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Geospatial Assessment of Water Distribution Network in Adamawa State Polytechnic, Yola.

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ABSTRACT
This research examined the water distribution in Adamawa state polytechnic, Yola main campus through the application of geospatial techniques.Primary data which includes water pipelines reduced levels. Coordinates of points, Topographical maps and satellite imagery of the research study area with attribute data were integrated into ArcGIS software, the spatial information in analogue or hardcopy format, were scanned and digitized in order to convert them into GIS format. Spatial data such as location of water supply (borehole) and pipe network were analyzed using the ArcGIS software 10.4, high resolution satellite image (digital globe) of the study area were acquired and digitized and then overlay. Digital elevation model was produced The water distribution network were mapped out and the source of water determined. It was discovered that onlyboreholes 1-3 sources of water location are placed appropriate in relation to flow orientation while the other 11 boreholes were meant to serve buildings attached to them there by causing water shortage to the structures and inhabitant whenever there is a breakdown of a borehole attached to a particular building as there is no network of pipes linking all the structures in the campus.

Keywords: Geospatial information, Water Distribution System, Global Positioning System, Reduced Level

I. INTRODUCTION

Water is a natural solvent that is inevitable, water distribution network exists among human society and very vital for human existence and without it, there would be no life on earth. Its infrastructure should be properly maintained to avoid future water problems. The total water requirement is on the increase and the per capita water consumption is also on the increase in population and civilization. There is need to provide sufficient water of appropriate quality and quantity has been one of the most important issues, which has made people began to transport water from other locations to their communities. (Audu and Ehiorobo, 2010) However Adamawa state polytechnic Yola is not an exceptional community when it comes to water distribution issues.

Distribution system infrastructure is generally the major asset of a water utility. Ogunmola et al, (2013) Describes the water Works systems as comprises all water utility mechanisms delivery of finished or portable water by means of gravity storage feed or pumps through distribution, pumping network to customers or other users, including distribution equalizing storage. These systems must also be able to provide water for non-potable uses, such as fire suppression and irrigation of landscaping. Water supply system is a complex system that integrates several spatial features. Therefore, there is need to use multi- support information system such as the Geo-spatial or GIS method or techniques in order to have the capability of storing; managing and analyzing the large data set that concerns water distribution network.

Musa (2001) stated that; Geo-spatial or GIS refers to the system of computer hardware and software for capturing, storing, analyzing, manipulating and displaying of spatial referenced

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data. In other words it is an organizing collection of computer hardware, software and geographic data designed to effectively capture, store, update, manipulate, analyze, and display all forms geographically referenced information. Secondly, it is a computerize system for retrieval and presentation of spatially referenced data. To sum it up, the spatial technique can and offered great capability for analyzing, integrating, modelling and presentation of spatial data which inturn can be a good output for efficient and effective plan formulation, evaluation as well as national decision making hence as depicted in this research, its application in this water distribution was indeed efficient and effective.

As water demands pressures raise increasingly on the existing water supply system, many studies attempted to develop a general water supply system to assist decision maker to make more design that will be used for long term operational period.Audu and Ukeme, (2013) Opined that "water distribution system is a network of pipelines that distribute water to the consumers. They are designed to adequately satisfy the water requirement for a combination of domestic, commercial, industrial and firefighting purposes. The requirements for good water distribution system should satisfy the following conditions that includes;Water quality should not get deteriorated in the distribution pipes, it should be capable of supplying water at all the intended places with sufficient pressure head, purity of distributed water should be maintained - This will involve having a completely water tight distribution system, maintenance of the distribution system should be easy and economical, during repairs; it should not cause any traffic obstruction i.ethe pipelines should not be laid under highways, carriage ways but below foot paths, adequate water pressure at the consumer's taps for a specific rate of flow (i.e., pressures should be great enough to adequately meet consumer needs). And also pressures should be great enough to adequately meet not only users' need but also things like fire fightingneeds..

Adequate water supply and distribution systems are not only fundamental to environmentally sustainable development in any country but also are important in the control of many water borne and water related – diseases such as cholera, diarrhoea, typhoid and para–typhoid fever, hepatitis, etc.Cullen (2005) pointed out that "a modern society has been victim of its own success. A higher quality of life has meant greater demands on our services as people use more water and burn more energy. Data collection and distribution, however, has not moved on". The challenges are: securing adequate and potable water for people, securing water for food, protecting the ecosystems, creating awareness among the financing water infrastructure. These challenges have continued to demand innovation and state- of-the- art technology needed for drastic changes in the location, planning, collection, distribution and management of water infrastructure. However, the geo-spatial technological technique of the surveying and geo-informatics profession has shown to be a good data capture and analytical tool for such scientific research.

Statement of the Problem

Investigation shows that the Adamawa State PolytechnicMainCampus has no water distribution base map. Infrastructural Projects are being carried out without considering the location of this pipelines cursing leakages and causing a redirection of this pipeline without considering the rate of flow of the water. Also, there is no comprehensive record of these facilities even the analogue map is not in existence; this makes it very difficult to ascertain the distribution of this pipeline. Boreholes are drilled without considering the topography of the area, requiring more pressure on the water to reach other part of the institution. The mapping of this water network using spatial techniques will provide an improve way of managing and monitoring of this facilities and for efficient and effective record keeping.

This aim at examine the location of polytechnic water Distribution network through the following objectives: -

1. Examine the location of source of water to the polytechnic community.
2.. Examine the distribution of pipeline routes.
3. Determine the geo-spatial information of water distribution system.

Water Distribution Network Components

Water distribution network contains all the various components of a water system and defines how the components are interconnected. These components include water reservoir, water pipes, water pumps, storage tanks, junctions and valves. According to Lansey and Mays (2008), a waterdistribution system consists of three major components: distribution piping network, pumpsand distribution storage. The components of water distribution system and their modeling purposes are shown in Table 1.

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Table 1- Components of Water Distribution System and Modelling purposes (Walski et al, 2003)

Component	Type of Network Modelling Element	Primary modelling purpose
Reservoir	Node	Provides water to the system
Pipe	Link	Conveys water from one node to another
Pump	Node	Raises the hydraulic grade to overcome elevation differences and friction losses.
Storage Tank	Node	Stores excess water within the system and releases that water at times of high usage.
Junction	Node	Removes (demand) or adds (inflow) water from/to the system.
Valve	Node or Link	Controls flow or pressure in the system based on specified criteria.

Geo-Spatial Information in Water Distribution System

A network of pipes, pumps, valves and other appurtenances are required to move water from the source to the consumer. Water distribution components form a large proportion of total investment in any water supply system (Rao, 2007). These components include water reservoir, water pipes, water pumps, storage tanks, junctions and valves. Douglas et al.(1995) reported that a pipe, which conveys the flow of water from one point to another in a pipeline network, is the primary water distribution network component. The principal characteristics of pipe are the pipe material, length, diameter and pipe carrying capacity factor (C- factor). Water pipeline systems need some periodic inspection for effective performance of the system.

Geospatial information is the basic ingredient for the physical planning, design and development of infrastructure (Ehiorobo and Audu, 2007). Geo-spatial information, which exists in real world in terms of space (with location) and time, can be represented in the form of maps, databases and statistical representation (Akinyede and Borroffice, 2004).

Coordinates are geospatial information used to represent the location of natural or man –made features on the earth‘s surface. They are set of values that define a position within a spatial reference (ESRI,2000). Geo-spatial information plays a significant role in the planning, design, location and maintenance management of water distribution infrastructure (WDI).

Furthermore, most components of water infrastructure are referenced to the surface of the earth (Audu and Ehiorobo, 2010).

Study area

The study area is the Adamawa state Polytechnic, Yola. The polytechnic has three campuses, one in Numan others are Jambutu and main campuses. The project area is that of the main campus which is primarily located in the heart of Jimeta town area on latitude 900C14’N and longitude 120C23’E at the south and latitude 900C15N and longitude 120C04’N at the north along AminuGaladima Way, opposite old cemetery and it is adjacent to the Police Barracks, Jimeta Yola. The inhabitants are 80% students and 20% staffs with a population range of 500 to 5000. The population changes with session. The campus occupies an area of about 2217.71sqm.

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Fig1.Satellite image of Adamawa State Polytechnic, Yola.
Source: Digital Globe (2023)

Material and Method

List of equipment used includes surveying tools, topo sheet of SPY, Hand held GPS and automatic level others are HP computers, External Hard disk. The software used are: Google Earth (satellite image). AutoCAD 2007. ArcGIS 10.4. Haested water CAD and Microsoft application packages.

DATA COLLECTION AND PROCESSING

During the survey, all details within the pipeline routes were recorded. Profile levelling was carried out with the aid of an automatic levelling instrument with the levels taken to determine the Reduced Levels(RL) and the route of each pipeline. The geo-spatial data of all the components of the water distribution pipelines such as boreholes, water pipes, water valves, storage tanks, water pumps were acquired using the geospatial techniques .

The topographic map of the area was scanned, digitized and use in producing Digital elevation model of the area. Contour intervals and roads were extracted from the topographic maps. The acquired elevation data of the components of the water distribution system were reduced using the height of instrument method. The accuracy of the traversing and the leveling operations were within the permissible accuracy. The geo-spatial information of the campus water distribution scheme was input into Microsoft Excel software and script files were created. The script files were exported into ArcGIS 10.4, where the geospatial information of the various components of water distribution network was plotted. The distribution layout vector plan was exported into the topographical model generated from the satellite imagery. The geospatial database, which was designed and created, was exported into Haestad Water CAD environment for the water distribution network analysis.

The water distribution network analysis using the Haestad water CAD was based on traverse lines representing length of pipes, intersection points as well as grow elevation obtained from DEM generated from the topo-map and from ground levelling. Analysis of DEM database with the Haedstad CAD was used to determine where pressures are low andhigh. These were used to identify if pipe sizes were adequate or not for delivering the required flow rates to various section of the school.

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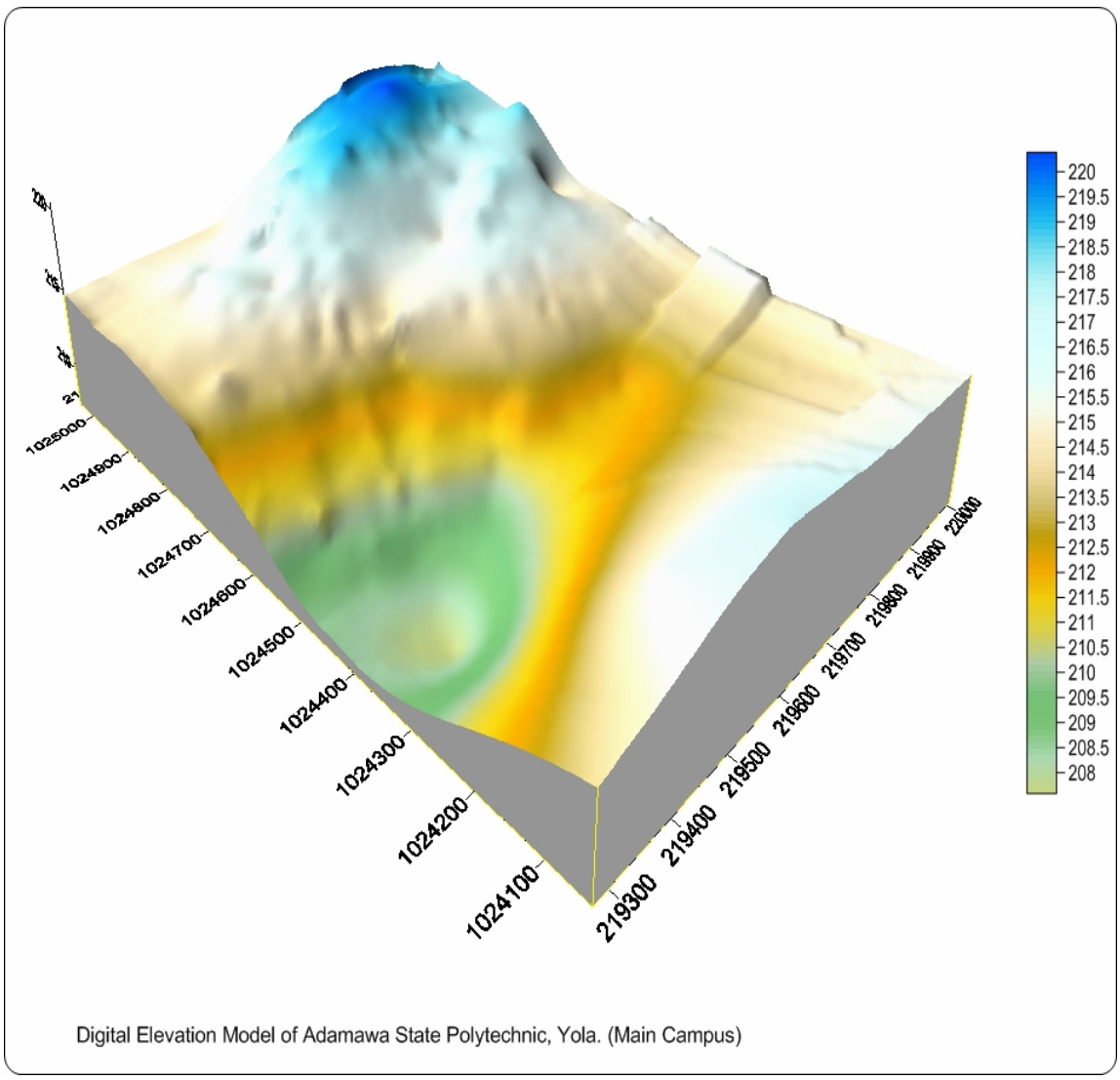
Results Presentation

Fig. 2 shows digital elevation of the study area. Fig 3 shows the existing water network system in the study area. Fig 4 shows the location of variovsborehols in the study are. Fig 5 shows the overlay of boreholes and the water distribution network on the satellite image of the study area. Table 2 Shows the Geo-Spatial Information and the Borehole Capacity in the Study Area whileThe Attribute information of the components of Water transmission and distribution pipelines are presented in Table 1. The study reveals 14 boreholes in the study area, 13 functional and one under construction. The main source of supply is the overhead tank close to the gate, other boreholes served as a supplement to the main borehole.



Digital Elevation Model of Adamawa State Polytechnic, Yola. (Main Campus)

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Figure 2: Digital Elevation Model (DEM) of Adamawa state polytechnic

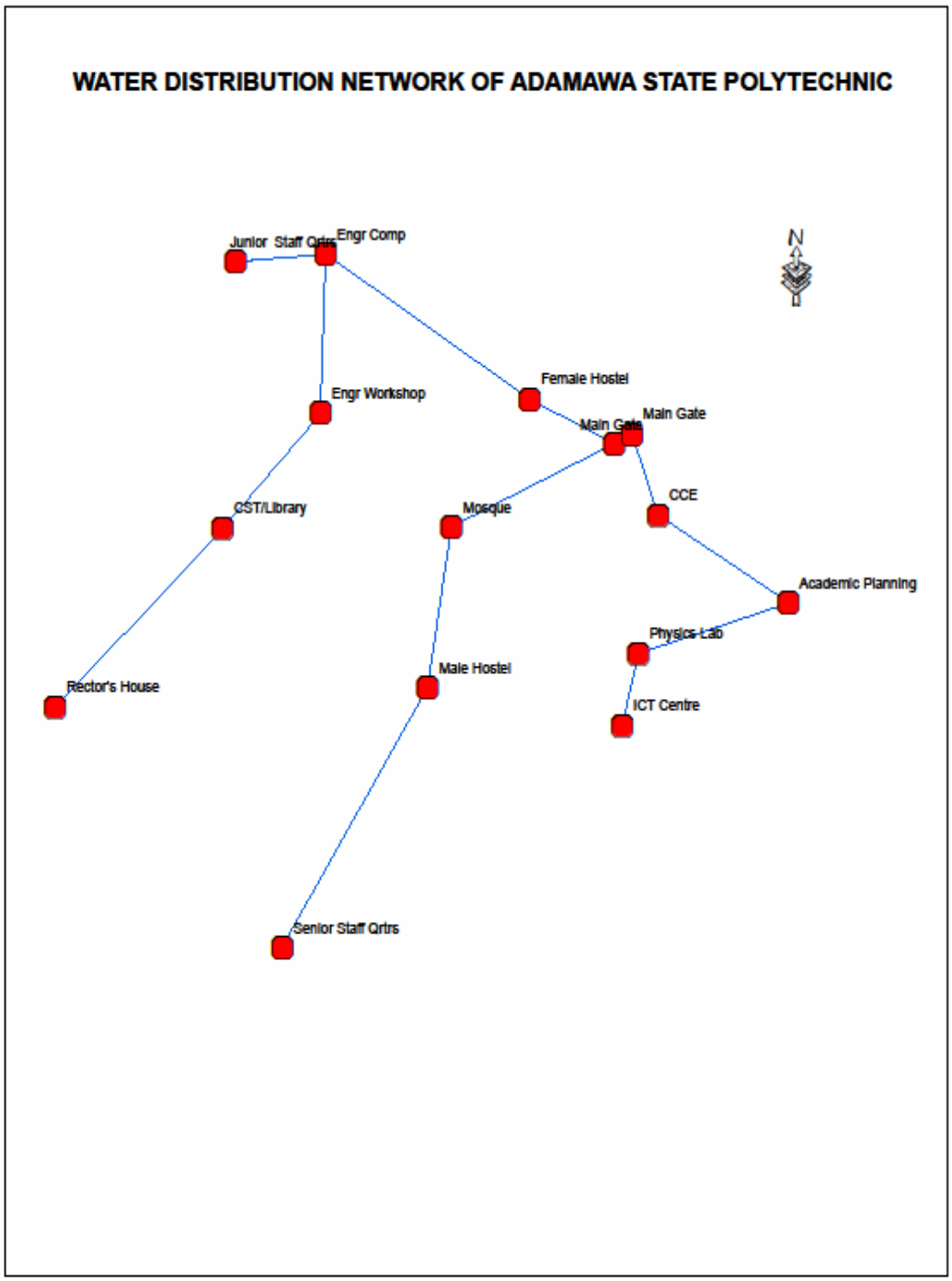

Figure 3: Showing existing pipe network in main campus.

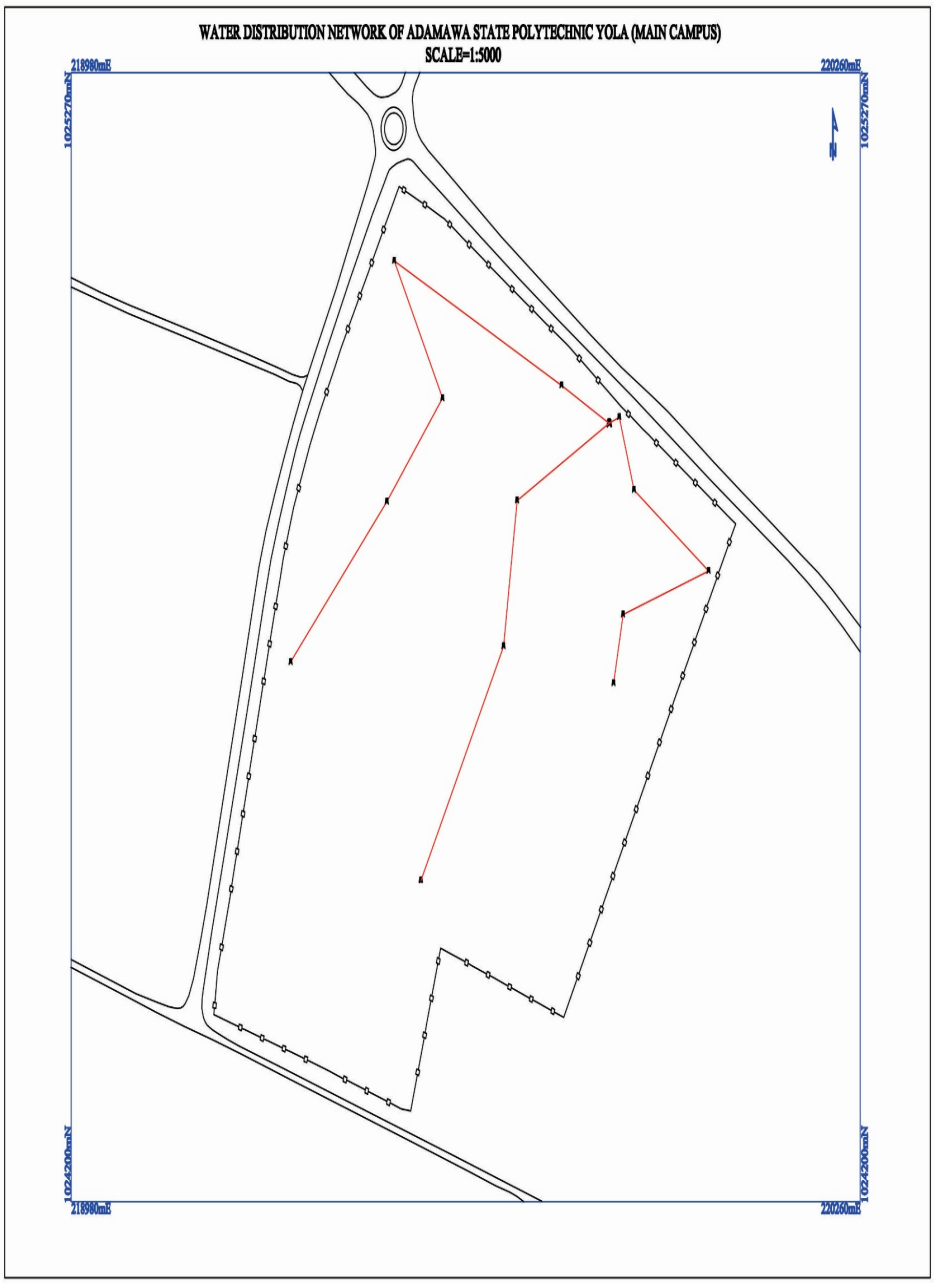

Fig 4: Water distribution network in Adamawa State Polytechnic, Yola.

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Fig 5: Overlay of water distribution network on satellite image of study area.

Table 2: Geo-spatial Information and the Estimated Borehole Capacity in the Study Area

Borehole (BH)	Service Area	Coordinates		Status	capacity (Litres)	Type of tank
		Easting (m)	Northing (m)			
Borehole 1	M source	0219852	1024933	Functional	50,0000	Overhead
Borehole 2	" "	0219868	1024941			
Borehole 3	F. hostel	0219774	1024971	Functional	3,000	Overhead

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Borehole 4	E.complx	0219581	1024959	Functional	3,000	Overhead
Borehole 5	Library	0219491	1024861	Functional	3,000	Overhead
Borehole 6	R. office	0219337	1024708	Functional	3,000	Overhead
Borehole 7	Mosque	0219702	1024862	Functional	3,000	Overhead
Borehole 8	CCE	0219892	1024872	Functional	15,000	Overhead
					5,000	Reservoir
Borehole 9	M/ hostel	0219680	1024724	Functional	3,000	Overhead
Borehole 10	SSQ	0219546	1024502	Functional	20,000	Overhead
					50,0000	Reservoir
Borehole 11	R. house	0220012	1024798	Functional	3,000	Overhead
Borehole 12	Phy/ Lap	0219874	1024754	Functional	3,000	Overhead
Borehole 13	ICT	0219859	1024692	Functional	20,000	Overhead
					5,000	Reservoir
Borehole 14	J SQ	0219503	1025089	U/Const.	U/Const .	U/Const.

II.

III. DISCUSSION

From the result in the study, DEM and geo-spatial information with the attribute data in table 2 is then used to determine areas that can have good water distribution based on the terrain of the study area and this is depicted by only average pipelines route reduced level (RRL) That is only those boreholes that serves as water source and their supply area with RRL having average route heights values that run with good or slope from high to low flows orientation are borehole holes 1, 2 and 3 but other boreholes do not meet this average RRL slope flow hence need to be reconsidered. Contour plays an important role in water distribution system which can be developed by known topography and adjusted based on elevation of terrain. The location with high topography will have high pressure of water supply if the pump is provided, pump discharge head was derived from the system pressures at the pump station and piping head loss. By considering these parameters within the area finally pressure contours are generated by inverse distance weight method using ArcGIS spatial analyst tool.

IV. CONCLUSION

Water distribution system should be based on a pipe layout that is suitable and have no less water stagnation within the pipe to avoid tuberculation, deposit of sediment. The capabilities and importance of GIS is demonstrated in this research. The result from the analysis shows there is no supply from the water board even with the proximity of the campus to their office. Boreholes have been identified as the primary source of water supply to polytechnic community and connection to the water board pipeline is a forgone issue. There is insufficient supply from the major borehole supplying water to the institution (source), water could not flow regularly through the network. Polytechnics populate resolve into using the individual boreholes drilled closer to them. The work carried out in this paper for Geospatial analysis of water distribution network in Adamawa state polytechnic, can also be used by the urban planners and municipal authorities, environmental engineers and water resource managers for different water demand and finding out the specific site for implementation of various developments.

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