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# Risk Assessment in Wastewater Treatment

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**ABSTRACT:** Broadly speaking, a risk assessment is the combined effort of:

- identifying and analyzing potential (future) events that may negatively impact individuals, assets, and/or the environment (i.e. hazard analysis); and
- making judgments "on the tolerability of the risk on the basis of a risk analysis" while considering influencing factors (i.e. risk evaluation).

Put in simpler terms, a risk assessment determines possible mishaps, their likelihood and consequences, and the tolerances for such events. The results of this process may be expressed in a quantitative or qualitative fashion. Risk assessment is an inherent part of a broader risk management strategy to help reduce any potential risk-related consequences.

Risk assessment can also be made on a much larger "systems" scale, for example assessing the risks of a wastewater treatment plant. Systems may be defined as linear and nonlinear (or complex), where linear systems are predictable and relatively easy to understand given a change in input, and non-linear systems unpredictable when inputs are changed. As such, risk assessments of non-linear/complex systems tend to be more challenging.

In the engineering of complex systems, sophisticated risk assessments are often made within safety engineering and reliability engineering when it concerns threats to life, environment, or machine functioning. The wastewater treatment systems, agriculture, nuclear, aerospace, oil, railroad, and military industries have a long history of dealing with risk assessment. Also, medical, hospital, social service, and food industries control risks and perform risk assessments on a continual basis. Methods for assessment of risk may differ between industries and whether it pertains to general financial decisions or environmental, ecological, or public health risk assessment.

Wastewater treatment is a process used to remove contaminants from wastewater and convert it into an effluent that can be returned to the water cycle. Once returned to the water cycle, the effluent creates an acceptable impact on the environment or is reused for various purposes (called water reclamation).<sup>[1]</sup> The treatment process takes place in a wastewater treatment plant. There are several kinds of wastewater which are treated at the appropriate type of wastewater treatment plant. For domestic wastewater (also called municipal wastewater or sewage), the treatment plant is called a sewage treatment plant. For industrial wastewater, treatment either takes place in a separate industrial wastewater treatment plant, or in a sewage treatment plant (usually after some form of pre-treatment). Further types of wastewater treatment plants include agricultural wastewater treatment plants and leachate treatment plants.

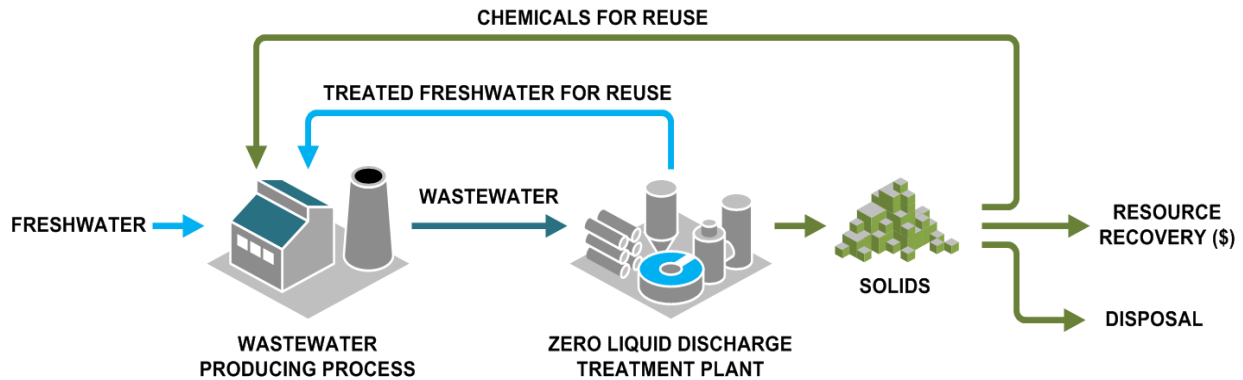
**KEYWORDS:** risk, assessment, wastewater, treatment, engineering, potential, complex, environment

## I. INTRODUCTION

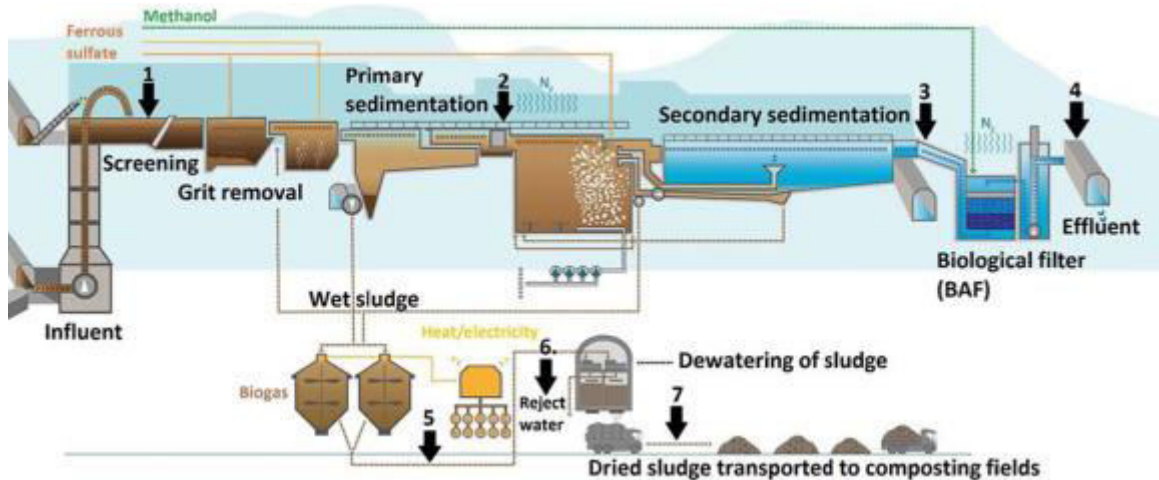
Wastewater treatment plants may be distinguished by the type of wastewater to be treated. There are numerous processes that can be used to treat wastewater depending on the type and extent of contamination. The treatment steps include physical, chemical and biological treatment processes.

Types of wastewater treatment plants include:

- Sewage treatment plants
- Industrial wastewater treatment plants
- Agricultural wastewater treatment plants
- Leachate treatment plants[1,2]

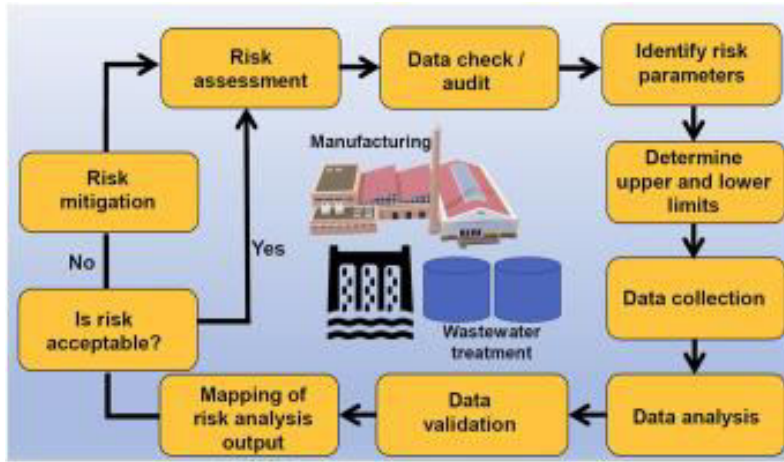


Managers and regulators of wastewater discharges need to make management decisions to protect natural systems impacted by varied stressors, where information and data may be scarce and uncertain. Risk assessment is an effective and transparent way of assessing wastewater discharges. It will clearly provide information needed for managing these discharges for the protection of beneficial uses. EPA Environment Protection Act has already developed guidance on how to undertake risk assessments in ambient waters (EPA publication 961, 2004). EPA Environment Protection Act is responsible for developing environmental Guidelines within the regulatory framework that encourages best practice. In particular, it produces guidance on recycling and discharges to waterways to ensure that schemes are both safe and sustainable. [3,4]



Water authorities, industries and other businesses discharging to waterways are expected to manage the risks associated with these schemes (Box 1). Where a risk assessment is required, it is their responsibility to obtain suitably qualified risk assessors to conduct the risk assessment. Risk managers are the individuals or organisations that have the responsibility or authority to take or require action to mitigate identified risk. This may be one individual, an organisation (e.g., water authority, industry, catchment management authority) or there may be several groups that have responsibility and authority for risk mitigation, forming a risk management team (e.g., State and local government organisations, industry and a catchment management authority). Risk assessors are professionals with experience in undertaking the risk assessment process. For relatively narrowly scoped and well defined risk assessments only one trained individual may be needed to do a risk assessment. For more complex risk assessments one individual can rarely provide the necessary breadth or expertise needed, and a risk assessment team is required. A risk assessment team should include at least one professional who is knowledgeable and experienced in using the risk assessment process. Other team members bring specific expertise on the local area, stressors, values (such as ecosystem and human health issues), scientific issues, facilitation of community consultations and any other type of expertise required for the assessment. [5,6]

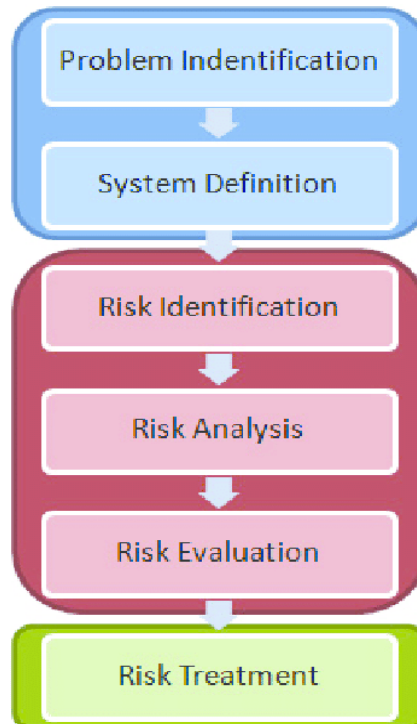




External view of wastewater treatment plant is:-



The process of risk assessment includes various steps:





The decision to conduct a risk assessment should in most cases be initiated directly by the wastewater discharger. A business may consider undertaking a risk assessment, where it is identified as useful for the assessment and management of the discharge. In making decisions on whether a risk assessment should be conducted, and the level of assessment required, consideration should be given .[7,8]

### III. DISCUSSION

The unit processes involved in wastewater treatment include physical processes such as settlement or flotation and biological processes such as oxidation or anaerobic treatment. Some wastewaters require specialized treatment methods. At the simplest level, treatment of most wastewaters is carried out through separation of solids from liquids, usually by sedimentation. By progressively converting dissolved material into solids, usually a biological floc or biofilm, which is then settled out or separated, an effluent stream of increasing purity is produced

Phase separation transfers impurities into a non-aqueous phase. Phase separation may occur at intermediate points in a treatment sequence to remove solids generated during oxidation or polishing. Grease and oil may be recovered for fuel or saponification. Solids often require dewatering of sludge in a wastewater treatment plant. Disposal options for dried solids vary with the type and concentration of impurities removed from water.

Solids such as stones, grit, and sand may be removed from wastewater by gravity when density differences are sufficient to overcome dispersion by turbulence. This is typically achieved using a grit channel designed to produce an optimum flow rate that allows grit to settle and other less-dense solids to be carried forward to the next treatment stage. Gravity separation of solids is the primary treatment of sewage, where the unit process is called "primary settling tanks" or "primary sedimentation tanks." It is also widely used for the treatment of other types of wastewater. Solids that are denser than water will accumulate at the bottom of quiescent settling basins. More complex clarifiers also have skimmers to simultaneously remove floating grease such as soap scum and solids such as feathers, wood chips, or condoms. Containers like the API oil-water separator are specifically designed to separate non-polar liquids

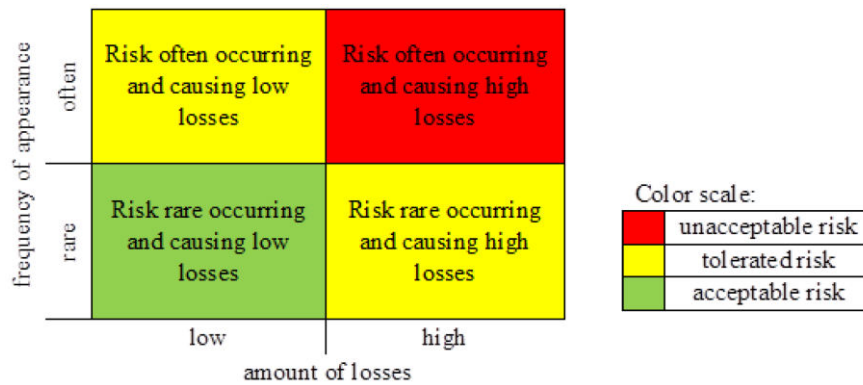
Oxidation reduces the biochemical oxygen demand of wastewater, and may reduce the toxicity of some impurities. Secondary treatment converts organic compounds into carbon dioxide, water, and biosolids through oxidation and reduction reactions. Chemical oxidation is widely used for disinfection.[9,10]

Secondary treatment is the removal of biodegradable organic matter (in solution or suspension) from sewage or similar kinds of wastewater. The aim is to achieve a certain degree of effluent quality in a sewage treatment plant suitable for the intended disposal or reuse option. A "primary treatment" step often precedes secondary treatment, whereby physical phase separation is used to remove settleable solids. During secondary treatment, biological processes are used to remove dissolved and suspended organic matter measured as biochemical oxygen demand (BOD). These processes are performed by microorganisms in a managed aerobic or anaerobic process depending on the treatment technology. Bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, and organic short-chain carbon molecules from human waste, food waste, soaps and detergent) while reproducing to form cells of biological solids. Secondary treatment is widely used in sewage treatment and is also applicable to many agricultural and industrial wastewaters.

Advanced oxidation processes are used to remove some persistent organic pollutants and concentrations remaining after biochemical oxidation. Disinfection by chemical oxidation kills bacteria and microbial pathogens by adding hydroxyl radicals such as ozone, chlorine or hypochlorite to wastewater. These hydroxyl radical then break down complex compounds in the organic pollutants into simple compounds such as water, carbon dioxide, and salts.

Anaerobic wastewater treatment processes (for example UASB, EGSB) are also widely applied in the treatment of industrial wastewaters and biological sludge.[11,12]

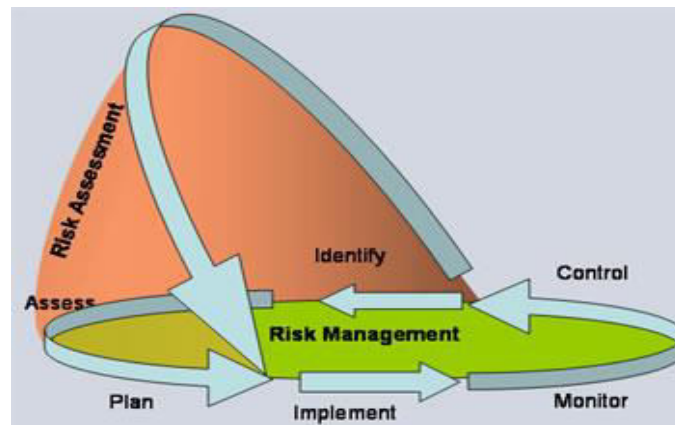
Polishing refers to treatments made in further advanced treatment steps after the above methods (also called "fourth stage" treatment). These treatments may also be used independently for some industrial wastewater. Chemical reduction or pH adjustment minimizes chemical reactivity of wastewater following chemical oxidation. Carbon filtering removes remaining contaminants and impurities by chemical absorption onto activated carbon. Filtration through sand (calcium carbonate) or fabric filters is the most common method used in municipal wastewater treatment.



Determination of risk

#### IV. RESULTS

Risk Management is a recurrent activity that deals with the analysis, planning, implementation, control, and monitoring of implemented measurements and the enforced security policy. On the contrary, Risk Assessment is executed at discrete time points (e.g. once a year, on demand, etc.) and – until the performance of the next assessment – provides a temporary view of assessed risks and while parameterizing the entire Risk Management process. This view of the relationship of Risk Management to Risk Assessment is depicted in figure as adopted from OCTAVE[13,14]

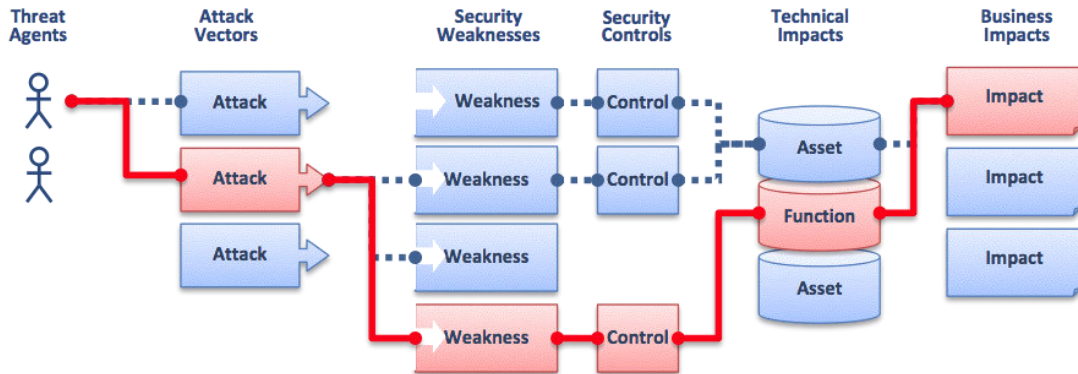


Risk identification states what could cause a potential loss; the following are to be identified:

- assets, primary (i.e. Business processes and related information) and supporting (i.e. hardware, software, personnel, site, organization structure)
- threats
- existing and planned security measures
- vulnerabilities
- consequence
- related business processes

The output of sub process is made up of:

- list of asset and related business processes to be risk managed with associated list of threats, existing and planned security measures
- list of vulnerabilities unrelated to any identified threats
- list of incident scenarios with their consequences.[15,16]



The activities of risk assessment has following basis:

The wastewater treatment plant is an important element of the water management infrastructure of each city, which provides one of the strategic services and makes a significant contribution to provide environmental safety and sustainable development. Short-term or long-term disruption of functionality of the WWTP has extensive impacts on the population and the environment. Therefore, similar to other human activities, it is necessary to assess and manage the risks associated with the operation of the WWTP. The risk assessment case study was carried out for a WWTP, which is intended for 1250 equivalent inhabitants. So far, none of the phases of risk management has been carried out for this WWTP, therefore the research team decided to use qualitative methods of risk identification (documentation reviews, safety audit, semi-structured interviews and a check-list). The methods were used in interrelationship and in three iterations to achieve a comprehensive risk identification. In the risk identification phase, 58 risks and 10 grouped assets were estimated and a risk register was created to examine the relationship between the risk and the assets. Subsequently, a risk analysis was performed. The output of the risk analysis was a description of the vulnerabilities of individual assets, determination of a verbal and index description of impacts and probability of risk activation and a risk estimate. Four levels of risk, where the reference level of risk was set at nine, were created as part of the risk estimate. The results of the risk assessment show that undesirable and unacceptable risks predominate in the operated WWTP. It is necessary to immediately implement countermeasures for at least 11 unacceptable risks. The article presents possible proposals for safety measures for unacceptable risks. This situation was also confirmed by the result of the safety audit, which found out that both the technological equipment and technical condition of the operated WWTP is at a very low level and in some areas does not correspond to current best available techniques in the field of wastewater management. The overall reconstruction of the WWTP, including an increase in its capacity, would contribute to the comprehensive minimization of undesirable and unacceptable risks. The complete processed risk assessment results were provided to the WWTP operator for further use. The article presented a proposal for the risk management screening procedure, including verification of methods suitable for the identification of risks for the WWTP for which risk management has not yet been implemented. Presented procedure and outputs (created risk register, verbal and index probability expression of danger activation, scale for verbal and index expression of impact and characteristics of risk levels) can be applied or modified for other analogous operations for safety and sustainability needs or on their basis create a uniform risk management methodology for the WWTP operation. The results for individual operations are further mutually comparable using a uniform risk management procedure.



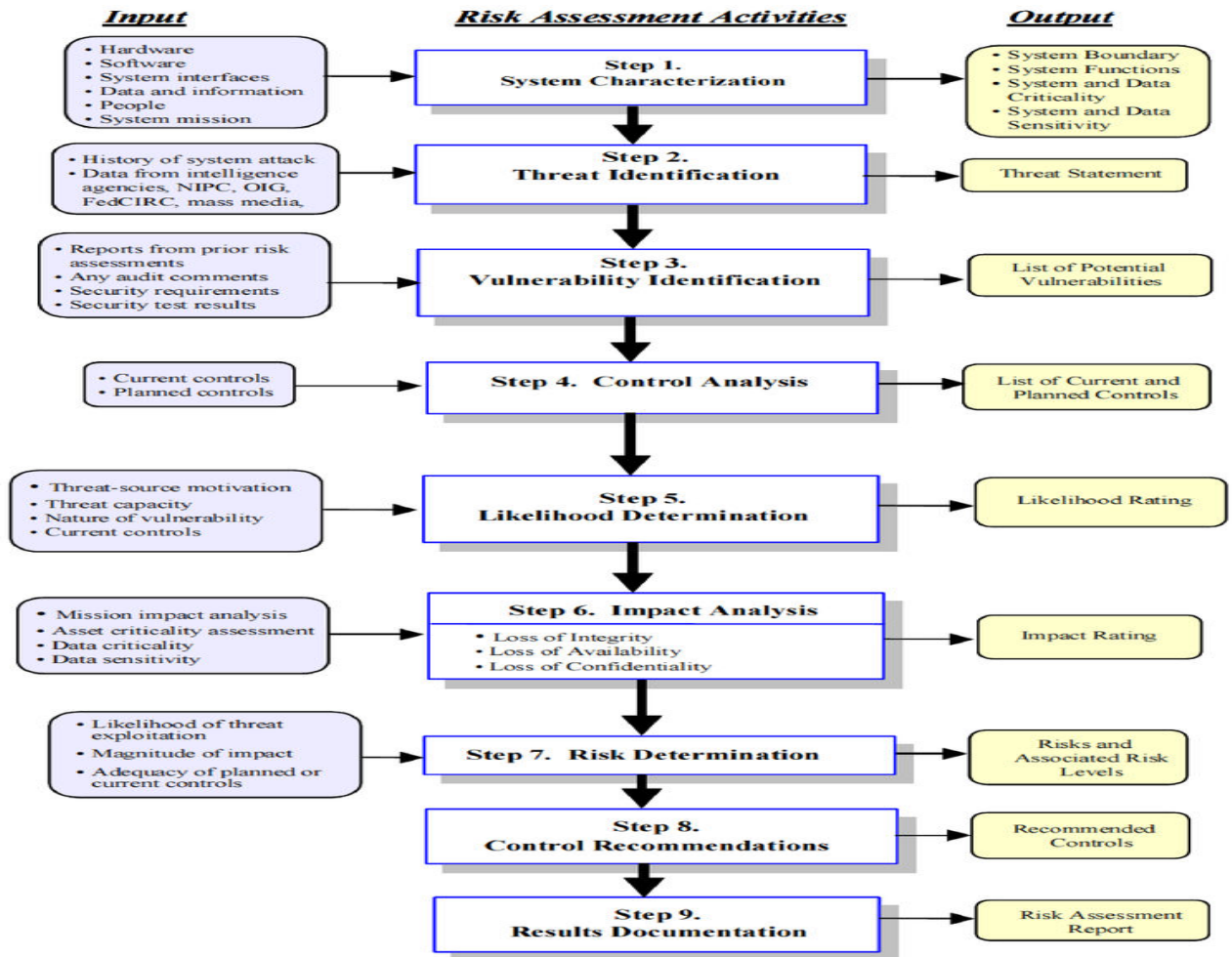


Figure 3-1. Risk Assessment Methodology Flowchart

## V. CONCLUSION

At present, wastewater reuse and recycling in water-stressed countries such as Iran has become a vital option for better management of water scarcity. However, despite the benefits of wastewater reuse, there is a probability of incomplete treatment of wastewater in accordance with the standards. Risk assessment of a wastewater treatment plant is required in order to determine the causes and consequences of failure in the treatment system. In addition, analyzing the risk factors revealed that the human error had the largest contribution to the risk calculation of the wastewater treatment plant failure. In this regard, a number of mitigation measures are hence proposed to improve the reliability of the wastewater treatment plant. [17,18]

## REFERENCES

1. "Wastewater treatment | Process, History, Importance, Systems, & Technologies". Encyclopedia Britannica. October 29, 2020. Retrieved 2020-11-04.
2. ^ Metcalf & Eddy, Inc. (2003). Wastewater Engineering: Treatment and Reuse (4th ed.). New York: McGraw-Hill. ISBN 0-07-112250-8.
3. ^ Tchobanoglous, George; Burton, Franklin L.; Stensel, H. David; Metcalf & Eddy, Inc. (2003). Wastewater Engineering: Treatment and Reuse (4th ed.). McGraw-Hill. ISBN 978-0-07-112250-4.





4. ^ Khopkar, S.M. (2004). Environmental Pollution Monitoring And Control. New Delhi: New Age International. p. 299. ISBN 978-81-224-1507-0.
5. ^ Von Sperling, M. (2015). "Wastewater Characteristics, Treatment and Disposal". Water Intelligence Online. **6**: 9781780402086. doi:10.2166/9781780402086. ISSN 1476-1777.
6. ^ Jones, Edward R.; van Vliet, Michelle T. H.; Qadir, Manzoor; Bierkens, Marc F. P. (2021). "Country-level and gridded estimates of wastewater production, collection, treatment and reuse". Earth System Science Data. **13** (2): 237–254. Bibcode:2021ESSD...13..237J. doi:10.5194/essd-13-237-2021. ISSN 1866-3508.
7. ^ Tchobanoglous, G., Burton, F.L., and Stensel, H.D. (2003). Wastewater Engineering (Treatment Disposal Reuse) / Metcalf & Eddy, Inc (4th ed.). McGraw-Hill Book Company. ISBN 0-07-041878-0.
8. ^ "Chapter 3: Analysis and Selection of Wastewater Flowrates and Constituent Loadings". Wastewater engineering: treatment and reuse. George Tchobanoglous, Franklin L. Burton, H. David Stensel, Metcalf & Eddy (4th ed.). Boston: McGraw-Hill. 2003. ISBN 0-07-041878-0. OCLC 48053912.
9. ^ Von Sperling, M. (2015). "Wastewater Characteristics, Treatment and Disposal". Water Intelligence Online. **6**: 9781780402086. doi:10.2166/9781780402086. ISSN 1476-1777.
10. ^ "Pollution Prevention Case Studies". Washington, D.C.: U.S. Environmental Protection Agency (EPA). 2021-08-11.
11. ^ Reed, Sherwood C. (1988). Natural systems for waste management and treatment. E. Joe Middlebrooks, Ronald W. Crites. New York: McGraw-Hill. ISBN 0-07-051521-2. OCLC 16087827.
12. ^ "Landfills Effluent Guidelines". EPA. 2018-03-16.
13. ^ Primer for Municipal Waste water Treatment Systems (Report). Washington, DC: US Environmental Protection Agency (EPA). 2004. EPA 832-R-04-001..
14. ^ Ajay Kumar Mishra Smart Materials for Waste Water Applications, Wiley-Scrivener 2016 ISBN 111904118X <https://onlinelibrary.wiley.com/doi/book/10.1002/9781119041214>
15. ^ Gupta, Ashok; Yan, Denis, eds. (2016-01-01), "Chapter 16 - Gravity Separation", Mineral Processing Design and Operations (Second Edition), Amsterdam: Elsevier, pp. 563–628, ISBN 978-0-444-63589-1, retrieved 2020-11-30
16. ^ Weber, Walter J. (1972). Physicochemical processes for water quality control. New York: Wiley-Interscience. ISBN 0-471-92435-0. OCLC 389818.
17. ^ BERGENDAHL, JOHN. "Applications of Advanced Oxidation for Wastewater Treatment" (PDF). Dept. Of Civil & Environmental Engineering, WPI.
18. ^ Wastewater engineering : treatment and reuse. George Tchobanoglous, Franklin L. Burton, H. David Stensel, Metcalf & Eddy (4th ed.). Boston: McGraw-Hill. 2003. ISBN 0-07-041878-0. OCLC 48053912.



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