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COASTAL CITIES POLLUTION CONTROL PROJECT

Executive summary of the EA Report

of the wastewater treatment plant and submarine outfall
of the Opatija agglomeration sewerage system

Environmental Management Plan

of the wastewater treatment plant and submarine outfall
of the Opatija agglomeration sewerage system

Executive summary of the EA Report

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1. Introduction

1.1 Conceptual Design of the Opatija – Lovran sewerage system for Matulji – Volosko – Opatija – Ičići – Ika – Lovran – Medveja coastal agglomeration was created and adopted in 2001.

- **Sanitary wastewaters sewerage system** means: “public drainage system comprising of a set of equipment and facilities for the collection of the sanitary wastewaters, their conveyance to the treatment plant, treatment and discharge into the receptor, and for the disposal of the sludge produced during the treatment process”.
- **Sanitary wastewaters** are: “the waters released after usage from homes, hospitality facilities, institutions, military and other non-industrial facilities”.
- **Wastewaters treatment plant** is: “the water facility construction with units for the treatment of wastewaters from public drainage systems before their discharge into the natural receptor” (hereafter: **WTP**).
- **Submarine outfall** is: “the water facility construction for discharging treated wastewater into the sea at the distance no less than 500 metres off the coastline and at the depth over 20 metres from the water surface of the receptor (hereafter: **SO**).

1.2 According to the Conceptual Design, and taking into consideration all pertinent factors and the adopted Spatial Plan of the Town of Opatija, the “Opatija” WTP is to be located in the border zone between the area of Punta Kolova and Ičići, around 350 metres further from the beginning of the existing long submarine outfall that, together with the WTP, makes up a technological unit – for the treatment and provision of sanitary wastewaters.

WTP on this location is satisfactory for the following reasons:

- it is situated almost at the “centre” of the sewerage system, which results in the least possible investment and operating costs,
- the location surroundings are relatively least developed in the whole area between Volosko and Lovran,
- during development, the negative impact on the environment will be relatively small due to the aforementioned condition of the surrounding area,
- relief and geological structure of the terrain are highly suitable for the location in the underground rooms,
- terrain configuration allows for the visual “concealment” of the access road, entrance plateau in front of the underground space and the filtration plant for air purification; thickly overgrown terrain provides extra “protection” (additional green belt to be planted),
- all air passing through the plant that could be contaminated by bad odours, will be purified by bio-filtration before it is released into the atmosphere in an entirely undeveloped surroundings (elevation around 60 meters above sea-level),
- the elevation of the WTP (around 25 metres above sea-level) enables a fully gravitational operation of the long outfall without the use of any additional power,

- the existing long submarine outfall is nearby and due to its technical condition and proven functionality is still fit to serve for the same purpose (considerable investment saving),
- the existing “temporary” plant Punta Kolova is located nearby and parts of its infrastructure can be used for the new plant, etc.

According to the Conceptual Design, the WTP load would, in stages, amount to (in “equivalent units”):

- until around 2010 33 000 EU, amount of wastewater $Q_{\max/\text{day}} = 8850 \text{ m}^3/\text{day}$
- until around 2025 46 000 EU, amount of wastewater $Q_{\max/\text{day}} = 11060 \text{ m}^3/\text{day}$

1.3 The purpose of the constructing of the “Opatija” WTP is determined by the needs of the municipal community within the framework of the coastal agglomeration to be served, and the natural environment that requires protection, and can be determined by the few basic principles of environment protection against sanitary wastewaters pollution:

- Coastal sea protection for specific purposes (tourism industry: diverse recreational activities of tourists and citizens, navigation and so on.).
- Ensuring ecological environment stability and sustainable development in the Liburnia Riviera – Rijeka Bay area, and the health protection of all local residents and visitors.
- Marine protection of Rijeka Bay waters (flora and fauna).
- Protection of underground, ground waters and torrential streams.

1.4 The modernisation of the existing system and extension of the new sections of the system has, so far, progressed most in the central part of Opatija and Ičići. The basic parts of the new main collecting system from the centre of Opatija to Ičići were constructed in this subsystem some 15 years ago. Temporary plant for the pre-treatment of wastewaters with the long submarine outfall (length of app. 1200 metres) was built on the Punta Kolova location.

1.5 Technically, the wastewaters treatment plant on the shore and the submarine outfall for treated wastewaters at the distance of over 500 metres off the coastline, are a single unit. This unit serves for the treatment of the sanitary wastewaters before their safe release into the environment and, therefore, as a whole, can be seen as a single sanitary wastewaters treatment plant.

1.6 The basic technical scheme of the WTP is adapted to the stages of its construction, to the expected higher standards of the treatment stage of the coastal municipal wastewaters, and to the specific qualities of the Opatija-Lovran public drainage system.

Matching the needs of the public sewerage system around the year 2025 (capacity app. 46 000 EU), the following course of the facilities construction and wastewaters treatment is planned, thus achieving the so-called “first stage of treatment” of the wastewaters:

- Partial mechanical treatment – involves the installation of the equipment in series:
 - automatic screens (d = 6 mm),
 - fine automatic screens (d = 1 mm),
 - compact station for the collection and treatment of the septic tanks contents
- Mechanical flotation
- Sludge dehydration with stabilisation

1.7 When planning the wastewaters treatment plant with submarine outfall design, the necessity of its placement “within the developed area” was taken into account. At the same time, the principal problems of such a location and their optimal neutralisation were taken into highest consideration for the benefit of the environment protection.

Sanitary wastewaters treatment has to be performed (partly) on the shore by applying the proper procedures. Following such treatment, the wastewaters are discharged into the Rijeka Bay sea by a long submarine outfall (existing: length: 1 211 m, discharge depth: 61 m; final length: 1 700 m).

For the overall environment protection against unfavourable side effects (visual, air quality, etc.), the treatment equipment and wastewaters treatment procedures must be located into a fully enclosed space (here, an underground space). That way, the harmful impacts could be under maximum control through technical measures and safety equipment, and managed according to the overall environment requirements.

The ventilation system will operate by sucking out all the air from the underground space (internal underpressure enables the outward bound movement of the contaminated air) where the decontamination equipment is placed, towards its bio-filtration purification plant.

The entire WTP complex will be developed by the appropriate horticultural and landscaping schem, in harmony with the natural environment and the importance of the location.

2. Overview of the project’s potential environmental impact

2.1 Wastewaters treatment plant and the submarine outfall, as the most important parts of the public sewerage system of the particular area, represent a permanent factor in the environment protection measures against the harmful effects of the wastewaters as a whole, and against all waste matters found in them.

WTP and SO by their nature may have certain unfavourable impact on the immediate, and the more distant environment as well. All wastewaters, collected through public sewerage system from a large drainage area, are concentrated inside them. By concentrating wastewaters into a single facility (“point”), the waste matters in them are concentrated as well, and finally there is a “concentration” of the potential harmful side effects and impacts on the immediate environment, and wider.

WTP and SO will have certain ecological impacts on the environment, which can be divided into:

- temporary impact, during preparation and construction;
- permanent impact, during operation.

2.2 Ecological impact during preparation and construction is the impact of the project on the natural environment around the construction site:

- Formation and preparatory works for the opening of the construction site – operation of machinery, traffic on the existing traffic routes, and so on.
- Clearing of the vegetation (bushes and small trees) from the construction site area, WTP complex and access road – impact on the landscape, visual effects, machinery operation, loaded vehicles traffic on the existing traffic routes, etc.
- Construction of the site access road and plateau – machinery operation, noise, use of explosives, vibrations, impact on the air (dust), traffic on the existing traffic routes, impact on precipitation waters, on the landscape, etc.
- Excavation of the plateau in front of the underground area, excavation of the underground space, etc. – machinery operation, noise, dust, use of explosives, vibrations, traffic on the existing traffic routes, impact on the precipitation waters, potential fuel and oil leakage from the machinery and vehicles and the consequent fire hazard, operation of the underground space ventilation, etc.
- Transportation of the excavated material to the permanent dumping site, machinery operation, noise, dust, loaded vehicles traffic on the existing roads, impact on the precipitation waters and municipal sewerage, etc.

2.3 Ecological impact during WTP and SO operation will be manifested on the environment around the project. This impact results from the very nature of the project function and the matters that are being treated and separated on shore (WTP) and transported into the sea by the existing submarine outfall (SO).

Project impacts during its operation may be connected with the functions of the WTP and SO in the public sewerage system, with the following consequences:

- Concentration of all sanitary wastewaters from the catchment area and the consequent potential hazards – possibility of incidental leakage into the environment (underground and on surface), etc.
- The noise of the treatment equipment, service vehicles and others, plus the vibrations that they produce.
- Bad odours that occur with wastewaters and waste matters.
- Impact of the permanent alteration of the landscape and vistas on location.
- Construction of a facility with the accompanying infrastructure, which is functionally in opposition with the immediate surroundings of the Opatija Riviera.

- Final disposal of partially treated sanitary wastewaters, which still contain certain quantities of waste matters, into the Rijeka Bay sea.
- Treatment (overall neutralisation) and permanent disposal of the separated coarse waste and sludge from the wastewaters, as a temporary solution during the early stages of the WTP operation, at Osojnica dumping site. Adequate treatment and stabilisation of the sludge is performed at the WTP (underground).
- Permanent solution for the waste and sludge disposal – within the county waste dumping site at the appropriate central plant.

2.4 Project's impacts on the air quality during construction will be the following:

- occurrence of dust during the clearing of the terrain, excavation/filling for access roads, excavation of the entrance plateau and the underground space portal,
- gases produced after the use of explosives for the excavation of rocky materials,
- gases produced while operating the construction equipment and vehicles for excavation, loading and transportation of materials and other machinery.

Emission of bad odours from wastewaters and separated waste matters, as the permanent impact on air quality during the WTP operation, will be fully eliminated by locating the entire plant in an enclosed underground space where the polluted air is retained and controlled for filtration and permanent neutralisation of bad odours.

2.5 Environmental impact of the noise produced by the treatment equipment will be reduced considerably due to its location in an enclosed underground space. Only the ventilators next to the contaminated air bio-filtration plant will be placed outdoors, on the WTP surface plateau (installed in sound-proof casings, min. 2 metres lower than the natural terrain surface, sheltered with a thick green belt).

The emission of noise during the project construction will be the most striking, but relatively short-term. Most of the noise will be produced by construction equipment and explosives used for excavation. To reduce the noise and mining vibrations impact to a permissible degree, all such works will be performed according to a specially designed Mining Works Project that has to take into consideration all relevant factors.

2.6 A more striking project impact on the landscape is expected during construction – the construction of the access road, entrance plateau, underground space portal, and air filtration plant plateau and access.

Impact on the landscape during operation will be reduced to a minimum due to the underground location of the facilities.

The project is visually sheltered from sight from all main directions. The underground entrance portal is facing southeast and is maximally retracted into a terrain basin between two “ribs” of a slope. Additional visual “shelter” is the angle from the main view points, directed from the bottom upwards.

2.7 The impacts of different waste matters during project's preparation and execution will be the following:

- vegetation removed from the construction area (app. 5 000 m²),
- excavation of the material for access roads, underground entrance plateau, WTP underground rooms and ventilation channel.

The total amount of the excavated material will be app. 15 000 – 20 000 m³ of material (in compact condition). A portion of the material (rocks) will be used in the realisation of the project itself, a portion will be used in the construction of the collecting system, while the smaller portion not fit for construction purposes will be permanently disposed of.

2.8 During the wastewaters treatment process, waste materials that need be removed from the plant and properly disposed of, are separated.

The following categories of waste materials will be produced at the WTP:

Compact station for septic tanks contents and fine automatic screens – waste materials collected at the screens are additionally dehydrated by spiral press. The original volume is reduced to 65%, and after dehydration the dry matter in the treated waste material amounts to app. 35-40%. After pressing, the waste is disposed of in closed PE biodegradable bags.

Sand trap – separated material, which is mostly mineral and rinsed off the organic matter, will be disposed of at the municipal dumping site.

Processing and sludge dehydration – will occur in the further stages of the WTP construction with the introduction of more advanced treatment stages. Adequately stabilised and drained sludge will be fit for the removal from the plant. At the early stages, it will be disposed of at Osojnica dumping site (planned to be used by the year 2010). Permanent solution for the sludge disposal is planned at the county plant for final treatment and permanent disposal of such waste from the whole County.

2.9 Simulations have shown that discharging of sanitary wastewaters, partially treated on shore, (not containing toxic matters or specific industrial pollutants), into the sea at sufficient distance, sufficient depth and into sufficient sea volume, is a very efficient way of their final disposal. (Supported by the results of the last research in the operation outfall efficiency in the outfall surroundings during the summer of 2001.)

Simulations in the zone closer to the discharge point have shown that, with the properly built and maintained submarine outfall with a diffuser at the end, with the same dimensions as the existing outfall, it remains possible, in the future as well, to achieve the dilution of the waste water concentration in the mixing zone to the ratio of 1:1 000. Thus, the problems of the concentration of nutrients and organic pollution at levels higher than the permitted, are solved. Therefore, the only pollution not “solved” by initial dilution is the bacteriological pollution, which is the reason for the planned outfall at greater distance from the shore.

Simulations in the more distant zone have shown that the radius of the bacteriological pollution field, with the concentrations that exceed the permitted ones for the second coastal

sea category (fit for bathing), is 200-300 metres from the discharge point (therefore, app. 600-700 m from the restricted coastal zone for outfall length of 1200 m), and that, within the 500 m radius from the discharge point, concentrations of 1-500 bacteria/100 ml of water may be expected (therefore, at least 400 m away from the restricted bathing zone).

When the sea is stratified due to the temperature differences (mostly in the summer), a submerged pollution field may be expected (polluted water does not reach the sea surface). It moves in the direction depending on the sea currents in the middle and bottom strata.

According to the earlier experiences of measuring the efficiency of the existing higher capacity outfalls (Rijeka, Pula, Split), it may be concluded that the negative environmental impact of the operation of the submarine outfall Punta Kolova (length 1200 m) will be negligible compared to the reception potential of the receptor sea, and will be limited to the zone further off the shore that will not in any situation directly affect the water quality in the coastal belt used for bathing and recreation. With the final extension of the outfall to 1700 m its impact will be additionally reduced.

Previous experiences indicate that the most common sources of occasional coastal pollution are the local sources of uncontrolled discharge of waste water, and not the properly constructed and well maintained long submarine outfalls, which have, in fact, proved to be valid and economical parts of the treatment plants, and not the means of transporting pollution downstream.

2.10 At the initial stage of the WTP operation (as in all similar plants on shore), only partial removal of waste matters from the water is planned, while the most part of the suspended waste matters is dumped into the sea together with the wastewater. This type of disposal is an acceptable and rational solution for the initial stage of the sewerage system construction and operation (considering the receptor qualities, length of the existing outfall, sea depth, and all other factors).

This type of “permanent “ disposal of waste matters in the form of suspensions can function until, according to the State Plan, the basic requirements for mandatory application of the higher treatment stage are reached, which results in “complete” sludge separation from the wastewaters.

At the later stage of the WTP operation, an raising of the wastewater treatment stage will become necessary, and a certain quantity of municipal sludge will be separated from the sanitary wastewater, processed and neutralised and, finally, safely disposed of.

At the initial stage of the WTP operation, the separated sludge is planned to be properly treated and stabilised with the aid of the set of sludge treatment equipment, in the underground space. Stabilised sludge will be dumped at Osojnica dumping site together with the urban waste. This sludge disposal location is planned until the year 2010, when Osojnica dumping site is scheduled to close.

Permanent and final disposal of the sludge separated from the wastewater is to be at the County Central Plant for the municipal sludge disposal. Further treatment and permanent dumping of the municipal sludge from the Opatija WTP, is planned to be performed at this central plant for final treatment and disposal of the sludge from all other wastewater treatment plants.

3. Environment protection measures during project construction and operation

3.1 Positive role of the sewerage system as a whole in the environment protection is unquestionable. However, certain parts of that system, including the WTP and SO, may have ecologically unfavourable and harmful effects on the environment and people in the immediate surroundings if the appropriate technical and other measures for the reduction or complete neutralisation of such effects are not applied.

Measures for the prevention and mitigation of the unfavourable ecological effects on the environment can be divided according to the characteristic phases of the entire project realisation:

- measures during project planning and design,
- measures relating to the specific parts of the sewerage system,
- measures during project construction,
- measures during project operation and maintenance.

3.2 According to the Conceptual Design, The Opatija WTP is designed in such a manner as to ensure that its potential negative impact on the environment is reduced to the minimum, i.e. acceptable scale. This design is adapted to the crucial impacts of the project:

- For the complete control of the harmful effects that stem directly from the concentration and sanitary wastewaters treatment processes, all treatment equipment will be located inside an enclosed underground space.
- All air contaminated by bad odours to be discharged from wastewaters and waste matters, will be purified in a special bio-filtration plant before it is safely released into the atmosphere.
- To mitigate the impact on the landscape, the project will be located on a suitable point where the terrain is visually sheltered. Access to the WTP will be visually sheltered as well.
- Treatment of the sludge separated from wastewaters (when this occurs) will be performed in the WTP itself, in the underground. During the initial period, the stabilised sludge will be disposed of at Osojnica dumping site. Permanent solution is the central county municipal sludge plant within the urban waste dumping site. To that end, the separated sludge will be adequately “prepared” in the WTP for the transport to the central plant.

3.3 Overall organisation and functioning of the public sewerage system already generates positive effects reflected in the WTP reduction/removal of harmful ecological impact.

3.4 During the WTP and SO planning and design phase, a number of measures for the reduction/removal of the harmful ecological effects have been planned, of which the most important ones are:

- The entire WTP, in all stages of its development, is located in an enclosed underground are, with an air suction ventilation system so that the internal space is

always under pressure. All air from the enclosed underground space of the WTP is filtered, for the removal of bad odours, before its release into the atmosphere.

- External design of the visible structures of the WTP – administration building, portal, is planned in such a way as to ensure neutral appearance in relation to the typical architecture of the surrounding buildings.
- Surface grounds of the WTP will be refined with the appropriate landscaping scheme and planting of typical Mediterranean trees and/or bushes, to match the natural vegetation of the surrounding area. Thus, an additional green belt shelter will be achieved.
- Security measures against unauthorised access inside the grounds of the WTP complex will be ensured.
- Materials and technologies applied in the construction of channels and pipelines, basins and equipment, will be used so as to remain permanently waterproof in all conditions.
- All noise producing equipment will be placed in an enclosed soundproof space.
- Mobile equipment likely to produce vibrations will be installed on the anti-vibration bases.
- The WTP design will ensure uninterrupted operation even in cases of the malfunction of certain parts – with the help of bypass channels and pipelines, safety overflows, alternative (electrical) power source with two independent power supply systems or an independent power generator, division into parallel technological (independent) lines, and similar measures.
- Project design solution for the final treatment and permanent sludge disposal will ensure minimal operating and transportation costs of municipal sludge stabilisation.
- During the initial period, the sludge will be disposed of at Osojnica municipal waste dumping site and treated at the WTP so that its condition and composition meet the standards prescribed by Waste Matters Act and Types of Waste Regulations.
- For permanent sludge treatment – after the central county waste dumping site with sludge treatment plant begins operation, sludge treatment at the WTP will be carried out only to the extent necessary for the safe transportation to the central dumping site.
- Remote control system for the management of the WTP operation is to be provided in accordance with the stipulations and standards defined within the technical documentation of the uniform supervising managing system (SMS) of the sewerage system.
- All WTP project documentation must take into consideration the seismic characteristics of the area, for the avoidance/reduction of the potential earthquake impact.
- Application of all domestic and, in cases when they do not exist, of foreign rules and regulations for the design, construction and maintenance of the WTP and SO. Positive experiences from other similar projects on the Croatian Adriatic coast and similar Mediterranean zones will be used for that purpose.

3.5 During the WTP and SO construction phase the following measures of the protection against harmful ecological impacts are planned:

- Construction site will be properly fenced in and protected against unauthorised access that might cause physical injury of people or damaging of equipment.
- Construction site will be formed, organised and equipped in accordance with professional regulations, contractor's organisational plan and other documents prescribed by the Building Act and other regulations from the domain of spatial projects execution.
- Construction works on the WTP complex site will be performed during tourist off-season. They will be restricted to a sensible daytime period. The machinery used will not produce noise above the prescribed level. Underground indoor facility refurbishment is possible during tourist high-season as well.
- The most extensive works will be the excavations for: access road, underground entrance plateau, underground WTP facilities, filtration plant plateau. Amount of explosive and its activation distribution will be planned and executed so that the oscillations velocity on the foundations of the structures in the vicinity of the construction site is below the permitted level for different types of buildings and constructions.
- The minefield will be covered with rubber or other protective screen for the prevention of the scattering of the mining debris in open spaces.
- To avoid negative impact on the traffic, transportation of the excavated material to the final dumping site will be limited to the periods when the traffic on the main road is of low intensity, especially if the transports are moving on the main road towards north (through Opatija) or south (through Ičići, Lovran).
- To reduce the dust problem, the contractor will be under obligation to occasionally pour water over the surface of the excavated material dumping ground. Similarly, the contractor will pour water over ground surfaces from which the wind might be likely to raise dust.
- After the construction works finish, the environment around the construction site "will be restored to its original condition". Landscaping scheme is to be performed according to the special documents and special requirements of the authorised services (relating to roads, water supply, etc. – Hrvatske ceste, Hrvatske vode, Gradska tehnička služba, etc.). Horticultural scheme provides for all the necessary measures for diminishing the unfavourable effects of the project on the landscape and visual appearance of the grounds.

3.6 Measures for prevention and reduction of unfavourable ecological impact of the WTP and SO during operation are more important than the previous ones. Introduction of additional and more effective measures and equipment for environmental protection is to be expected during the operation of the plant.

Measures for the prevention and reduction of the environmental impact of the WTP during its operation:

- For the needs of the plant in its regular and irregular regime, the appropriate Book of Rules and Regulations and Maintenance Plan will be drafted. Further, adequate staff training for the work on management and maintenance of the WTP and SO will be organised, in the framework of the whole sewerage system. All WTP surfaces will be regularly rinsed into the closed rainwater drainage system of the WTP, connected to the sanitary wastewaters pipeline, so that they all end up in the “treatment line”.
- Special attention will be given to the WTP’s entire suction ventilation system and filtration plant. Filtration units efficiency will be regularly monitored, and the removable modules regularly replaced with the new ones.
- In accordance with the existing rules and regulations (National Gazette 140/97. and 105/02.) at the outlet of the bio-filtration air purification plant, the discharged air will be monitored for pollutants by measuring the concentration of H₂S and ammonia (art. 20, National Gazette 140/97.).
- Continuous monitoring of the air quality will be set up in the vicinity of the neighbouring residential buildings, in the area of the potential impact of the emission into the atmosphere of the pollutants from the WTP ventilation system.
- There will be regular inspection of the condition of the submarine outfall pipeline and diffuser section.
- Programme for the measuring of hydraulic and technological load in the entire sewerage system will be put together and implemented. Further, the operation of the “treatment lines” of the WTP will be modified in accordance with that programme, in order to achieve maximum treatment efficiency.
- Programme for monitoring wastewater quality and septic tanks contents will also be put together and regularly implemented, at the inlet to the WTP and all WTP “check points”.
- Sea monitoring programme will be implemented in the area surrounding the submarine outfall discharge zone, in compliance with the Law and local regulations, and with authorised institutions programmes.
- The register of pollutants will be regularly updated, in compliance with the Law and local regulations.

Detailed technical measures are in plan for the prevention of any bad odours emission from the very start, and for the retention of wastewater and waste matters in enclosed spaces:

- Wastewaters channels and shafts – covering with solid walking plates sealed with rubber.
- Hydro-mechanical equipment for mechanical pretreatment – installed in closed tanks with a closed system of separated and treated waste materials disposal into closed PE-bags.
- Flotation basins – covering of basins with protective lids and connecting to the suction ventilation system.
- Sand trap – compact equipment with closed system of separated material disposal.
- Sludge compensation tank – covering of basin with protective lid and connecting to the suction ventilation system.

- Sludge treatment line – fully closed system with connection to the suction ventilation; dehydrated sludge (sludge cake) is odour free due to the increased concentration of dry matter (water missing).

The aforementioned demonstrates the determination not to let bad odours emission even within the enclosed underground space, and to “catch” the small quantities of contaminated air at the very point of origin with the aid of the ventilation system.

3.7 The most striking impact of the excavations is the relatively large quantity of excavated material. Large portion of the rocky material may be used in the construction, to build sanitary and rainwater sewerage system collectors, in landscaping, etc.

Smaller portion of excavated material not fit for use in construction will be permanently disposed of at a dumping site prescribed by the Plan.

3.8 At the initial stages of the WTP operation, only the waste materials with the so called “solid waste” characteristics will be separated from the wastewaters and disposed of as household waste at the appropriate dumping site for that type of waste.

Measures for impact mitigation and disposal of such waste are to be the following:

- Waste separated in the compact station for septic tanks contents and on fine automatic screens is automatically disposed of into continuous PE-bags that are biodegradable. This type of separated waste material is disposed of together with other household waste at the municipal dumping site.
- Waste separated in the sand trap - after the organic waste is rinsed off the grains, is to be disposed of at the municipal dumping site.

3.9 Adequate rainwater drainage system is also provided for the needs of the WTP complex, and it will collect precipitation waters from the waterproof surfaces made of asphalt or concrete. In addition, it will collect wastewaters from the rinsing of the external surfaces during draught periods. All waters will be conducted to the beginning of the WTP treatment line.

Separated waste material from the sinks, etc. will be regularly extracted and disposed of in the WTP units (station for the collection of septic tanks contents, sand trap), and if the waste material originates from oil it will be conducted and disposed of in the special unit (Rijeka Refinery, INA-Urinj).

3.10 Special safety measures are foreseen in case of an ecological incident that might occur at the WTP and SO. This is primarily accidental leakage of larger quantities of wastewater within the limits of the WTP complex on shore (almost exclusively into the underground; highly unlikely on surface), at the connection point of the WTP with the SO, and from the SO on the parts of it which should be watertight.

Sewerage system configuration immediately before the inflow of the wastewaters to the WTP (from north and south side) is such that the wastewaters can not flow into the very WTP using gravitation only. They have to be pumped with two main pumping stations, from the north and the south part of the system. This configuration of the sewerage system enables a very simple prevention of potential ecological accidents in the WTP and SO.

Further down we describe a few possible cases: incidents – and the solution for the situation:

- 1st situation: Leakage in the initial section of the “treatment line” – Stop the pumping of wastewaters towards the WTP on both main pumping stations (PS). Until the leakage is repaired on the WTP, the wastewaters are directed to the safety overflows of the main PS. For the protection of the sea environment, installation of the fine automatic screens at the safety overflow inlet is planned on both PS.
- 2nd situation: Leakage in the second section of the “treatment line” – Inflow of wastewaters to the WTP by pumping with both main pumping stations can continue. Mechanical pre-treatment is used – with fine screens. After that, partly treated wastewater is directed through the bypass lines of the WTP towards the SO.

In case of a major malfunction both PS cease pumping, and the procedure is the same as in the 1st situation.

- 3rd situation: Leakage from the main drainage (pressure) pipeline of one or the other PS – Stop the operation of the PS with the leaking pressure pipeline. Redirect the wastewaters from the respective part of the sewerage system catchment to the safety overflow outlet.
- 4th situation: Leakage from the main drainage pipeline of the WTP to the initial section of the SO – Shut down the WTP operation, as described in the 1st situation.

3.11 In addition to the practical technical measures and solutions for the WTP facilities, and for the enhancement of the plant safety, and prevention and mitigation of potential ecological accidents caused by the WTP operation, this project’s chief contractor – KD “komunalac”, Opatija, has also prepared the **Operating plan of measures in cases of incidental water pollution**.

4. Monitoring

Adequate monitoring of the environment and the project itself will be conducted the whole time of the project operation, in accordance with the legal provisions, and for the purpose of the timely detection of any harmful impact of the WTP and SO on the environment. The Monitoring will be conducted following the special programme from this Study. The Programme stipulates a series of measurements at sea, in air and on shore, in the surroundings of the project, of the different parameters, the changes of which may point to certain harmful environmental impacts.

Environmental Management Plan

of the wastewater treatment plant and submarine outfall
of the Opatija agglomeration sewerage system

1. Introduction

The coastal agglomeration Matulji – Volosko – Opatija – Ičići – Ika - Lovran – Medveja solves the problem of discharging municipal wastewaters by draining them into Rijeka Bay. The sewerage system is not integrated, so there are many subsystems with their own outfalls. The main part of Opatija area is connected to a temporary mechanical pre-treatment plant and long submarine outfall (length: 1200 m, depth: 61 m). Other sewerage subsystems are in a much worse condition, because of the inadequate treatment and the outfalls that are too close to the coast, and this is reflected especially in the sanitary quality of some parts of coastal sea area. Therefore, the integrated sewerage system of Liburnia Riviera was proposed by the Conceptual Design (2001) and Spatial Plan.

The project aims could be described with a few basic principles:

- coastal sea protection (for bathing and recreation)
- underground, ground water and torrential stream protection
- safeguard of the ecological environment stability and sustainable development in the Liburnia Riviera area (Rijeka Bay), and health protection of the local residents and tourists.

The wastewater treatment plant is planned as the central part of this sewerage system. According to the Conceptual Design, the unit will be situated between Punta Kolova and Ičići, about 350 meters further away from the beginning of the existing long submarine outfall and will be connected to it. So, after treatment, the wastewaters of the whole area would be discharged in front of Punta Kolova at some 1200 meters off the coast.

All parts of the treatment unit are to be situated underground, in two or three cross-connection tunnel. The basic technological scheme enables construction in stages, in accordance with the proposed capacities:

- | | | |
|--------------------------|-----------|--|
| • 1st phase | 15 000 EU | |
| • 2nd phase (until 2010) | 33 000 EU | $Q_{\max/\text{day}} = 8\,850 \text{ m}^3/\text{day}$ |
| • 3rd phase (until 2025) | 46 000 EU | $Q_{\max/\text{day}} = 11\,060 \text{ m}^3/\text{day}$ |

Since the sea around Liburnia Riviera is considered as a “less sensitive area“, the “first treatment stage” of the wastewater (*Government Plan for Water Protection, NN - National Gazette 8/99*) is taken into consideration in the design of the treatment plant:

- mechanical treatment: screen (d = 6 mm)
fine screen (d = 1 mm)
compact station for the collection and treatment of the septic tanks contents
- mechanical flotation
- sludge dehydration with stabilization

On the basis of Environmental Impact Study, The Ministry of Environmental Protection and Physical Planning judged the proposed project as environmentally acceptable (Decision, 14.10.2003), if the environmental protection measurements and monitoring plan are implemented.

2. Mitigation plan

Measures during Preparatory Phase:

- The wastewater treatment plant project should be designed in an enclosed underground space, with ventilation system which allows for internal underpressure.
- The air from the closed underground space must be purified from bad odours, by filtration before its discharge into the atmosphere.
- Landscape of the visible parts of treatment plant (administration building, gate-house) has to be in accordance with the environment and neighbouring structures.
- The Landscape of the plant should be horticulturally fitted with typical Mediterranean vegetation.
- Plan for the technical and organizational security measures against unauthorized approach inside the complex of the plant.
- To use the materials and ways of realisation of construction works (channels, pipes, basins, equipment) which will remain waterproof in all conditions.
- All used materials have to be corrosion resistant.
- By use of adequate materials, pipe profiles and inclination of channels and pipes inclination to insure sufficient flow speed for the removal of particula matters from the wastewater (ensure self – flushing of pipes and channels).
- In closed spaces of the plant, insure detectors of potentially expolosive gases connected with the ventilation system (to increase the air exchange in case of raised explosive gas concentration).
- All components of electrical installation with the sparkling risk should be situated in a separate room (insure so-called "anti-explosive S-type" of installation).
- All noise producing equipment should be located in the closed area with acoustic insulation.
- Insure the anti-vibrating bases for the vibrations producing equipment.
- Insure the measures to prevent the transmission of vibrations from mobile parts to pipes-system.
- Enable continued work of the plant even in the case of partial equipment malfunction, by designing bypass pipelines and channels, safety overflows, alternative source of electric power and other necessary equipment.
- Sludge treatment line must be designed to eliminate bad odours emission, by location of the equipment in a closed area.
- Insure the system of remote control operation in accordance with the principles and standards defined in the project of uniform SMS (supervising-managing system) of the sewerage system.
- All project documentation has to take into account seismic characteristics of the construction area.

Measures during Construction Phase:

- Construction of all parts of the project must be entrusted to a contractor with good references, equipped by all necessary machinery and adequately trained staff.
- The treatment plant must be constructed in sections and/or in segments according to previously adopted dynamics plan. The dynamics plan must be coordinated according to the conditions defined in the process of issuing of general and construction permit.
- All parts of the project need to be executed according to the specifications of the particular parts of the main design, which makes a component of construction permit (Geo-technical design, Design for protecting the construction site, Foundation design, Mining design, Concrete design, Design relating to the traffic during construction works, Hydro-technical design, Structural and architectural design, Electro-technical design, Design of automation and signalisation, Design of submerging pipe-lines, Installation design, Design of building site organisation, Design of clearing of building site, and other designs).
- All installations on location of the complex: wastewater treatment plant – submarine outfall, need be temporarily ensured during the construction works. For the temporary technical solutions during the construction works it is necessary to procure the agreement (consent) of the owner or manager of the infrastructure.
- Connection works to sewerage network will be executed according to a special design.
- It is necessary to ensure adequate accommodation and sanitary conditions for the staff. The building site must be safe and marked by visible signalisation.
- It is necessary to ensure adequate area for placing machinery and other equipment. Equipment and machines cannot be maintained on the building site. The machines out of order need to be immediately removed from the building site.
- It is necessary to obey the regulations: Safety at work, Safety in case of fire, and Safety in case of handling of explosive means.
- All fire safety regulations must be implemented on the building site.
- In case of engine oil leakage, the leak should be covered with fine sand or stony dust and the polluted material removed to an adequate dumping site. In case of larger polluted area, the contractor needs to implement safety measures by using permitted special means of cleaning.
- Activation of explosives causes the vibrations of the surrounding ground. The quantity and distribution of explosion activation need to be performed in a way that oscillations velocity of foundation of the structures made by reinforced concrete near the building site does not exceed 1 cm/s, of foundation of mortar objects must not exceed 0.8 cm/s, while of monuments and sacral monuments must be under 0.5 cm/s. Permanent control of velocities and accelerations should be performed with adequate seismic instruments.
- After mining, underground space must be aired. After being aired, workers can be back. The suction ventilation is recommended. Ventilators must be strong enough to keep the air clean.
- Activation of explosive also causes sound and air impact. Safety measures include sheltering of people and animals in the vicinity of the explosion site before the mining, and opening of the windows in the nearby structures.

- In order to prevent the scattering of pieces of stones, mine field needs to be covered with rubber covers or with covers made of similar material.
- The working hours on the building site must be in accordance with local authority regulations, because of the effect on residential and tourist buildings. Machinery must not produce noise above regulated limits.
- For every excavated quantity removed to a dumping site, a consent of authorised body of local management need to be procured.
- It is necessary to make investigation of watertightness in relation to the system (in sections and in a whole) or to particular parts of the system (tanks, shafts, basins, etc.)
- To diminish the problem of dust in the vicinity of building site, contractor is obliged to occasionally pour water over the temporary dumping site of excavated materials, especially during draught period and in summer.
- Transportation of excavated materials on a dumping site need to be limited on the period of a day when traffic on the main road Rijeka –Pula is reduced.
- After all construction works are finished, the whole area must be brought to orderly conditions prior to operating permit, relating to roads, public and private properties, or in accordance to conditions of authorised bodies. By horticultural fitting diminish the negative impact of the objects on environment.

Measures during Operation Phase:

- Sewerage network connected on the wastewater treatment plant is planned as sanitary. For that reason it is necessary to make control and eliminate illegal connectors to a sewerage network.
- Make a plan of maintaining the system, execute it and organise the adequate training of the staff working on maintaining of the treatment plant, in the framework of all sewerage system. Organise the intervention unit for the case of emergency.
- Regularly make supervision, regular checking of equipment and lubrication of movable parts and units.
- Pay a special attention to rinsing of pipe-lines and removing the sedimentation or solid footage in pump basins, shafts, and/or pipe-lines, regular removal of material separated on screens
- In cases of presuming the possibility of leaking of sewerage network, an investigation of waterproofness on critical sections needs to be executed.
- Temporary exploit a reserve system of electric power to check its correctness (functionality).
- Regularly (at least once a year) make inspection of the state of submarine outfall and diffuser section. Suggestion is to use video and/or photo documentation. In case of uncontrollable outflowing, repair work need to be executed. Diffuser section of outlet needs to be controlled in shorter intervals, while nozzles of diffuser need to maintain when being clean.

- Keep the system of signalisation of the route and location of submerge outlet (discharge) not only on terrain, but also in nautical maps. Forbid anchoring and trawl boats in zones of submerge pipelines.
- Make a design and sewerage network capacity and its realisation, adjusting working parameters of treatment equipment in accordance to real inflows to the system.
- Design and regularly execute the program of control and monitoring of wastewater quality (on the inlet and outlet of the plant).
- Define and make a program of monitoring environment conditions (sea, air).
- Continuously keep the list of pollutants in accordance to the Law and local regulations.
- Make program of analysing wastewater and sludge on pilot-units in order to obtain data for designing higher stages of treatment.
- Determine the real characteristics of sludge and reconsideration of suggestion of optimal technology and the way of recycling of sludge (depending on results of analysis).
- Inform authorised institutions, organisations and the whole community about the results of the System.

3. Monitoring plan

The program of environment monitoring includes two different areas: sea (as recipient of treated waste waters) and atmosphere (recipient of bad odours). Both of this is connected with very important wastewater monitoring program.

The suggested programs have a common aim of determination of changes comparing to a “zero” state of environment, making efforts to prevent harder oscillations to satisfaction of both, the legislative and the community.

Sea monitoring program

Monitoring the sea water quality on the bathing areas according to on Regulation referring to standards of sea quality on sea beaches (NN - National Gazette 33/96).

The suggested program need to be understood as initial demonstrating program, which will be the subject of additional changes depending on results of continuing investigations.

Detailed investigations of the submarine outfall impact on sea water quality carry out continued, two times a year (in the period from April to October), every five years, after loading the treatment unit with the capacity of 33 000 / 46 000 EU (second / third construction stage). The program of sea monitoring is including the following groups of parameters:

- sea currents (surface, bottom, intermediate) on the submerge disposition location.
- meteorological parameters (in order to explain the sea currents circulation)
- physical, chemical and microbiological characteristics of sea water in the area of submerge disposition (6 locations net with radius of 300 meters). Measurements of the next parameters have to be taken in water column (from surface to bottom):

- pH
- temperature
- salinity
- dissolved oxygen
- nutritive salts (nitrate, nitrite, ammonia, ortho-phosphate, ortho-silicate)
- faecal coliforms, total coliforms and faecal streptococcus
- sea transparency on every station
- benthonic communities in the vicinity of submerge disposition (once a year)
- heavy metals (zinc, cadmium, lead, copper)
- pesticide
- polychlorinated biphenyl

Atmosphere monitoring program

Air Quality - bad odours

- Measuring concentrations of H₂S and ammonia on location of wastewater treatment plant the nearest objects where people work or live. In order to explain these parameters it is necessary to measure wind speed and direction.
- Ensure continuous transfer of measured data to maintenance service of the plant and to competent institution for air quality control.
- Measuring mass concentrations of H₂S and ammonia on the exit of air purification unit.

Noise

- Perceived sound is to be measured by night, in time when plant works with highest capacity, when sources of noise are on. Measuring is to be performed on location of plant in nearest object where people work and live. Frequency of measuring: once a year

Wastewater monitoring program

This program will demonstrate the efficiency of the waste water treatment plant. It is based on inlet and outlet wastewater measurements, and including:

- quantity of wastewater (flow)
- physical, chemical and bacteriological characteristics on entrance and exit of the plant

Entrance measurements will include the next parameters:

- pH, electro-conductivity, dissolved oxygen, alkalinity
- sediments, total suspended matters
- chemical oxygen demand, biochemical oxygen demand (BOD₅)

- ammonia
- chlorides and sulfates
- total oils and greases

Exit measurements will include the next parameters:

- pH, electro-conductivity, dissolved oxygen, alkalinity
- sediments, total suspended matters (105°C and 550°C)
- chemical oxygen demand, biochemical oxygen demand (BOD₅)
- total nitrogen (Kjeldahl nitrogen, ammonia, nitrite, nitrate), total phosphorus, phosphate
- chlorides and sulfates
- total grease and mineral oils
- anion detergents

In the first year after the plant is constructed, measurements should be taken once a month (12 times a year). After that the frequency of the measurements will depend on results. In a case of satisfying results, frequency of measurements will reduce on 6 times a year.

Outlet wastewater testing has be supplemented by additional measurements (4 times a year) of:

- cation detergents
- total phenols
- heavy metals: mercury, zinc, cadmium, lead, copper, chrome

4. Institutional arrangements

Legal framework for environmental protection:

Basic environment protection principles are included in the *Spatial arrangement plan of Opatija* (adopted in 2001.).

- All waste materials on the area of Opatija and neighbourhood places will be carried out in accordance with *Directions for carried out waste materials* (NN – National Gazzete 32/98).
- An authorized institution will continuously supervise air contamination in accordance with technical standards and legislation:
 - *Directive on Recommended and Limitary Values of Air Quality* (NN - National Gazzete 101/96)
 - *Directive on Limitary Values of Hazardous Substances Emission in Air from Stationary Source* (NN - National Gazzete 140/97)
 - *Air Protection Act* (NN - National Gazzete 48/98)
- Water protection strategy is defined by *Regional Plan of Primorsko-Goranska County* and national legislation:
 - *Water Act* (NN - National Gazzete 107/95)
 - *Directive on Classification of Waters* (NN - National Gazzete 77/98)
 - *Government Plan for Protection of Waters* (NN - National Gazzete 8/99)
 - *Directive on Sea Water Quality Standards at Bathing Beaches* (NN - National Gazzete 36/96)
 - *Directive on Hazardous Substances in Waters* (NN - National Gazzete 78/98)
- Problem of noise is to be solved by implementing *Noise Protection Act* (NN - National Gazzete 17/90).
- Special protection measurements are regulated by:
 - *Fire Protection Act* (NN - National Gazzete 58/93)
 - *Elementary Accidents protection Act* (NN-National Gazzete 73/97)

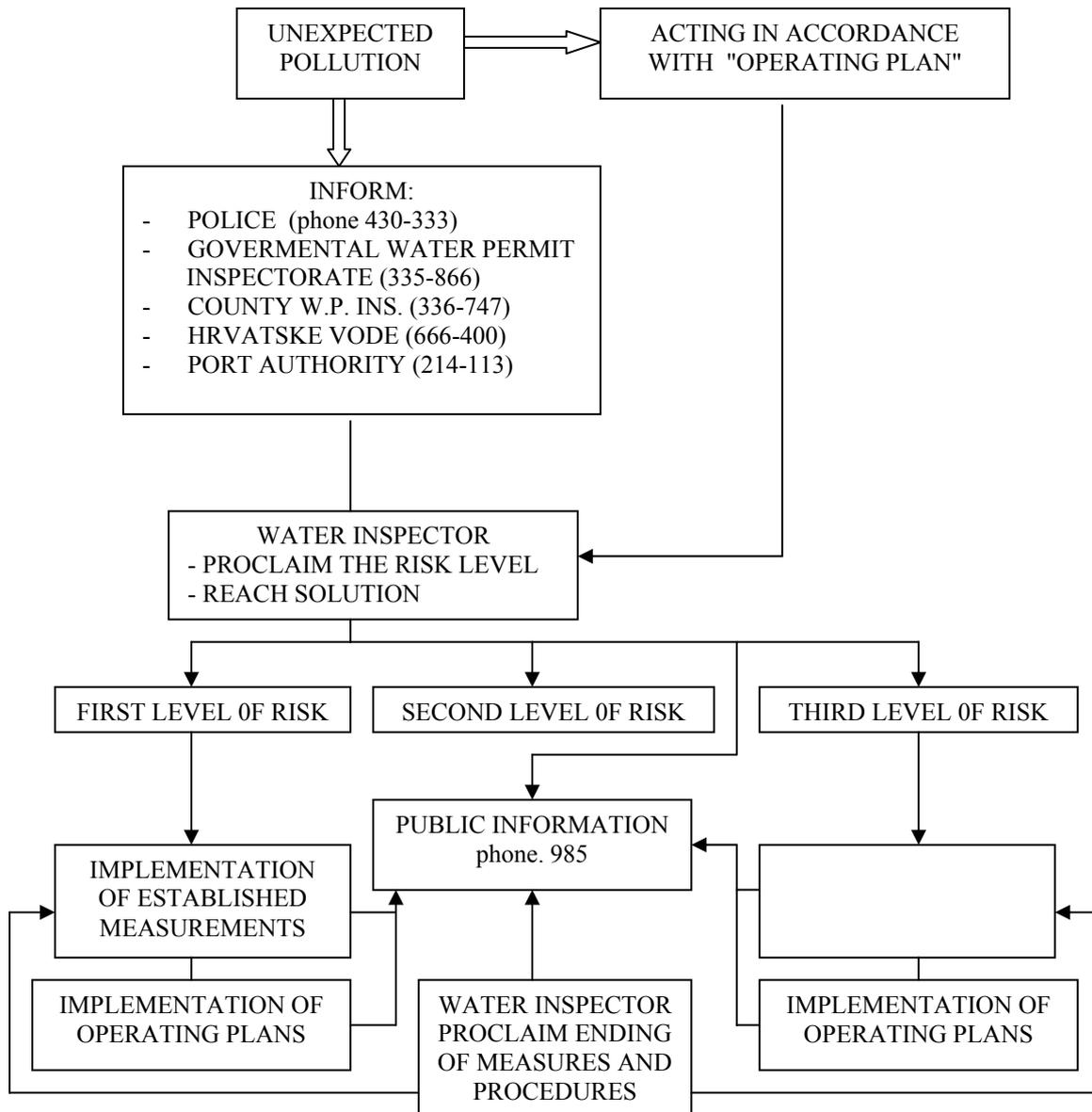
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Responsibilities for mitigation and monitoring

All sewerage system in area of Liburnia Riviera is managed by municipal company “Komunalac” (Opatija, Stubište Lipovica 2).

Decision making chain of command for environmental management:

An integral part of the *Operating Plan* for the case of unexpected pollution is next scheme:



5. Cost estimates

Waste water treatment plant - Costs of Construction

Part of the treatment plant	Costs of construction EUR
Approach road, crossroads reconstruction, environmental arrangements	136 000
Underground spaces, vertical ventilation channel	418 000
Complete equipment for mechanical and (partial) chemical treatment, facility for neutralization of dehydrated sludge, arrangement of dumping place.	2 372 000
Total power supply system.	267 000
Administration building, laboratory, workshop, storage, remote control and telemetry system.	444 000
TOTAL	3 637 000

Waste water treatment plant - Costs of Processing (annually)

	Costs of Processing EUR
Electrical energy for facilities.	8 750
Workforce.	50 400
Service and maintenance.	109 100
Additional costs for waste water and sludge treatment.	24 000
Waste transportation from screens, carrying for sludge.	76 650
TOTAL	268 900

Submarine outfall - Costs of Construction

	Costs of Construction EUR
Connection between treatment plant and existing submarine outfall.	136 000
Different works under sea surface (repairing, cleaning).	124 000
TOTAL	260 000

Submarine outfall - Costs of Processing (annually)

	Costs of Processing EUR
Annual control and cleaning.	4 800
Taking of and analyzing sea water samples.	4 000
TOTAL	8 800

6. Consultation with local NGOs and project-affected groups

During Construction Phase:

Besides the methods of information, which have been already used, like reports, interviews, articles in newspapers and organised discussions at the level of local government, following ways of cooperations are to be planned:

- intensify the cooperation to mass media (newspapers, radio, TV)
- intensify the cooperation with nongovernmental organisations (NGO)

According to future needs of local communities, as well as public, the representatives of investor will answer to all questions in order to give necessary explanations relating to the Project and its implementation. They will insist on systematic education and comprehension of local community relating to importance and characteristics of the project.

During Operation Phase

During the whole period of processing, it will be possibly to make organised visits to waste water treatment plant and other parts of sewerage system by every interested group or association.

Responsible person(s) will be at disposal to all interested persons submitting them by data relating to efficiency of process parts of the plant, problems and solutions for their solving, as well as data of authorised institutions for monitoring with explanations adjusted to the public.

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