD (Eng. Management) Adv. Diploma (Community Development)

2.5. Limitations (factors which affected implementation of the survey)

One of the main factors that affected the implementation of the survey was getting hold of the drilling companies. The survey teams prepared the survey schedule and made appointments with the drilling companies but most of them were not keeping the appointments. The teams had to visit one company several times before they got a chance to interview the management of the company.

Another factor that affected the implementation of the survey was the accessibility and identification of the location of the company. The Dar es Salaam city does not have physical addresses in the suburbs and the streets do not have street names, therefore, it requires extra effort to know the exactly location. This situation delayed the implementation of the survey.

Furthermore, traffic jams is another factor that contributed to the delay of the implementation of this survey project. Traffic jams sometimes made the survey teams to be stranded on the road for more than two hours. Therefore, in some of the situation, it was not possible to visit more than one drilling company in a day because of the traffic jams. In addition, some of the drilling companies were adamant and did not want to fill the form or to be interviewed. Despite of the efforts of the survey teams trying to explain to them the importance of this survey but they still refused to be interviewed. Still more, some of the companies accepted to fill the forms but they refused to fill part G of the questionnaire, which was asking about the financial issues of the companies.

3. Results of the Baseline Survey

3.1. Business Establishment

From the available data, it shows that the oldest drilling company was established in 1985 whereas the newest drilling company among the surveyed companies was established in 2012. The establishment of the companies is shown in Figure 3.1. According to the information available, about 39% of the companies were established in the period 2006 to 2010. A further analysis shows that about 30% of the drilling companies surveyed have been in business for more than 10 years (i.e. they were established in or before year 2000). This situation shows that there is a good business in drilling because a substantial number of businesses have survived for more than ten years.

However, there are a significant number of new companies (i.e. they were established after 2010) and they are about 14% of all of the interviewed companies. This situation also shows that there are a good number of new entrants into the drilling business.

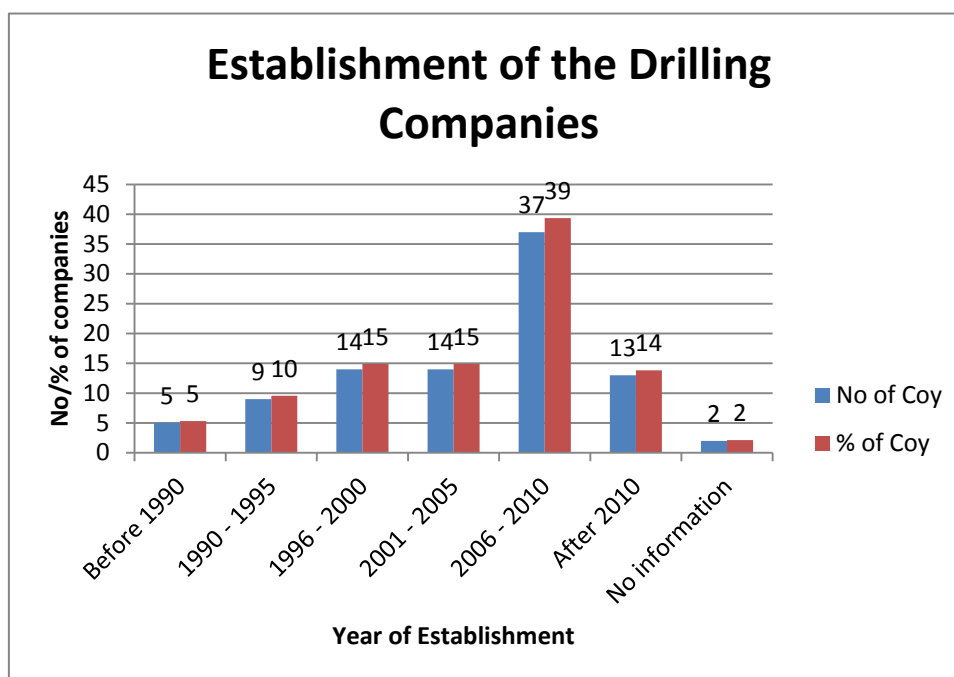


Figure 3.1: Year of Establishment of the Drilling companies

3.2. Business Location of the Drilling Companies

Figure 3.2 summarises the business location of the interviewed drilling companies. According to the available information, 66% of the interviewed companies are in Dar es Salaam, 14% are in Arusha and 6% are in Mwanza. The rest of the regions had only between 1% and 3% of the interviewed companies.

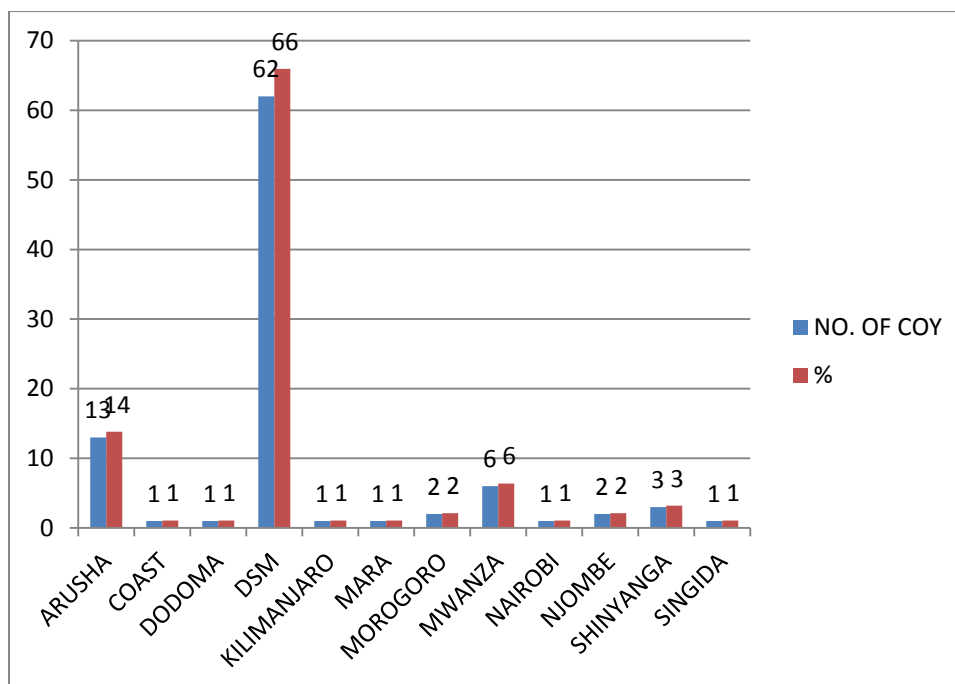


Figure 3.2 Location of the Interviewed Drilling Companies

3.3 Renewal of Drilling Permit

The majority of the interviewed companies (63%) had valid Drilling Permit. Figure 3.3 shows the latest year of the renewal of the drilling permit

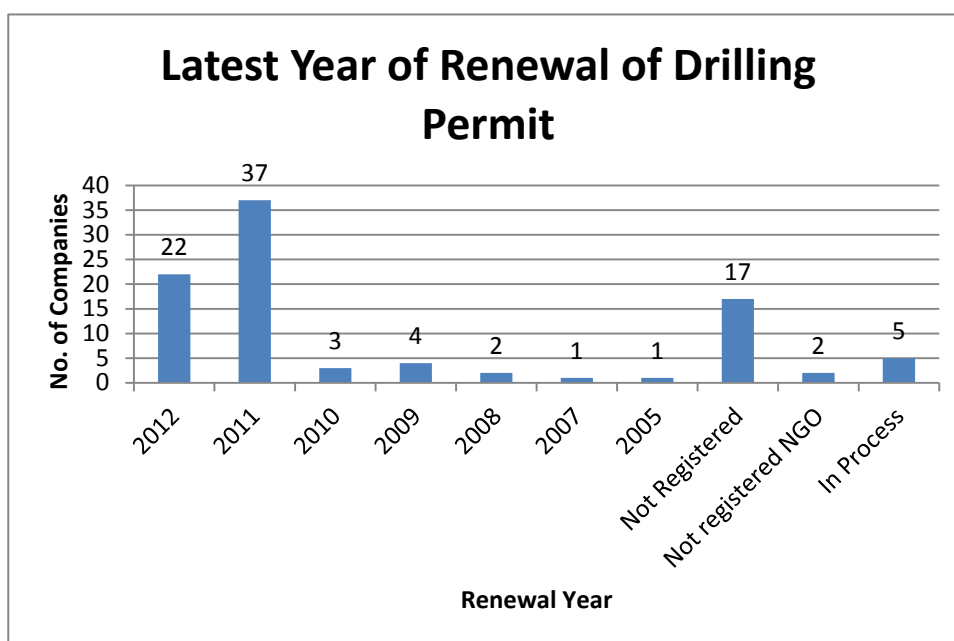


Figure 3.3 Latest Year of Renewal of the Drilling Permit

3.4 CRB Registration

From this work, it was revealed that the majority (60%) of the drilling companies were not registered with the CRB. It was further noted that 14% of the drilling companies were in the process of being registered with CRB. There were only 26 companies out of the 94 interviewed companies, which were registered as specialist contractor. The CRB registration situation is summarised in Figure 3.4

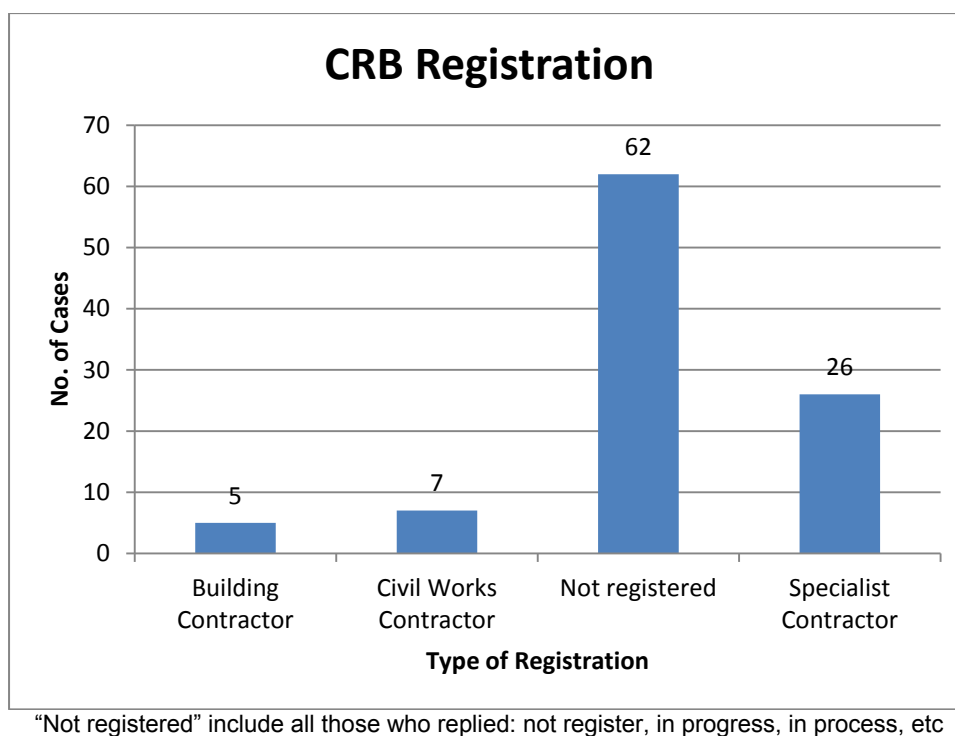


Figure 3.4 CRB Registration

3.5 Equipment

3.5.1 Drilling Equipment

The surveyed companies had different quantities and kinds of drilling equipment that is available in the market. Table 3.1, 3.2 and 3.3 give a statistical summary of the drilling equipment that were found in the survey (i.e. number of companies which owns rigs, average number of rigs among owned companies, maximum/minimum number of owned rigs, type of rigs, average/maximum/minimum capacity of depth/diameter).

Table 3.1: Statistical Data of Companies owning drilling rigs

Statistical Parameter	Value
Maximum	12
Minimum	0
Number of companies having only 1 (one) Rig	46
Number of companies having 0 (zero) rigs	10
Average	1.67

Median	1
--------	---

(No. of valid cases: 84)

From the main data entry, it was observed that the highest number of drilling rigs owned by an individual company was 12. There 10 companies that do not have drilling rigs but they totally depend on hired rigs. Also, there are 46 (49%) companies, which own only 1 drilling rig and there were 24 (26%) that owned 2 rigs. The number of companies that owned 3 rigs were 7 and only 7 among the interviewed companies has 4 or more rigs. This situation is summarised on Table 3.2

Table 3.2: Number of Rigs owned by Drilling Companies

Number of Rigs	0 Rigs	Only 1 Rig	2 Rigs only	3 Rigs only	4 Rigs only	5 Rigs only	6 Rigs only	>6 Rigs
Number of Companies	10	46	24	7	2	2	2	1
% of total interviewed companies	11	49	26	7	2	2	2	1

(No. of valid cases: 84)

The survey teams observed that there were myriad of models of drilling rigs owned by the drilling companies in Tanzania. It seems that almost each company orders its own machine from different suppliers, however, the PAT 301 drilling machine was found to be more popular because it is owned by 31 drilling companies. This situation is summarised on Table 3.3

Table 3.3: Type of Drilling Rigs in Surveyed Companies

S/No.	Model	Quantity	Manufacturer	Maximum Depth [meters]	Drilling Diameter (inch)
1	2518 HL	3	AMW INDIA	300	10
2	AIR DRILL	1	AIR DRILL AUSTRALIA	300	12
3	ALLAS COPRO	1	AQUADRILL R50	180	10
4	BAPTIST	1	HENK HOLTSLAG	40	5
5	BECPL	1	BALDEA ENTERPRISE CO. LTD	400	10
6	CABLE TOOL PERCUSSION	2	CHINA	140	8
7	CTQ 100	1	CHINA	150	10
8	DAF	1	MOBILE RIG	200	10
9	DK-1	1	SHERAM USA	1200	18
10	DSS 1000	1	DRLIING SPARES AND SERVICES	220	16
11	DTHR 450	1	KLR	250	16
12	DR150	1	DIP ROCK	120	6
13	FAHLING	1	FAHLING(USA)	250	10
14	GSDII	1	RANRAN MACHINERY CO.	150	20
15	HANJIN SEKO 4000	1	SEKO (SOUTH KOREA)	150	13
16	HANJIN SEKO 6000	4	SEKO (SOUTH COREA)	250	12

S/No.	Model	Quantity	Manufacturer	Maximum Depth [meters]	Drilling Diameter (inch)
17	HF 180	1	HANGFAN CHINA	180	10
18	INDIAN RIG	1	INDIA	300	
19	INGERSOLL RAND	1	GERMANY		
20	JCR 300	1	MODEL 300 (INDIA TYPE)	250	12
21	KLR	2	KLR (INDIA)	300	10
22	KLR 1000	1	ASHOK KLR	300	10
23	KLR 1500	1	KLR	300	10
24	KLR DTHR 1500	4	KLR	350	10
25	KOKEN RIG	2	JAPAN	200	10
26	KPR	1	KLR	300	16
27	KS 1000 MODEL T	1	REED SQUARE	60	6
28	KW20	3	KAISHAN CHINA	250	10
29	LS100	1		30	7
30	PAT 301	32	PAT DRILL	120	8
31	PAT 301T	1	PAT DRILL	100	8
32	PAT 304	1	PAT DRILL	120	10
33	PAT 401	1	PAT DRILL	80	10
34	PAT DRILL	1	PAT DRILL	80	10
35	PEETERS	1	PRIM 70 TPL	250	8
36	PERCUSSION	1	ITALY - IVECO	80	8
37	PNH 12	1	ASHOK LEYLAND INDIA	300	10
38	POWER 7000D	1	HANJIN D&B CO.LTD-KOREA	500	10
39	POWERSE 4000	1	SEKO FROM KOREA	150	10
40	PRD	3	PRD INDIA	200	13
41	PRD	1	JAIN HYDRAULIC DRILL RIG	200	10
42	PRD 2516	1	PRD	500	16
43	PRD 300	1	PRD	150	8
44	PRD 650	1	PRD	600	10
45	PRD CG 1613	1	PRD	150	8
46	PRD SUPER DRILL	1	PRD	200	10
47	ROCK BUSTER R.100	1	USA	200	10
48	ROTA SLUDGE	1	HENK HOLTSLAG	40	5
49	SANKIO	2	JAPAN	300	10
50	SCRAMM	1	USA TYPE	200	10
51	SCHRAMM 450	3	SCHRAMM	150	8
52	SD-600	1	KYOUNG DONG INDUSTRIAL	150	8
53	SGD-IIA	1	LILONG MACHINERY CO. LTD	250	10

S/No.	Model	Quantity	Manufacturer	Maximum Depth [meters]	Drilling Diameter (inch)
54	SMITH CAPITAL	2	SC	150	8
55	SUPER DRILLING RIG 5000	1	SUPER ROCK	500	10
56	SUPER 4000M	1	SANGMOO ENTERPRISES CO. LTD	200	10
57	SUPER ROCK 5000	1	DEEPROCK CANADA	150	12
58	SUPER ROCK DRILLING RIG 1000	4	SUPER ROCK	300	10
59	T3W	1	INGER SOL RAND (ATLAS COPCO)	300	12
60	T3WDH	1	ATLAS COPCO	800	8
61	TADANO	1	TADANO - JAPAN	100	
62	THIOLMRIG	1	ATLAS COPCO	300	10
63	THLM - 10	1	ATLAS COPCO	400	10
64	TRUCK MOUNTED DTH ROTARY	1	LEYLAND	250	12
65	UDR 1000	1	UDR	150	8
66	XU	1	XU ZIL	600	10
67	XY-1A-6	1	CHINA	120	10

3.5.2 Supporting Equipment

a) Water Tanker

Out of the 94 interviewed companies, 67 (71%) mentioned that they own at least one water tanker. A further analysis shows that out of the 67 companies that own water tankers, 11 companies owned 2 tankers, 3 companies owned 3 tankers and only 1 company owned 6 tankers.

In analysing the measures taken by the companies that do not own water tankers, 17 companies indicated that they lease water tankers while 5 companies indicated that they sub contract the supply of water. However, there are 2 companies that indicated that water tanker is not necessary. There are still 6 companies that did not have water tankers and they did not give information on what they do for the water services.

b) Cargo Trucks

Regarding the cargo trucks the available data shows that 78 (79%) out of the 94 interviewed companies had at least one cargo truck. Further analysis shows that 11 companies owned 2 trucks, 5 companies owned 3 cargo trucks, 1 company owned 4 trucks, 2 company owned 5 trucks, 1 company owned 6 trucks and 1 company owned 9 trucks.

The measures taken by those companies that do not own cargo trucks, the available data show that 13 companies lease the cargo trucks while 2 companies subcontract the cargo handling services. There is no company that showed that cargo trucks are not necessary, but 5 companies, which did not have cargo trucks did not give information how they handle their cargo.

c) Generators

For the generators, the available data shows that 84 (89%) out of the 94 interviewed companies had at least one generator. Further analysis shows that 22 companies owned 2 generators, 6 companies owned 3 generators, 4 companies owned 4 generators, 1 company owned 5 generators, and 4 companies owned more than 5 generators.

For the companies that do not own generators, 6 of them indicated that they lease the generator, 2 companies sub-contract and 7 companies mentioned that it is not necessary to have a generator.

d) Compressors

Out of the 94 interviewed companies, 69 (73%) companies owned at least one compressor. Further analysis shows that 13 companies owned 2 compressors, 6 companies owned 3 compressors, 3 companies owned 5 compressors, and 2 companies owned at least 6 compressors.

Regarding the measures taken by those companies that do not own compressors, the available data show that, 14 companies are leasing compressors and 5 companies subcontract the compressor functions. There are 12 companies that indicated that compressor is not necessary.

e) Vehicles

From the available data, it is clear that about 90% of all interviewed companies owned at least one vehicle. Data analysis shows that 18 companies owned 2 vehicles, 18 companies owned 3 vehicles, and 20 companies owned more than 4 vehicles.

Measures taken to source the vehicles include the following: 2 companies are leasing the vehicles, none of the companies indicated that they are sub-contracting the vehicle services and 3 companies indicated that it is not necessary to have vehicles.

3.5.3 Survey Equipment

a) Geophysical Prospecting Equipment (GPPE)

Regarding the GPPE, there are only 26 (28%) companies that own at least one GPPE. Six (6) companies own 2 GPPE, 1 company 3 GPPE, 2 companies own 4 GPPE and only 1 company owns 5 GPPE.

From the available data, it is shown that 22 companies are leasing the GPPE, while 45 companies are sub-contracting the GPPE functions and only 3 mentioned that this equipment is not necessary.

b) Well logging machine

There are only 48% companies out of the 94 companies that own at least one well logging machine and there is only 1 company that is having 2 well logging machine and another 1 company that own 4 well logging machines otherwise the rest are having only 1 well logging machine. Further analysis shows that 72 companies are leasing the well logging machines; 1

company is subcontracting the well logging services and 23 companies showed that well logging machine is not necessary.

c) Pumping Test Equipment

In the survey conducted there were only 33 (35%) companies out the 94 companies who had at least one Pumping Test Equipment. Eight (8) companies had 2 pieces of pumping test equipment, seven companies had 3 pieces of the equipment and 3 companies had more than 4 pieces of the equipment. For the companies that did not have pumping test equipment, 27 of them leased the equipment, 2 of them subcontracted the service and 13 companies indicated that it is not necessary to have the pumping test equipment. There are still 16 companies that do not have the pumping test equipment but they did not air their view regarding the pumping test equipment.

3.5.4 Operation and Maintenance

a) Maintenance of the Equipment

The respondents were given multiple options for selecting more than one means for maintenance and repair of the drilling equipment owned by the companies. The percentage that will be shown in this part, therefore, refers to the number of the companies that selected the particular option out of the 94 companies that the survey team were able to conduct interview and collect the forms. This means that the one cannot sum up the selected percentages because the percent will be more than 100% in total. From the available data it was shown that 36% of the companies are repairing and maintaining their drilling equipment in the workshop owned by their own companies. The companies that outsource the repairing and maintenance of their drilling equipment to other company's workshop were 27 representing 29% and the companies that only carry out repair and maintenance their drilling equipment on site by drillers themselves were 55 (58.5%).

There are 3 companies that selected "others", which mean that they do not use any of the options given but they use other methods. The mentioned methods include: a) they send the maintenance mechanics to the sites and b) they only hire equipment and hence they are not responsible for the maintenance of the equipment.

b) Workshop Equipment

The respondents were required to indicate workshop equipment and tools they possessed. They were given a list of workshop facilities and they were required to select all the types that apply for their companies. Since the respondents were allowed to check more than one answer, then the percentage shown in Table 3.4 refers to the percentage of the total sum of the companies that are having such facility and should not be summed up.

**Table 3.4: Workshop Equipment and Facilities possessed by the interviewed companies
(multiple response)**

Facility name	Number of Responses	% of Responses	% of Cases
Pit for repairing and maintenance of underneath of truck	18	6	19
Air compressor	54	18	57
Arc welder	56	18.6	59
Oxygen- Acetylene welder	38	12.6	40
Hydraulic press	24	8	26
Hand tools for heavy duty trucks	83	27.5	88
Lathe machine	12	4	13
Others	9	3	10
None	7	2.3	7
Total	301	100%	319%

(No. of valid cases: 94)

Data displayed in table 3.4 show that majority of the companies have hand tools for repairing of heavy duty trucks (88%), Arch welder (59%) and Air Compressor (57%). Very few companies have lathe machine (13%) and pity for repairing and maintenance of underneath of the truck (19%).

For those who selected others were also required to explain their responses. The following are workshop facilities that were written under others:

- Milling machine, Power Axel, Pille drill;
- Battery & Booster changer, Anul, Chamiblock;
- Pressure car washing machine;
- Tool box for servicing machines; and
- Use other workshops/outsource

c) Level of periodic maintenance

When asked about the type and level of periodical maintenance of drilling equipment that can be done by their own company, the respondent selected the responses as shown on table 3.5. From the data shown in table 3.5 most of the companies (93%) are changing of engine oil of the drilling equipment by themselves, 88% are changing the hydraulic oil and the filters by themselves, 83% are able to completely check and adjust of truck condition, while 86% of the companies are able to completely check and adjust rig machine condition and lastly 85% are able to carry out the greasing up of the drilling equipment by themselves.

For the companies that selected others, they added the following types of maintenance that they are carrying out by themselves:

- Full mechanical Services;
- Changing the spare parts ordered inside and outside the country;
- Mud-pump services; and

- Body work.

Table 3.5: Type and level of periodic maintenance that can be done by the company itself (multiple response)

Type of periodic maintenance	Number of Responses	% of Responses	% of Cases
Changing engine oil and filter	87	20.7	93
Changing hydraulic oil and filter	83	19.8	88
Complete checking and adjusting of truck condition	78	18.6	83
Complete checking and adjusting of rig machine condition	81	19.3	86
Grease up	80	19	85
Others (specify	8	1.9	09
None	3	0.71	03
Total	420	100%	447%

(No. of valid cases: 94)

3.6. Finance

In analysing the finance of the company the survey teams will present the capital investments made by the company, the sales and its proportion to the services offered, Total Sales, Gross Profit on Sales, Operating Profit as well as Net Profit or Loss. The section regarding the finance of the company was not fully filled by the companies. Some of the companies clearly marked that this information is classified information and is the secret of the company.

3.6.1 Capital

The data regarding the size of the capital of the surveyed companies vary a lot. The maximum amount is TZS 300 billion and the minimum is TZS 7.5 million. The average is TZS 5,042 million and the standard deviation is 36,311,362,357. The standard deviation is very high because this average has been skewed by one company that has 300 billion as its capital investment. The rest of the companies have less than 3 billion as their capital investment. The median for the capital investment is 217.5 million, in this case the median gives a better estimation of the central tendency than the mean. Figure 3.5 gives a picture of capital investment in drilling companies.

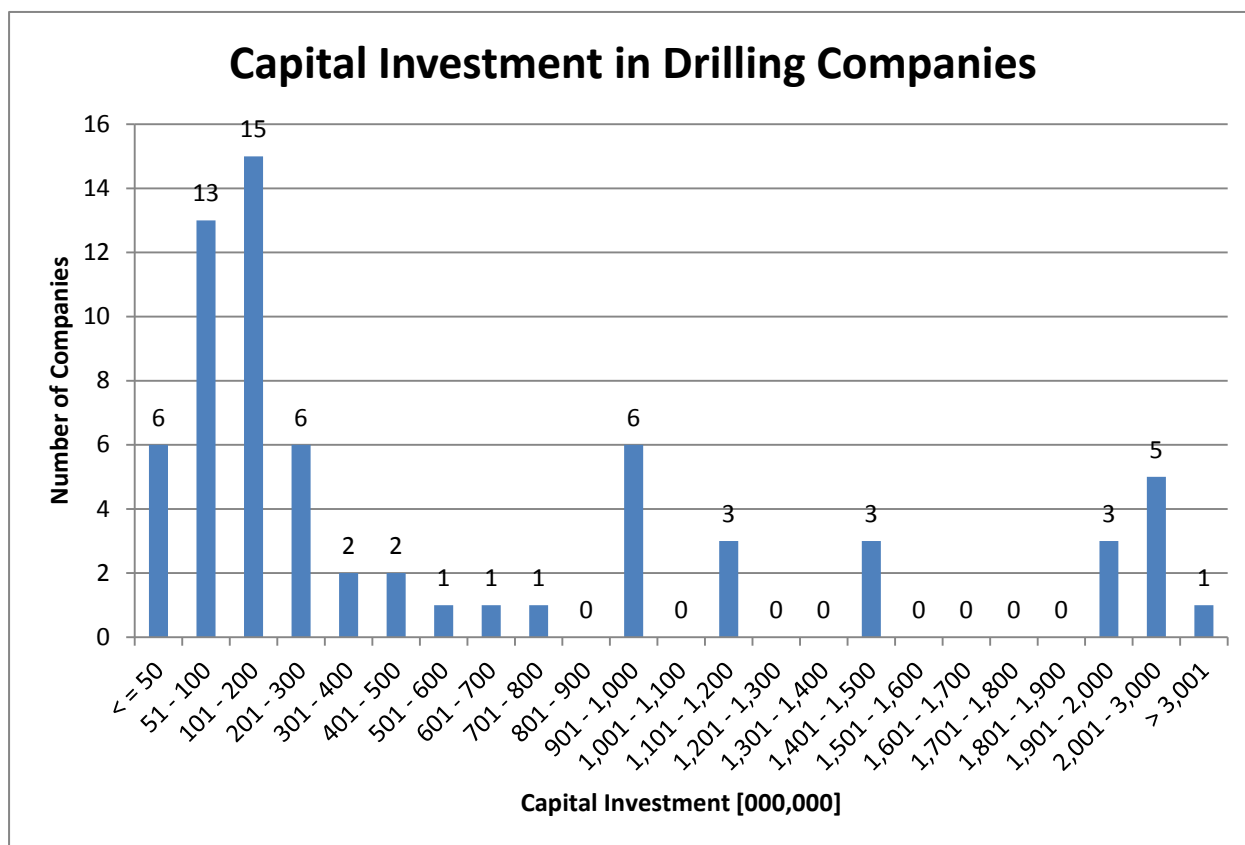


Figure 3.5: Capital Investment in Drilling Companies in Tanzania

3.6.2 Sales and its proportion by services in the past five years

The survey teams also prompted the respondents to explain the approximate percentage distribution of sales from different types of services among the total amount of sales for their companies. The areas to be compared were the following: Drilling Works; Survey; Brokerage Fee; and Other Services. Table 3.6 shows the sales proportions of the drilling companies with respect to the four items. From the information depicted in Table 3.6 shows that 17.5% of the companies that gave response to this item (i.e. valid cases) are getting their income from drilling works only. It can be also seen that 59 companies out of the 80 companies that gave response to this item (i.e. 73.8% of valid cases) have at least 50% of their income coming from the drilling works only.

Table 3.6: Sales of Drilling Works as a Proportion of Total Sales

Sales of Drilling Works %	No. of Companies	% of All Interview companies
100	14	14.9
90 - 99.9	16	17.0
80 - 89.9	14	14.9
70 - 79.9	8	8.5
60 - 69.9	3	3.2
50 - 59.9	4	4.3
40 - 49.9	5	5.3
30 - 39.9	4	4.3
20 - 29.9	4	4.3
10 - 19.9	5	5.3
1 - 9.9	3	3.2
No info	14	14.9
Total	94	100

(No. of valid cases: 94)

Distribution of Income from other services apart from drilling works

The sales of other services are also pronounced in these companies, especially the sales of other service and the survey works, but the brokerage fees are the least source of income for these companies. Table 3.7 shows the sales proportion of the income of the interviewed drilling companies. The information shown on Table 3.7 shows that there 14 companies whose income is 100% from drilling activities only, 16 companies whose income is at least 90% from drilling works and there are 3 companies whose income is at least 90% from sales of other services. Another extreme situation is that there are 35 companies (43.8% of valid Cases) whose income from survey is zero, 55 companies (68.8% of valid cases) whose income from brokerage is zero and also there are 26 companies (32.5% of valid cases) that do not have income from other services.

Table 3.7: Income of the Total Sales Proportion of the Surveyed Drilling Companies

% of Income as a Proportion from Total Sales	Sales of Drilling works	Sales of Survey	Sales of Brokerage Fees	Sales of Other Services
100	14	0	0	0
90 - 99.9	16	0	0	3
80 - 89.9	14	0	0	2
70 - 79.9	8	0	0	3
60 - 69.9	3	2	0	4
50 - 59.9	4	0	0	4
40 - 49.9	5	0	0	3
30 - 39.9	4	1	0	2
20 - 29.9	4	8	1	5
10 - 19.9	5	14	8	16
1 - 9.9	3	20	16	12
0	0	35	55	26
No info	14	14	14	14
Total	94	94	94	94

(No. of valid cases: 94)

3.6.3 Net profit or loss

The information regarding the net profit and loss was avoided by a number of companies. Some of the companies gave reasons that it is the secret of the company but others just refused without giving any reasons. For the companies that were willing to give the information regarding the net profit and loss the situation is as summarised in Table 3.8. The median is very far from the average and also the standard deviation is very high. This information indicates that the data shown on Table 3.8 is highly skewed.

Table 3.8: Profit and Loss in Drilling Companies

	Net Profit/ Loss (08/09) TZS	Net Profit/ Loss (09/10) TZS	Net Profit/ Loss (10/11) TZS
Maximum	9,600,000,000.00	10,400,000,000.00	11,600,000,000.00
Minimum	(364,000,000.00)	(152,000,000.00)	(223,000,000.00)
Average	361,817,579.83	363,422,375.37	347,304,219.91
Median	20,000,000.00	19,250,000.00	20,000,000.00
Standard Deviation	1,748,974,465.03	1,804,664,400.30	1,902,855,517.70

(No. of Valid Cases: 40)

The data shown on Table 3.8 is skewed due to the fact that there is one company, whose net income is very high (more than 9 billion) while the rest of the companies income are not even

0.5 billion. Also there is one company which has recorded only losses during those three years. We as researchers we doubt the authenticity of this data, because having a private company running under such big losses is not possible. Table 3.8b shows better results for the profit and loss after filtering the two companies, which cause the data to be skewed. The standard deviation is still high, but at least the median is approaching the average, which implies that the skew of the data has been highly reduced in Table 3.8b when compared to results in Table 3.8

Table 3.8b: Profit and Loss in Drilling Companies (after filtering two extremes)

	Net Profit/ Loss (08/09) TZS	Net Profit/ Loss (09/10) TZS	Net Profit/ Loss (10/11) TZS
Maximum	375,624,473.00	453,191,287.00	325,152,511.00
Minimum	700,000.00	1,200,000.00	700,000.00
Average	57,804,549.82	56,288,335.07	42,093,032.48
Median	20,000,000.00	19,250,000.00	20,000,000.00
Standard Deviation	96,175,627.46	99,199,060.19	64,656,042.42

(No. of Valid Cases: 38)

3.6.4 Sources of fund

Regarding the source of funds for new investment for the business, 67% of the interviewed companies showed that they use personal funds only and this is followed by 23.4% of the respondents who showed that the source of funds is borrowing from bank and from friends and affinities (See table 3.9 – both sources are 23.4%). There are 17 companies that showed that the sources of funds are from other sources apart from the ones listed. They mentioned the following sources:

- Advance payment from Customer;
- Donation from development partners;
- Donation from within; and
- Increasing the income of the company through efficient working.

Table 3.9 source of funds for new investment (multiple response)

Source of Fund	Number of Responses	% of Responses	% of Cases
Personal funds only	63	48.1	67
Borrowing from friend or affinity	22	16.8	23.4
Borrowing from private company	6	4.58	6.38
Borrowing from banks	22	16.8	23.4
Borrowing from government or related organization	1	0.76	1.06
Other (specify the answer)	17	13	18.1
Total	131	100%	139%

(No. of Valid Cases: 94)

3.6.5 Investment plan for procurement of new drilling equipment

The drilling companies were asked whether or not the company had any investment plan to purchase new drilling equipment. 83% of them replied affirmatively. The following question for those who replied affirmatively was in regard to the kind of the equipment that will be purchased. Table 3.10 summarises the responses of the interviewed companies.

Table 3.10 Equipment planned to be purchased by the drilling companies (multiple response)

Kind of Equipment to be purchased	Number of Responses	% of Responses	% of Cases
Drilling rig (with capacity to drill less than 100m depth)	5	4.07	5.49
Drilling rig (with capacity to drill between 100 and 200m depth)	41	33.3	45.1
Drilling rig (with capacity to drill more than 200m depth)	39	31.7	42.9
Supporting Equipment	12	9.76	13.2
Survey Equipment	23	18.7	25.3
Not applicable (The don't have plan to purchase new equipment)	3	2.44	3.3
Total	123	100%	135%

(No. of Valid Cases: 91)

Data shown in table 3.10 show that the majority of drilling companies that are planning to purchase drilling equipment are considering the drilling rig with high capacity to drill between 100 and 200m depth and the one that can drill more than 200m depth. The next item to be in the purchase list is the survey equipment: 25% of the companies that indicated that they want to purchase new equipment.

3.7. Human Resources

The staffing situation in the surveyed drilling companies is as shown in summarized on Table 3.11 and the distribution of the staff in the surveyed drilling companies is shown on Figure 3.6. The available data show that the highest number of permanent staff in the surveyed drilling companies is 63, the average is 14 staff and the median is 11. For the case of non-regular staff the highest number of staff is 18, the average of non-regular staff is 4 and the median is 2.

Table 3.11 Staffing Situation in the surveyed in the drilling companies

	Total Number of Staff Permanent	Total number of non-regular staff	Total
Maximum	60	18	63
Minimum	0	0	2
Average	14	4	18
Median	11	2	15
Standard Deviation	12	4	11

(No. of valid cases: 94)

The average of the total staff is 18, the median is 15 and the standard deviation is 11. The median is approximately equal to the average; therefore it implies that the distribution of the total staff in the drilling companies can be represented using normal distribution curve.

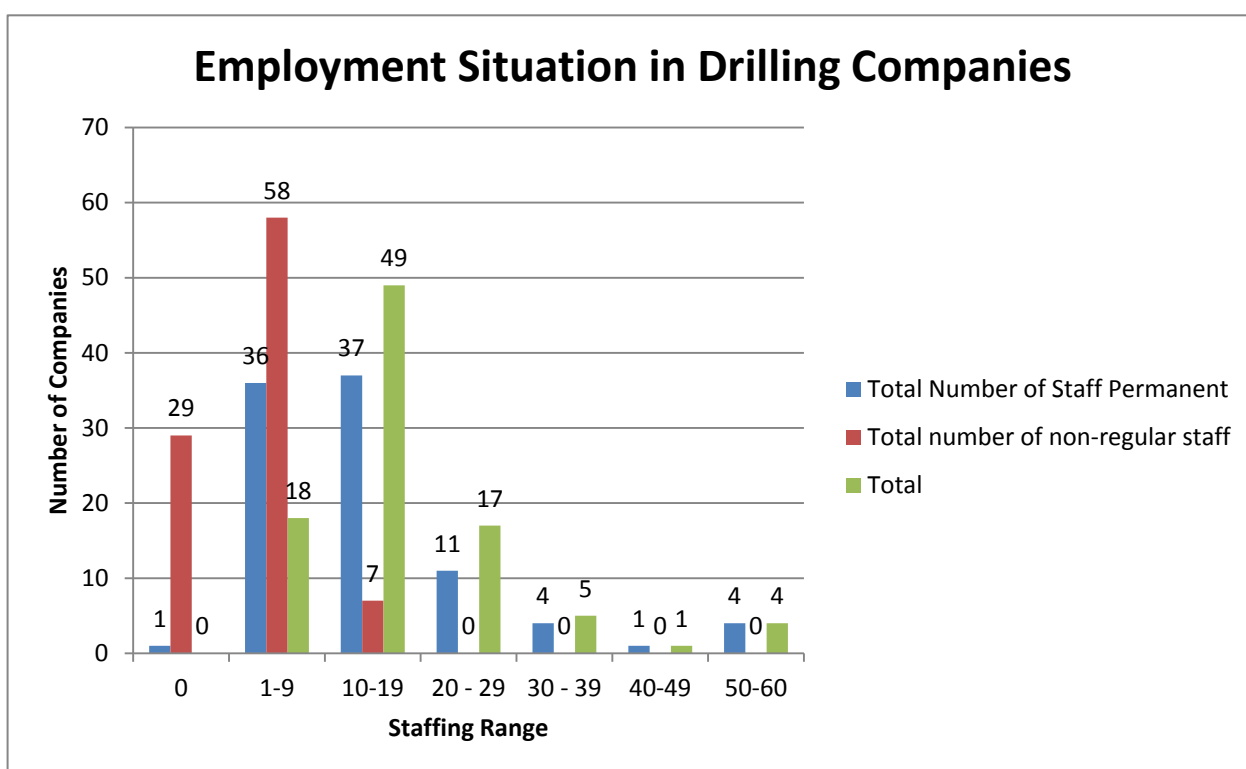


Figure 3.6: Staffing situation in drilling companies

3.7.1 Distribution of staff by divisions

The distribution of staff by position is as shown on Table 3.12. From the data shown in table 3.12 the drilling workers cadre (Drilling worker – helper and assistant technician) has the highest number of employees and this is followed by the administration cadre but the standard deviation for the drilling workers is very high (above 4). The median is approximately equal to the mean, which implies that the staffing data is normally distributed. In that situation, the average data and the median will depict the better distribution of staff by division in the surveyed drilling

companies. There are some companies that do not have some persons who are employed as management staff, especially for small companies where you find that the driller is everything (i.e. the manager, the administrator and the driller)

Table 3.12: Distribution of staff by position

Position	No. of Staff in the Position					
	Total	Maximum	Minimum	Average	Median	Standard deviation
Management	167	6	0	1.86	2.00	1.25
Administration	177	11	0	1.92	2.00	1.93
a) Engineer	123	16	0	1.32	1.00	2.15
b) Hydrogeologist	98	5	0	1.07	1.00	0.91
c) Drilling Supervisor	112	6	0	1.19	1.00	0.90
d) Driller (Rig in charge)	129	7	0	1.39	1.00	1.36
e) Assistant Driller (Operator)	172	10	0	1.87	1.00	1.89
f) Drilling Worker (Helper/Assis. Tech.)	352	20	0	3.78	3.00	4.16
g) Mechanics	117	11	0	1.27	1.00	2.01
h) Welder	107	8	0	1.15	1.00	1.46
i) Plumber	104	5	0	1.11	1.00	1.05

(No. of valid cases: 94)

3.7.2 Distribution of technical staff by position and expertise

The distribution of the technical staff and their level of education is summarised in Table 3.13. According to NACTE classifications, NTA 5 are Technician Certificates (FTC), NTA 6 are ordinary Diplomas, NTA 7 are higher /advance Diplomas, NTA 8 are Bachelor degrees, NTA 9 are masters degree and NTA 10 are Doctorate degrees. Therefore, Table 3.13 combined all the replies for whether written using the NTA codes or written using English word.

It is observed from table 3.13 that the proprietors of the drilling companies are calling some of their staff Engineers or Hydrogeologist while they are not qualified for those positions. The Engineering and Hydrogeologist positions should be occupied by people having at least a Diploma. In the interviewed companies there are 2 Engineers who possess Doctorate degrees, 4 Engineers who possess masters degree, 28 Engineers who possess Bachelor degree and 6 who possess Diplomas (i.e. Adv Diploma 4, Diploma 1 and Adv. Professional Diploma 1). Those who possess FTC, Form VI, Form IV and Basic Certificates should not be called Engineers because they are not qualified to be Engineers.

The majority of the Engineers possess Bachelor degrees, whereas the majority of the hydrogeologists and the drilling supervisors possess Diplomas. The majority of the Drillers (Rig in Charge) and Assistant Drillers are holding Form IV certificates, whereas the Drilling workers (Helpers and Assistant Technician) are STD VII leavers. STD VII certificate holders are the majority of the workers in the surveyed drilling companies followed by the Form IV certificate holders. Table 3.13b shows the types of certificates for each staff cadre and their distribution.

Table 3.13: Level of Education of the staff

Level of education	Management	Engineer	Hydrogeologist	Drilling Supervisor	Driller (Rig in charge)	Assistant Driller (Operator)	Drilling Worker (Helper/Assistant Tech.)	Mechanics	Welder	Plumber	Total
Doctorate	3	2	0	0	0	0	0	0	0	0	5
Masters	6	4	5	0	0	0	0	0	0	0	15
Bachelor Degree	33	28	8	0	0	0	0	3	0	0	72
Adv. Diploma	1	4	4	0	1	0	0	0	0	0	10
Diploma	10	1	28	23	11	2	0	1	1	2	79
ADV P	0	1	1	0	0	0	0	0	0	0	2
FTC	4	1	3	4	0	0	0	1	2	2	17
Form VI	4	2	1	3	1	0	0	1	1	1	14
Form IV	14	2	3	20	25	28	13	10	7	8	130
Basic Certificate	0	1	1	4	5	1	0	10	5	10	37
PGDP	0	0	1	0	0	0	0	0	0	0	1
NVA3	0	0	0	0	0	0	0	2	0	2	4
NVA2	0	0	0	1	0	0	0	1	2	2	6
NVA1	0	0	0	2	3	3	2	4	5	5	24
STD VII	3	0	2	8	13	20	37	11	22	23	139
DTPL	0	0	0	1	0	0	0	0	0	0	1
In Service*	0	0	0	1	0	0	0	0	0	0	1
On Job Training*	0	0	0	0	0	5	7	0	0	0	12
x-10	0	0	0	0	0	1	0	0	0	0	1
Total	78	46	58	67	59	60	59	44	45	55	571

(No. of valid cases: 94)

*In Service** - The do not have certificate but they are sent in short courses after gaining some experience

*On Job Training** - They learn by observing what others are doing – they do not have any kind of training

Table 3.13b: Type of Certificate

Type of Certificate	Management	Engineer	Hydrogeologist	Drilling Supervisor	Driller (Rig in charge)	Assistant Driller (Operator)	Drilling Worker (Helper/ Assis. Tech.)	Mechanics	Welder	Plumber
NTA 10	3	1	0	0	0	0	0	0	0	0
NTA 9	6	4	2	0	0	0	0	0	0	0
NTA 8	33	28	14	2	0	0	0	3	0	0
NTA 7	1	1	1	1	0	0	0	0	0	0
NTA 6	10	7	27	28	8	3	0	3	2	3
NTA 5	3	1	4	4	2	3	2	4	2	1
NTA 4	0	0	1	1	1	0	0	0	0	0

Type of Certificate	Management	Engineer	Hydrogeologist	Drilling Supervisor	Driller (Rig in charge)	Assistant Driller (Operator)	Drilling Worker (Helper/ Assis. Tech.)	Mechanics	Welder	Plumber
NTA 3	0	0	0	1	0	0	0	0	0	0
NTA 2	1	0	0	0	0	1	0	0	0	0
NVA 1	1	0	0	2	6	5	2	10	8	11
NVA 2	0	0	0	1	0	0	1	5	1	2
NVA 3	0	0	0	1	1	1	2	1	1	1
CSEE	4	0	1	8	8	6	4	2	1	0
Local*	0	0	1	0	0	0	0	0	0	0
On Job Training*	0	0	0	3	1	3	1	1	0	1
STD VII	0	0	0	1	2	4	5	0	2	0
GD II	0	0	0	0	0	1	0	1	1	0
GD I	0	0	0	0	1	0	0	0	0	0
Total	62	42	51	53	30	27	17	30	18	19

(No. of valid cases: 94)

Local - Training is done within the premises of the company and they do not have certificates*

On Job Training - They learn by observing what others are doing – they do not have any kind of training*

3.7.3 Years of Experience of the staff

Table 3.14 summarises the information regarding the years of experience of the technical staff. The information that is shown in table 3.14 indicates that the technical staff in the drilling industry has sufficient years of experience in the industry. Apart from the drilling workers (i.e. helpers and assistant technician), the majority of the staff have more than 4 years in the drilling job.

Table 3.14: Years of experience of the staff

Position	Years of Experience (x)									
	1<x<=4		4<x<=8		8<x<=12		>12 years		Total	
	N	%*	N	%	N	%	N	%	N	%
Management	8	9.3	13	8.1	21	17.5	39	30.2	81	16.3
a) Engineer	9	10.5	5	3.1	11	9.2	17	13.2	42	8.5
b) Hydrogeologist	9	10.5	7	4.3	10	8.3	21	16.3	47	9.5
c) Drilling Supervisor	6	7.0	16	9.9	15	12.5	21	16.3	58	11.7
d) Driller (Rig in charge)	2	2.3	18	11.2	18	15.0	11	8.5	49	9.9
e) Assistant Driller (Operator)	11	12.8	26	16.1	11	9.2	4	3.1	52	10.5
f) Drilling Worker (Helper/ Assistant Tech.)	22	25.6	20	12.4	3	2.5	1	0.8	46	9.3
g) Mechanics	7	8.1	17	10.6	13	10.8	4	3.1	41	8.3
h) Welder	7	8.1	19	11.8	9	7.5	2	1.6	37	7.5

Position	Years of Experience (x)									
	1<x<=4		4<x<=8		8<x<=12		>12 years		Total	
	N	%*	N	%	N	%	N	%	N	%
i) Plumber	5	5.8	20	12.4	9	7.5	9	7.0	43	8.7
Total	86	100.0	161.0	100.0	120.0	100.0	129.0	100.0	496.0	100.0

(No. of Valid Cases: 94)

* Percent in the years of experience

3.7.4 Human Resource Development

In this part the consultant asked the respondents about the measures that the drilling companies had taken to improve drilling technique and skills of their technical staff. The respondents were given the following options to select and they were allowed to select more than one option:

- Provided training and guidance from senior staff to junior ones during the works;
- Sent staff to training courses conducted at educational institution;
- Invited trainer/ instructor from outside to teach our staff on drilling site;
- Other (specify the answer); and
- No measures are taken to improve capacities of the staff.

Table 3.15 shows that the majority of the drilling companies (81.9%) are conducting in-house training in which the senior staffs are coaching the junior staff. A substantial number of drilling companies (35.1%) are also inviting trainers/instructors from outside to teach their staff at the drilling site.

Table 3:15 Measures taken to improve the drilling technique and skills (Multiple Answers)

Measures taken	No. of responses	% of Responses	% of Cases
Provided training and guidance from senior staff to junior ones during the works	77	54.6	81.9
Sent staff to training courses conducted at educational institution	22	15.6	23.4
Invited trainer/ instructor from outside to teach our staff on drilling site	33	23.4	35.1
Other (specify the answer)	1	0.7	1.1
No measures are taken to improve capacities of the staff	8	5.7	8.5
Total	141	100	150

(No. of Valid Cases: 94)

The next item of interest was to know who paid for the technical staff to attend the training courses. Also the respondents were given the following options:

- The staff who attends the training course;
- The company;
- The staff and company share the cost for the training; and
- Our company does not send our staff to training courses.

Table 3.16 summarises the responses of the interviewee regarding the one who paid for the technical staff to attend the training. It shows that the companies paid for their technical staff to attend training in most cases.

Table 3.16 Paying for the technical staff to attend training

Who paid for the technical staff to attend training?	No. of responses	% of Cases
The staff who attends the training course	3	3.2
The company	64	68.1
The staff and company share the cost for the training	5	5.3
Our company does not send our staff to training courses	22	23.4
Total	94	100.0

(No. of valid cases: 94)

3.7.5 Needs of staff for their capacity development

In this part the survey teams asked the respondents about capacities that the technical staff would need to improve in order to conduct drilling works properly. The respondents were given the following options to select and they were allowed to select more than one option:

- Planning of drilling works and Designing water wells;
- Drilling by DTH method;
- Drilling by mud rotary method;
- Casing and Screen pipes installation;
- Well Development;
- Pumping tests;
- Well Logging;
- Maintenance of Equipment; and
- Others (Specify).

From the data shown on table 3.17 it is clear that there is a need of training in all of the options that were given in the questionnaire. But the majority of the respondents consider that their technical staff needs to be trained in planning of drilling works and designing water wells (69.1%) and well logging (73.4%). In preference the two training should be followed by training in drilling by DTH method, pumping test and maintenance of equipment. There is one company that mentioned that all the capacity building areas mentioned are important.

Table 3.17 Capacities Which Needs to be strengthened by the technical staff

Capacity Areas	No. of responses	% of Responses	% of Cases
Planning of drilling works and designing water wells	65	15.0	69.1
Drilling by DTH method	58	13.4	61.7
Drilling by mud rotary method	49	11.3	52.1
Casing and screen pipes installation	45	10.4	47.9
Well development	41	9.5	43.6
Pumping tests	50	11.5	53.2
Well logging	69	15.9	73.4
Maintenance of Equipment	48	11.1	51.1
Others (Specify	8	1.8	8.5
Total	433	100.0	460.6

(No. of Valid Cases: 94)

For those who selected others added the training needs on Geological basic knowledge and safety education about wells management. There is only 1 company that did not see the importance of training, and it commented that they know all.

3.7.6 Preferable measures of capacity development

In this part we shall discuss the preferable measures of capacity development of the staff and cost sharing between the company and employees. The respondents were asked to select from the options the measures that are preferable for their companies to strengthen capacities of their technical staff. They were given the following options and they were allowed to select more than one option:

- Provide training and guidance from senior staff to junior ones during the works;
- Send staff to training courses conducted at educational institution;
- Invite trainer/ instructor from outside to teach our staff on drilling site; and
- Other (specify the answer).

Table 3.18 depicts the preferences of the respondents. It seems that all the options are preferable to the surveyed companies as the measures of capacity building since more than 50% of all the respondents selected these options. On Table 3.15 the drilling companies showed the measures that they had taken to improve drilling technique and skills of their technical staff. The option 1 (i.e. providing training and guidance from senior staff to junior ones during the works) was done by 81.9% of all drilling companies whereas the rest of the options were conducted by less than 40% of the companies. However, in this table 3.18 all three options are given almost equal chances.

Table 3.18 Preferable measures of capacity development

Preferable measures of capacity development	No. of responses	% of Responses	% of Cases
Provide training and guidance from senior staff to junior ones during the works	45	34.9	47.9
Send staff to training courses conducted at educational institution	40	31.0	42.6
Invite trainer/ instructor from outside to teach our staff on drilling site	40	31.0	42.6
Other (specify the answer)	4	3.1	4.3
Total	129	100	137.2

(No. of Valid Cases: 94)

For those who selected others had the following to say regarding the preferable measures of capacity development:

- To educate all drilling workers;
- To conduct study tours and short courses; and
- DDCA should start a special training unit for drilling.

3.8. Service Management

3.8.1 Clients of the Drilling Water Wells

With regard to clients of the companies surveyed, the respondents were given the following 4 categories of the customer for the drilling water wells and they were allowed to select more than one customer:

- Government / Local Government Authorities;
- Private Companies;
- Individual Households; and
- NGO/ Donor

The responses depicted on table 3.19 indicate that the drilling companies are carrying out their services in the entire client categories proposed to them. There are 17 companies out the interviewed 94 companies (18%), which had business with private companies and/or individual household only. These 17 companies had neither worked with the government/local government authorities nor with the NGO/Donor.

Table 3.19 Clients of the drilling well

Clients of the drilling water wells	No. of responses	% of Responses	% of Cases
Government / Local Government Authorities	65	23	69
Private Companies	77	27	82
Individual Households	85	30	90
NGO/ Donor	54	19	57

Total	281	100	299
-------	-----	-----	-----

(No. of Valid Cases: 94)

3.8.2 Contracts awarded in the past three years

The first issue under this part was to know the proportions of water well drilling works awarded from the government/ local government authorities among number of contracts and contract value, respectively, in the past three years. Table 3.20 summarises the proportion of the contract awarded from the government/local government authorities in terms of number of contract and in terms of contract value.

Table 3.20 Proportion of contract awarded from the government/ local government authorities

Comparison item	% Number of contracts	% value of contracts
Maximum	100	100
Minimum	0	0
Average	30.4	36.4
Median	20	30
Standard deviation	28.3	29.4

(No. of Valid Cases: 94)

The data depicted in table 3.20 indicate that there is a high deviation on the number of contracts that are being awarded from government/local government authorities to the drilling companies. There are some companies that have almost 100% of their contracts coming from the governments, while others had never got the government contracts. There are 29 companies out of the 94 interviewed companies that did not had any contract from the government and therefore they could not give information on the contracts obtained from the government, and there are also 32 companies, which did not give information on the values. This situation is well depicted in Figure 3.7.

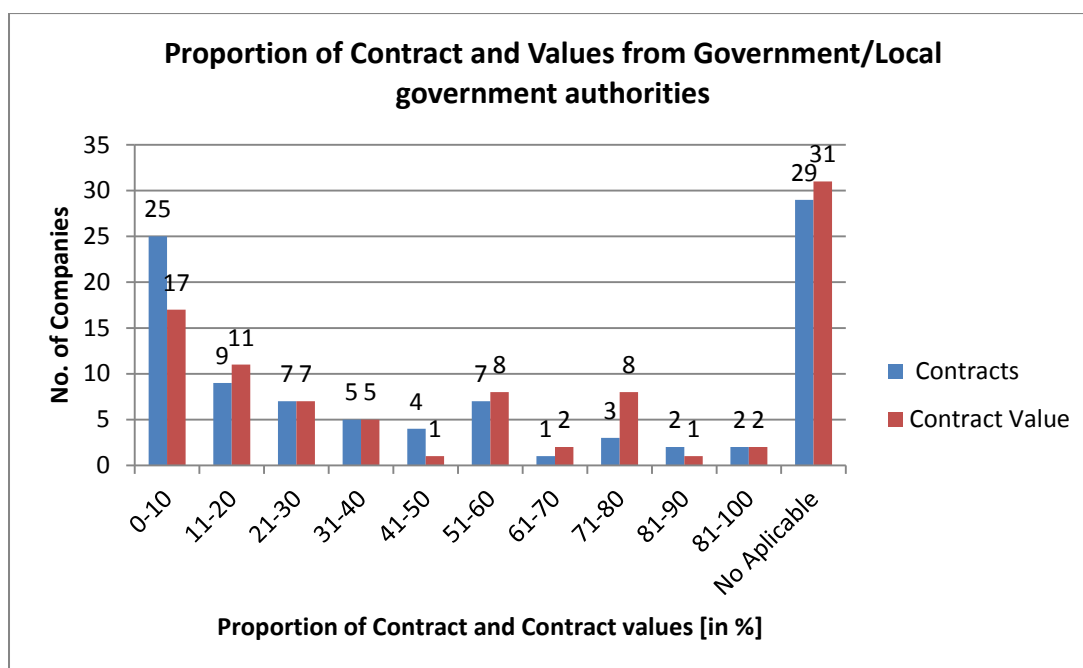


Figure 3.7: Proportion of contracts awarded by government/local government authorities

The next item to be analysed in is the total number of water drilling contract awarded in the past three years. Table 3.21 summarises the number of contract by types of the works the companies provided and the districts in which these works were conducted.

The following were the specific answers to “Other” mentioned in the table 3.21:

- Fire control, electricity and building;
- Building Work;
- Civil Works and Construction;
- Dripping works, irrigation; and
- Cattle keeping.

Table 3.21 Number of Contracts Awarded in the Past Three Years

Contracted Works	Number of Contracts by Fiscal Year								
	2008/09			2009/10			2010/11		
	Sum	Mean	Median	Sum	Mean	Median	Sum	Mean	Median
Drilling shallow well (hand dug well)	980	41	2	1,502	65	2	974	42	6
Drilling deep well (borehole)	983	14	8	1,161	16	9	1,630	22	9
Rehabilitation of well	230	10	7	244	11	9	281	12	8
Piping works	151	6	2	146	5	3	159	6	3
Construction of water supply facility	130	9	4	119	9	6	177	13	7
Groundwater survey	471	15	10	495	16	15	503	16	12
Other (please specify)	290	21	7	121	9	7	211	13	9

(No. of valid cases: 94)

Figure 3.8 shows that the drilling of the deep well (boreholes) is in increasing trend whereas the shallow wells drilling are on decreasing trend. The number of contracts for rehabilitation of wells, piping works, construction of water supply facilities and groundwater survey does not show a drastic change like the ones for drilling of shallow wells and boreholes.

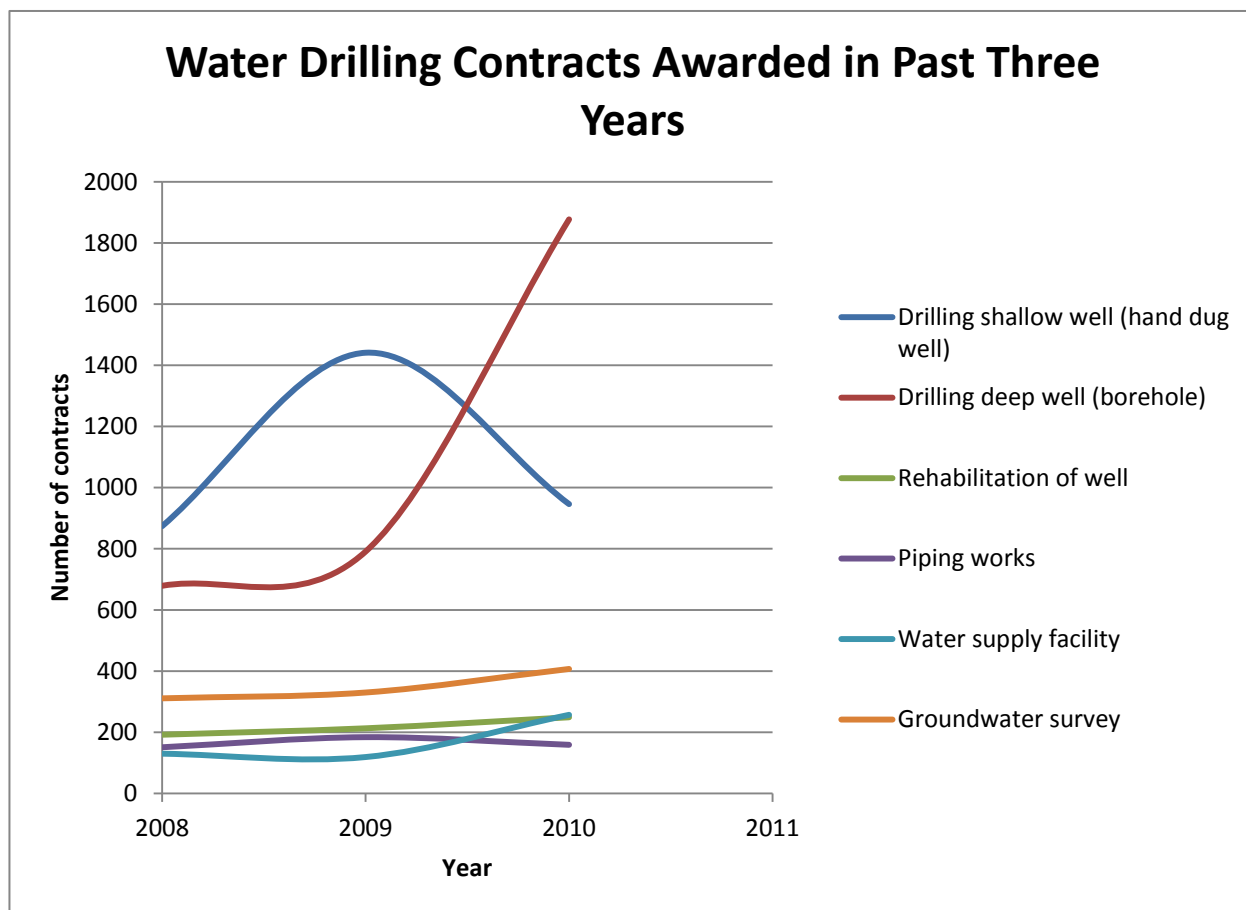


Figure 3.8: Trend in water drilling contracts

Table 3.22 summarises the distribution of surveyed drilling companies by the districts where they have worked and the type of works conducted in the past three years.

Table 3.22 Distribution of the Companies Surveyed by the Districts Where They have Worked and Type of Works Provided in the Past Three Years

[illegible]

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Region	District	Drilling Shallow Well		Drilling Deep Well		Rehabilitation of Well		Piping Works		Water Supply Facility		Groundwater Survey		Other		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Dodoma	Mpwapwa	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Dodoma	Dodoma Region	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Dodoma	Dodoma Rural (Msanga)	0	0	1	0.4	0	0	0	0	1	4.55	0	0	0	0	2	4.95
DSM	Ilala	4	7.27	14	5.53	3	6.82	3	8.11	1	4.55	3	4.84	1	4.17	29	41.3
DSM	Kinondoni	1	1.82	13	5.14	5	11.4	1	2.7	1	4.55	3	4.84	1	4.17	25	34.6
DSM	Temeke	3	5.45	15	5.93	1	2.27	3	8.11	1	4.55	3	4.84	1	4.17	27	35.3
DSM	DSM Region	5	9.09	16	6.32	2	4.55	5	13.5	4	18.2	12	19.4	8	33.3	52	104
Iringa	Iringa	1	1.82	4	1.58	1	2.27	1	2.7	0	0	0	0	0	0	7	8.37
Iringa	Kilolo	1	1.82	0	0	0	0	0	0	0	0	0	0	0	0	1	1.82
Iringa	Ludewa	1	1.82	0	0	0	0	0	0	1	4.55	0	0	0	0	2	6.37
Iringa	Mufindi	1	1.82	1	0.4	0	0	0	0	0	0	0	0	0	0	2	2.22
Iringa	Njombe	2	3.64	2	0.79	1	2.27	0	0	0	0	0	0	0	0	5	6.7
Iringa	Iringa Region	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Italy	Italy	1	1.82	0	0	0	0	0	0	0	0	0	0	0	0	1	1.82
Kagera	Biharamlo	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Kagera	Ngara	0	0	0	0	0	0	0	0	0	0	1	1.61	1	4.17	2	5.78
Kenya	Kenya	0	0	1	0.4	1	2.27	0	0	0	0	1	1.61	0	0	3	4.28
Kigoma	Kasulu	0	0	0	0	0	0	0	0	0	0	1	1.61	0	0	1	1.61
Kigoma	Kigoma	0	0	0	0	0	0	0	0	0	0	0	0	1	4.17	1	4.17
Kilimanjaro	Hai	0	0	2	0.79	0	0	0	0	0	0	0	0	0	0	2	0.79
Kilimanjaro	Moshi	2	3.64	4	1.58	0	0	1	2.7	1	4.55	0	0	0	0	8	12.5

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Region	District	Drilling Shallow Well		Drilling Deep Well		Rehabilitation of Well		Piping Works		Water Supply Facility		Groundwater Survey		Other		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Kilimanjaro	Rombo	0	0	2	0.79	1	2.27	0	0	0	0	0	0	0	0	3	3.06
Kilimanjaro	Same	1	1.82	7	2.77	0	0	0	0	1	4.55	0	0	0	0	9	13.5
Kilimanjaro	Kilimanjaro Region	1	1.82	4	1.58	0	0	0	0	0	0	1	1.61	0	0	6	5.01
Kilimanjaro	Mwanga	0	0	1	0.4	1	2.27	0	0	0	0	0	0	0	0	2	2.67
Lindi	Kilwa	0	0	3	1.19	2	4.55	1	2.7	1	4.55	0	0	0	0	7	13
Lindi	Lindi	0	0	2	0.79	0	0	0	0	0	0	0	0	1	4.17	3	4.96
Manyara	Babati	1	1.82	2	0.79	1	2.27	0	0	0	0	0	0	0	0	4	4.88
Manyara	Hanang	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Manyara	Kiteto	0	0	3	1.19	0	0	0	0	0	0	0	0	0	0	3	1.19
Manyara	Manyara Region	1	1.82	1	0.4	1	2.27	0	0	0	0	1	1.61	0	0	4	6.1
Manyara	Mbulu	0	0	3	1.19	0	0	0	0	0	0	0	0	0	0	3	1.19
Mara	Bunda	0	0	1	0.4	0	0	1	2.7	0	0	0	0	0	0	2	3.1
Mara	Musoma	0	0	2	0.79	1	2.27	1	2.7	0	0	1	1.61	0	0	5	7.37
Mara	Serengeti	0	0	1	0.4	0	0	0	0	0	0	1	1.61	0	0	2	2.01
Mara	Tarime	0	0	3	1.19	1	2.27	0	0	0	0	0	0	0	0	4	3.46
Mara	Mara Region	0	0	2	0.79	0	0	1	2.7	1	4.55	1	1.61	0	0	5	9.65
Mara	Rorya	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Mbeya	Kyela	0	0	0	0	0	0	0	0	0	0	1	1.61	0	0	1	1.61
Mbeya	Mbeya	1	1.82	3	1.19	0	0	1	2.7	1	4.55	1	1.61	0	0	7	11.9
Mbeya	Mbeya DC	1	1.82	1	0.4	0	0	0	0	0	0	0	0	0	0	2	2.22
Mbeya	Mbozi	1	1.82	1	0.4	2	4.55	1	2.7	0	0	0	0	0	0	5	9.47

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Region	District	Drilling Shallow Well		Drilling Deep Well		Rehabilitation of Well		Piping Works		Water Supply Facility		Groundwater Survey		Other		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Mbeya	Chunya	0	0	2	0.79	0	0	1	2.7	0	0	0	0	0	0	3	3.49
Mbeya	Mbarali	0	0	0	0	0	0	2	5.41	0	0	0	0	0	0	2	5.41
Morogoro	Kilombero	1	1.82	0	0	0	0	0	0	0	0	0	0	1	4.17	2	5.99
Morogoro	Kilosa	1	1.82	3	1.19	1	2.27	1	2.7	0	0	0	0	0	0	6	7.98
Morogoro	Morogoro	0	0	12	4.74	3	6.82	1	2.7	0	0	3	4.84	0	0	19	19.1
Morogoro	Kilombero	1	1.82	1	0.4	1	2.27	0	0	0	0	1	1.61	0	0	4	6.1
Morogoro	Mvomero	0	0	0	0	0	0	0	0	0	0	0	0	1	4.17	1	4.17
Morogoro	Ulanga	0	0	0	0	1	2.27	0	0	1	4.55	0	0	0	0	2	6.82
Morogoro	Morogoro Region	0	0	4	1.58	0	0	0	0	0	0	0	0	0	0	4	1.58
Mtwara	Masasi	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Mtwara	Mtwara	0	0	5	1.98	0	0	0	0	0	0	2	3.23	2	8.33	9	13.5
Mtwara	Newala	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Mtwara	Mtwara Region	0	0	0	0	0	0	0	0	0	0	1	1.61	0	0	1	1.61
Mwanza	Geita	0	0	1	0.4	0	0	1	2.7	0	0	1	1.61	0	0	3	4.71
Mwanza	Magu	0	0	1	0.4	0	0	0	0	0	0	1	1.61	0	0	2	2.01
Mwanza	Misungwi	0	0	2	0.79	0	0	0	0	0	0	0	0	0	0	2	0.79
Mwanza	Mwanza	1	1.82	2	0.79	1	2.27	0	0	0	0	0	0	0	0	4	4.88
Mwanza	Sengerema	0	0	0	0	1	2.27	2	5.41	0	0	0	0	0	0	3	7.68
Mwanza	Mwanza Region	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Mwanza	Ilemela	0	0	0	0	0	0	0	0	0	0	0	0	1	4.17	1	4.17
Mwanza	Misungwi	0	0	0	0	1	2.27	0	0	0	0	0	0	0	0	1	2.27

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Region	District	Drilling Shallow Well		Drilling Deep Well		Rehabilitation of Well		Piping Works		Water Supply Facility		Groundwater Survey		Other		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Rukwa	Sumbawanga	1	1.82	1	0.4	0	0	0	0	0	0	0	0	0	0	2	2.22
Ruvuma	Songea	0	0	2	0.79	0	0	1	2.7	0	0	0	0	0	0	3	3.49
Ruvuma	Tunduru	0	0	0	0	0	0	1	2.7	0	0	0	0	0	0	1	2.7
Ruvuma	Namtumbo	1	1.82	0	0	0	0	0	0	0	0	0	0	0	0	1	1.82
Shinyanga	Bariadi	1	1.82	3	1.19	0	0	1	2.7	1	4.55	0	0	0	0	6	10.3
Shinyanga	Kahama	0	0	2	0.79	0	0	1	2.7	0	0	0	0	0	0	3	3.49
Shinyanga	Kishapu	1	1.82	0	0	0	0	0	0	0	0	0	0	0	0	1	1.82
Shinyanga	Maswa	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Shinyanga	Meatu	1	1.82	1	0.4	0	0	0	0	0	0	0	0	0	0	2	2.22
Shinyanga	Shinyanga	0	0	2	0.79	1	2.27	1	2.7	0	0	3	4.84	0	0	7	10.6
Shinyanga	Shinyanga DC	0	0	0	0	0	0	0	0	0	0	1	1.61	0	0	1	1.61
Shinyanga	Shinyanga TC	0	0	0	0	0	0	0	0	0	0	1	1.61	0	0	1	1.61
Shinyanga	Shinyanga Region	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Shinyanga	Mwadui	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Singida	Iramba	1	1.82	1	0.4	1	2.27	0	0	0	0	0	0	0	0	3	4.49
Singida	Manyoni	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Singida	Singida	1	1.82	6	2.37	0	0	0	0	1	4.55	0	0	0	0	8	8.74
Singida	Singida DC	0	0	0	0	0	0	0	0	1	4.55	0	0	0	0	1	4.55
Singida	Singida Region	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Singida	Kiomboi	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Tabora	Igunga	0	0	0	0	0	0	1	2.7	0	0	1	1.61	0	0	2	4.31

Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project

Region	District	Drilling Shallow Well		Drilling Deep Well		Rehabilitation of Well		Piping Works		Water Supply Facility		Groundwater Survey		Other		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Tabora	Nzega	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Tabora	Tabora	0	0	3	1.19	1	2.27	0	0	0	0	0	0	0	0	4	3.46
Tabora	Urambo	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Tanga	Handeni	0	0	3	1.19	1	2.27	0	0	1	4.55	0	0	0	0	5	8.01
Tanga	Kilindi	1	1.82	0	0	0	0	0	0	0	0	0	0	0	0	1	1.82
Tanga	Korogwe	0	0	0	0	0	0	0	0	0	0	1	1.61	0	0	1	1.61
Tanga	Tanga	1	1.82	4	1.58	0	0	0	0	1	4.55	2	3.23	1	4.17	9	15.4
Unknown	Buli	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Unknown	Lundege	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	1	0.4
Unknown	Nkatu	0	0	0	0	0	0	0	0	1	4.55	0	0	0	0	1	4.55
Unknown	no info	0	0	0	0	0	0	0	0	0	0	1	1.61	0	0	1	1.61
Unknown	Private	0	0	0	0	0	0	0	0	0	0	1	1.61	0	0	1	1.61
	Total	55	100	253	100	44	100	37	100	22	100	62	100	24	100	497	700

(No. of Valid Cases: 94)

3.8.3 Contracts values awarded in the past three years

In this part we shall discuss the contract amounts for various types of works the companies were awarded. The average contract value for the shallow well in 2008/09 was around TZS 28.8 million whereas the average value of the shallow well almost doubled in 2009/10 before dropping to TZS 23.2 million in year 2010/11. The median values in all three cases are very far from the mean, which means that the data is highly skewed. For example in 2008/09 the average is TZS 28.8 million while the median is TZS 0.7 million, which means that half of the interviewed companies are charging less than 0.7 million for the shallow well. In this case the median value presents the better central tendency of the market price of drilling of shallow wells.

For the case of deep well the average contract values were TZS 370.5 million in 2008/09 then dropped to TZS 184.1 million in 2009/10 then increased a little bit to TZS 196.6 million in 2010/11. Similarly the values of the median in the three cases are very far from the mean. Since the median show half on the list, then the median values presents the better central tendency in this case than the average. The average contract values for the rehabilitation of the wells have been also on fluctuating up and down and the piping works however have been on increase constantly (see Table 3.23).

Table 3.23 Average value of water drilling contracts awarded in past three years

Contracted Works	Average & Median Value of Contracts					
	2008/09		2009/10		2010/11	
	Average	Median	Average	Median	Average	Median
Drilling shallow well (hand dug well)	28,797,059	700,000	48,660,882	12,000,000	23,203,421	6,000,000
Drilling deep well (borehole)	370,473,471	43,250,000	184,121,727	72,430,000	196,583,805	54,342,500
Rehabilitation of well	16,377,778	9,500,000	15,584,211	4,500,000	21,075,000	10,000,000
Piping works	17,052,000	3,000,000	38,342,888	3,000,000	58,317,500	13,000,000
Construction of water supply facility	89,461,538	10,000,000	61,369,231	17,000,000	69,143,846	17,000,000
Groundwater survey	10,390,000	4,000,000	19,218,000	5,000,000	9,972,917	6,000,000
Others	68,462,500	10,000,000	73,784,169	21,500,000	161,488,125	18,400,000

(No. of Valid Cases: 94)

3.8.4 Number of Wells Drilled in the Past Three Years

In 2009 there were a total of 1588 drilled wells, out of which 1,441 (about 91%) were successful. The majority of the wells were Type 2D (47.3% of all successful wells), followed by Type 1M (about 33% of all successful wells) and Type 2M (about 12% of all successful wells) (See table 3.24a).

Table 3.24 a) Number and Depth of Wells Drilled in 2009

Well Type	No. of Successful Wells			No. of Unsuccessful Wells			Total No. of Drilled Wells			Average Depth of All Wells Drilled (m)	
	Sum	Mean	Median	Sum	Mean	Median	Sum	Mean	Median	Mean	Median
1D	75	0.8	0	25	0.3	0	80	0.9	0	80	77.5
1M	479	5.2	0	16	0.2	0	495	5.3	0	105.8	80
2D	681	7.3	0	105	1.1	0	786	8.5	0	103.5	100

Well Type	No. of Successful Wells			No. of Unsuccessful Wells			Total No. of Drilled Wells			Average Depth of All Wells Drilled (m)	
	Sum	Mean	Median	Sum	Mean	Median	Sum	Mean	Median	Mean	Median
2M	168	1.8	0	3	0.0	0	171	1.8	0	95	100
3D	32	0.3	0	13	0.1	0	45	0.5	0	100	100
3M	6	0.1	0	5	0.1	0	11	0.1	0	350	350
Total	1441			167			1588				

(No. of Valid Cases: 94)

In 2010 there were a total of 1,687 drilled wells, out of which 1492 (about 88%) were successful. Similarly like the previous year, the majority of the wells were Type 2D (45.7% of all successful wells), followed by Type 1M (about 35.9% of all successful wells) and Type 2M (about 11.6% of all successful wells) (See table 3.24b).

Table 3.24 b) Number and Depth of Wells Drilled in 2010

Well Type	No. of Successful Wells			No. of Unsuccessful Wells			Total No. of Drilled Wells			Average Depth of All Wells Drilled (m)	
	Sum	Mean	Median	Sum	Mean	Median	Sum	Mean	Median	Mean	Median
1D	32	0.34	0	4	0.04	0	36	0.39	0	98.3	80
1M	535	5.75	0	21	0.23	0	556	5.98	0	89.5	80
2D	682	7.33	0	101	1.09	0	783	8.42	0	105	100
2M	173	1.86	0	37	0.4	0	210	2.26	0	104	100
3D	66	0.71	0	32	0.34	0	98	1.05	0	99	100
3M	4	0.04	0	0	0	0	4	0.04	0	150	150
Total	1492			195			1687				

(No. of Valid Cases: 94)

In 2011 there were a total of 2,062 drilled wells, out of which 1,800 (about 87.3%) were successful. The majority of the wells were Type 2D (45.5% of all successful wells), followed by Type 1M (about 37.8% of all successful wells) and Type 2M (about 13% of all successful wells) (See table 3.24c).

Table 3.24 c) Number and Depth of Wells Drilled in 2011

Well Type	No. of Successful Wells			No. of Unsuccessful Wells			Total No. of Drilled Wells			Average Depth of All Wells Drilled (m)	
	Sum	Mean	Median	Sum	Mean	Median	Sum	Mean	Median	Mean	Median
1D	40	0.43	0	11	0.12	0	51	0.55	0	92.3	85
1M	680	7.31	0	32	0.34	0	712	7.66	0	86.7	80
2D	819	8.81	0	150	1.61	0	969	10.4	0	113	100
2M	234	2.52	0	61	0.66	0	295	3.17	0	97.2	100
3D	27	0.29	0	8	0.09	0	35	0.38	0	92.5	85
3M	0	0	0	0	0	0	0	0	0		
Total	1800			262			2062				

(No. of Valid Cases:94)

3.8.5 Unit Price of Drilling Works and Pump Installation

The unit price for the drilling works and installation of pumps varies a lot among the interviewed drilling companies, in that case, the median values will better present the central tendency of the unit price for the drilling works than the average values. Table 3.25 presents the median of the unit price of drilling works and pump installation. It can easily be observed that the DTH wells are more expensive than the mud drilling.

Table 3.25 Unit Price of Drilling Works and Pump Installation (Median)

Contract Type	Item	Unit Price by Type of Well (Excluding VAT)					
		Type 1D	Type 1M	Type 2D	Type 2M	Type 3D	Type 3M
For Government/ LGA's	Drilling a successful well including drilling, development and pumping test (Tsh/ meter)	120,000	95,000	170,000	165,000	230,000	235,000
	Drilling an unsuccessful well for mud drilling excluding pumping test (Tsh/ meter)		70,000		100,000		120,000
	Drilling an unsuccessful well for DTH excluding PVC installation and development (Tsh/ meter)	109,000		110,000		140,000	
	Procurement and installation of pump (hand pump or submersible pump) (Tsh / pump)	2,500,000	1,800,000	3,850,000	3,250,000	4,100,000	3,000,000
For Private Institution/ Individuals	Drilling a successful well including drilling, development and pumping test (Tsh/ meter)	110,000	70,000	150,000	150,000	180,000	175,000
	Drilling an unsuccessful well for mud drilling excluding pumping test (Tsh/ meter)		60,000		70,000		120,000
	Drilling an unsuccessful well for DTH excluding PVC installation and development (Tsh/ meter)	85,000		100,000		110,000	
	Procurement and installation of pump (hand pump or submersible pump) (Tsh / pump)	1,500,000	1,000,000	1,800,000	1,600,000	1,675,000	1,500,000

3.8.4 Proportion of machinery costs to contracts amounts for drilling wells

The respondents were requested to approximate the percentage of machinery cost (e.g. depreciation of operation and maintenance cost of drilling rigs, accessories, vehicle and equipment) in a total contract price for drilling wells. According to the replies obtained from the drilling companies it show that the percentage of machinery cost vary from 3% to 90% of the contract amount with an average of 35% of the contract amount and the median is 36%. Since the median is approximately equal to the average, then the data can be considered to present a simple normal distribution.

The standard deviation in this part is 17.5, which is very high – this can be attributed to the fact that the interviewed companies vary a lot in the size of the company, the size of the equipment and the type of personnel who run the company. Figure 3.9 presents a better picture for proportion of the machinery costs to the contract amount.

There is only 1 company that showed that the proportion of the machinery costs is 90% and another 1 company which indicated that it is 70%. The two companies are taken as the extreme cases. Another extreme case is for the one company that indicated that the proportion of the machinery cost is 3%, this is too low for the depreciation and maintenance costs for the drilling rigs and accessories. Therefore the mean value (36%) and the median value (35%) can be taken as the better representation of the proportion of the machinery costs to the contract value.

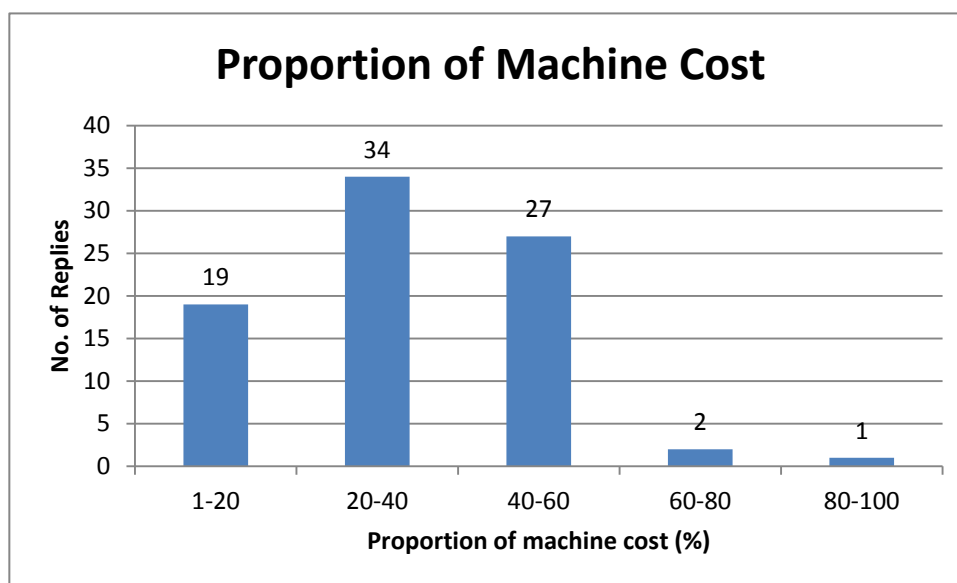


Figure 3.9: Proportion of machinery costs to the contract values

3.8.5 Process Management and Quality Control

In this section we shall analyse the average number of days for drilling a well and pump installation, methods of disposal of unsuccessful wells in the contracts and in the practice, terms and conditions related to warranty period in the contracts, and handling of application for the water use permit as well as groundwater permit.

a) Number of days for drilling a well and pump installation

Table 3.26 presents the average number of days taken for drilling the different types of wells and pump installation. It can be observed from the information depicted in table 3.19 that drilling of successful type 1D and type 2D of the well takes 5 days, type 1M takes 6 days, type 2M and type 3D takes 7 days and drilling of type 3M of the well takes 8 days. Pump installation is taking almost the same number of days the three types of wells.

Table 3.26 Average number of days for drilling a well and pump installation

	Average number of days required					
	Type 1D	Type 1M	Type 2D	Type 2M	Type 3D	Type 3M
Drilling a successful well including drilling, development and pumping test (days)	5	6	5	7	7	8
Drilling an unsuccessful well excluding PVC installation, development and pumping test (days)	3	3	2	3	4	4
Pump Installation (hand pump or submersible Pump) (days)	2	1	1	1	2	2

(No. of Valid Cases: 94)

b) Disposal of unsuccessful wells in the contracts

It was observed that the approximate percentage of unsuccessful well encountered by the drilling companies in average is 36%, maximum encountered unsuccessful well was 50% and minimum was 3%. Areas in which they encountered unsuccessful wells include: Arusha, Coast, Dar es Salaam, Dodoma, Iringa, Kilimanjaro, Lindi, Manyara, Mara, Mbeya, Morogoro, Mtwara, Mwanza, Njombe, Shinyanga, Singida, Tabora, and Tanga.

With regard to the measures taken for the unsuccessful wells when the company found dry hole in drilling works, the responses shows that 73 companies (78%) backfilled the dry wells, 1% left the hole open and 12% had other measures. For those who had other measures mentioned the following measures: use of cement plug, use concrete cover, capped the top, they handed it over to the client as it.

c) Methods of Backfilling

The respondents were requested to explain the methods they use for backfilling unsuccessful wells. The response for the backfilling of uncased wells are summarised in Table 3.27 and for the cased wells are in Table 3.28.

Table 3.27: Backfilling of uncased unsuccessful wells (multiple response)

Methods of Backfilling	Number of responses	% of Responses	% of Cases
Backfilling with drilled cuttings or sand without surface cementing	49	50.00	52.00
Backfilling with drilled cuttings or sand with surface cementing	30	30.61	32.00
Other (specify the answer	6	6.12	6.40
No experience	13	13.27	13.83
Total	98	100	104.23

(No. of Valid Cases: 94)

The data displayed in Table 3.27 show that the backfilling is done using drilled cuttings or sand. Some of the companies are cementing the surface (32%) and others are not cementing the surface (52%). Some 13.8% of the respondents have never experienced such situation while 6.4% of them use other methods such as covering with clay soil.

The methods that are used for backfilling of cased wells are as shown in Table 3.28. The four options for backfilling were all applicable according to the respondents. However, it seems that the simple majority are backfilling with drilled cuttings or sand with surface cementing for both annular space and inside casing (23.4%). This is followed in popularity with the backfilling with drilled cuttings or sand with surface cementing for only annular space (18.1%).

Table 3.28: Backfilling of cased unsuccessful wells (multiple response)

Methods of Backfilling	Number of responses	% of Responses	% of Cases
Backfilling with drilled cuttings or sand without surface cementing for only annular space	15	15.8	16.0
Backfilling with drilled cuttings or sand with surface cementing for only annular space	17	17.9	18.1
Backfilling with drilled cuttings or sand without surface cementing for both annular space and inside casing	8	8.4	8.5
Backfilling with drilled cuttings or sand with surface cementing for both annular space and inside casing	22	23.2	23.4
Other (specify the answer	10	10.5	10.6
No experience	23	24.2	24.5
Total	95	100	101.1

(No. of Valid Cases: 94)

Those who selected the “others” take the following measures for a cased unsuccessful well:

- They put a cap and cementing the round,
- They use gravel instead of drilled cuttings;
- Sometimes they use pipes of larger diameter, which is covered in one side to cover the casing;
- They pull out the casings then filling with cuttings,
- They remove casing then covering with PVC Carpet – i.e. they prepare a flat PVC and cover the hole;
- They refill or cement with PVC casing;
- They remove all pipes and then refilling;
- They back fill with drilled cuttings without cementing; and
- They protect the cased dry well by completing the construction.

The standard materials for backfilling are drilled cuttings (64%) and sand (14%). There are 20% of the respondents who selected “other”. Those who chose “other” specified the standard materials they use for backfilling as follows;

- gravel pack
- clay
- bentonite/ clay
- they put clay soil at the top
- they backfill by compaction
- they apply clay at the bottom and surface cement at the top

The standard depth from the top of the casing for backfilling with surface cementing is 1.6m on average and the median is 0.6m. The maximum depth is 10m and the minimum is 0.25m. It is

only three companies that wrote that the backfilling depth is 10m, which has somehow skewed the remaining data.

d) Method of covering the casing pipes

The respondents were asked to select the methods used for covering the casing pipes. They were given the following multiple options:

- Fitted with steel cover without pad lock;
- Fitted with steel cover with pad lock;
- Fitted with wooden cover;
- Closing by welding it with gas burner;
- Other (specify the answer);
- Remain the top opened

From the data depicted in table 3.29 it shows that there is no company that is leaving the top open. The majority are covering the casing pipes with a steel cover with a padlock (33%) followed by those who close the casing pipes by welding it with gas burner (21%).

Table 3.29: Methods of Covering the Casing Pipes (multiple response)

Methods of Backfilling	Number of responses	% of Responses	% of Cases
Fitted with steel cover without pad lock	4	4.1	4.3
Fitted with steel cover with pad lock	31	32.0	33.0
Fitted with wooden cover	9	9.3	9.6
Closing by welding it with gas burner	20	20.6	21.3
Other	32	33.0	34.0
Remain the top opened	1	1.0	1.1
Total	97	100	103.2

(No. of Valid Cases: 94)

There are 34% of the companies that showed “other” methods, which include:

- Covered with PVC
- using plastic cover
- iron cover with threads as that of the casing
- Remain back filled with surface cementing
- we just refill unless specified
- we put a piece of tree
- Fitted then covered with soil at the top
- using casing and closing
- Covered by a larger pipe filled by concrete

e) Warranty period in the contracts

The respondents were asked whether the terms and conditions on the warranty period were set in the contracts in which their companies had made with their respective clients in the past. From the summary of the results that are depicted in Table 3.30, the warranty clause is applied mostly to government and NGOs/Donors contracts as almost 52.1% of the respondents answered that all contracts with the government or NGO/Donor had the warranty clause. Meanwhile, it is rarely applied for the individual households. Only 22.3% of the respondents stated that all contracts with individual households had the terms and conditions on the warranty period.

Table 3.30: Warranty Period in the contracts

Client		Number of responses	% of Cases
Government	Yes, in all contracts	49	52.1
	Yes, in some of the contracts	13	13.8
	No, not at all	4	4.3
	No response	28	29.8
	Total	94	100
Private Company	Yes, in all contracts	34	36.2
	Yes, in some of the contracts	36	38.3
	No, not at all	9	9.6
	No response	15	16.0
	Total	94	100
Individual Households	Yes, in all contracts	21	22.3
	Yes, in some of the contracts	47	50.0
	No, not at all	20	21.3
	No response	6	6.4
	Total	94	100
NGOs/Donors	Yes, in all contracts	50	53.2
	Yes, in some of the contracts	13	13.8
	No, not at all	8	8.5
	No response	23	24.5
	Total	94	100

3.8.6 Business Projections

When asked whether their companies are interested in drilling works for projects funded by WSDP (the drilling works under WSDP means those which are procured by Local Government Authorities, Urban Water and Sewerage Authorities, or Ministry of Water for drilling of water wells to be used for water supply facilities (hand pumps and piped water supply schemes)), 99% of the responded company indicated that they are interested. There is only one company that showed that it is not interested drilling works for project funded by WSDP because they are more in service giving than business.

The companies were also asked to mention the obstacles that hinder them to participate and/or expand business opportunities in WSDP. The following were the multiple options that they were given to select:

- We cannot source sufficient investment fund for the business operation;
- Well qualified and skilled drillers are not enough in the labour market;
- Procurement rules for the drilling works under WSDP is too strict;
- Hydrogeological conditions of project areas are too difficult for us to operate; and
- Other (specify the answer)
- No obstacles are observed

Among the options given, it can be seen, from the information given in Table 3.31, that the main obstacle is the procurement rules under WSDP that are too strict (34% of the respondents). Another obstacle is that most of these drilling companies are small companies and they cannot source sufficient investment fund for the business operations (28.7% of the respondents).

Table 3.31: Obstacles to participate in WSDP (multiple response)

Methods of Backfilling	Number of responses	% of Responses	% of Cases
Cannot source sufficient investment fund for the business operation	27	20.1	28.7
Well qualified and skilled drillers are not enough in the labour market	10	7.5	10.6
Procurement rules for the drilling works under WSDP is too strict	32	23.9	34.0
Hydrogeological conditions of project areas are too difficult for us to operate	13	9.7	13.8
Other (specify the answer)	35	26.1	37.2
No obstacles are observed	17	12.7	18.1
Total	134	100	142.55

(No. of Valid Cases:94)

From the responses shown on Table 3.31 it is obvious that there were many other reasons than the options that were given in the questionnaire (37.2% of the respondents had other reasons). The reasons given by the participants include the following:

- No initial payments and delay in payments and corruption (2 responses);
- Delay in payment and corruption (8 responses);
- We have never participated (7 responses);
- Company policies restrict on types of tender to apply (1 response);
- Not Registered/ started recently (1 response);
- The first time to hear about WSDP /no experience/ I do not know WSDP (4 responses);
- Engineering Estimates for WSDP in drilling wells is low compared to the true market (1 response)

- No enough equipment specifically DTH, no equipment for testing the availability of water during drilling (1 response);
- High Competition (1 response);
- WSDP works are difficult to get (1 response);
- WSDP works are being given to the same companies (1 response);
- Water researches are not that perfect (1 response);
- Late response, Lack of feedback (1 response); and
- Accessibility due to Hydrological condition (1 response).

Four companies that selected the “other” options did not explain their obstacles. It seems that the lack of initial payment to start the drilling work, the late payments and corruption featured often in these responses and should be further investigated. Majority of the drilling companies are small firms and they do not have sufficient funds to run the whole drilling operation without the initial payments. If the payments are late, it makes the situation to be even worse.

3.9. External Environment

3.9.1 Laws & Regulations

a) Drilling Permit

In order to know whether the companies have knowledge on the water well drilling permit, the respondents were requested to show the latest year of renewal of the water well drilling permit at Ministry of Water. The companies that had valid drilling permit were 59 (63%), 26 companies out of the 94 interviewed companies (i.e. 28%) were not registered and 9 out of the 94 interviewed companies had already expired water well drilling permits.

b) Groundwater Permit and Water Use Permit

Furthermore, when they were asked, “Who applied for the groundwater permit to Basin Water Office in the past contracts before your company started the drilling, enlarging, or re-deepening wells?”, 54.3% of the respondent responded that it was the drilling company that applied for the groundwater permit, 50% of them claimed that it was the owner of the well (client) and 5.3% of them claimed that they don’t know about the groundwater permit. The responses are summarized on Table 3.32

Table 3.32: Application for Groundwater Permit (Multiple Responses)

Who applied for the groundwater permit	Number of responses	Percent of responses	% of Cases
Drilling company	51	49.04	54.3
Owner of the well (client)	47	45.19	50.0
Other (specify the answer	1	0.96	1.1
I don’t know about the groundwater permit	5	4.81	5.3
Total	104	100	110.7

(No. of Valid Cases:94)

The respondents were further asked, “Who applied for the water use permit to Basin Water Office for the drilled wells in the past contracts?” The responses to this question indicate that 77.7% of the respondents claimed that it was the owner of the well (client) who applied for the water use permit, while 18.1% claimed that it was the drilling company, and 11.7% of the respondents did not know about the water use permit. The responses are summarized on Table 3.33

Table 3.33: Application for Water Use Permit (multiple options)

Who applied for the water use permit to Basin Water Office for the drilled wells in the past contracts?	Number of responses	% of responses	% of Cases
Drilling company	17	16.67	18.1
Owner of the well (client)	73	71.57	77.7
Other (specify the answer	1	0.98	1.1
I don't know about the water use permit	11	10.78	11.7
Total	102	100	108.6

(No. of Valid Cases:94)

3.9.2 Relation with DDCA

In searching for the perception of the drilling companies on the relationship between them and DDCA, the respondents were asked, “Which statements below explain the relation of DDCA to your company most appropriately in your perception?” And they were given the following multiple options:

- DDCA is one of our competitors;
- DDCA provides us technical advice for drilling works;
- DDCA hire drilling equipment to us;
- DDCA is a regulator for drilling works in the water sector; and
- Other (specify the answer).

The respondents’ answers are as summarised in Table 3.34. Table 2.34 shows that the drilling companies considers DDCA to be their competitor in the drilling industry (37.2% of the respondents), but 43.6% considers DDCA as a provider of the technical advice for the drilling works. It seems that it is only a handful of companies that know the existence of the hiring of drilling equipment services at DDCA, because it is only a 22.3% of the interviewed companies that consider DDCA as an institution that hire drilling equipment to the drilling companies. Others (18.1%) consider DDCA as a regulator for the drilling works in the water sector.

**Table 3.34: Perception of the Drilling Companies on their relationship with DDCA
(multiple response)**

Perception of the Drilling Companies	Number of responses	% of Responses	% of Cases
DDCA is one of our competitors	35	27.1	37.2
DDCA provides us technical advice for drilling works	41	31.8	43.6
DDCA hire drilling equipment to us	21	16.3	22.3
DDCA is a regulator for drilling works in the water sector	17	13.2	18.1
Other	15	11.6	16.0
Total	129	100	137.2

(No. of Valid Cases: 94)

The majority of those who selected the “other” option mentioned that they do not have any working experience with the DDCA. But some of them commented the following:

- DDCA is a government agency for drilling water wells;
- DDCA creates unfair competition; and
- A lot of drilling works are given to DDCA as a priority.

Regarding the experiences in using services of DDCA apart from hiring of drilling equipment, the summary of the results shows that (see table 3.35):

- Only 2.1% of the interviewed companies had used the service of hiring drilling operators;
- 40.4% of the interviewed companies had used the technical advice for drilling works;
- 47.9% of the interviewed companies had used hydrogeological information of the drilling site; and
- 36.2% had no experience in using other technical support services by DDCA

Table 3.35: Experience in using services of DDCA (Multiple Options)

Experience in Using Services of DDCA	Number of Responses	% of responses	% of valid cases
Hiring drilling operators	2	1.6	2.1
Provision of technical advice for drilling works	38	30.6	40.4
Provision of hydrogeological information of the drilling site	45	36.3	47.9
Other	5	4.0	5.3
No experience in using other technical support services by DDCA	34	27.4	36.2
Total	124	100	131.9

(No. of Valid Cases:94)

For those who selected the “other” option in the questionnaire had used the following services from DDCA:

- Hiring of Geophysical equipment;
- Getting individual technical advice;
- Using DDCA’s technical experts; and

- For conducting pumping test.

In order to get the contents of support services the drilling companies are expecting to get from DDCA, the interviewer asked the drilling companies, “What kind of technical support services would your company expect from DDCA except for the drilling equipment hiring services?” The respondents were given the following multiple options to select:

- Provision of technical advice for drilling works on site;
- Provision of hydrogeological information of the drilling site;
- Other (specify the answer; and
- We are not interested in accessing technical support services from DDCA

The summary of the replies of the drilling companies is as shown in Table 3.36. It seems that the majority (83%) of the respondents are expecting to get hydrogeological information of the drilling site from DDCA. They also expect to get technical advice for the drilling works on site and only few of them (only 4.3%) are not interested in accessing technical support services from DDCA.

Table 3.36: Contents of Support Services Expected from DDCA (multiple response)

Expected Services	Number of responses	% of Responses	% of Cases
Provision of technical advice for drilling works on site	55	37.9	58.5
Provision of hydrogeological information of the drilling site	78	53.8	83.0
Other (specify the answer	8	5.5	8.5
We are not interested in accessing technical support services from DDCA	4	2.8	4.3
Total	145	100	154.3

(No. of Valid Cases: 94)

There are 10 respondents who selected the “other” option which includes the following:

- Location data and geological information;
- Well information from DDCA data bank; and
- Assistance in water quality measuring.

The respondents were asked, “What kind of hydrogeological information would your company like to access to at DDCA if the agency makes data of its drilling works available to the private companies?” Their responses are as summarised on Table 3.37, in which we see that the private companies would like to have information on:

- Success rate of drilling in certain area (79.8%);
- Maximum, Minimum and Average Drilling Depth of existing wells in certain area (87.2%);
- Detailed structures of existing wells in certain area (70.2%);
- Water Quality of existing wells in certain area (71.3%); as well as
- Water Level, Discharge Rate of existing wells in certain area (67%).

Table 3.37: Hydrogeological information requirements by Private Companies Expected from DDCA (multiple response)

Hydrogeological information required from DDCA if the agency makes data of its drilling works available to the private companies	Number of responses	% of responses	% of cases
Success rate of drilling in certain area	75	20.9	79.8
Maximum, Minimum and Average Drilling Depth of existing wells in certain area	82	22.8	87.2
Detailed structures of existing wells in certain area	66	18.4	70.2
Water Quality of existing wells in certain area	67	18.7	71.3
Water Level, Discharge Rate of existing wells in certain area	63	17.5	67.0
Others	3	0.8	3.2
None	3	0.8	3.2
Total	359	100	381.9

(No, of valid cases: 94)

When asked whether or not their companies are willing to pay for utilizing the support services to be provided by DDCA, 86 out 94 interviewed companies (91%) said “Yes”, indicating that they are willing to pay for the services rendered to them.

3.10. Needs for Drilling Equipment Hiring Service

3.10.1 Availability of Drilling Equipment Hiring Service

The interviewed companies were asked whether they have ever hired drilling rig(s) from DDCA or other private companies. This question aims at exploring their experiences in using drilling equipment hiring service for construction of water wells in the past. 48 companies (51% of all interviewed companies) indicated that they have previously used hiring services, but 46 companies (49% of them) have never used hiring services.

The respondents were requested to write down the list of companies from which their drilling companies hired the drilling rig(s) in the past. The answer to this part indicates the availability of drilling equipment hiring services. There were 53 companies, which were mentioned as offering the hiring services. The following companies were mentioned as the ones that offer the hiring services of the drilling equipment (Table 3.38).

Table 3.38: List of Companies Offering Drilling Equipment Hiring Services

s/no.	Hiring Drilling Company	Number of Responses
1	AI- WATER WELL DRILLERS	4
2	AL-SALLAF DRILLING WATER WELLS	1
3	AL-TACHI Investments	1

s/no.	Hiring Drilling Company	Number of Responses
4	AL-TTAI DRILLING CO	11
5	AQUA WATER	7
6	AQUA WELL DRILLING	2
7	AQUAMAN DRILLERS	1
8	Ardhi Water Wells	1
9	BADELA	2
10	BAHADELA DRILLING CO	2
11	Chemchem (Arusha)	1
12	CHIMBA DRILLING COMPANY	1
13	DDCA	13
14	DON- CONSULT LTD	2
15	EFAM CO. LTD	1
16	Global Tech Drilling & Exploration Co. Ltd	1
17	Great Lakes	1
18	HARNES AFRICA	1
19	HYROTECH DRILLING CO.LTD	6
20	Humac Laboratories Ltd	1
21	Humac Services Ltd	1
22	Individuals	4
23	Islamic Foundation (Morogoro)	1
24	JEMA DRILLERS	1
25	Karumba	1
26	Kisangani Group	1
27	LEON Water Resources	1
28	M/S ALTAE WATER WELL (Tanzania)	1
29	M/S KAJURU DRILLING (Kenya)	1
30	M/S SNUPPRO (Tanzania)	1
31	MAJI TECH	1
32	Maji Tech (Arusha)	1
33	Maswi Drilling Co. Ltd	2
34	NILE WATER DRILLING	1
35	O.C.I	3
36	Perkshi Company	1
37	Pirikon Company	1
38	PNR DRILLING SERVICES	3
39	PP SETY	1
40	PRECIOUS BLOOD FATHERS-DODOMA	1
41	RAMAN Iuv	1
42	SalumSeif	1
43	Seba Construction	1
44	SMS DRILLING CO.	1
45	Snub Pro	1

s/no.	Hiring Drilling Company	Number of Responses
46	Sparr Drilling Co. Ltd	1
47	Uvinju Group	1
48	VACUUM	1
49	VICTORIA	1
50	Victoria Boreholes Drilling Co. Ltd	1
51	VICTORIA DRILLING	2
52	Water Solution	1
53	WINAM DRILLING COMPANY	1

By observing the number of companies that are involved in hiring of drilling rigs to another company, it is obvious that there is no single company whose sole business is the hiring of drilling equipment. Each of the mentioned companies above are also doing the drilling works, which implies that the drilling rig hiring services is missing in Tanzania.

The hiring costs of the drilling rigs were given in three categories: per well, per meter and per day. Table 3.39 gives a picture of the costs of hiring of the drilling rigs per well. The maximum cost indicated for hiring of the drilling rig per well is TZS 16.5million but it can be as low as TZS 100 thousands only depending on the type of the drilling rig. The median is TZS 2million.

Table 3.39: Hiring costs of Drilling Rigs

	Hiring drilling rig per Well	Hiring drilling rig per Meter	Hiring drilling rig per Day
Maximum	16,500,000	4,000,000	2,500,000
Minimum	100,000	35,000	500,000
Average	4,604,255	445,625	1,200,000
Median	2,000,000	115,000	600,000
Standard Deviation	4,657,589	1,019,475	1,126,943

However, the maximum cost for hiring of the drilling rig per meter is TZS 4 million but it can be as low as TZS 35 thousands only depending on the type of the drilling rig. The median is TZS 115 thousands. And the maximum cost for hiring of the drilling rig day is TZS 2.5million but it can be as low as TZS 500 thousands per day. The median is TZS 600 thousands.

3.10.2 Needs for Hiring Service of DDCA

In order to explore the willingness of the surveyed drilling companies to use DDCA's drilling equipment hiring service to participate in drilling works under WSDP, the respondents were asked about options the company would prefer for the service. The multiple options given to the respondents are as follows;

- Only Drilling Rig;
- Rig with Technical Staff from DDCA;

- Only Technical Staff from DDCA;
- Others (specify; and
- None

The responses from the companies which expressed interest in using the hiring service of drilling rigs from DDCA (i.e. 83 companies) show that 25.3% of the respondent preferred to hire drilling rig only; 79.5% preferred rig with technical staff from DDCA; 4.8% wanted to have only technical staff from DDCA, 2.4% had other request (they mentioned drilling equipment and work equipment, and material). This situation is summarized on Table 3.40

Table 3.40: Preferred type of Hiring Services from DDCA (multiple response)

Preference of the Hiring Services	No of Responses	% of responses	% of cases
Only Drilling Rig	21	22.6	25.3
Rig with Technical Staff from DDCA	66	71.0	79.5
Only Technical Staff from DDCA	4	4.3	4.8
Others	2	2.2	2.4
Total	93	100	112

(No. of Valid Cases: 83)

To further explore their specific needs, the drilling companies which are interested in hiring drilling rigs from DDCA were asked to indicate the supporting equipment their companies would like to hire together with the drilling rig. They were given the following multiple options to select:

- Rig Accessories and Work Tools;
- Truck-mounted or trailer-mounted air-compressor for DTH Drilling;
- Truck-mounted or trailer-mounted mud pump for Mud Drilling;
- Cargo Truck with Crane;
- Water Tank Truck;
- Generator;
- Pumping Test Equipment;
- Fishing Tools;
- Others (specify; and
- None

Table 3.41 summarises the needs for the support equipment for those who showed interest in hiring drilling rigs. The responses from the companies who are interested in hiring drilling rigs from DDCA show that 71% of the drilling companies preferred Rig Accessories and Work Tools; 69% wanted to have Truck-mounted or trailer-mounted air-compressor for DTH Drilling; 50% needed Truck-mounted or trailer-mounted mud pump for Mud Drilling; 29% needed Cargo Truck with Crane; 31% preferred to have Water Tank Truck; 33% wanted to have Generator; 42% wanted to have Pumping Test Equipment; 46% selected to have Fishing Tools; 46%

selected had “Others” option;. Therefore, it is clear that needs of the drilling companies are high in terms of hiring accessories and supporting equipment together with the drilling rigs..

Table 3.41: Preferred type of Hiring Services from DDCA (multiple response)

Support Equipment needed	No of Responses	% of responses	% of cases
Rig Accessories and Work Tools	68	19.0	81.9
Truck-mounted or trailer-mounted air-compressor for DTH Drilling	66	18.5	79.5
Truck-mounted or trailer-mounted mud pump for Mud Drilling	47	13.2	56.6
Cargo Truck with Crane	28	7.8	33.7
Water Tank Truck	29	8.1	34.9
Generator	31	8.7	37.3
Pumping Test Equipment	40	11.2	48.2
Fishing Tools	44	12.3	53.0
Others (specify	4	1.1	4.8
Total	357	100	430.1

(No. of Valid Cases: 83)

Furthermore, the respondents were requested to indicate personnel from DDCA their companies would like to accompany with a drilling rig to carry out drilling work. There were 66 companies that indicated that they would like to hire the equipment with the technical personnel. Table 3.42 is summarizing the needs of the drilling companies for the support of the technical personnel. Most of the drilling companies (62.1%) would like to be accompanied by a technical instructor who will teach the operation of machine, and also 56.1% of them would like to be accompanied by a drilling supervisor who will control the drilling work of your drilling team. The rest of the responses are as summarized in Table 3.42

Table 3.42: Preferred type of Technical Personnel to accompany drilling rig (multiple response)

Preferred type of technical personnel to accompany the drilling rig	No of Responses	% of responses	% of cases
A technical instructor who will teach the operation of machine	41	28.7	62.1
A drilling supervisor who will control the drilling work of your drilling team	37	25.9	56.1
Mechanic who will carry out the daily maintenance of hired equipment	30	21.0	45.5
Mechanic who will teach the daily maintenance of hired equipment to your mechanic	32	22.4	48.5
Others (specify	3	2.1	4.5
Total	143	100	216.7

(No. of Valid Cases: 66)

The respondents were asked to mention expected benefits from using the hiring service of drilling rigs from DDCA. They were given the following multiple options:

- Increase of number of contracts which our company can work for WSDP;
- Eligibility to participate in bidding for the drilling works under WSDP;
- Reduction of investment costs for the drilling equipment;
- Other (specify the answer; and
- Not applicable

Table 3.43 summarises the results of their responses. The responses show that 85.5% of them selected “Increase of number of contracts which our company can work for WSDP”; 62.7% of them selected “Eligibility to participate in bidding for the drilling works under WSDP”; 47% selected “Reduction of investment costs for the drilling equipment”; and 4.8% selected “Other” option. Those who selected “other” expressed expected benefits as gaining new knowledge, doing big job in a short time and improve company’s reputation.

Table 3.43: Benefits from using the hiring service of drilling rigs from DDCA (multiple response)

Preferred type of technical personnel to accompany the drilling rig	No of Responses	% of responses	% of cases
Increase of number of contracts which our company can work for WSDP	71	42.8	85.5
Eligibility to participate in bidding for the drilling works under WSDP	52	31.3	62.7
Reduction of investment costs for the drilling equipment	39	23.5	47.0
Others	4	2.4	4.8
Total	166	100	200

(No. of Valid Cases: 83)

There were 11 companies that indicated that they are not interested in hiring equipment from DDCA. These 11 companies were asked to give out its reasons, why they are not interested in using the hiring services of the facilities offered by DDCA. They were given the following multiple options to select:

- We have enough number of drilling rigs;
- We are not interested in participating in the drilling works under WSDP;
- We do not have enough financial capacity to afford the hiring cost; and
- Other (specify the answer)

The responses from the interviewed drilling companies show that 10 out of the 11 (i.e. 90.9% of those who are not interested in hiring drilling rigs indicated that they have enough number of drilling rigs and 2 companies showed that they do not have enough financial capacity to afford the hiring cost and 2 companies had other reasons. For the 2 companies had other reasons and they mentioned the followings:

- They are dealing only with shallow wells (20-30m); and
- They plan to buy their own machines.

4. Preliminary Analysis

4-1. Categorization of Private Drilling Companies by Resources and Business Plan

In this chapter we shall categorise the interviewed drilling companies using the following parameters:

- i) Resources including equipment, human resources, and drilling techniques to conduct drilling works in basement rock areas and/or sedimentary layer areas
- ii) Current operation and future business plan to respond to demands for drilling works under WSDP
- iii) Interest in using DDCA's drilling equipment hiring services to participate in WSDP

The output of this categorization will be used to assess degree of expected positive impact of the project, i.e. contribution to drilling of wells under WSDP, to each group of companies. Table 4.1 shows the characterisation used in categorizing the drilling companies.

Table 4.1 Characteristics of Each Group of the Drilling Companies

Group	Characteristics
Group A :	<ul style="list-style-type: none"> - Has resources to drill water wells in basement rock areas. - Currently operates the drilling works for WSDP demands in basement rock areas.
Group B :	<ul style="list-style-type: none"> - Has resources to drill water wells in basement rock areas. - Currently operates the drilling works for demands from private sector only.
Group C :	<ul style="list-style-type: none"> - Has resources to drill water wells in sedimentary layer areas only. - Has a business plan to respond to WSDP demands while currently operates the drilling works for demands from private sector only. - Is interested in using DDCA's drilling equipment hiring service to participate in WSDP.
Group D :	<ul style="list-style-type: none"> - Has resources to drill water wells in sedimentary layer areas only. - Currently operates the drilling works for demands from private sector only. - Is interested in using DDCA's drilling equipment hiring service to participate in WSDP.
Group E :	<ul style="list-style-type: none"> - Has resources to drill water wells in basement rock areas. - currently operates the drilling works for WSDP demands in inland areas. - Is not interested in using DDCA's drilling equipment hiring service to expand business opportunities in WSDP.
Group F :	<ul style="list-style-type: none"> - has resources to drill water wells in basement rock areas. - Currently operates the drilling works for demands from private sector only. - Is not interested in using DDCA's drilling equipment hiring service to participate in WSDP.
Group G :	<ul style="list-style-type: none"> - Has resources to drill water wells in sedimentary layer areas only. - Currently operates the drilling works for WSDP demands in sedimentary layer areas only and has no future plan to do business in basement rock area under WSDP. - Is not interested in using DDCA's drilling equipment hiring service.

Group H :	<ul style="list-style-type: none"> - Has resources to drill water wells in sedimentary layer areas only. - Currently operates the drilling works for demands from private sector only. - Currently operates the drilling works for demands from private sector only and has no future plan to do business in WSDP. - Is not interested in using DDCA's drilling equipment hiring service.
-----------	---

The information shown in Table 4.2 indicates the level of potential of the project impact according to the set items of categorization. The key to the numerical value used is that 5 = Highest potential 1 = No potential.

Table 4.2: Assessment of the level of potential of Project Impact following the categorization

Resources (Equipment, Human Resource, Techniques)		Business Operation and Future Plan			Interest in DDCA's Hiring Services to Respond to WSDP Demand		Group	Level of Potential of Project Impact
For Basement Rocks	For Sedimentary Layer	Responding to WSDP Demand	Responding to Private Demand	Future Plan for WSDP	Interested	Uninterested		
x		x			x		A	3
x			x	x	x		B	
	x		x	x	x		C	5
	x		x		x		D	4
x		x				x	E	2
x			x			x	F	1
	x	x				x	G	3
	x		x			x	H	1

Based on the assessment of the level of potential of project impact described in Table 4.2, the companies surveyed can be grouped as listed in Table 4.3.

Table 4.3: Classification of the Interviewed Drilling Companies

Company Name	Resources (Equipment, Human Resource, Techniques)		Interested in Participating in WSDP		Interest in DDCA's Drilling Equipment Hiring Services to Respond to WSDP Demand		Clients of the Drilling Companies				Group
	for basement rock areas	for sedimentary layer only	Interested	Un-interested	Interested	Un-interested	Gov/ LGA	Private Companies	Individual Households	NGO	
AI-Water Well Drillers		x	x		x		x	x	x	x	C
AL-TTAI Drilling company Ltd		x	x		x		x	x	x	x	C
Amini Tech Company Ltd		x	x		x		x	x	x	x	C
Aqua Well drilling Company Ltd	x		x		x		x	x	x		A
Aquaman Drillers Ltd		x	x		x		x	x	x	x	D
Ardhi Water Wells Ltd	x		x		x		x	x	x	x	A
Arusha Aggregates Ltd		x	x		x		x	x	x		C
AS Drilling Company Ltd		x	x		x				x	x	C
Ashraf Water Wells Drilling Company		x	x		x		x	x	x	x	C
B.R.A		x	x		x			x	x		C
Bahadele Drilling Company		x	x		x		x	x	x		C
Basat contractors Ltd		x	x		x		x	x			C
Bubujiko Enterprises		x	x		x		x	x	x	x	C
Chem chem Drilling Co. Ltd		x	x		x		x	x	x		C
Chem Chem Well Drilling Company		x	x		x			x	x	x	C
Chimba Resources	x		x		x		x	x	x	x	A
CMG Construction Company Ltd	x		x		x		x	x	x	x	A
Coast Water Well Company		x	x		x			x	x		C
Drill Mat & Ground Water Services Ltd		x	x		x		x		x	x	C
Drilling Spares and Services Ltd	x		x			x	x	x	x	x	E
Efam Limited		x	x		x		x	x	x		C

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Company Name	Resources (Equipment, Human Resource, Techniques)		Interested in Participating in WSDP		Interest in DDCA's Drilling Equipment Hiring Services to Respond to WSDP Demand		Clients of the Drilling Companies				Group
	for basement rock areas	for sedimentary layer only	Interested	Un-interested	Interested	Un-interested	Gov/ LGA	Private Companies	Individual Households	NGO	
ELCT Southern Dioces (Konde Diocese)		x	x			x			x	x	H
Future Century Limited		x	x		x		x	x	x		C
Gaimo Construction Co. Ltd		x	x		x		x	x	x	x	C
Gem and Rock Ventures Co. Ltd	x		x		x		x	x	x	x	F
Germany and Tanzania Drilling Partnership Co. Ltd (GETA)	x		x		x			x			B
Global Resource Alliance-TZ	x		x		x		x	x	x		A
Global Tech Drillig and Exploration Ltd		x	x		x		x	x	x	x	C
GroundwaterExploration & Well Construction Co. Ltd		x	x		x		x	x	x	x	C
Ham Drillers Ltd	x		x		x				x		A
Himalaya Enterprises LTD		x	x		x			x	x		C
Holland Farm Ltd		x	x		x		x	x	x	x	C
Humac Services Ltd		x	x		x		x	x	x	x	C
Hydro Tech (T) Ltd	x		x			x	x	x	x	x	E
J.N.M Mining Services Ltd		x	x		x			x	x		C
Kikim Building Geotechnical and Drilling Contractors		x	x		x		x	x	x	x	C
Kilimanjaro Water Well Drilling		x	x		x		x	x	x	x	C
Kimani Minerals Ltd		x	x		x		x	x	x		C
K'S Interprice LTD	x		x		x			x	x		A
Layne Drilling (T) Ltd	x		x			x		x		x	E
Leone Resources Development Company Limited		x	x		x			x	x		C
Lima Economic and Development group	x		x		x		x	x	x	x	A
Lugoba Stones and Construction Co. Ltd		x	x		x		x	x	x	x	C
Lweru Water Wells Drilling Company Ltd		x	x		x			x	x		C

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Company Name	Resources (Equipment, Human Resource, Techniques)		Interested in Participating in WSDP		Interest in DDCA's Drilling Equipment Hiring Services to Respond to WSDP Demand		Clients of the Drilling Companies				Group
	for basement rock areas	for sedimentary layer only	Interested	Un-interested	Interested	Un-interested	Gov/ LGA	Private Companies	Individual Households	NGO	
M & M(T) Ltd		x	x		x		x	x	x	x	C
Maji Tech Engineering Ltd	x		x		x		x	x	x	x	A
Make Eng and Water Works Ltd	x		x		x		x	x	x	x	A
Marata Plumbers & Drillers Ltd		x	x		x		x	x	x	x	C
Maswi drilling company Ltd	x		x		x		x	x	x		A
Mavonda's Company Ltd		x	x		x					x	C
MC Water Wells Drilling Co. Ltd		x	x		x			x	x		C
MR. Water Drilling Company Ltd		x	x		x		x		x	x	C
Msabi(Maji Safi kwa Afya Bora Ifakara)		x	x		x		x	x	x		C
Muwanya Well Drilling	x		x		x			x	x		A
Nassa GeneralTraders Limited		x	x		x		x	x	x	x	C
Nile Well Drillers (Sole Proprietor)		x	x		x			x	x		C
Nyakilang'anyi Construction Ltd	x		x		x		x		x		A
O.C. I Industrial Holdings Ltd	x		x		x		x	x	x	x	A
Oroteti Ltd		x	x			x	x	x	x	x	G
Paramount Drill Wells Limited		x	x		x				x		C
PNR Services Ltd	x		x			x	x	x	x	x	E
Rahmy Company Ltd		x	x		x			x	x		C
Rehoboth Mining and Water Well Drilling Co		x	x		x			x	x		C
Research and Ground Water Drilling Co. Ltd (REGWA)	x		x		x		x				A
RRS Water Well Drilling Company		x	x		x		x		x		C
Ruko's Genaral Supplies Co. Ltd	x		x			x		x	x		E
Seba Drilling and Construction Ltd	x		x		x		x	x	x	x	A

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Company Name	Resources (Equipment, Human Resource, Techniques)		Interested in Participating in WSDP		Interest in DDCA's Drilling Equipment Hiring Services to Respond to WSDP Demand		Clients of the Drilling Companies				Group
	for basement rock areas	for sedimentary layer only	Interested	Un-interested	Interested	Un-interested	Gov/ LGA	Private Companies	Individual Households	NGO	
Serengeti Ltd	x		x		x		x				A
Serving Friends International	x			x		x	x				F
Shy Builders Ltd		x	x		x		x	x	x	x	C
SMS Amour Investment	x		x		x		x	x	x		A
SN-TECH (T) Ltd		x	x		x		x	x	x	x	C
Snub Pro Africa Ltd	x		x		x			x	x	x	A
Societ of the Precious Blood Water Project		x	x			x	x	x	x	x	G
Southern Highlands Participatory Organisation (SHIPO)		x	x			x			x	x	G
Sparr Drilling Company Ltd		x	x			x	x	x	x	x	G
Star Water Pumps	x		x		x					x	A
Sustainable Environment Management Action(SEMA)		x	x		x		x	x	x	x	C
Talha Water Well Drillers Ltd		x	x		x			x	x		C
Techno Drillers Co. Ltd	x		x		x			x	x		A
Uchama Drilling and Biogas Services		x	x		x		x		x		C
UK Global Trading Ltd		x	x		x				x		C
Vacuum Rotary Drilling Company	x		x		x		x	x	x	x	A
Water and Environmental Development Company Ltd		x	x		x		x				C
Water International Services LTD	x		x			x	x	x	x	x	E
Water Solutions Drilling Co. Ltd		x	x		x		x	x	x		C
Water Well Services Ltd		x	x		x			x	x		C
Water Wells Services Ltd		x	x		x		x	x	x	x	C
Watter Hub Tanzania LTD		x	x		x		x	x	x	x	C
Wells Technology Co. Ltd	x		x		x		x	x	x	x	A

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Company Name	Resources (Equipment, Human Resource, Techniques)		Interested in Participating in WSDP		Interest in DDCA's Drilling Equipment Hiring Services to Respond to WSDP Demand		Clients of the Drilling Companies				Group
	for basement rock areas	for sedimentary layer only	Interested	Un-interested	Interested	Un-interested	Gov/ LGA	Private Companies	Individual Households	NGO	
WEPMO (Water & Environmental Sanitation Projects Maintenance Organization)		x	x		x		x	x	x	x	C
Willy Enterprises Ltd	x		x		x		x	x	x	x	A
Winam General Traders Ltd		x	x		x		x		x	x	C
World Islamic Propagation and Humanitarian Services (WIPAHS)	x		x		x			x	x	x	A

From the analysis that was done in Table 4.3, it is now possible to come with the following groupings as shown in Table 4.4

Table 4.4: Grouping of the interviewed companies according to their capacities and interests

Group	Characteristics
Group A	<p>The following companies have resources to drill water wells in basement rock areas and are currently operates the drilling works for WSDP demands in basement rock areas):</p> <ul style="list-style-type: none"> • Aqua Well drilling Company Ltd • Ardhi Water Wells Ltd • Chimba Resources • CMG Construction Company Ltd • Global Resource Alliance-TZ • Ham Drillers Ltd • K'S Interprice LTD • Lima Economic and Development group • Maji Tech Engineering Ltd • Make Eng and Water Works Ltd • Maswi drilling company Ltd • Muwanya Well Drilling • Nyakilang'anyi Construction Ltd • O.C. I Industrial Holdings Ltd • Research and Ground Water Drilling Co. Ltd (REGWA) • Seba Drilling and Construction Ltd • Serengeti Ltd • SMS Amour Investment • Snub Pro Africa Ltd • Star Water Pumps • Techno Drillers Co. Ltd • Vacuum Rotary Drilling Company • Wells Technology Co. Ltd • Willy Enterprises Ltd • World Islamic Propagation and Humanitarian Services (WIPAHS)
Group B	<p>The companies that have resources to drill water wells in basement rock areas and are currently operating the drilling works for demands from private sector only (i.e. those who had contracts with Private Companies, Individual Households, and NGO/ Donor but not with the government) are the following:</p> <ul style="list-style-type: none"> • Germany and Tanzania Drilling Partnership Co. Ltd (GETA)
Group C	<p>The following companies have resources to drill water wells in sedimentary layer areas only and they have business plan to respond to WSDP demands (i.e. the companies are interested in participating in water drilling works under WSDP).</p> <ul style="list-style-type: none"> • UK Global Trading Ltd • AI-Water Well Drillers • AL-TTAI Drilling company Ltd • Amini Tech Company Ltd • Arusha Aggregates Ltd • AS Drilling Company Ltd • Ashraf Water Wells Drilling Company

	<ul style="list-style-type: none"> • B.R.A • Bahadele Drilling Company • Basat contractors Ltd • Bubujiko Enterprises • Chem chem Drilling Co. Ltd • Chem Chem Well Drilling Company • Coast Water Well Company • Drill Mat & Ground Water Services Ltd • Efam Limited • Future Century Limited • Gaimo Construction Co. Ltd • Global Tech Drillig and Exploration Ltd • GroundwaterExploration & Well Construction Co. Ltd • Himalaya Enterprises LTD • Holland Farm Ltd • Humac Services Ltd • J.N.M Mining Services Ltd • Kikim Building Geotechnical and Drilling Contractors • Kilimanjaro Water Well Drilling • Kimani Minerals Ltd • Leone Resources Development Company Limited • Lugoba Stones and Construction Co. Ltd • Lweru Water Wells Drilling Company Ltd • M & M(T) Ltd • Marata Plumbers & Drillers Ltd • Mavonda's Company Ltd • MC Water Wells Drilling Co. Ltd • MR. Water Drilling Company Ltd • Msabi(Maji Safi kwa Afya Bora Ifakara) • Nassa GeneralTraders Limited • Nile Well Drillers (Sole Proprietor) • Paramount Drill Wells Limited • Rahmy Company Ltd • Rehoboth Mining and Water Well Drilling Co • RRS Water Well Drilling Company • Shy Builders Ltd • SN-TECH (T) Ltd • Sustainable Environment Management Action(SEMA) • Talha Water Well Drillers Ltd • Uchama Drilling and Biogas Services • Water and Environmental Development Company Ltd • Water Solutions Drilling Co. Ltd • Water Well Services Ltd • Water Wells Services Ltd • Watter Hub Tanzania LTD • WEPMO (Water & Environmental Sanitation Projects Maintenance Organization) • Winam General Traders Ltd
Group D	<p>The following companies have resources to drill in sedimentary layer only</p> <ul style="list-style-type: none"> • Aquaman Drillers Ltd

Group E	<p>The following companies have resources to drill water wells in basement rock areas and they are currently operating the drilling works for WSDP demands in inland areas but they are not interested in using DDCA's drilling equipment hiring service to expand business opportunities in WSDP:</p> <ul style="list-style-type: none"> • Drilling Spares and Services Ltd; • Hydro Tech (T) Ltd; • Layne Drilling (T) Ltd; • PNR Services Ltd; • Ruko's Genaral Supplies Co. Ltd; and • Water International Services LTD
Group F	<p><i>There is only one company (Layne Drilling (T) Ltd) that has resources to drill water wells in basement rock areas and it currently operates the drilling works for demands from private sector only and it is not interested in using DDCA's drilling equipment hiring service to participate in WSDP.</i></p>
Group G	<p>The following companies have resources to drill water wells in sedimentary layer areas only. Currently operates the drilling works for WSDP demands in sedimentary layer areas only and they are not interested in using DDCA's drilling equipment hiring service.</p> <ul style="list-style-type: none"> • Oroteti Ltd • Societ of the Precious Blood Water Project • Southern Highlands Participatory Organisation (SHIPO) • Sparr Drilling Company Ltd
Group H	<p>There following companies have resources to drill water wells in sedimentary layer areas only and currently they operate the drilling works for demands from private sector only but they are not interested in using DDCA's drilling equipment hiring service.</p> <ul style="list-style-type: none"> • ELCT Southern Dioces (Konde Diocese)

4-2. Capacity Development Needs of the Private Drilling Companies

Table 4.5 summarises the capacity development needs of the interviewed companies. The data depicted in Table 4.5 indicate that almost all (96%) the interviewed companies have a certain need of capacity building. It is only three companies out of the ninety four interviewed companies (4%) that indicated that they do not need any capacity building. Those three companies are: Chimba Resources, Society of the Precious Blood Water Project, and PNR Services Ltd.

Table 4.5: Capacity needs for the interviewed drilling companies

[illegible]

Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project

Company Name	Planning of drilling works and Designing water wells	Drilling by DTH method	Drilling by mud rotary method	Casing and Screen pipes installation	Well Development	Pumping Test	Well Logging	Maintenance of Equipment	Others	Explanation of "Others"
Bubujiko Enterprises	x	x	x	x	x	x	x			
Chem chem Drilling Co. Ltd	x	x	x	x	x	x	x	x		
Chem Chem Well Drilling Company	x	x	x	x	x	x	x	x		
Chimba Resources									x	
CMG Construction Company Ltd	x			x	x	x	x	x		
Coast Water Well Company		x				x	x			
Drill Mat & Ground Water Services Ltd	x									
Drilling Spares and Services Ltd	x							x		
Efam Limited	x	x	x					x		
ELCT Southern Dioces (Konde Diocese)		x	x		x		x			
Future Century Limited		x				x	x			
Gaimo Construction Co. Ltd	x	x	x	x	x	x	x	x		
Gem and Rock Ventures Co. Ltd										
Germany and Tanzania Drilling Partnership Co. Ltd (GETA)	x							x		
Global Resource Alliance-TZ	x	x	x	x	x	x	x	x		
Global Tech Drillig and Exploration Ltd	x	x	x	x	x	x	x	x		
GroundwaterExploration & Well Construction Co. Ltd	x	x	x	x	x	x	x	x		
Ham Drillers Ltd	x	x	x	x	x		x			
Himalaya Enterprises LTD							x			
Holland Farm Ltd		x					x			
Humac Services Ltd	x	x	x	x	x	x	x	x		
Hydro Tech (T) Ltd	x									
J.N.M Mining Services Ltd							x			

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Company Name	Planning of drilling works and Designing water wells	Drilling by DTH method	Drilling by mud rotary method	Casing and Screen pipes installation	Well Development	Pumping Test	Well Logging	Maintenance of Equipment	Others	Explanation of "Others"
Kikim Building Geotechnical and Drilling Contractors	x	x	x	x	x	x	x			
Kilimanjaro Water Well Drilling						x	x			
Kimani Minerals Ltd	x	x	x	x	x	x	x	x		
K'S Interprice LTD	x	x	x	x				x		
Layne Drilling (T) Ltd	x		x	x			x	x		
LBS Water Well Drilling Company		x				x	x			
Leone Resources Development Company Limited	x	x	x				x	x		
Lima Economic and Development group	x	X	x	x	x	x	x		x	
Lugoba Stones and Construction Co. Ltd	x							x		
Lweru Water Wells Drilling Company Ltd			x	x				x		
M & M(T) Ltd		x	x			x	x			
Maji Tech Engineering Ltd	x		x				x			
Make Eng and Water Works Ltd		x	x				x			
Marata Plumbers & Drillers Ltd	x	x	x	x	x	x	x	x		
Masochi Water Resource Exploration Co. Ltd										
Maswi drilling company Ltd	x	x	x	x	x	x	x	x		
Mavonda's Company Ltd	x	x	x	x	x	x	x	x		
MC Water Wells Drilling Co. Ltd			x			x	x	x		
MR. Water Drilling Company Ltd	x	x	x	x	x	x	x	x		
Msabi(Maji Safi kwa Afya Bora Ifakara)		x								
Muwanya Well Drilling										
Nassa GeneralTraders Limited	x	x	x	x	x	x	x	x		
Nile WellDrillers (Sole Propriator)	x	x								

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Company Name	Planning of drilling works and Designing water wells	Drilling by DTH method	Drilling by mud rotary method	Casing and Screen pipes installation	Well Development	Pumping Test	Well Logging	Maintenance of Equipment	Others	Explanation of "Others"
Nyakilang'anyi Construction Ltd	x					x	x			
O.C. I Industrial Holdings Ltd		x				x	x			
Oroteti Ltd	x	x	x	x	x	x	x	x		
Paramount Drill Wells Limited	x									
PNR Services Ltd									x	not needed
Rahmy Company Ltd	x	x		x	x	x	x			
Rehoboth Mining and Water Well Drilling Co	x	x	x	x	x	x	x	x		
Research and Ground Water Drilling Co. Ltd (REGWA)							x			
RRSWater Well Drilling Company	x	x	x	x	x	x	x	x		
Ruko's Genaral Supplies Co. Ltd	x									
SebaDrilling and Construction Ltd	x	x	x	x	x	x	x	x		
Serengeti Ltd	x	x	x	x	x	x	x	x		
Serving Friends International	x	x	x	x	x	x	x			
Shinyanga Urban Water Supply & Sanitation Authority										
Shy Builders Ltd	x	x	x	x	x	x		x		
SMS Amour Investment							x	x		
SN-TECH (T) Ltd	x			x			x			
Snub Pro Africa Ltd	x							x		
Society of the Precious Blood Water Project									x	They know all
Southern Highlands Participatory Organisation (SHIPO)							x		x	Geological basic knowledge
Sparr Drilling Company Ltd	x	x		x	x	x	x	x		

*Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project*

Company Name	Planning of drilling works and Designing water wells	Drilling by DTH method	Drilling by mud rotary method	Casing and Screen pipes installation	Well Development	Pumping Test	Well Logging	Maintenance of Equipment	Others	Explanation of "Others"
Star Water Pumps	x									
Sustainable Environment Management Action(SEMA)	x	x	x	x	x	x	x			
Talha Water Well Drillers Ltd	x	x					x			
Techno Drillers Co. Ltd	x	x	x	x	x	x	x	x		
The Water Family Company (T) Ltd							x	x		
Uchama Drilling and Biogas Services										
UK Global Trading Ltd	x						x	x		
Vacuum Rotary Drilling Company	x							x		
Water and Environmental Development Company Ltd									x	All are important
Water International Services LTD							x			
Water Solutions Drilling Co. Ltd	x	x	x	x	x	x	x	x		
Water Well Services Ltd							x			
Water Wells Services Ltd										
Watter Hub Tanzania LTD	x	x	x	x	x	x	x	x		
Wells Technology Co. Ltd		x					x	x		
Wema Consult (T) Limited										
WEPMO (Water & Environmental Sanitation Projects Maintenance Organization)	x	x	x	x	x	x	x			
Willy Enterprises Ltd							x			
Winam General Treders Ltd	x	x	x	x	x	x	x	x		
World Islamic Propagation and Humanitarian Services (WIPAHS)	x						x			

5. Conclusion and Recommendations

The objectives of the conducted survey were to identify present level of capacity of the private drilling companies and capacity areas which need to be strengthened in order to increase their participation into WSDP and drilling of water wells in appropriate manner and to analyze characteristics and needs of the private drilling companies which are to be potential customers for the equipment hiring service by DDCA.

This capacity needs of the private drilling companies are shown in Table 4.5 and the characteristics of the companies are summarised Table 4.4. It was revealed that 96% of the interviewed companies had training needs as listed in Table 4.5. There are 3 companies out of the 94 interviewed companies (i.e. 4%), which showed that they do not need any kind of training.

For the hiring services to be offered by DDCA, it was shown that 83 companies out of the 94 interviewed companies (i.e. 88%) are interested in using DDCA Equipment hiring services to respond to WSDP Demands. Out of the 83 interested companies 79.5% of them preferred to hire the drilling rig with technical staff from DDCA. The results further show that 98% of the interviewed companies are interested in participating in WSDP.

Annexes

Annex 1: Terms of Reference

Terms of Reference for the Baseline Survey

Under Groundwater Development and Management Capacity Development (DDCAP) Project in the United Republic of Tanzania

This sets forth the terms of reference of the Contractor for the baseline survey under the Groundwater Development and Management Capacity Development (DDCAP) Project in the United Republic of Tanzania (hereinafter referred to as “the Project”).

1. Background of the Survey

1.1 Project Background

Ministry of Water (MoW) has been implementing the Water Sector Development Programme (WSDP) since 2007 in accordance with the National Water Policy (2002) and the National Water Sector Development Strategy (NWSDS). WSDP employs the Sector Wide Approach to Planning (SWAPs) to implement four programme components, i.e. i) water resources management, ii) rural water supply and sanitation, iii) urban water supply and sewerage, and iv) institutional strengthening and capacity building.

The overall programme objective of WSDP is to alleviate poverty through improvement in the governance of water resources management and the sustainable delivery of water supply and sanitation services. Under this overall objective, the programme is aimed to achieve increase of rural water supply coverage by 90% and urban water supply by 100%, respectively, by 2025.

For the rural water supply component, construction of an approximate number of 79,000 water supply facilities is required in order to provide safe water to 34.5 million un-served populations. WSDP estimates that 91% of these planned water supply facilities will rely on groundwater, which requires drilling of 1,200 wells annually. Although private drilling companies are the main actor¹ for groundwater development under WSDP, their current capacity of drilling wells is reported as approximately 600 per annum. In other words, their capacities such as technical skills and resources have a great gap to respond to demands in the water sector.

In order to address this challenge, MoW formulated “the Strategy for Strengthening Water Well Drilling Industry in Tanzania” in 2006. Proposed approaches for capacity development of the drilling industry are, among other things, establishment of hiring business of drilling equipment at Drilling and Dam Construction Agency (DDCA) to make the equipment available to the private drilling companies in association with technical instructions.

1.2 Project Purpose and Output

DDCA is an executive agency established in 1999 under Ministry of Water (MoW) by the Executive Agency Act 1997 and Executive Agencies (Drilling and Dam Construction Agency) (Establishment) Order 1999. Its primary functions include groundwater exploration and production by drilling, rehabilitating and maintaining shallow and deep wells as well as construction of dams.

Aiming at enhancement of capacities of the private drilling companies in borehole construction under WSDP, the Government of Tanzania requested the Government of Japan for a technical cooperation to strengthen capacities of DDCA to provide support to the water well drilling industry. In response to the

¹ DDCA is not eligible to participate in the competitive bidding for construction works under WSDP due to the Ministry's procurement rule.

request, the Japanese government through Japan International Cooperation Agency (JICA) agreed to implement the Project in the period between March 2012 and March 2016 in cooperation with MoW and DDCA. Expected outputs of the Project are as follows;

- Output 1: DDCA's ability to impart techniques and skills regarding water well drilling to private drilling sector is enhanced.
- Output 2: The capacity of DDCA in groundwater development, which is required to provide technical instructions, is enhanced.
- Output 3: A system to hire drilling equipment and machinery is established.

The Client consisting of staff from DDCA and Japanese experts are responsible for daily operation of the project activities under supervision of Department of Water Resources of MoW and JICA.

2. Survey Objective

The baseline survey is to be implemented as a part of activities related to Output 1 and 3 mentioned above. Its specific objectives are;

- 1) to identify present level of capacity of the private drilling companies and capacity areas which need to be strengthened in order to increase their participation into WSDP and drilling of water wells in appropriate manner.
- 2) to analyze characteristics and needs of the private drilling companies which are to be potential customers for the equipment hiring service by DDCA.

Output of the survey will be used for the following purposes;

- Identification of areas in which DDCA can provide support for capacity development of the private drilling companies within mandate of the agency
- Identification of mode of delivery of such support services by DDCA
- Indicators building and determination of those baseline and target values to measure effects of the services provided by DDCA
- Formulation of DDCA's business plan for the drilling equipment hiring service

3. Condition of Work

3.1 Equipment, Materials and Labour

The Contractor shall provide all equipment, materials, stationeries and staffs necessary for the above-mentioned works.

3.2 Expenses

All expenses including per diem, accommodations, transportation, fuel, communication, training of survey team, pre-test of survey tools and others necessary for the execution of the survey shall be borne by the Contractor. Moreover, the Contractor shall be responsible for health and life insurance of his staffs and for third party and be responsible for payment of tax.

4. Specifications

4.1 Target Group and Location of the Survey Area

The target group of the survey is all the private drilling companies which possess the water well drilling permit issued by MoW. As of the end of March 2012, a total of 126 private drilling companies are registered at MoW as holders of the water well drilling permit as shown in Annex 1. The Contractor shall

contact with and visit a head office of each company listed and make interviews in accordance with specifications described in this section.

4.2 Scope of Work

The scope of works for the survey is as follows.

- Training of Survey Teams and Pre-Test of Survey Tools
- Structured Interview with the Target Group
- Data Entry, Analysis and Reporting

4.3 Methodologies

1) Training of Survey Teams and Pre-Test of Survey Tools

To confirm the surveyors' skills and secure the accuracy of procedures for the survey, an orientation on the survey procedures and pre-test of questionnaires should be organized by the Contractor under the supervision of the Client prior to commencement of the actual works. The Contractor is responsible to finalize the questionnaires in consultation with the Client and prepare necessary number of those copies for the survey. The training of Survey Teams and Pre-Test of Survey tools shall be conducted as the following schedule;

- 1st day: to take through the Questionnaire
- 2nd day: to interview with the Questionnaire to two selected companies
- 3rd day: to review and modify the Questionnaire based on the result of the pre-test.

All expenses including arrangement of venue, transportation for the training of Survey Teams, Pre-Test of Survey tools shall be borne by the Contractor.

2) Structured Interview with the Target Group

Target Interviewee

Structured interviews with the private drilling companies listed in Annex 1 shall be conducted with using questionnaires. Interviewee(s) of each company should be those who are empowered to represent the company or who are in charge of business operation.

Confirmation of Contact of Private Drilling Companies

Currently there are 126 private drilling companies registered in MoW. Annex 1 includes company name, postal address, physical address, telephone number, fax number and E-mail address. As shown in Annex 1 almost all of postal addresses of the companies are provided while some other information (e.g. physical address, telephone number, fax number and E-mail) were not given or unavailable. The Contractor is required to obtain any available means of contact for each private drilling company at any cost since the Contractor has to contact with the company via either telephone, fax, E-mail for arrangement of interview survey.

MoW is currently working on update of the information and verification of the existing information. The updated contact information will be provided by the Client prior to the commencement of the work. Nevertheless in case the Contractor still finds some contacts unavailable via telephone, e-mail or mail, the Contractor shall make his/her best effort to find the way to accessing them with the consultation to the person in charge of MoW or any other organizations. Any abandonment due to the inaccessibility shall be subject to the Client's approval upon the explanation of the rational reason to be provided by the Contractor.

Send Questionnaire and Visit to Private Drilling Companies

The Contractor shall send questionnaires to the private drilling companies in advance of the interview so that the companies fill in the questionnaire before hand. The Contractor shall have interview based on the filled questionnaires to make them completed with additional information and data. Company brochures and other relevant documents specified in the questionnaires also need to be collected from the companies if those are available.

The draft questionnaire is attached in Annex 2. The Contractor shall finalize it with the Client through the pre-test and review of the questionnaire prior to commencement of the Survey.

Location of Private Drilling Companies

The location of 126 private drilling companies is as shown in the following table. Based on such information the Contractor shall prepare an efficient and effective plan of the Survey in terms of quality, time, cost and so on in order to accomplish the work within the period stipulated in the Agreement.

For the companies located outside of the country such as Kenya and Egypt the Contractor do not need to visit physically but contact with them to fill in the questionnaire by either Fax or E-mail.

Regarding five companies which have no information on location the Contractor shall confirm it in the work of confirmation of contact at the commencement of the Survey.

No. of private drilling company classified by Region (As the end of March 2012)

Region	No. of company
DSM	88
Arusha	12
Shinyanga	5
Dodoma	2
Mwanza	5
Musoma	2
Morogoro	2
Iringa	1
Mbeya	1
Mtwara	1
Kenya	2
Unknown	4
Total	126

3) Data Entry, Analysis and Reporting

The Contractor shall compile preliminary analysis reports which describes survey methodologies employed, survey results, and preliminary analysis in accordance with the reporting format attached in Annex 3.

4.4 Survey Items

The table below shows information and data which need to be collected in the baseline survey

Survey Item	Information to be Collected
-------------	-----------------------------

Survey Item		Information to be Collected
Basic Information of the Company		Company name
		Physical address and contacts
		Year of establishment
		Registration of the company under Contractors Registration Board
Equipment	Drilling Equipment	Model, manufacturer, year of manufacture, maximum drilling depth, diameter of production hole and conditions of drilling equipment owned by the company
	Supporting Equipment	Availability of supporting equipment and vehicles, Measures taken to source supporting equipment and vehicles in case the company does not own them
	Survey Equipment	Availability of survey equipment, Measures taken to source survey equipment in case the company does not own them
	Operation & Maintenance	Workshop equipment and facilities owned by the company and those capacity
Finance		Capital
		Sales and its proportion by services in the past five years, Net profit or loss
		Sources of fund
		Investment plan for procurement of new drilling equipment
Human Resources	Staffing	Distribution of staff by divisions
		Distribution of technical staff by position and expertise, Level of education, technical qualification and year of experiences in the drilling industry
	Human Resources Development	Support of the company for capacity development of staff
		Cost sharing in sending staff to training courses
		Needs of staff for their capacity development
		Preferable measures of capacity development of the staff and cost sharing between the company and employees
Service Management	Customer	Type of customers for drilling of water wells
	Contracted Works	Number of contracts awarded in the past five years, Contents of the services, client, target regions/ districts and value of the contract
		Proportion of WSDP related works in the number and value of the contract
		Number of wells drilled in the past three years
	Price	Average contract amount for drilling wells and installation of hand pump and submersible pump
		Proportion of machinery cost to contract amount for drilling wells
	Process Management and Quality Control	Average number of days for drilling a well and pump installation
		Terms and conditions related to disposal of unsuccessful wells in the contracts
		Terms and conditions related to warranty period in the contracts
	Business Plan	Willingness and plan to participate in drilling works under WSDP, Reasons of non-participation in WSDP
		Obstacles to participate and expand business opportunities in WSDP
External Environment	Laws & Regulations	Year of renewal of the water well drilling permit
		Understanding on responsibilities of well owners to obtain groundwater permit and water use permit under Water Resources Management Act (2009)

Survey Item		Information to be Collected
	Relation with DDCA	Perception on relation between the company and DDCA
		Experiences in using services of DDCA such as equipment hiring, implementation of geophysical survey, and provision of technical advice and relevant information
		Contents of support services expected to DDCA, Willingness to pay for utilizing the support services to be provided by DDCA
Needs for Drilling Equipment Hiring Service	Availability of Drilling Equipment Hiring Service	Experiences in using drilling equipment hiring service for construction of water wells in the past including type of equipment hired, rental cost and terms and conditions
	Needs for Hiring Service of DDCA	Willingness to use DDCA's drilling equipment hiring service to participate in drilling works under WSDP
		Preferred service options
		Expected benefits of using the hiring service
		Reasons why the company is not willing to use the hiring service by DDCA

4.5 Survey Schedule

Negotiation and signing of the agreement with the Client are expected to be on **15th May 2012**. The Contractor shall commence the works within one week after signing of the contract and reception of the notice to proceed from the Client. The Contractor shall complete all the works including submission of the final output of the survey not later than **31st August 2012**.

4.6 Output

The Contractor shall submit reports, survey data, and collected documents as specified below;

(1) Biweekly Progress Report

The Contractor shall submit six (6) copies of the biweekly progress reports to the Client every two weeks during implementation of the survey. The report shall briefly describe progress of the work, constraints, and work schedule for the subsequent reporting period with maximum of 10 pages each.

(2) Computerized Data of the Structured Interview

Data and information collected from the structured interview with the drilling companies shall be inputted into the MS Excel format and saved in CD-R for submission. The Client will provide the Contractor with the data entry forms. The deadline of submission of the survey data is **15th August 2012**.

Data Entry Forms in MS Excel format will be provided by the Client after the conclusion of the Agreement and will be finalized by the Contractor through the discussion between the Client and the Contractor.

(3) Preliminary Analysis Report

Findings from the survey shall be compiled as the preliminary report. A draft report format is attached in Annex 4 which will be finalized between the Contractor and the Client before commencement of the survey. The Contractor shall submit six (6) copies each for draft and final reports. The deadline of submission of the draft preliminary analysis report is **15th August 2012**.

(4) Documents Collected from the Private Drilling Companies

Company brochures and other documents collected from the private drilling companies during the survey shall be submitted together with the final version of the preliminary analysis report.

4.7 Formation of the Survey Team and Required Qualification

Staffing plan is tentatively set as described in this section. Minimum of two survey teams, which consists of one lead surveyor and one assistant surveyor in a team, are required. The Contractor should propose number and composition of the survey team with considering the scope of works, time frame and other requirements.

1) Survey Manager (one person)

[Responsibilities]

- To oversee planning and progress of works and provide overall quality control of the survey outputs.
- To finalise the questionnaires and train the surveyors on the use of the questionnaires.
- To communicate with the Client on daily operation of the survey and to report progress of the works.

[Required Qualifications]

- to hold bachelor or higher qualified degree in organizational and institutional development or business administration.
- to have experiences in overall management of projects similar to this assignment for more than 10 years.
- to have fluent communication skill in English.

2) Technical Supervisor (Maximum two persons)

[Responsibilities]

- To provide technical advice and quality assurance to the works to be conducted by the surveyors with regard to issues related to hydrogeology, drilling of wells and drilling equipment.

[Required Qualifications]

- to hold diploma or more qualified degree in hydrogeology.
- to have experiences in water well drilling projects for more than seven years.
- to be fluent in English and Swahili.

3) Lead Surveyors (one person per team)

[Responsibilities]

- To lead structured interviews with the target group.
- To analyse the survey results and compile the preliminary analysis report.

[Required Qualifications]

- to hold bachelor or more qualified degree either in organizational and institutional analysis/development, economics, or business administration
- to have skills and experiences in similar research works for more than five years.
- to have fluent communication skill in English and Swahili.

4) Assistant Surveyors (one person per team)

[Responsibilities]

- To assist the lead surveyors in structured interviews and report compilation.

[Required Qualifications]

- to hold diploma or more qualified degree either in organizational and institutional analysis/development, economics, or business administration.
- to have skills and experiences in similar research works for more than two years.
- to have fluent communication skill in English and Swahili.

5) Data entry clerk(s)

[Responsibilities]

- To conduct data entry under supervision of the Survey Manager

[Required Qualification]

Data entry clerk(s) is required to have skills and experiences in data processing of questionnaires with using MS Excel.

5. Items to be discussed in the Technical Proposal

The following items shall be clearly discussed in the Technical Proposal by the Contractor.

1) Experience and capacities of the organization

2) Work Plan and methodologies in responding to the Terms of Reference including;

- 2-1) Appreciation and counter proposal on the Terms of Reference including methodologies and procedures to conduct interviews, data analysis and reporting
- 2-2) Workable suggestions to improve the survey design and tools such as analytical framework shown in the report format and draft questionnaire
- 2-3) Work schedule and estimates of the staff input required to execute the assignment (**Form Tech-1 shall be attached to the Technical Proposal.**)
- 2-4) Composition and number of teams and task of each staff (**Form Tech-2 shall be attached to the Technical Proposal**)
- 2-5) Measures to be taken for quality control and time management for execution of the works
- 2-6) Data and information to be required from the Client for preparation of the survey by the Contractor

3) Curriculum Vitae (CVs) of the Survey Manager, Technical Supervisor, and all Lead/ Assistant Surveyors including information on his/her experiences in providing consulting services in similar works, qualifications and academic degree. Proposed position shall be clearly mentioned on the cover page of each CV. Failure of stipulation of the proposed position on CVs may be lead to the subtraction from the evaluated score.

Besides, the total number of pages of the Technical Proposal, excluding CVs, should not exceed more than 15 pages.

Annex 2: Questionnaire for the Structured Interview

Draft Questionnaire for Capacity Assessment of Private Drilling Companies in Water Well Drilling

Dear Sir/ Madam,

Drilling and Dam Construction Agency (DDCA) in cooperation with the Ministry of Water (MoW) and Japan International Cooperation Agency (JICA) has launched a project to strengthen its capacities in provision of support to private drilling companies in the country. An overall goal of the project is that number of water wells necessary to achieve the target of the Water Sector Development Programme (WSDP) is drilled with enhanced participation of the private sector.

Aiming at achieving these objective and overall goal, DDCA is planning to formally establish drilling equipment hiring services for the private sector. This questionnaire is designed to know current level of capacities of the private drilling companies serving for construction of water wells and their needs for the drilling equipment hiring services and other technical support by DDCA. It has been sent to each company which is registered as the holder of the water well drilling permit at MoW.

We would highly appreciate it if an executive in charge of business operation of your company could fill in this questionnaire. Opinions and information from your office are very important for DDCA to understand needs of the private sector for its capacity development support.

All the information we obtain from the questionnaire and interview will be used by DDCA and MoW solely for planning of capacity development support for the private sector as well as drilling equipment hiring services. Your response will be treated with confidence and the data will be presented in a way that neither identity of the respondent nor company's name will be connected with specific survey data in case that the survey reports and data are to be published. This survey is part of the WSDP program of the Ministry of Water and the data provided will be used solely for the research purpose.

On Behalf of Permanent Secretary, Ministry of Water and Managing Director of DDCA

[For Filling and Submission of the Questionnaire]

1. Please fill in the questionnaire either on this electronic file by directly typing answers or on the hard copy by printing this file and writing with a pen.
2. A consultant team assigned for this survey will visit your office to collect the questionnaire and make a further clarification in (*survey period*) according to a prior appointment. Please complete the questionnaire by their visit to your office.
3. You can reach us at the following address for any clarification on this survey;
Bureau for Industrial Cooperation (BICO)
Mwl. JKNyerere Mlimani Campus, University of Dar es Salaam
P.O. Box 35131 Dar es Salaam
Tel: 2410113 Mobile: 0713601005, 0783601005, 0752587767
E-mail: bico@udsm.ac.tz and send copy to: bico_udsm@yahoo.co.uk

Section A: Company Information

A1:	Company Name			
A2:	P.O. Box			
A3:	Physical Address			
	Region:	District:		
	Ward:	Sub ward/ Village:		
	Street/ Sub-Village:	Plot No.:		
A4:	Telephone/Mobile		A5: Fax No.	
A6:	Email			
A7:	Website			
A8:	Year of Establishment		A.9 Year of starting of Drilling Operations	
A10:	Registration to Contractors Registration Board (CRB)	Please write class(es), if your firm is currently registered at CRB.		
A11:	Latest Year of Renewal of the Water Well Drilling Permit at Ministry of Water			

Section B: Participation in Drilling Works Funded by WSDP

B1.	<p>Is your company interested in participating in drilling works for projects funded by WSDP? The drilling works under WSDP means those which are procured by Local Government Authorities, Urban Water and Sewerage Authorities, or Ministry of Water for drilling of water wells to be used for water supply facilities (hand pumps and piped water supply schemes).</p> <p>Yes(go to B3).....</p> <p>1</p> <p>No(go to B2).....</p> <p>.....2</p>	
B2.	<p>What are reasons why your company is not interested in the drilling works under WSDP? (Please write down in the boxes provided the numbers of all of the items which apply.)</p> <p>The contract value is not attractive for us 1</p> <p>We do not have enough number of drilling rigs which capacity satisfy requirements of the works 2</p> <p>We do not have enough number of skilled technical staff 3</p> <p>Financial capacity of our company is weak to operate drilling works under WSDP 4</p> <p>Other (specify the answer) 5</p> <p>Not applicable (We are interested in participating in WSDP)..... 99</p>	
B3.	<p>Are there any obstacles for your company to participate and/or expand business opportunities in drilling works under WSDP? (If "Yes" Please write down in the boxes provided numbers of all of the items which apply.)</p> <p>We cannot source sufficient investment fund for the business operation 1</p> <p>Well qualified and skilled drillers are not enough in the labor market 2</p> <p>Procurement rules for the drilling works under WSDP is too strict 3</p> <p>Hydrogeological conditions of project areas are too difficult for us to operate 4</p> <p>Other (specify the answer) 5</p> <p>No obstacles are observed 6</p>	

Section C: Needs for Drilling Equipment Hiring Service and Other Technical Support

(1) Drilling Equipment Hiring Service

C1.	Has your company ever hired drilling rig(s) from DDCA or other private companies? (Please choose a number from the following and fill in the right box.)	
	Yes 1	
	No 2	

C2.	From which organization(s) has your company hired the drilling rig(s)? Please write down all names of the organizations in the space provided below.

C3.	How much was/ were the hiring costs for the drilling rigs? Please fill in each model of the rig and its hiring cost.		
	Model of the Drilling Rig Hired	Hiring Cost (Tsh.)	Unit of Hiring Cost (Please circle where applicable)
			Per Day / Per Well
			Per Day / Per Well
			Per Day / Per Well
			Per Day / Per Well

C4.	Is your company interested in using the hiring service of drilling rigs from DDCA <u>to participate in drilling works under WSDP</u> when such service is put in place officially?	
	Yes 1	
	No 2	

If the answer to Question C4 is "Yes", please answer to Questions C5, C6, C7, and C8.

If the answer to Question C4 is "No", please go to Question C9.

C5.	Which options would your company prefer for the hiring services of drilling rigs from DDCA? (Please write down in the boxes provided numbers of all of the items which apply.)	
	Only Drilling Rig.....1	
	Rig with Technical Staff from DDCA.....2	
	Only Technical Staff from DDCA.....3	
	Others (specify:)4	
	None.....5	

C6.	If you selected 1 or 2 in above C5, which supporting equipment would your company like to hire together with the drilling rig? (Please write down in the boxes provided numbers of all of the items which apply.)	
	Rig Accessories and Work Tools.....1	
	Truck-mounted or trailer-mounted air-compressor for DTH Drilling.....2	
	Truck-mounted or trailer-mounted mud pump for Mud Drilling3	
	Cargo Truck with Crane4	
	Water Tank Truck.....5	
	Generator.....6	
	Pumping Test Equipment.....7	
	Fishing Tools8	
	Others (specify:)9	
	None.....10	

C7.	If you selected 2 or 3 in above C5, what personnel from DDCA would your company like to accompany with a drilling rig to carry out drilling work? (Please write down in the boxes provided numbers of all of the items which apply.)	
	A technical instructor who will teach the operation of machine.....1	
	A drilling supervisor who will control the drilling work of your drilling team.....2	
	Mechanic who will carry out the daily maintenance of hired equipment.....3	

	Mechanic who will teach the daily maintenance of hired equipment to your mechanic.....4 Others (specify):....5 None.....6	
C8.	What kind of benefits would you expect from using the hiring service of drilling rigs from DDCA? (Please write down in the boxes provided numbers of all of the items which apply.) Increase of number of contracts which our company can work for WSDP 1 Eligibility to participate in bidding for the drilling works under WSDP 2 Reduction of investment costs for the drilling equipment 3 Other (specify the answer) 4 Not applicable (We are not interested in using the hiring service)..... 99	
C9.	If the answer to Question C4 is "No", what are reasons why your company is not interested in using the hiring service of drilling rigs from DDCA? (Please write down in the boxes provided numbers of all of the items which apply.) We have enough number of drilling rigs. 1 We are not interested in participating in the drilling works under WSDP 2 We do not have enough financial capacity to afford the hiring cost 3 Other (specify the answer) 4 Not applicable (We are interested in using the hiring service.)..... 99	

(2) Technical Support from DDCA

C10.	Which statements below explain the relation of DDCA to your company most appropriately in your perception?(Please write down in the boxes provided numbers of all of the items which apply.) DDCA is one of our competitors 1 DDCA provides us technical advice for drilling works 2 DDCA hire drilling equipment to us 3 DDCA is a regulator for drilling works in the water sector 4 Other (specify the answer) 5	
C11.	What kind of services of DDCA has your company used before apart from hiring of drilling equipment?(Please write down in the boxes provided numbers of all of the items which apply.) Hiring drilling operators 1 Provision of technical advice for drilling works 2 Provision of hydrogeological information of the drilling site 3 Other (specify the answer) 4 No experience in using other technical support services by DDCA 5	
C12.	What kind of technical support services would your company expect from DDCA except for the drilling equipment hiring services?(Please write down in the boxes provided numbers of all of the items which apply.) Provision of technical advice for drilling works on site..... 1 Provision of hydrogeological information of the drilling site 2 Other (specify the answer) 3 We are not interested in accessing technical support services from DDCA 4	
C13.	What kind of hydrogeological information would your company like to access to at DDCA if the agency makes data of its drilling works available to the private companies? (Please write down in the boxes provided numbers of all of the items which apply) Success rate of drilling in certain area.....1 Maximum, Minimum and Average Drilling Depth of existing wells in certain area2 Detailed structures of existing wells in certain area.....3 Water Quality of existing wells in certain area.....4 Water Level, Discharge Rate of existing wells in certain area.....5 Others (specify:)6 None.....7	
C14.	Is your company willing to pay for the technical support services to be provided by DDCA? Yes 1 No 2	

Section D: Equipment Owned by the Firm

D1. Operative Drilling Rig

Please list all operative drilling rigs owned by your firm in the table below. For the question No. 4) below, please refer to Attachment 1 of drawings of standard structure of water wells attached in the last page of this questionnaire.

1) Model Name	2) Manufacturer	3) Year of Manufacture	4) Capacity of Maximum Drilling Depth of Rigs by Type of Wells (m)						
			Well Type	Type 1D	Type 1M	Type 2D	Type 2M	Type 3D	Type 3M
Example: PAT 301	PAT Drill	2000	Maximum Depth (m)	-	80	-	40	-	-
			Drilling Dia. (inch)	-	8"	-	10"	-	-
			Maximum Depth (m)						
			Drilling Dia. (inch)						
			Maximum Depth (m)						
			Drilling Dia. (inch)						
			Maximum Depth (m)						
			Drilling Dia. (inch)						
			Maximum Depth (m)						
			Drilling Dia. (inch)						
			Maximum Depth (m)						
			Drilling Dia. (inch)						
			Maximum Depth (m)						
			Drilling Dia. (inch)						
			Maximum Depth (m)						
			Drilling Dia. (inch)						

Note1) Please refer to Attachment 1 "Standard Structure of Water Wells in Tanzania"

2) For each applicable well type, please specify maximum depth and drilling diameter of each drilling rig.

3) Drilling diameter shall be of actual production hole diameter which is selected by your company for each well type and each drilling rig.

D2. Supporting Equipment

1) Equipment	2) Availability (Please circle where applicable.)	3) Number of Equipment Owned by your firm	4) How does your firm source it for drilling operation if the equipment is not owned? (Please circle where applicable.)
Water Tanker	Owned/Not owned		Lease/Sub-contract/Not necessary
Cargo Truck	Owned/Not owned		Lease/Sub-contract/Not necessary
Generator	Owned/Not owned		Lease/Sub-contract/Not necessary
Compressor	Owned/Not owned		Lease/Sub-contract/Not necessary
Vehicle	Owned/Not owned		Lease/Sub-contract/Not necessary

D3. Survey Equipment

1) Equipment	2) Availability (Please circle where applicable.)	3) Number of Equipment Owned by your firm	4) How does your firm source it for drilling operation if the equipment is not owned? (Please circle where applicable.)
Geophysical Prospecting Instrument	Owned/Not owned		Lease/Sub-contract/Not necessary
Well Logging Machine	Owned/Not owned		Lease/Sub-contract/Not necessary
Pumping Test Equipment	Owned/Not owned		Lease/Sub-contract/Not necessary

D4. Maintenance of Drilling Equipment

D4. 1 How do you maintain and/or repair your drilling equipment? (Please write down in the boxes provided numbers of all of the items which apply.)	
Repair and Maintain in workshop owned by your company.....1 Outsource repairing and maintenance to other company's workshop2 Only repair and maintenance on site by drillers.....3 Other (specify)....4	
D4.2 Which workshop equipment and tools are possessed by your company? (Please write down in the boxes provided numbers of all of the items which apply.)	
Pit for repairing and maintenance of underneath of truck.....1 Air compressor.....2 Arc welder.....3 Oxygen- Acetylene welder.....4 Hydraulic press5 Hand tools for heavy duty trucks.....6 Lathe machine7 Others (specify:)8 None.....9	
D4.3 Which type and level of periodical maintenance of drilling equipment can be done by your company by itself? (Please write down in the boxes provided numbers of all of the items which apply.)	
Changing engine oil and filter.....1 Changing hydraulic oil and filter.....2 Complete checking and adjusting of truck condition.....3 Complete checking and adjusting of rig machine condition4 Grease up5 Others (specify:)6 None.....7	

Section E: Capacities of Staff in Drilling of Wells

E1. Number of Staff of the Firm

Division	Position		Number of Staff			Average Year of Experience in Drilling Industry	Level of Education (Refer to Attachment 2)		
			Permanent	Non-Regular	Sub-Total		Level	Type of certificate	Name of Institute
Management									
Administration									
Technical	a) Engineer	1							
		2							
		3							
	b) Hydro-geologist	1							
		2							
		3							
	c) Drilling Supervisor	1							
		2							
		3							
	d) Driller (Rig in Charge)	1							
		2							
		3							
	e) Assistant Driller (operator)	1							
		2							
		3							
	f) Drilling Worker (Helper/ Assistant Technician)	1							
		2							
		3							
	g) Mechanics	1							
		2							
		3							
	h) Welder	1							
		2							
		3							
	i) Plumber	1							
		2							
		3							
Total Number of Staff									

E2. Capacity Development of Staff

E2.1	What kind of measures has your company taken to improve drilling technique and skills of your technical staff?(Please write down in the boxes provided numbers of all of the items which apply.)	
	Provided training and guidance from senior staff to junior ones during the works1 Sent staff to training courses conducted at educational institution 2 Invited trainer/ instructor from outside to teach our staff on drilling site3 Other (specify the answer: _____) ...4 No measures are taken to improve capacities of the staff5	
E2.2	Who paid for your technical staff to attend the training courses? (Please write down in the boxes provided numbers of all of the items which apply.)	
	The staff who attends the training course1 The company2 The staff and company share the cost for the training3 Our company does not send our staff to training courses4	
E2.3	What kind of capacities do you think your technical staff need to improve in order to conduct drilling works properly?(Please write down in the boxes provided numbers of all of the items which apply.)	

	Planning of drilling works and Designing water wells1 Drilling by DTH method.....2 Drilling by mud rotary method3 Casing and Screen pipes installation4 Well Development5 Pumping tests6 Well Logging7 Maintenance of Equipment8 Others (Specify:9	
E2.4	What kind of measures is preferable for your company to strengthen capacities of your technical staff? (Please write down numbers of all of the items which apply.) Provide training and guidance from senior staff to junior ones during the works1 Send staff to training courses conducted at educational institution 2 Invite trainer/ instructor from outside to teach our staff on drilling site3 Other (specify the answer:) ...4	

Section F: Business Operation of the Firm

F1.	Who have asked for water well drilling to your company since the start of your business? (Please write down in the boxes provided numbers of all of the items which apply.) Government / Local Government Authorities1 Private Companies2 Individual Households3 NGO/ Donor4			
F2.	What are proportions of water well drilling works awarded from the government/ local government authorities among number of contracts and contract value, respectively, in the past three years? <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;">F2.1. Number of Contracts □ %</td> <td style="width: 50%; border: none;">F2.1. Contract Value □ %</td> </tr> </table>		F2.1. Number of Contracts □ %	F2.1. Contract Value □ %
F2.1. Number of Contracts □ %	F2.1. Contract Value □ %			

F3. Contracts in the Past Three Years

Please write down number of contracts awarded from all the clients in the past three years and those target districts.

Contracted Works	Number of Contracts by Fiscal Year			Target Districts (Refer to Attachment 3 "Simplified Geological Map")
	2008/2009	2009/2010	2010/2011	
Drilling shallow well (hand dug well)				
Drilling deep well (borehole)				
Rehabilitation of well				
Piping works				
Water supply facility				
Groundwater survey				
Other (please specify)				

F4. Value of Contracts in the Past Three Years

Please fill in the contract values by fiscal year and type of the contracted works.

Contracted Works	Contract Value (T. Shilling)		
	2008/2009	2009/2010	2010/2011
Drilling shallow well (hand dug hole)			
Drilling deep well (borehole)			
Rehabilitation of well			
Piping works			
Water supply facility			
Groundwater survey			
Other (please specify)			

F5. Number and Depth of Wells Drilled in the Past Three Years

Please fill in number and depth of wells your company drilled in the past three years. For the type of well, Please refer to Attachment 1 of drawings of standard structure of water wells attached in the last page of this questionnaire.

Well Type	2009				2010				2011			
	No. of successful wells	No. of unsuccessful wells	Total No. of drilled wells	Average Depth of All Wells Drilled(m)	No. of successful wells	No. of unsuccessful wells	Total No. of drilled wells	Average Depth of All Wells Drilled(m)	No. of successful wells	No. of unsuccessful wells	Total No. of drilled wells	Average Depth of All Wells Drilled(m)
1D												
1M												
2D												
2M												
3D												
3M												
Total												

F6. Average Unit Price for Drilling Works and Pump Installation

What is the unit price for each item and type of well mentioned in the table below? Please refer to Attachment 2 of drawings of standard structure of water wells attached in the last page of this questionnaire for the type of wells.

Contract Type	Item	Unit Price by Type of Well (Excluding VAT)					
		Type 1D	Type 1M	Type 2D	Type 2M	Type 3D	Type 3M
For Government/ LGA's	Drilling a successful well including drilling, development and pumping test (Tsh/ meter)						
	Drilling an unsuccessful well for mud drilling (1M, 2M, 3M) excluding pumping test (Tsh/ meter)						
	Drilling an unsuccessful well for DTH (1D, 2D, 3D) excluding PVC installation and development (Tsh/ meter)						
	Procurement and installation of pump (hand pump or submersible pump) (Tsh / pump)						

Baseline Survey on Private Drilling Companies
Under the Groundwater Development and Management Capacity Development (DDCAP) Project

For Private Institution/ Individuals	Drilling a successful well including drilling, development and pumping test (Tsh/ meter)						
	Drilling an unsuccessful well for mud drilling (1M, 2M, 3M) excluding pumping test (Tsh/ meter)	X		X		X	
	Drilling an unsuccessful well for DTH (1D, 2D, 3D) excluding PVC installation and development (Tsh/ meter)		X		X		X
	Procurement and installation of pump (hand pump or submersible pump) (Tsh / pump)						

F7. Proportion of Machinery Cost

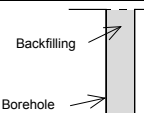
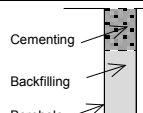
F7.	What is an approximate percentage of machinery cost (e.g. depreciation of operation and maintenance cost of drilling rigs, accessories, vehicle and equipment) in a total contract price for drilling wells?	□ %
-----	--	-----

F8. Average Number of Days Necessary for Drilling Works and Pump Installation

How many days are required for drilling works and pump installation on average?

Well Type	Drilling a successful well including drilling, development and pumping test (days)	Drilling an un successful well excluding PVC installation, development and pumping test (days)	Pump Installation (hand pump or submersible Pump) (days)
Type 1D			
Type 1M			
Type 2D			
Type 2M			
Type 3D			
Type 3M			

F9. Methods of Dry hole Abandonment

F9.1 What is an approximate percentage of which you have encountered unsuccessful well since your company started drilling works?	□ %
F9.2 In which areas have you often experienced unsuccessful wells? Please mention all regions in the space provided below.	
F9.3 What kind of measure has been taken for the unsuccessful wells when your company found dry hole in drilling works? (Please write down in the boxes provided numbers of all of the items which apply.)	
Backfilled.....1 Remain the hole opened.....2 Other (Specify the answer:).....3	
F9.4 If you selected 1 in above F9.3, which type of backfilling for uncased wells (Dry hole) is/are standard in your company? (Please choose number(s) from the flowing options and fill.)	
 Backfilling with drilled cuttings or sand without surface cementing ...1	 Backfilling with drilled cuttings or sand with surface cementing2
Other (specify the answer:).....3	
No experience.....4	
F9.5 Which type of backfilling for cased wells (unsuccessful well after well completion and development) is/are standard in your	

company? (Please choose number(s) from the flowing options and fill.)	
	Backfilling with drilled cuttings or sand without surface cementing for only annular space.....1
	Backfilling with drilled cuttings or sand with surface cementing for only annular space2
	Backfilling with drilled cuttings or sand without surface cementing for both annular space and inside casing3
	Backfilling with drilled cuttings or sand with surface cementing for both annular space and inside casing4
Other (specify the answer:).....5	
No experience.....6	

F9.6	What is the standard material for backfilling?	
	Drilled cuttings.....1	
	Sand.....2	
	Other (Specify the answer:).....3	
F9.7	In case of backfilling with surface cementing, please specify its standard depth from the top of the casing.	m
F9.8	In case of backfilling cased hole, how do you close the top of casing pipes?	
	Fitted with steel cover without pad lock.....1	
	Fitted with steel cover with pad lock.....2	
	Fitted with wooden cover.....3	
	Closing by welding it with gas burner.....4	
	Other (specify the answer:)... 5	
	Remain the top opened6	

F10. Warrant and Permissions

F10.	Were the terms and conditions on the warranty period set in the contracts which your company has made with your respective clients in the past?	
	F10.1 Government/ LGA	Yes, in all contracts 1 Yes, in some contracts2 No, not at all 3
	F10.2 Private Company	Yes, in all contracts 1 Yes, in some contracts2 No, not at all 3
	F10.3 Individual Households	Yes, in all contracts 1 Yes, in some contracts2 No, not at all 3
	F10.4 NGO/ Donor	Yes, in all contracts 1 Yes, in some contracts2 No, not at all 3
F11.	Who applied for the groundwater permit to Basin Water Office in the past contracts before your company started the drilling, enlarging, or re-deepening wells? (Please write down in the box provided numbers of all of the items which apply.)	
	Drilling company1	
	Owner of the well (client)2	
	Other (specify the answer _____) 3	
	I don't know about the groundwater permit4	
F12.	Who applied for the water use permit to Basin Water Office for the drilled wells in the past contracts?(Please write down in the box provided numbers of all of the items which apply.)	
	Drilling company1	
	Owner of the well (client)2	
	Other (specify the answer _____) 3	
	I don't know about the water use permit 4	

Section G: Finance

G1. Capital (Tsh)	
-------------------	--

	2008/2009	2009/2010	2010/2011
G2. Total Sales (Tsh)			
G3. Gross Profit on Sales (Tsh)			
G4. Operating Profit (Tsh)			
G5. Net Profit or Loss (Tsh)			

G6.	What is approximate percentage distribution of sales from different types of services among the total amount of sales?	
	G 6.1 Drilling Works	□ %
	G 6.2 Survey	□ %
	G 6.3 Brokerage Fee	□ %
	G 6.4 Other Services	□ %
G7.	Where does your company source funds for new investment for your business? (Please write down in the box provided numbers of all of the items which apply.)	
	Personal funds only	1
	Borrowing from friend or affinity	2
	Borrowing from private company	3
	Borrowing from banks	4
	Borrowing from government or related organization	5
	Other (specify the answer)	6
G8.	Does your company have any investment plan to purchase new drilling equipment?	
	Yes	1
	No	2
G9.	If the answer to G 8 is "Yes", what kind of equipment will be purchased? (Please write down in the box provided numbers of all of the items which apply.)	
	Drilling rig (with capacity to drill less than 100m depth).....	1
	Drilling rig (with capacity to drill between 100 and 200m depth	2
	Drilling rig (with capacity to drill more than 200m depth)	3
	Supporting Equipment	4
	Survey Equipment	5
	Not applicable (We don't have plan to purchase new equipment).....	99

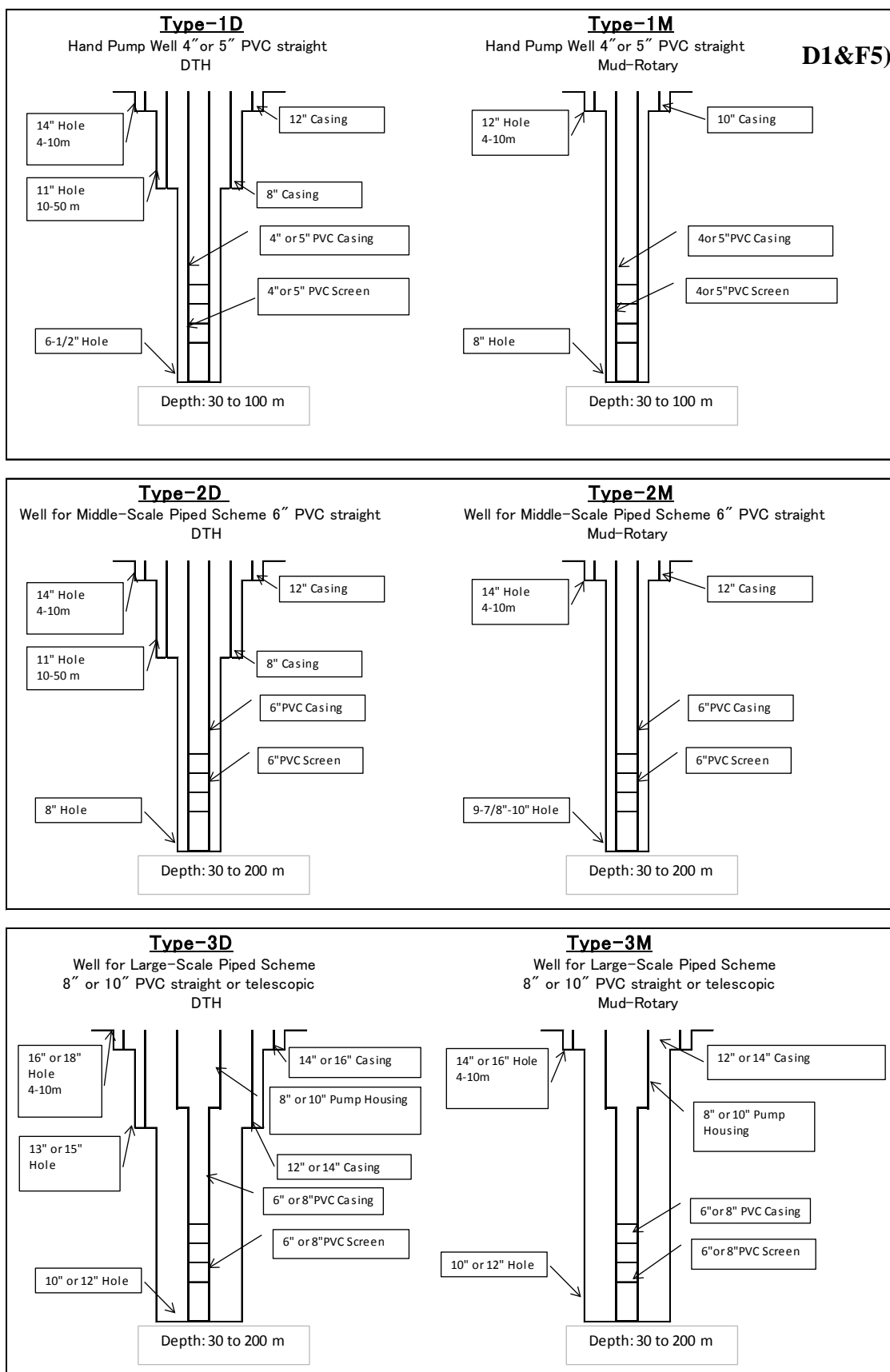
Date of the Interview	// 2012 (Date/ Month/ Year)	Name of Respondent/ Position	
-----------------------	--------------------------------	---------------------------------	--

This is the end of the questions. Thank you very much for your cooperation.

For the use of the survey team:

Date of the Interview	// 2012 (Date/ Month/ Year)	Name of Lead Surveyor	
-----------------------	--------------------------------	-----------------------	--

Attachment 1: DDCA Standard Structure of Water Wells in Tanzania (Question



Attachment 2: Level of Education in Tanzania (Question E1)

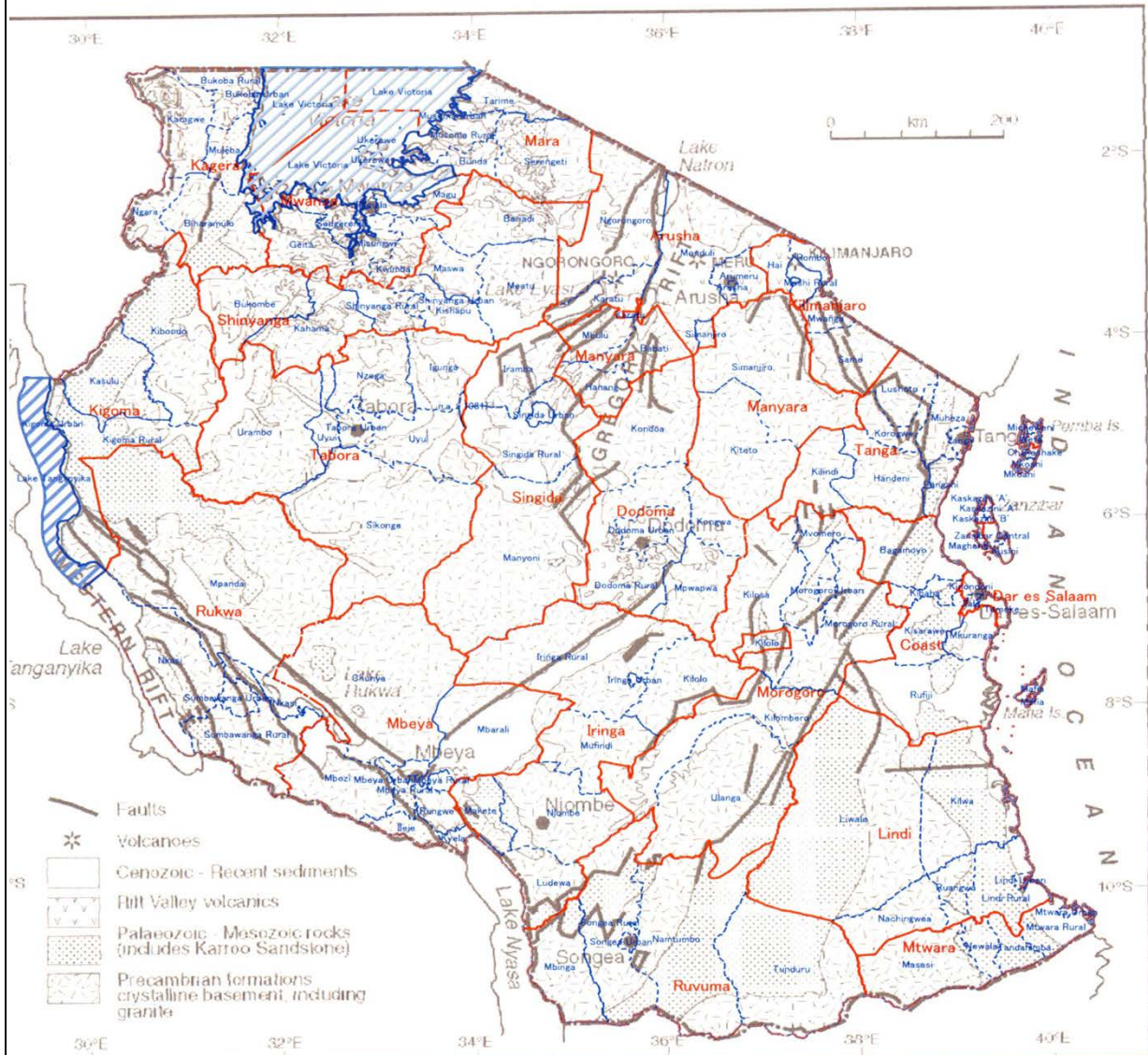
<Level of Education>

<i>Educational Level</i>
Standard 1~7 (Primary School)
Form 1~4 (Secondary School)
Form 5, 6 (Advanced Secondary School)
Diploma
Degree
Doctor

<Type of Certificate>

<i>Certificate Code</i>	<i>Type of Certificate</i>	<i>Area (for WDMI)</i>
NVA 1	National Vocational (Artisanal) Award Level 1	(a) Construction Technology
NVA 2	National Vocational (Artisanal) Award Level 2	(b) Water Science and Technology
NVA 3	National Vocational (Artisanal) Award Level 3	(c) Mechanical Technology
		(d) Electrical Technology
NTA 4	Basic Technical Certificate	(a) Water Supply and Sanitation Engineering
NTA 5	Technician Certificate	(b) Hydrogeology and Meteorology
NTA 6	Ordinary Diploma	(c) Hydrogeology and Water Well Drilling
		(d) Water Laboratory Technology
		(e) Irrigation Engineering
NTA 7	Higher Diploma	Water Resources and Irrigation Engineering
NTA 8	Bachelor's Degree	

Simplified Geological Map



c. BGS - Water Aid

0 50 100 200 300 400 500 km

Annex 3: Member List of the Survey Team

Staff Composition and Task Assignment

S/ No	Name of Staff	Organi- zation	Area of Expertise	Position Assigned	Task Assigned	Academic Background	Work Experience for Last 5 Years
1	Prof. E.A.M. Mjema	BICO	<ul style="list-style-type: none"> • Project Management • Performance Management • Operations Management • Logistics • ICT 	Survey Manager	<ul style="list-style-type: none"> • To oversee planning and progress of works and provide overall quality control of the survey outputs • Communicate with the Client on daily operation of the survey and progress of the works 	B.Sc (Engineering) M.Sc (Engineering Management) Dr.Ing. (Computer Simulation)	<ul style="list-style-type: none"> • Survey for situational analysis of human resources in education sector • Coordinated acountry – wide survey on the status and needs of small medium enterprises in Tanzania • Lead a team to carry out mid-term evaluation of Angaza Zaidi programme • Established baseline information for the specific organizational performance indicators for TCRA • Lead a team to carry out institutional assessment of CHRAGG
2	Dr. P. M. S. Bujulu	BICO	<ul style="list-style-type: none"> • Geotechnical eng. • Drilling technology • Hydrogeology, g/water prospecting and well development 	Technical Supervisor 1	To provide technical advice and quality assurance to the works to be conducted by the surveyors with regard to issues related to hydrogeology, drilling of wells and drilling equipment	Ph.D (Geotechnical Engineering) M. Civ. Eng. (Geo-technique and Infrastructure) B.Sc. (Eng.) Civil Engineering	<ul style="list-style-type: none"> • Geotechnical Investigation for construction of the proposed Kigamboni Bridge at Kurasini Creek, Dar es Salaam • Geotechnical Investigation for construction of the proposed TANESCO Power Plant at Majani Mapana, Tanga • Geotechnical Investigation for the proposed Construction of Water Treatment Plant, Sludge Lagoon and Elevated and Ground Water Tanks at Mambogo, Morogoro
3	Mr. M. Songo	BICO	<ul style="list-style-type: none"> • Hydrogeology • Geophysics • Water well drilling • Surface water hydrology • Environment • Minerals and rocks 	Technical Supervisor 2	To provide technical advice and quality assurance to the works to be conducted by the surveyors with regard to issues related to hydrogeology, drilling of wells and drilling equipment	B.Sc. Honours in Geo-hydrology B.Sc (Hons)Environm ental Management Diploma in Water Resources Engineering	<ul style="list-style-type: none"> • Groundwater Investigations, Environment, borehole siting and water well Drilling – Mpwapwa District Council and World Bank • Morogoro, Iramba and Singida rural district councils- First year Rural water Supply and Sanitation Project Investment Programme - World Bank supported project. • Groundwater investigations, drilling, pump installation and training of well care takers at Kilwa under Kilwa Kisiwani

4	Dr. H. Bwire	BICO	<ul style="list-style-type: none"> • Civil engineer • Transportation Planning and Traffic Engineering • Highway Engineering 	Lead Surveyor	<ul style="list-style-type: none"> • To lead structured interviews with the target group • To analyse the survey results and compile thereport 	PhD M.Sc(Highway Engineering) B.Sc. (Eng.)	<ul style="list-style-type: none"> • Study on Identifying Transport Potential Development Areas, worked as a Team Leader. • Household Interview Travel Survey for Dar es Salaam Transport Policy and System Development Master Plan. • Study of Road Traffic Accidents in Tanzania Mainland
5	Mr. S. Merchiory	BICO	<ul style="list-style-type: none"> • Groundwater Hydrology • Mechanical Engineering 	Lead Surveyor	<ul style="list-style-type: none"> • To lead structured interviews with the target group • Analysis of survey results and compile the report 	M.Sc Technology (Groundwater Hydrology) Master of Dev. Management B.Sc. Eng.	Groundwater Geophysical Survey in Somaliland and Puntland for Food and Agriculture Organization of the United Nations (FAO), Somalia office based in Nairobi, Kenya
6	Mr. M.Sahani	BICO	<ul style="list-style-type: none"> • Hydrogeology • Groundwater Prospecting • Well Drilling 	Assistant Surveyor	To assist the lead surveyors in structured interviews and report compilation	B.Sc. General FTC-Water Resources Engineering (Hydrogeology)	Supervising field works including; Hydro-geological & Geophysical Survey, Well drilling, Pump test, Water treatment
7	Ms. H.Kimambo	BICO	<ul style="list-style-type: none"> • Geotechnic Engineering 	Assistant Surveyor	To assist the lead surveyors in structured interviews and report compilation	Bachelor of Transportation and Geotechnic engineering	<ul style="list-style-type: none"> • Geotechnical Investigation for construction of the proposed Kigamboni Bridge at Kurasini Creek • Geotechnical Investigation for construction of the proposed TANESCO Power Plant at Majani Mapana, Tanga • Ground Investigation for Construction of the Proposed Aga Khan University, Arusha Campus
8	Ms J.A. Mtana	BICO	<ul style="list-style-type: none"> • Project Management • Data processing 	Data Entry Clerk	To prepare excel database and to manage the data entry	MEM (Project Management) PGD (Eng. Management) Adv. Diploma (Community Development)	<ul style="list-style-type: none"> • A Study of Community Participation in the Management of Urban Settlement Upgrading under Community Infrastructure Upgrading Programme (CIUP) • Mid- term evaluation of AMREF ANGAZA ZAIDI PROGRAMME

Annex 3: Survey Itinerary

Appendix 4: List of Targeted Companies for Interview and List of Drilling Companies that were actually interviewed

Table Ap4.1: list of Drilling Companies that were originally targeted

Cnt No.	Company Name	POSTAL ADDRESS	REGION	PHYSICAL ADDRESS
1	WATER SOLUTIONS DRILLING CO. LTD	P. O. BOX 2780	MWANZA	NEW SAFARI HOTEL
2	SOCIETY OF THE PRECIOUS BLOOD	P.O. BOX 1951 DODOMA	DODOMA	MIYUJI AREA
3	MAJI TECH ENGINEERING LTD	P.O. BOX 189 ARUSHA	ARUSHA	1 st FLOOR, USA PLAZA-USA RIVER, ARUSHA
4	SPARR DRILLING CO. LTD	P. O. BOX 1522 MWANZA	MWANZA	MABATINI SINAI AREA BLOCK 8 PLOT CC MWANZA
5	MASWI DRILLING CO. LTD	P. O. BOX 6496 DAR ES SALAAM	DSM	MSIMBAZI, DAR ES SALAAM
6	VICTORIA DRILLING CO. LTD	P. O. BOX 1357 DAR ES SALAAM	DSM	CHANG'OMBE AREA, NEAR VETA
7	PNR SERVICES LTD	P. O. BOX 6014 DAR ES SALAAM	DSM	267 DUNGA STREET AREA ,KINONDONI
8	LIMA ECONOMICS GROUP	P. O. BOX 10946 DAR ES SALAAM	DSM	YOMBO DOVYA
9	OKUTO DRILLING CO. LTD	P. O. BOX 10131 ARUSHA	ARUSHA	
10	WATER WELL APPLICATION SYSTEMS LTD	P. O. BOX 1918 ARUSHA	ARUSHA	MNAZI HOTEL (ARUSHA)
11	CHEM CHEM DRILLING CO. LTD	P. O. BOX 12893 ARUSHA	ARUSHA	UNGA LIMITED
12	GLOBAL RESOURCE ALLIANCE	P. O. BOX 721 MUSOMA	MUSOMA	MUSOMA TOWN
13	SHY BUILDERS LTD	P. O. BOX 187 SHINYANGA	SHINYANGA	MWANGA KARANGA AREA
14	AQUAMAN DRILLERS LTD	P. O. BOX 14764 ARUSHA	ARUSHA	THEMI AREA
15	CHIMBA RESOURCES (T) LTD	P. O. BOX DAR ES SALAAM	DSM	154 EMBETI ROAD, MIKOCHE NI B
16	PP SETTY INTERNATIONAL LTD	P. O. BOX 20940 DAR ES SALAAM	DSM	ZANAKI STREET
17	MAKE ENGINEERS AND WATER WELLS	P. O. BOX 12240 DAR ES SALAAM	DSM	SHEKILANGO ROAD-OPP UBUNGO NHC
18	ARDHI WATER WELLS LTD	P. O. BOX 38520 DAR ES SALAAM	DSM	Plot No80 1st Floor Nkurumah Road DSM
19	NYANZA BOTTLING CO. LTD	P. O. BOX 2086 MWANZA	MWANZA	PLOT 73 NYAKATO INDUST. AREA
20	SNUB PRO ENERGY SERVICES INC. AFRICA LTD	P. O. BOX 19126 DAR ES SALAAM	DSM	SINZA KWA REMMY
21	WATTERHUB (T) LIMITED	P. O. BOX 77132 DAR ES SALAAM	DSM	MWALIMU HOUSE - UHURU ST.
22	MR. WATER DRILLING CO. LTD	P. O. BOX 19755 DAR ES SALAAM	DSM	BLOCK 882 PLOT No. 03 UPANGA
23	GEM AND ROCK VENTURES CO. LTD	P. O. BOX 2701 ARUSHA	ARUSHA	AZIMIO/TUCTA HOUSE 1ST FLOOR
24	TACHI INTERNATIONAL DRILLING CO. LTD	P. O. BOX 31809 DAR ES SALAAM	DSM	NSSF BUILDING MWENGE AREA
25	ARUSHA AGGREGATE CO. LTD	P. O. BOX 2547 ARUSHA	ARUSHA	MAJENGO BLOCK F
26	OROTETI ARUSHA CO. LTD	P. O. BOX 65 ARUSHA	ARUSHA	NJIRO AREA
27	AQUA WELL DRILLING CO. LTD	P. O. BOX 13975 DAR ES SALAAM	DSM	KARIAKOO

28	UK GLOBAL TRADING CO. LTD	P. O. BOX 23240 DAR ES SALAAM	DSM	MBEZI BEACH, PLOT 409
29	HYDROTECH (T) LIMITED	P. O. BOX 32803 DAR ES SALAAM	DSM	MWENGE
30	NANRA CONSTRUCTION LTD			
31	PUMPS INTERNATIONAL & SOLAR LTD	P. O. BOX 2635 DAR ES SALAAM	DSM	PLOT 26 D NYERERE RD
32	SHINYANGA MAJI OFFICE	P. O. BOX 147 SHINYANGA	SHINYANGA	
33	SN. TECH (T) LTD	P. O. BOX 70846 DAR ES SALAAM	DSM	PLOT 2234 BLOCK 160 NKRUMAH
34	KARUMBA DRILLING CO.LTD	P. O. BOX 77069 DAR ES SALAAM	DSM	MIOGONI STR. KINONDONI
35	GREAT RUAHA DRILLING AND EXPLORATION LTD	P. O. BOX 41042 DAR ES SALAAM	DSM	135 ALY KHAN ROAD UPANGA
36	HUMAC SERVICES LTD	P. O. BOX 162 MWANZA	MWANZA	NYAKATO
37	WEDECO LTD	P. O. BOX 125 SHINYANGA	SHINYANGA	SHINYANGA TOWN/MATANDA
38	REGWA CO.LTD	P.O.BOX19755 DSM.		
39	WINAM GENERAL TRADERS LIMITED	P. O. BOX 11969 DAR ES SALAAM	DSM	
40	NYAKIRANG'ANYI CONSTRUCTION LIMITED	P. O. BOX 28 MUSOMA	MUSOMA	INDUSTRIAL AREA BURUTI NYAKATO
41	WINNERS STRADERS INTERNATIONAL	P.O.BOX 13156 DAR ES SALAAM	DSM	
42	WELL DRILLING COMPANY LTD	P. O. BOX 36272 DAR ES SALAAM	DSM	
43	K'S BUTRANE CO. LTD	P. O. BOX 77069 DAR ES SALAAM	DSM	
44	EFAM LTD	P. O. BOX 14014 DAR ES SALAAM	DSM	VICTORIA AREA, KINONDONI
45	FRIEDKIN CONSERVATION FUND	P. O. BOX 2785 ARUSHA	ARUSHA	BURKA
46	GEWECO LTD	P. O. BOX 11464 MWANZA	MWANZA	MWANZA TOWN
47	MASOCHI WATER RESOURCES CO. LTD	P. O. BOX 157 DODOMA	DODOMA	IRINGA ROAD
48	DEZO CIVIL CONSTRUCTION CO. LTD	P. O. BOX 104678 DAR ES SALAAM	DSM	
49	CMG CONSTRUCTION CO. LTD	P. O. BOX 235 MWANZA	MWANZA	
50	STAR WATER PUMP	P. O. BOX 21788 DAR ES SALAAM	DSM	UDOE STREET KARIAKOO
51	AL-TTAI DRILLING CO	P. O. BOX 23485 DAR ES SALAAM	DSM	ALGERIA STREET
52	MM WATER AND ONLAND WORKS CO.	P. O. BOX 65568 DAR ES SALAAM	DSM	SUM NUJOMA ROAD
53	ORIENTAL CONSTRUCTION.LTD	P.O.BOX 48364 NAIROBI KENYA	KENYA	
54	KANISA LA KIINJILI LA KILUTHERI	P. O. BOX 97 NJOMBE	IRINGA	NJOMBE
55	DRILL MAT AND GROUNDWATER SERVICES LTD	P. O. BOX 35812 DAR ES SALAAM	DSM	23
56	MINGOYO CONTRACTORS	P. O. BOX 77219 DAR ES SALAAM	DSM	MIKOCHEMI PLOT 432
57	AG WELL DRILLING LTD	P. O. BOX 66229	DSM	AZIKIWE STREET
58	WELLS TECHNOLOGY COMPANY LTD	P. O. BOX 34120 DAR ES SALAAM	DSM	SINZA AREA

59	M&M(T)LTD	P.O.BOX 31609 DAR ES SALAAM	DSM	
60	SWEAT WATER WELL(T)LTD	P.O.BOX 11716 DAR ES SALAAM	DSM	REGENT ESTATE
61	SERENGETI LTD	P. O. BOX 8599 DAR ES SALAAM	DSM	REGENT ESTATE BLOCK A PLOT 299
62	UNDERGROUNDWATER WELLS CO. LTD	P. O. BOX 77112 DAR ES SALAAM	DSM	LUMUMBA/MKUNGUNI, KARIAKOO
63	AL-WATTAN DRILLING CO. LTD	P. O. BOX 23480 DAR ES SALAAM	DSM	
64	BAHADELE DRILLING COMPANY	P. O. BOX 25081 DAR ES SALAAM	DSM	BUGURUNI SOKONI
65	FEDAKO LIMITED	P. O. BOX 12730 DAR ES SALAAM	DSM	MAFERE STR. PLOT 65/32 KINONDONI
66	MIRISHOS FRESH WATER DRILLING COMPANY	P. O. BOX 46163 DAR ES SALAAM	DSM	TABATA SEGEREA/BUZA LULENGE
67	HOLLAND FARM LIMITED	P. O. BOX 8152 DAR ES SALAAM	DSM	KIGAMBONI Hse No.37 TUA MOYO
68	GERMANY AND TANZANIA (GETA) DRILLING PARTNERSHIP SERVICES LTD	P. O. BOX 77586 DAR ES SALAAM	DSM	
69	LWERU WATER WELLS DRILLING COMPANY LTD	P. O. BOX 29885 DAR ES SALAAM	DSM	42 MBEZI BEACH
70	BASAT CONTRACTORS LTD	P. O. BOX 12545 DAR ES SALAAM	DSM	USHIRIKA BLD, LUMUMBA ROAD
71	AL-NASSER GENERAL TRADERS LIMITED	P. O. BOX 72494 DAR ES SALAAM	DSM	NARUNG'OMBE/LUMUMBA STREET
72	ISLAMIC FOUNDATION	P. O. BOX 6011 MOROGORO	MOROGORO	MOROGORO
73	DRILLING SPARES AND SERVICES LTD	P.O.BOX 40859 NAIROBI KENYA	KENYA	L/R 209/10795, MOMBASA LOAD
74	KLR MALENGA DRILLING COMPANY LTD	P.O.BOX 328003 DAR ES SALAAM	DSM	
75	MARATA PLUMBER AND DRILLERS LIMITED	P. O. BOX 8585 DAR ES SALAAM	DSM	SHEKILANGO ROAD
76	LAYNE DRILLING COMPANY LTD	P. O. BOX 2372 MWANZA	MWANZA	
77	ARMITAGE ENGINEERING (T) LTD	P. O. BOX 15118 DAR ES SALAAM	DSM	
78	AMANDUS ENTERPRISES	P. O. BOX 23276 DAR ES SALAAM	DSM	
79	FUTURE CENTURY LTD	P. O. BOX 76363 DAR ES SALAAM	DSM	COCOBACH
80	O.C.I INDUSTRIAL HOLDINGS LTD	P. O. BOX 35009 DAR ES SALAAM	DSM	MWENGE AREA
81	HARDWARE DRILLING COMPANY ARUSHA			
82	LUGOBA STONES CONSTRUCTION LTD	P.O. BOX 54470 D'SALAAM	DSM	CHANG'OMBE MANDELA ROAD DAR ES SALAAM
83	HYDRO WORKS CONSTRUCTION (T) LTD	P. O. BOX 35009 DAR ES SALAAM	DSM	
84	DRILL MASTER AFRICA	P. O. BOX 2 MWADUI MINES SHINYANGA	SHINYANGA	
85	DYNAMIC DRILLERS LTD	P. O. BOX 72671 DAR ES SALAAM/ P. O. BOX 100 BUKOBA	DSM	
86	CM-WELL BORING CO.LTD	P. O. BOX 621884 DAR ES SALAAM	DSM	
87	MMEKU WATER WELLS DRILLING CO.	P. O. BOX 36083 DAR ES SALAAM	DSM	ALGERIA STREET

88	WATER TRANS INTERNATIONAL LTD	P. O. BOX 2148 DAR ES SALAAM	DSM	MJIMWEMA-KIGAMBONI PLOT.24 BLOCK A
89	MUCOBA ENTERPRISES	P. O. BOX 2121 DAR ES SALAAM	DSM	
90	MIKINDANI SANA LTD	P. O. BOX 664 MTWARA	MTWARA	
91	COAST WATER WELL DRILLING	P. O. BOX 5066 DAR ES SALAAM	DSM	INDIAN STREET
92	TALHA WATER WELLS DRILLERS LTD	P. O. BOX 16612 DAR ES SALAAM	DSM	PUGU ROAD
93	JIDAR INDUSTRIES (T) LTD	P. O. BOX 77122 DAR ES SALAAM	DSM	
94	LBS WATER WELLS DRILLING CO.	P. O. BOX 36413 DAR ES SALAAM	DSM	
95	HMM COMMERCIAL INVESTMENT CO.	P. O. BOX 6784 MOROGORO	MOROGORO	
96	POLLO ITALIA TANZANIA LTD	P. O. BOX 8661 DAR ES SALAAM	DSM	
97	MLAKI BUILDING AND WATER ENG. CO.	P. O. BOX 40207 DAR ES SALAAM	DSM	
98	GEORGES WELL CONSTRUCTION	P.O.BOX 61517 DAR ES SALAAM	DSM	
99	KADET	P. O. BOX 7709 DAR ES SALAAM	DSM	
100	NTUZUGIANI EAST AFRICA LTD	P. O. BOX 10494 DAR ES SALAAM	DSM	
101	BOLEYN INTERNATIONAL (T) LTD	P. O. BOX 72593 DAR ES SALAAM	DSM	
102	EASTLAND WATER WELL DRILL CO. LTD	P. O. BOX 21317 DAR ES SALAAM	DSM	
103	HOMEPRIDE CONSTRUCTION CO. LTD	P. O. BOX 464 MBOZI, MBEYA	MBEYA	ILALA BUNGONI
104	AL WATER WELL DRILLERS	P. O. BOX 4965 DAR ES SALAAM	DSM	FIRE AREA, KARIAKOO
105	SMS AMOURY INVENSTMENT	P.O. BOX 65335 DAR ES SALAAM	DSM	
106	AS DRILLING CO. LTD	P.O BOX 12125 ARUSHA	ARUSHA	NJIRO GHOROF MBILI PLOT No 84
107	AL-SAGGAF DRILL LTD	P.O. BOX 15079 DAR ES SALAAM	DSM	SOMALI STREET KARIAKOO
108	HAM DRILLERS	P.O. BOX 8881 DAR ES SALAAM	DSM	MBEZI
109	RAHMY CO.LTD	P.O. BOX 38575 DAR ES SALAAM	DSM	PLOT NO 651,SINZA
110	NILE WELL DRILLERS	P.O. BOX 22313 DAR ES SALAAM	DSM	PLOT NO 1/8 LINDI/ARUSHA STREET-ILALA
111	NASSER GENERAL TRADER	P.O. BOX 36 BARIADI,SHINYANGA	SHINYANGA	CCM GROUND-SIMANDOBA
112	TWABAHA CONSTRUCTION LTD	P.O. BOX 21336 DAR ES SALAAM	DSM	TABATA
113	ASHRAF WATER WELL DRIL. CO	P.O. BOX DAR ES SALAAM	DSM	CHANGANYIKENI
114	WEPMO	P.O. BOX 38340 DAR ES SALAAM	DSM	UBUNGO
115	SEBA CONSTRUCTION&DRIL.CO	P.O. BOX 25487 DAR ES SALAAM	DSM	AMANA UHURU STR.
116	LEORNE RESOURCE	P.O. BOX 35599 DAR ES SALAAM	DSM	PLOT NO 2283,BLOCK H MBEZI BEACH
117	MAVONDA CO LTD	P.O. BOX 63242 DAR ES SALAAM	DSM	SIDO BUILDING BLOCK A, ALONG BIBI TITI ROAD

Under Groundwater Development and Management Capacity Development (DDCAP) Project

118	TECHNO DRILLERS	P.O. BOX 12146 DSM	DSM	MAVUNO HOUSE 1ST FLOOR NO 104 AZIKIWE STR.
119	TANSFORMER AGR.&CONST.	P.O. BOX DAR ES SALAAM	DSM	MIKOCHENI
120	PIONEER WELL DRILLING LTD	P.O. BOX 15035 DAR ES SALAAM	DSM	KINONDONI ADA ESTATE
121	PARAMOUNT WATER W&DRILL	P.O. BOX 72883 DAR ES SALAAM	DSM	MSASANI
122	VACUUM ROTARY	P.O. BOX 33607 DAR ES SALAAM	DSM	MTONI MTONGANI, TEMEKE
123	BUBUJIKO IENTERPRISE	P.O. BOX 32 DAR ES SALAAM	DSM	KINONDONI
124	GLOBAL TECH DRILLING &EXP	P.O. BOX 19996 DAR ES SALAAM	DSM	KHANGA STR. KINONDONI B NEAR KINONDONI MAHAKAMANI
125	MUWANYA WELL DRILLING	P.O. BOX 97 DAR ES SALAAM	DSM	KINONDONI VIJANA HOSTEL PLOT NO KMY/KMB/415 LOWER STREET MWINYIJUMA ROAD
126	JIDAR INDUSTRIES (T) LTD	P.O. BOX 1145DAR ES SALAAM	DSM	

Table Ap4.2: List of Interviewed Company

Original or New	Company Name	Postal Address (i.e. P.O. Box)	Physical Address	
			Region	District
O-27	Aqua Well Drilling Company Ltd	13795 DSM	DSM	Ilala
O-015	Chimba Resources	169 DSM	DSM	Kinondoni
O-008	Lima Economic and Development group	10946 DSM	DSM	Temeke
O-005	Maswi drilling company Ltd	2197 MWANZA	DSM	Ilala
O-091	Coast Water Well Company	5066 DSM	DSM	Ilala
O-114	WEPMO (Water & Enironmental Sanitation Projects Maintenance Organization)	38340 DSM	DSM	Kinondoni
O-039	Winam General Treders Ltd	11969 DSM	DSM	Ilala
O-123	Bubujiko Enterprises	732 DSM	DSM	Temeke
O-055	Drill Mat & Ground Water Services Ltd	35812DSM	DSM	Kinondoni
O-080	O.C. I Industrial Holdings Ltd	35009 DSM	DSM	Kinondoni
O-028	UK Global Trading Ltd	66612 DSM	DSM	Kinondoni
O-075	Marata Plumbers & Drillers Ltd	13805 DSM	DSM	Kinondoni
O-021	Watter Hub Tanzania LTD	77132	DSM	Ilala
O-113	Ashraf Water Wells Drilling Company	1691 DSM	DSM	Kinondoni
O-104	Al-Water Well Drillers	4964	DSM	Ilala
O-050	Star Water Pumps	21788	DSM	Ilala
O-116	Leone Resources Development Company Limited	35599	DSM	Kinondoni
O-067	Holland Farm Ltd	8152	DSM	Temeke
O-020	Snub Pro Africa Ltd	19126	DSM	Kinondoni
O-115	Seba Drilling and Construction Ltd	25487 DSM	DSM	Ilala
O-058	Wells Technology Co. Ltd	34120	DSM	Kinondoni
N-012	Uchama Drilling and Biogas Services	2774	DSM	Ilala
O-070	Basat contractors Ltd	12545	DSM	Ilala

Baseline Survey on Private Drilling Companies
Under Groundwater Development and Management Capacity Development (DDCAP) Project

O-110	Nile WellDrillers (Sole Propriator)	22313	DSM	Ilala
O-108	Ham Drillers Ltd	888	DSM	Kinondoni
O-044	Efam Limited	14014	DSM	Kinondoni
O-051	AL-TTAI Drilling company Ltd	23485	DSM	Ilala
N-005	Chem Chem Well Drilling Company	45243	DSM	Temeke
O-064	Bahadele Drilling Company	25081	DSM	Ilala
O-117	Mavonda's Company Ltd	63242	DSM	Ilala
O-121	Paramount Drill Wells Limited	72883	DSM	Ilala
O-004	Sparr Drilling Company Ltd	1522	MWANZA	MWANZA
O-007	PNR Services Ltd	6014	DSM	Kinondoni
N-014	Water Wells Services Ltd	72671	DSM	Kinondoni
O-069	Lweru Water Wells Drilling Company Ltd	71711	DSM	Kinondoni
O-022	MR. Water Drilling Company Ltd	8383	DSM	Ilala
O-040	Nyakilang'anyi Construction Ltd	28	Mara/Dar es salaam	Musoma
O-017	Make Eng and Water Works Ltd	12240	DSM	Kinondoni
O-018	Ardhi Water Wells Ltd	38520	DSM	Ilala
O-013	Shy Builders Ltd	187	Shinyanga	shinyanga
O-111	Nassa GeneralTraders Limited	36 Bariadi	Shinyanga	Bariadi
O-025	Arusha Aggregates Ltd	2547 Arusha	Arusha	Arusha
O-054	ELCT Southern Dioces (Konde Diocese)	97 Njombe	Njombe	Njombe
N-010	Southern Highlands Participatory Organisation (SHIPO)	227 Njombe	Njombe/ Iringa	Njombe
O-001	Water Solutions Drilling Co. Ltd	2780 Arusha	Arusha	Arusha
O-122	Vacuum Rotary Drilling Company	3219 DSM	DSM	Kinondoni
O-082	Lugoba Stones and Construction Co. Ltd	39819 DSM	DSM	Kinondoni
O-037	Water and Environmental Development Company Ltd	125 SHINYANGA	Shinyanga	Shinyanga Town
O-003	Maji Tech Engineering Ltd	189	Arusha	Arumeru
O-046	Groundwater Exploration & Well Construction Co. Ltd	11464	Mwanza	Nyamagana
O-036	Humac Services Ltd	162 MWANZA	Mwanza	Nyamagana
O-011	Chem chem Drilling Co. Ltd	12893 ARUSHA	Arusha	Arusha
O-012	Global Resource Alliance-TZ	721 MUSOMA	Mara	Musoma
N-002	B.R.A	10693	DSM	Ilala
O-124	Global Tech Drillig and Exploration Ltd	19996 DSM	Mwanza	Ilemela
O-076	Layne Drilling (T) Ltd	726 MOROGORO	Morogoro	Morogoro Urban
O-061	Serengeti Ltd	72374	DSM	Kinondoni
O-068	Germany and Tanzania Drilling Partinership Co. Ltd (GETA)	30319 DSM	DSM	Kinondoni
O-033	SN-TECH (T) Ltd	70848	DSM	Ilala
O-126	Ruko's Genaral Supplies Co. Ltd	1145	DSM	Kinondoni
O-029	Hydro Tech (T) Ltd	32803 DSM	DSM	Kinondoni
O-038	Research and Ground Water Drilling Co. Ltd (REGWA)	1806 UPANGA	DSM	Kinondoni
O-109	Rahmy Company Ltd	38575 DSM	DSM	Ilala
N-001	Amini Tech Company Ltd	2241 DSM	DSM	Kinondoni
O-079	Future Century Limited	301 BAGAMOYO	COAST	Bagamoyo
O-125	Muwanya Well Drilling	97 DSM	DSM	Kinondoni
N-008	RRS Water Well Drilling Company	45 DSM	DSM	Ilala
O-049	CMG Construction Company Ltd	235 MWANZA	Mwanza	Nyamagana

Baseline Survey on Private Drilling Companies
Under Groundwater Development and Management Capacity Development (DDCAP) Project

O-059	M & M(T) Ltd	31609	DSM	Kinondoni
N-015	Himalaya Enterprises LTD	40774	DSM	Ilala
N-016	Water Well Services Ltd		DSM	Kinondoni
N-017	Msabi (Maji Safi kwa Afya Bora Ifakara)	284	Morogoro	Ifakara
N-019	Kilimanjaro Water Well Drilling		DSM	Kinondoni
N-020	World Islamic Propagation and Humanitarian Services (WIPAHS)	1895	DSM	Ilala
N-013	Water International Services LTD		DSM	Kinondoni
N-021	Serving Friends International	2565	Arusha	Arusha
N-022	K'S Interprice LTD	993	Kilimanjaro	Moshi
O-023	Gem and Rock Ventures Co. Ltd	2701	ARUSHA	Arusha City Centre
O-014	Aquaman Drillers Ltd	14764 ARUSHA	ARUSHA	ARUSHA
O-118	Techno Drillers Co. Ltd	12146	ARUSHA	ARUSHA
N-023	Gaimo Construction Co. Ltd	13489	ARUSHA	ARUSHA
N-024	Willy Enterprises Ltd	436 ARUSHA	ARUSHA	ARUSHA
O-106	AS Drilling Company Ltd	12125	ARUSHA	Arusha Town
N-025	Rehoboth Mining and Water Well Drilling Co	1940	ARUSHA	Arusha
O-105	SMS Amour Investment	65335	DSM	Ilala
O-026	Oroteti Ltd	65	ARUSHA	Arusha
N-028	Kikim Building Geotechnical and Drilling Contractors	79360	DSM	Ilala
N-009	Sustainable Environment Management Action(SEMA)	365 SINGIDA	SINGIDA	Singida Municipality
N-026	J.N.M Mining Services Ltd	11940	DSM	Kinondoni
N-027	Kimani Minerals Ltd	70812	DSM	Kinondoni
N-029	MC Water Wells Drilling Co. Ltd		DSM	Temeke
O-073	Drilling Spares and Services Ltd	40859-00100 NAIROBI,KENYA		Nairobi
O-092	Talha Water Well Drillers Ltd	24115,DSM	DSM	Temeke
O-002	Society of the Precious Blood Water Project	1951	Dodoma	Dodoma

Legend (Original or New): O=original, N=new

Ministry of Water (MoW)
Drilling and Dam Construction Agency (DDCA)
Japan International Cooperation Agency (JICA)

DDCAP

Capacity Development Support Plan for Private Sector

Version 1

January 2013

Groundwater Development and Management Capacity Development (DDCAP)
Project

Contents

1	BACKGROUND	1
2.	OUTLINE OF CAPACITY DEVELOPMENT SUPPORT PLAN	2
2.1	Purpose of the Plan.....	2
2.2	Composition of Capacity Development Support Plan Companies.....	2
2.3	Target Groupe of the Plan.....	2
2.4	Classification of Private Drilling Companies.....	2
2.5	Evaluation of Project Effect Potential of Classified Groups of Private Drilling Companies ...	3
2.6	Capacity Development Support Plan	4
2.7	Technical Insruction Structure.....	5
3.	TECHNICAL INSTRUCTION SYSTEM	6
3.1	Teaching Guidance	6
3.2	Technical Instruction Module.....	8
3.3	Internal Certification System of the Instructors	11
3.4	Training System for the Instructors	11
3.5	Certification System for the Engineer in Private Sector	12
3.6	Preparation of Process on Accumulation, Share and Utilization of Results of Technical Instruction	13

Tables

Table 1	Classification of Private Drilling Companies	3
Table 2	Classified Groups of Private Drilling Companies and Project Effect Potential	4
Table 3	Composition of Teaching Guidance	6
Table 4	Characteristics of Classified Group of Private Companies	9
Table 5	Technical Instruction Module Drilling Techniques by Classified Group of Private Drilling Companies	9
Table 6	Internal Certification System of Technical Instructors	11
Table 7	On-site Checklist of Drilling Technical Level (Draft)	13
Table 8	Technical Instruction Review	13

Figures

Figure 1	Structure of Training System of the Instructor	12
----------	--	----

Appendix

List of 94 Classified Private Drilling Companies Through the Baseline Survey

1 BACKGROUND

Ministry of Water (MoW) has been implementing Water Sector Development Programme (WSDP), in order to realize the National Water Sector Development Strategy (NWSDS). A target of WSDP is that water supply and sanitation facilities in rural areas are provided 90% and 75% respectively by 2025. In likewise, it is that water supply and sewerage system is completely installed in urban areas, and an average of water supply in whole country is become 93% by 2025.

A plan of a number of water supply facilities to be constructed by the rural water supply component of the WSDP is 79,754, in order to provide safe water to approximately 34.5 million un-served populations. The water source of 91% out of the planned facilities is expected from the groundwater. Therefore, it is estimated that the drilling 1,200 wells annually are required for achievement of the target. Although private sector are the main actor for groundwater development of the rural water supply component of the WSDP, their current capacity of drilling wells annually is reported as approximately 600. In other words, their capacities such as technical abilities and resources have a great gap compared with the demand written in the above.

In order to address this challenge, MoW formulated a “Strategy for Strengthening Water Well Drilling Industry in Tanzania” in 2006, and mandated the capacity development of private drilling companies to DDCA (Drilling and Dam Construction Agency) by launch their new services such as a hiring of drilling equipment and technical instructions.

In response to the request of the Government of Tanzania for the technical cooperation to DDCA, the Government of Japan agreed on Minutes of Meeting (M/M) and Record of Discussions (R/D) between the MoW, DDCA and Japan International Cooperation Agency (JICA) in December 15th 2011. Based on this background, the Groundwater Development and Management Capacity Development Project (DDCAP) was started on March 2013. A purpose of the project is to “enhance the DDCA’s capacity to support the water well drilling industry” by strengthening of DDCA’s techniques for groundwater development and their capacity of technology transfer toward private drilling companies, and by establishment of an equipment hiring system in DDCA.

The following outputs are planned in order to achieve the overall target and the project purpose written in the above.

Output 1: DDCA’s ability to impart techniques and skills regarding water well drilling to private drilling sector is enhanced.

Output 2: The capacity of DDCA in groundwater development, which is required to provide technical instructions, is enhanced.

Output 3: A system to hire drilling equipment and machinery is established.

This Capacity Development Support Plan for Private Sector (hereinafter referred to as “CDSP”) is the plan to develop their capacity especially the area identified as the shortfall in the private drilling companies. The target areas to be developed the capacity were identified by the baseline survey. The capacity development policy was formulated according to the results of the analysis of the baseline survey. The CDSP is the specific plan to implement the policy, and main products of the activity of 【1-2】 related to the output 1 above, and stipulated in PDM (Project Design Matrix) of the Project, which intends to enhance the DDCA’s ability to impart techniques and skills regarding water well drilling to private drilling sector.

The support DDCA in carrying out technical instruction for private sector by the project team will be carried out entire project period. Accordingly, the CDSP will be updated and/or modified by reflecting the results of the activities.

2. OUTLINE OF CAPACITY DEVELOPMENT SUPPORT PLAN

2.1 PURPOSE OF THE PLAN

The purpose of the Capacity Development Support Plan (CDSP) is to enhance the DDCA's ability to impart techniques and skills regarding water well drilling to private drilling sector. The area identified as the shortfall in the private drilling companies was identified by the baseline survey. The technical instruction for the private sector should be provided based on the CDSP. The teaching guidance is provided in association with the CDSP.

2.2 COMPOSITION OF CAPACITY DEVELOPMENT SUPPORT PLAN COMPANIES

The capacity development support plan for private drilling companies includes three options i.e. equipment hiring, provision of hydrogeological information and technical instruction. Among them, concrete contents of the plans for equipment hiring and provision of hydrogeological information are stipulated in the Hiring Guideline and Database Manual respectively. The capacity development support plan for private drilling companies clarifies the concrete plan of the following activities:

- Establishment of a technical instruction system
- Formulation of teaching guidance
- Facilitation of DDCA's technical instructors
- Technical instruction to private drillers

2.3 TARGET GROUPE OF THE PLAN

The target group is the management of Drilling Project Department of DDCA, which is main institution to make technical instruction to the private secotor. The technical instructors of the DDCA who selected fromt the senior drillers of the drilling department of DDCA, are also the target group of the plan.

As six drilling rig are procured for hiring, at least six technical instructors are to be selected. With consideration of retirement of staffs and activities of internal training of DDCA's drillers, another six technical instructors are expected to be selected by the year of 2013. The project targets 12 technical instructors who are selected from 35 senior drillers of DDCA according to the evaluation by the drilling project operation department of DDCA.

2.4 CLASSIFICATION OF PRIVATE DRILLING COMPANIES

99 % of 94 target private drilling companies surveyed show their interest in the drilling works under RWSS (Rural Water Supply and Sanitation) component of WSDP. However, only 16 of 94 companies had experiences of the works of WSDP. The following issues were pointed out as obstacles for the participation in WSDP:

- Lack of investment fund
- Lack of qualified and skilled drillers
- Strict procurement rules of drilling under WSDP
- Difficult hydrogeological conditions for drilling

In order to support private drilling companies in their capacity development to cope with their challenges related techniques and equipment, DDCA is planning to provide their technical support services. Different contents of technical support services will be provided by DDCA according to the challenges, ability and interests of the companies. In order to classify the private drilling companies, the following three criteria were selected.

The reasons of selection of above criteria are described below:

To Own Large-capacity drilling rig and experience of DTH drilling

In order for the participation in WSDP, the private drilling companies need drilling equipment and techniques which correspond to well specifications of WSDP. According to the results of drilling works in 1st phase of RWSS component of WSDP, drilling depth of one borehole was 114 m in maximum, 78 m in minimum and 96 m in average. Diameter of casing and screen pipes were not less than 150 mm in 97 % of drilled boreholes¹. Furthermore, most of the location of the drilling sites are hard rock areas. Therefore, DTH method should be used for drilling. In order to correspond these conditions, large-capacity drilling rigs and technique of DTH drilling are required. The companies which fulfill these conditions are regarded to be capable for the drilling under WSDP in both respects of equipment and techniques.

To be Interested in DDCA's equipment hiring services

DDCA will conduct technical support services, mainly by hiring equipment and technical instruction. In this reason, this criterion was selected as the second one. 83 companies show their interest in DDCA's equipment hiring services. The other companies have a purchase plan of new equipment with their own investment fund or they already own enough number of equipment.

To be Interested in DDCA's technical support services

Some of companies are not interested in equipment hiring but are interested in technical instructions and provision of hydrogeological information.. This criterion was selected in order for the examination of support measures.

With the above three criteria, the private drilling companies were classified in five groups between A to E, as shown in **Table 1**. The characteristics of companies which belong to each group are described below, without equipment hiring. List of 94 private drilling companies with their classification and further detailed information are attached in this CDSP as an **APPENDIX**.

Table 1 Classification of Private Drilling Companies

Group	Number of Companies	Classification Criteria		
		1) Large-Capacity Drilling Rig and Experience of DTH Drilling	2) Interest in Equipment Hiring Services	3) Interest in Technical Instruction and Provision of Hydrogeological Information
A	23	23	17	22
B	60	0	60	58
C	3	3	0	3
D	7	0	0	7
E	1	1	0	0
Total	94	37	83	90

2.5 EVALUATION OF PROJECT EFFECT POTENTIAL OF CLASSIFIED GROUPS OF PRIVATE DRILLING COMPANIES

As a result of the baseline survey, private drilling companies are classified into five groups of A to E. In order to formulate a capacity development support plan for private drilling companies, group-wise project effect was considered. **Table 2** shows numbers of company by classified group. The potential of project impact was evaluated by using parameters of situation such as availability of equipment, interest in DDCA's services and experience of drilling under WSDP.

¹ Calculated from Water Sector MIS and records of Rural Water Supply Directorate of Ministry of Water

Table 2 Classified Groups of Private Drilling Companies and Project Effect Potential

Group	Numbers of Company	DTH Drilling Equipment	Interest in DDCA's Service		Experience of Drilling under WSDP	Project Effect Potential
			Equipment Hiring	Technical Instruction and Provision of Hydrogeological Information		
A	23	23	23	22	11	4
B	60	0	60	58	3	5
C	3	3	0	3	1	3
D	7	0	0	7	1	2
E	1	1	0	0	0	1

Note) Figures show numbers of company

Group B is a largest group and 60 companies belong to the group. The DTH drilling equipment to correspond to basement rock drilling is not available in the companies of Group B. However, almost all of them are interested in both equipment hiring and technical support. On the other hand, only three companies of 60 have experiences of drilling under WSDP. Consequently, Companies of Group B has the largest potential to use DDCA's equipment hiring and technical support services and participate in WSDP. Therefore, the potential of project impact is evaluated to be level 5 which is the highest rank.

A total of 23 companies belong to Group A. All of them own DTH drilling equipment and are also interested in DDCA's equipment hiring and technical instruction services. In addition, 11 companies of 23 have experiences of drilling under WSDP. This group is evaluated to be potential in the respect of their intention to the business expansion. Therefore, level 4 is given to this group as a result of evaluation.

Three companies of Group C own DTH drilling equipment therefore, are not interested in equipment hiring services. It means their intention of the business expansion is smaller than that of companies of Group A. However, they are interested in technical instruction and hydrogeological information. Their potential for the participation in WSDP can be expected, if the proper approach of technical instruction is taken. As the potential of project impact is in some extent limited, level 3 is given to this group, which is a middle potential level.

Seven companies of Group D neither own DTH drilling equipment nor are interested in equipment hiring services. However, they are interested in technical instruction and hydrogeological information. The characteristics of Group D are similar to Group C. However, their intention of the business expansion and the participation in WSDP is evaluated to be lower than the one of Group D, because they are not interested in equipment hiring services even though they do not own DTH drilling equipment. Therefore, the potential of project impact is evaluated to be considerably limited. Level 4 is given to this group, which is a lower rank in potential levels.

A company of Group E already owns DTH drilling equipment. On the other hand it is interested in neither equipment hiring nor technical support services. Only one company belong to this group. Consequently, very low project impact potential is expected to this group. Therefore, the lowest level of Level 1 is given to this group.

2.6 CAPACITY DEVELOPMENT SUPPORT PLAN

The capacity development for private drilling companies is conducted with the measures of three options, i.e. equipment hiring services, technical instruction and provision of hydrogeological information. The combination of these options becomes a support plan which is based on the situation and needs of private drilling companies. This is a major component of the plan. The proposed capacity development support plan for private drilling companies is summarized as below, with consideration of characteristics of classified groups of private drilling companies and potential of project impact.

1) Plan for Introduction of DTH Drilling

(Target: Group B Companies [Project Effect Potential – Level 5])

This plan targets Group B of which project impact potential was evaluated to be highest level of 5. This group has the largest numbers of the companies among all the groups. Companies which belong to this group are interested in both equipment hiring and technical instructions, as they have no experience of the DTH drilling at basement rock area. The major component of support plan is the combination of the hiring of DTH drilling equipment and instruction of drilling techniques. Further capacity development is expected by the provision of hydrogeological information as a supplementary support measure.

2) Business Expansion Support Plan

(Target: Group A Companies [Project Effect Potential – Level 4])

Companies which belong to this group already own DTH drilling equipment and approximately a half of them have experiences of drilling under WSDP. They are interested in both equipment hiring and technical instruction. Thus the potential of project impact was evaluated to be Level 4. The combination of equipment hiring, technical instruction and provision of hydrogeological information is the major component of this plan. However, some of companies of this group are expected to expand their business, as they have already own DTH drilling equipment. The arrangement of equipment hiring services is required with consideration of the priority between Group A and Group B.

3) Technical Instruction Plan

(Target: Group C, D, E Companies [Project Effect Potential – Level 3,2,1])

Only 11 companies belong to these groups. This plan targets to companies which are not interested in equipment hiring, notwithstanding whether or not they own DTH drilling equipment. Therefore, the major component of the plan is a combination of technical instruction and provision of hydrogeological information.

Three companies of Group C are interested in only the provision of hydrogeological information. Among seven companies of Group D, only three companies are interested in technical instruction. On the other hand, all seven companies of Group D are interested in provision of hydrogeological information. Consequently, two cases can be expected. One is the support by the combination of both technical instruction and provision of hydrogeological information and another is the support only by provision of hydrogeological information.

A company of Group E is not interested in any technical support service. Therefore, only an approach of public relations is applicable to this group.

2.7 TECHNICAL INSTRUCTION STRUCTURE

The technical instruction will be carried out by the drillers accompanying the hiring equipment. DDCA is required to conduct proper technical instruction which corresponds to capacity and needs of each private company. Basic contents and the structure of technical instruction to the companies of each classified group are described below. Using this structure, specific contents of technical instruction is determined according to types of contract with each private drilling company.

● Technical Instruction to Group A Companies

The companies of this group already have experiences of DTH drilling with large-capacity drilling equipment. The basic idea is dispatchment of only one technical instructor, as they can organize a drilling team with a required technical level. The work of the technical instructor is to explain the specific operation of equipment hiring, checking of technical level through entire drilling process and instruction for proper work implementation in each technical area.

● Technical Instruction to Group B Companies

The companies of this group do not have experience of DTH drilling with large-capacity drilling equipment. They need to acquire techniques in entire drilling process. Among such techniques, DTH drilling techniques are especially important. A technical instructor need to conducts

technical instruction in entire drilling process. Furthermore, on the job training to private drillers by the instructor is required, in case private drillers do not have sufficient technical level. Therefore, another option of field OJT including dispatchment of one or two drillers are will also be prepared.

● Technical Instruction to Group C,D Companies

Companies of these groups are interested in technical support services. However, they are not interested in equipment hiring. Furthermore, each company has different expectation of technical areas to be instructed. The basic idea is dispatchment of one technical instructor for specific technical areas according to needs of each company. Several options are supposed, such as dispatchment of technical instructors for borehole logging, pumping test, DTH drilling etc., The tariff of dispatch of technical instructors is stipulated in the equipment hiring guideline.

3. TECHNICAL INSTRUCTION SYSTEM

The capacity development policies of DDCA's ability of technical instruction are "acquisition of theoretical knowledge of drilling mechanism", "standardization of techniques", "technical instruction of entire drilling process by DDCA's technical instructor" and "unified and common techniques of well rehabilitation and tool fishing". Based on these policies, a technical instruction system is established through activities of 1) formulation of teaching guidance, 2) establishment of certification system for the instructor, 3) establishment of training system for the instructor and 4) establishment of certification system for engineer in private sector and 5) preparation of process on accumulation, share and utilization of results of technical instruction. Contents of these activities are described below.

3.1 TEACHING GUIDANCE

DDCA's technical instructors need to acquire theoretical knowledge and teaching method in technical areas of entire drilling process. The Project Team are currently conducting the listing-up of items of technical instruction and preparation of teaching guidance. A teaching guidance contains "Objective", "Contents", "Teaching Method" and "Materials". General books of drilling techniques which are used in DDCA, manuals which were prepared in the projects, catalogs and/or manuals of suppliers of drilling materials and equipment are used as materials for the teaching guidance. *Table 3* shows composition of teaching guidance.

Table 3 Composition of Teaching Guidance

Technical Area / Item	Objective
1 Site Mobilization	
1-1 Site Preparation and Drilling Machine Setting-Out	To be able to explain and advise proper site preparation and drilling machine installation on site.
2 Drilling Tools and Equipment	
2-1 Selection of drilling bit and drilling method	To be able to explain and advise differences between drilling methods and how to select them according to geological conditions.
2-2 Rotary Bits	To be able to explain and advise type, structure and use of rotary bits for mud drilling.
2-3 DTH and DTH Bit	To be able to explain and advise type, structure and use of DTH and DTH bits for DTH drilling.
2-4 Rig Accessory	To be able to explain and advise necessary contents and specifications of rig accessory such as drill pipe, drill collar etc.
2-5 Casing Tools	To be able to explain and advise specifications of steel casing pipes to be used as surface and conductor casing.
2-6 Drilling Equipment	To be able to explain and advise specifications of major drilling equipment such as drilling rig, mud pump, compressor, supporting truck etc.
2-7 Drilling Calculation	To be able to explain and advise necessary calculation for drilling work such as unit conversion, calculation of discharge rate, annular volume etc.
2-8 Weight of drilling tools	To be able to explain and advise unit weight and total of drilling tools weight which shall be balanced with rig capacity during drilling.

Technical Area / Item	Objective
2-9 Rotary bit rotation speed and weight on bit	To be able to explain and advise suitable bit rotation speed and weight on bit so as to use them effectively and safely during mud drilling.
2-10 DTH Bit rotation speed and weight on bit	To be able to explain and advise suitable DTH bit rotation speed and weight on bit so as to use them effectively and safely during DTH drilling.
3 Drilling Drawbacks	
3-1 Countermeasures against lost circulation during mud drilling	To be able to explain and advise how to prevent from lost circulation and countermeasures against it during mud drilling.
3-2 Countermeasures against lost circulation during DTH drilling	To be able to explain and advise how to prevent from lost circulation and countermeasures against it during DTH drilling.
3-3 Countermeasures against bore wall collapse during drilling	To be able to explain and advise how to prevent from bore wall collapse and countermeasures against it during mud drilling.
3-4 Countermeasures against bore wall collapse during DTH drilling	To be able to explain and advise how to prevent from bore wall collapse and countermeasures against it during DTH drilling.
3-5 Countermeasures against jamming of drilling tools	To be able to explain and advise how to prevent from jamming of drilling tools and countermeasures to recover it.
4 Drilling Control	
4-1 Mud control	To be able to explain and advise rolls of mud fluid to conduct effective drilling and how to keep condition of mud.
4-2 Mud Pump Operation	To be able to explain and advise how to operate mud pump for effective use.
4-3 Casing for mud drilling	To be able to explain and advise specifications of surface and conductor casings and procedure to install and remove them.
4-4 Drilling operation for mud drilling	To be able to explain and advise how to control various parameter of drilling and procedures of each work such as pipe connection, cleaning hole etc.
4-5 Bit control and repairing for mud drilling	To be able to explain and advise how to control and repair bits for effective use.
4-6 Air control for DTH drilling	To be able to explain and advise rolls of air and how to control pressure and delivery for effective DTH drilling.
4-7 Air compressor operation	To be able to explain and advise how to operate air compressor for effective use.
4-8 Casing for DTH drilling	To be able to explain and advise specifications of surface and conductor casings and procedure to install and remove them.
4-9 Drilling operation for DTH drilling	To be able to explain and advise how to control various parameter of drilling and procedures of each work such as pipe connection, cleaning hole etc.
4-10 Bit control and repairing for DTH drilling	To be able to explain and advise how to control and repair DTH bits for effective use.
5 Borehole Logging	
5-1 Borehole logging instruments	To be able to explain and advise principles, measuring items and operation procedures of borehole logging.
5-2 Interpretation of borehole logging results	To be able to explain and advise how to determine screen position from borehole logging results.
6 Casing Program / Installation	
6-1 PVC casing, screen pipe	To be able to explain and advise specifications of PVC casing, screen pipe.
6-2 Casing Program	To be able to explain and advise how to determine casing size, borehole size and how to prepare casing program.
6-3 Role of centralizer	To be able to explain and advise use of centralizer and how to determine its installation depth.
6-4 Casing, screen pipe installation	To be able to explain and advise preparation and procedures of installation of casing, screen pipe.
7 Gravel Packing	
7-1 Determination of gravel size	To be able to explain and advise how to determine gravel size suitable to well structure and aquifer formation.
7-2 Calculation of gravel volume	To be able to explain and advise how to calculate gravel volume for the proper preparation on site.
7-3 Gravel packing	To be able to explain and advise gravel packing procedures and precautions to prevent from failure of packing.

Technical Area / Item	Objective
8 Well Development	
8-1 Well cleaning after drilling	To be able to explain and advise several well cleaning methods to be selected according to well conditions, such as bailing, swabbing, air-lifting etc.
8-2 Single-tube method air-lifting	To be able to explain and advise single-tube method air-lifting which is popular method.
8-3 Double-tube method air-lifting	To be able to explain and advise double-tube method air-lifting which is more safe methods than single-tube one.
9 Back-Filling & Surface Cementing	
9-1 Back-filling	To be able to explain and advise procedures of back-filling.
9-2 Surface cementing	To be able to explain and advise how to calculate mixing of cement and water and how to place it.
10 Site Demobilization	
10-1 Precautions upon site demobilization	To be able to explain and advise precautions upon site demobilization to prevent from damage to third parties and environment.
11 Well Investigation	
11-1 Necessary information of well rehabilitation plan	To be able to explain and advise information about well, pump and water supply facility is necessary to formulate rehabilitation plan.
11-2 Well rehabilitation plan	To be able to explain and advise necessary contents of well rehabilitation including data provision and work contents.
12 Tool Fishing	
12-1 Tool fishing plan	To be able to explain and advise necessary contents of tool fishing including down-hole investigation and work plan.
12-2 Fishing tools	To be able to explain and advise type of several fishing tools and their use.
13 Well Rehabilitation	
13-1 Phenomena and causes of well deterioration	To be able to explain and advise several type of well deterioration such as incrustation on screen, sand production etc. and their causes.
13-2 Methods of well rehabilitation	To be able to explain and advise several methods of well rehabilitation such as mechanical and chemical cleaning, sedimentation removal etc.
13-3 Usage of well camera	To be able to explain and advise usage of well camera to observe inside conditions of well.
14 Pumping Test	
14-1 Purpose and methods of Pumping Test	To be able to explain and advise purpose of pumping test and major pumping test methods.
14-2 Pumping test equipment	To be able to explain and advise necessary equipment to conduct pumping test.
14-3 Selection of Submersible Pump	To be able to explain and advise how to select suitable submersible pump according to capacity of well.
14-4 Interpretation of test results	To be able to explain and advise interpretation of step drawdown test and constant discharge rate test and recovery test in order to determine well capacity and select proper pump.
15 Water Quality Analysis	
15-1 Purpose of Water quality analysis	To be able to explain and advise purpose of water quality analysis as a general knowledge.
15-2 Item of water quality analysis	To be able to explain and advise items analysed for groundwater and their effect on human health.

3.2 TECHNICAL INSTRUCTION MODULE

As described in Chapter 2, the private drilling companies were classified into five groups of A to E. The target of the technical instructions are groups A to D, of which the characteristics are shown in *Table 4*.

Table 4 Characteristics of Classified Group of Private Companies

Group	Classification Criteria		
	Large-Capacity Drilling Rig and Experience of DTH Drilling	Interest in Equipment Hiring Services	Interest in Technical Instructions and Provision of Hydrogeological Information
A	Available	Interested	Interested
B	Not available	Interested	Interested
C	Available	Not interested	Interested
D	Not available	Not interested	Interested

Each classified group of private drilling companies which are shown in **Table 1** has different needs for the enhancement of drilling techniques of their staffs. In **Table 5**, each technical area is given with the rank of importance by 4 ranks. In **Table 5**, there are two categories of rank of technical area as the followings:





Needs of Private Companies: Four ranks are determined based on the needs of expectation of private companies for which technical areas they want to enhance the technical level of their staffs, as a results of the baseline survey. The 1st rank is that 60 to 80 % of the companies of each group are willing to enhance the technical area. Then, respectively, the 2nd is 40 to 60 %, the 3rd is 20 to 40 % and the 4th is 0 to 20 %.

Training plan by Group: Another category of the rank is determined by the project team with consideration of the analysis of the necessary technical areas for each group of companies. For example, the companies of group B expect technical enhancement in DTH drilling rather than mud drilling. However, the project team regarded technical enhancement in mud drilling was also important for the companies of group B, as the techniques of mud drilling is required as well during the drilling of surface layers of wells of basement rock. Accordingly technical areas related to mud drilling were given with high rank as well as those related to DTH drilling in the training plan by group. Regarding group C and D, training plan by group is same as needs of private companies, since they are not the target of the equipment hiring.

Table 5 Technical Instruction Module Drilling Techniques by Classified Group of Private Drilling Companies

Technical Area / Item	Needs of Private Companies				Training Plan by Group			
	A	B	C	D	A	B	C	D
1 Site Mobilization								
1-1 Site Preparation and Drilling Machine Setting-Out								
2 Drilling Tools and Equipment								
2-1 Selection of drilling bit and drilling method								
2-2 Rotary Bits								
2-3 DTH and DTH Bit								
2-4 Rig Accessory								
2-5 Casing Tools								
2-6 Drilling Equipment								
2-7 Drilling Calculation								
2-8 Weight of drilling tools								
2-9 Rotary bit rotation speed and weight on bit								
2-10 DTH Bit rotation speed and weight on bit								
3 Drilling Drawbacks								
3-1 Countermeasures against lost circulation during mud drilling								
3-2 Countermeasures against lost circulation during DTH drilling								
3-3 Countermeasures against bore wall collapse during mud drilling								
3-4 Countermeasures against bore wall collapse during DTH drilling								
3-5 Countermeasures against jamming of drilling tools								

Technical Area / Item	Needs of Private Companies				Training Plan by Group			
	A	B	C	D	A	B	C	D
4 Drilling Control								
4-1 Mud control								
4-2 Mud Pump Operation								
4-3 Casing for mud drilling								
4-4 Drilling operation for mud drilling								
4-5 Bit control and repairing for mud drilling								
4-6 Air control for DTH drilling								
4-7 Air compressor operation								
4-8 Casing for DTH drilling								
4-9 Drilling operation for DTH drilling								
4-10 Bit control and repairing for DTH drilling								
5 Borehole Logging								
5-1 Borehole logging instruments								
5-2 Interpretation of borehole logging results								
6 Casing Program / Installation								
6-1 PVC casing, screen pipe								
6-2 Casing Program								
6-3 Role of centralizer								
6-4 Casing, screen pipe installation								
7 Gravel Packing								
7-1 Determination of gravel size								
7-2 Calculation of gravel volume								
7-3 Gravel packing								
8 Well Development								
8-1 Well cleaning after drilling								
8-2 Single-tube method air-lifting								
8-3 Double-tube method air-lifting								
9 Back-Filling & Surface Cementing								
9-1 Back-filling								
9-2 Surface cementing								
10 Site Demobilization								
10-1 Precautions upon site demobilization								
11 Well Investigation								
11-1 Necessary information of well rehabilitation plan								
11-2 Well rehabilitation plan								
12 Tool Fishing								
12-1 Tool fishing plan								
12-2 Fishing tools								
13 Well Rehabilitation								
13-1 Phenomenon and causes of well deterioration								
13-2 Methods of well rehabilitation								
13-3 Usage of well camera								
14 Pumping Test								
14-1 Purpose and methods of Pumping Test								
14-2 Pumping test equipment								
14-3 Selection of Submersible Pump								
14-4 Interpretation of test results								
15 Water Quality Analysis								
15-1 Purpose of Water quality analysis								
15-2 Item of water quality analysis								

Note:  : 60 to 80 %  : 40 to 60 %  : 20 to 40 %  : 0 to 20 %

Above figures are percentage of number of companies which expect to enhance the techniques of their staff in each technical area to number of all the companies of each group

The technical instruction module in *Table 5* is utilized for the formulation of training plan for each private companies with consideration of their specific needs and technical level.

3.3 INTERNAL CERTIFICATION SYSTEM OF THE INSTRUCTORS

Prior to the commencement of equipment hiring business, technical instructor are certified by the Project. As six drilling rig are procured for hiring, at least six technical instructors are to be certified. With consideration of retirement of staffs and activities of internal training of DDCA's drillers, another six technical instructors are expected to be certified by the year of 2013. An instructors' seminar is planned to be held in March 2013 for the purpose to explain how to conduct technical instruction by using teaching guidance. This seminar targets 12 or more candidates of technical instructors who are selected from 35 senior drillers of DDCA according to the evaluation by the drilling project operation department of DDCA. Upon the completion of the seminar, comprehension of each candidate is measured by an intelligibility test. The candidates who achieved required intelligibility level are certified as technical instructors. *Table 6* summarizes this internal certification system.

Table 6 Internal Certification System of Technical Instructors

Activity	Contents
Selection of Candidates of Technical Instructors	Among senior drillers who were selected based on evaluation by the drilling project department of DDCA, candidates of technical instructors are selected, with the consideration of technical level and DDCA's personnel assignment plan.
Instructors' Seminar	An instructor's seminar is held for candidates of technical instructors for the purpose to explain how to conduct technical instruction using teaching guidance. Participants of the seminar is 12 persons in maximum and the period is one day.
Intelligibility Test	Confirmation of comprehension of participants of the instructors' seminar related to teaching guidance, by mean of an intelligibility test.
Certification of Technical Instructors	Candidates of technical instructors who fulfill the following conditions are certified by DDCA as technical instructors. <ul style="list-style-type: none"> - To have attended the instructors' seminar - To have achieved not less than 80 % in the intelligibility test

3.4 TRAINING SYSTEM FOR THE INSTRUCTORS

In order to keep necessary number of technical instructors i.e. 12 persons, supplementation of the instructor is required according to the necessity. The various outputs from the Project are utilized for the training of the instructor. In the stage of initial certification of technical instructors, outputs such as competence test, technical instruction, intelligibility test and internal certifications are produced. Furthermore, technical instructors will be a trainer for the other drillers. Through activities of capacity development of DDCA's senior drillers related to Output 2, outputs such as manuals and intelligibility test regarding technical areas to be enhanced are produced. By using such outputs, the continuous training activities of DDCA are materialized. Furthermore, certified technical instructors internally conduct training of DDCA's drillers in technical areas of entire drilling process. The results of intelligibility tests and training, which are produced during the capacity development activities, can be used as the basic data for the selection of candidates of supplementation of technical instructors. All the above outputs constitute the training system the instructors.

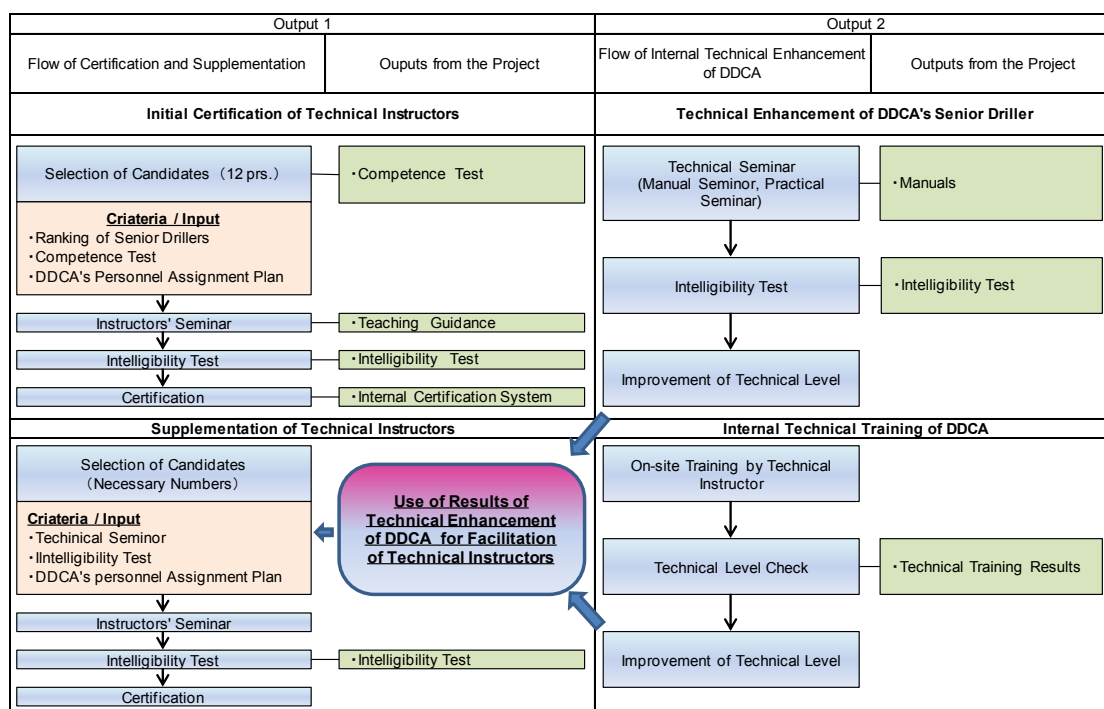


Figure 1 Structure of Training System of the Instructor

3.5 CERTIFICATION SYSTEM FOR THE ENGINEER IN PRIVATE SECTOR

In order for private drilling companies who use the equipment hiring services to acquire necessary drilling techniques, continuous use of equipment hiring is required for a step-by-step improvement. For the efficient technical instruction, technical instructors are required to evaluate the impact instructed private drillers. In this purpose, on-site checklist of drilling technical level as shown in **Table 7** is prepared. In drilling sites for technical instruction, technical instructors check the technical level of the instructed driller who is the rig in charge of the drilling team of the company. One of three technical level is given to each technical areas, that is, A: To have sufficient knowledge to complete works, B: To have knowledge of works, however there is still room for improvement and C: Lack of necessary basic knowledge for works. The entry column on checklist for remarks on technical instruction is filled with challenges on technical instruction, advices from experts, proposals for improvement of teaching method and so on. After the completion of technical instruction, the checklist is submitted to the drilling project operation department. The instructed drillers who achieved required technical level is certified by DDCA, with the approval of CEO. The drilling project department keeps checklists as basic data for the next technical instruction.

Table 7 On-site Checklist of Drilling Technical Level (Draft)

On-site Checklist of Drilling Technical Level			
Name of Trainee :		Ref. No. :	
Position :		Date :	
Company Name :		Borehole Number :	
		Location / Areas :	
Name of Technical Instructor of DDCA:			
Technical Area	Technical Level	Items of which challenges were observed	Observation
1 Site Mobilization			
2 Drilling Tools and Equipment			
3 Drilling Drawbacks			
4 Drilling Control			
5 Borehole Logging			
6 Casing Program / Installation			
7 Gravel Packing			
8 Well Development			
9 Back-Filling & Surface Cementing			
10 Site Demobilization			
11 Well Investigation			
12 Tool Fishing			
13 Well Rehabilitation			
14 Pumping Test			
Remarks on Technical Instruction:			

3.6 PREPARATION OF PROCESS ON ACCUMULATION, SHARE AND UTILIZATION OF RESULTS OF TECHNICAL INSTRUCTION

Technical instruction methods and contents of teaching guidance are required to be improved through the implementation of technical instruction. In this purpose, results of technical instruction are periodically reviewed by the drilling project operation department, by using checklist which was described in Clause 4). The results of technical instruction is annually reviewed. Technical instruction methods and contents of teaching guidance are revised based on the results of review of technical instruction. **Table 8** summarizes these contents of technical instruction review.

Table 8 Technical Instruction Review

Activity	Contents
Preparation of Materials for Review	Based on technical level checklists, necessary data such as results of technical instructions, numbers and specifications of boreholes drilled and improvement of technical level of instructed drillers etc., are summarized by the drilling project operation manager.
Review Meeting	Based on the prepared materials, the drilling project operation department holds a review meeting in order to examine the following issues: <ul style="list-style-type: none"> - Results of technical instructions (numbers and technical areas) - Improvement of technical level of instructed private drillers - Proposal for revision of technical instruction methods and contents of teaching guidance with consideration of the results of implementation of technical instructions - Preparation of technical instruction review report A review meeting is held once a year.
Revision of Technical Instruction System	The technical instruction system is revised according to the review report. Contents of revision are disseminated to all technical instructors.

Appendix : List of 94 Classified Private Drilling Companies Through the Baseline Survey

No	Name of Companies	Location	Number of Owned Rigs	Equipment and Techniques		Business Plan	Interest in DDCA's New Technical Support Services		Group
				Experiences in Drilling under WSDP	Large-Capacity Drilling Rig and Experiences of DTH Drilling		Interest in Equipment Hiring Services	Interest in Technical Instruction or Provision of Hydrogeological Information	
1	AI-Water Well Drillers	DSM	2	Not experienced	Not available	Having plan	Interested	Interested	B
2	AL-TTAI Drilling company Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
3	Amini Tech Company Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
4	Aqua Well Drilling Company Ltd	DSM	12	Experienced	Available	Not having plan	Interested	Interested	A
5	Aquaman Drillers Ltd	ARUSHA	1	Experienced	Available	Not having plan	Interested	Interested	A
6	Ardhi Water Wells Ltd	DSM	3	Experienced	Not available	Not having plan	Interested	Interested	B
7	Arusha Aggregates Ltd	ARUSHA	2	Not experienced	Not available	Having plan	Interested	Interested	B
8	AS Drilling Company Ltd	ARUSHA	1	Not experienced	Not available	Having plan	Interested	Interested	B
9	Ashraf Water Wells Drilling Company	DSM	2	Not experienced	Not available	Having plan	Interested	Interested	B
10	B.R.A	DSM	3	Not experienced	Not available	Having plan	Interested	Interested	B
11	Bahadele Drilling Company	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
12	Basat contractors Ltd	DSM	2	Not experienced	Not available	Having plan	Interested	Interested	B
13	Bubujiko Enterprises	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
14	Chem chem Drilling Co. Ltd	ARUSHA	No answer	Not experienced	Not available	Having plan	Interested	Interested	B
15	Chem Chem Well Drilling Company	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
16	Chimba Resources	DSM	3	Experienced	Available	Not having plan	Interested	Interested	A
17	CMG Construction Company Ltd	MWANZA	4	Not experienced	Available	Having plan	Interested	Interested	A
18	Coast Water Well Company	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
19	Drill Mat & Ground Water Services Ltd	DSM	2	Not experienced	Not available	Having plan	Interested	Interested	B
20	Drilling Spares and Services Ltd	KENYA	4	Not experienced	Not available	Having plan	Not interested	Interested	D
21	Efam Limited	DSM	1	Experienced	Available	Having plan	Interested	Interested	A
22	ELCT Southern Dioces (Konde Diocese)	NJOMBE	2	Not experienced	Not available	Not having plan	Not interested	Interested	D
23	Future Century Limited	COAST	1	Not experienced	Not available	Having plan	Interested	Interested	B
24	Gaimo Construction Co. Ltd	ARUSHA	2	Not experienced	Available	Having plan	Interested	Interested	A
25	Gem and Rock Ventures Co. Ltd	ARUSHA	2	Not experienced	Not available	Having plan	Interested	Interested	B
26	Germany and Tanzania Drilling Partnership Co. Ltd (GETA)	DSM	1	Not experienced	Available	Having plan	Interested	Interested	A

No.	Name of Companies	Location	Number of Owned Rigs	Equipment and Techniques		Business Plan	Interest in DDCA's New Technical Support Services		Group
				Experiences in Drilling under WSDP	Large-Capacity Drilling Rig and Experiences of DTH Drilling		Interest in Equipment Hiring Services	Interest in Technical Instruction or Provision of Hydrogeological Information	
27	Global Resource Alliance-TZ	MARA	1	Not experienced	Not available	Having plan	Interested	Interested	B
28	Global Tech Drillig and Exploration Ltd	MWANZA	1	Not experienced	Not available	Having plan	Interested	Not interested	B
29	Groundwater Exploration & Well Construction Co. Ltd	MWANZA	0	Not experienced	Not available	Having plan	Interested	Not interested	B
30	Ham Drillers Ltd	DSM	1	Not experienced	Not available	Not having plan	Interested	Interested	B
31	Himalaya Enterprises LTD	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
32	Holland Farm Ltd	DSM	2	Not experienced	Not available	Having plan	Interested	Interested	B
33	Humac Services Ltd	MWANZA	1	Not experienced	Not available	Having plan	Interested	Interested	B
34	Hydro Tech (T) Ltd	DSM	3	Experienced	Available	Not having plan	Not interested	Interested	C
35	J.N.M Mining Services Ltd	DSM	1	Not experienced	Available	Having plan	Interested	Interested	A
37	Kikim Building Geotechnical and Drilling Contractors	DSM	2	Not experienced	Not available	Having plan	Interested	Interested	B
38	Kilimanjaro Water Well Drilling	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
39	Kimani Minerals Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
36	K'S Interprice LTD	KILIMANJARO	1	Not experienced	Not available	Having plan	Interested	Interested	B
40	Layne Drilling (T) Ltd	MOROGORO	6	Not experienced	Available	Not having plan	Not interested	Not interested	E
41	Leone Resources Development Company Limited	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
42	Lima Economic and Development group	DSM	2	Not experienced	Not available	Having plan	Interested	Interested	B
43	Lugoba Stones and Construction Co. Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
44	Lweru Water Wells Drilling Company Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
45	M & M(T) Ltd	DSM	0	Not experienced	Not available	Not having plan	Interested	Interested	B
46	Maji Tech Engineering Ltd	ARUSHA	3	Experienced	Available	Having plan	Interested	Interested	A
47	Make Eng and Water Works Ltd	DSM	2	Experienced	Available	Having plan	Interested	Interested	A
48	Marata Plumbers & Drillers Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
49	Maswi drilling company Ltd	DSM	5	Experienced	Available	Having plan	Interested	Interested	A
50	Mavonda's Company Ltd	DSM	0	Not experienced	Not available	Having plan	Interested	Interested	B
51	MC Water Wells Drilling Co. Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B

No.	Name of Companies	Location	Number of Owned Rigs	Equipment and Techniques		Business Plan	Interest in DDCA's New Technical Support Services		Group
				Experiences in Drilling under WSDP	Large-Capacity Drilling Rig and Experiences of DTH Drilling		Interest in Equipment Hiring Services	Interest in Technical Instruction or Provision of Hydrogeological Information	
52	MR. Water Drilling Company Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
53	Msabi (Maji Safi kwa Afya Bora Ifakara)	MOROGO RO	1	Not experienced	Not available	Not having plan	Interested	Interested	B
54	Muwanya Well Drilling	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
55	Nassa General Traders Limited	SHINYANGA	0	Not experienced	Not available	Having plan	Interested	Interested	B
56	Nile Well Drillers (Sole Proprietor)	DSM	3	Not experienced	Not available	Having plan	Interested	Interested	B
57	Nyakilang'anyi Construction Ltd	MARA	2	Experienced	Available	Having plan	Interested	Interested	A
58	O.C. I Industrial Holdings Ltd	DSM	5	Not experienced	Available	Having plan	Interested	Interested	A
59	Oroteti Ltd	ARUSHA	2	Not experienced	Not available	Having plan	Not interested	Interested	D
60	Paramount Drill Wells Limited	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
61	PNR Services Ltd	DSM	4	Experienced	Available	Not having plan	Interested	Not interested	A
62	Rahmy Company Ltd	DSM	2	Not experienced	Not available	Having plan	Interested	Interested	B
63	Rehoboth Mining and Water Well Drilling Co	ARUSHA	1	Not experienced	Not available	Having plan	Interested	Interested	B
64	Research and Ground Water Drilling Co. Ltd (REGWA)	DSM	1	Not experienced	Available	Not having plan	Interested	Interested	A
65	RRS Water Well Drilling Company	DSM	0	Not experienced	Not available	Having plan	Interested	Interested	B
66	Ruko's General Supplies Co. Ltd	DSM	1	Not experienced	Available	Not having plan	Not interested	Interested	C
67	Seba Drilling and Construction Ltd	DSM	2	Not experienced	Available	Having plan	Interested	Interested	A
68	Serengeti Ltd	DSM	1	Not experienced	Not available	Not having plan	Interested	Interested	B
69	Serving Friends International	ARUSHA	1	Not experienced	Not available	Having plan	Not interested	Interested	D
70	Shy Builders Ltd	SHINYANGA	1	Experienced	Not available	Having plan	Interested	Interested	B
71	SMS Amour Investment	DSM	1	Not experienced	Available	Having plan	Interested	Interested	A
72	SN-TECH (T) Ltd	DSM	1	Not experienced	Not available	Not having plan	Interested	Interested	B
73	Snub Pro Africa Ltd	DSM	1	Not experienced	Available	Having plan	Interested	Interested	A
74	Society of the Precious Blood Water Project	DODOMA	1	Not experienced	Not available	Having plan	Not interested	Interested	D
75	Southern Highlands Participatory Organisation (SHIPO)	NJOMBE	2	Not experienced	Not available	Not having plan	Not interested	Interested	D

DDCAP Technical Support Plan

No.	Name of Companies	Location	Number of Owned Rigs	Equipment and Techniques		Business Plan	Interest in DDCA's New Technical Support Services		Group
				Experiences in Drilling under WSDP	Large-Capacity Drilling Rig and Experiences of DTH Drilling		Interest in Equipment Hiring Services	Interest in Technical Instruction or Provision of Hydrogeological Information	
76	Sparr Drilling Company Ltd	MWANZA	2	Experienced	Not available	Not having plan	Not interested	Interested	D
77	Star Water Pumps	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
78	Sustainable Environment Management Action(SEMA)	SINGIDA	2	Not experienced	Available	Having plan	Interested	Interested	A
79	Talha Water Well Drillers Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
80	Techno Drillers Co. Ltd	ARUSHA	1	Not experienced	Not available	Having plan	Interested	Interested	B
81	Uchama Drilling and Biogas Services	DSM	0	Not experienced	Not available	Having plan	Interested	Interested	B
82	UK Global Trading Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
83	Vacuum Rotary Drilling Company	DSM	1	Not experienced	Available	Having plan	Interested	Interested	A
84	Water and Environmental Development Company Ltd	SHINYAN GA	0	Not experienced	Not available	Having plan	Interested	Interested	B
85	Water International Services LTD	DSM	2	Not experienced	Available	Having plan	Not interested	Interested	C
86	Water Solutions Drilling Co. Ltd	ARUSHA	5	Experienced	Available	Having plan	Interested	Interested	A
87	Water Well Services Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
88	Water Wells Services Ltd	DSM	1	Not experienced	Not available	Not having plan	Interested	Interested	B
89	Watter Hub Tanzania LTD	DSM	2	Experienced	Available	Having plan	Interested	Interested	A
90	Wells Technology Co. Ltd	DSM	1	Not experienced	Not available	Having plan	Interested	Interested	B
91	WEPMO (Water & Enironmental Sanitation Projects Maintenance Organization)	DSM	0	Not experienced	Not available	Not having plan	Interested	Interested	B
92	Willy Enterprises Ltd	ARUSHA	1	Not experienced	Not available	Having plan	Interested	Interested	B
93	Winam General Treders Ltd	DSM	0	Experienced	Not available	Having plan	Interested	Interested	B
94	World Islamic Propagation and Humanitarian Services (WIPAHS)	DSM	1	Not experienced	Available	Not having plan	Interested	Interested	A

Number of companies in each group

A: 23, B: 60, C:3, D: 7, E: 1, Total: 94

Drilling and Dam Construction Agency (DDCA)
Japan International Cooperation Agency (JICA)

DDCAP

Teaching Guidance For Capacity Development Support Plan for Private Sector

Version 1

February 2013

Groundwater Development and Management Capacity Development (DDCAP)
Project

Contents

INTRODUCTION

1 Site Mobilization

1-1 Site Preparation and Drilling Machine Setting-Out	1-1
---	-----

2 Drilling Tools and Equipment

2-1 Selection of drilling bit and drilling method	2-1
2-2 Rotary Bits	2-2
2-3 DTH and DTH Bit	2-3
2-4 Rig Accessory	2-4
2-5 Casing Tools	2-5
2-6 Drilling Equipment	2-6
2-7 Drilling Calculation	2-7
2-8 Weight of drilling tools	2-8
2-9 Rotary bit rotation speed and weight on bit	2-9
2-10 DTH Bit rotation speed and weight on bit	2-10

3 Drilling Drawbacks

3-1 Countermeasures against lost circulation during mud drilling	3-1
3-2 Countermeasures against lost circulation during DTH drilling	3-2
3-3 Countermeasures against bore wall collapse during mud drilling	3-3
3-4 Countermeasures against bore wall collapse during DTH drilling	3-4
3-5 Countermeasures against jamming of drilling tools	3-5

4 Drilling Control

4-1 Mud control	4-1
4-2 Mud Pump Operation	4-2
4-3 Casing for mud drilling	4-3
4-4 Drilling operation for mud drilling	4-4
4-5 Bit control and repairing for mud drilling	4-5
4-6 Air control for DTH drilling	4-6
4-7 Air compressor operation	4-7
4-8 Casing for DTH drilling	4-8
4-9 Drilling operation for DTH drilling	4-9
4-10 Bit control and repairing for DTH drilling	4-10

5 Borehole Logging

5-1 Borehole logging instruments	5-1
5-2 Interpretation of borehole logging results	5-2

6 Casing Program / Installation

6-1 PVC casing, screen pipe	6-1
6-2 Casing Program	6-2
6-3 Role of centralizer	6-3
6-4 Casing, screen pipe installation	6-4

7 Gravel Packing

7-1 Determination of gravel size	7-1
7-2 Calculation of gravel volume	7-2
7-3 Gravel packing	7-3

8 Well Development

8-1 Well cleaning after drilling	8-1
8-2 Single-tube method air-lifting	8-2
8-3 Double-tube method air-lifting	8-3

9 Back-Filling & Surface Cementing

9-1 Back-filling	9-1
9-2 Surface cementing	9-2

10 Site Demobilization

10-1 Precautions upon site demobilization	10-1
---	------

11 Well Investigation

11-1 Necessary information of well rehabilitation plan	11-1
11-2 Well rehabilitation plan	11-2

12 Tool Fishing

12-1 Tool fishing plan	12-1
12-2 Fishing tools	12-2

13 Well Rehabilitation

13-1 Phenomenon and causes of well deterioration	13-1
13-2 Methods of well rehabilitation	13-2
13-3 Usage of well camera	13-3

14 Pumping Test

14-1 Purpose and methods of Pumping Test	14-1
14-2 Pumping test equipment	14-2
14-3 Selection of Submersible Pump	14-3
14-4 Interpretation of test results	14-4

15 Water Quality Analysis

15-1 Purpose of Water quality analysis	15-1
--	------

Tables

Table 1	Classification of Private Drilling Companies.....	1
Table 2	Characteristics of Classified Group of Private Companies	1
Table 3	Technical Instruction Module Drilling Techniques by Classified Group of Private Drilling Companies.....	2
Table 4	Identified Technical Areas Covering Drilling Works of DDCA.....	3
Table 5	Technical Area / Item Covered by Teaching Guidance and Manuals.....	4

INTRODUCTION

CAPACITY DEVELOPMENT SUPPORT PLAN

This teaching guidance was formulated based on the Capacity Development Support Plan for Private Sector (hereinafter referred to as “the CDSP”), which was prepared by the Project Team in January 2013. The baseline survey on private drilling companies was conducted in 2012 in the course of the Project. As a result, 94 companies which responded to the structured interview were classified into five groups of A to E, as shown in **Table 4**. For each of these groups, Three types of capacity development support plan were formulated, i.e. “Plan for Introduction of DTH Drilling (Group B)”, “Business Expansion Support Plan (Group A)” and Technical Instruction Plan (Group C, D and E)”.

Table 1 Classification of Private Drilling Companies

Group	Number of Companies	Classification Criteria		
		1) Large-Capacity Drilling Rig and Experience of DTH Drilling	2) Interest in Equipment Hiring Services	3) Interest in Technical Instruction and Provision of Hydrogeological Information
A	23	23	17	22
B	60	0	60	58
C	3	3	0	3
D	7	0	0	7
E	1	1	0	0
Total	94	37	83	90

The target groups of technical instructions by DDCA is Group A to D of which the characteristics are shown in **Table 3**. Each group has different needs for the enhancement of drilling techniques of their staffs. **Table 3** shows the needs of the each group of the private companies and supposed training plan by the Project. Each technical area is given with the rank of importance by 4 ranks in two following two categories:

Needs of Private Companies: Four ranks are determined based on the needs of expectation of private companies for which technical areas they want to enhance the technical level of their staffs, as a results of the baseline survey. The 1st rank is that 60 to 80 % of the companies of each group are willing to enhance the technical area. Then, respectively, the 2nd is 40 to 60 %, the 3rd is 20 to 40 % and the 4th is 0 to 20 %.

Training plan by Group: Another category of the rank is determined by the project team with consideration of the analysis of the necessary technical areas for each group of companies. For example, the companies of group B expect technical enhancement in DTH drilling rather than mud drilling. However, the project team regarded technical enhancement in mud drilling was also important for the companies of group B, as the techniques of mud drilling is required as well during the drilling of surface layers of wells of basement rock. Accordingly technical areas related to mud drilling were given with high rank as well as those related to DTH drilling in the training plan by group. Regarding group C and D, training plan by group is same as needs of private companies, since they are not the target of the equipment hiring.





Table 2 Characteristics of Classified Group of Private Companies

Group	Classification Criteria		
	Large-Capacity Drilling Rig and Experience of DTH Drilling	Interest in Equipment Hiring Services	Interest in Technical Instructions and Provision of Hydrogeological Information
A	Available	Interested	Interested
B	Not available	Interested	Interested
C	Available	Not interested	Interested
D	Not available	Not interested	Interested

Table 3 Technical Instruction Module Drilling Techniques by Classified Group of Private Drilling Companies

Technical Area / Item	Needs of Private Companies				Training Plan by Group			
	A	B	C	D	A	B	C	D
1 Site Mobilization								
1-1 Site Preparation and Drilling Machine Setting-Out								
2 Drilling Tools and Equipment								
2-1 Selection of drilling bit and drilling method								
2-2 Rotary Bits								
2-3 DTH and DTH Bit								
2-4 Rig Accessory								
2-5 Casing Tools								
2-6 Drilling Equipment								
2-7 Drilling Calculation								
2-8 Weight of drilling tools								
2-9 Rotary bit rotation speed and weight on bit								
2-10 DTH Bit rotation speed and weight on bit								
3 Drilling Drawbacks								
3-1 Countermeasures against lost circulation during mud drilling								
3-2 Countermeasures against lost circulation during DTH drilling								
3-3 Countermeasures against bore wall collapse during mud drilling								
3-4 Countermeasures against bore wall collapse during DTH drilling								
3-5 Countermeasures against jamming of drilling tools								
4 Drilling Control								
4-1 Mud control								
4-2 Mud Pump Operation								
4-3 Casing for mud drilling								
4-4 Drilling operation for mud drilling								
4-5 Bit control and repairing for mud drilling								
4-6 Air control for DTH drilling								
4-7 Air compressor operation								
4-8 Casing for DTH drilling								
4-9 Drilling operation for DTH drilling								
4-10 Bit control and repairing for DTH drilling								
5 Borehole Logging								
5-1 Borehole logging instruments								
5-2 Interpretation of borehole logging results								
6 Casing Program / Installation								
6-1 PVC casing, screen pipe								
6-2 Casing Program								
6-3 Role of centralizer								
6-4 Casing, screen pipe installation								
7 Gravel Packing								
7-1 Determination of gravel size								
7-2 Calculation of gravel volume								
7-3 Gravel packing								
8 Well Development								
8-1 Well cleaning after drilling								
8-2 Single-tube method air-lifting								
8-3 Double-tube method air-lifting								
9 Back-Filling & Surface Cementing								

Technical Area / Item	Needs of Private Companies				Training Plan by Group			
	A	B	C	D	A	B	C	D
9-1 Back-filling								
9-2 Surface cementing								
10 Site Demobilization								
10-1 Precautions upon site demobilization								
11 Well Investigation								
11-1 Necessary information of well rehabilitation plan								
11-2 Well rehabilitation plan								
12 Tool Fishing								
12-1 Tool fishing plan								
12-2 Fishing tools								
13 Well Rehabilitation								
13-1 Phenomenon and causes of well deterioration								
13-2 Methods of well rehabilitation								
13-3 Usage of well camera								
14 Pumping Test								
14-1 Purpose and methods of Pumping Test								
14-2 Pumping test equipment								
14-3 Selection of Submersible Pump								
14-4 Interpretation of test results								
15 Water Quality Analysis								
15-1 Purpose of Water quality analysis								
15-2 Item of water quality analysis								

Note:  : 60 to 80 %  : 40 to 60 %  : 20 to 40 %  : 0 to 20 %

Above figures are percentage of number of companies which expect to enhance the techniques of their staff in each technical area to number of all the companies of each group

The technical instruction module in **Table 3** is utilized for the formulation of training plan for each private companies with consideration of their specific needs and technical level. In order to implement

CONTENTS OF TEACHING GUIDANCE

The baseline survey on DDCA's drilling organization was conducted in the course of the Project, for the purpose to reveal the current status of drilling works and the technical level of drillers in DDCA. The results of the baseline survey were compiled in the Technical Support Plan for the Drillers in DDCA (hereinafter referred to as "TSP") which was formulated in January 2013. This plan identified 15 technical areas which cover the drilling works of DDCA including eight technical areas necessary to be enhanced and two new technical areas to be needed, as shown in **Table 4**.

Table 4 Identified Technical Areas Covering Drilling Works of DDCA

No.	Technical Area	All Areas	Areas to be Enhanced	New Areas to be Needed
1	Site Mobilization	✓		
2	Drilling Tools and Equipment	✓	✓	
3	Drilling Drawbacks	✓		
4	Drilling Control	✓	✓	
5	Borehole Logging	✓	✓	
6	Casing Program / Installation	✓		
7	Gravel Packing	✓	✓	
8	Well Development	✓	✓	
9	Back-Filling & Surface Cementing	✓	✓	
10	Site Demobilization	✓		
11	Well Investigation	✓		

No.	Technical Area	All Areas	Areas to be Enhanced	New Areas to be Needed
12	Tool Fishing	✓	✓	✓
13	Well Rehabilitation	✓	✓	✓
14	Pumping Test	✓	✓	
15	Water Quality Analysis	✓	✓	

The technical instructions will be implemented by the technical instructors of DDCA who accompany with the hiring equipment. In the course of the Project, DDCA will select 12 technical instructors who will conduct technical instructions to both private drillers and drillers in DDCA, regarding all 15 technical areas. Since DDCA had not had unified teaching guidance before the Project, this teaching guidance was formulated to be used for such technical instructions by DDCA's technical instructors.

As shown in **Table 5**, this teaching guidance covers all 15 technical areas and contains guidance for each technical items and materials. Contents of two manuals for drillers in DDCA also forms a part of materials for the teaching guidance. Technical areas and items are the important basic units for the activities of technical training and guidance in the Project, in the respects of the manual formulation, training plan, technical evaluation and so on. They are commonly used between three major training related documents i.e. the Teaching Guidance, the Manual for Drilling Works and the Manual for Well Rehabilitation and Tool Fishing, as shown in **Table 5** Table .

Table 5 Technical Area / Item Covered by Teaching Guidance and Manuals

TA Code	Technical Area / Item	Teaching Guidance	Manual for Drilling Works	Manual for Well Rehabilitation and Tool Fishing
1	Site Mobilization	✓		
1-1	Site Preparation and Drilling Machine Setting-Out	✓		
2	Drilling Tools and Equipment	✓	✓	
2-1	Selection of drilling bit and drilling method	✓	✓	
2-2	Rotary Bits	✓	✓	
2-3	DTH and DTH Bit	✓	✓	
2-4	Rig Accessory	✓	✓	
2-5	Casing Tools	✓	✓	
2-6	Drilling Equipment	✓	✓	
2-7	Drilling Calculation	✓	✓	
2-8	Weight of drilling tools	✓	✓	
2-9	Rotary bit rotation speed and weight on bit	✓	✓	
2-10	DTH Bit rotation speed and weight on bit	✓	✓	
3	Drilling Drawbacks	✓		
3-1	Countermeasures against lost circulation during mud drilling	✓		
3-2	Countermeasures against lost circulation during DTH drilling	✓		
3-3	Countermeasures against bore wall collapse during mud drilling	✓		
3-4	Countermeasures against bore wall collapse during DTH drilling	✓		
3-5	Countermeasures against jamming of drilling tools	✓		
4	Drilling Control	✓	✓	
4-1	Mud control	✓	✓	
4-2	Mud Pump Operation	✓	✓	
4-3	Casing for mud drilling	✓	✓	
4-4	Drilling operation for mud drilling	✓	✓	
4-5	Bit control and repairing for mud drilling	✓	✓	
4-6	Air control for DTH drilling	✓	✓	
4-7	Air compressor operation	✓	✓	
4-8	Casing for DTH drilling	✓	✓	
4-9	Drilling operation for DTH drilling	✓	✓	
4-10	Bit control and repairing for DTH drilling	✓	✓	
5	Borehole Logging	✓	✓	

TA Code	Technical Area / Item	Teaching Guidance	Manual for Drilling Works	Manual for Well Rehabilitation and Tool Fishing
5-1	Borehole logging instruments	✓	✓	
5-2	Interpretation of borehole logging results	✓	✓	
6	Casing Program / Installation	✓		
6-1	PVC casing, screen pipe	✓		
6-2	Casing Program	✓		
6-3	Role of centralizer	✓		
6-4	Casing, screen pipe installation	✓		
7	Gravel Packing	✓	✓	
7-1	Determination of gravel size	✓	✓	
7-2	Calculation of gravel volume	✓	✓	
7-3	Gravel packing	✓	✓	
8	Well Development	✓	✓	
8-1	Well cleaning after drilling	✓	✓	
8-2	Single-tube method air-lifting	✓	✓	
8-3	Double-tube method air-lifting	✓	✓	
9	Back-Filling & Surface Cementing	✓	✓	
9-1	Back-filling	✓	✓	
9-2	Surface cementing	✓	✓	
10	Site Demobilization	✓		
10-1	Precautions upon site demobilization	✓		
11	Well Investigation	✓		
11-1	Necessary information of well rehabilitation plan	✓		
11-2	Well rehabilitation plan	✓		
12	Tool Fishing	✓		✓
12-1	Tool fishing plan	✓		✓
12-2	Fishing tools	✓		✓
13	Well Rehabilitation	✓		✓
13-1	Phenomenon and causes of well deterioration	✓		✓
13-2	Methods of well rehabilitation	✓		✓
13-3	Usage of well camera	✓		✓
14	Pumping Test	✓	✓	
14-1	Purpose and methods of Pumping Test	✓	✓	
14-2	Pumping test equipment	✓	✓	
14-3	Selection of Submersible Pump	✓	✓	
14-4	Interpretation of test results	✓	✓	
15	Water Quality Analysis	✓	✓	
15-1	Purpose of Water quality analysis	✓	✓	
15-2	Item of water quality analysis	✓	✓	

REFERENCES

Australian Drilling Industry Training Committee Limited. Drilling The Manual of Methods. Applications, and Management 4th ed. Australia, J.S. McMillan Printing Group, 2002, 615p

National Waterwell & Drilling Association of Australia. Drillers Trainig and Reference Manual 4th ed. Australia, Trend Lithographics PTY. Ltd., 1982, 291p

Technical Area: 1 Site Mobilization

Item: 1-1 Site Preparation and Drilling Machine Setting-Out

1: Objectives

To be able to explain and advise for proper site preparation and drilling machine installation on site.

2. Contents

- Site Preparation
- Drilling Machine Carrying-in
- Drilling Machine Setting Out

3. Teaching Methods

- (1) Explain necessary items to be confirmed prior to site mobilization using the work instructions.
- (2) Explain precautions to be considered during drilling machine carrying-in, using the work instructions.
- (3) Explain machine setting layout using site layout using the work instructions.

4. Materials

1-1M1 Work Instructions on Site Preparation and Drilling Machine Setting Out

1-1M1 WORK INSTRUCTION ON SITE PREPARATION AND DRILLING MACHINE SETTING-OUT

(1) Preparation Works in Workshop and Depot

Before setting out to the drilling location it should be made sure that the drilling equipment and drilling tools are in good working conditions and that all subs and cross-over pieces to attach the drilling tools are available and as well all clamps and lifting devices for the various diameters. It would be very helpful, when the driller could be provided with a list in order to prepare all necessary equipment for the borehole to be drilled:

- Proposed depth of the borehole
- Drilling method to be applied
- Drilling diameters to be drilled
- Formation to be encountered
- Approximate situation of the water level expected
- Approximate thickness of overburden / soft formation

The well completion material, i.e. casing pipes, screens, bottom caps, centralizers, bolts, well caps, gravel, clay (bentonite) sealing pellets, cement etc. should be available and complete before starting the actual drilling works. Fuels and lubricants should be available in the required quantity to allow for a safe completion of the drilling works. When the drilling location is situated in a far distance in remote areas, camping facilities should be available for the drilling personnel to allow them to spend one week working on the location. All necessary safety and security precautions for the personnel, equipment, machinery, lorries and vehicles should be assessed and checked before setting out to the drill site. Communication facilities (cell phones) should be provided for and daily contact times should be agreed upon between site personnel and management.

(2) Mobilization to Drilling Sites

A transfer of the drilling site to the drilling team should have been conducted. The drilling site should have enough working and storage space for the drilling- and cargo equipment and the access conditions should be fair enough or being provided for by community assistance or other means to allow smooth access to the site. It is better to set out with the drilling equipment, drilling rig, compressor truck and cargo truck in a convoy. Should something happen on the way to the drilling location, help and assistance is easily available. If the drilling location is in a far distance from the headquarters and/or zonal offices, the convoy should depart from the depot at the morning time, to make sure that all the equipment has reached the location by early to late afternoon, having enough time available to set up the equipment and lorries safely and to prepare and arrange the camping equipment properly on site. This will allow for a better and fresh start of the drilling activities the other day in the early morning.

The team leader should meet the community members and explain them about the works, which are going on the next days and discuss an eventual participation in any part of the works by the community. It should be properly explained to the local population that the works are going to have a certain noise level, which is unavoidable and that it would be better for the safety of the people to stay some distance away from the center of drilling operation.

Normally the drilling location is not quite leveled and pebbles and rocks are still lying around on the location. Quite often there is additional bush clearing required. All these works can be carried out by the local people before setting the drilling equipment directly on the drill point.



Source: JICA's Rural Water Supply Project in Metropolitan Area in Tanzania

Figure 1 Drilling Equipment Set on Site

(3) Setting up of drilling equipment and camping facilities

Upon the results of the geophysical survey and other exploration methods, a steel peg is placed in the ground, representing the exact location of the drilling site. The drilling rig is then properly placed, that the borehole can be drilled directly on the spot, where the peg was.

Some necessary considerations should be made beforehand:

If possible place the drilling machine in such a way, that the rig can be removed from the site without having to go backwards over the then installed water well. This should be only allowed when there is limited space available and when there is no other chance at all to leave the site than to drive over the well.

Try to observe the general direction of the wind and if possible orientate the drilling rig in a way that no dust while drilling will go in the direction of the driller's operation stand.

Behind the drilling rig (working area) should be enough space available to handle the drill pipes with a length of 6 m each and the temporary casings with a length of 5 m. For easy and safe handling therefore, a space should be available of 8-10 m behind the working table of the drilling rig. The compressor truck should be placed alongside the drilling rig, depending on the available hose length of the high pressure hose connection from the compressor to the drilling rig.

As seen in the photo above, a safety rope is stretched out around the working area to prevent entrance of people, who are not working on the site.

The jacks of the drilling rig have to be placed on stable ground, quite often on top of a wooden beam or a steel bar. Make sure that the drilling rig is very accurately leveled, that the mast is really vertically fixed on top of the drilling location.

The height of the drilling rig's working table (clamping table) has to be measured and marked in the daily drilling reports, because this height is the only accurate reference point after drilling, because the original top of the ground surface is covered by some 0.5 m with drill cuttings from the borehole. The height of the table from the original ground surface is important, when to measure the exact drilling depth and the installation depth of casing and screens.



Source: JICA's Rural Water Supply Project in Swaziland

Figure 2 Fixing the jacks (out rigger) of the drilling rig



Source: JICA's Rural Water Supply Project in Swaziland

Figure 3 Measuring the height of the working table

(4) Safety and Security regulations throughout the works

It will be good practice, if every day at commencement of works and after the day's work a safety inspection could be carried out. Normally the Asst. Drilling Superintendent or the Head-Driller should remind the drilling staff and strengthen their daily awareness of:

- Is the safety rope still stretched out properly?
- Is the sign board with project name still fixed and visible to out side people?
- Is everybody wearing helmet, safety boots and working gloves?
- Are hoisting and lifting tools in good working condition?
- Are the connecting subs between drill pipes and drilling tools in good working condition?
- Is the working area inside of the stretched rope clean and in order?
- Are all hand tools like pickax, hammers, wrenches in good working order?
- Are all safety belts for working at higher elevation in good working condition?
- Are all rotation parts, like pulleys and chains appropriately covered?
- Is the welding equipment in good order with welding mask, goggles etc.?

At least once in a week all vehicles, lorries, the drilling rig, compressor and generator have to be checked properly in terms of lights, brakes, towing clutches etc. All electrical parts of the drilling equipment like generator cables should be properly insulated and inflammable objects to be stored at safe places.

Regular maintenance procedures will be explained later in the report.

Necessary measures shall be taken to protect the environment in the surrounding of the drilling location. When passing villages, schools and homesteads drivers should limit the speed of their vehicles and be aware of little children playing along the tracks. No trees or other plants should be cut or removed without consent of the local population.

After the drilling works, the working area should be transformed again as much as possible to its original condition.

No industrial waste like plastic bags, cement bags or other non-organic waste should be left behind, when leaving of the site after completion of the drilling- and well construction works.

(5) Check Items for Site Preparation and Drilling Machine Setting Out

● Site Confirmation

- A drilling point shall be the one selected by the geophysical survey.
- Access road shall allow drilling rig and support truck to pass.
- Site shall be leveled and at least 20 m x 30 m of work space shall be secured.
- The water for the work shall be available near the site.

● Mobilization of Equipment and Materials

- The maximum payload of the truck and the total weight of the equipment and materials shall be grasped so as not to avoid the excess load on the truck.
- Timber shall be put on the floor of the truck cargo in order that sling wires shall be easily handled.
- The capacity of the crane and safe working radius shall be grasped.
- After the loading on the truck, the loads shall be fixed by sling wires etc., so as to prevent from the load shifting.
- A list of equipment and materials to be mobilized shall be prepared before hand, so as not to forget to load anything.
- Heavy loads shall be put at lower position so as to stabilize the loads and to prevent from the damages.

● Setting Out of Drilling Rig

- In front of the drilling rig, space for the drilling tools such as drill collars, drill pipes, casing pipes etc. shall be secured. The drilling rig shall be located at the place where it can easily go out from the site after the drilling works.
- The mast shall be raised only after the drilling is set horizontally at the drilling point by using four jacks. Timbers or steel plate shall be put under each jack, in order to prevent from the land subsidence.

● Layout of Other Equipment

- A suction pit of mud shall be located within the distance where the suction hose of mud pump reaches.
- A mud circulation system is composed of mud suction pit, settlement pit and delivery trench. Dimensions of a mud suction pit and a settlement pit shall be approximately 2 m x 2 m x 2 m (8 m³). In order to prevent from the collapse, the wall of pit shall be inclined and be protected with the mortar in case of sandy or clayey soil.
- Approximately 3 nos. of water tanks of 3 m³ shall be set around the mud pit (See **Figure 4**).

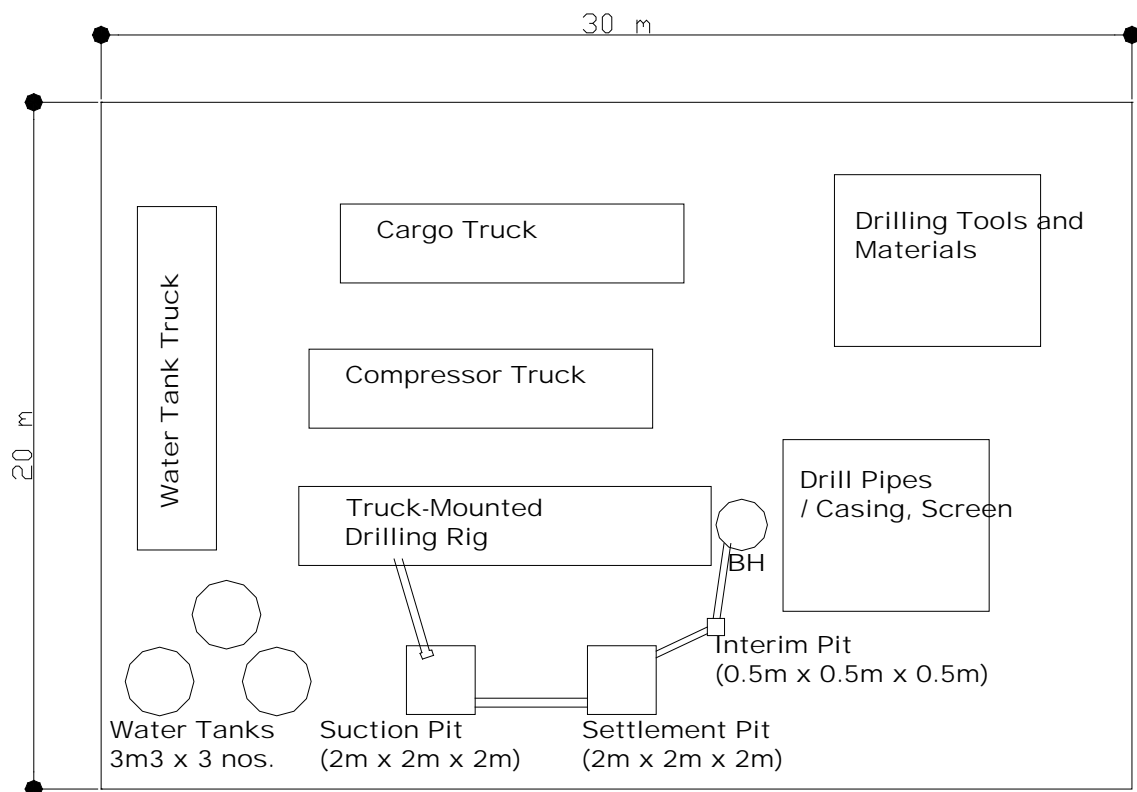


Figure 4 Standard Layout of Drilling Equipment on Site

