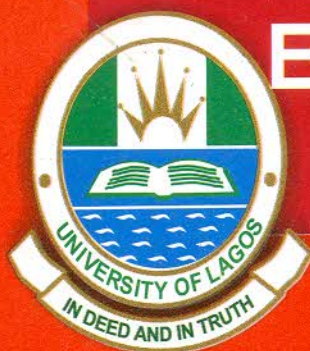




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IMPROVING THE HYDRAULIC SYSTEM FOR WATER SUPPLY TO THE UNIVERSITY OF ILORIN ACADEMIC BUILDINGS

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ABSTRACT

This paper is aimed at addressing the problem of water supply to some academic buildings at University of Ilorin, Ilorin, Nigeria. The assessment and analysis of present condition of water distribution to these buildings showed that, despite increase in volume of water pumped to the central distribution tank, some buildings are not getting water due to insufficient residual pressure. This necessitated the analysis of the system and hydraulic design of an elevated steel tank that will ensure regular water supply by gravity at sufficient pressure to all academic buildings. The study showed that the total daily water demand within the academic areas at University of Ilorin main campus is 1200m^3 . Analysis of nodal pressures at various demand points within the network was carried out using EPANET software for different sizes of tank ranging from 100 to 300m^3 . The results showed that the provision of 100m^3 , 150m^3 , 200m^3 , 250m^3 or 300m^3 steel tank at respective heights of either 12.0m , 11.5m , 11.0m , 10.5 or 10.5m will be hydraulically sufficient to supply water by gravity to all academic buildings. The comparison of the advantages of various tank sizes showed that a 300m^3 tank is more desirable and provide better flexibility.

Keywords: *Water supply, residual pressure, nodal pressure, hydraulic system, network.*

1.0 INTRODUCTION

A distribution system supplies water in good quality, adequate quantities and at sufficient pressure to meet system requirements to the users. After complete treatment of water, it becomes necessary to distribute the water either by continuous or intermittent supply system to a number of houses, estates, industries and public places by means of a network of distribution system. This distribution system is made up of finished water storage, transmission and distribution pipes of various sizes, valves of varying functions, meters, pumps etc. The design of water transport and distribution systems consists of two parts: hydraulic and engineering. The main parameters considered in hydraulic design are pressure and hydraulic gradient. Engineering (non-hydraulic) design criteria are: provision of easy access to the vital parts of the system

for maintenance purpose, selection of durable pipe materials, joints, fittings, valves and other appurtenances. Nemanja (2006) stated that apart from sufficient flows, pressures and velocities, a well-designed system should fulfil the following additional requirements:

- reduced operational costs in regular supply conditions,
- ensure reasonable supply during irregular situations (such as power/pump failure, pipe burst, fire events, system maintenance, rehabilitation or reconstruction) and
- allowance for future extension.

Water distribution systems must be designed to satisfy maximum anticipated water demands which normally occur on hot and summer days when larger than normal amounts of water are used for personal purposes and washing of vehicles and equipment. The configuration of

the distribution system is determined primarily by size and location of demand point, street patterns, location of treatment and storage facilities, and topography. For efficient distribution, it is required that water should reach every consumer within the system by a gravity system, pumping system or dual system (i.e. combined gravity and pumping system). Whenever the source is at a higher level than the point of water use, it is possible to avoid mechanical pumps and allow the force of gravity to deliver the water. Storage tanks either underground or elevated provide both needed storage capacity and sufficient head to deliver water to all parts of the distribution system. Elevated water storage is being used to maintain sufficient supply under adequate pressure and operational flexibility for water systems. These structures are usually constructed with a welded steel tank container supported by steel columns or a steel pedestal. Methods for sizing and locating these facilities to provide equalization and emergency storage have changed little over the years (Walski, 2004). Water distribution storage is provided to ensure the reliable supply, maintain pressure with the system, equalize pumping and treatment rates, reduce the size of transmission mains, and improve operational flexibility and efficiency. Numerous decisions must be made in the design of a storage tank, including size, location, type, and expected operation (Walski, 2004). Water distribution storage tanks can be ground, standpipe, or elevated depending on the purpose of its construction. Ground storage is usually located remote from the treatment plant but within the distribution system. It can be constructed below the ground, partially below the ground or above ground level in the distribution system. It may be accompanied by pump stations if not built at elevations providing the required system pressure by gravity. However, if the terrain permits, this design location of ground tanks at elevation sufficient for gravity flow is preferred as the operational cost is reduced. Elevated storage tanks are usually located in

the areas having the lowest system pressures during intervals of high water use. Elevated tanks are generally located at some distance from the pump station(s) serving a distribution pressure level, but not outside the boundaries of the service area. Other considerations for siting of elevated storage are conditions of terrain, suitability of subsurface soil and/or rock for foundation purposes, and hazards to low-flying aircraft etc. Elevated tanks are built on the highest available ground and can provide up to static pressures of 75psi in the system, so as to minimize the required construction cost and heights as stated in Department of Army and Air Force (1985). In general, elevated storage is more effective and economical than ground storage because of the reduced pumping requirements, and the storage can also serve as a source of emergency supply since system pressure requirements can still be met temporarily when pumps are out of service.

Water distribution storage tanks and pumps are constructed to maintain the energy levels needed for water to reach the discharge points by gravity or pumping or combined. (Walski, 2004) identified the following factors that directly influence the position, capacity and operation of these components as:

- Topographical conditions
- Location of supply and demand points,
- Patterns of demand variation,
- Conveyance capacity of the network.

Hydraulic design of distribution system primarily deals with pressures and hydraulic gradients. Although flow velocities, pressure and flow fluctuations are also important design factors. The pressure criterion is usually given as the minimum/maximum pressure required or allowed, at the most critical point of the system. The starting point while setting the minimum pressure is the height of typical buildings present in the area, which in most urban areas consist of three to six floors. According to (Nemanja, 2006), pressure of 5–10m remaining above the highest tap, usually leads to a minimum pressure of 20–30m above the street level. In the case of higher buildings, an internal boosting system is normally provided. Maximum pressure limitations are

required to reduce the additional cost of pipe strengthening. Some authors who have worked on distribution systems came up with minimum and maximum pressure expected in the pipe mains. It is however desirable to keep pressures within the limits specified as much as possible. (Bhardwaj, 2001) stated that water supply system needs to guarantee a minimum pressure even at the most remote point in the supply area. Typically, minimum acceptable water system pressures are 35-40psi (23.5-26.8m) and maximum pressures are 100-120 psi (67.1-80.5m). Some other authors like Jain (1999), Ministry of Environment, Water Stewardship Division, (2007) recommended that minimum residual pressure of water coming out of domestic fittings at home should be at least 20psi (13.4m).

In order to supply adequate quantity of water of acceptable quality, it is necessary for the designer to assess the requirements for water supply. This exercise is done for various locations to be served and then total requirement is worked out. The demand for water in any area is dependent on many factors which include climate, standard of living, quality of water, water rate, population and rate of development. At the University of Ilorin main campus, the study area, there are four areas of water demand which are students' halls of residence, staff quarters, office and academic buildings, and students' canteen. Water supplied to these areas is used for domestic (drinking, bathing, flushing, washing etc), institutional (in laboratories, health centre, watering of lawn, etc) or commercial purposes (in restaurants, canteens and kiosks). (Abodunrin, 1996) estimated average water demand for University of Ilorin student's hostel and academic buildings to be 88.87 l/c/d and 41.34 l/c/d respectively. (Raju, 1995) and (Shri, 2005) recommended 45 l/c/day for water use in schools and allied institutions. The rate of development through increase in population, industrial and commercial activities in an area affect the water demand. As the population increases, water demand increases because more people will have to be served. Water

supply systems are designed not only to meet the present but also the future water demand. As a result, a design period is chosen. (Oyeyemi, 1995) recommended a design period between 10 and 20 years as appropriate for small water supply schemes. Designing for too small population can have a disastrous effect if the community develops much faster than anticipated. At the same time, over-designing the system requires an exaggerated capital investment on the part of present population.

University of Ilorin main campus has three central surface concrete distribution tanks each with a capacity of one million litres and situated at the highest point (380.1 m.a.s.l) within the University. These tanks supply water by gravity flow to other smaller reservoirs and tanks on various buildings in the academic area and students' hostels. In recent years, it has been observed that some academic buildings have been facing problem of insufficient pressure to serve the storage tanks placed on buildings within the academic areas. As a result, water supply to some academic buildings such as Faculty of Agriculture, Geography & Environmental Management and, Peace & Strategic Studies buildings is supplemented with lift pumps. Also, some other academic buildings such as Performing Art, Mass Communication, Science Education, Counsellor Education and Art & Social Sciences buildings are not connected to the central distribution system because of their elevations relative to the location of central storage tank. This study is to solve the aforementioned problem with a suitable water supply scheme (by gravity) that will ensure adequate flow and pressure to all the buildings.

2.0 THEORETICAL BACKGROUND

2.1 THE STUDY AREA

The University of Ilorin was established in 1975 and physical development activities commenced on the main campus in 1979. The campus is located some 10km north-east of Ilorin, the capital of Kwara State. Ilorin lies between latitude 8° and 10° of equator and longitude $2^{\circ}24'$ and $6^{\circ}15'$ east of the prime meridian in the north central part of Nigeria.

The total size of the site is approximately 15,000 hectares. The University main campus presently has twelve faculties and a college of Health Sciences. The population of the students and staff as at 2010/2011 academic session are about 25,000 and 3100 respectively. The faculties are Arts, Agriculture, Basic Medical Sciences, Business & Social Sciences, Clinical Sciences, Communication and Information Science, Education, Engineering & Technology, Law, Pharmaceutical Sciences, Science and Veterinary Medicine. Each of the faculties has departmental buildings for different programmes. Also, there are administration buildings, a postgraduate school, bank buildings, staff quarters, works department, canteens, health centre, student hostels, lecture theatres, etc. Each of these buildings has various tank sizes placed on roof tops to receive and store water from central distribution tank to meet domestic, commercial and institutional needs.

2.2 HYDRAULIC NETWORK ANALYSIS

Hydraulic network analysis (HNA) is a process of using a water distribution system computer model to analyze performance capabilities and to define the requirements necessary to meet system design standards for pressure and flow. HNA is a very useful tool in planning, design and operation of water distribution system. In designing, various types of facilities such as wells, pipelines, pumps, valves, storage tanks can be sized using pressure and flow calculations resulting from hydraulic modelling. Operation of water distribution using HNA involves the development of operating strategies which may be based on emergency conditions, energy management restriction, water availability etc. The hydraulic analysis of flow in complex pipes system is usually based on steady state conditions which requires selecting a pipe diameter which will convey the required discharge between two locations of known elevations with specific reservoir surface elevation or pressure (Tezcan et al; 1998). The hydraulic performance of the existing

distribution system can be evaluated by pressure survey and hydrant-flow tests. The method of computation usually adopted is the balancing heads (or pressures) by correcting the flow. This method involves long series of successive non-linear mathematical equations which can be solved using software such as EPANET, Pipe-Flow-Expert etc. EPANET is a computer program that performs both steady state and extended period simulation of hydraulic behaviour within pressurized pipe networks. It tracks the flow of water in each pipe, the pressure at each node and the height of water in each tank throughout the network during a simulation period comprised of multiple time steps. Hydraulic simulation model aided with EPANET computes junction heads and link flows for a fixed set of reservoir levels, tank levels, and water demands over a succession of points in time. From one time step to the next, reservoir levels and junction demands are updated according to their prescribed time patterns while tank levels are updated using the current flow solution. The solution for heads and flows at a particular point in time involves solving simultaneously the conservation of flow equation for each junction and the headloss relationship across each link in the network. This process, known as “hydraulically balancing” the network, requires using an iterative technique to solve the nonlinear equations involved (Lewis, 2000).

3.0 METHODOLOGY

3.1 WATER DEMAND ESTIMATE

The population data for students (Undergraduate and Postgraduate) and staff (Academic and Non Academic) within the academic area were collected from Academic Planning Unit of University of Ilorin. The total population of students and staff in every Departments/Faculties/Units within the academic area as at 2010/2011 academic session was estimated to be 23,391. AED Design Requirements (2009) recommends that in order to account for fluctuations in water use at facilities, a safety or capacity factor (CF) should be introduced into the design calculations. The AED Design Requirement

(2009) gives the expression for water demand as

$$\text{Daily water demand} = (\text{ADD} \times P \times \text{CF}) \quad (1)$$

Where ADD = Average Daily Demand, P = Total population, CF = Capacity factor.

3.2 NETWORK ANALYSIS USING EPANET 2.0

The fundamental relationship of conservation of mass and energy mathematically describe the flow and pressure distribution within a pipe network under steady state condition. Figure 1 skeletally illustrates the distribution network and the various buildings labelled (B1 – B44). The distribution network pattern of water supply to academic buildings from the central distribution reservoir/tank through main-line is drawn in EPANET workspace and all the necessary input data such as nodal and inlet elevations (m), pipe length (m), pipe diameter (mm), roughness coefficient, nodal demand (water demand per building, m³/d), tank diameter (mm), initial, minimum and maximum water levels in storage tank (m). These are fed into the programme for the analysis of pressure

heads at various demand points. The residual pressure (m), heads (m), elevations (m) and demand (m³/d) were generated as output. Hydraulic analysis based on elevated steel tank involves the determination of the height to which the tank will be elevated to in order to have a sufficient pressure for water distribution by gravity flow. Then, distribution tank (assumed to be ground level) at elevation of 382.5m (m.a.s.l) can be elevated to provide enough residual pressure that can take care of insufficient residual pressure of water reaching the buildings. This is done in EPANET's Network Map by increasing the total elevation of distribution tank alone in step of 1m. The incremental steps were added to the actual ground elevation of the tank while other tank input parameters such as equivalent tank diameter, initial, minimum and maximum water level were kept constant. The iteration was done until residual pressure on all the buildings was at least 12.5m i.e. the average heights of the tallest building within the academic area (10.5m) plus height of tank on it (2m). The program was run for tank capacities of 100m³, 150m³, 200m³, 250m³ and 300m³ at different incremental height until the residual pressure in all buildings was greater than or equal to 12.5m.

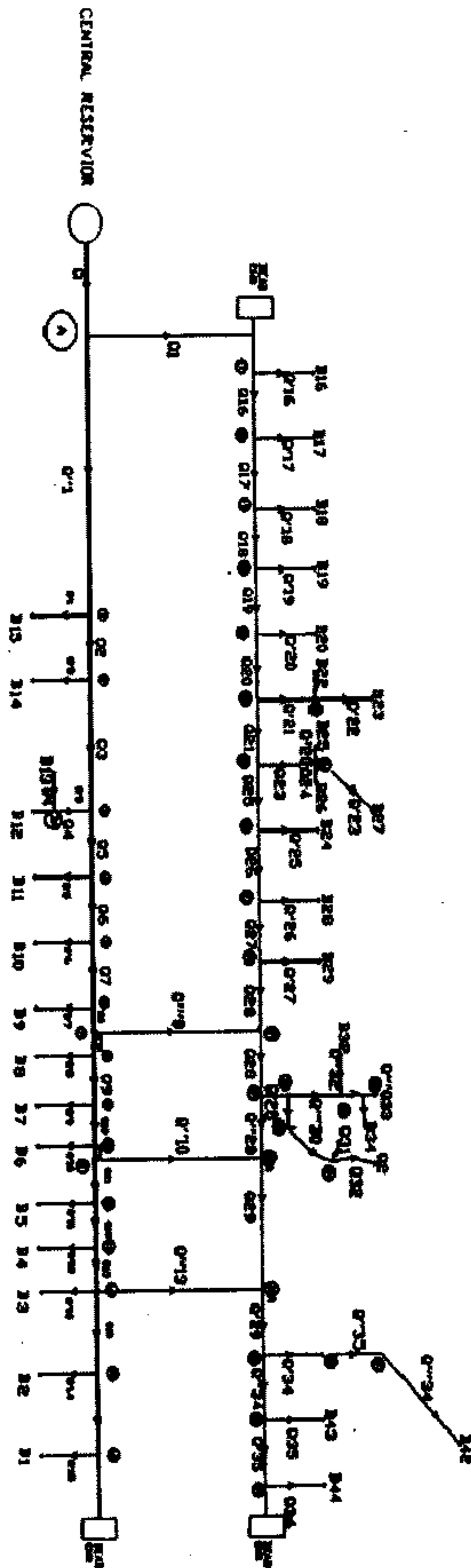


FIGURE 3 SKELETAL ILLUSTRATION OF THE
WATER SUPPLY SYSTEMS AT THE
UNIVERSITY OF ILERIN SHOWING THE
ACADEMIC BUILDINGS 31 - 344

4.0 RESULTS AND DISCUSSION

Total population of staff and students in all the Departments/Faculties/Units within the academic area were obtained from Academic Planning Unit of University as 23,391. By adopting Average Daily Demand (ADD) of 45 l/c/d for office buildings/academic activities and with population of 23,391, the corresponding capacity factor (Cf) is interpolated to be 1.13 (AED Design Requirements, 2009). Then, total water demand is estimated to be approximately 1200 m³/d.

The results of the analysis for the present ground tanks using EPANET showed that some academic buildings have residual pressures less than 12.5m. Therefore, supply of water would not reach the tanks on these buildings. In order to solve this problem, a distribution tank has to be elevated to a certain height to provide adequate head needed for water supply by gravity. Several sizes of tanks were considered. They include 100m³, 150m³, 200m³, 250m³ and 300m³ with equivalent tank diameters for the rectangular steel tanks calculated to be 7.14m, 8.74m, 10.09m, 11.28m and 12.40m respectively. The tank to be provided will receive water directly from the ground tank. The problem is then reduced to finding the elevation of the steel tank to satisfy pressure and flow requirements of the system. The

initial, minimum and maximum water levels in the tank were taken to be 0.5m, 0.3m and 2.5m respectively for all tank sizes. The roughness coefficient for old cast iron and plastic pipes as they exist in the present network were taken to be 90 and 150 respectively (Satterfield, 2010).

At a stanchion height of 10.5m for 300m³ tank, the residual pressure on all the buildings was found to be greater 12.5m. Thus, this height is hydraulically sufficient to supply water by gravity to all the academic buildings. Table 1 gives a typical summary of residual pressure on some of the academic buildings at the beginning and the end of iteration processes for the 300m³ tank. The number of buildings with low residual pressure when the 300m³ tank was assumed to be on ground level was found to be 24. However, at the end of each iteration and as system was solved at various trial heights, the number of buildings with low residual pressure decreased. The same analysis was repeated for the tank capacities of 250m³, 200m³, 150m³ and 100m³ and the hydraulic heights obtained were 10.5m, 11.0m, 11.5m and 12.0m respectively. The tank details and results of the hydraulic analysis obtained for different tank capacities are as presented in Table 2. Based on the result, some of the buildings within the academic areas with high pressure may need to be provided with pressure reducing valves along the pipelines so as to reduce the excessive pressure that might be generated.

Table 1: Summaries of Residual Pressure on Academic Buildings for 300cum Elevated Steel Tank

Block ID	Departmental/Faculty Buildings	Residual pressure when the 300cum distribution steel tank is elevated to height of											
		0.0m	1.0m	2.0m	3.0m	4.0m	5.0m	6.0m	7.0m	8.0m	9.0m	10.0m	10.5m
B1	Veterinary Medicine & Mathematics	14.80	15.80	16.80	17.80	18.80	19.80	20.80	21.80	22.80	23.80	24.80	16.00
B10*	Faculty of Comm. Science & Electrical Engr.	5.50	6.50	7.50	8.50	9.50	10.50	11.50	12.50	13.50	14.50	15.50	27.14
B11	Students' Canteen	16.64	17.64	18.64	19.64	20.64	21.64	22.64	23.64	24.64	25.64	26.64	17.85
B12*	Sociology (BSS)	7.35	8.35	9.35	10.35	11.35	12.35	13.35	14.35	15.35	16.35	17.35	13.36
B13*	Geography & Environmental Managt	2.86	3.86	4.86	5.86	6.86	7.86	8.86	9.86	10.86	11.86	12.86	17.56
B14*	Accounting & Finance Dept (BSS)	7.06	8.06	9.06	10.06	11.06	12.06	13.06	14.06	15.06	16.06	17.06	12.99
B15*	Economics & Bus. Admin Depts	6.08	7.08	8.08	9.08	10.08	11.08	12.08	13.08	14.08	15.08	16.08	12.97
B16*	Performing Art Dept	2.49	3.49	4.49	5.49	6.49	7.49	8.49	9.49	10.49	11.49	12.49	12.64
B17*	Mass Communication & Edu Technology	2.47	3.47	4.47	5.47	6.47	7.47	8.47	9.47	10.47	11.47	12.47	21.34
B18*	Science Education & Edu. Managt Dept	2.14	3.14	4.14	5.14	6.14	7.14	8.14	9.14	10.14	11.14	12.14	15.75
B2*	Biology & Chemistry Laboratory	10.84	11.84	12.84	13.84	14.84	15.84	16.84	17.84	18.84	19.84	20.84	15.44
B20*	Counsellor Education Dept	5.25	6.25	7.25	8.25	9.25	10.25	11.25	12.25	13.25	14.25	15.25	15.60
B21*	Art & Social Sci. Edu. Dept	4.94	5.94	6.94	7.94	8.94	9.94	10.94	11.94	12.94	13.94	14.94	14.60
B22*	Faculty of Agriculture	5.10	6.10	7.10	8.10	9.10	10.10	11.10	12.10	13.10	14.10	15.10	18.09
B23*	Centre for Peace & Strategic Studies	4.10	5.10	6.10	7.10	8.10	9.10	10.10	11.10	12.10	13.10	14.10	18.77
B24	Faculty of Agric Professorial Suite	7.59	8.59	9.59	10.59	11.59	12.59	13.59	14.59	15.59	16.59	17.59	19.77
B25*	Crop Protection & Agronomy & Forest Dept	8.27	9.27	10.27	11.27	12.27	13.27	14.27	15.27	16.27	17.27	18.27	22.80
B26*	Animal Production Dept	9.27	10.27	11.27	12.27	13.27	14.27	15.27	16.27	17.27	18.27	19.27	25.60
B27*	Agricultural Laboratory	12.27	13.27	14.27	15.27	16.27	17.27	18.27	19.27	20.27	21.27	22.27	18.05
B28*	Unilorin Sugar Research Institute	12.10	13.10	14.10	15.10	16.10	17.10	18.10	19.10	20.10	21.10	22.10	28.94
B29	Networking Operating Centre (NOC)	15.10	16.10	17.10	18.10	19.10	20.10	21.10	22.10	23.10	24.10	25.10	31.55
B3*	Plant Biology & Zoology Dept	7.55	8.55	9.55	10.55	11.55	12.55	13.55	14.55	15.55	16.55	17.55	33.87
B31	Agric Engineering Dept	18.44	19.44	20.44	21.44	22.44	23.44	24.44	25.44	26.44	27.44	28.44	37.89
B32	Agric Engineering Workshop	21.05	22.05	23.05	24.05	25.05	26.05	27.05	28.05	29.05	30.05	31.05	28.00
B33	Statistics Dept (Science)	23.37	24.37	25.37	26.37	27.37	28.37	29.37	30.37	31.37	32.37	33.37	32.93
B34	Faculty of Engineering & Chemical Engrg	27.39	28.39	29.39	30.39	31.39	32.39	33.39	34.39	35.39	36.39	37.39	38.84
B35	e-library	17.50	18.50	19.50	20.50	21.50	22.50	23.50	24.50	25.50	26.50	27.50	23.34
B38	Computer Based Test Center (CBT)	22.43	23.43	24.43	25.43	26.43	27.43	28.43	29.43	30.43	31.43	32.43	32.71
B39	Geology Dept	28.34	29.34	30.34	31.34	32.34	33.34	34.34	35.34	36.34	37.34	38.34	38.21
B4	Physics Lab and Central Research Lab	12.84	13.84	14.84	15.84	16.84	17.84	18.84	19.84	20.84	21.84	22.84	31.09
B41	Chemistry/ Industrial Chem Dept	22.21	23.21	24.21	25.21	26.21	27.21	28.21	29.21	30.21	31.21	32.21	31.02
B42	Chemical Engineering Laboratory	24.71	25.71	26.71	27.71	28.71	29.71	30.71	31.71	32.71	33.71	34.71	21.72
B43	Faculty of Art Professorial Suite	20.59	21.59	22.59	23.59	24.59	25.59	26.59	27.59	28.59	29.59	30.59	22.18
B44	All Depts in Faculty of Art	20.52	21.52	22.52	23.52	24.52	25.52	26.52	27.52	28.52	29.52	30.52	20.07
B5*	Biochemistry Dept	11.22	12.22	13.22	14.22	15.22	16.22	17.22	18.22	19.22	20.22	21.22	18.01
B6*	Microbiology Dept & Faculty of Science	11.68	12.68	13.68	14.68	15.68	16.68	17.68	18.68	19.68	20.68	21.68	15.44
B7*	Mechanical & Civil Engineering Lab.	9.57	10.57	11.57	12.57	13.57	14.57	15.57	16.57	17.57	18.57	19.57	25.17
B8*	Mechanical & Civil Engineering Depts	7.51	8.51	9.51	10.51	11.51	12.51	13.51	14.51	15.51	16.51	17.51	16.58
B9*	Central Engineering Lab.	4.94	5.94	6.94	7.94	8.94	9.94	10.94	11.94	12.94	13.94	14.94	22.77
B37	Computer Service & Info. Tech. (COMSIT)	22.43	23.43	24.43	25.43	26.43	27.43	28.43	29.43	30.43	31.43	32.43	32.71
B36	Unilorin Consultancy Service	22.43	23.43	24.43	25.43	26.43	27.43	28.43	29.43	30.43	31.43	32.43	32.71
B30**	Engineering Lecture Theatre (ELT)	-	-	-	-	-	-	-	-	-	-	-	-
B19**	Education Lecture Theatre (EdLT)	-	-	-	-	-	-	-	-	-	-	-	-
B40**	Science Lecture Theatre (SLT)	-	-	-	-	-	-	-	-	-	-	-	-

Note: * Buildings with their residual pressure less than 12.5m at begining when distribution tank was directly on ground level

** Buildings that are not connected to the distribution network

Table 2: Tank Details and Results of Hydraulic Analysis for Different Tank Capacities

Tank Details/ Capacities	100 m³	150 m³	200 m³	250 m³	300 m³
Hydraulic Height of Tank to Ensure Minimum Pressure (m)	12.00	11.50	11.00	10.50	10.50
Minimum Pressure in the System (m)	14.64	14.50	13.60	12.64	12.64
Maximum Pressure in the System (m)	42.69	40.80	39.80	38.84	38.84
Minimum Water Level in the Tank (m)	0.30	0.30	0.30	0.30	0.30
Maximum Water Level in the Tank(m)	2.50	2.50	2.50	2.50	2.50
Initial Water Level in the Tank (m)	0.50	0.50	0.50	0.50	0.50
Height of the Tank (m)	2.50	2.50	2.50	2.50	2.50
Width of the Tank (m)	6.00	4.50	6.00	7.50	9.00
Length of the Tank (m)	7.50	13.50	13.50	13.50	13.50
Equivalent Tank Diameter (m)	7.14	8.74	10.09	11.28	12.40

Figure 2 illustrates a graphical relationship between the number of buildings with low residual pressure and elevation of tank for various tank sizes. Figure 3 shows the graphical relationship between tank sizes and the required height to supply water by gravity.

From the studies, a 300m³ steel tank elevated to hydraulic height of 10.5m is more desirable than other tank sizes used in the analysis. The use of 300m³ tank to supply water to academic buildings at a height of 10.5m was compared with 100m³ tank at a height of 12.0m. Considering the cost of construction and erection of the two tanks and in meeting up with daily water demand of 1200m³ within academic area of University of Ilorin, 300m³ tank has the following advantages over 100m³ tank;

- The number of daily pumping required in 300m³ tank is about 4

while that of 100m³ tank is about 12 times. Thus, a frequent refilling of the tank is minimised.

- The time of usage of water stored in 300m³ tank is about 3 times that of 100m³ tank. Thus, a regular supply of water is maintained.
- Extra storage provided by 300m³ tank is higher than that of 100m³ tank because of its relatively large capacity.
- The cost of construction of the tank and stanchions for 300m³ tank is relatively high compared with 100m³ tank but its overall advantages are more appreciable than that of 100m³ tank.
- There are more construction problems in erecting 100m³ tank to a height of 12.0m than that of 300m³ tank to a height of 10.5m because of its relatively high stanchion for the tank.

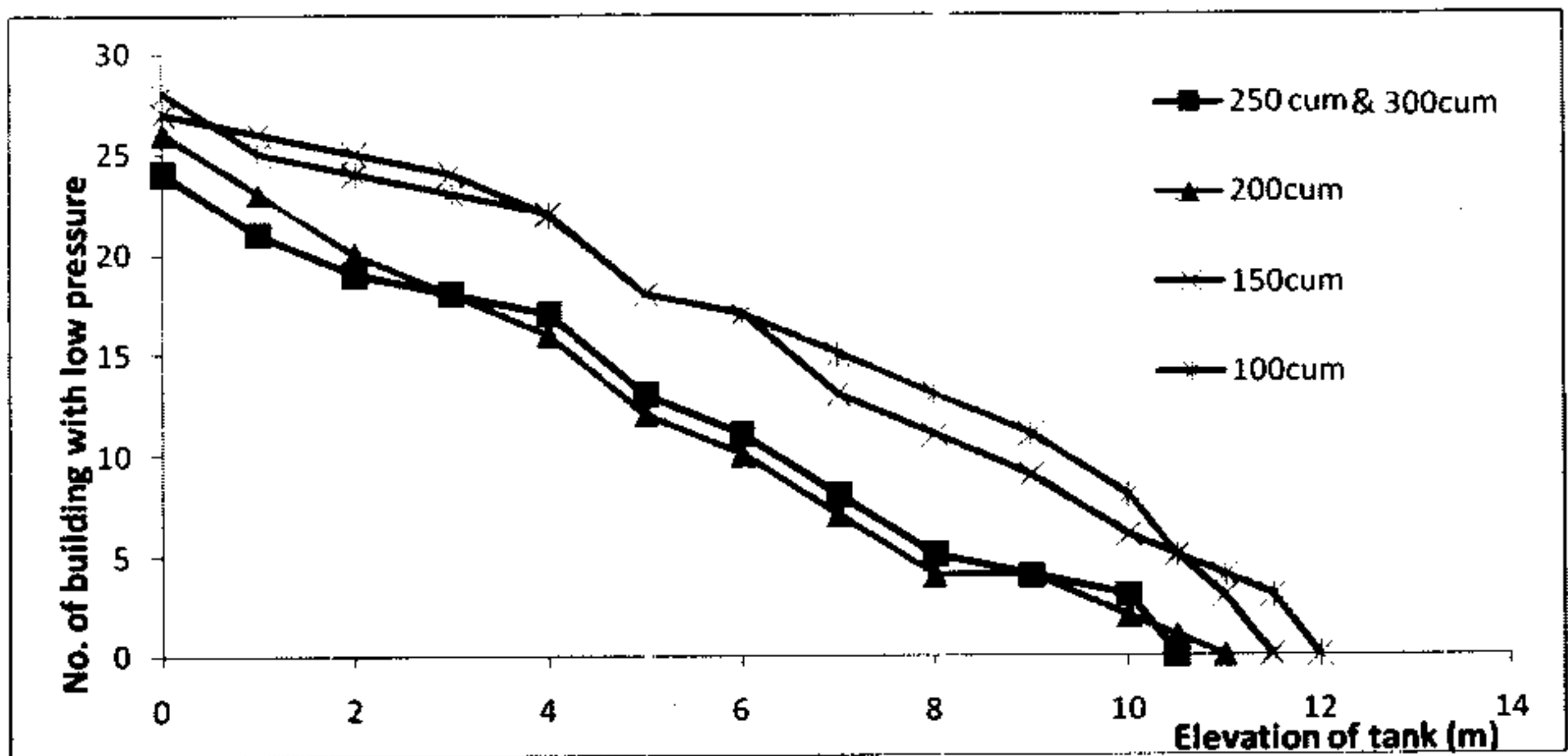


Figure 2: No. of Buildings with Low Residual Pressure Vs Elevation of Tank for Different Tank Sizes.

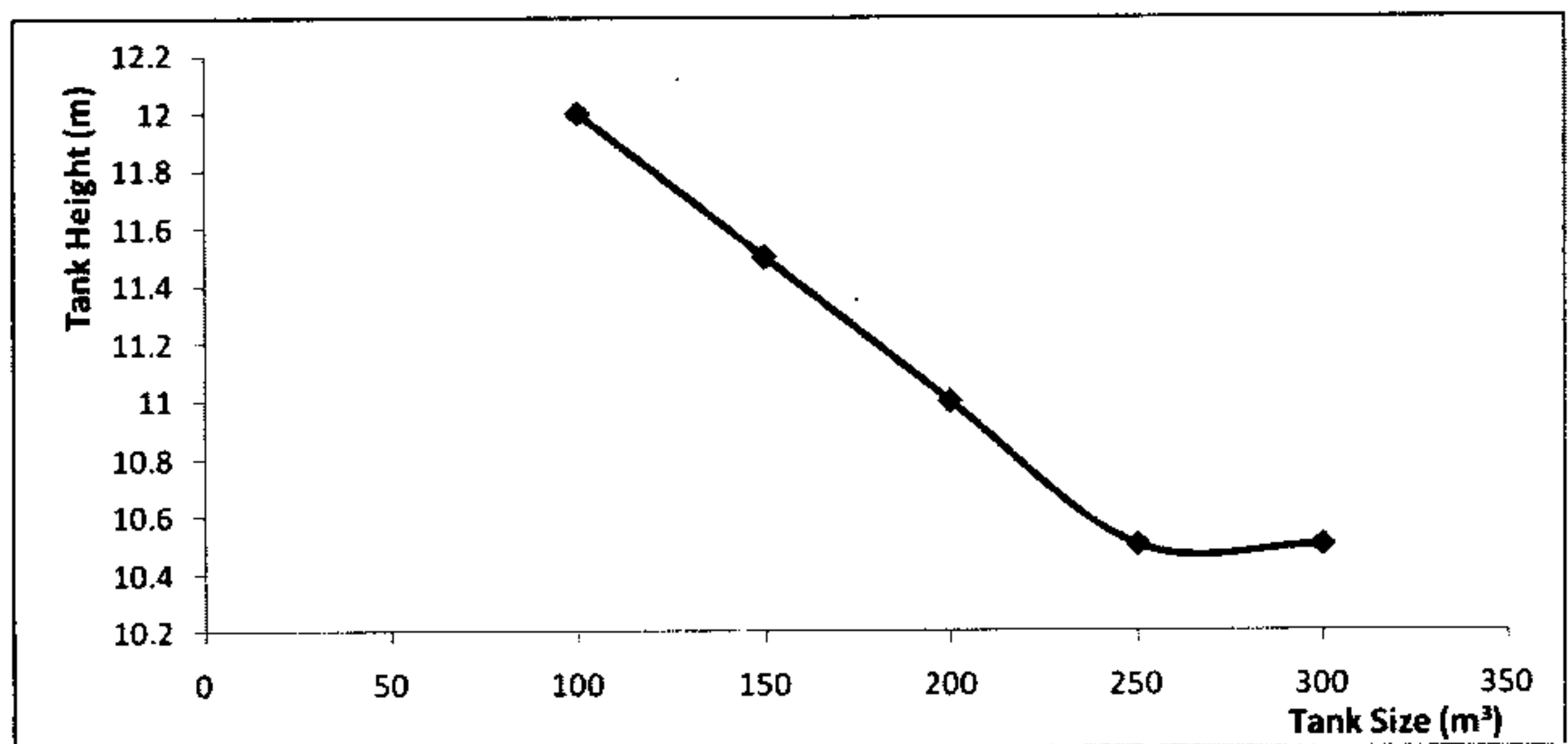


Figure 3: Hydraulic Height (Tank Height, m) to Ensure Minimum Pressure Vs Tank Sizes (m³).

5.0 CONCLUSION & RECOMMENDATIONS

The analysis done using EPANET software showed that, providing a 300m³ tank at a height of 10.5m above ground surface, will take care of insufficient pressure in the system and will ensure water supply by gravity to all academic buildings. The comparison of the advantages of various tank sizes showed that a 300m³ tank is more desirable and provide better flexibility and

therefore recommended. Also, this tank will provide for additional storage and require less frequent pumping when compared to the smaller elevated tanks. Although, its capacity is not sufficient for daily water requirement and it's recommended that water be pumped three to four times for 24 hours water supply. Construction of this elevated steel tank would further cut-off the huge amount of money the University is spending in operating and maintaining boreholes that are supplying water to some academic buildings.

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