Wastewater and Waste Solid Treatment Technologies

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BOOKS ARCADE

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CHAPTER 1

INTRODUCTION TO CONSTRUCTION AND DEMOLITION WASTE

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Excavation, demolition, building, remodeling, and roadwork all result in the production of construction and demolition (C&D) waste, which is a mixture of inert and noninert elements. Inert materials and noninert waste are the two main types of construction waste[1],[2]. Around 70% of all C&D waste, as according government statistics, consists of soft inert materials that can only be used as fill in earth filling and reclamation projects (such as soil, earth, and slurry). About 12–15% of the total trash is made up of hard, inert materials that can be recycled or utilised as granular materials or aggregates for building projects (such as rocks and cracked concrete). The recovered aggregates can be used in concrete mix applications, drainage bedding layers, and road subbase. In general, landfills are used to dispose of 15–18% of total construction waste, which includes noninert waste (such as wood, bamboo, and packaging trash). Due to its numerous advantages and affordable production costs, recycled concrete aggregate (RCA) has the possibility of replacing natural aggregate concrete [3],[4]. However, because people are still ignorant of its cost-benefit advantages and production process, recycled aggregate concrete is not widely used in building.

Management of C&D waste at both the international and national levels:

An estimated 890 million tonnes of C&DW are produced in Europe each year. According to Tam et al., 42% of all trash in Australia is associated with C&DW, of which 81% is concrete waste. Hong Kong and Japan produce 38% and 16% of the total waste produced each year, respectively. Additionally, it was stated that the USA produced 569 million metric tonnes of C&DW in 2017. This threat does not specifically target South Africa. According to Muzenda, 21% of South Africa's total waste is made up of C&DW. Despite the fact that construction activities produce these wastes, three billion tonnes of raw materials are produced into building material each year. It is essential to reuse these waste materials as much as possible during construction for the industry's sustainability. The production of coarse recycled concrete aggregate (CRCA) from leftover concrete was reported to have a positive long-term net benefit with a value of US$ 22,334,116 per year, compared to the production of crushed coarse natural aggregate (CNA), which had a negative long-term net benefit with a value of US$ -31,841,109 per year [5].

Utilizing RCAs has a considerable financial advantage, which lowers the price of recycled aggregate concrete (RAC). Compared to making standard concrete built using CNA, recycling concrete debris to create new concrete at the same demolition site resulted in cost savings for RAC of 63.13%. However, when it was done using CRCA that was obtained from a recycling facility, the cost savings for RAC were reduced to 12.62%.India currently consumes roughly 1.4 billion tonnes of sand and 2 billion tonnes of crushed stone annually, according to estimates. Additionally, manufactured sand (M sand) is also replacing river sand, adding to the burden on quarries. Uncontrolled mining to satisfy the enormous demand has exhausted the supply of natural aggregates and highlighted the need for secondary materials to take their place. Building demolition is the main factor in the production of C&D waste. According to government statistics, India produces 12 to 15 million tonnes of C&D garbage annually. However, numerous academics claim that the amount of C&D waste actually produced in India is vastly underestimated.

C&D waste impacts on environment

Due to the significant amount of trash produced during building, demolition, remodelling, and related activities, the construction sector has long been recognised as one of the leading causes of adverse environmental effects. More people are interested in more environmentally friendly and economical concrete materials like recycled aggregate concrete as a result of growing environmental concerns over the harm that using natural aggregates does to the environment. There are impact categories including global warming, grassland acidification and nutrition, carcinogenic, ozone layer depletion, freshwater acidification, grassland ecotoxicity, and aquatic eutrophication, so according LCI methodology.

Impact of C&D waste on the economy

C and D garbage recycling and reuse can significantly reduce costs. Compared to recycled aggregates, natural aggregates are more expensive. It is possible to reduce the cost of the land needed for garbage disposal as well as the labour costs associated with landfill cleaning. The conventional method of waste management has traditionally been to dump these wastes in sanitary landfills, but in the future, this will not be possible. Circular economy is a potential solution to the growing volumes of CDW in order to considerably reduce or eliminate the amount being dumped. A circular economy is an economic system based on commercial models that substitutes reducing, using, recycling, and retrieving materials for the end-of-life idea. Frameworks for the circular economy (CE), in particular material recovery and manufacturing that emphasises CDW reuse, recycling, and reprocessing into modern building applications

Effects of C&D waste on social life

Oil, solvents, and resins are frequently included in C&D trash, which can represent a significant source of soil contamination and subterranean water pollution if deposited illegally. The main causes of C&D waste include respiratory conditions, land space consumption, landfill depletion, power and non-energy resource use, resource depletion, creation of solid waste, and dust and gas emission.

Effects of C&D waste on social life

Buildings have a long lifespan, and their effects extend far into the future, where there will be scarce resources, pollution, and unstable climatic circumstances. Numerous studies have demonstrated that the negative effects that building activities have on the environment are serious and must be stopped. The building industry makes a significant contribution to the advancement of society. Although this is acknowledged, it is also asserted to be a significant factor in the state of the ecosystem. Land depletion, energy demand and consumption, solid waste creation, gas and dust emissions, noise pollution, and the use of natural resources, especially non-renewable resources, are some of its detrimental effects on society. The noise generated by the site's building activities has an impact on the tranquilly, comfort, and health of the locals and the surrounding community, as well as on the overall bustle of the area's schools, hospitals, and other day-to-day services. The marble dust poses a significant environmental danger and is typically dumped on riverbeds. The creation of spreading clouds of dirt from earth movements, destruction, and other building activities has a detrimental effect on the rising numbers of people suffering from respiratory ailments [6].

Bibliography

[1] P. Sormunen and T. Kärki, “Recycled construction and demolition waste as a possible source of materials for composite manufacturing,” *Journal of Building Engineering*. 2019. doi: 10.1016/j.jobe.2019.100742.

[2] R. Islam, T. H. Nazifa, A. Yuniarto, A. S. M. Shanawaz Uddin, S. Salmiati, and S. Shahid, “An empirical study of construction and demolition waste generation and implication of recycling,” *Waste Manag.*, 2019, doi: 10.1016/j.wasman.2019.05.049.

[3] Z. Abdollahnejad, M. Mastali, M. Falah, T. Luukkonen, M. Mazari, and M. Illikainen, “Construction and demolition waste as recycled aggregates in alkali-activated concretes,” *Materials*. 2019. doi: 10.3390/ma12234016.

[4] S. Jain, S. Singhal, and N. K. Jain, “Construction and demolition waste generation in cities in India: an integrated approach,” *Int. J. Sustain. Eng.*, 2019, doi: 10.1080/19397038.2019.1612967.

[5] “Effects of Lifestyle Changes on Semen Quality in Healthy Young Men Living in Highly Polluted Areas (FAST),” *Case Med. Res.*, 2019, doi: 10.31525/ct1-nct04012385.

[6] Various, “Consumption, Environmentally Significant,” *Int. Encycl. Soc. Behav. Sci.*, 1993.

CHAPTER 2

APPLICATION OF C&D MATERIALS

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The building, remodelling, maintenance, and demolition of homes, big building structures, highways, bridges, piers, and dams results in the production of construction and demolition (C&D) debris [1],[2]. Wood, steel, concrete, plaster, brickwork, plaster, metals, and asphalt are the main components of C&D waste. Because it may contain dangerous substances like lead and asbestos, C&D trash is noteworthy [3],[4]. Although estimates vary, it is generally agreed that between 15% and 20% of municipal solid trash is generated by construction and demolition activities. The capacity of landfills that take C&D trash is constrained. A lot of them have already closed or will soon. Only around 7% of the C&D trash produced in Connecticut is now listed as being recycled; the majority of it is dumped in out-of-state landfills. These numbers solely represent the waste that is reported to the DEEP by Connecticut-permitted solid waste facilities. The majority of clean fill produced and recycled or reused, scrap metal recycled from building projects, materials shipped straight from a work site to an out-of-state recyclable end market, and commodities reused on site are not included in the reported recycling rate of 7%.

C&D Material

When new buildings and civil engineering structures are constructed, as well as when older buildings and civil engineering structures are refurbished or demolished, C&D materials are produced (including deconstruction activities). Public works initiatives such as highways and roads, bridge, utility facilities, piers, and dams are examples of civil engineering structures.C&D materials frequently include big, hefty materials like:

- Concrete
- Plastics
- Gypsum
- Glass
- Wood
- Metals
- Asphalt
- Bricks
- Salvaged building components
- Earth, rock, trees, and stumps from clearing areas [5]

Materials used in construction and demolition (C&D) comprise waste produced during the construction, refurbishment, or demolition of civil engineering structures. More than twice as much municipal solid garbage as usual was produced in the United States in 2015, according to the EPA's estimate of almost 550 million tonnes of C&D debris produced globally. The need to mine and process fresh resources can be reduced by using some of existing C&D materials in new projects. Recycling C&D materials has the potential to significantly reduce waste, construction costs, environmental effect, and landfill space.

Various C&D Material Types:

When buildings are being built, demolished, or renovated, three major forms of construction and demolition debris are produced:

- Non-hazardous or inert waste
- Hazardous waste covered by the Resource Conservation and Recovery Act, which is regulated by the EPA (RCRA)
- Products with potentially regulated hazardous components in some states

Since the majority of debris is non-hazardous, the EPA does not regulate it. Concrete, cinder blocks, asphalt, plaster, slate, masonry, and drywall are some non-hazardous waste examples.

- Doors, windows, siding, and brick
- Lumber, hardwood, wood wastes, pallets, and wood laminates
- Steel, pipes, rebar, copper, brass, flashing, and other types of steel;
- Insulation without asbestos

According to U.S. state or federal rules, hazardous waste often requires specific C&D treatment and disposal. Paints, thinners, resins, adhesives, varnish, solvents, and the containers used for these materials can all be considered hazardous waste.

- Treated wood, such as on utility poles or decks
- Asbestos-containing products
- Mercury- or lead-containing goods

Benefits of Reducing C&D Material Disposal:

- Reducing the volume of C&D waste burned or discarded in landfills can:
- Increased business prospects within the local community, especially when deconstruction and selected demolition techniques are applied. • Create economic activity and jobs in the recycling sector.
- Lower total building project costs by avoiding purchase and disposal expenditures and donating recovered materials to eligible 501(c)(3) nonprofit organisations for a tax deduction. Reuse on-site also saves money on transportation.
- Cause a reduction in the number of disposal facilities, potentially easing the related environmental problems.
- Reduce the environmental impact of the manufacture of new materials and the extraction, use, and consumption of virgin resources.

Reduce landfill space use:

The main advantage of recycling materials is the reduction in resource and energy consumption that results from stopping the manufacturing of new materials. Several frequently utilised C&D materials and applications are as follows:

- Things that are simple to remove, such as doors, hardware, appliances, and fixtures. These can be recovered and used for other jobs, for rebuilding, or as donations.
- Wood cutoffs can be used in place of full length timber to create cripples, lintels, and blocks. On-site wood waste can be chipped and used as groundcover or mulch.
- Gypsum that has been depapered and crushed can be added to soil in small amounts.
- On-site recycling of brick, concrete, and masonry is possible for use as fill, subbase, or driveway bedding.
- Extra insulation from external walls can be used as a soundproofing material in inside walls.
- Paint can be mixed up again and used as a primer layer on other projects or in storage or garage spaces.
- Materials for packaging might be returned to suppliers for reuse [6].

Bibliography

[1] J. Yang *et al.*, "Nanomaterials for the removal of heavy metals from wastewater," *Nanomaterials*. 2019. doi: 10.3390/nano9030424.

[2] S. Esposito, "'Traditional' sol-gel chemistry as a powerful tool for the preparation of supported metal and metal oxide catalysts," *Materials*. 2019. doi: 10.3390/ma12040668.

[3] A. Zwolak, M. Sarzyńska, E. Szpyrka, and K. Stawarczyk, "Sources of Soil Pollution by Heavy Metals and Their Accumulation in Vegetables: a Review," *Water, Air, and Soil Pollution*. 2019. doi: 10.1007/s11270-019-4221-y.

[4] M. Kapahi and S. Sachdeva, "Bioremediation options for heavy metal pollution," *Journal of Health and Pollution*. 2019. doi: 10.5696/2156-9614-9.24.191203.

[5] Epa.gov, "Sustainable Management of Construction and Demolition Materials," 2022.

[6] T. Imtiaz, A. Ahmed, M. D. Sahadat Hossain, and M. Faysal, "Microstructure analysis and strength characterization of recycled base and sub-base materials using scanning electron microscope," *Infrastructures*, 2020, doi: 10.3390/INFRASTRUCTURES5090070.

CHAPTER 3

CONSTRUCTION AND DEMOLITION WASTE

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Any time construction or demolition work is done, such as when building roads, bridges, flyovers, subways, remodelling, etc., garbage is produced. The majority of its components are inert and non-biodegradable, including concrete, stucco, metal, wood, and polymers. This trash is disposed of in part in the municipal stream [1], [2]. These wastes take up a lot of area in the container or roadside garbage bin due to their weight, high density, and frequent bulkiness [3],[4]. Large, massive mounds of this kind of debris are frequently seen placed on roadways, especially during major construction projects, which causes traffic congestion and disturbance. Small generating trash, such as that from individual home construction or demolition, makes its way into the neighbouring municipal bin/vat/waste storage depots, adding weight to the garbage and lowering its suitability for further processing, such as composting or energy recovery [5].

Characteristics: Due to the various types of building materials utilised, this category of trash is complex, but generally speaking, it may include the following materials:

Major components include:

- cement concrete
- bricks
- cement plaster
- steel
- rubble
- stone
- timber/wood

Small parts Conduits:

- Pipes
- electrical fixes
- ures
- Panels

Storage of Demolition and Construction Waste:

- The optimum place to store these wastes is at the point of generation, or the source. They not only hinder traffic if they are left lying about or tossed on the road, but they also increase the workload for the local authority. The following guidelines should be adhered to at all costs:

- All debris from building and demolition projects should be kept on the site itself. To prevent waste from being dispersed and unsightly, a suitable screen should be offered.
- In order to permit its subsequent grading and reuse, garbage should be kept as separated into various heaps as feasible.
- Material that can be utilised again on the same site for building, levelling, paving roads, etc. should be maintained in separate piles from material that will be sold or dumped.
- The neighbourhoodorganisation or a private business can make arrangements to rent an adequate number of skip containers or trolleys, which can be parked at the site and transported using skip lifters or tractors as necessary.
- The local government may take into consideration employing its outdated vehicles, particularly tractors and trailers, old lorries, or tippers for this purpose whenever a new, more efficient system is implemented in a municipality.

Collection and Transportation: Skip lifters equipped with hydraulic hoist systems should be utilised for effective and speedy removal of construction debris if it is stored in skips. Tractors can remove trailers if they are being used. Front-end loaders can be used in conjunction with strong tipper trucks to handle very big volumes, minimising the time needed for loading and unloading. There may be two possibilities for modest generators of building waste, such as petty repair/maintenance jobs:

- Particular locations for such dumping by the local body
- Clearance on a fee basis.

Reusing and Recycling:

These materials' separation and the state of the separated material are essentially what determine how they are used. Since most of these substances are strong, their potential for reuse is very high. However, it would be ideal to have recycled material quality standards. Waste from construction and demolition projects can be reused in the following ways, according on their condition:

- Bricks, stone slabs, lumber, conduits, piping railings, etc. can all be utilised again on site, if possible.
- The sale or auction of materials that cannot be used on the site because of a restriction on the design or a change in the design.
- Recycling companies can make use of plastics, broken glass, waste metal, etc.
- Where the traffic does not consist of large moving loads, building materials such as rubble, brick bats, broken plaster or concrete pieces, etc., can be used for activities such as levelling and undercoating lanes.
- Larger useless pieces may be delivered to be used as fill in low-lying areas.
- Sand, dust, and other fine materials can be utilised as a cover material for sanitary landfills.

Disposal: Construction and demolition trash does not produce chemical or biochemical contamination because it is primarily inert in nature. Therefore, as said above, every effort should be taken to use and recycle them. Low-lying regions can be filled in or levelled using the material. For residual waste, which is typically kept in closed mines and quarries, specific landfills are occasionally built in industrialised nations.

The similar approach can be taken in our nation's cities that are close to open-pit mines or quarries, where sand is frequently utilised as filler. To evaluate the material's usability in the given circumstances, a proper sample of the material must be taken to determine its physical and chemical properties.

Aspects of Planning and Management:

The relevant local government should develop a plan for effectively using construction waste. It is possible to map the low-lying regions that need to be filled in for building activities and create a backup plan so that debris from any demolition or construction work can be sent there first in the event that it occurs. However, such an action must be carefully planned and carried out with the approval and supervision of the relevant authority.

Aspects of Institution and Regulation:

There should be a suitable institutional system in place to handle the collection, transportation, interim storage (if required), utilisation, and disposal of construction and demolition waste. In certain towns, the Engineering or the Planning Department is in charge of building and demolition trash while the Sanitary Department or the Health Department is in charge of municipal garbage. In such cases, it is crucial that either the collection of demolition and construction debris is delegated to the Solid Waste Management Department or that these departments cooperate closely together. It is crucial that the right responsibility is established and that official information is easily accessible regarding the current situation [6].

Bibliography

[1] S. H. Ghaffar, M. Burman, and N. Braimah, “Pathways to circular construction: An integrated management of construction and demolition waste for resource recovery,” *J. Clean. Prod.*, 2020, doi: 10.1016/j.jclepro.2019.118710.

[2] K. Kabirifar, M. Mojtahedi, C. Changxin Wang, and T. Vivian W.Y., “A conceptual foundation for effective construction and demolition waste management,” *Cleaner Engineering and Technology*. 2020. doi: 10.1016/j.clet.2020.100019.

[3] C. Luangcharoenrat, S. Intrachooto, V. Peansupap, and W. Sutthinarakorn, “Factors influencing construction waste generation in building construction: Thailand’s perspective,” *Sustain.*, 2019, doi: 10.3390/su11133638.

[4] M. L. S. Oliveira, M. Izquierdo, X. Querol, R. N. Lieberman, B. K. Saikia, and L. F. O. Silva, “Nanoparticles from construction wastes: A problem to health and the environment,” *J. Clean. Prod.*, 2019, doi: 10.1016/j.jclepro.2019.02.096.

[5] B. C. Guerra, A. Bakchan, F. Leite, and K. M. Faust, “BIM-based automated construction waste estimation algorithms: The case of concrete and drywall waste streams,” *Waste Manag.*, 2019, doi: 10.1016/j.wasman.2019.03.010.

[6] R. V. Silva, J. de Brito, and R. K. Dhir, “Use of recycled aggregates arising from construction and demolition waste in new construction applications,” *Journal of Cleaner Production*. 2019. doi: 10.1016/j.jclepro.2019.117629.

CHAPTER 4

C&D WASTE MANAGEMENT

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Construction and demolition (C&D) waste is made up of discarded or used building materials, as well as debris and rubble from the building, repair, renovation, and destruction of structures. Reduce, Recycle, and Reuse. Waste reduction is accomplished by deconstruction, minimization, and prevention [1],[2]. When a structure is being demolished, it should only be done when it has reached the end of its useful life [3],[4]. This is known as deconstruction, which is the process of building in the opposite direction from how it was originally built. The ability to utilise recovered elements in new creations is a benefit of deconstruction. Unsalvageable materials must be repurposed and made into useful items. If this type of waste management is used, practically all of the garbage can be turned into resources, and only a small amount needs to be disposed of.

C&D Waste Generation:

Organizations that produce C&D are divided into two categories under the C&D Waste Management Rules, 2016, known as C&D waste manufacturers and C&D waste bulk generators. The people who are in charge of producing C&D trash are known as generators, however bulk alternators are those who produce C&D waste in quantities more than 20 tonnes per day or 300 tons per project every month. Concrete, earth, steel-wood-plastic, and bricks and mortar are the four categories into which the bulk generators must separate their waste.Due to the extensive construction, remodelling, and demolition activities carried out in India, a huge amount of C&D trash is produced. However, because there are few recycling facilities, the garbage must be dumped in dumping grounds or in the open. As a general rule, new construction and restoration are estimated to have produced 40–60 kg per sqm of C&D waste, while demolition is estimated to have produced 300–500 kg per sqm.Buildings made of RCC, brick, or stone produce C&D trash. In India, C&D waste is made up of 36% soil, sand, and gravel, 31% brick and masonry, 23% concrete, 5% metal, 2% bitumen, 2% wood, and 1% miscellaneous materials, according to TIFAC (Technology Information, Forecasting and Assessment Council, 2001). This gives an overview of the C&D components, albeit the percentage will change depending on where you are. [5].

C&D waste recycling: The most crucial management cycle activity is recycling. Urban local bodies or bulk generators can transport C&D waste to recycling facilities (ULBs). The trash generators are being charged tipping fees by some ULBs. To prevent pollution in the cities, the majority of ULBs also provide land on the outskirts of the cities for recycling facilities.

C&D waste recycling facilities come in three varieties: semi-mobile, mobile, and stationary. Mobile plants offer the advantage of being transportable to demolition sites, but they are only able to handle quasi concrete or masonry waste. In the semi-mobile recycling facility, ferrous materials are removed via magnetic separation, while impurities are removed manually. Although such factories are not able to process mixed demolition trash containing materials like metal, wood, and plastic, the quality of the finished product is better than that of a mobile unit in such a plant.

All operations can be performed by stationary plants. These facilities might feature recycling equipment for both dry and wet processing. Aggregates of various sizes are separated by a screening process after metallic waste has been separated from C&D waste. Recycling materials are cleaned in wet processing facilities, and then light materials and sludge are segregated. Fine soil like clay and silt make up sludge, which is then processed via a press to create dry soil known as filter press material.

Recycled Materials from C&D Waste

The subsequent main resources are attained after reprocessing;

- Sand
- Coarse aggregates
- Filter press material

The trash generated during construction and demolition (C&D) may be made up entirely of cement concrete or may also include a mixture of soil, brick and natural stone waste, and other materials. Sand and coarse aggregates are obtained from recycled materials when C&D waste is solely composed of cement concrete waste, such as from RCC members, railway sleepers, and similar other concrete members. Recycled Concrete Aggregates are coarse aggregates produced from such C&D trash (RCA). Coarse aggregates made from C&D trash that also includes concrete debris and brick/stone masonry waste are known as recycled aggregates (RA). As a result, RCA and RA have different qualities.

Recycling C&D Waste:

May turn this garbage into recycled sand and aggregates using cutting-edge C&D waste processing technologies, which have a variety of uses in a range of building applications.

- Increase recycling of waste from building, demolition, and excavation.
- Increase the production of high-quality, high-value recycled sand and aggregates that can take the place of natural resources in a variety of construction applications, such as the fabrication of concrete and asphalt.
- Ensure that a sustainable source of sand and aggregates can satisfy rising demand.
- Preserving the availability of sand and aggregate in locations where natural reserves are dwindling
- Sand and aggregate shipping expenses can be reduced because recycled resources are frequently generated closer to urban centres.
- By generating recycled sand and aggregates closer to the market, your processing facility can reduce its carbon footprint.
- Only maximise material recovery and the removal of the different pollutants that would otherwise limit the ultimate destination for your recycled sands and aggregate products by introducing a cleaning plant for your C&D waste.

C&D Waste Recycling Plant can be customized:

Each plant we build is developed in accordance with the unique requirements of the project due to the very varied nature of construction, demolition, and excavation waste. Every recycling facility for construction and demolition garbage that we work with must adopt a unique strategy due to the various contamination levels, fines content, and input material variety (excavation debris, railway ballast, etc.). Depending on your unique needs, each plant we develop comprises a range of processing stages:

- Nutrition and pre-screening
- Scrubbing of aggregate
- Removal of contaminants
- Metals elimination
- Sand washing
- Size of aggregate
- Initial water purification
- Sludge Control[6]

Bibliography

[1] K. Vinck, L. Scheelen, and E. Du Bois, "Design opportunities for organic waste recycling in urban restaurants," *Waste Manag. Res.*, 2019, doi: 10.1177/0734242X18817714.

[2] Z. Pei, "Roles of neighborhood ties, community attachment and local identity in residents' household waste recycling intention," *J. Clean. Prod.*, 2019, doi: 10.1016/j.jclepro.2019.118217.

[3] H. T. T. Nguyen, R. J. Hung, C. H. Lee, and H. T. T. Nguyen, "Determinants of residents' E-waste recycling behavioral intention: A case study from Vietnam," *Sustain.*, 2019, doi: 10.3390/su11010164.

[4] K. N. Burns, S. K. Sayler, and R. L. Neitzel, "Stress, health, noise exposures, and injuries among electronic waste recycling workers in Ghana," *J. Occup. Med. Toxicol.*, 2019, doi: 10.1186/s12995-018-0222-9.

[5] D. K. M. Soni, "Recycled C&D Waste Materials," 2022.

[6] Cdeasia, "C&D Waste Recycling," 2022.

CHAPTER 5

C&D WASTE IMPACTS ON ECONOMY

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Rag pickers in large cities collect a significant amount of recyclable materials, such as paper, plastic, and metal, from trash cans, the side of the road, or from streets, markets, etc., providing the raw materials for the thriving recycling facilities. In India, about 0.75 million tonnes of plastic garbage are recycled annually [1],[2]. This industry is particularly lucrative in metro areas, where each stage of the transfer can bring in anywhere from Rs 3 to Rs 15 per kg. Around 14% to 20% of the total rubbish in smaller cities and municipalities is made up of recyclable materials (TERI, 1998) [3],[4]. This does not include the paper and plastic materials kept in the homes for sale. The pre-granulation stage and post-granulation stages of the Indian plastic recycling business are valued at 25 billion rupees and 39 billion rupees, respectively [5].

In addition to producing more money and lessening pollution, landfill gas can be utilised to replace fossil fuels. In the industrialised world, turning landfill gas into powder is now a successful business. As a result of the indiscriminate use of chemical fertilisers, the organic element of municipal solid waste can be composted to create 0.6 million tonnes of organic fertiliser annually, which could help to partially offset the pollution and land degradation. Plastic waste can significantly alter soil properties, including bulk density, porosity, saturated hydraulic conductivity, field capacity and soil water repellenceMicroplastics in soil can create new water channels that cause erosion and dry out soilsA 1- to 2-km-wide area surrounding the site is unsuitable for habitation or plant life due to the offensive aromas that come from landfills and the explosion risks caused by methane leaks. Even though there is a severe lack of land in cities and land prices are skyrocketing, the land is therefore kept undeveloped.

- Costs and the calibre of the land
- Contamination of soil and land degradation can come from waste pollution:
- Waste can result in higher amounts of nitrogen, volatile organic compounds including gasoline and solvents, hydrocarbons, and heavy metals.
- Waste can smother plants and produce micro-habitats
- Waste can suffocate plants and produce micro-habitats.
- The condition of the land and water is seriously threatened by toxic waste dumps. Prices for land and homes are typically lower than usual in areas where waste pollution is a problem.

Vacationing and other businesses

The potential for tourism in landscapes, beaches, and rivers can be significantly impacted by waste pollution. Other economic activities like shipping, fishing, aquaculture, and leisure are also impacted by marine pollution. For instance, the cost of rebuilding boats and other equipment harmed by abandoned fishing gear is a considerable annual expense for the fishing sector. According to 2017 estimates from the UN, waste pollution costs the global economy $51 million annually from fishing fleets and $622 million annually from tourism. At least $8 billion in annual losses are predicted for the marine industries overall.

Costs of waste cleanup

The costs incurred by the government, businesses, nonprofit organisations, and communities are among the economic effects of waste pollution. There isn't a complete estimate of how much it will cost to clean up coastlines and other locations. However, a sizeable percentage of council funds are used to clean the streets and beaches, at the expense of ratepayers, whether or not they are involved in waste pollution. Costs include the time and goodwill of volunteers as well as the expenses of non-profit organisations like Clean Up Australia and Tangaroa Blue. Businesses and large landowners also invest a significant amount of money in waste pollution cleanup, which might have to be passed on to consumers. As an illustration, sewerage providers shell out about $2 million a year to repair equipment that has been harmed by improper things being flushed down the toilet.

Transport issues:

The three sets of respondents identified transportation-related environmental impacts as the fourth-most significant environmental consequence of building operations. The interference with road traffic was deemed by architects and quantity surveyors to be the most significant environmental consequence of building operations. Road traffic, on the other hand, was ranked first by structural engineers. It is crucial to note that although the contractors and consultants questioned brought up the issue of traffic, they mostly blamed it on road construction.

Soil modification:

Based on responses from all three categories of respondents, soil modification was evaluated as the eighth most significant environmental impact of building operations. The group of environmental impacts with the lowest ranking included soil modification. Land occupation was deemed to be the most crucial element in this category by all stakeholders.

Water emissions:

The three groups of respondents gave the water emissions category the lowest rating. Each of the three teams gave water from excavation a high ranking relative to the other criteria in the group. According to the respondents, water emissions from construction operations in Ghana do not have a significant environmental impact.

Effects on Biodiversity:

According to the three groups of respondents, the effects on bio - diversity group was identified as the second most significant environmental consequence of construction operations. Within the top ten most significant environmental effects of building activities in Ghana, the removal of vegetation, disruption of the ecosystem, and loss of edaphic soil, all of which fall within the effects on biodiversity category of environmental impacts, were also listed. Additionally, the contractors and consultants questioned supported this.

Local Issues With relative relevance indices of 0.932, 0.933, and 0.800, respectively, architects, quantity surveyors, and structural engineers identified the local issues group as the third most significant environmental impact of building operations. The most significant environmental consequence of construction activities, according to architects, is noise and vibration generation. Both structural engineers and quantity surveyors identified vibration and noise generation as the most crucial factor. Additionally, there is a tonne of evidence to back up the claim that building activities produce dust, noise, and vibration [6].

Bibliography

[1] A. Vaiciukevičiūtė, J. Stankevičienė, and N. Bratčikovienė, "Higher education institutions' impact on the economy," *J. Bus. Econ. Manag.*, 2019, doi: 10.3846/jbem.2019.10156.

[2] S. Li, H. Deng, and K. Zhang, "The impact of economy on carbon emissions: An empirical study based on the synergistic effect of gender factors," *Int. J. Environ. Res. Public Health*, 2019, doi: 10.3390/ijerph16193723.

[3] G. McCartney, W. Hearty, J. Arnot, F. Popham, A. Cumbers, and R. McMaster, "Impact of political economy on population health: A systematic review of reviews," *American Journal of Public Health*. 2019. doi: 10.2105/AJPH.2019.305001.

[4] I. Shkolnyk, S. Kozmenko, O. Kozmenko, and B. Mershchii, "The impact of economy financialization on the level of economic development of the associate eu member states," *Econ. Sociol.*, 2019, doi: 10.14254/2071-789X.2019/12-4/2.

[5] S. I. Humbatova, R. K. Gasimov, and N. Q. Hajiyev, "The impact of oil factor on Azerbaijan economy," *Int. J. Energy Econ. Policy*, 2019, doi: 10.32479/ijeep.8001.

[6] S. O. Ametepey and S. K. Ansah, "Impacts of Construction Activities on the Environment□: the Case of Ghana," *Academia*, 2015.

CHAPTER 6

C&D WASTE IMPACTS ON ENVIRONMENT

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Management of waste from construction and demolition. Environmental effects of C&D waste have grown to be a severe and urgent problem [1],[2]. It poses a risk to the environment, ecological resources, wildlife, and people. The management of garbage from construction and demolition is essential for sustainable development. The use of comprehensive waste management techniques is recommended [3]. Environmentally friendly technology are required for the management of C & D waste. The goal should be to produce as little trash as possible. Sorting and segregating C&D garbage can help recover useable products. Recycling products can be kept out of the trash. Applying the 3R's principle reduce, reuse, and recycle and finally, if appropriate, incineration and landfill disposal can be used to manage C&D waste. The parts of C&D trash and whether they can be recycled, reused, biodegraded, burned, or disposed of in landfills.

Buildings have a long lifespan, and their effects extend far into the future, where there will be scarce resources, pollution, and unstable climatic circumstances. Numerous studies have demonstrated that the negative effects that building activities have on the environment are serious and must be stopped. The building industry makes a significant contribution to the advancement of society. Although this is acknowledged, it is also asserted to be a significant factor in the state of the ecosystem. Land depletion, energy demand and consumption, solid waste generation, gas and dust emissions, noise pollution, and the exploitation of non-renewable resources are only a few of its detrimental effects on society. The world has warmed by about 0.5°C annually over the past 100 years, which is attributable to elevated concentration of a few traces of greenhouse gases, the most notable of which is carbon dioxide (CO_2). Over the past few decades, there has been a quicker global increase in energy demand and related CO_2 emissions [4].

Energy use is always increasing, and the results are devastating. To combat the issue of excess energy use and consequently lower the accompanying CO_2 emissions, developed nations should improve their energy efficiency. Due to urbanization and industrialization, over half of India's energy consumption is attributable to the construction industry. Large amounts of CO_2 are produced as a result of the use of non-renewable fuel sources in the production of resources, during construction, and by occupants or other end users of buildings or structures over the course of their useful lives. The ecosystem is receiving a warning and treatment from the climatic changes brought on by global warming, and new construction techniques are required. Dust, noise, smoke, and odour are the most frequent negative effects of diverse activities on the environment (fugitive discharge). Dust and noise are the main environmental issues in the context of C & D waste management. The creation of expanding clouds of dirt from earth movements, demolition, and other building activities has a negative impact on the rising number of individuals suffering from respiratory disorders as well as a negative impact on the deteriorating surfaces.

Various restoration tasks and façade dusting are also included in the activities that generate dust. Additionally, in such circumstances, powder services must be established, necessitating careful examination and the selection of suitable preventative measures. In India, numerous activities involving marbles, such as cutting, polishing, polishing, and grinding, result in the distribution of about 6 MT of trash. Nearly 95% of the marble produced in India is mined in Rajasthan, which has around 4000 marble mines and is considered to have the largest marble reserves in the world. The neighborhood is where about 70% of the processing trash is dumped. The marble dust poses a significant environmental danger and is typically dumped on riverbeds. During the dry season, the marble dust trails in the air, soars, and settles on the vegetation and crops, posing numerous dangers. Each of these has a unique impact on regional bionetworks and the environment. The issue of water logging is brought on by the dropped marble dust, which reduces the permeability and porosity of the top soil. Additionally, due to an increase in soil alkalinity caused by the tiny component of marble dust, the soil becomes infertile. According to a 2017 study by IIT Kanpur, road dust from C & D Waste accounts for the majority of urban pollution, constituting 56% of all PM10 pollutants and 38% of all hazardous and respirable PM2 pollutants [5].

Paints, solvents, oils, and washing water are just a few of the polluting fluids used in the construction sector, which can harm the ground and neighbouring pavements. To lessen the risks of pollution on the ground, such polluting fluids should be utilised with caution. Through correct product usage, employees should limit the use of superfluous shuttering oil. Alternative oils made from synthetic and vegetable bases are more expensive but better for the environment and can be advised because they pose fewer risks to employees. The tranquilly, comfort, and health of the locals and the surrounding community are all negatively impacted by the noise generated by the construction work at the site, which also has an impact on the overall bustle of nearby schools, hospitals, and other day-to-day services. The re-processing of C & D trash, pneumatic hammers, concrete mixers, operating various machines at the site, and demolition are the main sources of noise. The necessity to take action and create laws in India is urged by the numerous negative effects of the noise caused by the dumping, processing, and reuse of C & D waste on the environment. C&D waste management has a great potential to become genuinely circular. The goals of the 2015 resource efficiency action plan, which lists C&DW as one of the "priority" waste streams, are congruent with this. Interventions motivated by the circular economy put additional emphasis on:

- Extending the economic life of the materials
- Preserving as much of their fundamental worth or quality as possible
- Cutting down on hazardous materials in garbage and products

This would lead to less circular recovery of low-grade material and more prevention of C&DW (since materials would be retained in the economy for as long as possible) [6].

Bibliography

[1] M. D. Vaverková, "Landfill impacts on the environment— review," *Geosciences (Switzerland)*. 2019. doi: 10.3390/geosciences9100431.

[2] R. Kaur, G. K. Mavi, S. Raghav, and I. Khan, "Pesticides Classification and its Impact on Environment," *Int. J. Curr. Microbiol. Appl. Sci.*, 2019, doi: 10.20546/ijcmas.2019.803.224.

[3] M. Ungar and K. Hadfield, "The differential impact of environment and resilience on youth outcomes," *Can. J. Behav. Sci.*, 2019, doi: 10.1037/cbs0000128.

[4] M. Yazdani, K. Kabirifar, B. E. Frimpong, M. Shariati, M. Mirmozaffari, and A. Boskabadi, "Improving construction and demolition waste collection service in an urban area using a simheuristic approach: A case study in Sydney, Australia," *J. Clean. Prod.*, 2021, doi: 10.1016/j.jclepro.2020.124138.

[5] G. Manjula, V. Rajagopalan, and N. T. Nayahi, "Environmental assessment of solid waste dump site," *J. Environ. Biol.*, 2019, doi: 10.22438/jeb/40/4(SI)/JEB_12.

[6] S. Gupta, "The Impact of C & D Waste on Indian Environment: A Critical Review," *Civ. Eng. Res. J.*, 2018, doi: 10.19080/cerj.2018.05.555658.

CHAPTER 7

INTRODUCTION TO TYPES AND SOURCES OF WASTEWATER

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Making sure that everyone has access to clean and adequate water sources is becoming harder as populations rise and natural habitats deteriorate [1],[2]. Lessening our pollution output and improving wastewater management are significant components of the answer [3],[4]. Increasing the treatment, recycling, and safe re-use of wastewater as a source of water, energy, and nutrients is a key component of a circular, sustainable economy. This also entails decreasing ecological pollution [5],[6]. Homes, hospitals, farms, and businesses all serve as sources of wastewater in small towns. In certain towns, combined sewers are used to collect both sewage and storm-water runoff through roads, farms, lawns, and other land uses. Therefore, wastewater may include any waste oils, street debris, pesticides, fertilisers, and waste from both animals and people. A normal household's wastewater may consist of toilet waste, wasted waters from sinks, bathtubs, showers, washing machines, as well as dishwashers, as well as any other items that may be poured down the drain or flushed into the toilet.

Numerous disease-causing organisms are present in both human and animal faeces and urine. Hazardous substances and heavy metals that are known to cause a range of health and environmental concerns may also be present in wastewater. Hospital patients, people who are ill or disease carriers, or any other person may introduce disease-causing organisms (pathogens) into a community's wastewater. It's possible for carriers to be asymptomatic or even unaware of their condition. Animal waste often enters through farms, factories for packaging and processing meat, as well as rats and other animals discovered in or near sewage or sewers.

The majority of our wastewater, whether it is treated or not, ultimately finds its way into our rivers, streams, lakes, and seas, occasionally via groundwater, the subterranean water source that we use to draw well water. We often think that groundwater is clean, and in most cases, this assumption is true. However, well water that has been tainted by sewage is a frequent source of epidemics of illnesses associated with wastewater. There are several methods for humans to "catch" illnesses from sewage. Pathogens in wastewater may be spread by direct contact with the sewage, consuming sewage-contaminated food or water, or coming into touch with human, animal, or insect carriers.

For instance, coming into direct contact with raw sewage dumped outside, playing in a yard with a malfunctioning septic system, touching it, bathing or swimming in contaminated water, or working with or coming into contact with animals or wastewater while not practising good hygiene can all result in direct contact.

Houseflies may be used as an example to highlight the risks presented by disease carriers. Flies always land right on the food they consume because they have tastes on their feet. On any particular day, this may mean that they followed picnic food with raw sewage, which is a fly favourite. Millions of germs may be carried by a housefly's body hairs, which would subsequently spread to whatever the fly touched. Communities can prevent the spread of illness by flies and other disease-carrying organisms including rodents, lice, cockroaches, and mosquitoes by ensuring that wastewater is treated and disposed of appropriately. Communities can assist to reduce the various, non-wastewater related illnesses that these animals and insects may bring by reducing their number. However, the fecal-oral route, or eating or drinking contaminated food or water, or failing to wash hands after coming into touch with sewage, is by far the most prevalent method for humans to get infections from wastewater.

There may be serious health problems if untreated wastewater enters water that is a source of drinking water for the population. When water is highly polluted with garbage, drinking water treatment might be less effective. Communities require efficient water and wastewater treatment to guarantee the safety of their drinking water. Communities must also take precautions to prevent the incorrect disposal of untreated garbage on land where it might come into touch with humans or attract animals or insects that spread illness.

Explaining the problem

Throughout the whole water cycle, water contamination is rising. Global wastewater production and pollution levels are rising as a result of population increase, rapid urbanisation, and economic development. Water pollution caused by industry and agriculture is common. Groundwater and surface water are polluted by the increased use of chemical fertilisers and pesticides, as well as by the irrigation of untreated wastewater. In many places, industry still dumps garbage straight into waterways. Serious negligence is being shown to wastewater management. Safely recycled wastewater is vastly underappreciated as a prospective, cost-effective, and long-lasting source of water, energy, nutrients, and other recoverable components. Cities with untreated wastewater have a serious problem. Untreated wastewater is often dumped into the nearest drainage channel or body of water in metropolitan areas with lower standards of living. The air in often heavily populated residential zones is polluted by household effluent, human waste, harmful chemicals, and medical waste.

The future course

The vast prospects in wastewater must be taken advantage of by the government. Water, energy, nutrients, and other recoverable components can all easily and affordably obtained from wastewater that has been safely handled. Wastewater may assist to satisfy rising demand. In municipal operations, sustainable agriculture, energy generation, and industrial growth, wastewater is used in a variety of treatment procedures and operational systems. Better wastewater management has expenses, but the benefits greatly exceed them. By generating more chances for industry and adding more "green" employment, the good effects on water quality and supply brought about by expanding wastewater recycling and safe reuse would advance public health, environmental sustainability, and economic growth.

Farmers may need access to wastewater. Wastewater is a useful source of nutrients and water for crops, improving crop nutrition, food security, and livelihoods. By lowering the danger of exposure to pathogens, better wastewater treatment may enhance the health of agricultural workers. In "industrial symbiosis," wastewater may be utilised. Industry uses a lot of water and releases a lot of wastewater. In addition to utilising rainwater for irrigation, car washing, and toilet flushing, many industries are also using part of their "process water" for cooling or heating.

Bibliography

[1] A. Jechow, C. C. M. Kyba, and F. Hölker, “Beyond all-sky: Assessing ecological light pollution using multi-spectral full-sphere fisheye lens imaging,” *J. Imaging*, 2019, doi: 10.3390/jimaging5040046.

[2] R. Nan, “Rapid detection method of ecological pollution in scenic spot under different tourism disturbance,” *Ekoloji*, 2019.

[3] Y. Rosenberg, T. Doniger, and O. Levy, “Sustainability of coral reefs are affected by ecological light pollution in the Gulf of Aqaba/Eilat,” *Commun. Biol.*, 2019, doi: 10.1038/s42003-019-0548-6.

[4] N. Zheng, “Automatic early warning method for landscape tourism ecological environment pollution of mountain scenic spot,” *Ekoloji*, 2019.

[5] M. Tytła, “Assessment of heavy metal pollution and potential ecological risk in sewage sludge from municipal wastewater treatment plant located in the most industrialized region in poland—case study,” *Int. J. Environ. Res. Public Health*, 2019, doi: 10.3390/ijerph16132430.

[6] P. E. Signoretta, V. Buffel, and P. Bracke, “Mental wellbeing, air pollution and the ecological state,” *Heal. Place*, 2019, doi: 10.1016/j.healthplace.2019.03.003.

CHAPTER 8

TYPES AND SOURCES OF WASTEWATER

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Wastewater is a result of all the domestic, commercial, and industrial activities we engage in on a daily basis, which transforms potable water into water that is basically unusable. Water that hasn't been treated because it's been polluted by a variety of foreign substances cannot be used for other purposes [1],[2].

Literally everything produces waste water. Wastewater is produced in our homes, businesses, factories, schools, hospitals, farms, and other establishments [3],[4]. The subsequent discharge of this wastewater may successfully contaminate other different water bodies and even result in nutrient contamination.

Wastewater also includes sewage water, which comes from things like bathing, washing, toilets, kitchen sinks, and cleaners. Wastewater is simply all the contaminated water from numerous sources that renders the water unfit for human consumption [5],[6]. Blackwater, Yellowwater, and Greywater are the three categories into which wastewater may normally be divided.

Blackwater

Blackwater is wastewater that comes from appliances like dishwashers, sinks used for food preparation, and toilet fittings. It is made up of a variety of chemicals and materials that may pass via toilets, sink drains, and bath drains, including urine, faeces, toilet paper, and wipes. Since the organic debris in this water is home to millions, if not billions, of bacteria, blackwater is also regarded as being very harmful.

Yellow water

As the name implies, yellow water is yellow. This is due to the significant volume of pee present. Unlike other forms of wastewater, Yellow water only contains urine as a source of pollution.

Greywater

Greywater comes from a variety of sources, including food and non-toilet fixtures, washing machines, spas, and baths.

To make things easier, it is a sort of wastewater that, in contrast to the aforementioned yellow water and blackwater, is free of pee and faeces. Unlike blackwater, graywater is good for certain limited reuse, such as watering your garden.

Pollutant Sources and Causes in Wastewater

Urban Wastewater Sources

Nearly everywhere generates waste water. These include residential residences, lodging facilities, inns, eateries, cafés, motels, bars, resorts, educational institutions, places of worship, sports arenas, theatres, medical facilities, clinics, and housing of all kinds.

Agricultural fields also create wastewater. Agriculture needs a steady supply of freshwater to irrigate the agricultural fields so they are healthy and produce well. Sadly, after being utilised in agriculture, the water also becomes effluent. This is due to the widespread use of synthetic chemicals in agriculture, including growth hormones, pesticides, herbicides, insecticides, and fertilisers.

These might contaminate the water, and as a result, wastewater could flow off into other other bodies of water including rivers, lakes, streams, seas, and oceans, creating new sources of sewage. Aside from nutrient contamination, agricultural runoff may also contribute to cultural eutrophication. As we use more water in our everyday activities, we are turning more of that water into wastewater, thereby considering it worthless for us and depleting an already finite supply of clean water. We cannot ignore the reality that the majority of the wastewater ultimately makes its way into the numerous water bodies on our globe, despite the fact that 70% of it is water. These water bodies then begin to get contaminated by effluent, finally rendering that supply of water, which was really important to us, worthless.

Marine habitat destruction and loss

Diverse natural habitats where wastewater may runoff can also get polluted with this pollution. Waterbodies aren't the only natural resource that wastewater can contaminate. The animals that live in these environments might be wiped out by this effluent, which is driven by chemicals and other dangerous elements. If wastewater is heavily contaminated, the habitat and its ecosystem risk being totally destroyed. A serious threat to marine life, cultural eutrophication is brought on by nitrogen contamination from agricultural run-off.

Increased Disease Prevalence

A habitat for several disease-causing organisms is wastewater. According to the World Health Organization, waterborne illnesses claim the lives of up to 3.4 million people annually. In addition to the different illnesses that wastewater may carry, it also includes a number of gases that, when inhaled, may result in a number of respiratory issues as well as cancers in the body. If the contaminated water body is close to a large population, many individuals will be exposed to these hazardous vapours, making the situation even more perilous.

Additionally, because the majority of the chemicals used in agriculture today are harmful, if animals or people come into touch with this wastewater, they may be vulnerable to a number of diseases and even death.

Loss of Soil Health

Due to the presence of several toxic compounds and irritants in wastewater, it is possible for it to destroy the integrity and fertility of the soil. Due to this, the soil may produce fewer crops overall, with a noticeably lower yield of those crops. After being watered with wastewater, these crops may be ingested by people, posing potential health risks. Constant soil exposure to sewage may ultimately cause the soil to dry up and develop into a desolate wasteland that is completely unproductive.

Bibliography

[1] M. Gao, L. Zhang, A. P. Florentino, and Y. Liu, “Performance of anaerobic treatment of blackwater collected from different toilet flushing systems: Can we achieve both energy recovery and water conservation?,” *J. Hazard. Mater.*, 2019, doi: 10.1016/j.jhazmat.2018.10.055.

[2] L. Zhang *et al.*, “Co-digestion of blackwater with kitchen organic waste: Effects of mixing ratios and insights into microbial community,” *J. Clean. Prod.*, 2019, doi: 10.1016/j.jclepro.2019.117703.

[3] R. Xu, S. Xu, L. Zhang, A. P. Florentino, Z. Yang, and Y. Liu, “Impact of zero valent iron on blackwater anaerobic digestion,” *Bioresour. Technol.*, 2019, doi: 10.1016/j.biortech.2019.121351.

[4] M. Gao, B. Guo, L. Zhang, Y. Zhang, and Y. Liu, “Microbial community dynamics in anaerobic digesters treating conventional and vacuum toilet flushed blackwater,” *Water Res.*, 2019, doi: 10.1016/j.watres.2019.05.077.

[5] M. Žitnik, U. Šunta, K. Godič Torkar, A. Krivograd Klemenčič, N. Atanasova, and T. Griessler Bulc, “The study of interactions and removal efficiency of Escherichia coli in raw blackwater treated by microalgae Chlorella vulgaris,” *J. Clean. Prod.*, 2019, doi: 10.1016/j.jclepro.2019.117865.

[6] A. Oarga-Mulec, J. F. Hanssen, P. D. Jenssen, and T. G. Bulc, “A comparison of various bulking materials as a supporting matrix in composting blackwater solids from vacuum toilets,” *J. Environ. Manage.*, 2019, doi: 10.1016/j.jenvman.2019.05.005.

CHAPTER 9

TYPES OF WASTEWATER TREATMENT

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The effluent finally makes its way to the wastewater treatment facility after continuing to flow through the collecting system. When the flow enters the plant, it initially goes through preliminary treatment [1],[2]. The order of therapy is as follows: preliminary, primary, secondary, and maybe advanced or tertiary. Additionally, the "sludge" or particles that are removed from the wastewater stream need to be treated [3],[4].

Preliminary Treatment

The initial procedures that the wastewater goes through are those of preliminary treatment. Typically, flow monitoring is required in order for the operator to determine how much wastewater is being treated [5],[6]. Screenings removal is often followed by flow monitoring. Screenings include huge foreign things like sticks or even a stray golf ball as well as elements that resemble strings. These substances must be eliminated since they may harm equipment or block up systems. Bar screens and other tools designed for this purpose may be used to remove screenings. Grit removal comes next in the early treatment phase.

Sand, gravel, eggshells, and other inorganic materials make up grit. Grit should be eliminated to protect pumps and other mechanical equipment from wear and abrasion. Grit may clog pipes and lines as well. Equipment for sampling is often employed in this influent region to gather tiny amounts of effluent for examination. The operator can identify the pollution loadings entering the facility by sampling (influent).

Pumps for raw sewage are a frequent component of preliminary treatment. For the raw sewage pumps to operate properly, screening and grit removal are crucial. These substances will block the pipes and wear down the interior components. These pumps move the flow to the subsequent stage of treatment for raw sewage: Primary Therapy.

Physical settling, the first stage of treatment, eliminates solids. The main settling tank (or clarifier) slows down the wastewater entering it so that the heavier particles may sink to the bottom. Grease and other lighter substances will float to the top of the tank. The design of settling tanks includes components that allow for the removal of both settled and floating solids. Rectangular or circular primary clarifiers are available. Both kinds function equally effectively when created and maintained appropriately. Not all plants get first-aid. Primary sludge is produced during primary treatment. For final removal, the sludge is taken out and pumped to the solids treatment process. What remains after we take out the settling and floating pollutants? Solids from the wastewater's first treatment are still present. Either these substances are dissolved or they are suspended. Very tiny particles are dissolved solids (e.g., dissolving sugar in water). The solids are there even if you cannot see them. The same ends of a magnet may be compared to suspended solids. Solids resist one another. Despite their tiny size, these solids may be seen by the naked eye. Through the latter stage of therapy, Secondary Treatment, we eliminate these dissolved and suspended materials.

Secondary Treatment Work

To stabilise the dissolved solids, a biological treatment technique known as secondary treatment is utilised. The organic solids (food) in the wastewater are consumed by microorganisms (like bacteria), who then transform the organics into a cellular or biological mass that may be removed later. These biological activities all include breathing oxygen. These aerobic creatures need oxygen to function correctly and effectively. Another set of settling tanks or clarifiers is an essential component of secondary treatment procedures. The biological material that has accumulated during the biological treatment is removed by these secondary clarifiers (final clarifiers).

Secondary processes come in a variety of forms that might be used. Activated sludge is a secondary process that is quite popular. When wastewater is treated using activated sludge, it is combined with organisms that have been returned from secondary clarifiers. From the secondary clarifiers, organisms are continuously returning. Return sludge or return activated sludge is what this is.The subsequent procedure is known as disinfection in many plants. Disinfection is the process of rendering disease-causing germs inactive. It is sometimes mistaken with sterilisation, which refers to the eradication of all living things. Following secondary treatment, the effluent is often subjected to one of two types of disinfection:Either(1) Chlorination; (2) UV light.

Chlorine is used in the process of chlorination, either as a liquid or, less often nowadays, as a gas (sodium hypochlorite). The bacteria are oxidised by the chlorine. Testing the faecal coliform group serves as a means of keeping track of this procedure's efficacy. This indicator group of bacteria is more difficult to eradicate than diseases and is simple to cultivate in a lab. To get rid of any remaining chlorine, some chlorination systems additionally contain dechlorination units. UV light bulbs enclosed in transparent housings are used in ultraviolet (UV) disinfection systems to make direct contact with the treated secondary effluent.

Through the use of a germicidal photochemical wavelength, UV light eradicates harmful organisms. UV does not leave any residue in the wastewater, in contrast to chlorination. UV-using plants must have two UV systems or a backup chlorine system. These UV systems also need a lot of electricity.

Advanced Treatment:

Due to potential harm to the receiving stream, certain treatment facilities may be needed to remove nutrients (nitrogen and phosphorus) (e.g., ammonia toxicity to fish). To eliminate nutrients, extra solids, and/or biochemical oxygen demand, advanced treatment methods are applied. Beyond secondary therapy, advance treatment offers a very high degree of care. The mechanisms involved in removing nitrogen are biological. Chemical additives are often needed to remove phosphorus.

Bibliography

[1] G. Crini and E. Lichtfouse, "Advantages and disadvantages of techniques used for wastewater treatment," *Environmental Chemistry Letters*. 2019. doi: 10.1007/s10311-018-0785-9.

[2] F. Wollmann *et al.*, "Microalgae wastewater treatment: Biological and technological approaches," *Engineering in Life Sciences*. 2019. doi: 10.1002/elsc.201900071.

[3] M. Molazadeh, H. Ahmadzadeh, H. R. Pourianfar, S. Lyon, and P. H. Rampelotto, "The use of microalgae for coupling wastewater treatment with CO2 biofixation," *Frontiers in Bioengineering and Biotechnology*. 2019. doi: 10.3389/fbioe.2019.00042.

[4] K. Li *et al.*, "Microalgae-based wastewater treatment for nutrients recovery: A review," *Bioresource Technology*. 2019. doi: 10.1016/j.biortech.2019.121934.

[5] T. Luukkonen, A. Heponiemi, H. Runtti, J. Pesonen, J. Yliniemi, and U. Lassi, "Application of alkali-activated materials for water and wastewater treatment: a review," *Reviews in Environmental Science and Biotechnology*. 2019. doi: 10.1007/s11157-019-09494-0.

[6] Y. Liu, H. H. Ngo, W. Guo, L. Peng, D. Wang, and B. Ni, "The roles of free ammonia (FA) in biological wastewater treatment processes: A review," *Environment International*. 2019. doi: 10.1016/j.envint.2018.11.039.

CHAPTER 10

WASTE WATER TREATMENT PLANT (WWTP)

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An industrial facility known as a waste water treatment plant (WWTP) uses a mix of mechanical, physical, chemical, and biological techniques to remove pollutants from incoming wastewater. In order to cleanse and filter raw sewage before releasing it into waterways, WWTPs are utilised[1],[2]. These facilities are crucial infrastructure assets in India that must remain completely functioning throughout the year [3],[4]. Local governments often manage and fund these facilities. The treatment process downstream may be affected by changes to the operational parameters, and since there are severe penalties for violating the terms of an environmental licence, effective operation necessitates a thorough investigation of the treatment system [5],[6].

Worldwide, treating household wastewater (DWW) consumes significant quantities of electrical energy each year. Energy costs are predicted to grow in the future as demand for energy resources rises and fossil fuel stocks are exhausted. By using the right technology, the chemical energy that could be found in the organic chemicals found in DWWs might assist to improve the energy and financial balance of DWW treatment facilities. The two types of domestic wastewater are as follows: Due to the presence of protein, fatty substances, complex carbohydrates, as well as various types of emerging and other pollutants, black water, which comes from toilets and kitchens, typically has high concentrations of organic matter (more than 10,000 mg/L), while grey water, which comes from bathrooms and laundry rooms, has lower concentrations of organic matter (400 to 1000 mg/L) and accounts for the majority of wastewater flow.

The present analysis includes both domestic wastewater categories to indicate untreated home wastewater. An emerging device called a bioreactor was created to clean wastewater and produce power via the interaction between microbes and electrodes. It is a technique that makes use of electroactive microorganisms that function as a biocatalyst at the anode compartment and transform organic materials found in sewage water for the generation of bioelectricity while also purifying wastewater.

Although the technology has gained greater traction in recent years, it is still a long way from being used in the field. Its scaling limitations, including as internal and external resistance, size concerns, and cathode challenges, are what prevent it from being used more widely. Waste water treatment goals from the early 1900s through the early 1970s centred on the removal of colloidal, suspended, and floatable debris, the treatment of biodegradable organics, and the eradication of harmful organisms. The development of treatment techniques and the change in emphasis toward the decrease of biological oxygen demand (BOD), total suspended solids (TSS), and pathogenic organisms did not occur until the middle of the 1970s and 1980s.

Additionally, researchers were starting to get a better understanding of the role of nutrients like nitrogen and phosphorus as well as the effects they had on aquatic habitats. WWTPs may use a variety of techniques, including chemical oxidation, chemical reduction, biological oxidation, and biological reduction. An enormous quantity of power is needed for this plant. The Parliament's analysis of prior data shows that a rise in power costs is expected in the long run. Since ratepayers provide financial support for the council, excessive expenditure will probably affect the council's capacity to perform capital works projects. Over the last three years, India's cost of power has gone up for the facility. The cost of running the treatment facility is also expected to rise in anticipation of this trend. Ratepayers will eventually be responsible for paying the increased costs, either via rate increases or by the funding of little or no capital works projects.

The Cairns Regional Council (CRC) manages the resources for and operates the WWTP in this study. Three 25kW VSD A-recycle pumps and eight 7.6kW mixers make up the bioreactor. The WWTP's average monthly power expense increased from $52,000 in 2014 to $54,000 in 2015. An examination into the best submersible mixer layout might lead to a reduction in the number of mixers needed for the bioreactor or in the operating duration of the mixers, which would reduce the cost of power over the next ten years as well as the population of Cairns. Therefore, a study of the existing submersible mixer architecture may lead to a reduction in the cost of power to run the facility, possibly saving money for Council. Given that the Council runs a second treatment centre with a comparable layout and is also building a new facility, this advantage may increase.

Due to increased globalisation and industrialisation, the globe is now undergoing an energy crisis. There is a need to find alternate ways to create energy effectively since the majority of renewable energy sources are being exhausted. Research efforts worldwide are now heavily concentrated on the hunt for innovative, sustainable, and efficient energy sources. In the area of wastewater management, it is necessary to either create a brand-new, dependable, environmentally friendly, and economically advantageous technology or to enhance an already existing one. It becomes possible to address the current water demand by reusing grey water using localised, inexpensive treatment systems. Constructed wetlands (CW) systems and bioreactors have developed as appealing solutions for environmentally friendly wastewater treatment in recent years. You may handle wastewater treatment by using these two passive methods.

The activated sludge process is a typical sort of treatment procedure. In the bioreactor, raw sewage is treated by simulating biological processes that happen naturally. Each zone of the bioreactor, which processes raw sewage, produces a separate biological response to help remove contaminants like ammonia compounds. The WWTP bioreactor is the primary treatment element of the WWTP and is a segmented activated sludge process. The sewage is broken down and its impurities are removed in the bioreactor, which is a multi-compartment box-like structure. The following zones make up the Northern WWTP of the Cairns Council, an activated sludge compartmentalized bioreactor.

Bibliography

[1] S. Wolff, J. Kerpen, J. Prediger, L. Barkmann, and L. Müller, "Determination of the microplastics emission in the effluent of a municipal waste water treatment plant using Raman microspectroscopy," *Water Res. X*, 2019, doi: 10.1016/j.wroa.2018.100014.

[2] F. K. Jaber, S. W. Hachem, and F. M. S. Al-Zwainy, “Calculating the indexes of earned value for assessment the performance of waste water treatment plant,” *ARPN J. Eng. Appl. Sci.*, 2019.

[3] D. Młyński, P. Bugajski, and A. Młyńska, “Application of the mathematical simulation methods for the assessment of the waste water treatment plant operation work reliability,” *Water (Switzerland)*, 2019, doi: 10.3390/w11050873.

[4] M. Stanculescu, C. A. Badea, I. Marinescu, P. Andrei, O. Drosu, and H. Andrei, “Vulnerability of SCADA and Security Solutions for a Waste Water Treatment Plant,” in *2019 11th International Symposium on Advanced Topics in Electrical Engineering, ATEE 2019*, 2019. doi: 10.1109/ATEE.2019.8724889.

[5] M. Karamouz and M. A. Olyaei, “A Quantitative and Qualitative Framework for Reliability Assessment of Waste Water Treatment Plants Under Coastal Flooding,” *Int. J. Environ. Res.*, 2019, doi: 10.1007/s41742-018-0141-8.

[6] G. Oluleye, D. Wigh, N. Shah, M. Napoli, and A. Hawkes, “A framework for biogas exploitation in Italian waste water treatment plants,” *Chem. Eng. Trans.*, 2019, doi: 10.3303/CET1976166.

CHAPTER 11

PROCESSES USED BY WASTEWATER TREATMENT PLANTS

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Various procedures are used in wastewater treatment facilities to clean wastewater, including:

Coagulation

a method of removing the majority of suspended particles and other other impurities by adding different chemicals to a reaction tank [1],[2].

Flocculation

The water next enters the flocculation chamber where the particles are gradually mixed together with long-chain polymers to produce visible and settleable particles [3],[4]. The flocculation process is finished.

Sedimentation

Water and flocculated material enter the chamber of the gravity settler, which is a large circular device, and circulate outward from the centre. Water rises to the top of the clarifier during a protracted settling phase and spills beyond its walls. Due to gravity, the solids might then form a sludge blanket at the bottom of the clarifier [5],[6]. After that, the solids are swept into a tube-shaped compartment in the centre of the clarifier where gradual mixing takes place. An operation for dewatering receives the sludge that pumps up from the bottom. By using filter or belt presses, the procedure completely removes the water from the sludge, producing a cake that is solid. The water from the sludge is squeezed out using a press and two belts. A hopper is used to convey the sludge to a landfill once it has been placed there.

Filtration

The water that has overflowed into gravity sand filters will then be pumped out. Usually, two to four feet of sand are inserted in the filter, packed densely. When the feedwater runs through, the particles are caught.

Disinfection

The next stage is disinfection or chlorination to eliminate the microorganisms in the water after it has passed through gravity-sand filters. In order to maintain the filters' cleanliness and disinfection, this step is sometimes carried out upstream of the filtering process.

Distribution

The wastewater is recycled in an industrial process and is often piped into a storage tank that may be utilised as needed by the facility. Primary, secondary, and tertiary treatments are the three basic processes that wastewater treatment facilities use to function.

Solids (which float to the bottom of the tank) are broken down during the primary treatment process into sludge, which is then used to treat water during the secondary stage. Large sedimentation tanks are where the procedure is carried out. After that, the sludge from the sedimentation tank is used for anaerobic digestion, which is the process by which microorganisms break down organic materials.The pollutants are biologically removed from the wastewater by microorganisms once the treated water is discharged for secondary treatment. Both aerobic and anaerobic methods are used during the therapy procedure. In certain cases, the process is linked or differs depending on the bacterial populations. Before releasing or reusing the wastewater, the last treatment stage, or tertiary treatment, completes the final polishing.

Primary, secondary, and tertiary degrees of treatment are some of the stages at which wastewater is processed. The majority of municipal wastewater treatment facilities employ primary and secondary stages of treatment, while some additionally use tertiary treatments. Although the kind and sequence of treatment may differ from one treatment facility to the next, the fundamental elements are shown in this schematic of the Ottawa-Carleton wastewater treatment facility.

Individual septic systems, straightforward collecting systems that immediately release effluent to surface waterways, or municipal lagoons that are periodically drained may be used as wastewater treatment facilities in small settlements. The trash is often treated and distributed at these facilities as near to the source as is practical, reducing operating expenses and maintenance needs. Less garbage will pollute drinking water sources if it can remain in a lagoon for a longer period of time before being released. Others discharge the garbage into water sources immediately, while other municipalities keep the trash in lagoons.

The sewage is temporarily stored in lagoons under the surface before being released into the earth or into a body of water. As part of the basic treatment process, solid waste is allowed to sink to the bottom of shallow lagoons that are less than 1.5 metres deep over the course of 6 to 20 days. But most toxins that cause issues for ground and surface waterways cannot be successfully removed by shallow lagoons. For a period of six months to a year, deep lagoons with a depth of more than three metres may be used for long-term storage and treatment. Small towns often have annual lagoon emptyings. Wastewater disposal in rural areas often takes place on nearby property. If the soil is healthy and there are no nearby water sources, microbes in the soil may extract and degrade pollutants from wastewater. This may be a successful way to clean wastewater since land is readily available in many rural regions. The quality of the lake, river, or groundwater source that supplies drinking water is at risk in certain places, however, because of the manner trash is disposed of in such areas.

State water quality agencies have identified malfunctioning wastewater treatment systems as the second greatest threat to water quality, with the Environmental Protection Agency estimating that between 10 and 20% of small community wastewater treatment facilities in the United States are not operating properly (after underground storage tanks). A significant contamination problem arises for a large number of rural areas when insufficient wastewater treatments are paired with inefficient drinking water treatment.

Bibliography

[1] C. M. de Bont, W. C. Boelens, and G. J. M. Pruijn, "NETosis, complement, and coagulation: a triangular relationship," *Cellular and Molecular Immunology*. 2019. doi: 10.1038/s41423-018-0024-0.

[2] X. Yang *et al.*, "Bacterial Endotoxin Activates the Coagulation Cascade through Gasdermin D-Dependent Phosphatidylserine Exposure," *Immunity*, 2019, doi: 10.1016/j.immuni.2019.11.005.

[3] J. Naceradska, L. Pivokonska, and M. Pivokonsky, "On the importance of pH value in coagulation," *J. Water Supply Res. Technol. AQUA*, 2019, doi: 10.2166/aqua.2019.155.

[4] M. Cugno, A. Borghi, S. Garcovich, and A. V. Marzano, "Coagulation and skin autoimmunity," *Frontiers in Immunology*. 2019. doi: 10.3389/fimmu.2019.01407.

[5] M. Pazzola, "Coagulation traits of sheep and goat milk," *Animals*. 2019. doi: 10.3390/ani9080540.

[6] N. Ziliotto, F. Bernardi, D. Jakimovski, and R. Zivadinov, "Coagulation pathways in neurological diseases: Multiple sclerosis," *Frontiers in Neurology*. 2019. doi: 10.3389/fneur.2019.00409.

CHAPTER 12

BENEFITS OF MODERN WASTEWATER TREATMENT

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A wastewater treatment system contributes to the environmental safety and cleanliness of our water. Waste water from toilets, sinks, washing machines, bathtubs, and all other residential water-using equipment is collected, stored, treated, and disposed of by a wastewater treatment system [1],[2]. A wastewater treatment system typically includes a septic tank as well as any related pipelines, drains, percolation zones, and fittings that make sure the water is properly treated and released. Many new constructions nowadays feature a wastewater treatment facility on the site.

Having a contemporary wastewater treatment system has several advantages.

1. Prevents Potential Diseases

Systems for treating wastewater remove unwanted organisms and eradicate microorganisms that cause sickness. Before the wastewater exits the tank and reaches the ground, it filters out such impurities. By preventing infections from reaching plants, farm animals, or water supplies, this filtration process contributes to environmental protection [3],[4].

2. Inexpensive

If properly maintained, wastewater systems may endure for up to 15 years. They provide a relatively affordable way to purify water and keep undesirable microorganisms at bay. You may now get a lot of grants and other types of financial aid to help with the price of getting and/or maintaining a residential wastewater system [5],[6].

3. Little to No Odor Emissions

Modern waste water systems emit very little smell compared to older systems. People are often deterred from investing in a septic tank or similar system by odour emissions because they cannot handle the odours it might sometimes emit. Once properly maintained, smells are not a problem with contemporary systems.

4. Not Paying Water Bills

Nowadays, water fees are an unwelcome reality in many nations. You won't have to worry about paying water costs if your property has a private wastewater system. You save money in this area since it doesn't cost much to pump water into the system.

5. Requires Minimal Upkeep

Modern wastewater systems are far more durable and need much less maintenance than earlier ones. A septic tank may need de-sludging every one to two years, depending on use, with maintenance checks only being done every two to three years. By looking for certain early warning indicators of issues, you may do your own inspections in the meantime.

6. Quicker Solids Decomposition

The majority of contemporary wastewater systems are aerobic systems, which can break down particles considerably more quickly than earlier systems. As a result, blockages are less of a problem, de-sludging is needed less often, and fewer sediments pollute the drainage field and groundwater.

7. Wasteful less

Septic tanks of today waste less water than main lines. There is no surplus waste water that has to be treated for just one load of washing or toilet usage. The used water is naturally purified and returned to the soil.It is crucial to have a working wastewater treatment system because it may stop the spread of illness, save the environment, and ultimately save you money. Additionally, investing in a wastewater system is now more financially practical because to technological advancements that make current systems cheaper, more efficient, and simpler to operate than earlier ones.

One of life's most essential necessities is water, and as the country's urbanisation has fast increased, so has the need for and use of it. Around 80% of the water made available for domestic use is wastewater. The majority of the time, untreated wastewater is dumped into the environment and either sinks into the ground as a potential groundwater pollutant or enters the natural drainage system, where it pollutes the areas downstream.

Pollution problems are increasing the workload on sewage treatment systems, industrial wastewater treatment facilities, and associated infrastructure. Today's water is notably more contaminated with chemicals, heavy metals, and dangerous substances. Advanced waste management techniques and more efficient wastewater treatment techniques are used to get the purified water. These techniques filter the water, remove impurities, and absorb carbons.

Local municipalities should build additional small-scale wastewater treatment facilities. If there are no local water treatment facilities, the communities must be urged to assist the wastewater treatment personnel by collecting wastewater wherever it can be done. This will cut down on their workload and improve the effectiveness of the wastewater treatment procedures. In order to generate water that is fit for drinking and is also useful to people and animals, additional wastewater treatment facilities will eventually need to be erected.

To address this problem, individuals must assume leadership roles and create novel concepts and technology. In order for people to take appropriate action to safeguard and maintain the environment in which they live, they must first be informed about wastewater so that they may be aware of the potentially damaging effects that it may have.

A thorough training programme for wastewater operators will provide a local government additional substantial advantages in addition to maintaining compliance with certification standards. Efficiency in utility O&M depends on a well-trained personnel. When it comes to running efficient facilities, good training will pay off significantly over time. Local leaders with a keen eye will make sure that the O&M budgets include enough money to send workers to the top training programmes. This might include sending employees to training sessions held off-site, covering the cost of their course registration and travel fees, or scheduling training sessions for employees to attend while they are at work and designating other staff to cover the rest of the shift.

Contracting for on-site training that is specifically tailored to each wastewater plant is another option for training. Technical education is not always required. The development of a more effective and productive workforce also depends on the implementation of training programmes in management, supervision, and other crucial skills, such as computer use and good report writing.

There should be a designated training coordinator if the workforce is sizable enough. This person may assess the training requirements for the employees and keep an eye out for suitable training opportunities or courses. The training coordinator is in charge of scheduling personnel for off-site training, organising on-site training sessions, and keeping an eye on the training budget. The coordinator should assess the training courses to identify which ones are most useful in raising employee productivity. A technical background in water or wastewater treatment is required of the person in charge of organising training.

Bibliography

[1] G. Crini and E. Lichtfouse, "Advantages and disadvantages of techniques used for wastewater treatment," *Environmental Chemistry Letters*. 2019. doi: 10.1007/s10311-018-0785-9.

[2] F. Wollmann *et al.*, "Microalgae wastewater treatment: Biological and technological approaches," *Engineering in Life Sciences*. 2019. doi: 10.1002/elsc.201900071.

[3] M. Molazadeh, H. Ahmadzadeh, H. R. Pourianfar, S. Lyon, and P. H. Rampelotto, "The use of microalgae for coupling wastewater treatment with CO2 biofixation," *Frontiers in Bioengineering and Biotechnology*. 2019. doi: 10.3389/fbioe.2019.00042.

[4] K. Li *et al.*, "Microalgae-based wastewater treatment for nutrients recovery: A review," *Bioresource Technology*. 2019. doi: 10.1016/j.biortech.2019.121934.

[5] T. Luukkonen, A. Heponiemi, H. Runtti, J. Pesonen, J. Yliniemi, and U. Lassi, "Application of alkali-activated materials for water and wastewater treatment: a review," *Reviews in Environmental Science and Biotechnology*. 2019. doi: 10.1007/s11157-019-09494-0.

[6] Y. Liu, H. H. Ngo, W. Guo, L. Peng, D. Wang, and B. Ni, "The roles of free ammonia (FA) in biological wastewater treatment processes: A review," *Environment International*. 2019. doi: 10.1016/j.envint.2018.11.039.