ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 1 , January 2021

Evaluation of Water Supply Systems and Quality of Drinking Water

Bekmamadova Gulnoza Akmalovna

Acting Assistant Professor, Department of “Design, construction and engineering communications development",
Tashkent Institute of Architecture and Civil Engineering, Tashkent city, Republic of Uzbekistan

ABSTRACT: This article discusses the issues of evaluationthe quality of drinking water for the population, the reliability of a water supply system, taking into account the separation of water supply and distribution systems into external and home-based and developing effective solutions to provide the population with quality drinking water, especially in small towns and villages. In order to study and improve methods for assessing water quality, the Tupolang reservoir was studied for compliance with the requirements of state standards, hygienic and technical conditions for industrial spills and bottling of water for drinking needs of the population.Also, the availability coefficient of the water supply system and the methods for managing the quality of its operation were studied. At the same time, this method takes into account violations of the water supply system, environmental risks and energy costs, the repair strategy, and the optimization of the control system.
In addition, recommendations are given to improve the quality of water supply management.

KEY WORDS: water quality, water infrastructure, external water supply and distribution systems, home-based systems, availability factor.

I.INTRODUCTION

Currently, the use of water resources of reservoirs as a source of drinking water for the population is becoming an urgent problem in the world. In this regard, special attention is paid to the development of new methods for preserving the chemical and biological properties of water accumulated in reservoirs from the course of rivers.

In many countries such as the USA, Australia, the Netherlands, Denmark, Austria, China, Russia, Kazakhstan, etc. the issues of developing operating modes for reservoirs based on mathematical and geographic information technologies are being studied in order to ensure their safe and reliable operation, as well as reduce pollution of water resources and preserve their quality.

With population growth, the need for water is increasing dramatically. Water scarcity has a negative impact on both the living conditions of the population and the economic development of the country. According to the UN report “Let's take care of every drop of water: an agenda for water”, almost 40 percent of the world's inhabitants are already suffering, to one degree or another, from a shortage of fresh water. By 2030, due to lack of water, about 700 million people may become refugees. Today, more than two billion people drink contaminated water, 4.5 billion — deprived of adequate sanitation services [17-19].

In Uzbekistan, over the past six years, about 13 thousand kilometers of water pipelines and water supply networks, more than 1.6 thousand water wells, as well as 1.4 thousand water towers and reservoirs have been built and reconstructed. At the same time, there are still a number of unresolved problems related to the provision of high-quality drinking water to certain regions, primarily in the Republic of Karakalpakstan, Bukhara, Jizzakh, Kashkadarya, Surkhandarya, Syrdarya and Khorezm regions.

The constant increase in population, the construction of new housing estates, the expansion of cities and settlements require the adoption of effective measures to radically improve the guaranteed water supply system, aimed at modernizing and accelerating the development of water intake structures, water pipelines, pumping stations,

distribution units and water supply networks based on the active introduction of modern energy-saving and resource-saving technologies.
Water infrastructure has a great impact on both the environment and the social sphere, since it is associated with the massive and prolonged use of water, which is a natural resource, in favor of society. In Uzbekistan, in the highlands, occurs comparatively much rainfall, and in these areas there are relatively many sources of water. However, in the flat terrain located in the central part of the country, there is a shortage of water sources due to the small amount of precipitation. These areas receive water from rivers flowing from the upper reaches, with large rainfall. However, river flow is constantly decreasing due to the large consumption of water for irrigation of cotton, which is grown over a vast territory.

As described above, water resources in Uzbekistan are unevenly distributed, and in general regions where there is a shortage of water prevail. There are problems not only in amount of water resources, but also in their quality. Water supply facilities in Uzbekistan are burdened with problems of the quality and quantity of water resources, in particular drinking water.

In order to create comfortable and favorable social and living conditions for the general population, especially in rural areas, to achieve widespread access to high-quality drinking water for consumers, to increase the efficiency of the provision of water supply and sanitation in Uzbekistan, Presidential Decree No. PP-2910 of April 20, 2017 was adopted "On the program for the integrated development and modernization of drinking water supply and sanitation for 2017-2021" [20].

Currently, in order to carry out deep reforms in agriculture and water management, specialists in the field of construction, design and operation are tasked with resolving the most pressing issues. In particular,
the rational use of hydraulic structures, the repair of structures and building elements, the elimination of defects, and the cleaning of sediments in reservoirs [1-4].

Despite the fact that Uzbekistan is located between two large rivers, the Amu Darya and Syr Darya, at present the water shortage is about 10%, and in 2030 it can reach 15%, and taking into account climate change and a decrease in the volume of river flows it can reach 33%.

Based on this, the role of scientific research is important in developing effective solutions to provide the population with high-quality drinking water and to improve the reliability of water structures.

II. LITERATURE SURVEY

The process of accumulation of pollution in reservoirs is mainly aimed at the results of bathometric studies using statistical methods to create empirical formulas. The problems of sediment accumulation in most Avakyan A.B., Skrilnikov V.A., IsmagilovKh.I., MukhamedzhanovF.Sh. Brune G.M. and other scientists. [1-2], [5-7].

The processes of changing water quality as a result of changes in chemical and bacteriological properties in the composition of sediment in reservoirs are reflected in the scientific works of Kipshakbayev N.K., Vuglinskiy V.S., Gaparov F.A., Sadikov A.H., Shneer I.A., Sokolov V.I. and other scientists [4], [8-11].

In the conducted researches, the study was carried out by mathematical models and bathometric studies of the main part of the water receiving installation of the reservoir. In this connection, taking into account the hot climate of Uzbekistan and its focus on agricultural production, there is a problem of using water in reservoirs not only for irrigation, industrial or energy purposes, but also as a source of drinking water.

In addition, it should be noted the works of Zhurba M.G., Poletaeva T.N., IgnatchikS.Yu. etc. regarding the design of water structures and ensuring their reliability [12-14].

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 1 , January 2021

III. METHODOLOGY

Successful reform of housing and communal services is possible only if the degree of achievement of the main goal of the reform - improving the quality of services provided - will have a concrete quantitative assessment. For example, when concluding agreements between consumers (residents) and a management company operating an internal water supply system, quantitative indicators (scale) should be determined by which it is possible to determine the level of water supply quality, the degree to which obligations are fulfilled and the reasonableness of the costs to ensure the quality of water supply.

Despite the outward simplicity of such an approach, its practical implementation is very difficult. This is primarily due to the fact that in the existing system of operation of water supply systems, managing operating organizations, which interact with the water consumer (population, tenants, etc.), are not producers of drinking water, the quality of which is quantified by standards (Sanitary Rules and Norms - SanPIN, state standard-GOST, Building Norms and Rules-SNiP) and can be measured and checked in one way or another. These organizations do not create water supply networks and equipment, do not engage in water intake and water treatment. Their functions are reduced to ensuring the smooth functioning of already created systems, minimizing unproductive (useless) water losses, rational use of energy resources and possible reduction of environmental risk caused by accidents in systems.

Therefore, it is advisable to divide the water supply system into two parts: head structures (HS), which extract and process natural water using complex physical, chemical and bio-technologies into a vital food product - drinking water (producing goods), and a water supply and distribution system (WSDS), which provides services for the delivery of drinking water.

WSDS operation is divided into the operation of external water supply and distribution systems (EWSDS), which provides bulk water supplies, and the operation of home-based systems (IWSDS), which maintains internal water supply systems in working condition and sells drinking water at retail to numerous consumers - to the population.

There are no quantitative criteria for the quality of the operation of the IWSDS, collected in a separate document for evaluation by the consumer and regulatory organizations operation of IWSDS.

It can be tried to develop these criteria by summarizing and systematizing the available regulatory data on the individual links and elements of the water supply system, but even a quick overview of the various, often not verifiable (for example, the number of shutoff valve operation cycles) requirements of SNiPs, SanPINs, GOSTs and other regulatory documents, suggests that the practical use of these documents will be extremely difficult. In addition, each water supply system is unique in its own way, operates in external conditions and hydraulic modes that are unique to it, so using the average regulatory requirements for the operation of a particular system will not allow understanding between consumers and managing operating organizations.

Therefore, the criteria for the quality of the operation of IWSDS should be based on theoretical studies of the modes of their operation, maintenance, impact on natural water sources and the environment, which will link disparate indicators of modern standards into a single system.

In order to study and improve methods for assessing water quality, the Tupolang reservoir was studied for compliance with the requirements of state standards, hygienic and technical conditions for industrial spills and bottling of water for drinking needs of the population.

The main objectives of the research to assess the water quality of the Tupolang reservoir were as follows:
1. A study of the seasonal dynamics of changes in the water quality of the Tupolang reservoir in accordance with O’zDSt 951:2011 “Sources of centralized drinking water supply. Hygienic, technical requirements and selection rules”.
2. A study of the seasonal dynamics of changes in the water quality of the Tupolang reservoir in accordance with O’zDSt 950:2011 “Drinking water. Hygienic requirements and quality control”.
3. Scientific substantiation and drawing up a conclusion on the water quality of the Tupolang reservoir, its compliance with the hygiene requirements and the suitability of water for drinking needs of the population.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 1 , January 2021

4. Development of technical conditions (hygienic and technical regulations for water treatment, post-treatment, flotation, coagulation, disinfection of water and other, if necessary) for industrial spills and bottling of water from the Tupolang reservoir.
5. In the future, in the process of exporting bottled water to foreign countries, work will be done to prepare relevant scientific and technical documentation, organize a laboratory base, purchase the necessary instruments and equipment for monitoring the water quality of the Tupolang reservoir using the international standard ISO 17025 "Drinking water".
To solve the tasks and achieve the goal of the study, the water quality of the Tupolang reservoir in the summer and winter periods of the year was studied.

IV. EXPERIMENTAL RESULTS

In many sectors of scientific and industrial activity, a reliable theory of reliability has been successfully used by all interested parties to fundamentally understand the degree of "usefulness" of the functioning of complex systems [12], [15-16].By definition, reliability is the feature of an object to perform its functions for a given period of time while maintaining specified performance indicators. For the operation of water supply systems, this can be formulated as a feature:
- to provide consumers with water in the required volume and with the required quality for given water losses, energy and labor costs for its supply;
- to influence, within acceptable limits, on environmental components (for example, when relocating sections of external networks) during the term of the contract between consumers and the managing organization. Moreover, of course, the duration of the contract should be commensurate with the average life of the systems.

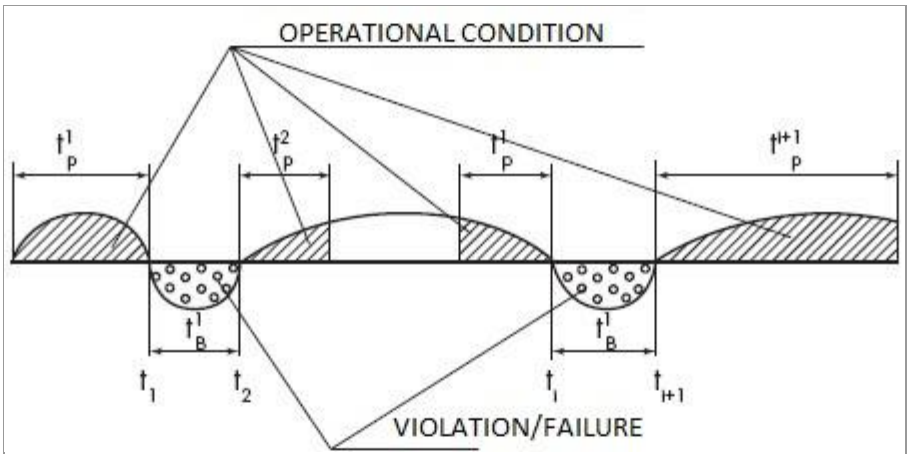

Fig. 1. Timing diagram of the functioning of the water supply system

In time, the functioning of the system consists of intervals of operation and failures, determined by a violation of water supply or operating requirements for the system (Figure 1). Therefore, it is easier to quantify the operational reliability of water supply systems through the availability factor, which determines the fraction of the time of “normal” functioning of the system for the control period of the contract:

$$K_r = \frac{\sum T_p^i}{\sum \left(T_p^i + T_B^i\right)},$$

where T_p – system normal functioning time;
$T_в$ – duration of violations in the system.

Using the availability factor (as well as other well-known reliability indicators, for example, the probability of failure-free operation, failure rate, etc.) to assess the operational reliability of water supply systems can give a positive result only at the first stage of the formation of relations between consumers and the managing operational organization (IWSDS), when only the possibility of assessing the quality of operation is important, without taking into account many features. For example, a water supply disturbance may be complete or minor. This may relate to one consumer or

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 1 , January 2021

a group of them, etc. In addition, the economic justification of operational measures based on the availability factor is possible only in a general way.

A more differentiated assessment of the quality of operation of water supply systems can be obtained using the converted availability factor:

$$K_r = \frac{T \cdot N - \sum_{i=1}^{j} t_{0,i} \cdot n_i}{T \cdot N},$$

whereT – estimated time (contract validity period);
N – total number of consumers in the system;
n_i – the number of consumers with a water supply disturbance over time $t_{0,i}$;
j – the total number of violations in the water supply.

However, in this form, the availability coefficient (and, accordingly, its derivative - operating costs) does not answer the following questions: how successfully and rationally the system is being operated, what are the reserves to improve the quality of water supply and reduce the costs associated with it. And most importantly, how to develop and optimize a system operation strategy, starting from its current state.

A new approach to the operation of the system based on the management of potential failures and environmental risks of the water supply system by organizational methods (optimization of repair strategies, monitoring systems, etc.) can answer to above indicated questions (13-14).
In general terms, the operation quality management technique consists of the following steps.

1. The degree of violation of water supply, environmental risk and energy costs in the event of a failure in the system is determined by the following parameters:
- the magnitude of the violation (deviation of parameters, disturbing effect, etc.);
- duration of failure;
- the frequency of repetition of such failures for a given period of time.
The results obtained make it possible to differentially evaluate the quality of operation of the system based on the converted availability factor, as well as calculate the material costs associated with the failures that have arisen.

2. At this stage, possible strategies for the implementation of operational measures are developed, their adjustable parameters are determined, and a variant calculation of the impact of operational measures in certain conditions on the quality of water supply are developed, environmental risk during the operation of the system and all socially significant material costs associated with the operation of the system under consideration strategies are determined. For example, the well-known system of scheduled preventive repairs (SPR) provides for repairs that eliminate the physical deterioration of system equipment, performed at regular intervals, and unforeseen repairs that restore the equipment and parts of the system without changing their physical deterioration in case of accidents.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 1 , January 2021

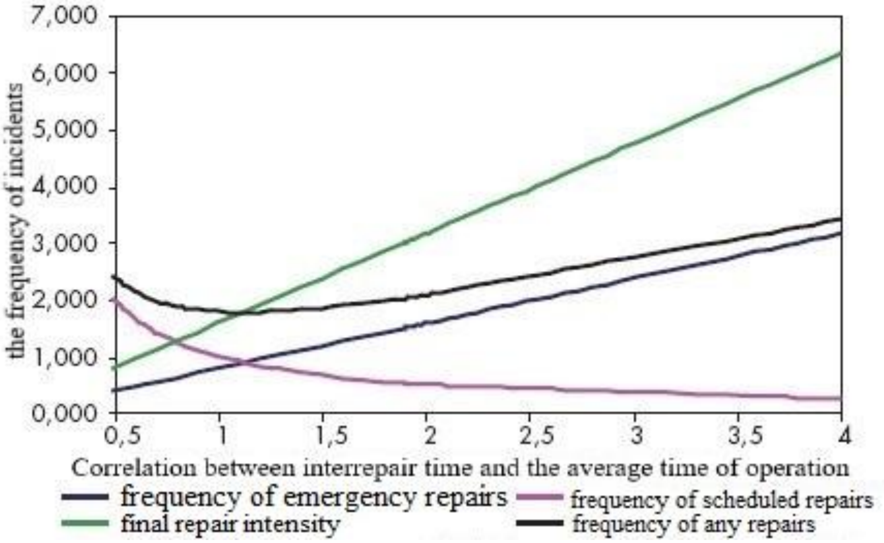

Fig2. A graphical representation of the dependence of the failure rate on the ratio of the overhaul period and the average service life for strictly periodic scheduled repairs and minimal emergency

For such a repair strategy, the failure parameter — the frequency, as well as the general economic indicator — the intensity of operating costs (the entire set of costs associated with the operation, per unit time) depends on the designated overhaul period (Figure 2). Similar dependencies developed for the majority of practically used strategies for operating water supply systems allow, firstly, to assess the quality of operation and material costs associated with its provision, with the existing operational strategy and, secondly, to outline ways to optimize the ratio of quality and associated costs (Figure 3).

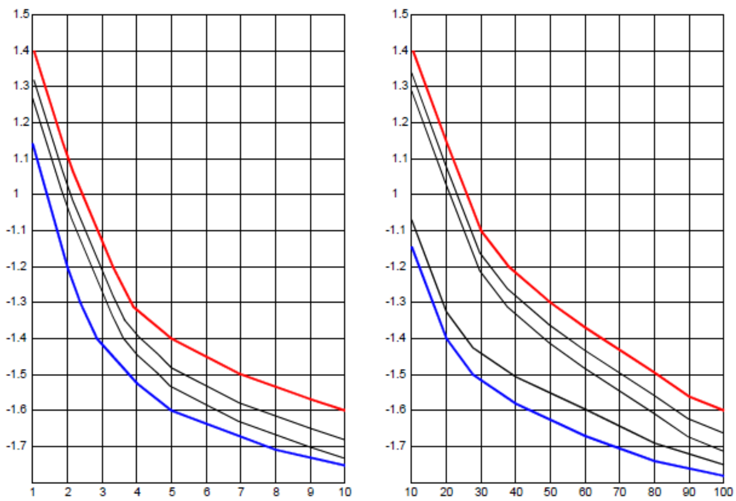

Fig 3.
An economically optimal overhaul period with various cost ratios associated with planned and emergency operational situations and the relative cost of scheduled repairs

3. The final stage of operating quality management involves step-by-step optimization of the control system.

Having assessed the failure parameters, as well as the magnitude of environmental risk and unproductive losses in the current conditions, it is possible to determine under which strategies of operating the water supply system the best indicators will be achieved. But their implementation may require fundamental changes in the structure of operating enterprises, financial activities. In modern conditions, most of the equipment malfunctions are eliminated in an

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 1 , January 2021

emergency. At the same time, studies have shown that the best indicators of quality of operation and economic efficiency in most cases provide strategies with various options for scheduled repairs. To make the transition to them, additional material resources will be required, at least at the initial stage.

4. Research of water quality of the Tupolang reservoir has established the foolowing:
- water quality of the Tupolang reservoir does not meet the hygiene requirements for the total microbial number (TBN), the index of Escherichia coli (IEC), turbidity, the content of aluminum and fluorine.
- the dynamics of changes in microbiological indicators is characterized by an increase in microbial contamination of water in the summer and autumn periods of the year.
- the highest concentration of turbidity of the water in the reservoir (up to 13 MPC) is observed in the spring season and the lowest (up to 2 MPC) in the summer-autumn season.
- oganoleptic and toxicological indicators in the water of the Tupolang reservoir do not go beyond hygienic standards.
- fluorine in the water of the Tupolang reservoir is present in amounts from 0.1 to 0.18 mg/l, which is lower than the required standard value from 3.8 to 7.0 times, respectively, depending on the season of the year.
- in the winter period of time, magnesium concentrations in all water samples increase by 1.3-1.7 times and amount to 13-17 mg/l with a norm of 10 mg/l.
- in spring, in sample No. 4, the target of the Tupolang reservoir on the border with the Zarchop River, beryllium was found in water in concentrations of 0.01 mg/l, which is 5 times higher than the established hygiene standard.

V.CONCLUSION AND RECOMMENDATIONS

Despite the significant material costs of modern operational activities, it is impossible to withdraw part of the funds from them for the implementation of planned measures, since the effect of implementing optimal strategies will not be obtained immediately, but after a certain time. A decrease in investments in emergency services at this stage will definitely lead to a deterioration in the quality of operation and environmental safety. Only when as a result of the application of optimal operating strategies will a real reduction in unproductive expenditure of resources be achieved, a decrease in the load of emergency services and, accordingly, a reduction in the volume of their financing, the implementation of optimal operating strategies can be intensified by the funds released.

To justify the mechanism of redistribution of funds without deteriorating the quality of operation of water supply systems at each stage of the implementation of optimal operation strategies, as well as to invest them at the initial stage, a methodology has been developed that determines the economic effect of implementation at the end of each stage, performance indicators at this moment, and further direction of material investments.

In the context of the study, the following is recommended:
1. The performance of water supply systems should be based on consumer requirements and environmental protection.
2. It is necessary to adopt a road map aimed at using the capabilities of reservoirs to provide drinking water to the population and its affinity with the country's housing and communal services.
3. These requirements should be set out in one document, which will be used to assess the quality of work of operating (managing) organizations.
4. A methodology for managing operating organization is proposed, which allows optimizing its managment to achieve a given quality of operation.
5. The resources of the Tupolang reservoir are the most acceptable for the creation of the production of drinking water that meets the requirements of the standard of the Republic of Uzbekistan, as well as international standards.

For industrial spills and bottling of water of the Tupolang reservoir, it is necessary to create an engineering infrastructure that helps to eliminate turbidity, aluminum, beryllium, microbial contamination in the water, as well as mandatory fluorination of water.

REFERENCES

[1] Авакян А.Б., Салтанкин В.П., Шарапов В.А. Водохранилища. - М.: Мысль, 1987. -325 с.
[2] Скрыльников В.А., Кеберле С.И., Белесков Б.И. Повышение эффективности эксплуатации водохранилищ. Ташкент: Издательство «Мехнат», 1987г. - 244 с.
[3] Putz K., Benndorf J. The importance of pre-reservoirs for the control of eutrophication of reservoirs // Reservoir Management and Water Supply an Integrated System, vol.2. -Prague, 1997. P. 165-171.492.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 1 , January 2021

[4] Кипшакбаев Н.К, проф. Соколов В.И. Водные ресурсы бассейна Аральского моря – формирование, распределение, водопользование, «Водные ресурсы Центральной Азии» (Материалы научно-практической конференции, посвящённой 10-летию МКВК 20-22 февраля 2002г.), Алматы, 2002г.

[5]Исмагилов Х.А. *Некоторые морфометрические зависимости Амударьи в среднем и нижнем течении*. Труды САНИИРИ. Ташкент, 1968, вып.117, с.70-91.

[6]Мухамеджанов Ф.Ш. Расчёт переформирования русла у низконапорных плотин. - В кн: Пособия и методические указания для расчётов и проектирования. Ташкент, 1962, 45 с.

[7]Brune G.M. *Trap efficiency of reservoirs*. Trans. Amer. Geophys. Union,1953, vol.34, № 3, p. 617-635.

[8] ВуглинскийВ.С*Водные ресурсы и водный баланс крупных водохранилищ СССР*, Л..: Гидрометеоиздат, 1991.- 222 с.

[9] Садыков А.Х., Гаппаров Ф.А. *Метод расчёта ежегодного сокращения объёма водохранилища на основе водных балансов предыдущих лет его эксплуатации.* Сб. научных трудов (к 80–летию САНИИРИ им. В.Д.Журина), Ташкент, 2006г., - С. 404-410.

[10] Шнеер И.А. Осаждение наносов и грунтов. Научные труды (Ташкентский Государственный.Университет), 1964, вып.237, - С. 5-152.

[11] Sediment control methods: d. Reservoirs.-J. Hydraul.Dsiv.Proc. Amer. Soc, of Civil Eng., 1973, vol 4.

[12] М.Г. Журба, Л.И. Соколов, Ж.М. Говорова. Водоснабжение. Проектирование систем и сооружений в 3 томах, 2- издание –М.:АСВ, 2004. – 718с.

[13] Т.Н.Полетаева. И.Б. Синежук, Л.Г.Зайченко, О.В. Майстренко, Ю.Г. Акулова. Методические указания к выполнению курсового проекта “Водоснабжение и водоотведение жилого здания”/ДонНАСА – Макеевка, 2010 г. - 95 с.

[14] Игнатчик С.Ю. Обеспечение надежности и энергосбережения при расчете сооружений для транспортирования сточных вод// Водоснабжение и санитарная техника. –2010г., №8, 56-61с. [16] Sedimentcontrolmethods: d. Reservoirs.-J. Hydraul.Dsiv.Proc. Amer. Soc, ofCivilEng., 1973, vol 4.

[15] Абрамов Н.Н. Надежность систем водоснабжения. М.: Стройиздат,1979.-231 с.

[16] Ильин Ю.А. Надежность водопроводных сооружений и оборудования. – М.: Стройиздат, 1985.-240с.

[17] http://news.un.org/ru/story/2018/03/1325832

[18] http://documents.vsemirnyjbank.org/curated/ru/261331468185330892/Social-impact-analysis-of-water-supply-and-sanitation-services-in-Central-Asia-the-case-of-Uzbekistan

[19] http://suvsoz.uz/vodosnabjenie/quality/

[20] http://lex.uz/