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SUSTAINABLE WATERS
NURSECOAST-II

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SOCIAL FACTORS REPORT FOR WASTEWATER TREATMENT AT RURAL TOURIST DESTINATIONS

DELIVERABLE D.1.3

Effelsberg, N. & Dozza, E.

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Introduction

This report contributes to the project Nursecoast-II, whose goal is to reduce seasonal increase in wastewater production and nutrient discharges in touristic areas. It summarises the results of the group of activities focused on socio-economic considerations.

It is estimated that around 70–80% of the total water supply becomes wastewater and is released into natural water streams. As water becomes contaminated, it poses a threat to health and the environment, subsequently losing its aesthetic and economic value (Chitthaluri et al. 2023).

In the project six wastewater treatment plants (WWTPs) were selected as pilots to test new technologies and nature-based solutions, aiming to improve deficiencies in the current treatment systems. The selected WWTPs had to meet four criteria: be located within the distance of 100 km from the coastline of the Baltic Sea, have a PE below or equal to 2000, be operating in 2019 and 2021 and have the Baltic Sea as the end receiver of their treated wastewater.

This report compiles social as well as economic and legal considerations that need to be taken into account when considering to improve wastewater treatment management, examining the state of the WWTPs before the implementation of new technologies.

Thereby, it highlights the negative social impacts that a poorly managed plant can have on local communities, tourism and business activities and elaborates on how the pilot solutions can mitigate these issues.

The report is structured as follows. The first section explains the methodology used in this study. The second section assesses the status of the pilot study areas before the pilot implementation, focusing on the environmental and societal impacts of seasonality on wastewater treatment in rural areas, with particular attention to tourism.

The third section covers the predictions of the impacts of the pilot solutions on the previously identified issues, highlighting the anticipated social sustainability of these options. This analysis will help project partners to identify and advocate for the potential of all the pilot technologies across the Baltic Sea Region.

The last section of the report describes the legal framework in which the pilots operate, with a focus on requirements for improving wastewater treatment plants.

The overall aim of this report is to enhance local authorities' understanding of the relationship between investment in wastewater management, environmental quality, and tourism development. Tourism is a fundamental economic driver in rural areas around the Baltic Sea, and its success is closely linked to the quality of the environment. However, tourism development also significantly increases water consumption, which presents challenges for effective wastewater management.

Methodology

Numerous steps were taken to define core elements that can be evaluated, utilising the six pilot plants.

Identifying social threats is fundamental for understanding the baseline conditions of the selected areas, allowing for a comprehensive evaluation of how the proposed technological solutions can meet the needs of the local communities. In order to gather the information to assess the baseline conditions, a survey to be distributed to the relevant project partners was developed through the following steps.

Firstly, to identify the key socio-economic components impacted by wastewater management a literature research was conducted (e.g. Hussain et al 2001, Serreli et al. 2021) and the ecosystem services provided by the pilot areas were selected (tab. 1). Through this, seven key components could be determined (fig. 1).

Figure 1: Socio-economic components

ECOSYSTEM SERVICES

CATEGORY	DIVISION	GROUP/CLASS	DESCRIPTOR
Cultural	**Direct, in-situ and outdoor interactions with living systems that depend on presence in the environmental setting**	Physical and experiential interactions with natural environment; Intellectual and representative interactions with natural environment	Using the environment for sport and recreation; using nature to help stay fit; Watching plants and animals where they live; using nature to destress; Researching nature, Studying nature; The beauty of nature
	Indirect, remote, often indoor interactions with living systems that do not require presence in the environmental setting	Spiritual, symbolic and other interactions with natural environment	The things in nature that have spiritual importance for people, that we think should be conserved, that we want future generations to enjoy or use
Provisioning	**Biomass**	Cultivated terrestrial plants, aquatic plants or reared aquatic animals for nutrition, materials or energy; Wild plants or animals (terrestrial and aquatic) for nutrition, materials or energy	Any crops and fruits grown by humans for food; food crops
			Material from plants, fungi, algae or bacterial that we can use
			Plants or animals that are cultivated in fresh or salt water that we eat, use as a material or as a source of energy
			Wild plants or animals for food, use as a material or as a source of energy (also algea, fungi)
	Genetic material from all biota (including seed, spore or gamete production)	Genetic material from plants, algae or fungi	Seeds, spores and other plant materials collected for maintaining or establishing a population
			Plants. fungi or algae that we can use for breeding
			Individual genes extracted for the design and construction of new biological entities
		Genetic material from animals	Animals used for replenishing stock
			Wild animals that we can use for breeding
	Water	Surface water used for nutrition, materials or energy, genetic material from plants, algae or fungi	Drinking water from sources at the ground surface
			Surface water that we can use for things other than drinking

Regulation & Maintenance		
	Ground water for used for nutrition, materials or energy	Drinking water from the below ground
		Sub-surface water that we can use for things other than drinking
Transformation of biochemical or physical inputs to ecosystems	Mediation of wastes or toxic substances of anthropogenic origin by living processes	Decomposing wastes
		Filtering wastes
	Mediation of nuisances of anthropogenic origin	Reducing smells
		Reducing noise
		Screening unsightly things
Regulation of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Providing habitats for wild plants and animals that can be useful to us
	Pest and disease control	Controlling pests and invasive species
	Lifecycle maintenance, habitat and gene pool protection	Controlling disease
	Water Conditions	Controlling the chemical quality of freshwater

CICES Version 5.1, EEA 2024

Table 1: Impacted ecosystem services (CICES Version 5.1, EEA 2024)

Furthermore, six main parameters that represent the primary problems resulting from deficient wastewater management were determined through literature review (fig. 2) (e.g. Singhirunnusorn 2011, Boldrin & Formiga, 2023).

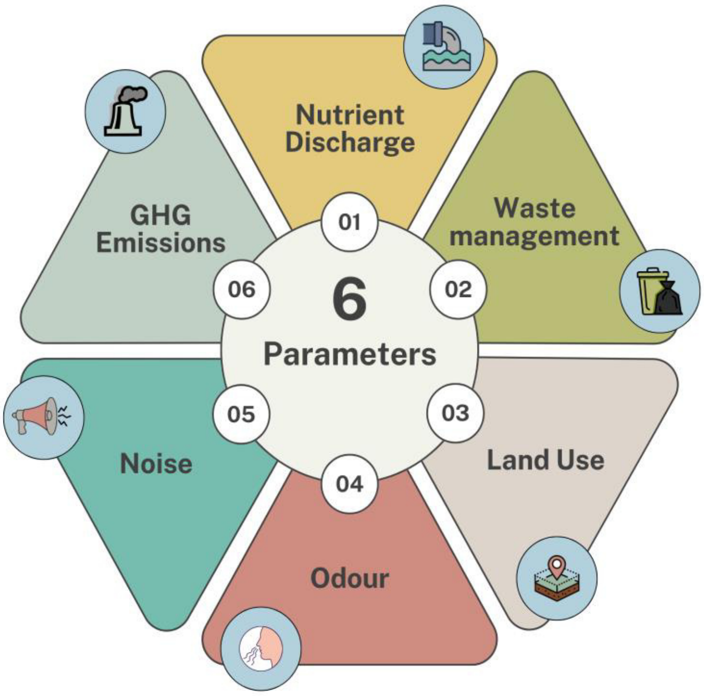

Figure 2: Parameters

Based on these results, questions were developed on how specifically the parameters have an impact on the social factors and what data is needed for the assessment.

The first parameter whose impact was analysed is nutrient discharge. Decreasing the amount of nutrients in wastewater "is an important aspect of water quality management because excessive nutrient concentrations often prevent water bodies from meeting designated uses (Carey & Migliaccio, 2009)". The focus was placed on the recreational use of water bodies to analyse the impact of nutrient pollution on tourism, such as loss of customers for businesses, negative reviews, cancelled trips and refund demands. Also the impact of nutrient discharge on agriculture was examined, with possible effects including animal or plant illness, changes in crop yields and soil productivity.

Secondly, waste management at the plants was investigated, focusing on the types of waste produced, their disposal methods and costs, as well as the potential for by-product reuse within a circular economy framework.

Another parameter that has been taken into consideration was land use. The WWTP location, particularly its proximity to populated areas, is a significant factor in determining its impact. A WWTP can affect its surroundings simply by its presence, creating a visual impact, preventing alternative land use or influencing property values.

Location is also fundamental in ascertaining the impact of the parameters noise and odour. If the plant is located near populated areas, issues with noise and odour can adversely affect residents and businesses.

Finally, the greenhouse gas (GHG) emissions from the WWTPs, primarily focusing on the plants energy mix were investigated. Figure 3 illustrates which parameters can affect the socio-economic components.

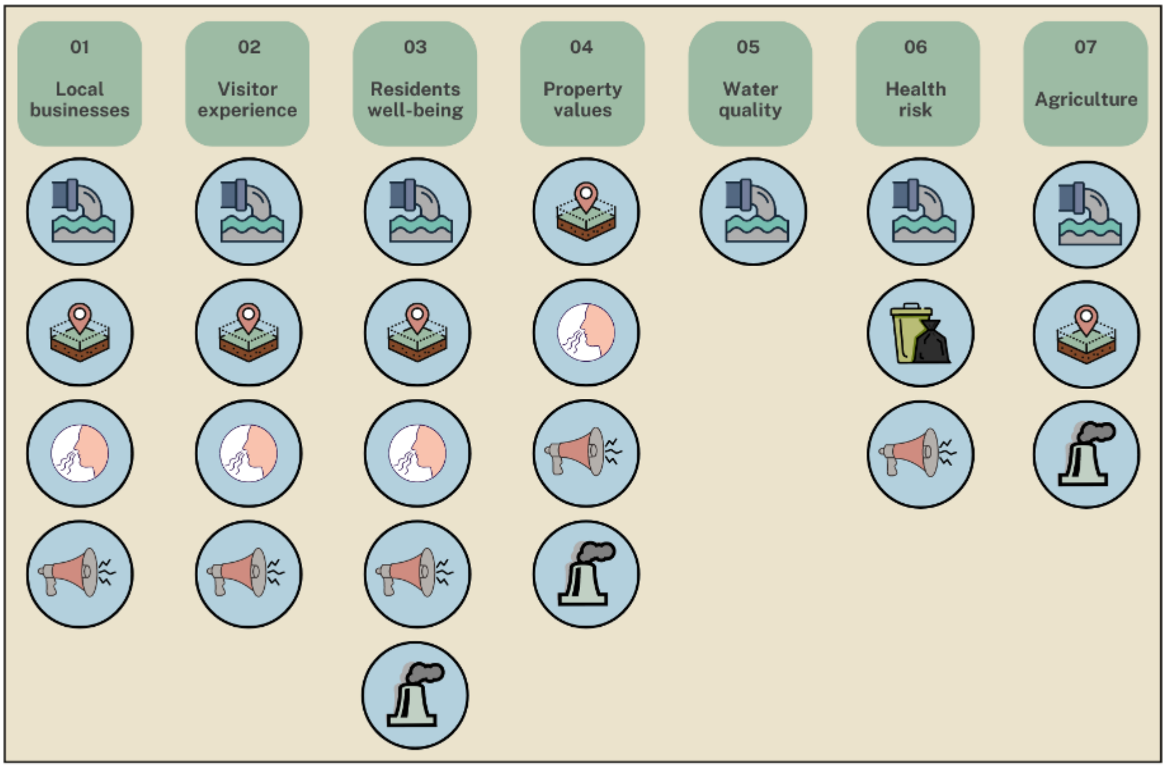

Figure 3: Parameters impacting the socio-economic components

As a result, the survey was designed and distributed to the relevant project partners in May:

- LP: The Szewalski Institute of Fluid-Flow Machinery Polish Academy of Sciences (IFFM PAS), Poland
- PP 3: Natural Resources Institute Finland (LUKE), Finland
- PP 6: Aalborg University (AAU), Denmark
- PP 7: The Bogdan Janski Bure Misie Community Foundation (BMCF), Poland
- PP 11: Municipality of Ingå, Finland
- PP 18: VNK serviss LtD, Latvia.

The survey consists of 46 questions, divided into a different section for each parameter. The data gathered is used to describe the actual effects that the WWTPs in the pilot regions have on the socio-economic components determined in this study. The results of the survey were then shared with Aalborg University (AAU), in order to predict the effect of the new technologies on the identified social threats.

Baseline Conditions

In this section the current impacts of the WWTP at the sites designated for the pilot studies are described. The aim of this section is to show an overview of how the identified parameters can affect socio-economic components. It should be noted that in one of the pilot sites (Pilot 4) there is no pre-existing wastewater treatment plant, so the baseline assessment will mainly consider the other five plants.

Due to the insufficient wastewater treatment in the current treatment plants, nutrient discharge poses a threat that can impact nearby water bodies such as the Baltic Sea, contributing to eutrophication.

Effects of eutrophication are observed in some bodies of water nearby the wastewater treatment plants (WWTPs), occasionally leading to complaints and hindering recreational activities. This can be attributed to multiple factors, with wastewater discharge being one of the contributing elements. Nevertheless, it was generally not possible to directly assess the impact of nutrient discharge from the wastewater treatment plants on bathing water. This is mainly due to the small size of the plants, the infrequency of water analyses and the lack of data.

The type of waste produced varies from plant to plant, with sludge being a common by-product. While wastewater valorisation initially focused mainly on water reuse, the potential for valuable resources recovery has been recognized (Duque et al., 2021). Sludge can be used for nutrient recovery or energy production, transforming what would otherwise be a waste product into a valuable resource that provides both economic and environmental benefits (Gupta et al., 2021). However, in this study the reuse is often limited due to the small size of the WWTPs and the consequently low volume of sludge produced. Currently, only one plant reuses its sludge in agriculture, while another transports its sludge to a larger facility, where part of it is used for biogas production.

In terms of the land use parameter, three of the plants considered are less than 500 metres from a populated area leading to a possible visual impact on residents or visitors. However, the small size of the plants helps minimise their visibility. In some cases, this is further mitigated by situating the plant underground or employing vegetation to screen it from nearby buildings.

When it comes to odour and noise pollution, the proximity to populated areas plays a relevant role as well. Odour is in fact reported to be the most significant issue among the parameters assessed. Four out of five plants have experienced problems with unpleasant smells, and three of these plants have received complaints from the surrounding communities. The odour issue worsens during the tourist season, when the volume of wastewater exceeds the plants' capacity.

Noise, on the other hand, appears to be a minor issue. Only one plant generates noise that can be heard from the nearest building, but no complaints have been reported.

The information on GHG emissions from the WWTPs are mainly derived from their energy consumption. Two of the plants reported using only renewable energy sources, while the others use a mix of renewable and non-renewable energy sources.

In Figure 4 an overview of the impact assessment of each pilot on the socio-economic components is displayed.

Baseline conditions

Pilot	Local Business	Visitors Experience	Residents Well-being	Property Values	Water Quality	Health Risk	Agriculture
Pilot 1 Latvia	X	~	~		~		
Pilot 2 Finland	~	~	~		~		
Pilot 3 Denmark	—	~	~				
Pilot 4 Denmark	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Pilot 5 Poland	X	X	X		—		—
Pilot 6 Latvia	X	X	X		~		

Legend: X Negative Impact; — No Data; ~ Uncertain or partial impact

Figure 4: Baseline conditions of socio-economic components of the pilot sites

Prediction of Impacts

In this section the predicted impacts of the pilot solutions on the previously identified social issues are examined. The predictions have been developed by the Project Partners at Aalborg University (AAU), based on their knowledge of the technologies that will be implemented and on the results of the baseline conditions assessment.

The new technologies are expected to reduce the nutrients input in the treated wastewater. In particular, nanobubbles are supposed to improve the removal of nitrogen and degradation of micropollutants. In the locations where constructed wetlands are installed, there will be no more wastewater discharge. Effluent will be used for irrigation in two of the plants. Constructed wetlands will also eliminate the need for waste sludge disposal, as the sludge will be mineralised in the wetland. Consequently, waste management costs will decrease. Nanobubbles technology is not predicted to have an impact on the amount of sludge produced.

For what concerns visual impact, the nanobubbles technology will not change the appearance of the plants. Where constructed wetland will be installed, the plants will blend in more with the surrounding environment, and probably the land occupied will be reduced.

The new technologies are predicted to have a positive impact on odour problems. Since unpleasant odour usually arises from leaks or design errors, the advanced nature of these technologies should resolve this issue. Furthermore, nanobubbles technology specifically needs decreased or no aeration in the activated sludge process, further reducing the transfer of odour compounds into the air. One plant will be built in a different location than the current one, further away from populated areas, in order to minimise odour and visual impact.

Noise impact is expected to be minimised with the implementation of the new technologies.

The energy consumption is expected to be reduced in most sites with the implementation of the pilot solutions.

Figure 5 gives an overview about whether the pilot solution is predicted to have a positive impact on the social issues, reflected by the selected parameters.

Prediction of Impacts

Pilot	Nutrient Discharge	Waste Management	Land Use	Odour	Noise	GHG Emission
Pilot 1 Latvia	✓			✓		
Pilot 2 Finland	✓			✓		
Pilot 3 Denmark	✓			✓		✓
Pilot 4 Denmark	✓	✓	✓			
Pilot 5 Poland	✓	✓	✓	✓	✓	
Pilot 6 Latvia	✓	✓	✓	✓		

Legend: ✓ Positive Impact

Figure 5: Prediction of the impacts of new technologies and nature-based solutions

Legal Framework

In this section the legal framework in which the pilot project partners operate is illustrated. Legal requirements, restraints and obstacles that can be faced whilst improving their wastewater treatment are identified.

- Latvia, Jurkalne & Blazma: The municipal decision-making body, the city council, must approve investments if they utilise EU funding which get financed through a state treasury loan. Political parties' resistance to new technologies and their preference for the lowest possible tariffs hinder improvements in wastewater treatment facilities, negatively impacting environmental quality.
- Finland, Barösund: Property owners are responsible for ensuring their wastewater systems meet basic cleaning requirements, removing 80% of organic matter, 70% of phosphorus, and 30% of nitrogen. Systems that do not meet these standards must be renewed, and both construction and renovation require permits. New building systems are approved through the building permit process, while old systems usually need an action permit. Municipalities may also impose additional measures. A professionally prepared wastewater plan must accompany permit applications. For systems serving more than 100 people, an environmental permit under the Environmental Protection Act is required.
- Denmark, Vallensved: A significant benefit of the nano bubble generator is its straightforward implementation, which is not hindered by regulatory obstacles.
- Denmark, Skovgaard Gods: Setting up the plant requires several permits:
    a. Infiltration or Waterbody Connection Permit, to either infiltrate the treated water or connect to a waterbody.
    b. Land Use Change Permit
    c. Conservation Board Approval, which ensure that the facility to be constructed does not visibly, audibly, or otherwise disrupt the existing surroundings
    d. Coastal Directorate Approval

  A research programme will establish the feasibility of using wastewater for irrigation.
- Poland, Nowy Klincz: In order to implement the pilot, a water permit from the national water management authority and a building permit from the local authority are required.

Conclusion

This report has highlighted the key socioeconomic components that must be addressed to improve wastewater management and underlined the significant negative impacts that poorly managed WWTPs can have on local communities, tourism, and business activities. The findings of this report are instrumental in validating the importance and relevance of the project. By documenting the anticipated positive impacts of new technological solutions on WWTP efficiency, the report demonstrates the project's potential to deliver substantial social benefits and improve the quality of life in local communities.

The survey results showed that odour is the most impacting parameter. Assessing the impact of other parameters, such as nutrient discharge, proved challenging due to the small size of the plants and the lack of data.

Overall, new technological solutions show promise in mitigating the identified impacts, enhancing the efficiency and sustainability of wastewater treatment.

Regarding the legal framework, various permits are required to renovate or establish wastewater treatment plants, and these requirements differ by country. However, no significant obstacles appear to hinder the implementation of the solutions identified in the pilot case studies.

The report will then serve as a resource for stakeholders, offering actionable insights and recommendations to optimise socio-economic and environmental outcomes in wastewater treatment management.

Literature

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ANNEX I: The Pilots

The WWTPs that were selected as pilot sites had to meet four criteria: be located within the distance of 100 km from the coastline of the Baltic Sea, have a PE below or equal to 2000, be operating in 2019 and 2021 and have the Baltic Sea as the end receiver of their treated wastewater.

Pilot	**Location**	**Description/Technology**
Pilot 1	Jurkalne, Latvia	Oxygen Nanobubbles
Pilot 2	Barösund, Finland	Scaling and updating on-site WWTS
Pilot 3	Vallensved, Denmark	Nanobubbles - Improved aeration at already existing plant – improvement of capacity
Pilot 4	Skovgaard Gods, Denmark	Constructed wetland with reuse of treated wastewater for irrigation
Pilot 5	Nowy Klincz, Poland	Constructed wetland, nanobubbles and reuse of treated wastewater for irrigation
Pilot 6	Blāzma, Latvia	Constructed wetland as a post-treatment solution

ANNEX II: Survey Questions

Nr.	Question	
1.	How many people are employed directly by the WWTP (full-/part-time)?	Open-Ended Response
2.	What is the rate of non-fatal incidents at the workplace?	Open-Ended Response
3.	Does the plant have any environmental certifications?	Yes
		No
		Please provide details.
4.	Is the quality of bathing water in the pilot area monitored?	Yes
		No
		Please provide details.
5.	Is there any public information about the current quality of water (on a daily/weekly basis)?	Yes
		No
		Please provide details.
6.	Is there data available on nutrient discharge from the WWTP?	Yes
		No
		Please provide details.
7.	Please upload available data on the WWTP nutrient discharge.	Open-Ended Response
8.	Does the nutrient discharge from the WWTP have a detectable impact on bathing water quality, resulting in conditions that make it less enjoyable or unsuitable for recreational use (algae bloom, e. coli etc.)?	Yes
		No
		Please provide details.
9.	What were the economic implications of the resulting conditions of bathing water for business activities near the sea?	Loss of customers or clients
		Reputation loss
		Less tourists
		Negative publicity/reviews
		Cancelled trips

		Demanded refunds
		Other (please specify)
10.	Does the nutrient discharge from the WWTP have a detectable impact on plant/animal agriculture?	Yes
		No
		Please provide details.
11.	What are the economic implications of the impact of nutrient discharge on agriculture?	None of the above
		Exposure to infectious diseases for farmers
		Illness of animals (medicine, veterinarian...)
		Illness of plants (pesticides...)
		Increased crop yields and soil productivity
		Decreased crop yields and soil productivity
		Other (please specify)
12.	What are the local water bodies and groundwater used for?	None of the above
		Drinking Water
		Irrigation
		Agricultural production
		Industrial purposes
		Other (please specify)
13.	Is there data available on groundwater or water bodies quality?	Yes
		No
		Please provide details.
14.	Please upload available data on groundwater or water bodies quality.	Open-Ended Response
15.		Yes
		No

	Does the nutrient discharge from the WWTP have a detectable impact on water bodies/groundwater? And does it ever prohibit the use of the water?	Please provide details.
16.	What are the economic implications of groundwater pollution?	Clean-up costs
		Costs of alternative water supplies
		Costs on healthcare
		Other (please specify)
17.	Can you think of any other relevant information regarding nutrient discharge?	Open-Ended Response
18.	Which types of waste does the WWTP generate?	None of the above
		Solid
		Sludge
		Biological
		Chemical
		Other (please specify)
19.	Is hazardous waste generated at the WWTP, and if so, how is it handled?	Open-Ended Response
20.	How much sewage sludge is generate at the WWTP on average?	Open-Ended Response
21.	How is the sewage sludge managed at the WWTP?	Open-Ended Response
22.	Are the by-products (sludge, biogas) reused or repurposed, and if so is there an economic benefit for the WWTP?	Yes
		No
		Please provide details.
23.	What are the costs of waste disposal for the WWTP?	Open-Ended Response
24.	What is the size (floor space) of the WWTP?	Open-Ended Response
25.	What is the distance of the WTTP from populated areas, including residential neighbourhoods, commercial districts, and tourist attractions?	Open-Ended Response
26.	Is the WWTP visible from touristic/recreational areas?	Yes
		No

		Please provide details.
27.	Does the WWTP's appearance blend in with the surrounding environmental setting, or does it stand out?	Yes
		No
		Other (please specify)
28.	Are property values in the vicinity of the WWTP affected?	Decreased property/land value in vicinity of the WWTP
		Increased property/land value in vicinity of the WWTP
		Relocation of people or business activities due to the presence of the WWTP
		No
		Other (please specify)
29.	Does the presence of the WWTP have an impact on the attractiveness of surrounding business activities?	Yes
		No
		Please provide details.
30.	Does the WWTP use up space that otherwise could be used for the production of food/material/energy or for a recreational purpose?	Yes
		No
		Please provide details.
31.	Can you think of any other relevant information regarding land use/location/appearance?	Open-Ended Response
32.	Is there an odour or a smelling overflow coming from the WWTP that is noticeable from populated areas, including residential neighbourhoods, commercial districts, and tourist attractions?	Yes
		No
		Please provide details.
33.	What are the economic implications of the odour coming from WWTP for surrounding business activities?	None of the above
		Loss of customers or clients
		Negative publicity/reviews
		Reputation loss
		Less tourists

		Cancelled trips
		Demanded refunds
		Other (please specify)
34.	Have there ever been any complaints about unpleasant odour?	Yes
		No
		Please provide details.
35.	Can you think of any other relevant information regarding odour?	Open-Ended Response
36.	Does the WWTP make noise that is noticeable from populated areas, including residential neighbourhoods, commercial districts, and tourist attractions?	Yes
		No
		Please provide details.
37.	What are the economic implications of the noise coming from WWTP for surrounding business activities?	None of the above
		Loss of customers or clients
		Reputation loss
		Less tourists
		Negative publicity/reviews
		Cancelled trips
		Demanded refunds
		Other (please specify)
38.	Have there ever been any complaints concerning noise pollution?	Yes
		No
		Please provide details.
39.	Can you think of any other relevant information regarding noise?	Open-Ended Response
40.	What is the total energy consumption of the wastewater treatment plant (WWTP) on average? (Specify if per day/week/month)	Open-Ended Response
41.	What is the energy source of the WWTPs electricity?	Renewables
		Oil

		Natural Gas
		Coal
		Other
		Please provide details.
42.	Is there data available on CO_2 emissions from the WWTP?	Yes
		No
		Please provide details.
43.	Please upload available data on CO_2 emissions from the WWTP.	Open-Ended Response
44.	Can you think of any other relevant information regarding emissions?	Open-Ended Response
45.	Are there any local legal requirements, restraints and obstacles, that is preventing changes in infrastructure/operation necessary to reduce the above described impacts? If yes, which are they?	Open-Ended Response
46.	Please upload any relevant document.	Open-Ended Response