
Group 11

METRO CEBU RIVER SCAN CHALLENGE 2024

RESEARCH REPORT

A Research Report and Innovative Solution Proposal Presented
to the Faculty of the Department of Civil Engineering School of Engineering,
University of San Carlos, Cebu City, Cebu, Philippines

And the Universities from the Netherlands
Rotterdam University of Applied Sciences and
Hanze University of Applied Sciences

In partnership with the following local organizations:



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INTRODUCTION

In September 2022, the Butuanon River overflowed due to heavy rainfall sweeping away 20 barangays in Mandaue City. According to the Mandaue City Disaster Risk Reduction Management Office (MCDRRMO), this was the highest water level recorded by the city government in recent years with the flood water reaching up to 1.5m from ground level excluding the rise of water from the Butuanon riverbed up to the ground level. Because of this, the Department of Public Works and Highways (DPWH) carried out flood control projects that started in June 2023 to protect Purok Zenia, Sitio Pulang Bukid, Barangay Alang-Alang, in the City of Mandaue. Despite the effectiveness of the retaining walls in protecting the people from the flood, it is ineffective in protecting the Butuanon River from the people. The presence of unattended piled-up garbage on the riverside and along the river can be seen throughout the downstream side of the Butuanon River. According to the residents in the Barangay, it is the poor waste management and weak local forces that drove them to throw their garbage in the riverside. Because of this, researchers found a new innovative way of collecting this garbage promoting a clean and healthy environment for the people of Barangay Alang-Alang.

This research aims to address problems that concern the Butuanon River Downstream side, specifically in Purok Zenia, Sitio Pulang Bukid, Barangay Alang-Alang, in the City of Mandaue. This study should engage in various areas including the different factors that play a role in these problems: Government and Non-governmental Organizations (NGOs), private companies, and the community itself. This study aims to generate a long-term solution that addresses flood protection, accessibility, and waste management in the Butuanon River.

Furthermore, this study extends to the maintenance of the said solution and assesses its effectiveness after the solution is implemented.

OBJECTIVES OF THE STUDY

This study aims to address the problems of Purok Zenia, Sitio Pulang Bukid, Barangay Alang-Alang, in the City of Mandaue concerning the Butuanon River. With the initial community assessment, according to the residents, the main problem of the community is the poor waste disposal management which also contributes to the flooding in the area. Specifically, the study will focus more on generating long-term solutions that address the problem of the community on waste disposal. The proposed solutions generated by this study will be guided by the following research questions:

1. What long-term solution should be implemented to reduce the garbage problem on the riverside of Butuanon River?
 - a. What policies should the local government implement to manage the waste disposal of the community?
 - b. What garbage collecting mechanism should be generated to help the people collect the garbage in the Butuanon River, especially the parts of the river where it is hard to access?
 - c. How can the people increase the accessibility of the Butuanon River to maintain its protection and cleanliness?

SCOPE AND LIMITATIONS

The research was conducted at Purok Zenia, Sitio Pulang Bukid, Barangay Alang-Alang, in the City of Mandaue from April 15 to 26, 2024, focusing on the downstream side of the Butuanon River. With the aforementioned river spanning across two cities, the scope of the research was limited to one area in particular to tackle the issues of waste disposal and management, which tie into the accessibility, the livelihood of the residents, the health and safety, the coordination between the local community, as well as the maintenance along the Butuanon River. The section of the River closest to Purok Zenia, was inaccessible due to the Concrete Retaining Wall situated at the riverbank, separating the river from the residents, which prohibited the further inspection of the river's natural ecosystem. In addition, the river water tests were also forgone due to biological hazards for the researchers per the prescribed directions from the University.

METHODOLOGY

This research discusses the solutions that may help mitigate flood control and waste management in Purok Zenia, Sitio Pulang Bukid, Barangay Alang-Alang, in the City of Mandaue portion of the Butuanon River.

DATA COLLECTION

Site Assessment

A. *Waste management.* To determine the waste management situation, residents were asked about the common problems they faced. According to them, poor maintenance of the drainage system and the inconsistency of garbage pick-up were among their biggest problems, as they are the main causes of flooding in the area. Although clean-up drives are conducted every 2 weeks, they remain insufficient to maintain the cleanliness of the river.

B. *Water quality.* According to the residents, a test on the water quality of the river was conducted a few years ago. They were informed that a harmful chemical was found in the river, prompting them to avoid using or approaching the river. Moreover, they also shared that oil is sometimes dumped in the river, causing it to turn red occasionally. However, during the site visit, it was observed that the color of the river was black, which is caused by the waste build-up that accumulated over time and the waste produced by the factories upstream.

C. *Water level.* Residents reported that their main concern was the elevated water levels. They highlighted that severe flooding occurred in September 2022, caused by rainfall reaching an estimated height of 4 feet or more, leading to water entering their homes and soaking furniture and other belongings.

Focus Group Discussions/Interviews

Several focus group discussions were conducted during the community meeting held on April 17, 2024, to gather the perspectives of the individuals living in the area and to explore their personal experiences related to the common problems faced by the community. The following questions were asked:

1. Introduction
 - a. Names
 - b. How many years have you been living by the river?
2. What are the community's conditions?
 - a. What is the situation for the residents by the River?
 - b. What is the situation of the community in that area?

- c. If you could rank the top 3 issues from the previous question in the current situation in your area, what are these?
3. What are the reasons that the conditions in your area have been difficult/poor?
 4. What have you done, or what has the community done?
 5. What other actions can you take and who else should participate in solving the issue?
 6. What proper actions should the Barangay take?
 7. What programs or platforms should the barangay make in our area, if given the chance?

Data Analysis

In the comprehensive data analysis section of the study, both qualitative and quantitative methodologies were employed to gain a thorough understanding of the community perceptions and the physical conditions impacting the area.

Quantitative Analysis: The site inspections provided crucial data on environmental conditions. Quantitative measurements included detailed recordings of flood levels, which were analyzed to establish average, minimum, and maximum levels under varying weather conditions. This data was crucial for predicting flood risks and understanding the temporal patterns of water rise. Additionally, waste accumulation along the river was quantified to identify hotspots and analyze trends over time. This information was pivotal in pinpointing areas that require immediate intervention and informing strategies for enhanced waste management practices.

Qualitative Analysis: In parallel, focus group discussions were conducted to delve into the community's perspectives on waste management and flood risk. These discussions involved diverse community segments, including riverside residents, local business owners, and community organization representatives. The discussions were recorded, transcribed, and

systematically structured into datasets for thematic analysis. Key inquiry areas included experiences with waste management, observations of flood impacts, and community-driven suggestions for environmental improvements. The qualitative data was manually coded to unearth recurring themes such as the direct impact of poor waste management on flooding and community responses to waste disposal initiatives. Further analysis led to the development of major themes, notably "Barriers to Effective Waste Management" and "Community Engagement and Responsibility." These themes were richly illustrated with direct quotes from participants, adding depth to the real-world implications of the identified issues.

The integration of these qualitative insights with quantitative data from site inspections created a robust foundation for understanding the complexities of environmental management in the community. This approach not only validated the subjective experiences of the community with objective environmental data but also highlighted the importance of community involvement in crafting effective solutions. The findings underscore the need for targeted policies that enhance infrastructure while simultaneously bolstering community awareness and participation in sustainable environmental practices.

RESULTS AND DISCUSSIONS

Managing waste disposal is crucial for the residents of Sitio Zenia Barangay Alang-alang and the environment. Moreover, this also requires the cooperation of the residents of the said barangay to manage the waste disposal properly. This study aims to provide the following policies that the local government should strengthen in implementation:

1. Waste Segregation

Enforce current local ordinances, and national policies mandating the residents to separate wastes into different categories such as recyclable, non-recyclable, and organic waste, to make recycling easier.

2. Recycling Programs

Establish recycling programs such as curbside pickup where the residents can deposit recyclables such as plastic, paper, glass, and such.

3. Penalties

Regulate the policies by enforcing fines and penalties for the people who throw waste everywhere in the barangay, especially in the river. Any person who litters shall suffer a minimum 5-day jail sentence or a fine of one hundred pesos (P100) to two thousand pesos (P2000). (City Ordinance No. 10-2006-372)

The implementation of a garbage trap within the river will allow for the efficient and effective collection of garbage flowing through the river. This mechanism will be then managed and coordinated with the local purok organization of the local area which organizes the clean-up drive of the community every 2 weeks. In addition to this, a local NGO named ASA has committed to cleaning up the river and the area surrounding it. The garbage trap will give the local community and other NGOs the capability to clean up the downstream section of the river without the risk of their bodies being in contact with the contaminated water.

Furthermore, educational programs shall be organized to raise awareness of the Butuanon River's ecological value. By improving the Butuanon River's accessibility and involving the local community in its upkeep, residents may collaborate to preserve this natural resource for coming generations.

POLICY RECOMMENDATIONS

Bottom-up approach

Implementation of Bantay Basura

The researchers conclude one of the main challenges of Barangay Alang-Alang is the lack of cooperation by residents. The practical solution made by the researchers is a Footbridge that supports the Bantay Basura proposals. To implement this, the barangay would utilize the purok system to monitor each street community within the barangay. Each Purok has a set of officers that have a mandate to support community initiatives of the Barangay which have a mandate to the existing partnerships and initiatives on waste management wherein the Barangay has a set budget for the Puroks.

The researcher suggested the implementation of Bantay Basura, establishing a local barangay Bantay Basura group headed by Barangay officials and appointed members. This group is expected to facilitate regular bi-monthly clean-up drives and conduct routine inspections and maintenance of the footbridge proposed in the following section. This group is also expected to facilitate the live monitoring of the nearby river. In addition, it establishes a live monitoring program of the nearby river to monitor water levels and to identify and apprehend litterers. This live monitoring program may use CCTVs to aid the Bantay Basura group in their efforts.

Partnerships with local businesses

The researchers find it important to partner with local businesses within the community like the 'karenderia' or sari-sari stores to give incentives to customers who can bring their own reusable containers and bags. Strengthening the implementation of the Ordinance No. 12-2010-562 known as *AN ORDINANCE REQUIRING RETAIL*

ESTABLISHMENTS TO PROVIDE AND USE ONLY PAPER BAGS OR REUSABLE BAGS AND PROHIBIT THE DISTRIBUTION OF DISPOSABLE PLASTIC BAGS AND STYROFOAM BY SUCH ESTABLISHMENTS IN THE CITY OF MANDAUE, PROVIDING PENALTIES FOR THE VIOLATIONS THEREOF, AND FOR OTHER PURPOSES. This will also garner community collaboration in reducing single-use plastic waste and can promote alternatives that are reusable for the community.

CONCLUSION

The researchers were critical of how waste has been handled and the lack of forces in local efforts in recent years. The researchers are determined to find ways to solve the challenges along the Butuanon riverside. The researchers aim to propose simple, long-lasting solutions that don't require fancy technology. They're talking about things like flood control, better waste management, and making the area easier to get around in. The researchers of this study want the local government to get the community involved, especially with an idea called 'Bantay Basura', and by working together with local businesses.

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PROPOSED SOLUTION

1.1. Design of the Solution

The improper management of waste in the downstream section of the river has been a huge problem for years. Solving this problem is not just dependent on the designed solution by the group, but also on the cooperation of the community.

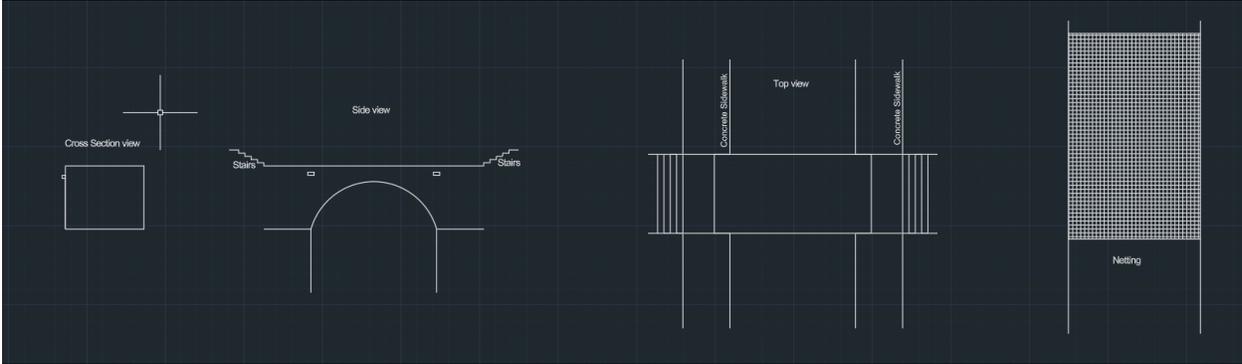


Figure 1. Footbridge Garbage Trap

The implementation of a garbage trap within the river is the sole focus of the design. This is then integrated into a footbridge which will allow for the possibility of cooperation between both sides of the river to clean up. The garbage trap provides the community and its members with a safe and efficient way to collect the garbage flowing through the river and also those stuck on the river banks beside it.

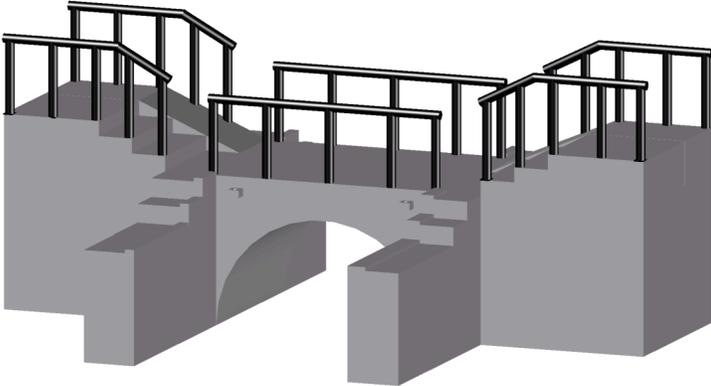


Figure 2. 3D rendered design of the Footbridge

The garbage trap is used by pulling up the net with 2 ropes connected by a rivet on both sides of the upstream face of the footbridge. The rivet is composed of a permanent attachment for one side of the rope and a pulley for the ease of collection of the garbage.

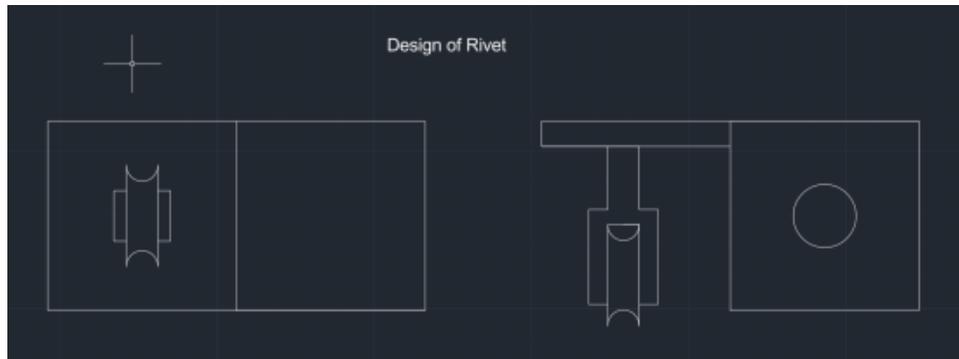


Figure 3. Design of Rivet for Net Installation

1.2. Location Analysis

Throughout the entire span of the Butuanon River that is covered by Purok Zenia, the group observed that the riverside opposite Purok Zenia either had an abandoned structure that took up a length of the span, steep slopes, or residences. All of these are unsuitable locations for the footbridge due to several factors such as a more costly and labor-intensive construction in those, and an even more costly and labor-intensive demolition of residential houses and the relocation of the residents.

After a thorough discussion and consideration, it was decided that the most suitable location for the footbridge with garbage trap would be at the boundary between Purok Marigold and Purok Zenia, which is where the riprapping wall begins (Approximate coordinates: 10.34082°N, 123.953713°E, refer to Figure). This location was chosen because it has the least dwellings in the area that would be affected by the construction of the footbridge, a slope that is

not too steep, and it is not affected by the abandoned structure. In deciding the location of the footbridge, factors such as the practical and community-related aspects were taken into account.

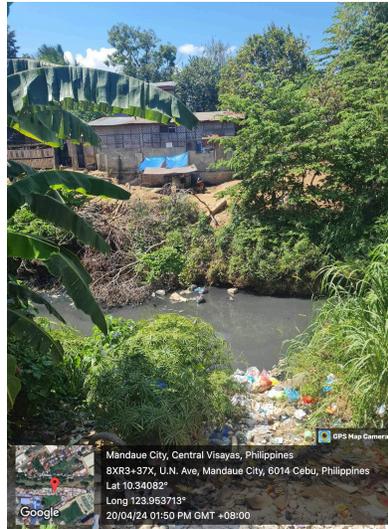


Figure 4. Location for the Proposed Solution

1.3. Social Cost-Benefit Analysis with Explanation

1.3.1 . Social Cost

1.3.1A. Transportation

Considering the width of the pathway along the sides of the Butuanon River, transportation means are difficult to address hence, enforcing a pathway for the equipment and machinery needs to be considered in the cost of the project. Furthermore, there would be difficulties in transporting the materials and equipment to be used since the pathway is not wide enough to fit a vehicle, which is also the reason for poor waste disposal since the garbage truck cannot access the area. Some areas need to be cleared up for vehicles to pass through. The removal includes relocation of mini-stores, clearing of recreational areas, and many more which also contributes to destruction costs.

1.3.1B. Materials costing

According to the estimated cost of bridge structure per linear meter tabulated by the Department of Public Works and Highways (DPWH), the cost of a Reinforced Concrete Design Girder Bridge with Reinforced Concrete Pile Foundation is estimated to be PhP 545,000 per linear meter for low water level site condition in the Philippines Region VII. With this data, the estimated cost for the proposed bridge would be:

Table 1. Quantity Takeoff

Material/Structure	Estimated cost per Linear Meter (PhP)	Linear meter	Total cost for the Bridge (PhP)
RCDG Bridge with R.C. Pile Foundation	544,525.99	17.5	9,529,205
Trash trap Netting	65	4.2	273

For the walkway, the estimated unit cost for the concrete new pathway construction according to the DPWH table 10 is PhP32,397,452.47 per kilometer. Since the proposed walkway for the riverside is 32m, the cost of the walkway is approximately PhP1,263,500 for both sides of the river. With these in mind, the total estimated cost for the proposed solution is:

Table 2. Bill of Materialas

Material/Structure	Total cost for the Bridge (PhP)
RCDG Bridge with R.C. Pile Foundation	9,529,205
Trash trap Netting	273
Concrete New Road Construction with PCC 230mm	1,263,500
TOTAL ESTIMATED COST	10,792,978

This estimated cost includes the manpower, materials, and equipment used for the construction. However, this value will further vary depending on factors that may affect the strength and conditions of the river.

1.3.2 Social Benefits

The footbridge will help the residents of Alang-alang to navigate the river. This will also connect the Barangays of Alang-Alang and Paknaan therefore enhancing their interpersonal relationship and promoting social connections through community activities and programs making the Local Government Units address the problems of both communities. This helps engage the people in the community to be involved in decision-making, planning, and activities that will affect the people in Barangay Alang-Alang and Paknaan.

The trash trap will help the community maintain a trash-free river, especially during floods where the trash obstructs the drainages in the area. This trash trap ensures that it is accessible and easier for people to collect the garbage in the river. Furthermore, the footwalk will allow the residents to clean the trash in the riverside easily. Once the penalty is approved, it will be easy for the community to maintain the cleanliness of the river and the riverside. Also, maintaining the cleanliness of the river will reduce the waterborne diseases for humans and wildlife that rely on the river.

Garbage traps serve as visible reminders of the importance of environmental stewardship and waste reduction. Community members can see the direct impact of their actions on the health of the river and the surrounding ecosystem, fostering a sense of environmental responsibility and encouraging sustainable behaviors such as proper waste disposal and recycling.

1.4. Planning

The initial phase of implementing the footbridges with garbage traps focuses on diligent planning and preparation to lay the groundwork for the project. Site inspection and evaluation to identify suitable locations along the river for the footbridges and garbage traps. Design development taking into account both practicality and perception with the surrounding environment for the footbridge with garbage trap structure. Quantity takeoff assessments to determine the materials and resources needed for construction. Identification and engagement of non-governmental organizations (NGOs) and community partners to garner support and involvement in the project. This phase is critical as it sets the foundation for subsequent project activities and ensures alignment with project objectives and stakeholder expectations.

In order to promote cooperation and address any potential issues, the second phase is centered on interacting with the stakeholders and local community. Consultation with those who live close to the river to get their opinions and resolve any issues or complaints they may have about the project creation of relocation plans for any people or families that would have to move in order to make room for the building of the footbridges and garbage traps. Implementation of mitigation measures to minimize disruptions and ensure the well-being of affected communities. Monitoring and evaluation of social protection measures to safeguard the rights and livelihoods of vulnerable populations. This phase, spanning over a designated period, emphasizes the importance of community participation and social responsibility in achieving project success.

The final phase of the project is when the footbridges and trash traps are being built using eco-friendly products and sustainable building techniques to reduce their negative effects on the environment. The construction of the footbridge and the incorporation of trash cans to efficiently collect waste and floating debris. Quality assurance and control measures to ensure compliance

with design specifications and safety standards. Ongoing monitoring of construction progress and adjustments to mitigate any unforeseen challenges. This phase, with a specified timeline, focuses on turning plans into tangible infrastructure, demonstrating tangible progress toward river conservation and environmental stewardship.

Strategic planning, community involvement, and sustainable construction techniques are combined in each phase of the implementation plan to achieve long-term benefits for the river ecosystem and the surrounding communities. This is why the footbridge with the garbage trap project cannot be realized without it

1.5. Stakeholders involved

- LGUs - Local government units oversee regulatory compliance, allocate funding, and issue permits for construction projects in river ecosystems.
- Environmental Agencies - Environmental agencies provide guidelines and monitor environmental impacts to ensure projects adhere to sustainability standards and protect the river ecosystem.
- Civil Engineers and Architects - Civil engineers and architects are responsible for the design and structural integrity of footbridges and garbage traps. They collaborate closely with environmental experts to ensure that structures are effective in waste management without causing harm to the river environment.
- Residents / Land Owners - Local communities residing near the riverbanks are key stakeholders as they are directly affected by waste pollution and benefit from improved waste management infrastructure. Their engagement is essential for garnering support, concerns, and ensuring the long-term utilization of footbridges and garbage traps.

- Industries and Businesses - Industries and businesses operating near the river are significant contributors to waste generation. They have a responsibility to implement environmentally friendly practices, such as proper waste disposal and recycling, to minimize their impact on the river's health. Collaboration with these stakeholders is essential to develop and implement effective waste management strategies.
- Environmental NGOs and Advocacy Groups - These organizations may provide expertise, funding, or volunteer support for the planning, construction, and maintenance of footbridges and garbage traps.
- Maintenance and Operations Team - Dedicated teams responsible for the ongoing maintenance and operation of footbridges and garbage traps play a critical role in ensuring their functionality and effectiveness over time.
- Private Sectors (Construction companies, etc.)

1.6. Operation and Maintenance

Maintaining the efficiency and environmental impact of a footbridge equipped with a net requires efficient management and upkeep; this is to ensure that the footbridge remains structurally stable for as long as feasible. With the proposed design mentioned above, the net will serve as a garbage trap for the residents of Sitio Zenia Barangay Alang-Alang, allowing them to collect and dispose of trash more quickly and easily without getting themselves in the river.

1.6.1. Conducting a Regular Inspection

Applying this activity will help us to identify any signs of damage or deterioration. This inspection is mainly for the beams, stairs, and support posts. This will also include the garbage trap to ensure that the waste is filtered essentially. The support structure and foundations of the

bridge should also be regularly inspected for cracks and exposed rebars. If needed, they should be repaired and sealed.

1.6.2. Repairing

Address any defects or damages that were found during inspection as soon as possible, this way we can ensure that the footbridge is safe and maintain its structural integrity.

1.6.3. Painting/Coating

It will help especially metals to prevent any form of corrosion and it will also extend their lifespan.

1.6.4. Stability of Structure

Ensuring that the footbridge is stable, there is a monitoring session wherein it is to look for different signs of movement that could indicate the instability of the said structure.

1.6.5. Cleaning

The garbage trap is detachable for ease of use when collecting garbage and debris. A minimum of two (2) workers, preferably four (4) or more, should handle the collection, wearing safety harnesses to prevent falling and other accidents. The collection will be operated with an even number of workers on each end of the footbridge, dragging the river-bottom end of the net to the water's surface. Additionally, for the footbridge to last longer, there should be a regular removal of leaves, debris, etc. that could affect the drainage channels and the structure itself.

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