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INTEGRATED DEVELOPMENT FOR WATER SUPPLY AND SANITATION

Case studies on well drilling problems

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NO ONE HAS come to deny that safe and adequate potable water is one of the indisputable first order-ranking human needs. Though this is the prevailing theoretical hard fact, in reality particularly in the third world countries the actual situation is by far and large deviates from the global thinking.

Ethiopia being a third world country can not be excluded from the nations who are suffering from the negative social and economical outcomes of the potable water shortage problem. The total coverage for potable water is very low. The percentage of the population who has access to clean and safe water is very minimal. Moreover, the rural people particularly women and children are the victims of the critical problem. Furthermore, much can not be mention as a positive remark regarding the water supply and sanitation aspects of the urban and semi-urban areas.

There are very many reasons that can be attributed as possible causes to this significant problem. Among the reasons, groundwater resource development activities that have seen facing numerous problems right away from the planning to the implementation and management stages are worth mentioning. Drilling of wells which is one of the common practices to supplying the urban and the rural community with safe water has been observed to have repeated problems and thereby a number of wells abandoned as the result of the problem. Effort has been made to study different cases in order to establish findings that would stimulate appreciation of the problems and lead to think about the respective solutions.

The problem

The study paid modest attention to the problems in groundwater resource development mainly to the common problems in drilling and well completion activities. In the drilling world the most apparent representative problem is the nature of the job itself. It is a job that you can not see with your naked eye what really is happening deep in the subsurface. Thus, the major problem emanates from the nature of the job.

Due to lack of skilful management less attention is paid to resource allocation, i.e., human, financial and material resources. This situation can be considered as the second representative problem. The problems enhanced by inexperienced technical performances and those encountered due to the incompatibility of the drilling methods with the formations to be drilled are also notable.

The number of abandoned wells due to the above noted problems are increasing from time to time and observed to facilitating the overall potable water shortage.

Objective

In light of the current theories and experience indicating the means and ends how to minimize the common drilling and well completion problems and thereby improving the results of drilled wells which would apparently maximize the amount of safe and clean potable water is the target of the study. To realise this objective effort has been made to scrutinising the drilling and well completion problems through reviewing different literature's. Besides, close examinations on actual field experiences have also been made to identify the causes of the problems in order to be in a better position to achieve the envisaged objective.

Thus, the specific aim of the study is for the achievement of the following:

- To be able to develop research oriented problem solving attitude.
- To facilitate exchange of experiences among professionals and organizations of similar interest.
- To develop the basis and make practical the importance of data collection which is the corner stone for such an activity.

Approach

Drilling is a field that has no precise guidelines to be followed so strictly. Its implementation merely based upon field experiences. So, you may find endless arguments amongst drillers on a single point where the points of arguments emanate from previous experiences and common sense reaction on the raised issues. Thus, own experience, listening and talking to others and reading relevant books, publications and manuals was the chosen approach to start the study. Moreover, more attention and time was given for discussion with drilling experts to listen and thereby learn from their experiences. The experiences of these fellow professionals were organized in the form of case studies. With this approach more than 45 cases are collected and studied.

Method of analysis

The method of analysis was organized to encompass rational and consistent approaches. In line with this, during the problem analysis drilling and well completion well problems were set as focal problems and a logical approach was adopted to see the possible causes for the noted problems and the respective effects of the problems. Moreover, to improve the prevailing problems for the future an objective analysis pattern, i.e., putting the desired condi-

tion and stating the means, which would enable to achieve the setted goal, was applied. With these analytical approaches the issues discussed and findings established. Finally alter native analysis made to indicate different options.

Common drilling problems

It is not uncommon to have problem in any field of activity. The degree and the magnitude of the problems, however, vary to the nature of the causes of the problems. Drilling problems and the respective causes by their nature are very much complicated. Since the problems occur out of our sight, below our feet and deep in the subsurface, most of the time the problem identification step is performed by mere speculation.

The most common drilling problems are:

- Loss of circulation.
- Cave-in hole (collapse).
- Bridging in wells.
- Crookedness of wells/deflection of wells.
- Pollution and corrosion in wells.
- Mud cake formation.
- Stacked tools.

Causes and effects of the problems

A Problem well identified can be considered as partially solved. Hence, to identify any problem developing sound analytical approach becomes an indispensable task. The logical relationship of cause and effect must be well organized to the identified problems. Mixing their logical relationship may lead to hampering further problem analysis tasks.

In light of the above explanation, examples how the cause and effect analyses were done cited as follows:

- *Problem*: Loss of circulation.
- *Causes* : Natural or intrinsic fractures, induced or created fractures, highly permeable formations, clogging of the opening of the drill bit are the main subsurface causes for circulation loss problem.
- *Effects* : Partial or full interception of the drilling fluid which finally result in staking of the bit and the pipe may occur. In addition to this, at times, collapse of the borehole wall in unconsolidated formation may occur.

Typical well completion problems

As has been discussed earlier, most of the time it is difficult to get as such an independent well completion problem. Many of the problems are directly inter linked with drilling operations. However, well completion problems can be classified into two, i.e. effects of the drilling problem that would represent the cause in the well completion problems and problems not directly associated with the drilling operations. One way or the other all the common drilling problems may facilitate well completion problems.

The following points illustrate how the drilling problems are facilitating well completion problems.

- *Drilling problem*: Deflection of wells.
- *Related well completion problem*: Difficulty in lowering casing strings, casing and screens may not be landed at prearranged depths and also difficulty in grouting (the casing may closely adhere to one side and non-uniform filling of the annular space results) may occur.
- *Drilling problem*: Mud cake formation.
- *Related well completion problem*: Clogging of the screen that may result in smaller discharge or even dry well.

Other problems that are assumed to be the causes for well completion problem are elaborated as follows:

- Poor well design.
- Reckless casing and screen lowering.
- Bridging during gravel packing.
- Improper well development.
- Negligence during pump installation.
- Improper grouting and not sealing the well properly.
- Poorly organized and conducted pumping test operation.
- Well interference due to not keeping optimum well spacing.
- etc.

Case studies

In fields like drilling it would not be surprise if one gives more attention to the happening data rather than the theoretical approaches. Based on the broadly described theoretical background information trying to understand own problem and then acting accordingly is the only way out to tackle faced drilling and completion problems.

To make practical such an approach, information on actual practical experiences have to be collected, discussed and the final findings be noted and compiled in a manner that they can be useful for future reference and exchange of experience.

More than forty-five different drilling and well completion problems from different parts of the country were collected and analyzed. The collected data were filled in a format that contains the following information:

- Location of the site.
- Drilling time (year)/rig type/depth.
- Encountered problem.
- Cause of the problem.
- Given solution.
- Current remark.

Findings of the study

- Drilling problems and poor well completion performances share reasonable amount of percentage in the overall lesser achievement in groundwater resource development.
- Following a logical problem identification approach and thereby be able to set strategically achievable goals is observed being an important task to be accomplished with respect to the noted problems.
- Unlike other problems, drilling problems are very much complicated and the respective solutions are entirely

based on the experiences of the drillers in which they are able to take the preventive actions before the occurrence of the problems.
- During the drilling problem analysis the cause and effect relationship at times observed to be mixed. A cause to a certain problem seen becoming an effect to another cause. Thus, it becomes necessary to identify the initial cause of the problem.
- Well completion problems are emerging mainly from problems faced during actual drilling activities and from technical failures, which are accounted for improper planning and lack of drilling experiences.

Interpretation of results

With out studying causes contributing to the occurring problems, it is natural that proposal of remedial action may not be feasible. The following interpretations of findings attained through close examinations of different case histories. The broader categorization of the causes of the problem indicated that the following are the main causes to well drilling and completion problems:

Poor technical performances

Poor technical performances due to improper planning, lack of drilling skill, experience limitation, negligence, weak workshop conditions, shortage of spare parts, lack of skill for maintenance activities, etc found out to be the causes for poor technical performances.

Unfavourable geological conditions

The geological causes that enhance drilling problem are observed to be natural and man made causes. The natural causes (fractures, joints…) are geological features already existing in the subsurface prior to the drilling operation. The man made causes were enhanced to occur in the subsurface due to weak drilling performances like unskilled application of drilling fluids and creation of induced fractures due to limitation of drilling experience.

Technological defects

From the study three points, i.e. poor quality products, old age of equipment and negligent workmanship were enumerated to facilitate technological defects.

Recommendations

The target of the study was to see very closely the actual field experiences through case histories and to propose solutions that would technically and financially be feasible.

It has been deduced that most of the problems have originated from poor resource management (human, technical and material). Thus, by making an extra effort to minimize the noticed defects one really can make a dramatic positive remark. In this regard, carrying out capacity building activities with participation of all the concerned members (the management body and the technical group) aiming at a long-term success would entail the required result.

The following are proposed to bring substantial solution to the well drilling and completion problem:

Participatory planning approach

From the case studies it has been deduced that most of the problems occurred due to improper planning. There was less or no communication among the concerned bodies. Besides, most of the decisions taken to solve the encountered problems were the results of traditional management, which were exercised on reaction basis. On the other hand, over all projects management approaches did not seem to take into account strategic viewpoints. Hence, to minimize such problems Participatory Planning Approach from the initial to the final stages of the project phase should be implemented.

Improved training approach

All the problems that are the results of poor planning, lack of experience and skill deficiency can be improved through appropriate training. The most important thing is that inorder to have effective and efficient performances one has to believe in the requirements of different types of training programs. In general,the proposed types of training's for this particular purpose are management training's which would assist in bringing attitudinal changes to the workers and the management group and skill training's which would help to minimize the noted technical problems.

Improved maintenance approach

Inorder to improve the equipment conditions and thereby to minimize the associated drilling problems, the maintenance condition of the rigs and related equipment need close consideration. In connection with this, the workshop conditions have to be improved and more attention must be given to preventive maintenance and detail action plans have to be developed for the actual executions.

Improved drilling rigs and materials approach

During the study extra effort has been made to know the situations of the drilling rigs and the respective accessories which were deployed to carry out the then drilling operations and as well as to study the conditions of some of the rigs which are currently engaged in similar activities. Accordingly, most of the rigs are found to be very old and serve more than two decades.

In order to minimize causes of the problems categorised as technological defects (old aged equipment and poor material qualities) the following are proposed:

- Equipment Standardization should be adopted. Different makes and models of rigs in one organization are apparently represent a problem in human and material resource management.
- Replacement of rigs, accessories and other related materials has to be considered. However, before making practical this point cost benefit analysis approach (expected service from the rig i.e. for rural or urban water

supply, the initial investment, the running costs, the material quality, etc) should be made practical.

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References

CLARK, L., 1988, The Field Guides to Water Wells and Boreholes, Open University.

DRISCOLL, F.G., 1986, Groundwater and Wells, Johnson Division, St. Paul Minnesota.

FREEZ, R.A., and CHERRY, J.A., 1979, Groundwater, Prentice-Hall,Inc., Eaglewood Cliffs, N.J.

ROWLES, R.,1995, Drilling for Water a Practical Manual

SERADA,N.G., and SOLOVYOU, E.M., Drilling of Oil and Gas Wells.

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