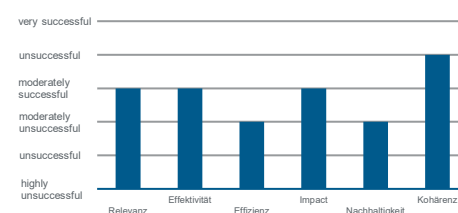


Ex-post evaluation

Wastewater treatment in Bihać, Bosnia and Herzegovina

Title	Wastewater treatment in Bihać		
Sector and CRS code	Drinking water, water management, sanitation and sewage, basic supply (14030)		
Project number	BMZ No. 2007 65 925		
Commissioned by	BMZ, EU		
Recipient/Project-executing agency	Ministry of Finance of Bosnia and Herzegovina/City of Bihać		
Project volume/ Financing instrument	EUR 24.61 million total volume, EUR 17 million grant (investment – KfW), EUR 0.5 million grant (CM – KfW), EUR 2.94 million (investment – EU)		
Project duration	12/2009 – 09/2018		
Year of report	2023	Year of random sample	2020

Overall rating:
moderately unsuccessful



Objectives and project outline

The aim of the project was to ensure the environmentally friendly and hygienically safe collection and treatment of wastewater in the city of Bihać (outcome). By doing so, the project would help improve the living conditions of the population in the city of Bihać and protect natural resources (impact). The project included the expansion of the wastewater network and the construction of a sewage treatment plant in Bihać, as well as measures to discharge rain water.

Key findings

Despite its developmental relevance and effectiveness, the sustainability of the project is under significant threat. The city of Bihać must heavily subsidise the operation of the oversized sewage treatment plant (population drain) due to low tariffs. Process engineering is the right choice for achieving EU standard values, but is too ambitious for Bihać's operator and economic status. The project has been rated "moderately unsuccessful" for the following reasons:

- Despite the high relevance due to the overall concept for wastewater collection and its central treatment, the targets have, for the most part, not been achieved: the planned connection rate (53% of the population) was narrowly missed and the operating cost coverage is only 40%. This is mainly due to tariffs and connection numbers being far too low.
- Due to the high infiltration of external water, the actual purification efficiency of the wastewater treatment plant is disproportionate to the high investment costs.
- Nevertheless, the increase in the disposal rate and the proper treatment of the wastewater generated are helping to improve the living conditions of the target group. The water quality of the Una river has also presumably improved due to the construction and operation of the sewage system.
- The sustainability of the project is jeopardised by inadequate financing for operations and reinvestment, the imbalance in the management of wastewater and precipitation, the lack of a sewage sludge disposal path, an insufficient connection rate, and the likelihood of further subsidence.

Conclusions

- Early measurement campaigns to determine external water in the sewer system as well as geotechnical investigations of the substrates for infrastructure as part of the feasibility study allow early countermeasures to be taken in the event of critical findings. The same applies to the critical analysis of future scenarios for capacity planning (population, connection rate).
- Adapting the wastewater treatment plants to suit the local economic conditions and the political will of the partner can improve economic efficiency and ownership.
- Discussing necessary tariff increases in the project cycle at an early stage can have a positive effect on their implementation and sustainability.

Rating according to DAC criteria

Overall rating: 4

Ratings:

Relevance	3
Coherence	2
Effectiveness	3
Efficiency	4
Overarching developmental impact	3
Sustainability	4

Relevance

In the city of Bihać, there was no comprehensive wastewater collection or treatment prior to the start of the project. In its overall concept, the combined wastewater collection system was not designed for the central treatment of wastewater in a sewage treatment plant. Instead, the collected wastewater streams were discharged untreated at around 35 locations along the Una river and other receiving water bodies (smaller tributaries and trenches). In addition, there was a low connection rate to the central wastewater network of approx. 30% (approx. 22,000 of 77,000 inhabitants at present). The insufficient capacity of the collection networks also led to frequent flooding in some districts after periods of sustained rainfall. In addition, the geographically sensitive location of the city of Bihać (karst) required stronger measures to protect the ground water that was at risk from the septic tanks in common use on the outskirts of the urban area.

Against this backdrop, there were corresponding problems both for general municipal hygiene and for the long-term ecological development of the region.

From today's perspective, the main problems of wastewater collection and disposal in the city of Bihać were correctly identified. The expanded sewer network also appears to be a suitable solution for collecting wastewater, thus improving the basic sanitation of the population.

The strategy for the treatment of wastewater is designed to meet EU standards. The decision to build a sewage treatment plant that would meet the EU limits is understandable, since the country wishes to join the EU, despite this compliance not being absolutely necessary at the time of the project appraisal. However, the chosen concept must be assessed as highly ambitious for the local conditions and creates major challenges for the city and the operator (see section on "Sustainability"). The purification concept consists of mechanical and biological treatment using an activated sludge process. It is designed such that in addition to the advanced sewage treatment for eliminating nitrogen, the sludge is aerobically stabilised. Therefore, the plant does not use a pre-treatment for mechanically separating organic solids. The plant is also equipped with UV disinfection in line with the requirements set out in the EU Bathing Water Directive. However, the measurements available of the quality of the wastewater over the past four years question this concept, as the construction and operating costs are out of proportion with the purification capacity actually required and achieved. Consequently, the concept fails to address the objective of improved municipal hygiene and the protection of ground water (see section on "Efficiency"). The low level of pollution is primarily due to the infiltration of external water (rain and ground water) into the sewer network. The sewer network is dilapidated, especially due to its age, and there are leaks in many of the pipes. Cracked and corroded concrete pipes, ground subsidence and high traffic volumes place considerable strain on the network. Although this was recognised in the feasibility study, it was only identified as a problem in the detailed planning. However, even in the detailed planning, the inflow of ground water and rainwater in relation to the sewage was significantly underestimated at 0.75:1; the actual ratio is 3:1.

From today's perspective, the chain of effects still appears plausible and comprehensible. A functioning wastewater disposal and treatment system (outcome) improves the basic sanitation of the population. The measure thus contributes to improving the health situation of the population and also contributes to the protection of natural resources (impact).

Wastewater collection and treatment is essential for preserving the Una river as an ecologically sensitive water body and therefore meeting the local and regional strategic objectives (as required by the Sava River Basin Agency and Adriatic Sea Watershed Agency for example). However, constructing the sewage treatment plant appears sceptical in terms of relevance, since the target effluent values are already achieved in the inflow to the plant.

Giving both the sewer network and sewage treatment plant consideration at the same time was the right decision to help protect natural resources. Although the complementary measure addressed the issue of industrial discharge, it did not follow up on the approaches to the creation and continuation of an industrial land register.

Since it financed municipal facilities for basic public services, the project was in accordance with the Bosnian government’s development objectives and the priorities of the German development cooperation, which was involved in urban water management in Bosnia and Herzegovina, including with regard to supplying water and disposing of wastewater in Banja Luka.¹

From today’s perspective, its relevance is still rated as moderately successful.

Relevance rating: 3

Coherence

The project was implemented as part of a wider German development cooperation programme in various cities in Bosnia and Herzegovina focusing on water supply and wastewater treatment. In 2012, the German Federal Government decided to downgrade Bosnia and Herzegovina, as a partner country in the German development cooperation, from category A to category B starting in 2013. As a result, the scope of the development cooperation with Bosnia and Herzegovina was reduced. From this point, there were no new commitments as part of the “municipal cooperation”.

The project was carried out in coordination with other donors in the sector, as reflected in part by the European Union’s cofinancing efforts. Like other measures in the priority area of “municipal infrastructure” in Bosnia and Herzegovina, the planning and design of the sewage treatment plant meets EU standards. The project thus enables the partner country of Bosnia and Herzegovina to converge with EU legislation (the EU *acquis communautaire*), which was in line with the sector strategy. The decision was made in favour of wastewater treatment technology that would meet the EU requirements set out in the Bathing Water Directive for moderately polluted wastewater. There was no overlap with TC activities or other donors.

One positive aspect is that, in addition to the FC project, the city centre of Bihać will be connected to the sewage system as part of a project financed and to be implemented by the city. This was agreed during the project appraisal. After an unsuccessful tender in 2022, the tender for this work will be reissued in 2023. In addition, the city of Bihać is in the process of obtaining approval (still pending) from the road building authority to tear up the regional road concerned.

Coherence rating: 2

Effectiveness

The project objective at outcome level was to ensure the environmentally friendly and hygienically safe collection and treatment of wastewater in the city of Bihać. Following the implementation of the project, wastewater is now safely collected and fully treated in most of the city of Bihać.

Using the indicators defined in the project appraisal, the target achievement at the outcome level is summarised in the table below:

Indicator	PA status	Target value at PA	Ex post evaluation
(1) Increase in the population’s connection rate to the urban wastewater network	31%	53%	Not achieved: 48%

¹ BMZ no. 2008 66,038, evaluated with an overall rating of 3 (2019)

(2) Quality of wastewater treatment in the sewage treatment plant	n/a	BOD ≤ 25 mg/l; COD ≤ 125 mg/l; SS ≤ 30 mg/l	Achieved: BOD ≤ 11 mg/l; COD ≤ 35 mg/l; SS ≤ 16 mg/l
(3) Improvement in the quality of the Una river's surface water**)	n/a	BOD < 5 mg/l; COD < 69 mg/l; E.coli < 10 ² MPN/100ml	BOD = 0.99 mg/l COD = 1.19 mg/l E.coli = 750 &or 3.9*10 ³ MPN/100 ml*)
(4) Coverage of the plants' operating costs from tariff revenues following commissioning	n/a	100%	Not achieved: ~ 40%

*) There are only two measurement results from October 2016, directly after the completion of the sewage treatment plant in September 2016.

***) The indicator regarding the quality of the surface water is considered in the section "Impact".

As the connection rate is slightly below expectations, indicator 1 is not achieved. Despite connection and use being compulsory, the fact remains that less than half of the population is connected to the sewer network today. Both the failure to enforce official administrative requirements and the decline in population due to migration in the region and the city of Bihać are contributory factors.

The required wastewater criteria (indicator 2) have been fully met. However, these values are already achieved in the inflow to the sewage treatment plant.

Indicator 4, which concerns operating cost coverage, has not been achieved. This is considered in detail in the section "Sustainability".

Currently, only part of the design capacity of the sewage treatment plant is required; one of the two biological treatment lines in the plant is not in use. UV disinfection is likewise not in operation. Since the current E.coli value is not measured in the effluent, there is no information regarding effluent concentrations. The assumption that the E.coli values would be negligible was cited as the reason for taking UV disinfection out of operation. It seems likely that the main reason for this is energy or cost savings.

Two pump stations for discharging combined sewage, one pump station for transferring sewage, two combined sewer overflow outlets and one sewer shaft from the old combined sewer system were inspected as part of the assessment of the wastewater system. Noteworthy was that none of the facilities visited had been closed off and, in some cases, were freely accessible to the general public. The cover lids for the pump shafts were also not closed, which must be considered as gross negligence. The sewer network is occasionally used for waste disposal.

Vodovod continues to pursue the strategy of deploying the personnel responsible for operating the water supply network in the operation of the sewage system as well. This is extremely unusual in water management, particularly for hygiene reasons. Vodovod's head office does not have any shower facilities.

As was the case at the time of the project appraisal, there are three major commercial or industrial dischargers (hospital, dairy, brewery), some of which undergo a pre-treatment process, although this is not mandatory. There are indications of industrial wastewater being discharged, though this is not being systematically examined. The policies as part of the complementary measure to record commercial or industrial discharge in a land register so it can be controlled were not pursued any further.

When measured against the three indicators considered, the objectives at outcome level have largely not been achieved. However, a key indicator regarding the sewage treatment plant's effluent values has been achieved in full. The population's connection rate also increased significantly (from 31% to 48%), even if it does remain below the set target (53%). From the perspective of EPE, the indicator for covering costs is considered primarily from a sustainability point of view and is therefore reflected in the evaluation of the criterion on sustainability. Its effectiveness therefore continues to be rated as moderately successful.

Effectiveness rating: 3

Efficiency

Due to payment delays and the resulting termination by the contractor, a new tender was necessary for the expansion of the network. This led to a delay of nine months and increased costs of almost EUR 900,000. The contract with the second contractor was also terminated prematurely, which meant the warranty obligation for the functionality of the system as a whole was lost. The later necessary rectification of defects had to be partly financed by the city of Bihać.

To remedy the enormous subsidence problems encountered by the sewage treatment plant, the warranty obligation was extended by 30 months until the end of April 2021. The project's implementation has therefore encountered significant, albeit justified, delays, with the time used to repair the extensive damage to the sewage treatment plant caused by subsidence. Since the subsidence has not abated, it remains questionable from today's perspective whether the high costs for laying the pipes above ground or the supposedly excessive costs for securing the pipelines with piles would not have been a more efficient choice.

The specific investment costs for wastewater services per capita (EUR ~772 CAPEX/capita) are comparatively high. However, these are appropriate for the installed process technology, including structural difficulties (subsidence), based on the goal of meeting European standards and the requirement stipulating a moderately polluted inflow of wastewater. Still, the choice of where to build the plant should be called into question, since it was known at the start of the project planning that the soil conditions were insufficient. It remains unclear why more time was not invested in finding a more suitable plot of land for the sewage treatment plant.

The actual purification capacity of the sewage treatment plant is highly disproportionate to the high investment costs, which has an adverse effect on the project's allocation efficiency. The failure to cover the high operating and reinvestment costs for advanced technology is also problematic for the water supplier as well as the city of Bihać. The question remains whether alternative wastewater treatment methods would have made more sense given the circumstances that are now known. Trickling filter technology, for example, is much simpler to operate and would have saved the city the high subsidies. Under this system, it would also have been possible to add a UV disinfection stage to comply with all EU standards. It cannot be assumed that such a simpler and cheaper process technology (in terms of construction and operation), which is in line with the city of Bihać's level of development and financial ability, would have led to unresolvable conflicts over potential accession to the EU.

The UV disinfection stage is currently not in use because, according to statements from Vodovod, it is not necessary. Proof of this statement could not be provided. Since 75% of the inflowing wastewater consists of rainwater or groundwater, the sewage treatment plant largely treats external water, according to Vodovod's measurement data, at considerable cost. Furthermore, the overall efficiency is affected by the connection rate to the wastewater network in Bihać, which has not achieved the project's expectations. The operator has not managed to encourage households to comply universally with the obligation to connect to the network.

The efficiency of the construction of the sewer network and therefore the efficiency of expanding the network within the scope of the project remains unclear, as the pump stations visited that discharge combined sewage were not in operation due to the time of year and were evidently poorly maintained (debris in the pump station). A combined sewer overflow that was inspected was evidently in operation more frequently, as was clear from the wastewater residue in the cross-section with the receiving water. Considering the limited funds, it is clear why the measures classified as a priority (two river-side collectors and culverts) were initially selected and implemented from the general drainage plan and why the secondary (old) sewer network was not the primary focus. However, it would have been helpful to take a number of rainwater retention basins into consideration at the same time (possibly for a second expansion phase). This would make it possible to reduce the amount of water transported to the sewage treatment plant – especially during rainy periods – and thus reduce inefficiencies.

When assessing the allocation efficiency of the wastewater treatment, the question arises as to whether the same effluent values could have been achieved with a simpler process technology. This would have required political approval for a gradual process, with possible temporary exemption for non-compliance with EU standards by the partners. Initially unused funds could have been used to improve the rainwater system and could have been invested, for example, in the construction of a rain retention and treatment system. This would have meant that more rainwater

and external water was kept out of the sewage treatment plant, so more concentrated sewage could be treated in the sewage treatment plant. Contrary to assumptions from the final inspection, the high infiltration of external water into the sewage treatment plant is not only a problem when the Una river floods, but also a fundamental problem. In addition, operation of the sewage system and the sewage treatment plant in particular requires a certain will and level of economic strength that has not yet been achieved in Bihać.

The proportion of costs for consulting services is considered to be rather low at 7% of the total costs. This is an efficient consulting/investment cost ratio for a project in the wastewater sector.

Given the low tariff level, the water utility company, Vodovod Bihać, is not in a position to assume full financial responsibility for the sewage treatment plant. Operation of the sewage treatment plant is heavily subsidised by the city. The selected technology for the sewage treatment plant should therefore not be regarded as a model for Bosnia and Herzegovina. Instead, wastewater treatment plants should be adapted to reflect local economic conditions and partner commitment (investment costs, operating and maintenance costs). Moreover, the city of Bihać and the operator Vodovod have unfortunately not yet addressed the question of where, exactly, these volumes of external water are entering the system and how the problem can be permanently rectified.

Overall, the project is rated as unsuccessful in terms of efficiency.

Efficiency rating: 4

Impact

The overarching development objective (impact) defined at the time of the appraisal was to help improve the living conditions of the population and protect natural resources. No indicators were defined for this. Ultimately, however, indicator 3, which was originally defined at module objective level, refers directly to this objective. An improvement in the quality of the Una river's surface water has not yet been demonstrated. The only two available measurement results are from October 2016 and refer to its condition directly after the completion of the sewage treatment plant. At that time, the E.coli value was significantly above the target value. Nothing is known about the current water status. The lack of relevant measurement values can also be interpreted as an indication that water quality was assigned a low priority by the city of Bihać or Vodovod.

During the project appraisal, it was assumed that if the objectives were achieved at outcome level, they would inevitably also be achieved at impact level. This correlation is also valid from the evaluation's perspective. The target was realistic and is still in accordance with current needs and findings.

The increase in the wastewater management rate and correct treatment of the wastewater are contributing to an improvement in the target group's living conditions. It can also be assumed that the water quality of the Una river was improved by the construction and operation of the sewage system. However, this has not yet been proven.

Currently, the population of Bihać and the municipality are not yet sufficiently noticing or appreciating the positive environmental impacts from the sewage treatment plant (a clean Una river). More focus on public relations could therefore help bring about the political approval needed to increase the tariff.

The project continues to generate high costs for the owner (city of Bihać) and the operator of the sewage treatment plant (Vodovod Bihać). These costs must be paid from the city's tax revenues, which could hinder the implementation of other potential development projects.

Despite it being difficult to determine whether the goal was achieved, the project is rated as moderately successful from an impact perspective due to the plausible influence on the environment and living conditions.

Impact rating: 3

Sustainability

The sewage treatment plant is currently in good operating condition. However, the second biological process line, a mechanical treatment stage (raking) and UV disinfection are not used. Due to

the low utilisation of the sewage treatment plant, some mechanical components are out of operation (e.g. aeration units) and therefore have no impact. Some components in the control system were defective, although data transfer to the SCADA system and therefore automatic control of the aeration function did work. The laboratory is equipped with state-of-the-art technology, but is not used often. The main reason for this is the lack of budget for consumables (e.g. cuvettes for the photometric measurement of pollutants). Staffing of the sewage treatment plant must be assessed as low, with at least four important positions vacant. Both must be considered in light of the plant's operation, which was economically deficient (see below). According to their own statements, the maintenance schedule drawn up by the manufacturer of the sewage treatment plant is observed.

The visit made it clear that no regular maintenance processes are currently performed for the sewer network. In addition, there is a lack of appropriate machinery (e.g. flushing vehicles for the larger sewer diameters financed by the project) and competent operating technicians. In general, but especially in the case of the water supply and wastewater treatment network, Vodovod is very much overstaffed by international standards, due in particular to the integration of ex-soldiers after the civil war. However, overstaffing mostly affects administration, meaning maintenance of the network is not sufficient despite there being a ratio of 1.6 employees per 1,000 residents.

In Bihać there is currently only a fee for wastewater collection, but not for the treatment of wastewater in the sewage treatment plant. The existing fee of BAM 0.25/m³ falls far short of covering the costs (currently only 40% of operating costs are covered by the tariff revenue), which is preventing Vodovod Bihać from operating in an independent, future-focused manner. The tariff adjustment agreed as part of the complementary measure and urgently required due to the construction of the sewage treatment plant has still not taken place. According to the municipality, the need to increase the fee will be discussed by the city council in the near future following the parliamentary elections in October 2022. For this, the operator, Vodovod, has worked out that a tariff of BAM 0.4/m³ for wastewater treatment would cover the costs. However, it can be assumed that the costs estimated by Vodovod per m³ of sewage can only cover minimal maintenance and operating costs for the new plant. In future, higher reinvestment expenditure must be assumed, which will require a higher tariff. In addition, due to migration and tourism, not all households connected to the sewage system continuously produce wastewater and therefore cannot contribute to covering the costs.

For political reasons, an increase in the water tariff (joint tariff for water supply and wastewater treatment) by a maximum of 15% is assumed. This would be an ideal first step, but would remain significantly below the adjustment required to make Vodovod financially independent. Assuming a reasonable amount of 4% of income for water per household, a fee of up to BAM 4/m³ can be regarded as socially affordable in Bihać.

As yet, there is no strategy in place for treating and utilising sludge. As a result, the dewatered sludge is stored in the properly designed sludge storage area. Surplus waste is deposited illegally on the sewage treatment plant site. Two of the four available analyses of the sludge prove that the sludge quality requirements for agricultural use (chrome and nickel content) have not been met. The original plan to utilise the sludge for agriculture is therefore questionable. This shows the necessity of supervising commercial (e.g. car workshops) and industrial dischargers. The costs of thermal treatment currently exceed Vodovod's or the city of Bihać's financial opportunities. It is noteworthy that the amount of sludge generated, which only amounts to around 550 tonnes of pure sludge a year or 110 tonnes dry residue per year, is extremely low. It can be assumed that the activated sludge becomes largely mineralised during aerobic stabilisation. However, the proper treatment of the sludge is very important for the functionality of the sewage treatment plant. The route for the disposal of sludge, which has not yet been developed, therefore represents a further challenge to the sustainable operation of the sewage treatment plant. This illegal depositing of sludge also poses a risk to nature and the population (leaching of nutrients, water pollution, methane gas emissions, etc.).

The current high level of financial support from the city of Bihać cannot be regarded as sustainable. It can be assumed that the city of Bihać will continue to fund the sewage treatment plant due to its importance, especially for the conservation of nature and resources of the Una river. However, it is questionable whether these funds are sufficient to operate the plant at a professional level and cover the amortisation costs, regular maintenance work and required materials. A gradual increase in the tariff is crucial for ensuring that the operation of the sewage treatment plant is

financially sustainable. There is also a need to increase the collection rate. In 2021, this stood at just 76% for Vodovod Bihać's total services (water supply and wastewater treatment).

There are still problems with severe ground subsidence on the site of the sewage treatment plant despite the improvements made during the warranty period, and this is having a negative effect on the functionality of the plant due to the possibility of underground pipelines breaking between the different treatment stages. Pipelines are already breaking out of their anchors. Further subsidence can be assumed due to the fluctuating groundwater levels in the Una river, which will cause pipes to break in the medium term.

The water quality of the river is of enormous relevance to the economic and living conditions of the city (increasing tourism). It can therefore be assumed that protecting the Una river will continue to be the focus and that long-term protection of resources is guaranteed.

The sustainability of the project is jeopardised by inadequate financing for operations and reinvestment, the imbalance in the management of wastewater and precipitation (high operating costs for treating external water), the lack of a sewage sludge disposal path, an insufficient connection rate and the likelihood of further subsidence. We rate sustainability as not successful.

Sustainability rating: 4

Notes on the methods used to evaluate project success (project rating)

Projects are evaluated on a six-point scale, the criteria being **relevance, coherence, effectiveness, efficiency, overarching developmental impact and sustainability**, as well as the final **overall rating** of developmental effectiveness. The scale is as follows:

Level 1	very successful: result that clearly exceeds expectations
Level 2	successful: fully in line with expectations and without any significant shortcomings
Level 3	moderately successful: project falls short of expectations but the positive results dominate
Level 4	moderately unsuccessful: significantly below expectations, with negative results dominating despite discernible positive results
Level 5	unsuccessful: despite some positive partial results, the negative results clearly dominate
Level 6	highly unsuccessful: the project has no impact or the situation has actually deteriorated

Rating levels 1-3 denote a positive assessment or successful project while rating levels 4-6 denote a negative assessment.

The **overall rating** on the six-point scale is compiled from a weighting of all six individual criteria as appropriate to the project in question. Rating levels 1-3 of the overall rating denote a "successful" project while rating levels 4-6 denote an "unsuccessful" project. It should be noted that a project can generally be considered developmentally "successful" only if the achievement of the project objective ("effectiveness"), the impact on the overall objective ("overarching developmental impact") **and the** sustainability are rated as at least "moderately successful" (level 3).