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# CONSTRUCTION WASTE MANAGEMENT OF PADMA BRIDGE RAIL LINK PROJECT (PBRLP) AND ITS ENVIRONMENTAL IMPACTS: A CASE STUDY

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## ABSTRACT

*Padma Bridge, the landmark structure in the history of Bangladesh, is a duel deck steel truss bridge where the ballastless track line passes through the lower deck. Padma bridge will connect the southwestern districts to the rail network from Dhaka through Padma Bridge Rail Link Project (PBRLP). The research paper illustrates the construction waste management at the Mawa- Bhanga Section of PBRLP and its impacts on the surrounding environment by summarizing and comparing test results for various parameters of air, surface water, and groundwater sample. The development progress in construction industries has great effects on the environment, especially in environmental change and waste produced. Construction waste comprises both Inert and non-inert waste effluents that mix with the surrounding air and water and thus those are contaminated. From the different test data analyses, the adverse effects are determined. A few recommendations are suggested for construction waste management for such huge development projects.*

***Keywords****: construction waste management, padma bridge, environmental impacts assessment, air quality, surface water, groundwater.*

## INTRODUCTION

Construction and demolition waste (CDW) is defined as a mixture of surplus materials generated from the construction, renovation, and demolition activities, for example, site clearance, land excavation, roadwork, and demolition. Depending on the chemical response, CDW is divided into inert and non-inert materials. Concrete, bricks, and sub-soil are the common types of inert materials, and these are hardly participating in chemical reactions under typical circumstances. In contrast, rebar and wood are non-inert materials and are readily involved in chemical reactions (Md. R. Hasan et al., 2022). Some of the common CDW can be lumber, drywall, metals, masonry (brick, concrete), carpet, plastic, pipe, rocks, dirt, paper, cardboard, or green waste related to land development. Waste materials from new wood for construction work like plywood, chip wood, dimensional lumber, shavings and sawdust, and different demolition wood waste are considered as wood waste in the construction site. Cut pieces of metallic materials such as new metal studs, metal beams, and pipes are considered metallic waste. Besides these, plastic and other different types of waste materials can be found on any construction site(Chowdhury et al., 2016). Directly or indirectly, from constructing new structures and demolition of old or renovated structures, a considerable amount of CDW has been generated as unwanted materials. It is estimated that construction and demolition debris is about 15-30% of all solid waste by weight, and it represents a significant component of municipal solid waste (Md. R. Hasan et al., 2022). Construction & Demolition waste (CDW) is not managed effectively in most countries. These vast amounts of construction waste cause a huge loss to the economy and environment (R. Hasan et al., 2022). A country's economic progress is reliant on construction projects. The construction industry provides numerous job opportunities, and economic contributions, and serves as a basis for other businesses.

The role it plays in socio-economic development goes beyond its share in national output. A study has shown that civil works and building construction consume 60% of raw materials, with building projects accounting for 40% of this volume. In addition, the construction industry produces approximately 35% of total waste to the environment globally. Similarly, the industry uses 35% of energy and releases 40% of carbon dioxide into the atmosphere, at the global level. In developing countries, construction activities account for 80% of the total capital asset, 10 % of their GDP, and more than 50 % of the wealth invested in fixed assets (Tafesse et al., 2022). Nowadays, Bangladesh has huge development works. Mega projects such as Padma Bridge Rail Link Project (PBRLP) are ongoing around the country and are copious and many to start in the upcoming days. According to previous reviews, before starting construction work in any region waste generation and management becomes an important issue. But research and technical resource related to the construction waste management scenario in Bangladesh is very poorly disregarded. Some statistics are available relating to solid waste generation and management. But when it comes to construction and demolition wastes, sufficient information is not available to predict future conditions and thus take preventive measures. In Bangladesh, concerns about construction waste management are hardly seen among consumers as well as clients. When profit maximization and completion of a project within due time is the main goal, CDW Management could be regarded as an extra burden (Chowdhury et al., 2016). As a result, contractors or clients have to bear profit loss because of additional overhead costs and delays, and loss of efficiency due to extra time spent on cleaning. Since subcontractors have to estimate the amount of cost and time for waste generation during bidding, subcontractors have often blamed construction waste generation (Md. R. Hasan et al., 2022). It is estimated that about 85-90% of the generated CDW is dumped in Bangladesh. Inefficient CDW management is the main reason for the unauthorized dumping in Bangladesh. Bangladesh's old landfills are almost reaching their capacity, and uncontrolled landfill sites are chosen for the CDW (Md. R. Hasan et al., 2022). For the scarcity of dumping sites, illegitimate dumping along verges is increasing. Consequently, the adjacent environment is polluting, and toxin materials from this waste infiltrate soil and drinking water and frighten residents' health. Reduced landfill space, exhaustion of resources, ingesting of energy and non-energy resources, global warming, and increased environmental pollution (including air, water, soil, and noise pollution) is the noteworthy environmental effects caused by CDW (Md. R. Hasan et al., 2022). Construction waste generation has become a major apprehension due to its straight impacts on the environment while affecting the efficiency of this industry. Building activity has vast environmental influences from air pollution and water pollution. The most important and unpleasant environmental effect is from incineration which discharges pollutants into the air (Chowdhury et al., 2016). The construction sector contributes about 23% of air pollution, 50% of climatic change, 40% of drinking water pollution, and 50% of landfill waste(R. Hasan et al., 2022). The circulation of polluting emissions - waste - is a topical issue at the level of employees involved in construction, society, and the state. However, construction waste may also contain substances that are hazardous to the environment and human health (e.g. chemicals). They cause soil and subsoil contamination. After that, groundwater could be polluted as a result of precipitation. It is also noted that construction can have both direct (polluting emissions, degradation of ecosystems) and indirect (extraction of natural resources, production of used raw materials for construction) environmental impacts. The main sources of pollution during the construction life cycle are harmful gases, noise, dust, chemicals, and various types of solid and liquid waste, which cause air, water, noise, and vibration, as well as soil and soil pollution, respectively (Tambovceva et al., 2020). It is high time to consider controlling the generation of CDW in different projects to achieve sustainable development of CDW (Md. R. Hasan et al., 2022).

Environmental impact assessment as a tool to avoid the adverse effect of economic matters was introduced in response to the challenges that arose in the nature-society-economy system (NSES). Today, the interaction of society and nature is demonstrated through the economy, particularly in the construction, reconstruction, expansion, and redevelopment of numerous economic facilities, which is inevitably accompanied by deviations in parameters, and qualitative and quantitative features of the environment. Afterwards, it could potentially cause damage to the environment. This makes environmental safety, environmental protection, rational use and reproduction of natural resources necessary (Barna, 2021).

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## DESCRIPTION OF STUDY AREA

Bangladesh is making determined strides towards greater participation in global and regional markets, but transportation infrastructure and logistics insufficiencies severely limit such efforts. With noteworthy developments to connectivity and transport schemes infrastructure, the country could become a transport hub within the region, and reap immense economic benefits as a result. Given scarce land resources, Bangladesh views railways as the most efficient, cost-effective, and environmentally friendly means of augmenting the movement of freight and passengers through the country. Importance is being given to the railway division since it is considered the greatest land transportation choice for the country. It is a better people-moving means than long-distance buses, is more cost-effective for carrying bulk freight, and has overall lower hostile environmental influences than other means of transport. It is considered the preferred solution to cracking many of the country’s land transport limitations.

Bangladesh Railway, the state-owned rail transport agency, is developing the BDT392.46bn ($4.55bn) project named as “Padma Bridge Rail Link Project(PBRLP)” with Chinese financial support. The main construction work on the railway project started in July 2018, following the signing of a loan agreement with the Chinese Exim Bank in April 2018. China is funding 85% of the project total while the Government of Bangladesh will be backing the remaining 15%. The 169km rail link includes four sections likewise the 3km link between Dhaka and Gandaria, the 37km-long Gandaria-Mawa section, the 42km-long Mawa-Bhanga section, and the 87km-long Bhanga-Jessore section. The project also has 43.2km of loop and siding line, standing the total track length to 215.2km. The PBRLP comprises 66 major bridges with the 6.1km-long Padma bridge, as well as 244 minor bridges, and 29 level crossings along the route. The total length of viaducts will be 23.7km. The rail link project also includes 14 new station buildings, the remodeling of six existing station buildings, with computer-based railway relay interlocked signaling and telecommunications systems for 20 stations. It is planned to be completed in 2025. The rail link will connect the Munshiganj, Shariatpur, Madaripur, and Narail districts with Dhaka a. Padma Bridge Rail Link Project (PBRLP) is bringing an conclusion to the lifetime misery of publics of the southwest region of Bangladesh. This will reduce the distance between Dhaka and Jessore by 212km. As a results, the travel time will shrink from 6 hours to only 2.5 hours. GDP will upsurge by 1% as a whole. This project will convey amity and sunshine to the southwest region which just safeguards another landmark toward fulfilling Bangabandhu's vision. The new route will also not have any speed or load limitations and will allow Bangladesh Railway to introduce national and regional broad-gauge container train services. The rail link will also generate an opportunity to construct another line in the route to connect Barisal and the Payra Deep Sea Port.

China Railway Engineering Corporation (CREC) and 12 of its subordinates are involved in the construction of the project. The Corps of Engineers of the Bangladesh Army was chosen as the construction supervision consultant (CSC) for the project in January 2017. Professional services firm SMEC and its wholly-owned subsidiary ACE Consultants were contracted by the Corps of Engineers of Bangladesh Army to provide consultancy services for the project in July 2017.

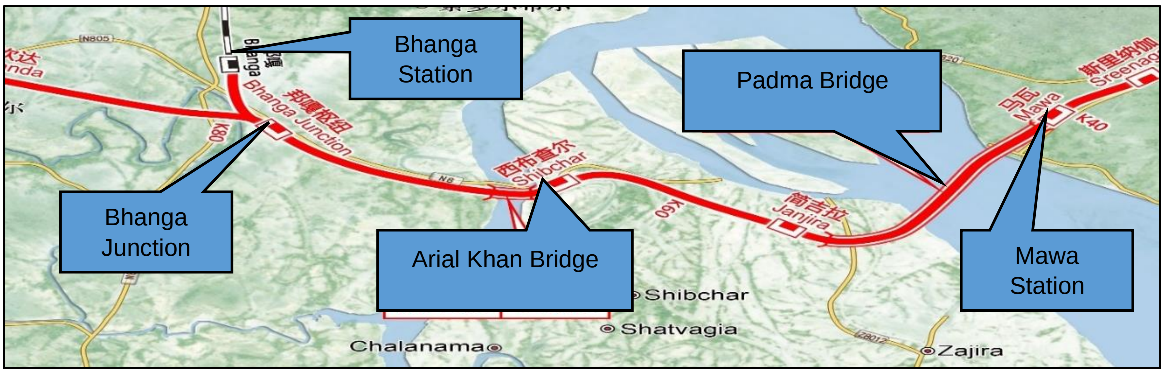


Figure 1 Location of study area.

The Mawa-Bhanga section will connect Mawa to Bhanga, via the Padma Bridge with proposed alignment 42.195 km of route length, including the 6.15 km of Padma Bridge, completed in June 2022 except rail line. The chainage measurements begin at Mzwa as 39+630 Km and are recorded continuously to Bhanga Station as 82+825 Km. Also, there are one steel truss bridge on the Arial Khan river, 11 other semi-through plate girder (STPG) steel bridges, another PC-T girder bridge, 32 underpasses, 37 box culverts, 31 km long embankments, 4 newly constructed railway stations with modern facilities and 42 km long railway tracks with 13.2 km long high-speed ballastless track and rest portion of ballasted tracks are the main features of the Mawa-Bhanga Section.

The contract is related to the implementation of environmental quality as per national regulations of Environment Conservation Rule, 1997 (ECR ’97) with its schedules & amendments and ISO 14001:2015 requirements in the designated locations approved by the consultant and employer. According to Bangladesh laws and regulations, the CREC is submitting reports, notices, and information to Relevant Authorities. The CREC is providing environmental performance data as required by the Employer to a scope and frequency determined by the Employer, according to all the applicable Laws, EIA, and SEMP. CREC is submitting an environmental report every month, which includes environmental protection management and monitoring results. This research is featured on the CDW management and Environmental Impact Assessment (EIA) through ambient air quality, surface & groundwater quality monitoring at the Mawa-Bhanga section.

## OBJECTIVES

This research aims to

- Describe the construction & demolition waste generation & management of the project.
- Assess the environmental impacts of C&D waste by summarizing & comparing test reports of various parameters regarding ambient air, surface & groundwater collected from different locations of the study area.
- Identify the lacking of an existing waste management system.
- Find out the recommendation for modifications to be made regarding C&D waste management.
- Provide a database from which the environmental impacts of the project can be assessed.
- Provide an early indication should any of the environmental control measures or practices fail to achieve acceptable standards.
- Monitor the performance of the project and the effectiveness of the mitigation measures.
- Determine project compliance with regulatory requirements, standards, and government policies.
- Take remedial actions if unexpected problems or unacceptable impacts arise.

## METHODOLOGY

The research is divided into two main categories as Construction & Demolition waste (CDW) management and Environmental impact assessment. Since CDW management is not accurately followed & lacking an adequate number of related research in Bangladesh, a lot of related researches study is a must for knowing the dawn of this research. Followed by the research study, primary data was collected from different types of work sites identifying categories, causes & sources of generation, and disposal ways of CDW waste. Collected data was summarized, analyzed, and compared based on categories, causes & sources of generation and disposal ways and finally recommended a better way of waste management. As for environmental impact assessment, secondary data is collected from monthly environment monitoring reports submitted by the construction team starting from September 2020 to June 2022. Air samples are collected from three locations (one point on track and another point at 50m away from the track alignment at each location) for testing of nine parameters such as CO, NO, $NO_2$, $SO_2$, $O_3$, Volatile Organic Carbon (VOC), $PM_{10}$, $PM_{2.5}$, and air temperature. Air Quality Standard Values are considered by the Department of Environment (DoE), GoB. Surface water samples are also collected from three locations (one point 25m upstream and 25m downstream at each location) for testing of nine parameters such as Total Organic Carbon (TOC), Total Phosphate (TP), Total Suspended Solid (TSS), Oil & Grease, Dissolved Oxygen (DO), pH, $BOD_5$, COD & temperature. Groundwater samples are also collected from three locations for testing of seven parameters such as

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pH, Total Dissolved Solid (TDS), As, Fe, Mn, S, and Cl. Collected data are summarized in tabulated form. A graphical comparison of different parameters is shown concerning the progress of the project.

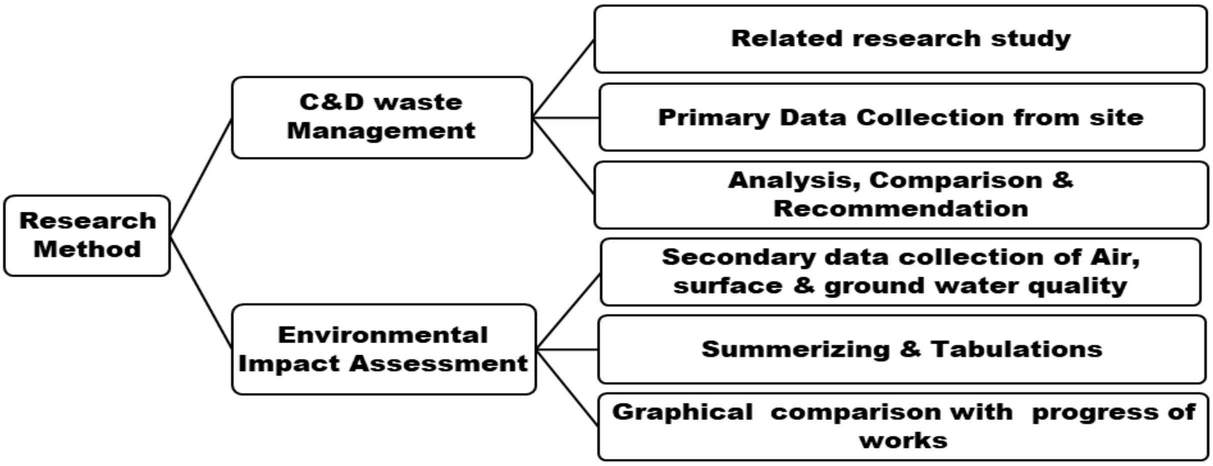


Figure 2 Research Methodology

## CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

Table 1 An overview of construction & demolition waste of PBRLP (Mawa-Bhanga)

| Works | Main components | Types | Avg. Gen (kg/day) | Disposal way | Possible Effluent |
|---|---|---|---|---|---|
| Concreting, & asphalt paving | Cement, sand, stone, admixture | Inert | 50 | Donate, reuse, dust control | Fe, $PM_{10}$, $PM_{2.5}$, TDS, TSS, CO, $O_3$, NO, $NO_2$, Mn, S, As, VOC, $H_2S$, TOC polymer, resin, organic fat |
| Masonry | Bricks, cement, sand, Tiles | Inert | 15 | Landfill, Illegal disposal | Fe, $PM_{10}$, $PM_{2.5}$, Cl |
| Rebar | Rebar, Binding wire | Non-Inert | 20 | Reuse, Recycle, Scrap | Fe, C |
| Formwork & Scaffolding | Iron, cardboard, timber, wood, bamboo | Inert & non-inert | 10 | Reuse, recycle, scrap, landfill, burning | Fe, C, CO, PM10, $PM_{2.5}$, S, $SO_2$, CO, NO, $NO_2$, $O_3$ |
| Embankment | Sand, Soil, vegetation | Inert | 10 | Landfill, Illegal disposal | TSS, TDS, $PM_{10}$, $PM_{2.5}$, Cl, TOC |
| Paint & varnish | Paint, varnish | Non-inert | - | Flown away to air | VOC, TDS, TSS, Oil & grease |
| Glass | Glass | Inert | 3 | Landfill, Illegal disposal, Recycle | TDS, TSS, Cl, TP |
| Wrapping & packaging | Plastic, paper, polythene | Inert | 20 | Landfill, illegal disposal, burning | CO, $SO_2$, VOC, TOC, $CO_2$, |
| Demolition | Concrete, rebar, etc. | Inert & Non-Inert | 20 | Landfill, Illegal disposal, Reuse, Recycle | Fe, $PM_{10}$, $PM_{2.5}$, TDS, TSS, C, O, Mn, S, As |
| Electrical, sanitary & plumbing | Pipes, wires, ceramics | Inert | 5 | Landfill, illegal disposal, reuse, recycle | Cl, Fe |

Source: Field observation, 2022.

## ENVIRONMENTAL IMPACTS OF CONSTRUCTION WASTE

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Environmental base survey (EBS) of ambient air, surface water, and Groundwater quality assessment i.e., above mentioned nine parameters was carried out in October 2019 before the construction began in a full swing at predefined locations and points. Regular monitoring was started in September 2020 and considered up to June 2022 with an interval from April 2021 to July 2022 due to the COVID-19 second wave. For the convenience of presentation, the monitoring period has been divided into seven successive observation periods such as Sep, 20-Nov, 20; Dec, 20-Feb, 21; Mar,21; Aug, 21-Oct, 21; Nov, 21-Jan, 22; Feb, 22-Apr, 22 & May, 22-Jun, 22 for Ambient Air and Surface Water Quality as well as Sep, 20, Dec, 20, Mar,21, Aug, 21, Nov, 21, Feb, 22 & May, 22 for Groundwater Quality.

Table 2 Ambient air quality assessment

| ID | Ch. | Monitoring Period | Description of Parameters | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CO | NO | $NO_2$ | $SO_2$ | $O_3$ | VOC | $PM_{10}$ | $PM_{2.5}$ | Tem |
| | | | µg/m$^3$ | µg/m$^3$ | µg/m$^3$ | µg/m$^3$ | µg/m$^3$ | ppm | µg/m$^3$ | µg/m$^3$ | $^0$C |
| AAQ-D-5-Track | 41+300 | EBS | 258 | 12.5 | 9.9 | 11.9 | 18.6 | 0.018 | 75 | 34.3 | 31 |
| | | 1st | 619.3 | 51.9 | 25.1 | 26.6 | 26 | 0.054 | 71.5 | 48.4 | 34.1 |
| | | 2nd | 463.3 | 74.1 | 46.5 | 16.2 | 16.7 | 0.18 | 94 | 56.7 | 28.3 |
| | | 3rd | 430 | 60.2 | 47.6 | 17.6 | 18.7 | 0.069 | 85 | 47 | 31.6 |
| | | 4th | 423 | 53.5 | 43.2 | 13.3 | 19.3 | 0.12 | 111.7 | 52 | 32.9 |
| | | 5th | 479.7 | 56.6 | 42 | 14.1 | 21.2 | 0.028 | 144.3 | 60.3 | 25.6 |
| | | 6th | 450 | 29.8 | 19.4 | 18.3 | 19.4 | 0.031 | 149.7 | 61 | 28.9 |
| | | 7th | 502 | 29.1 | 23.1 | 26.8 | 22.4 | 0.017 | 138.5 | 52.5 | 31.4 |
| AAQ-D-5-50m | | EBS | 262 | 12.2 | 9.3 | 10.5 | 19.2 | 0.02 | 73 | 35.7 | 31 |
| | | 1st | 664.7 | 48.4 | 24.1 | 27 | 30.1 | 0.065 | 67.7 | 47.1 | 34.2 |
| | | 2nd | 477.7 | 64.2 | 39.8 | 16.3 | 14.8 | 0.181 | 91.3 | 57.7 | 28.3 |
| | | 3rd | 439 | 56.5 | 42.3 | 17.4 | 17.9 | 0.057 | 79 | 45 | 31.8 |
| | | 4th | 412.7 | 50.6 | 44 | 14.4 | 17.9 | 0.112 | 105.7 | 50.3 | 32.8 |
| | | 5th | 483.3 | 50.9 | 44 | 14.3 | 20 | 0.03 | 139 | 55.3 | 25.8 |
| | | 6th | 498.7 | 41.4 | 19.3 | 18.6 | 16.7 | 0.028 | 143.7 | 56 | 28.9 |
| | | 7th | 446 | 33.2 | 14.7 | 18.9 | 14.3 | 0.022 | 132 | 47 | 31.3 |
| AAQ-D-6-Track | 63+466 | EBS | 543.8 | 32.5 | 16.3 | 25.9 | 34.7 | 0.035 | 126.7 | 52.3 | 30 |
| | | 1st | 647.3 | 48.5 | 27.7 | 17.5 | 37.3 | 0.181 | 66.7 | 44.3 | 28.5 |
| | | 2nd | 369.3 | 85.9 | 56.6 | 5.6 | 27.8 | 0.153 | 105.7 | 63 | 24 |
| | | 3rd | 343 | 80.2 | 59.5 | 9.8 | 22.1 | 0.121 | 98 | 64 | 33.6 |
| | | 4th | 346 | 67.5 | 55 | 9.5 | 23.7 | 0.046 | 85.7 | 48.7 | 31.8 |
| | | 5th | 448.3 | 67.8 | 56.6 | 10.2 | 26.3 | 0.033 | 130.7 | 56 | 26 |
| | | 6th | 500.7 | 40.7 | 22.7 | 11.7 | 21 | 0.101 | 167.7 | 75.7 | 28.9 |
| | | 7th | 563.5 | 40.1 | 23 | 11.6 | 20.5 | 0.022 | 141.5 | 59 | 32.4 |
| AAQ-D-6-50m | | EBS | 342.8 | 24.7 | 14.3 | 22.9 | 29.4 | 0.03 | 120.5 | 48.3 | 30 |
| | | 1st | 653 | 53.4 | 30.7 | 22 | 33.8 | 0.178 | 65.1 | 43.3 | 27.9 |
| | | 2nd | 348 | 90.4 | 57 | 6.3 | 24.6 | 0.134 | 105.3 | 64 | 23.9 |
| | | 3rd | 349 | 82.3 | 61.3 | 7.7 | 21.5 | 0.12 | 103 | 68 | 33.2 |
| | | 4th | 325 | 66.1 | 54.2 | 10 | 21.8 | 0.054 | 81.3 | 44.7 | 31.4 |
| | | 5th | 452.3 | 67.7 | 56.6 | 10.2 | 26.3 | 0.048 | 134 | 61 | 25.2 |
| | | 6th | 502 | 46.3 | 29.5 | 12.9 | 20.2 | 0.043 | 178.7 | 81.7 | 27.9 |
| | | 7th | 507 | 46.3 | 29.2 | 12.3 | 20 | 0.023 | 146 | 60 | 32.7 |
| AAQ-D-8-Track | 76+400 | EBS | 475 | 57.2 | 61.3 | 65.3 | 98.4 | 0.027 | 79.3 | 34.6 | 32 |
| | | 1st | 769.3 | 62.8 | 37.8 | 25.4 | 31 | 0.133 | 70.4 | 45.4 | 30.8 |
| | | 2nd | 374 | 95.4 | 75 | 3.9 | 21.4 | 0.133 | 115 | 64.7 | 24.2 |
| | | 3rd | 350 | 87.9 | 65.7 | 6.7 | 18.5 | 0.123 | 110 | 69 | 35.6 |
| | | 4th | 353.7 | 85.7 | 64.8 | 8.5 | 24.3 | 0.048 | 85.7 | 52.7 | 32.7 |
| | | 5th | 434 | 84.5 | 64.2 | 9.2 | 25.9 | 0.037 | 135.3 | 62.7 | 26.4 |
| | | 6th | 429 | 52.9 | 43.9 | 10.8 | 24.3 | 0.032 | 166.3 | 64.7 | 29.1 |
| | | 7th | 427 | 53.5 | 44.6 | 11.7 | 25.4 | 0.021 | 157.5 | 59 | 32.6 |
| | | EBS | 328 | 54.5 | 53.5 | 53.8 | 82.7 | 0.024 | 72.7 | 28.6 | 32 |
| | | 1st | 670.3 | 53.2 | 35 | 31.4 | 30.3 | 0.144 | 64.2 | 42.9 | 30.8 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AAQ-D-8-50m | | 2nd | 329 | 92.4 | 72.2 | 4.6 | 17.4 | 0.139 | 96.3 | 59.7 | 24.2 |
| | | 3rd | 337 | 85.4 | 64.3 | 6.2 | 17.2 | 0.123 | 104 | 60 | 35.5 |
| | | 4th | 338.7 | 83.4 | 61.6 | 8.8 | 21 | 0.048 | 82.7 | 48 | 32.5 |
| | | 5th | 422 | 82.5 | 60.3 | 9 | 22.3 | 0.04 | 126 | 53 | 25 |
| | | 6th | 407.3 | 49.7 | 50.2 | 10.1 | 21.1 | 0.025 | 148.7 | 53 | 28.3 |
| | | 7th | 395.5 | 48.7 | 48.4 | 9.8 | 20.8 | 0.02 | 148 | 51 | 32.4 |
| Dept. of Envt. (DoE) Air Quality Standard Value | | | ≤10000 | ≤ 100 | ≤ 100 | ≤ 365 | ≤ 157 | NF | ≤ 150 | ≤ 65 | NF |

Sources: EBS (PBRLP), 2019; Monthly Enviromental Monitoring Reports (PBRLP), 2020-2022.

Table 3 Surface water quality assessment

| ID | Ch. | Monitoring Period | Description of Parameters | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TOC | TP | TSS | Oil & Grease | DO | pH | $BOD_5$ | COD | Tem |
| | | | mg/L | mg/L | mg/L | mg/L | mg/L | | mg/L | mg/L | $^0C$ |
| SP04 - UpS 25 | 62+ 364 | EBS | 8.7 | 0.67 | 37.8 | 5.2 | 4.7 | 7.3 | 3.9 | 157 | 29 |
| | | 1st | 14.5 | 7.4 | 27.8 | 7 | 4.5 | 7.8 | 24.2 | 56.1 | 28 |
| | | 2nd | 11.6 | 4.5 | 24.1 | 4.7 | 1.2 | 7.4 | 20.2 | 25.8 | 21.9 |
| | | 3rd | 10.7 | 3.1 | 49.7 | 4.1 | 1.1 | 7.9 | 8.5 | 10.3 | 26.6 |
| | | 4th | 11.6 | 2.9 | 87.2 | 4.2 | 3.5 | 8.1 | 6.6 | 11.1 | 30.6 |
| | | 5th | 7.5 | 0.5 | 55.7 | 4.6 | 5.2 | 7.3 | 11.2 | 17.9 | 22.8 |
| | | 6th | 9.9 | 1.1 | 342 | 4.9 | 3.8 | 7.4 | 13.7 | 20.1 | 23.3 |
| | | 7th | 8.8 | 0.2 | 336 | 4.4 | 4.5 | 7.6 | 11.8 | 18.3 | 28.3 |
| SP04 - DownS25 | | EBS | 8.2 | 0.35 | 39.2 | 4.9 | 4.8 | 7.3 | 4.1 | 161 | 29 |
| | | 1st | 14.5 | 7.4 | 26.6 | 7.6 | 4.4 | 7.8 | 17.9 | 49.1 | 28.5 |
| | | 2nd | 11.2 | 2.7 | 22.2 | 5.3 | 2 | 7.7 | 17.4 | 21.4 | 21.8 |
| | | 3rd | 10.4 | 2.7 | 47.3 | 4.5 | 1 | 7.7 | 8.4 | 10.1 | 26.5 |
| | | 4th | 10.8 | 2.4 | 76.6 | 4.3 | 3.5 | 8.1 | 7.8 | 13.3 | 30.6 |
| | | 5th | 9.1 | 0.5 | 69.3 | 4.9 | 4.6 | 7.3 | 13.4 | 20 | 23 |
| | | 6th | 11.1 | 1 | 383 | 4.8 | 3.2 | 7.3 | 25.7 | 34.8 | 23.5 |
| | | 7th | 9 | 0.3 | 1045 | 4.4 | 4.5 | 7.7 | 16 | 23.9 | 28.9 |
| SP05 - UpS 25 | 67+ 210 | EBS | 9.2 | 0.96 | 42.7 | 4.1 | 4.9 | 7.7 | 3.6 | 142 | 28 |
| | | 1st | 12.9 | 4.9 | 11.1 | 3.8 | 4.4 | 8 | 12.7 | 39.8 | 27.9 |
| | | 2nd | 8.3 | 2.3 | 12.3 | 4.1 | 3 | 8.2 | 13.6 | 19.2 | 23.7 |
| | | 3rd | 4.2 | 1.6 | 40.5 | 3.4 | 3.3 | 8.5 | 7.7 | 12.6 | 29.4 |
| | | 4th | 13.4 | 1.5 | 52.4 | 4 | 5.4 | 8.3 | 8.4 | 15 | 30.6 |
| | | 5th | 8.4 | 0.1 | 74.3 | 3.7 | 5.1 | 7.9 | 11.9 | 17.7 | 22.7 |
| | | 6th | 8 | 0 | 88.3 | 3.8 | 6.4 | 8.1 | 7.5 | 9.7 | 25.9 |
| | | 7th | 6.6 | 0 | 90.5 | 2.9 | 5.9 | 8.5 | 7.8 | 10.4 | 28.7 |
| SP05 - DownS25 | | EBS | 10.22 | 0.96 | 45.3 | 3.1 | 4.8 | 7.6 | 3.6 | 139 | 28 |
| | | 1st | 12.4 | 5.4 | 11.9 | 3.6 | 4.7 | 8.1 | 12.6 | 37.7 | 27.8 |
| | | 2nd | 7.5 | 2 | 11 | 3.2 | 2.8 | 8.1 | 13 | 19.6 | 23.7 |
| | | 3rd | 4.1 | 1 | 38.9 | 3.3 | 3.4 | 8.7 | 7.5 | 12.5 | 29.6 |
| | | 4th | 12.5 | 1.1 | 51.7 | 3.5 | 5.3 | 8.4 | 7.9 | 15.7 | 30.6 |
| | | 5th | 8.1 | 0.1 | 80.3 | 4 | 4.8 | 8 | 12.9 | 18.6 | 22.9 |
| | | 6th | 8.2 | 0 | 104 | 3.3 | 6.5 | 8.1 | 6.2 | 10.8 | 25.5 |
| | | 7th | 6.8 | 0 | 95.5 | 2.8 | 6.2 | 8.5 | 8.3 | 11.9 | 28.8 |
| SP06 - UpS 25 | 79+ 595 | EBS | 7.3 | 0.67 | 31.3 | 2.2 | 5.3 | 6.9 | 2.3 | 98 | 28 |
| | | 1st | 11.7 | 3.7 | 20.6 | 4.6 | 4 | 7.1 | 24.4 | 63 | 28.6 |
| | | 2nd | 8.7 | 3.1 | 22.1 | 3 | 3.7 | 8 | 9.3 | 12.5 | 23.4 |
| | | 3rd | 6.5 | 2.8 | 41.5 | 2.2 | 3.5 | 8.7 | 6.2 | 8.7 | 32.2 |
| | | 4th | 7.4 | 1.9 | 63.6 | 2.3 | 4 | 8.3 | 11.3 | 16.3 | 31.4 |
| | | 5th | 7.4 | 0.4 | 85 | 3.3 | 4.7 | 7.4 | 8.3 | 12.4 | 23.3 |
| | | 6th | 6.3 | 0.3 | 102 | 3.7 | 5.3 | 7.8 | 7.3 | 9.9 | 26.6 |
| | | 7th | 8.3 | 0.1 | 107 | 3.4 | 4.7 | 7.6 | 11 | 14.5 | 30.2 |
| | | EBS | 7.2 | 0.57 | 31.9 | 2.3 | 5.5 | 6.8 | 2.4 | 105 | 28 |

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| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SP06 - Dow nS25 | | 1st | 11.7 | 4.3 | 21.8 | 4.7 | 3.8 | 7.2 | 27 | 65.5 | 27.9 |
| | | 2nd | 8.9 | 2.8 | 23.8 | 3.7 | 3.6 | 8.1 | 9.8 | 13.2 | 23.5 |
| | | 3rd | 7.9 | 1.6 | 43.2 | 2.8 | 3 | 8.6 | 7 | 10.4 | 32.5 |
| | | 4th | 9.1 | 1.4 | 56.9 | 1.8 | 3.4 | 8.2 | 10.7 | 15.5 | 31.3 |
| | | 5th | 7 | 0.4 | 94.7 | 3.6 | 4.5 | 7.5 | 7.5 | 10.9 | 23.6 |
| | | 6th | 6.2 | 0.3 | 113 | 3.6 | 5.5 | 7.8 | 7.9 | 9.9 | 26.7 |
| | | 7th | 6.2 | 0.1 | 121 | 3.6 | 5.4 | 7.9 | 8.1 | 11.2 | 31.1 |
| DoE Surface Water Standard for irrigation | | | NYS | 8 | 150 | 10 | ≥5 | 6.5 - 8.5 | ≤10 | 200 | 45 |
| The Schedule-3(A) of (standards for Inland Surface Water) ECR '97 has been considered | | | | | | | | | | | |

Sources: EBS (PBRLP), 2019; Monthly Enviromental Monitoring Reports (PBRLP), 2020-2022.

Table 4 Surface water quality assessment

| ID | Ch. | Monitoring Period | Description of Parameters | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | pH | TDS | As | Fe | Mn | S | Cl |
| | | | | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| SP06-GW001 | 42+500 | EBS | 6.75 | 521 | 0.015 | 0.64 | 0.21 | 0.04 | 146.5 |
| | | Sep, 20 | 6.93 | 278 | 0.045 | 0.02 | 0.01 | 0 | 48.9 |
| | | Dec, 20 | 7.8 | 328 | 0.05 | 0.04 | 0.03 | 0 | 55.1 |
| | | Mar,21 | 7.8 | 357 | 0.005 | 1.5 | 0.1 | 0 | 63.5 |
| | | Aug, 21 | 6.9 | 316 | 0 | 0.7 | 0.2 | 0 | 68.4 |
| | | Nov, 21 | 7.1 | 303 | 0 | 0.89 | 0.1 | 0 | 93 |
| | | Feb, 22 | 7.3 | 370 | 0 | 0.14 | 0.1 | 0 | 96.9 |
| | | May, 22 | 7.6 | 536 | 0 | 0.11 | 0.2 | 0 | 232 |
| SP07-GW001 | 67+100 | EBS | 7.3 | 210 | 0.001 | 0.1 | 0.002 | 0 | 27.1 |
| | | Sep, 20 | 6.43 | 256 | 0.012 | 0.16 | 0.01 | 0 | 37.5 |
| | | Dec, 20 | 7.9 | 558 | 0.04 | 0.21 | 0.02 | 0 | 58.2 |
| | | Mar,21 | 7.7 | 355 | 0.007 | 1 | 0.004 | 0 | 58.6 |
| | | Aug, 21 | 6.7 | 478 | 0 | 2.8 | 0 | 0.4 | 86.5 |
| | | Nov, 21 | 7.1 | 501 | 0.001 | 1.79 | 1 | 0.1 | 78 |
| | | Feb, 22 | 7.2 | 557 | 0.002 | 1.2 | 1.1 | 0.1 | 72 |
| | | May, 22 | 7.3 | 453 | 0 | 3.01 | 0 | 0.1 | 73.2 |
| SP08-GW001 | 76+386 | EBS | 7.3 | 210 | 0.001 | 0.1 | 0.002 | 0 | 27.1 |
| | | Sep, 20 | 6.87 | 295 | 0.024 | 0.23 | 0.03 | 0 | 56.1 |
| | | Dec, 20 | 7.4 | 522 | 0.02 | 0.35 | 0.05 | 0 | 76.4 |
| | | Mar,21 | 7.8 | 510 | 0.014 | 3 | 0.1 | 0 | 62.1 |
| | | Aug, 21 | 6.7 | 1329 | 0 | 5 | 0.1 | 0.2 | 108.2 |
| | | Nov, 21 | 7.1 | 501 | 0.001 | 1.79 | 1 | 0.1 | 78 |
| | | Feb, 22 | 7.2 | 557 | 0.002 | 1.2 | 1.1 | 0.1 | 72 |
| | | May, 22 | 7.1 | 507 | 0.002 | 0.58 | 0.1 | 0 | 678 |
| Bangladesh (DoE) Standard | | | 6.5-8.5 | ≤1000 | ≤0.05 | 0.3-1.0 | ≤0.1 | 0 | ≤150-600 |
| The Schedule-3(B) of (standards for Drinking Water) ECR '97 has been considered | | | | | | | | | |

Sources: EBS (PBRLP), 2019; Monthly Enviromental Monitoring Reports (PBRLP), 2020-2022.

## RESULTS AND DISCUSSION

From Table 1, the disposal methods and its possible effluent to the environment i.e., air, water, etc. can easily be sorted out and from the following Table 2, Table 3, and Table 4, the summarized test results of individual parameters for air, surface water and groundwater samples collected from predefined locations & points can be observed. Most of the parameters are showing a significant rise either throughout the project going on or spanning a certain observation period depending upon the types of work going on in the surrounding. The values which deny DoE standards indicate the failure of the environmental controlling measures. For an easy illustration, the most two significant and alarming parameters from each quality assessment are graphically presented in figures [3], [4] & [5] with the progress of works going on.

Figure [3] represented PM10 & PM2.5 content in the surrounding air of the sample collection point with DoE limits of 150 µg/m³. A significant amount of arises are to be identified as the construction

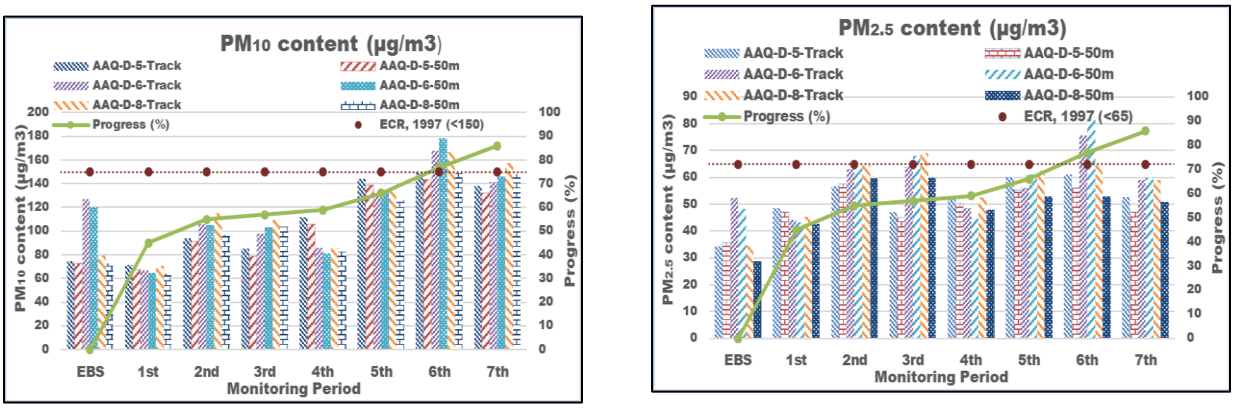


Figure 3 $PM_{10}$ & $PM_{2.5}$ content variation in the air with work progress

process going. Due to the acceleration of the earthwork activities, and sub-ballast & ballast laying works are at the peak, the $PM_{10}$ & $PM_{2.5}$ content was rising gradually and crossed the DoE limit during the 6th observations periods.

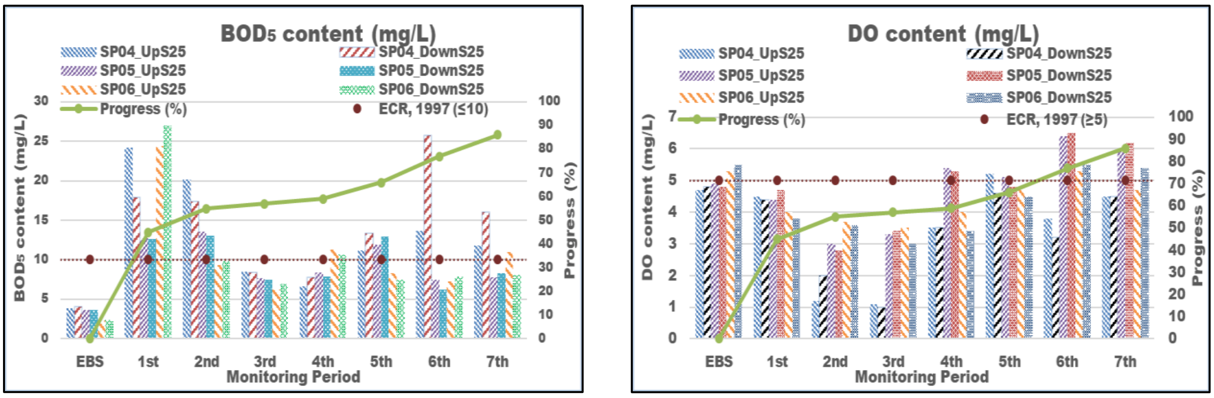


Figure 4 BOD5 & DO content variation in the surface water with work progress

Figure [4] shows the $BOD_5$ & Dissolved Oxygen content in surrounding surface water, those are interrelated too. Due to the lack of organic waste production at the construction site, during the 3rd to 4th observation. Both parameters are largely dependent on other factors also, such as temperature, pH, salinity, current of flowing water, etc.

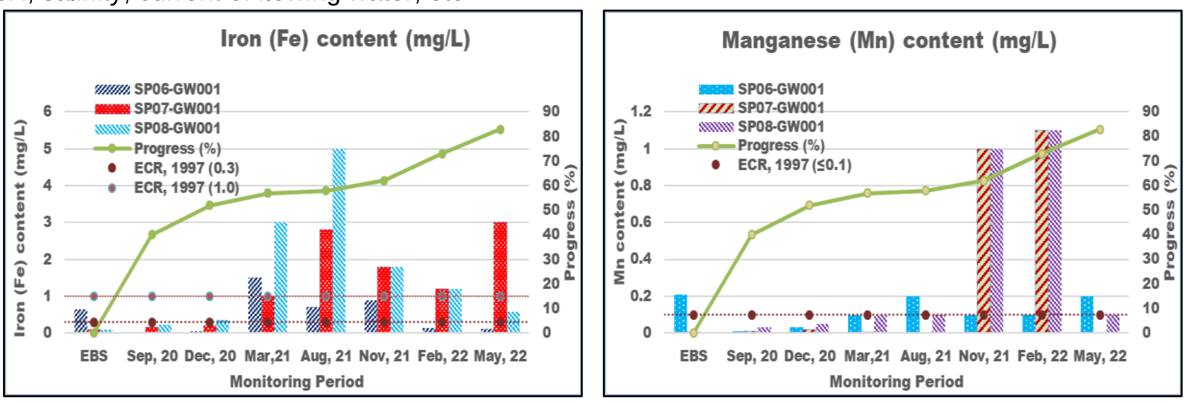


Figure 5 Fe & Mn content variation in the Groundwater with work progress

Figure [5] represents the Iron & Manganese content in the groundwater of the localities during the construction period. Both parameters overwhelmingly existed during a few periods of observation also out of ECR'97 limits. Since Fe & Mn contamination in the groundwater done by weathering of the stones used during the construction work has long-term poorly effects on the health risk of the surrounding people.

## CONCLUSION

The goal of a sustainable society is to manage waste in a method that reduces latent pollution. Devotion to proper professional safety and health requirements defends workers from harm and raises consciousness of pollution and how to decrease it. The more people comprehend, the better the environment and working circumstances. The case study is trying to establish a substantial impact of construction waste management on the surrounding environment. In Bangladesh, most project management are focusing on safety assurance only rather than giving equal emphasis on construction management. Proper CDW management is also lacking in such a mega project indicating the huge negligence in this regard. Some recommendations are here below to improve construction waste management:

- A strict law should be enforced regarding CDW management.
- Proper planning and clear methodology should be ensured by the clients, consultants and contractors.
- Consultants should have enough instructions to monitor this accurately.
- A well-trained third-party private organization can take part as a sub-contractor for CDW management like many European countries.
- Above all, mass awareness should be increased regarding this.

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