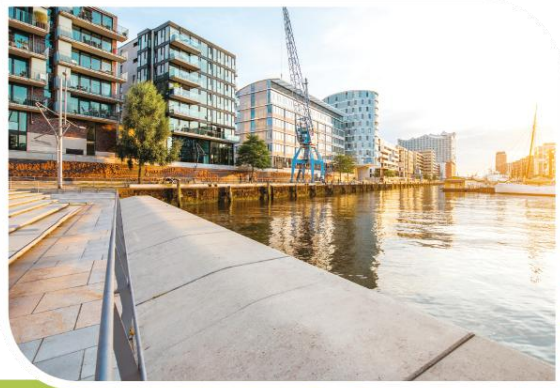
Spanish pilot operational tests report

Deliverable DB3.3









Real-time pollution-based control of urban drainage and sanitation systems for protection of receiving waters

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1 Introduction

This report aims to demonstrate the effectiveness of the LIFE-RUBIES solution in optimizing the management of the pilot study actuators, with the primary objective of minimizing pollutant discharge into the Manzanares River and subsequently reducing its environmental impact on overall river water quality. The implementation has shown promising results in achieving these crucial environmental goals.

The solution deployed through AQDV has been successfully integrated into real-time decision-making processes, providing substantial benefits to CYII operators through two primary mechanisms:

- Firstly, the AQDV actuator setpoints serve as valuable operational recommendations. Operators skillfully combine these AQDV-generated insights and recommendations with additional critical operational parameters, including comprehensive information about the upstream sewer system conditions, detention tank status, operational capacity of both upstream and downstream Wastewater Treatment Plants (WWTPs), resource availability, and scheduling constraints. This integrated approach enables operators to make well-informed, optimal decisions regarding setpoint implementation.
- Secondly, following each precipitation event, a detailed post-analysis report is generated and a summary is distributed to operators via email. This systematic review process facilitates the resolution of operational uncertainties and provides in-depth analysis of key decisions, contributing to the continuous improvement of existing operational protocols. Furthermore, regular collaborative meetings are conducted with operators to share project developments and engage in focused discussions regarding potential operational enhancements, particularly concerning the management of recent rainfall events. This iterative feedback loop ensures continuous system optimization and knowledge transfer among all stakeholders.

As a secondary yet significant objective, this report serves to comprehensively summarize and update deliverable DB3.1, focusing on the Spanish pilot deployment of instrumentation and AQDV UD environment. This updated analysis encompasses all substantial improvements and modifications implemented from September 2022 to the present date, with particular emphasis on three l areas:

- Firstly, we provide a detailed examination of Canal Isabel II's sensors and actuators configured within the AQDV system. This includes a thorough review of their operational parameters, performance metrics, and integration protocols, ensuring optimal functionality within the broader control framework.
- Secondly, the report extensively documents the newly installed infrastructure, specifically addressing:
    - Recently deployed sewer system sensors and their technical specifications

- New river monitoring equipment and its operational parameters
- Advanced sampling equipment utilized during sampling campaigns, including detailed methodologies and quality assurance protocols

➢ Thirdly, we present a comprehensive overview of the AQDV implementation and configuration specific to the Madrid pilot site, encompassing:

- Detailed architectural framework and system topology
- Communication protocols and network connectivity solutions
- Integration of radar information and rainfall forecast systems
- Configuration and optimization of the online SWMM model, including calibration procedures and validation results

This updated documentation reflects the evolution of the Madrid pilot project, incorporating final configuration, main results and lessons learned.

2 Update on the sensors and actuators configured in the pilot site

In the previous deliverable, section 4.4 "Sensors and actuators data connection" provided an initial inventory of Canal Isabel II's monitoring infrastructure integrated into AQDV. This updated report expands upon that foundation and details the comprehensive sensor and actuator network currently being implemented in the system.

According to deliverable 3.3 an initial sensor configuration was listed consisting of:

- Level sensors strategically positioned throughout major collectors and storage tanks within the study area, providing real-time water level monitoring
- Flow meters installed at pumping stations and wastewater treatment plants, enabling continuous flow measurement and system performance analysis
- One rain gauge.
- Multiple quality sensors monitoring effluent parameters at La Gavia and Butarque waste water treatment plants WWTPs), providing continuous water quality assessment

Also 20 operational gates were configured distributed throughout the study area, enabling dynamic flow control.

Most of these sensors and gates location and configuration can be seen in the AQDV synoptic displays, providing a comprehensive visualization for the system operators.

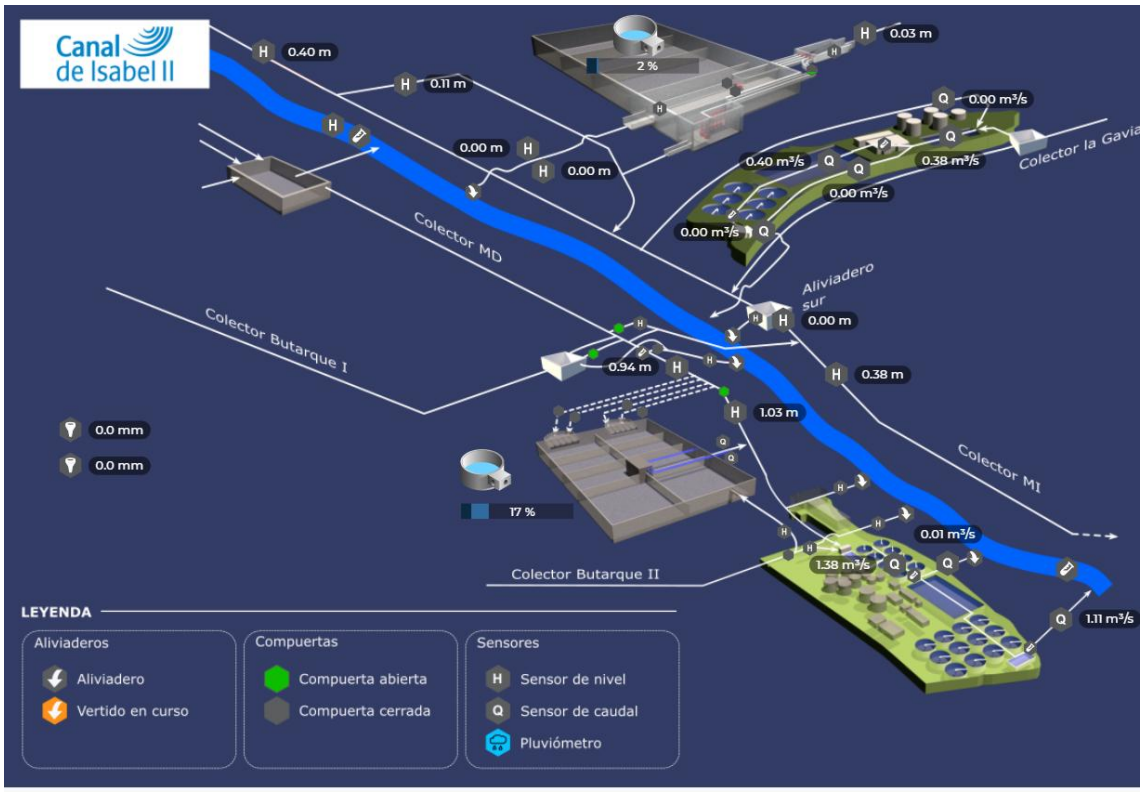


Figure 1.- General synoptic display for all the case study area with main sensors and actuators.

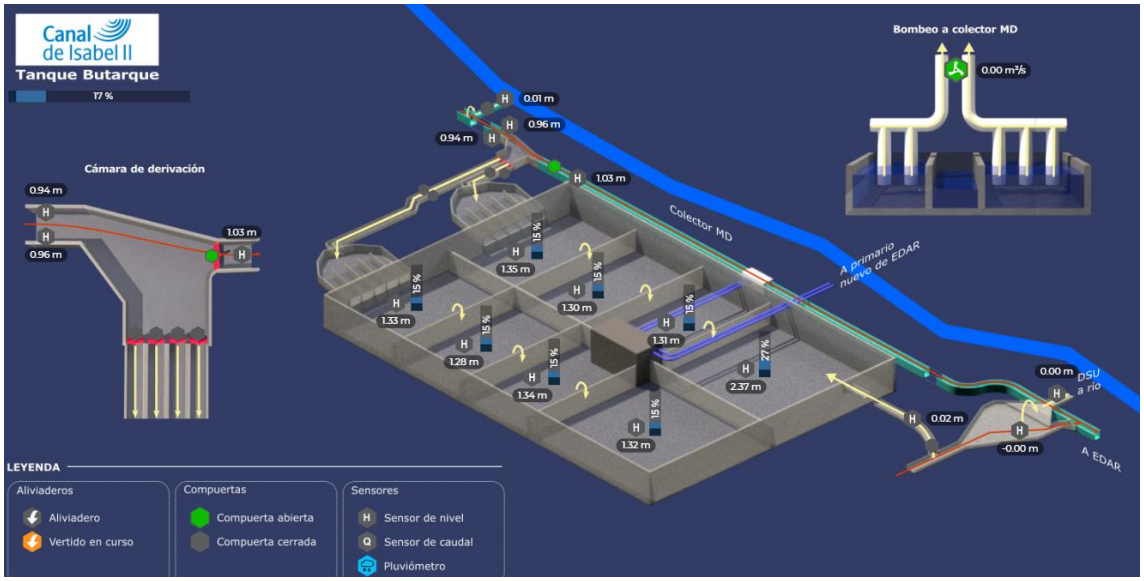


Figure 2.- Synoptic display for Butarque tank

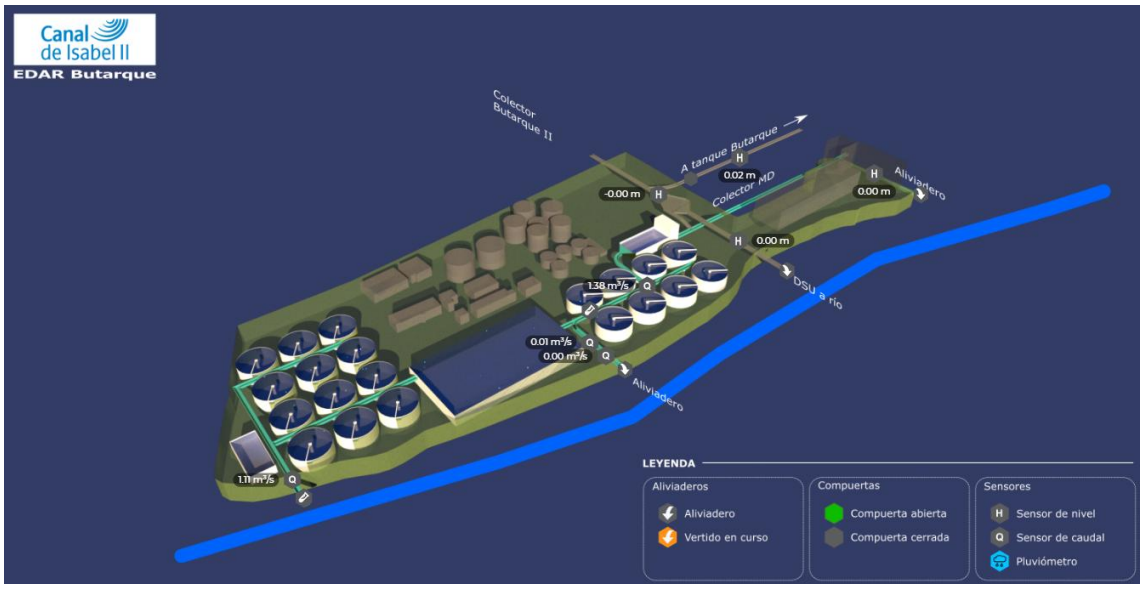


Figure 3.- Synoptic display for Butarque WWTP

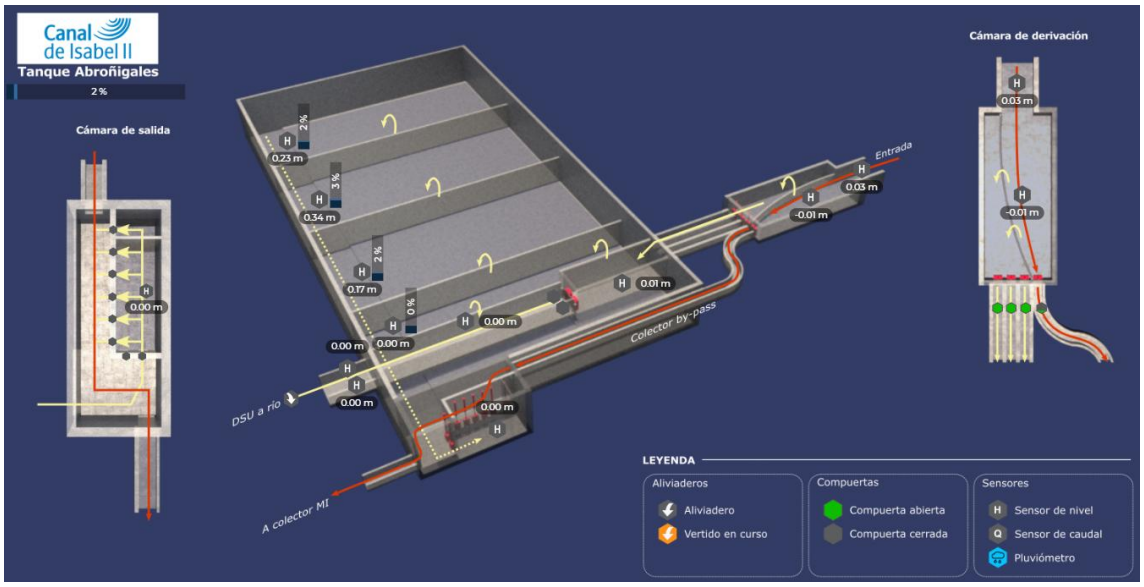


Figure 4.- Synoptic display for Abroñigales tank.

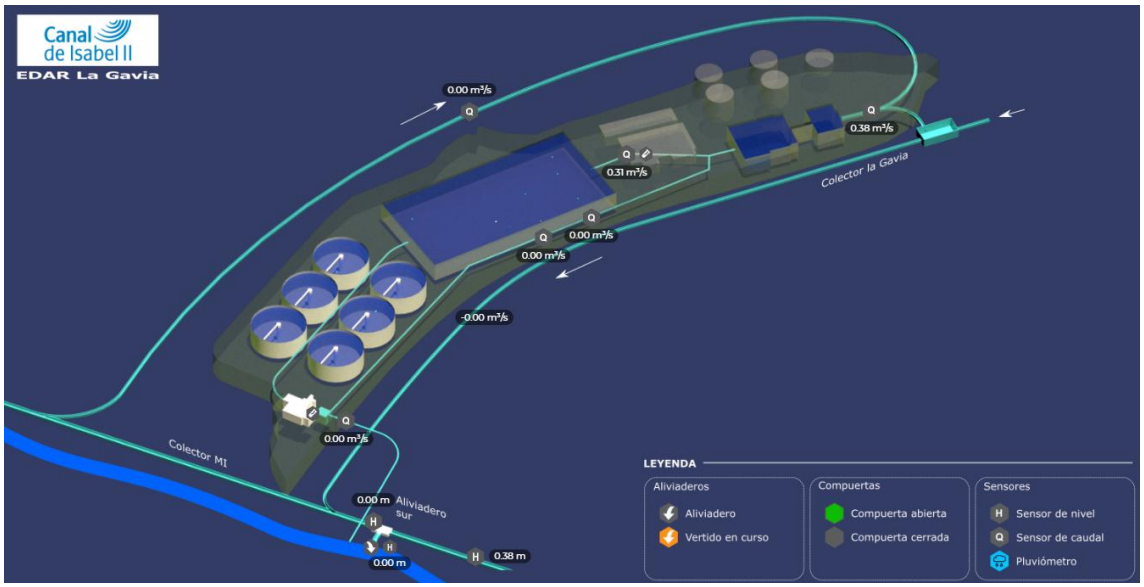


Figure 5.- Synoptic display for La GAvia WWTP.

As the project evolved and in response to operators' feedback, the monitoring system was strategically expanded beyond the initial pilot zone boundaries to incorporate additional sensors in critical locations. This enhancement was implemented to optimize operational efficiency and improve decision-making capabilities. The key expansions included:

- Upstream sensors of the pilot study: This was important for operators because they could anticipate the flows that would reach the pilot area and predict whether these would increase in the next few minutes or, on the contrary, if the peak flows had already passed and subsequently the forecast would be that lower flows would arrive.

- Sensors monitoring the status and operation of Sur WWTP located downstream of the pilot study: Although this WWTP is outside the pilot study area, operators insisted, and rightly saw, that knowing the operational status of the WWTP was important, especially for managing the emptying of Abroñigales and Butarque tanks where, once the rain episode is over, it is necessary to empty them as quickly as possible but without exceeding the maximum capacity of the WWTP that could cause untreated flow discharges through the WWTP's head bypass. Due to the limited capacity of Butarque WWTP, a significant fraction of the volume released by the tanks needs to be treated in Sur WWTP.
- Two additional raingauges were included to enhance data reliability in case the initial rain gauge would be affected by maintenance

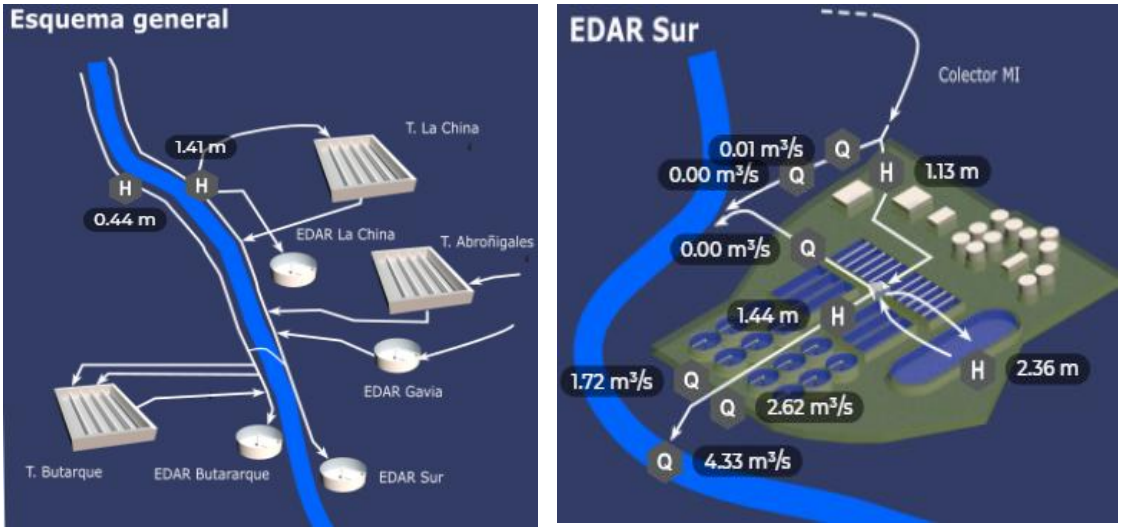


Figure 6.- Strategic system expansions implemented in AQDV based on operator feedback. The left panel displays newly integrated upstream monitoring sensors, while the right panel illustrates Sur WWTP sensors

3 Additional sensor deployment and monitoring campaigns

Section 3 of deliverable DB3.1 outlined the additional sensor deployment that was initially planned. This description has since become outdated, and the following subchapters describe the new sensors that have been successfully installed and integrated into the system, the ones installed in the sewer system and those ones installed in the Manzanares river.

3.1 Sewer

The figure below shows the location and the sewer sensors installed in the project:

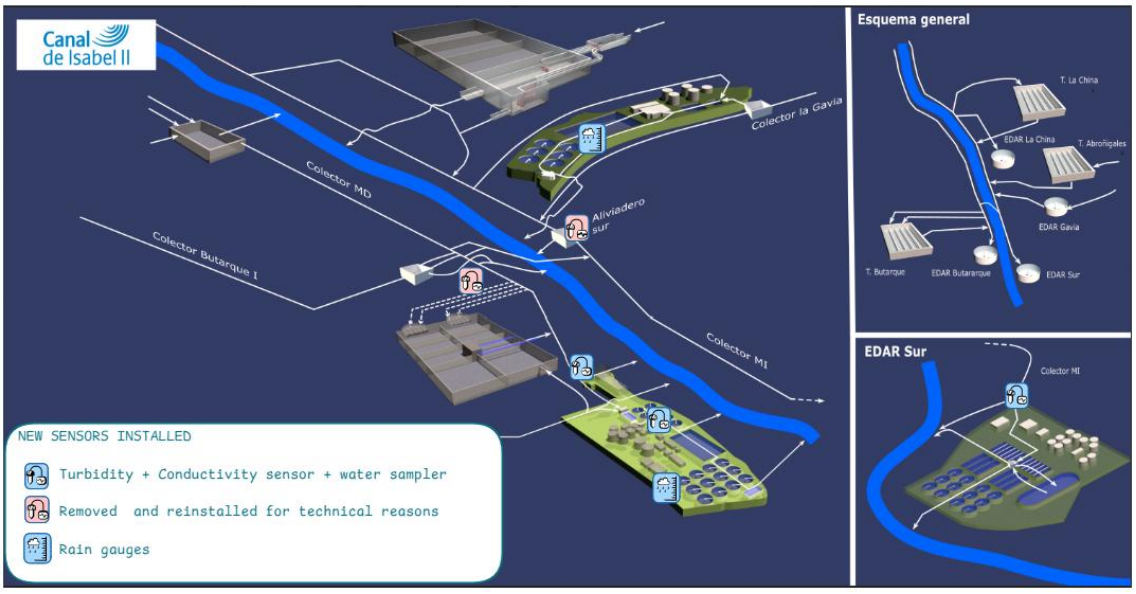


Figure 7.- Sewer sensors installed during the LIFE Rubies project in Madrid pilot area

- 2 temporary raingauges located in Butarque WWTP and Gavia WWTP operational since July and November 2022 respectively and discontinued in October 2025 once the Life Rubies KPI analysis is finished.

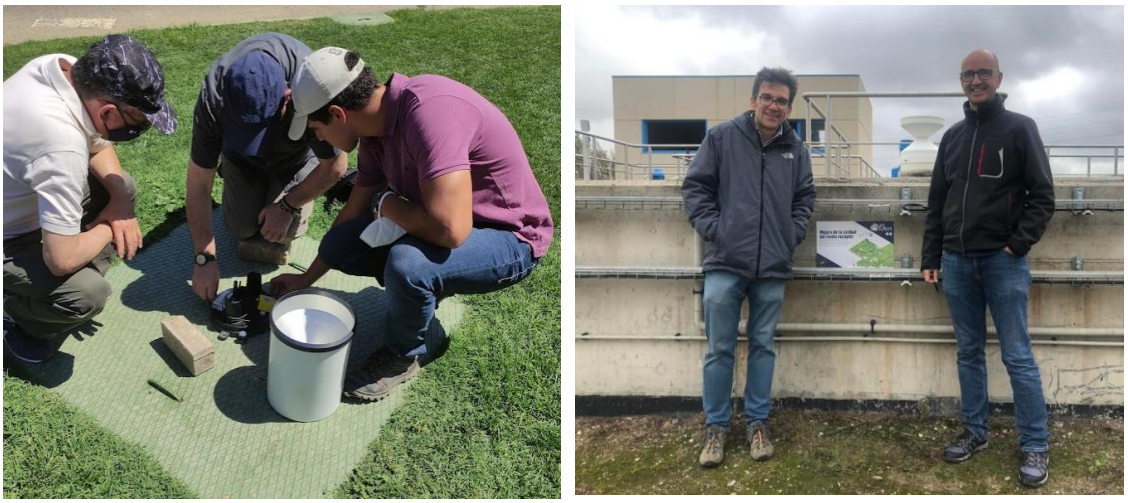


Figure 8.- Installation of the two raingauges

- In Butarque WWTP after primary treatment:
  - A fixed turbidimeter is installed to continuously measure the quality of the effluent from the primary treatment that cannot be treated in the secondary when its capacity is exceeded.
  - Also, a temporary water sampler is installed to do sampling campaigns (2 in dry weather and 3 in rain events) so a correlation can be defined between turbidity and other pollution parameters such as suspended solids (SS) DBO5 and DQO



Figure 9.- Water sampler and turbidimeter installed in Butarque WWTP after primary treatment.

- In the right margin interceptor: The goal here was also to install a turbidimeter and conductivimeter as well as a temporary water sampler in order to continuously measure those two parameters and then estimate the pollution discharged through the right

margin interceptors by correlating the continuous measurements with the other pollution parameters obtained by field sampling campaigns. We started installing it in Partidor Butarque, which is the main CSO discharging point of the right margin interceptor but we had several maintenance problems there (mainly related with sulfidic gases and health and safety protocols because the location had significant accessibility problems. We had it here from December 2023 until January 2025. After that time where we missed several important rain events we decided to move the sensors to the entrance of Butarque WWTP, still in the same right margin interceptor so the water (and the quality) would be the same as in the Partidor but the sensors maintenance was easier. It has been installed here since January 2025 until October 2025

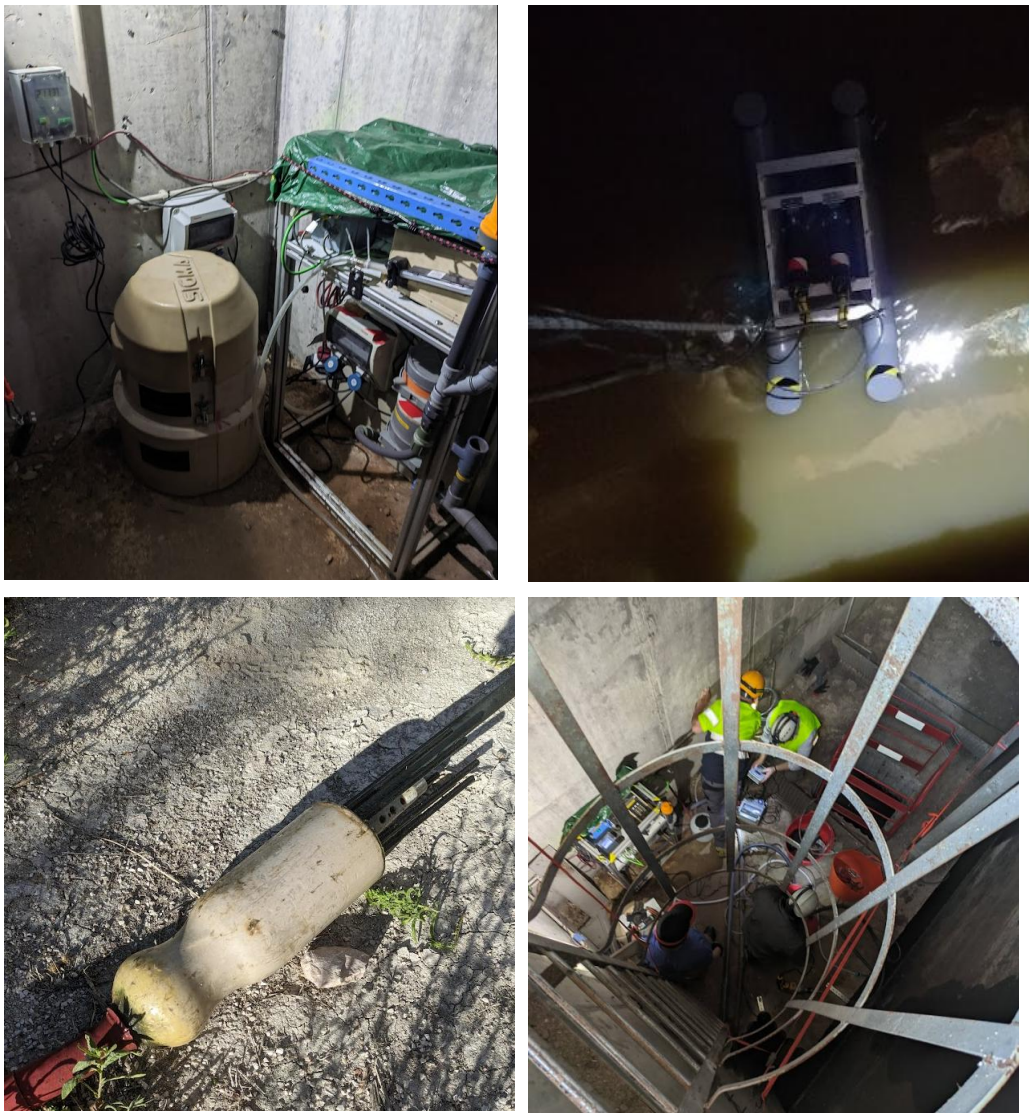


Figure 10.- Installation done in Partidor Butarque. After some months it was moved to the entrance of Butarque WWTP for maintenance problems



Figure 11.- Installation done at the entrance of Butarque WWTP

- Similar approach happened to the left margin: We first installed a turbidimeter in Alivadero Sur CSO but the maintenance there was very difficult and dangerous, so we moved the installation downstream the left margin interceptor until the entrance of Sur WWTP where we installed a conductivimeter a turbidimeter and a water sampler from xxx until xxx when we had enough sampling campaigns to obtain the correlations.



Figure 12.- Water sampler turbidimeter and conductivimeter sensors installed at the entrance of Sur WWTP

3.2 Manzanares river

In Manzanares river the two control sections (one upstream the pilot area and another one downstream) were identified in deliverable 3.1.

The upstream one located near Oliva tank was the place we finally installed our sensors thanks to the collaboration of the Madrid municipality who left us some space in a shelter they already had to house and protect the monitoring equipment.

The downstream section, we planned initially to locate it near Sur WWTP but some difficulties there to provide water supply as well as big hydraulic and quality turbulences observed during rain events discouraged us and instead, we installed near Butarque WWTP before the effluent discharging point.

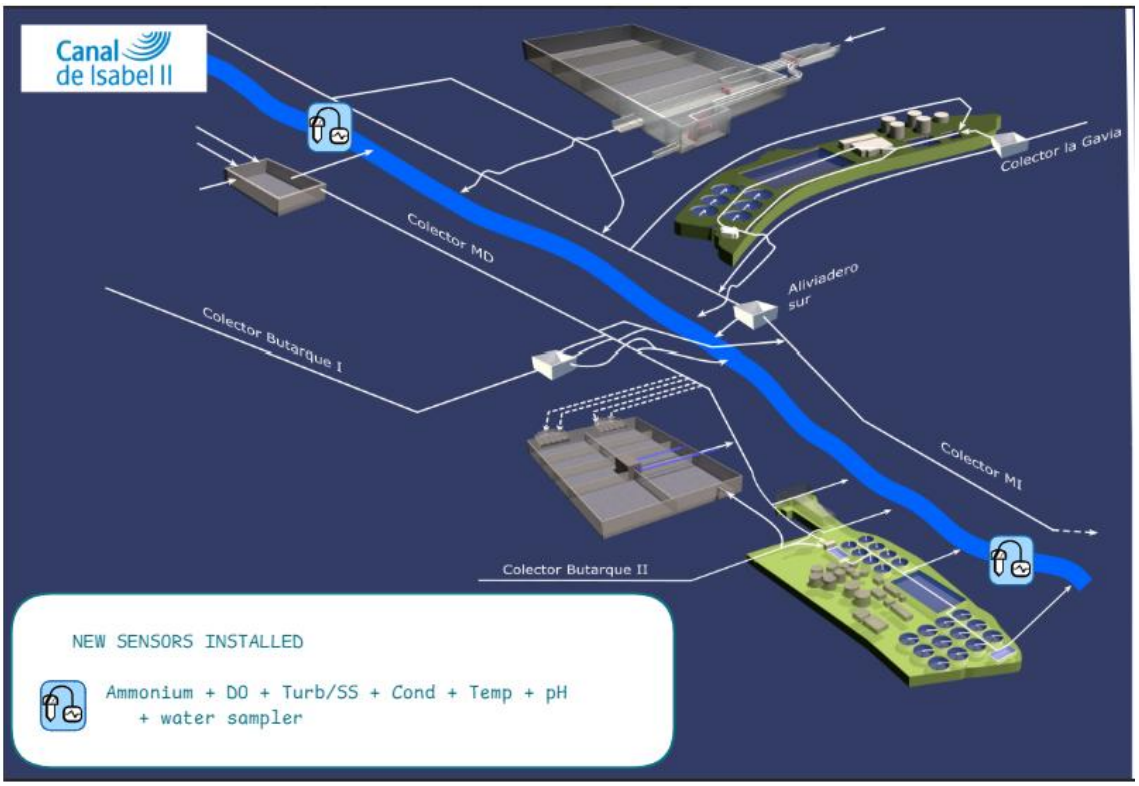


Figure 13.- Manzanares river sensors installed during the LIFE Rubies project in Madrid pilot area

In both locations the solution was the same as the one showed in Figure 14 as well as the sensors installed: ammonium, nitrate, dissolved oxygen, turbidity/TSS, EC (conductivity), UVAS-254, temperature and pH. Also, a water sampler has been included in order to obtain some more pollution data to understand the river behavior and to calibrate the model.

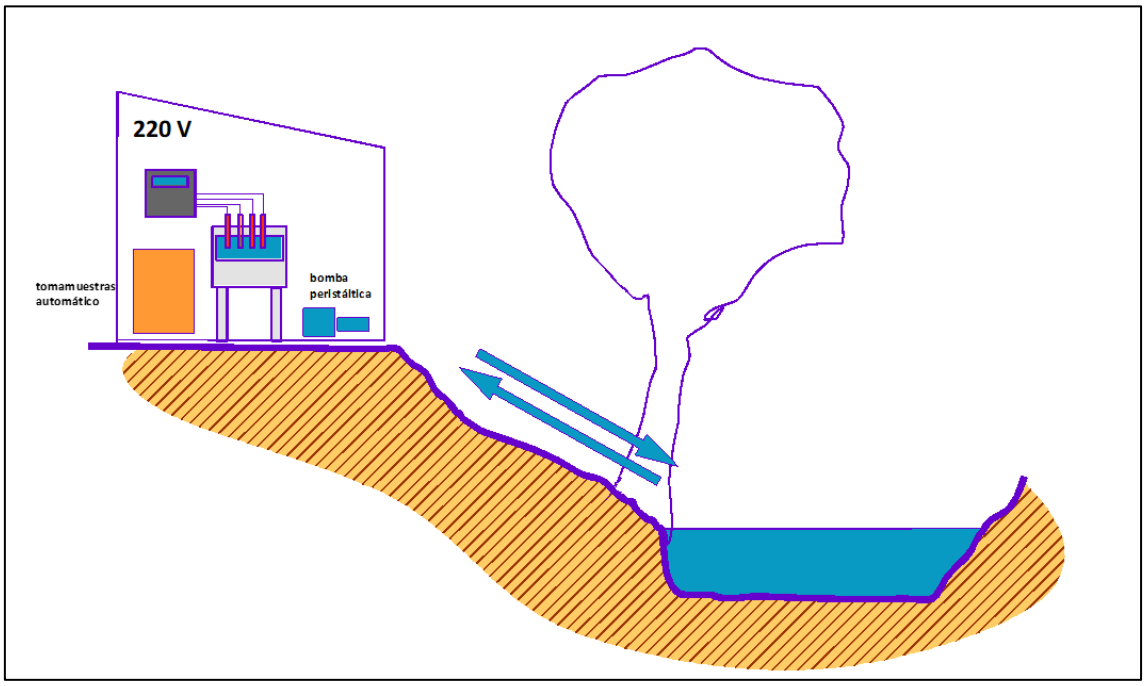


Figure 14.- Scheme of the monitoring station structure with the peristaltic pump pumping the river water to the bucket where the sensors are located.



Figure 15.- Manzanares river upstream sensor location near Oliva tank



Figure 16.- Manzanares river downstream sensor location near Butarque WWTP effluent

4 AQDV UD deployment and improvements

4.1 IT architecture

Deliverable D3.3 from September 2022 originally proposed a two-phase implementation approach of the software AQDV UD which was structured as:

- Phase 1: Cloud Server Configuration
  - Implementation of cloud server installation
  - One-way FTP communication with CYII SCADA data
  - Focus on system monitoring and performance analysis
  - Provision of operational insights and alerts
  - Generation of key performance indicators
- Phase 2: Direct Network Integration
  - Installation within CYII network infrastructure
  - Implementation of bidirectional OPC communication
  - Direct control capabilities for system actuators
  - Real-time data exchange and control implementation

However, subsequent evaluation revealed that the Phase 1 implementation was fully operational and functionally successful, demonstrating excellent results. Given this success, coupled with the significant challenges associated with integrating AQDV into CYII's network infrastructure (primarily due to Canal´s strict cybersecurity protocols and IT compliance requirements), a decision was made to postpone the second phase and formally incorporate it into CYII's after-LIFE Plan for future development.

While Phase 1 presented certain operational limitations that will be addressed in Phase 2 (such as data communication latency and reduced system robustness), it has nonetheless proven highly effective for its intended purposes. The current implementation successfully fulfills the core requirements of monitoring the Manzanares system's performance, providing comprehensive real-time status updates, generating timely warnings and alerts (particularly during Combined Sewer Overflow events), and delivering valuable operational recommendations for actuator setpoints.

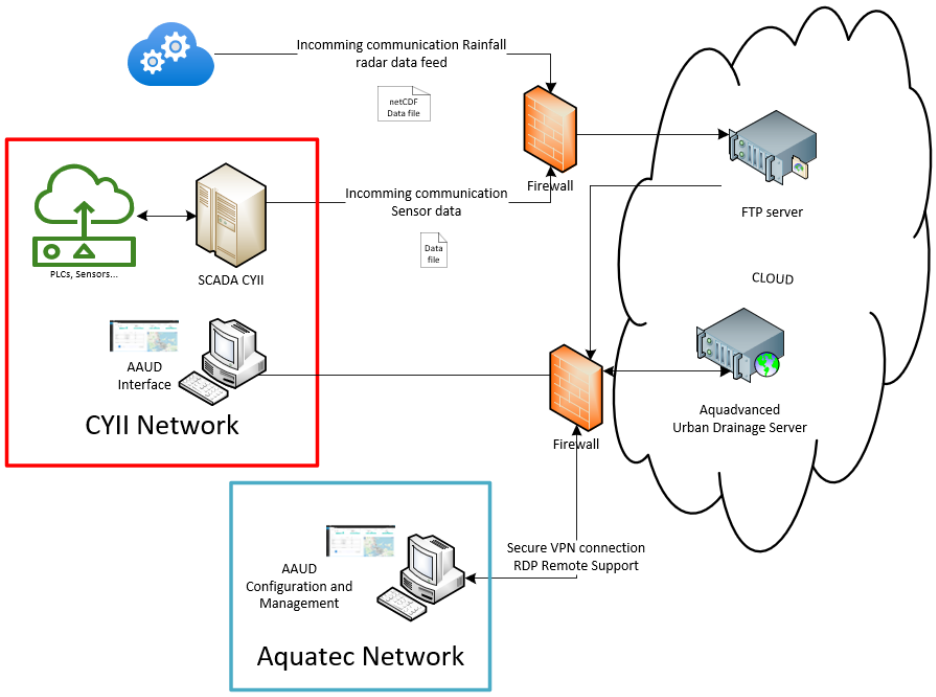


Figure 17.- IT architecture to connect with AQDV UD with CYII systems via ftp

4.2 Radar rain data connection (observed and forecasted)

Initially, the project implemented AEMET's radar system within the AQDV platform. This service provided observed rainfall data from the Spanish National Meteorological Agency (AEMET) along with 1-hour forecast data from a nowcasting service, covering 400km² around the Manzanares river with a 4km² (2km x 2km) resolution matrix. The system was configured to receive netCDF files every 10 minutes via FTP for processing and integration into the platform.

However, subsequent validation against ground-based rain gauges revealed significant limitations in the quantitative accuracy of AEMET's radar data. While the system proved adequate for qualitative assessment (identifying rainfall where it was raining and if it was heavy or soft rain), it substantially underestimated actual rainfall accumulation by approximately 90% in cells where rain gauges were present. This significant discrepancy rendered the data unsuitable for reliable sewer system modelling and flow estimation.

To address these limitations, a strategic decision was made to transition to CYII's proprietary radar system which demonstrated superior accuracy. Although CYII's radars still showed some underestimation of rainfall (ranging from 5% to 60% in general), this represented a substantial improvement over the previous system. Furthermore, CYII has committed to a long-term radar system maintenance and enhancement project, promising continued improvements in accuracy over the coming years.

Table 1.- Error percentage of AEMET radar and CYII radar data compared with raingauge data

Rain event	Rain gauge data (mm)	AEMET radar (mm)	CYII Radar (mm)	AEMET Radar error (%)	CYII Radar error (%)
5/12/2022	12.30	1.28	18.05	89.61%	-46.71%
13/12/2022	32.87	2.43	16.07	92.61%	51.11%
9/3/2022	13.20	1.72	5.49	86.97%	58.41%
22/4/2023	7.75	0.84	6.83	89.16%	11.84%
23/5/2023	6.73	0.45	6.35	93.31%	5.53%
26/5/2023	25.10	2.17	9.59	91.36%	61.79%
Average				**90.50%**	**23.66%**

The final radar configuration implemented in AQDV offers several advantages over the original system:

- 15-minute update frequency or radar file measurements
- Integration with AEMET's 10-minute radar composition for gap-filling
- Extended 2-hour nowcasting forecast capability
- Improved spatial resolution of 1x1 km² (compared to AEMET's 2x2 km²)

The communication and integration with AQDV was the same as with AEMET, every 15 minute a netCDF file was received via FTP with information of the current rain in all the radar scope and then information of the 2-hour rain forecasted. These files were processed and integrated in AQDV platform.

This upgraded system provides a more reliable foundation for operational decision-making and hydraulic modelling within the LIFE-RUBIES project framework.

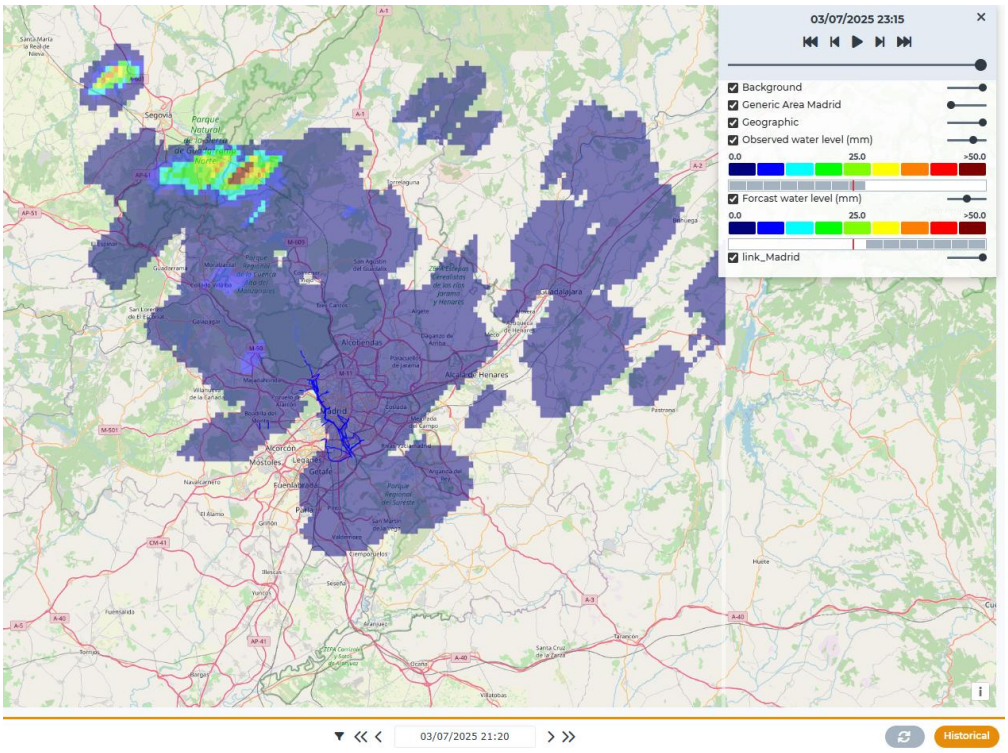


Figure 18.- Example of the 3/7/2025 rain event radar data in AQDV.

4.3 Detailed hydraulic model connection

Chapter 4.5 of deliverable DB3.1 explained that a detailed hydraulic model done in SWMM would be configured to run online with real and forecasted rain data measurements in order to provide the expected forecasted data (tank volumes, sewer levels, and CSO flows mainly) to be used as useful information to provide better setpoints recommendations for the actuators. At that point some general model configuration ideas were described, now that the system is already configured and has been in operation for several months the most important configuration is described below.

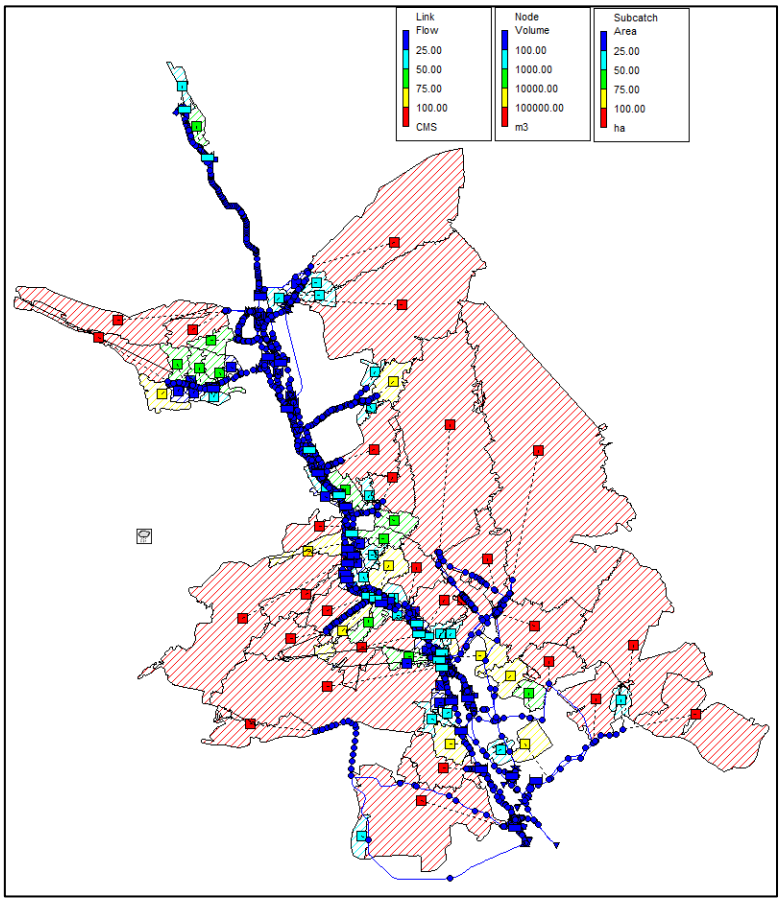


Figure 19.- View of the SWMM model for all the Manzanares system configured in AQDV to run in real time

- Model inputs that are updated for each model run according to real sensor measurements. The data configured here is:
  - Radar rain hindcast and nowcasting
  - Real tank volumes in Butarque and Abroñigales. This means that for each model run, the real volume measured in the tanks is introduced as an initial condition in SWMM model.
- Model outputs that are extracted from the SWMM model results and introduced as time series in AQDV database:
  - Flows: These are mainly CSO flows in the different CSO discharging points (Partidor Butarque, Aliviadero Sur, Abroñigales tank CSO, upstream Butarque WWTP) and some link flows to compare with real measurements (Influent to Butarque WWTP)
  - Levels: These are mainly extracted to compare with real level measurements
  - Butarque and Abroñigales tank volumes as key indicators
- AQDV global settings configuration data to run SWMM as an operational model:

- Spin up or coldstart time: It is a time interval along which a model starting from a simplified initial condition (e.g. no movement, no water or dry weather condition) reaches a realistic dynamic equilibrium, so that after this coldstart time the model results can be analyzed and compared with real field data. This coldstart time is only applied the first model run, in the next model runs hindcast time is applied. **The final configuration is 1 day.**
- Hindcast time: It is a time interval of the model run period that is past relative to the current launching time of the model. The goal of the hindcast period is to do a simulation with the best boundary conditions available. **The final configuration is 2 hours.**
- Forecast time: It is a time interval of the model run period that is the future relative to the current launching time of the model. In the forecast period the boundary conditions are only based in forecasts (rain forecast, flows, or actuators future setpoints). **The final configuration is 1 hour.**
- SWMM launch frequency: It defines the period between SWMM runs or how often the SWMM model is launched. **The final configuration is 5 minutes.**

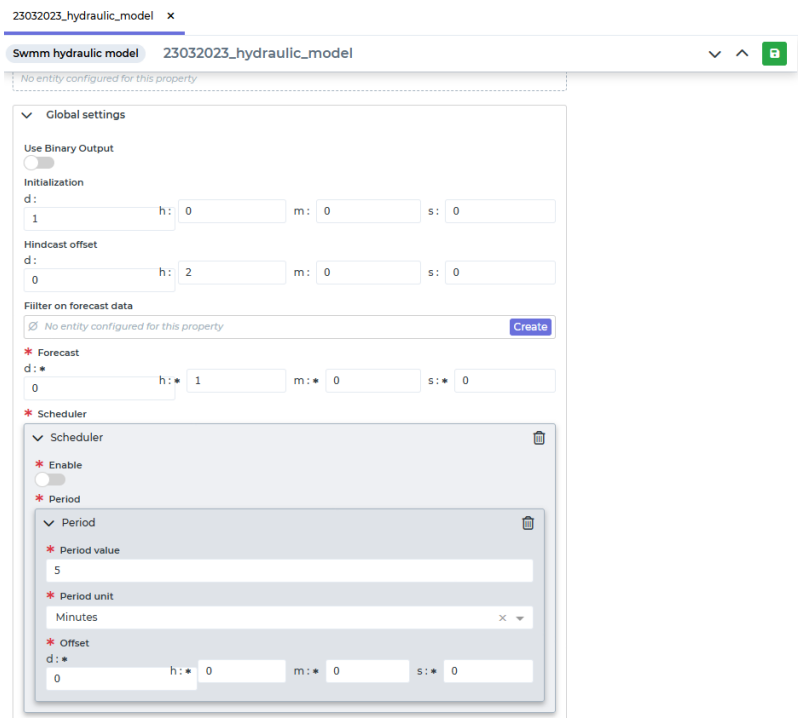


Figure 20. -SWMM Global settings configured in AQDV to run as an operational model

- SWMM results vs real sensors measurements synoptic view to estimate model accuracy: The synoptic view shown in Figure 21 is configured so that clicking the icons in the synoptic gives a time series graph comparing real sensor data with model results.

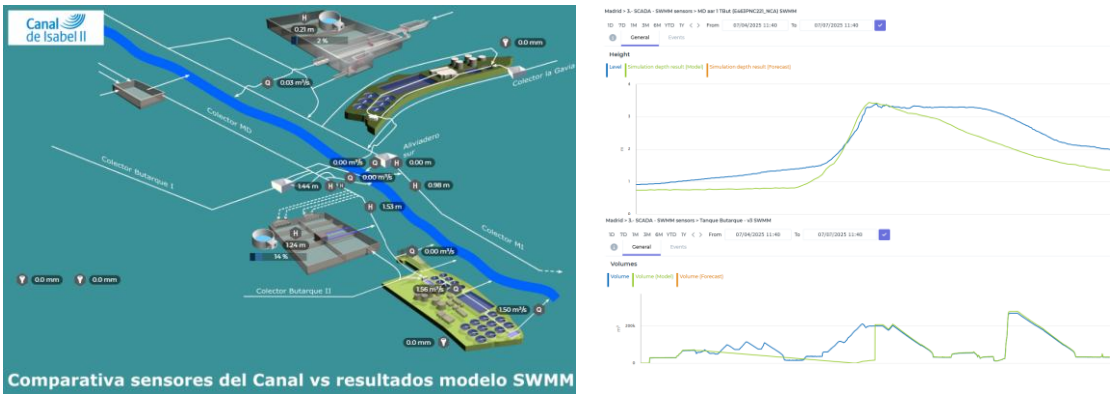


Figure 21.- Synoptic and some example graphs comparing real sensors measurements and model results

After several months operating the system with the SWMM model configured, and despite the efforts done in trying to obtain a proper calibration, we can conclude that the model results differ a bit from the real data measurements. There are three main reasons for this:

- The offline model in SWMM also was not correctly validated because there is some basic information related with sewer slopes, sewer cross sections and manholes heights and connections for which Canal de Isabel had no confirmed data. Therefore, this information had to be inferred from surrounding data. In the coming years the model should be improved with more detailed data collected from CYII inspections and updated SIG data.
- The rain data used as input data in the model comes from CYII radar presented in chapter 4.2 where we saw that the data was underestimating the real rain by 5 to 50%.
- Finally, the pilot area is located downstream the Manzanares system, this means that upstream there are several tanks and actuators that are implemented in the model based on theoretical operational rules, but in practice, these operation rules for a specific rain can differ a lot so these operation differences are transferred downstream in the system, amplifying the differences between the actual sensor measurements and the model results.

4.4 Real time quality estimation

Chapter 6 presents a description about the correlations obtained in several sewer points where online turbidity and conductivity sensors were installed together with automatic samplers to characterize pollution both in dry weather and in rain events. Correlations were obtained between the following parameters:

- Turbidity data and suspended solids, DQO and DBO5
- Conductivity data and Ammonium, Total Phosphorus and Total Nitrogen

Based on these correlations and thanks to the continuous measuring of turbidity and conductivity provided by the sensors installed, we can upload in AQDV a real time estimation of SS, DQO, DBO5, Ammonium, Ptotal and Ntotal concentrations.

Down below we provide an example about how to configure in AQDV the ammonium concentration in Sur WWTP influent based on the correlations identified. The steps followed are:

1. After the sampling campaigns accomplished both during dry weather flow (DWF) and rain episodes, two correlations were obtained. Correlation corresponding to rain episodes, were CSO can occur will be used to estimate the discharged pollution to the river (see figure below)

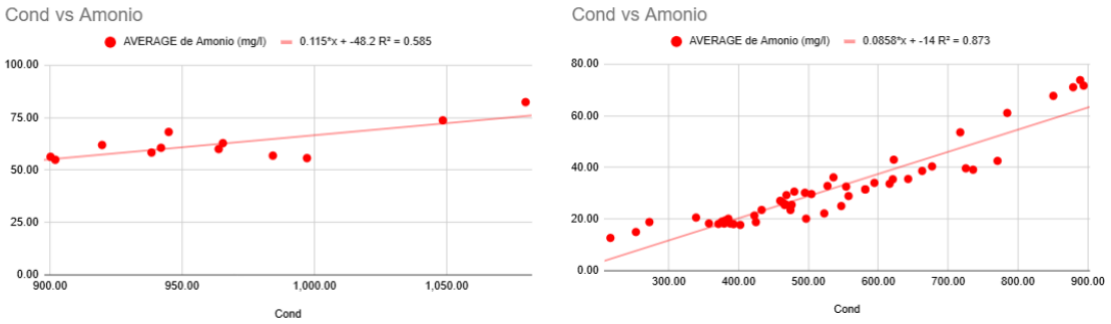


Figure 22.- Conductivity vs Ammonium correlations in Sur WWTP influent. Left DWF correlation, right rain events correlation

1. The limit between DWF and rain events needs to be defined in AQDV. In this case, this threshold was defined when sensor level MD aar 1 TBut (E463PNC221_NCA) measured more than 2.2 m

2. Configure the secondary time series for ammonium in AQDV with the correlation relation depending on the sensor level time series and the conductivity time series (Figure 23).

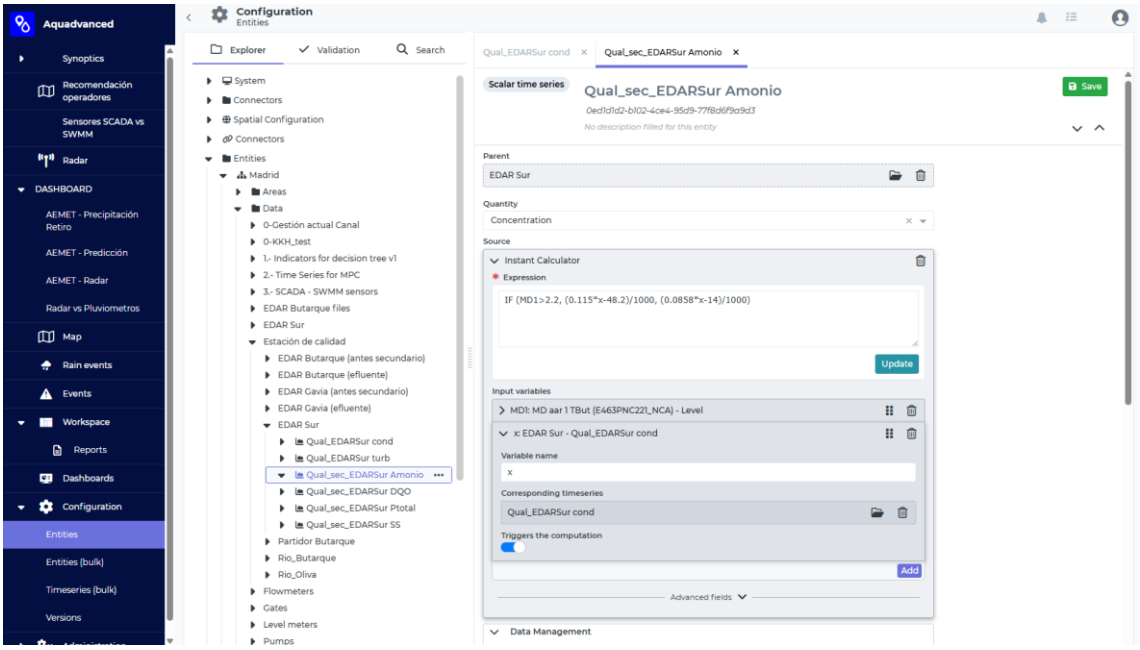


Figure 23.- Configuration of the secondary time series for ammonium in EDAR Sur

4.5 Pollution-based Model Predictive Controller (PBMPC) implementation in AQDV

4.5.1 PBMPC methodology and software demonstrator

In Chapter 3 of deliverable DB3.2, the Pollution-based Model Predictive Controller (PBMPC) was described. This controller is based on solving on-line finite-horizon optimal control problems formulated using the system mathematical model as constraints and last system measurements as model updates (Camacho and Bordons, 2004). In general, control objectives are formulated in terms of an objective function $\boldsymbol{J}$ to be minimized over a time ahead finite- horizon $\boldsymbol{H}$ to compute the optimal control law. In the MPC methodology, the optimal control problems are solved numerically on-line allowing for the inclusion of additional information to the problem such as constraints on the system variables (i.e., actuator bounds) or disturbance forecasts.

The objective or cost function $\boldsymbol{J(k)}$ to be optimized at every time instant *k* is defined as a summation of different goals, which can be separated into hydraulic and quality objectives:

- Hydraulic objectives

The main objectives related to the network hydraulic behavior are the following:

  - The minimization of the CSO discharges from the sewer network to the water receiving bodies ($\boldsymbol{J_{cso}(k)}$).
  - The optimization of the WWTP operation, by sending the maximum allowed inlet flow ($\boldsymbol{J_{wwtp}(k)}$).
  - The minimization of the excess of volumes/flows in tanks or sewers with respect to the operational safety values ($\boldsymbol{J_{safety}(k)}$).
  - The maximization of the smoothness of the control actions through time, so that the differences between a certain control action value at a time step, and its value at the next one, are minimized ($\boldsymbol{J_{smooth}(k)}$).

- Quality objectives

The main quality objective is related to the minimization of the CSO pollutants loads to the environment, expressed as the sum (or squared sum) of the different CSO masses ($\boldsymbol{J_{mass}(k)}$).

Considering these goals, the objective function $\boldsymbol{J(k)}$ can be written as follows:

$$\boldsymbol{J(k) = a_{mass}J_{mass}(k) + a_{cso}J_{cso}(k) + a_{wwtp}J_{wwtp}(k) + a_{safety}J_{safety}(k) + a_{smooth}J_{smooth}(k)} \quad (1)$$

where the different goals are weighted according to their importance. For this problem, the safety goal has the highest priority to avoid flooding and damage to the infrastructures. Then, the CSO/mass and WWTP goals are prioritized to protect the environment and the treatment plant respectively. Finally, the smooth goal to guarantee the smoothness of the control actions protecting the existing actuators is considered.

In Chapter 5 of deliverable DB3.2, the performance of the PBMPC controller applied in Madrid pilot was tested using a set of real raining scenarios showing promising behavior in terms of

reduction of CSO volumes and Mass released to the environment. To carry out this virtual demonstration, a software demonstrator was implemented. This tool allows simulating the real-time interaction between the MPC controller and the (virtual) reality during a rain scenario. In this process, at every simulation time instant k (i.e. 5 minutes), the following loop is carried out (**Figure 24**) : the current rain and the network states (i.e. tank levels) are read, then, the MPC controller computes optimal set-points for the actuators and they are applied to the virtual reality (network detailed model) running one-time step simulation. Then, the next loop corresponding to k+1 time instant can start.

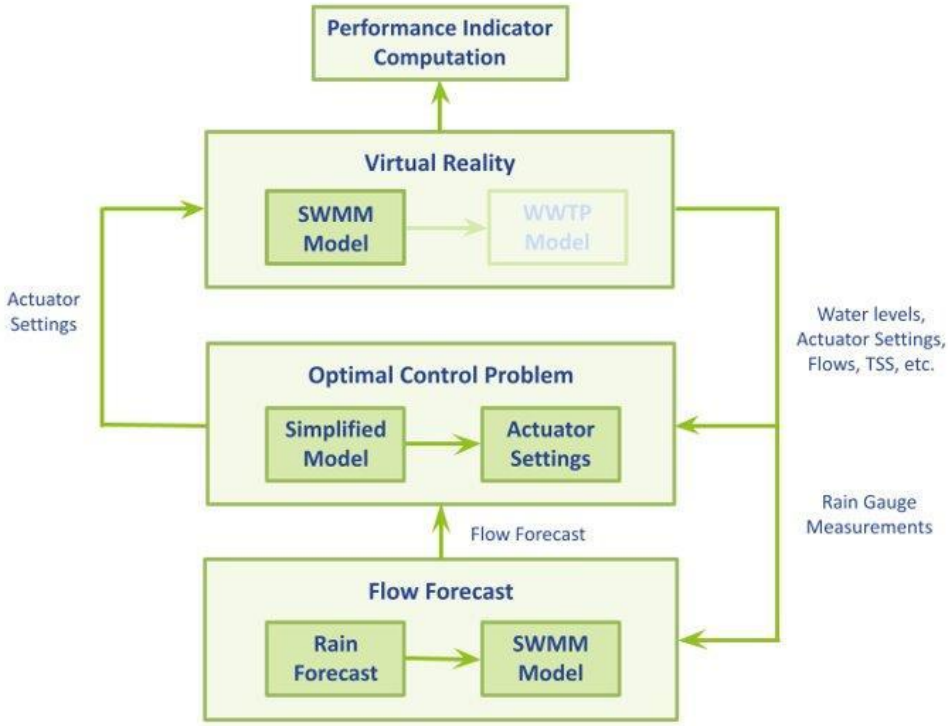


Figure 24.- Real-time closed-loop between Reality (UDN) and the controller

Once the full rain scenario is simulated, main KPIs related to the impacts on the environments as CSO volumes and released Mass can be computed. This closed-loop can also be run by considering that actuators are operated according to the reference operation used by the operator. In this way, the performance of the MPC controller can be compared with the reference operation using a set of real scenarios.

To implement the workflow depicted in **Figure 24**, a software demonstrator has been implemented in Python in an object-oriented manner. A wrapper class called MPC contains all the necessary elements to run a closed-loop simulation including the controller parametrization (e.g., prediction horizon, time step), the SWMM model relevant elements for both simulation and forecast (tanks, nodes, links and actuators), the variable names of the simplified model implemented in GAMS (input and output), and the paths to the SWMM files and GAMS executable.

Two additional classes have also been implemented to manage the SWMM simulations and the GAMS optimization problems. The `SWMM` class subclasses the `PySWMM` class, freely available through the `pyswmm` Python module, and adds a few additional methods and attributes to run

hydraulic simulations while easing the handling of rain time-series, initial and final simulation times, actuator setting modification and results extraction. Finally, the GAMS class implements the execution of the `gams.exe` file to solve the consecutive optimal control problems arising in MPC, the extraction of the solution of these problems, and the modification of the input and initial conditions files. Figure 3 shows the different `SWMM` and `GAMS` class instances appearing as attributes of an `MPC` class instance.

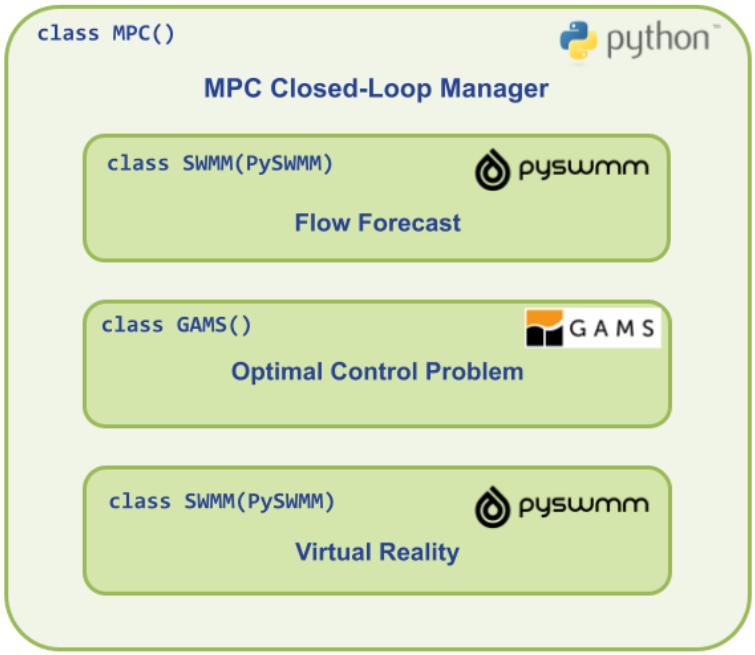


Figure 25.- Main attributes of an MPC class instance to run MPC closed-loop simulations.

4.5.2 PBMPC AQDV integration

As outlined in Chapter 2 of deliverable DB2.1, in order to enable real tests of the PBMPC controller, the closed-loop depicted for the virtual tests (**Figure 24**) needs to be adapted (**Figure 26**). In this sense, according to the general workflow, every time instant (5 minutes):

- Controller receives sensor measurements from the reality through AQDV platform.

Controller receives real rain measurement and the corresponding forecast for the horizon prediction through AQDV platform.

- Controller receives estimations of the inflows and TSS at the pilot inlets during the prediction horizon through AQDV platform.

Controller computes setpoints for the current time instant and the prediction horizon.

Setpoints corresponding to the current time instant are applied to the reality through AQDV platform.

- Setpoints for the current time instant and the prediction horizon are applied to the Virtual Reality through AQDV platform.

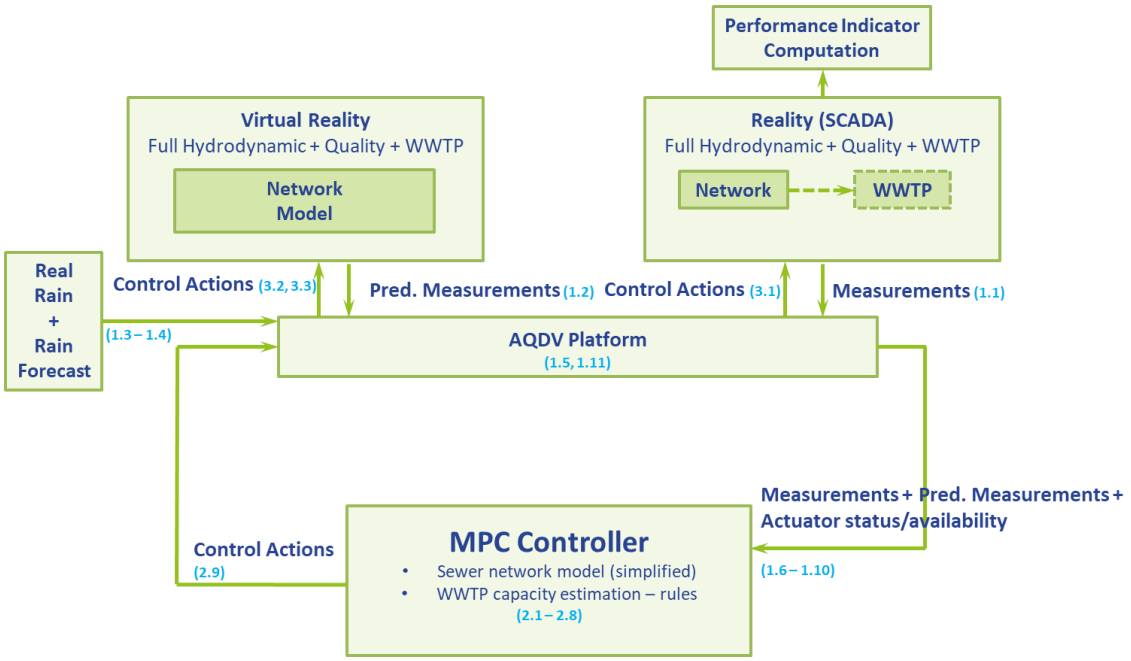


Figure 26.- Real-time closed-loop between Reality (UDN+WWTP) and the controller through AQDV platform and the integration of the Virtual Reality: adaptations to specific Madrid pilot characteristics and non-ideal situations

The closed-loop scheme depicted in **Figure 26** shows the main tasks to be executed by the controller or the AQDV platform during each control interval (i.e., 5 min). These tasks are numbered in blue following the next codification:

- 1.xx: Initial tasks of the control loop at the current time instant *k* executed by AQDV platform related, mainly, to gather sensor measurements from the SCADA and forecasts from the Virtual Reality and send to the controller the needed input data.
- 2.xx: These tasks are executed sequentially by the controller once 1.xx tasks end and are focused to compute the optimal setpoints for the current time instant k and the ahead interval (k, k+H].
- 3.xx: These tasks are executed sequentially by AQDV platform once 2.xx tasks end and are devoted to send computed setpoints for the current time instant *k* to the SCADA and run the Virtual Reality in the interval [k, k+H] using computed setpoints to generate input forecasts needed by the controller in the next time instant *k+1*

In the Controller - AQDV closed-loop depicted in **Figure 26**, AQDV platform has the central role orchestrating the different entities involved in the close-loop (Virtual Reality, SCADA, Controller) according to the detailed workflow and the established scheduling. Every time instant (5 minutes):

- (Time instant k) AQDV platform executes tasks 1.xx interacting with the Virtual Reality and the SCADA.
- (Time instant k) AQDV platform run the Controller which executes tasks 2.xx using the inputs generated in tasks 1.xx .

- (Time instant k) AQDV executes tasks 3.xx interacting with the Virtual Reality and the SCADA using the outputs generated in tasks 2.xx.

As mentioned above, AQDV platform manages the workflow depicted in Figure 7. In this sense, AQDV platform can run external python APIs through the configuration of specific AQDV entities called 'Script Models'. In general, when configuring a AQDV Script Model (Figure 9):

- All AQDV time series needed as inputs for the API must informed.
- All AQDV time series mapping the outputs computed by the python API need to be informed.
- The specific python API and its location have to be informed.
- The time frequency needed to run the python API has to be informed.

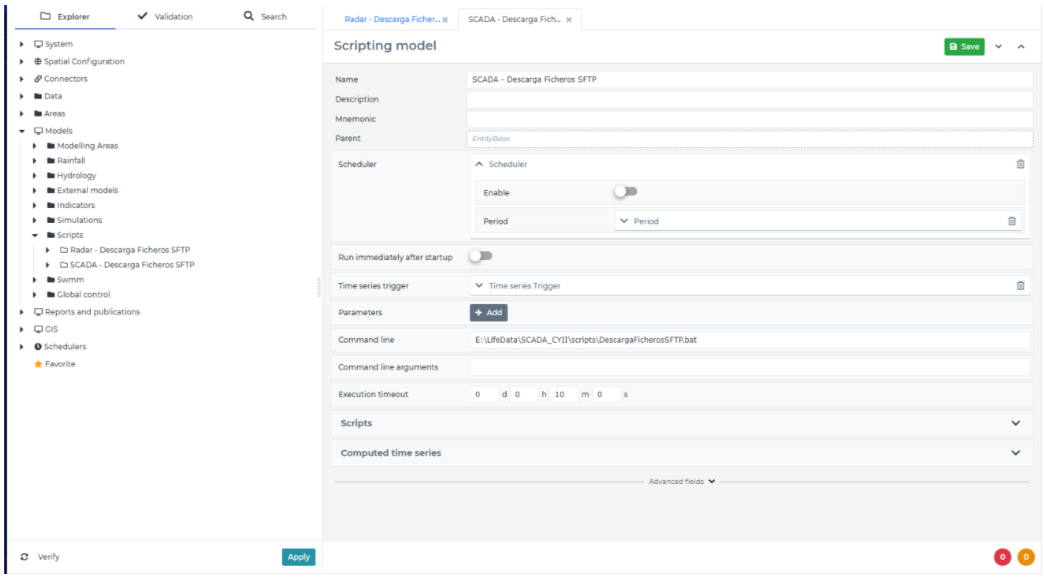


Figure 27.- ***AQDV script model configuration GUI.***

In this way, AQDV runs periodically the python API which can retrieve from AQDV database the time series identified as inputs and update those time series identified as outputs. To do so, the python API must use the python 'aquadvanced_sap' package which enables specific functions which allow to retrieve data from AQDV and post computed data to this platform.

Considering the python software demonstrator used for the virtual tests (**Figure 24** and **Figure 25**), this API has been re-coded readapting the inputs / outputs management using the python 'aquadvanced_sap' package so that data from AQDV times series can be retrieved and posted. The resulting API has been packaged and deployed in the AQDV server as standalone application using Poetry tool (https://python-poetry.org/). Then, a specific AQDV Script Model (RUBIES_API) has been created to execute periodically the MPC controller according to the closed-loop depicted in **Figure 26** (tasks 2.xx). In Figure 10, the main fields of the RUBIES_API script model configured to run periodically the PBMPC controller can be seen.

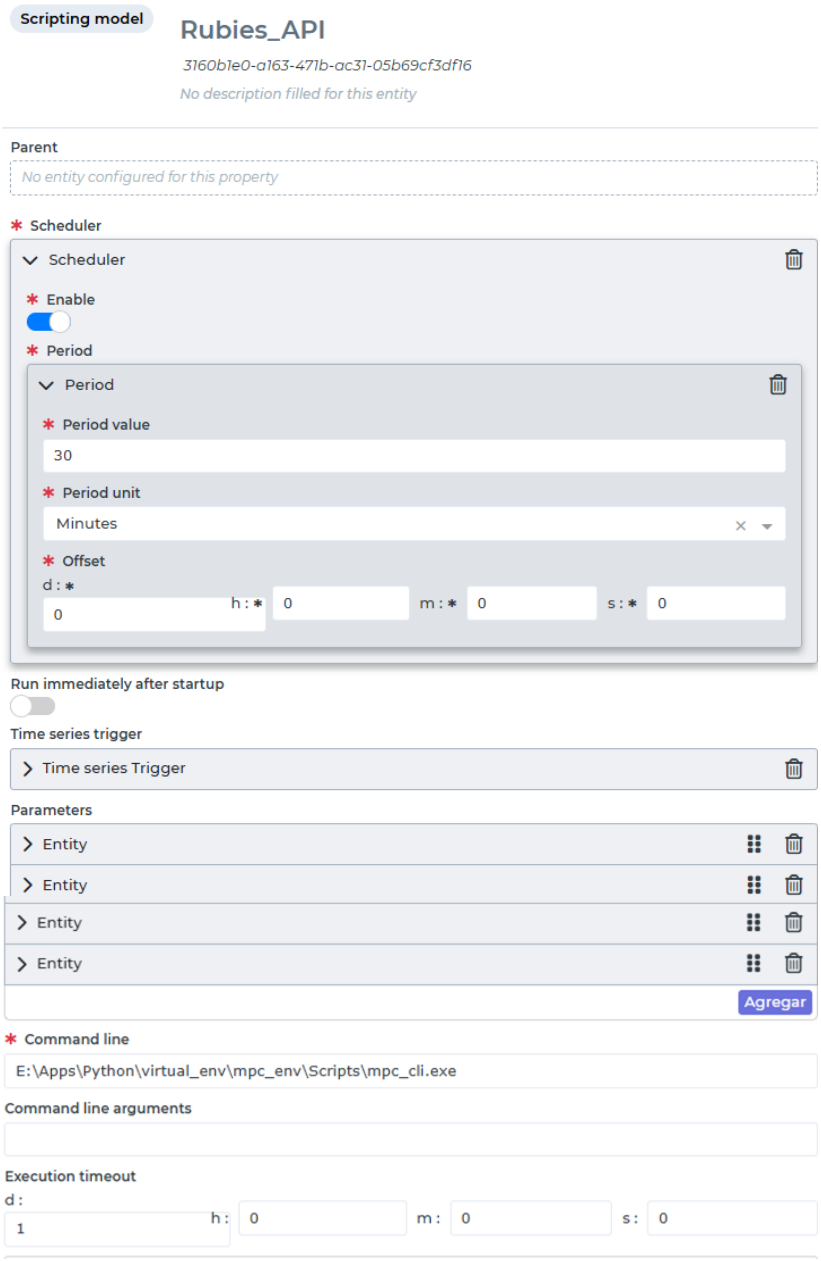


Figure 28.- RUBIES_API script model configured to run periodically the PBMPC controller

5 Hydraulic operational tests results

5.1 Introduction

This chapter outlines the methodology and key results obtained from evaluating AQDV's hydraulic operation strategy during the period from March 2024 to September 2025. Throughout this timeframe, over 25 rain events were analyzed in real-time to validate AQDV's recommended setpoints and assess their operational effectiveness. This analysis included monitoring operator-implemented setpoints to identify potential improvements in operational protocols, which were subsequently discussed through post-event communications and meetings.

A significant outcome of the LIFE RUBIES project has been the substantial enhancement of CYII's operational strategy, particularly evident during the analyzed 18-month period. This evolution is demonstrated by the marked difference in handling similar rain events between 2024 and 2025, reflecting tangible improvements in reducing CSO discharges and their impact on river water quality. Detailed examples of these operational improvements are presented in chapter 8.

The assessment of operational improvements presented unique challenges in terms of direct before-and-after comparisons. Two main factors complicated this evaluation: first, the inherent difficulty in finding identical rain events for comparison between pre-and post-LIFE periods; and second, the gradual implementation of operational improvements, which began in 2023 and continued through September 2025, with further enhancements planned in the After-LIFE phase.

To address these challenges, KPIs were calculated using model-based simulations of real rain events that occurred between March 2024 and September 2025. Two scenarios were developed:

- The before-LIFE scenario utilized a SWMM sewer model implementing the previously established operational protocols in Canal de Isabel.
- The after-LIFE scenario employed the same model but incorporated MPC-hydraulic computed setpoints for the pilot area's main actuators (pumps and gates), replacing the original CYII operational protocols

This modelling approach provided the foundation for computing various performance indicators, including hydraulic sewer KPIs (detailed in this chapter), quality sewer KPIs (Chapter 6), and environmental river KPIs (Chapter 7).

5.2 Methodology

This chapter presents a comprehensive overview of the methodology implemented for operational testing.

The methodology followed a structured approach comprising several key steps:

- **Weather Monitoring and Event Preparation**

Regular monitoring of weather forecasts was conducted several times per week to identify potential rainfall events in advance. This early detection enabled proper preparation for both sampling activities and real-time event monitoring.

- **Real-time Event Monitoring**

During rainfall events, real-time monitoring was performed through AQDV to:

  - Track system performance
  - Validate AQDV's recommended setpoints
  - Compare real operator-implemented setpoints with AQDV recommendations.

- **Post-Event Analysis**

Following each rainfall event and subsequent system normalization (return to dry-weather conditions with empty tanks), a comprehensive post-event report was generated, documenting:

  - Rainfall event characteristics
  - System performance, focusing on key installations (tanks and WWTPs)
  - Comparative analysis between AQDV-proposed and operator-implemented actuator management
  - Identification of operational problems, and potential improvements

- **CYII Communication**

Results were communicated through summary emails to CYII operators highlighting problems, doubts, key findings and improvement opportunities and through regular follow-up meetings with operators (eight sessions were done between June 2023 and September/October 2025) to:

  - Present project progress and AQDV improvements
  - Analyze recent rainfall events
  - Address operational questions
  - Discuss potential management protocol improvements
  - Gather operator feedback for AQDV optimization

- **KPI analysis**

Periodically (monthly or bi-monthly) rainfall 5-minute interval data from the newly installed raingauges was downloaded and, for significant rainfall events, the following analyses were performed:

- Calibration Analysis
  - Adaptation of the general Manzanares system model to reflect actual management protocols
  - Comparison of real versus modeled levels and CSO flows.
  - Assessment of model accuracy and deviation analysis
- Scenario Modelling
  - Baseline scenario: Simulation using original CYII management protocols
  - Enhanced scenario: Simulation applying hydraulic MPC-derived setpoints.
  - Calculation of hydraulic KPIs for both scenarios
  - Comparative analysis of CSO reduction percentages between scenarios

Annex 1 provides some examples of the documents prepared in these key steps with a post-event report and summary mail sent to Canal de Isabel operators, operators meeting summary, and report presenting comparison between calibration and KPI modelling results for the same specific rain event. We have deliberately limited the inclusion of all documentation to maintain deliverable conciseness and accessibility, particularly given that many working documents were in Spanish and contained internal communications with CYII.

5.3 General KPI event results

As mentioned in the previous methodology chapter, KPIs CSO volumes discharged in river Manzanares in the pilot area have been obtained based on computer modelling results comparing two scenarios:

- Baseline scenario with original management protocols and rules implemented by Canal de Isabel before the Life Rubies project started.
- Enhanced scenario with MPC setpoints for main actuators.

A total of 25 rain events were modelled for comparison covering from March 2024 until September 2025, more than a year and a half.

It is important to mention that some of these rain events include several simulation days comprising periods without rain in between two consecutive rain episodes. As these dry periods were too short to consider the possibility of emptying the tanks and return the system to its normal dry weather flow states, it seemed reasonable to consider them as part of the rain event. This situation is especially evident in March 2025, which was a very rainy month (more than 150

mm of precipitation where measured). Thus, in this month we decided to separate the model runs per weeks.

The following table presents the results obtained for each rain event modeled and the comparison between them. This comparison is presented as percentage reduction of CSO volumes discharged in river Manzanares.

Table 2.- Baseline scenario results with SWMM rules model.

Rain Event				SWMM rules results							
				CSO							Flood
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (m3)	Total (m3)
08/03/2024	**11.4**	7	1.63	0	0	51083	0	159203	46220	**256506**	**14135**
11/03/2024	**11.8**	8	1.48	0	0	57774	0	179810	49371	**286955**	**13996**
28/03/2024	**11.8**	6	1.97	0	0	42371	0	150052	24277	**216700**	**9287**
27/04/2024	**7.8**	14	0.56	0	0	32261	0	46075	3344	**81680**	**0**
08/06/2024	**4.2**	5	0.84	0	0	22223	0	16778	3705	**42706**	**0**
10/06/2024	**29.8**	8	3.73	2204	0	175351	0	414347	129427	**721329**	**244692**
20/09/2024	**17**	3	5.67	20767	0	51037	0	233790	63417	**369011**	**78924**
07/10/2024	**5.2**	3	1.73	0	0	26732	0	36756	10592	**74080**	**0**
12/10/2024	**21.9**	11	1.99	12245	0	83423	0	313645	54122	**463435**	**150680**
16/10/2024	**13.2**	28	0.47	0	0	76750	0	186278	38185	**301213**	**12370**
29/10/2024	**23.6**	16	1.48	1097	0	115926	0	384775	106843	**608641**	**154863**
01/11/2024	**9.6**	1.5	6.40	1440	0	89294	0	96088	37141	**223963**	**12864**
20/01/2025 - 3 days rain	**21.4**	76	0.28	0	0	131980	0	383706	50333	**566020**	**11896**
27/01/2025	**5.6**	5	1.12	0	0	29937	0	27906	6022	**63865**	**0**
29/01/2025	**5.4**	8	0.68	0	0	29209	0	12577	1199	**42985**	**0**
11/02/2025	**14.2**	7	2.03	0	0	75274	0	267050	72919	**415243**	**57742**
01/03/2025	**18.2**	40	0.46	0	0	121643	0	366547	72140	**560330**	**79500**
03/03/2025 - 7 days	**64.8**	168	0.39	107188	0	927532	0	1501777	418868	**2955366**	**442662**
10/03/2025 - 7 days	**45.4**	168	0.27	104605	0	660558	204433	955048	296432	**2221076**	**299597**
17/03/2025 - 7 days	**51.4**	168	0.31	91985	0	678701	84149	1207019	324264	**2386118**	**262732**
03/04/2025 - 2 days	**47.4**	48	0.99	76502	0	741655	7818	1094817	348222	**2269013**	**425818**
11/04/2025 - 3 days	**24.4**	98	0.25	8511	0	336736	0	536959	145515	**1027721**	**69940**
18/04/2025 - 2 days	**12**	13	0.92	0	0	128836	0	187097	58561	**374494**	**12184**
02/05/2025 - 1 days	**29**	24	1.21	21493	0	255817	0	609514	173687	**1060511**	**211461**
3/7/2025	**5.2**	28	0.19	0	0	18782	0	24471	6060	**49313**	**0**

Table 3.- Enhanced scenario model results with MPC setpoints

Rain Event				MPC results							
				CSO							Flood
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (m3)	Total (m3)
08/03/2024	11.4	7	1.63	0	0	5134	0	121867	32817	159819	505
11/03/2024	11.8	8	1.48	0	0	5171	0	139363	36104	180638	498
28/03/2024	11.8	6	1.97	0	0	3224	0	93531	26096	122851	9247
27/04/2024	7.8	14	0.56	0	0	5166	0	27268	13341	45775	0
08/06/2024	4.2	5	0.84	0	0	2981	0	9480	8707	21169	0
10/06/2024	29.8	8	3.73	22228	0	127406	75637	380465	163316	769052	166609
20/09/2024	17	3	5.67	65	0	4075	0	186497	52306	242942	51199
07/10/2024	5.2	3	1.73	0	0	4031	0	23122	9355	36509	0
12/10/2024	21.9	11	1.99	536	0	41273	0	238192	74958	354960	114068
16/10/2024	13.2	28	0.47	0	0	12662	0	157407	41326	211395	2878
29/10/2024	23.6	16	1.48	6973	0	59412	55276	333136	115927	570723	104103
01/11/2024	9.6	1.5	6.40	22548	0	59167	0	63911	43987	189612	13213
20/01/2025 - 3 days rain	21.4	76	0.28	0	0	17432	0	308097	62564	388092	2064
27/01/2025	5.6	5	1.12	0	0	5429	0	15029	12044	32503	0
29/01/2025	5.4	8	0.68	0	0	1644	0	2709	13718	18072	0
11/02/2025	14.2	7	2.03	0	0	7488	0	211493	57239	276220	19512
01/03/2025	18.2	40	0.46	0	0	13647	0	291576	62558	367780	34545
03/03/2025 - 7 days	64.8	168	0.39	85825	0	597930	146308	1336917	424964	2591944	264896
10/03/2025 - 7 days	45.4	168	0.27	155880	0	463536	254299	953295	306862	2133871	200305
17/03/2025 - 7 days	51.4	168	0.31	73852	0	453454	184112	1034189	322955	2068562	184128
03/04/2025 - 2 days	47.4	48	0.99	213911	0	517331	255055	973163	383123	2342583	260496
11/04/2025 - 3 days	24.4	98	0.25	0	0	136673	0	445329	122313	704315	28024
18/04/2025 - 2 days	12	13	0.92	9351	0	82909	0	142260	65830	300350	6368
02/05/2025 - 1 days	29	24	1.21	59688	0	198063	128976	536087	194864	1117678	123533
3/7/2025	5.2	28	0.19	0	0	3071	0	16645	5839	25555	0

Table 4.- KPIs CSO and flood percentage reduction with the enhanced MPC scenario

Rain Event				Analysis			
				Improvement			
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	CSO	Flood	Total	Comments
08/03/2024	11.4	7	1.63	37.69%	96.43%	40.76%	
11/03/2024	11.8	8	1.48	37.05%	96.44%	39.81%	
28/03/2024	11.8	6	1.97	43.31%	0.44%	41.55%	
27/04/2024	7.8	14	0.56	43.96%		43.96%	
08/06/2024	4.2	5	0.84	50.43%		50.43%	
10/06/2024	29.8	8	3.73	-6.62%	31.91%	3.14%	Apparently MPC causes more CSO but this is because it reduces floods so there is more water volume getting into the pilot area causing CSO. Considering Floods as CSO there is a 2.5 % improvement in MPC
20/09/2024	17	3	5.67	34.16%	35.13%	34.33%	
07/10/2024	5.2	3	1.73	50.72%		50.72%	
12/10/2024	21.9	11	1.99	23.41%	24.30%	23.63%	Not only CSO are improved but also floods are slightly improved with MPC
16/10/2024	13.2	28	0.47	29.82%	76.73%	31.67%	
29/10/2024	23.6	16	1.48	6.23%	32.78%	11.61%	Not only CSO are improved but also floods are improved with MPC
01/11/2024	9.6	1.5	6.40	15.34%	-2.71%	14.36%	
20/01/2025 - 3 days rain	21.4	76	0.28	31.43%	82.65%	32.49%	Not only CSO are improved but also floods are improved with MPC
27/01/2025	5.6	5	1.12	49.11%		49.11%	
29/01/2025	5.4	8	0.68	57.96%		57.96%	
11/02/2025	14.2	7	2.03	33.48%	66.21%	37.48%	
01/03/2025	18.2	40	0.46	34.36%	56.55%	37.12%	
03/03/2025 - 7 days	64.8	168	0.39	12.30%	40.16%	15.93%	CSO are slightly improved and also floods are
10/03/2025 - 7 days	45.4	168	0.27	3.93%	33.14%	7.40%	CSO are slightly improved and also floods are
17/03/2025 - 7 days	51.4	168	0.31	13.31%	29.92%	14.96%	
03/04/2025 - 2 days	47.4	48	0.99	-3.24%	38.82%	3.40%	Apparently MPC causes more CSO but this is because it reduces floods so there is more water volume getting into the pilot area causing CSO. Considering Floods as CSO there is an improvement in MPC
11/04/2025 - 3 days	24.4	98	0.25	31.47%	59.93%	33.28%	
18/04/2025 - 2 days	12	13	0.92	19.80%	47.73%	20.68%	
02/05/2025 - 1 days	29	24	1.21	-5.39%	41.58%	2.42%	Apparently MPC causes more CSO but this is because it reduces floods so there is more water volume getting into the pilot area causing CSO. Considering Floods as CSO there is an improvement in MPC
3/7/2025	5.2	28	0.19	48.18%		48.18%	

These results highlight the following ideas:

- Canal de Isabel ´ s current standard operation procedure prior to the implementation of the Life Rubies solution, could clearly be improved. This circumstance was foreseen by Canal Technicians, reason why this case study was conducted.
- The average benefit from MPC scenario vs baseline scenario is about reducing 28.5 % the total CSO volume discharged to the Manzanares river.
- For big rain events which widely exceed the storage capacity of the detention tanks, the benefit obtained in terms of CSO reduction is reduced. On the other hand, in short rain episodes with high rainfall intensity and small total precipitation volume the CSO mitigation which can be obtained with the optimized operation procedure increases. These results evidence that there is a maximum rainfall volume which can be managed by the drainage system above which CSO is unavoidable. As the tanks will be filled anyway, the only difference obtained from the optimized procedure is that beginning of the CSO discharge may be delayed in time. However, for small rain events, operation criteria of the infrastructure may make the difference and the limitations of Canal de Isabel ´ s management criteria are evidenced in a similar way as the benefits of a centralized and predictive control-based procedure are highlighted.
- Related with the previous point, results obtained evidenced that for big rain events, the MPC scenario apparently discharged a bigger CSO volume than when accomplishing the baseline scenario simulation (this can be seen for example in the rain episode corresponding to 10/6/2024, where CSO improvement is -6.62%). This inconsistency demanded closer analysis. Once this study was accomplished, it was evidenced that with the baseline operation procedure higher flood volumes were being obtained while the MPC was minimizing this flooding, increasing CSO volume instead. If these flood reductions are counted as volumes not being discharged to the river Manzanares then in all cases it is verified that the MPC presents a decrease in CSO discharge, even if it may result very slightly significant when managing heavy rain long episodes (for 10/6/2024 rain event CSO reduction is only 3.14 %).
- It can therefore be concluded that the MPC scenario always improves and for all rain events the baseline scenario control strategy.

5.4 Detailed operational testing for a rain event

An example of the methodology steps described in chapter 5.2 corresponding to the analysis of the 11$^{th\ of}$ April 2025 rain event is presented in this chapter together with the results obtained. In addition, for each step, some general comments corresponding to other rain events will be explained.

Annex 1 will present some of the related documents created for the operational testing.

5.4.1 Weather monitoring and event preparation

As mentioned previously, several days a week the weather forecasts were monitored.

In the case of this rain event, in order to obtain a field campaign pollutant characterization of the eventual CSO, a first mail was sent 4 days previous to the rain event so that automatic water samplers could be programmed and the laboratory could be ready in case the rain was confirmed. In first instance, prediction indicated that rain could be starting on Friday 11th but with low probability, considering higher rain probability for Saturday and Sunday. However, in the coming days the predictions changed and moved to Friday. Last mail communication was made on the same Friday at 06:50 am, confirming that the rain episode was expected to start in the coming hours.

Despite the intention of accomplishing a field campaign, the samplers located at the entrance of Butarque WWTP did not start up, and no sampling was obtained at this point. Samples taken at the primary treatment bypass where discarded and not taken to the laboratory for analysis.

5.4.2 Real time and post event analysis

CYII operators (as well as AQUATEC for some rain events) use in real time the centralized information gathered by AQDV from Canal SCADA, as well as the setpoints computed to decide the operation procedure. However, this information and suggested operation need to be weighed, considering also other relevant information which may constrain the rain episode management. Mainly, this limitation comes from the situation of the wastewater system upstream and beyond the case study infrastructure (empty storage volume of detention tanks located upstream and hydraulic capacity of the WWTP located downstream the study area clearly limit the operation.

Then usually a week later, AQUATEC was doing a post event report and sending a mail to the operators with the doubts and potential improvements identified. This post event report and summary mail is included in Annex 1.2. Because these were working documents, they are written in Spanish but a short summary of the rain event is included below:

- Rainfall: 10-15 mm total, with 3 intense periods causing CSO discharges.
- Tank Filling:
    - Butarque tank was already full at the starting of the rain period because of previous rain events.
    - Abroñigales tank was at 23% and only filled to 29% on April 11th, despite the bypass gate being at 25% and closed gates at the Convenio chamber diverting water there.
- CSO (Combined Sewer Overflow):
    - CSOs occurred at Partidor Butarque (141,000 m3), Butarque II (294,000 m3), and Sur outfall (233,000 m3), and at the Sur WWTP head (350,000 m3).
    - No CSOs at Butarque WWTP head or Abroñigales emergency outfall.
- Tank Emptying:
    - Limited options for emptying due to continued rain.
    - Abroñigales is emptying slowly at 0.3 m3/s.

- Automation could help empty tanks faster, especially given the low level and flow at Sur WWTP lamination tank in some moments (as seen in



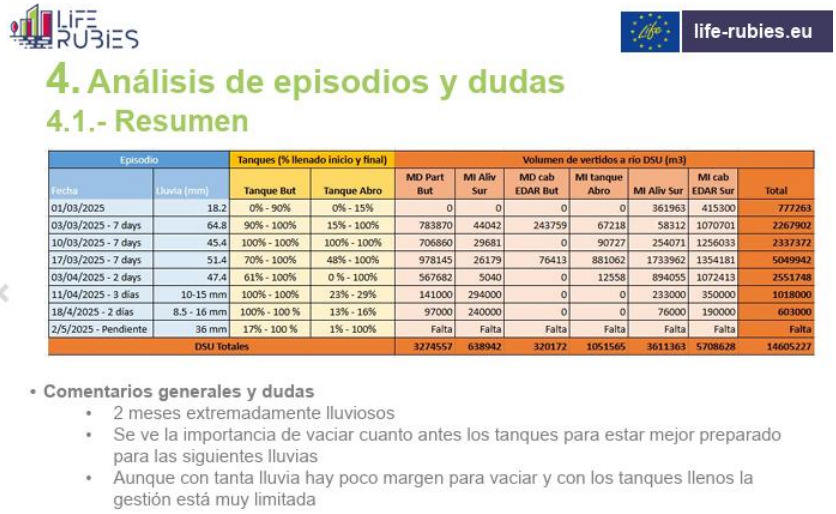
Figure 29.- AQDV graphs showing Butarque and Abroñigales real tank filling evolution and the suggested emptying strategy for the 11/4/2025 rain event

5.4.3 CYII operators meetings

March and April 2025 were extremely rainy months so CYII operators were very busy but once operation was back to normality a meeting was held (ROC 7 meeting the 5/%/2025) with the following goals:

- Give a general overview of the project to a new operator that had join the works
- Inform about the LIFE – RUBIES project update and the next tasks
- Improvements on the operation during the last rain events
- Analysis of these two last months rain events and solving doubts about them
- AQDV tool improvements so that it can be more useful

Annex 1.3 includes the presentation done during that meeting.



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4. Análisis de episodios y dudas

4.1.- Resumen

Episodio		Tanques (% llenado inicio y final)		Volumen de vertidos a rio DSU (m3)						
Fecha	Lluvia (mm)	Tanque But	Tanque Abro	MD Part But	MI Aliv Sur	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total
01/03/2025	18.2	0% - 90%	0% - 15%	0	0	0	0	361963	415300	777263
03/03/2025 - 7 days	64.8	90% - 100%	15% - 100%	783870	44042	243759	67218	58312	1070701	2267902
10/03/2025 - 7 days	45.4	100% - 100%	100% - 100%	706860	29681	0	90727	254071	1256033	2337372
17/03/2025 - 7 days	51.4	70% - 100%	48% - 100%	978145	26179	76413	881062	1733962	1354181	5049942
03/04/2025 - 2 days	47.4	61% - 100%	0 % - 100%	567682	5040	0	12558	894055	1072413	2551748
11/04/2025 - 3 dias	10-15 mm	100% - 100%	23% - 29%	141000	294000	0	0	233000	350000	1018000
18/4/2025 - 2 días	8.5 - 16 mm	100% - 100 %	13% - 16%	97000	240000	0	0	76000	190000	603000
2/5/2025 - Pendiente	36 mm	17% - 100 %	1% - 100%	Falta	Falta	Falta	Falta	Falta	Falta	Falta
DSU Totales				3274557	638942	320172	1051565	3611363	5708628	14605227

- **Comentarios generales y dudas**
  - 2 meses extremadamente lluviosos
  - Se ve la importancia de vaciar cuanto antes los tanques para estar mejor preparado para las siguientes lluvias
  - Aunque con tanta lluvia hay poco margen para vaciar y con los tanques llenos la gestión está muy limitada

Figure 30.- Meeting presentation slide where a general summary of the rain events analyzed was presented as well as some general comments and doubts

5.4.4 Rain event calibration analysis

For this task the general SWMM Manzanares system model is used and the model is adapted to simulate this rain specific rain event applying some minor changes to the RTC (real time control) file trying to adapt as best as possible the gate and pumps real movements from the reality to the simulated ones. In this rain event for example being from 2025 several improvements were made since the beginning of the project and the most important one was that the upstream Butarque WWTP by pass gate was closed during all the rain event to avoid CSO discharges in this point while Butarque tank is not fully filled.

To estimate the calibration difference CSO volumes during the real operation are computed and compared with the modelled ones. In this particular rain event, the Aliviadero Sur CSO discharge was not computed in the CSO calibration error because the sensor data was not measuring correctly for some periods (see Figure 31).

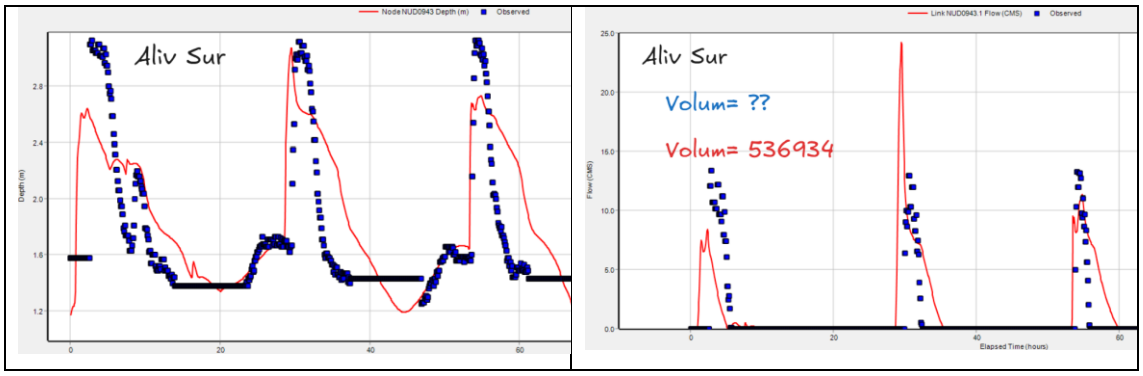


Figure 31.- Calibration data for Aliviadero Sur sensor. The model (red lines don't look back compared with the measured values (blue dots) but there are some periods where the signal is kept constant for some hour which means there was some measuring error.

Table 5.- CSO volume calibration results for 11/4/2025 rain event. ID 1 are the volumes from real operation while ID2 are the model results. Aliviadero Sur is marked in red because they are not computed in the CSO volumes since the measured data is not valid.

ID	Descripción	MD Partidor But	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	Total
1	Gestión real del Canal	159876	0	3529	233525	163405
2	SWMM David para calibración modelo	138173	0	0	536934	138173
% Calibration Difference		13.57%	#DIV/0!	100.00%	-129.93%	**15.44%**

As seen in table 5 for this rain event there is a 15% error which is not bad. This error is changing depending on the rain event ranging from 2% for the 1/11/2024 rain event to 73% for the rain event of 17/3/2025. Two main reasons have been identified when error is higher than 50%:

In the cases where differences are higher than 50% there are two main reasons:

- The model runs with the rain measured data in the two rain gauges being south of the Manzanares system, but some rain events might differ a lot the real rain in the north than in the south, in those cases it is impossible to calibrate the model.
- The real operation of the tanks specially in the emptying phase of the upper system part might be very different than the modelled operation and this affects to the flows getting in the pilot area. Also, in these cases calibrating the results is very difficult or impossible.

Annex 1.4. presents the calibration report for the rain 11/4/2025 rain event.

5.4.5 Scenario modelling and KPI computation

The last step consists in using modelling the same rain data used for the calibration model but with these two scenarios:

- The baseline scenario: Using the same SWMM model used for the calibration but the actuators are moved according to the original CYII management rules and protocols that they had at the beginning of LIFE-Rubies project
- The enhanced scenario: Again, it uses the same SWMM model but in this case the actuators setpoints are computed according to the MPC hydraulic method.

Table 6 shows that for this rain event the improvement achieved is 33% and annex 1.5 includes the hydraulic KPI report with some detailed graphs to understand the differences.

Table 6.- Hydraulic KPI of CSO reduction between MPC enhanced scenario (ID 6) and the baseline scenario (ID3)

ID	Descripción	MD Partidor But	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	Total CSO	Total Flood	Total reduction
3	SWMM David con Qentrada EDAR But=3	8511	336736	0	536959	1027721	69940	1097661
6	Resultados Luis con MPC	0	136673	0	445329	704315	28024	732339
% MPC improvement		100.00%	59.41%	#DIV/0!	17.06%	**31.47%**	**59.93%**	**33.28%**

In this case the main difference is caused because MPC is able to partially empty the tanks in the periods between rains sending it to the WWTP without causing extra CSO, and this means when it rains again it can store more water in the tanks thus reducing CSOs to the river (see Figure 32).

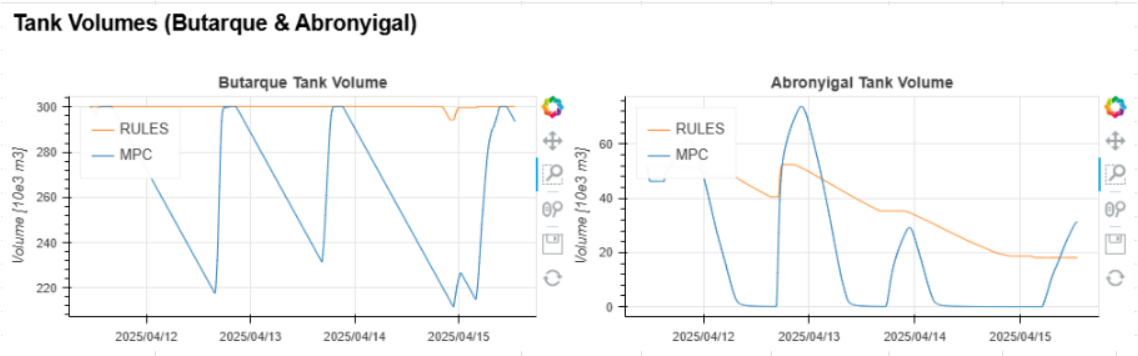


Figure 32.- Butarque and Abroñigales tank volumes retention during 11/4/2025. In blue is the enhanced scenario with MPC setpoints while in orange is the baseline scenario.

For this rain event also MPC causes flooding reduction which means that for the MPC scenario higher flows get into the pilot area as seen in the entrance point Qin4 (flooded volumes gets out of the system and that's why for KPI analysis it is computed similarly as CSO discharge because this volume gets into the city surface but at some point, it reaches back the sewer or it reaches the river).

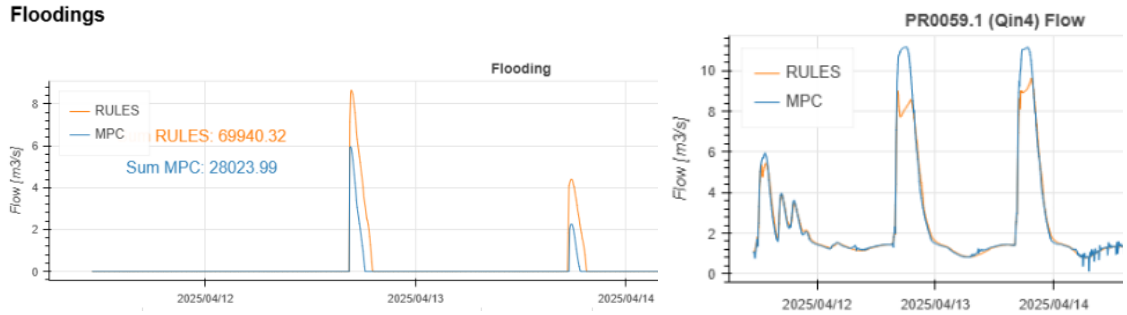


Figure 33.- Reduction of floodings between MPC scenario and baseline scenario (left graph) and this causes an increased volume in the pilot area flow entrance point Qin4 (right graph)

6 Quality operational tests results

6.1 Introduction

Similar to Chapter 5, this section outlines the methodology and key results obtained from evaluating AQDV's quality operation strategy during the period from March 2024 to September 2025, analyzing the same events examined in the hydraulic tests.

The quality-based KPIs were calculated by comparing model results for the same two scenarios but focusing on key water quality parameters: Suspended Solids (SS), Chemical Oxygen Demand (COD), Ammonium, Total Phosphorus (Ptotal), Total Nitrogen (Ntotal) and Biochemical Oxygen Demand (BOD5).

Extensive sampling campaigns and laboratory analysis of CSO discharge quality during rain events played a crucial role in this assessment:

- To develop pollutant correlations to estimate real time quality (see chapter 4.4)
- And to compute Mean Event Concentrations (MEC) used to transform CSO's volumes to mass pollution discharged to the river.

The following subchapters provide detailed information about these analyses and their results.

6.2 Methodology

This chapter presents a comprehensive overview of the tasks followed to complete the quality operational tests.

The methodology followed a structured approach comprising several key steps:

- Dry weather and rain events sampling campaigns and laboratory results for several pollution parameters
- Compute pollutant correlations and MEC values for each CSO discharging point based on the previous sampling campaigns together with similar testing accomplished in other projects.
- From the KPIs operational testing results for the baseline scenario discharged volumes, obtain the pollutant mass discharged
- Model the enhanced scenario applying suspended solids quality MPC-derived setpoints
- Calculation of quality KPIs for both scenarios and comparative analysis of CSO reduction percentages between scenarios.

6.3 Water sampling results

6.3.1 Water sampling campaigns and laboratory analysis results

In chapter3.1 the water samplers installed were described, there were 3 of them although one was initially installed in Partidor Butarque and then later on moved to Butarque WWTP entrance, and the goal was to do at least for each location:

- **2 dry weather flow campaigns:** with 24 water bottles collected (one per hour) which later on were mixed to obtain 6 samples (1 every 4 hours) to be taken to the laboratory (see Figure 34)
- **3 rain events campaigns:** In this case the goal was to collect 12 water bottles, the 6 first ones with a frequency of 10 minutes and the last 6 ones with a frequency of 20 minutes, so we could analyze 3 hours of CSO discharge with more frequency results at the start of the event where higher pollution concentrations can be expected. Of course, this planification was theoretical. For rain events of shorter duration not all of the samples were collected.

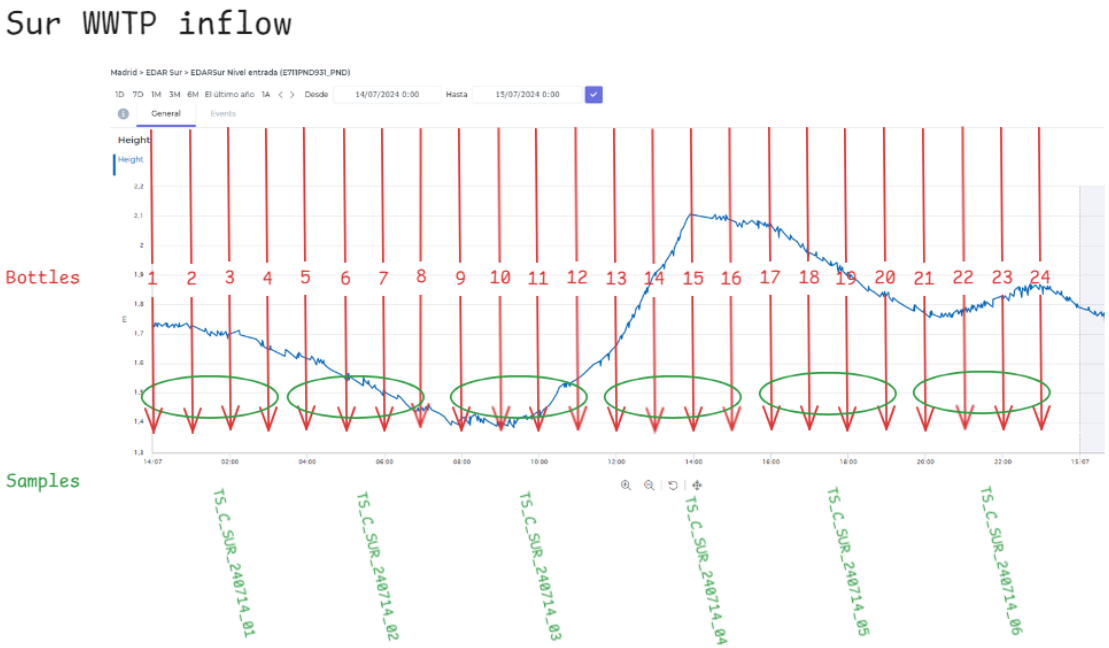


Figure 34.- Example of the bottles and the samples taken to the laboratory for analysis for the 14/7/2024 DWF campaign in Sur WWTP inflow

By pass EDAR Sur

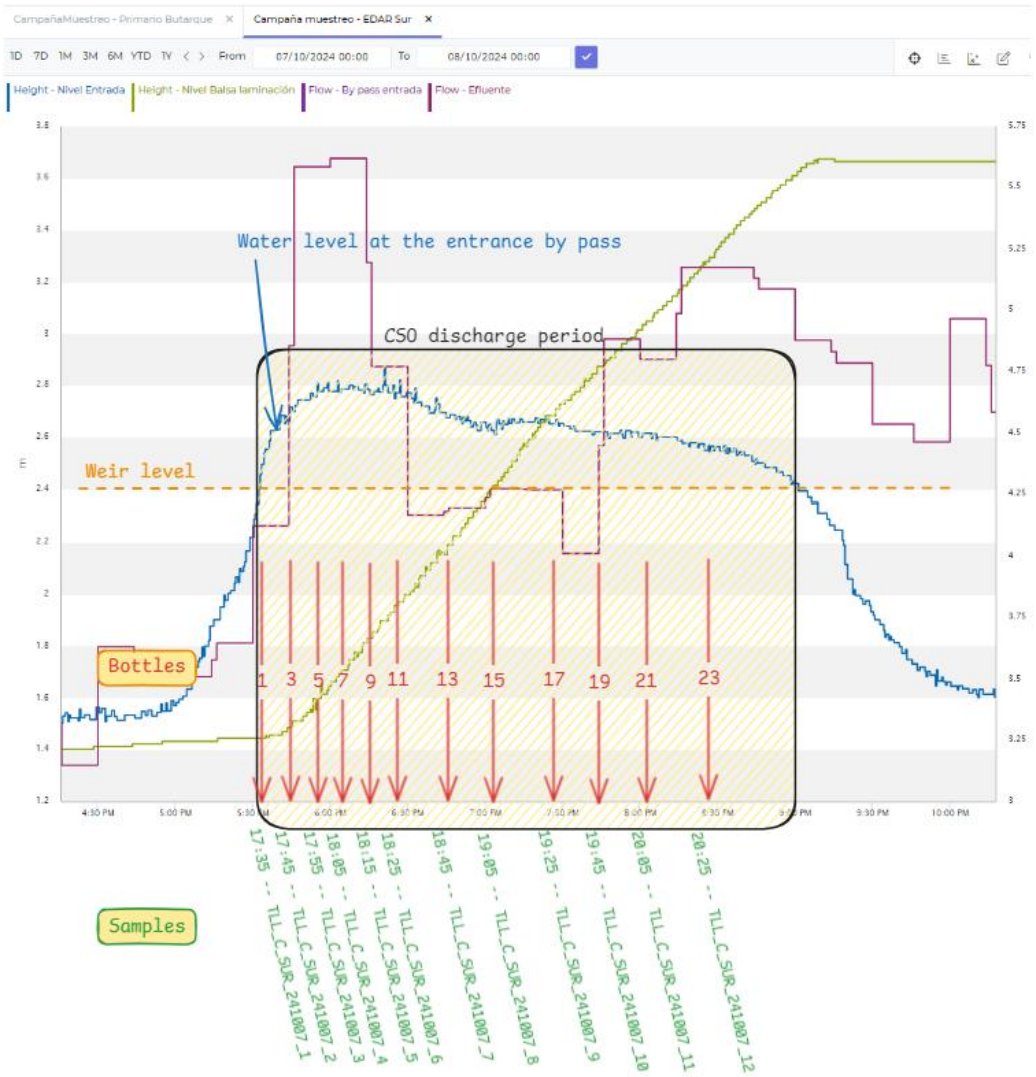


Figure 35.- Example of the bottles and the samples taken to the laboratory for analysis for the 7/10/2024 rain event campaign in Sur WWTP entrance by pass

The table below shows the total number of campaigns and samples analyzed at each location:

Table 7.- Number of campaigns, dates and samples analyzed at each location

Location	Campaign date and samples	
	DWF	Rain event
Partidor Butarque	09/04/2024 - 6 samples 07/06/2024 - 12 samples 28/07/2024 - 6 samples	09/10/2024 - 12 samples
By pass in Butarque WWTP entrance		11/02/2025 - 8 samples 04/03/2025 - 12 samples 08/03/2025 - 12 samples 20/03/2025 - 12 samples 03/07/2025 - 11 samples
By pass in Butarque WWTP secondary treatment	09/04/2024 - 6 samples 07/06/2024 - 12 samples 07/07/2024 - 6 samples	19/09/2024 - 11 samples 29/10/2024 - 11 samples 11/02/2025 - 2 samples 01/03/2025 - 11 samples 07/03/2025 - 11 samples 20/03/2025 - 12 samples
By pass in Sur WWTP entrance	14/07/2024 - 6 samples 22/07/2024 - 6 samples 09/04/2024 - 6 samples	07/10/2024 - 12 samples 12/10/2024 - 7 samples 16/10/2024 - 9 samples 29/10/202 - 12 samples 21/01/2025 - 12 samples

Each laboratory analysis of the water samplers included these parameters:

- Turbidity
- Conductivity
- Total Suspended Solids
- COD (or DQO in Spanish)
- Total Ammonium (amonio in Spanish)
- Ptotal
- NTotal
- BOD5 (Or DBO5 in Spanish)

Annex 2 presents the raw values of the laboratory analysis for each sample of each campaign.

6.3.2 Correlations

The range of pollutant indicators that can be measured in relation to water quality is very broad, but most of these parameters can't be measured in real time and the cost of a monitoring system for evaluating them is unaffordable. That's why we looked for correlations with turbidity and

conductivity which can be measured in real time at a reasonable cost and with considerable accuracy as long as probe maintenance is guaranteed

It is commonly assumed that the determination of solids concentration, especially suspended solids, is a good indicator of general pollution presence in rainwater. This is because most pollutants are associated with sediments, and more specifically with finer particles and there are several studies that show there are good correlations between turbidity and concentrations of suspended solids (Anta J., 2009), (Bertrand-Krajewski, 2004), (Lastra, 2018). Even in the Spanish legislation it is mentioned that an initial estimation of suspended solids can be obtained considering 3 mg/l of SS is equivalent to 1 NTU in turbidity.

So we were looking for these correlations when we realized we could also find a positive and significant correlation between conductivity and soluble pollutants, even though there was not much biography about it (Andriy Malovanyy, 2013), (Qiangqiang Yu, 2019)

With all the laboratory analysis results we looked for correlations between:

- Turbidity and non-soluble contaminants (suspended solids, DQO and DBO5)
- Conductivity and soluble contaminants (Ammonium, Total Phosphorus and Total Nitrogen)

These correlations are site specific and different between dry weather flows and rain events data, mainly because water source is different and so it must be the pollution related.

Annex 3 presents the correlations data and graphs obtained in each location and Figure 36 and Figure 37 show an example of these correlations one for turbidity and another for conductivity.

We were surprised to check that correlations were much better in conductivity than in turbidity as seen in the annex, especially in rain events that is where CSO are discharging to the river and where we were interested to obtain these correlations, but even if some of these correlations in turbidity are poor, they can be used for real time estimation of the pollutant parameters.

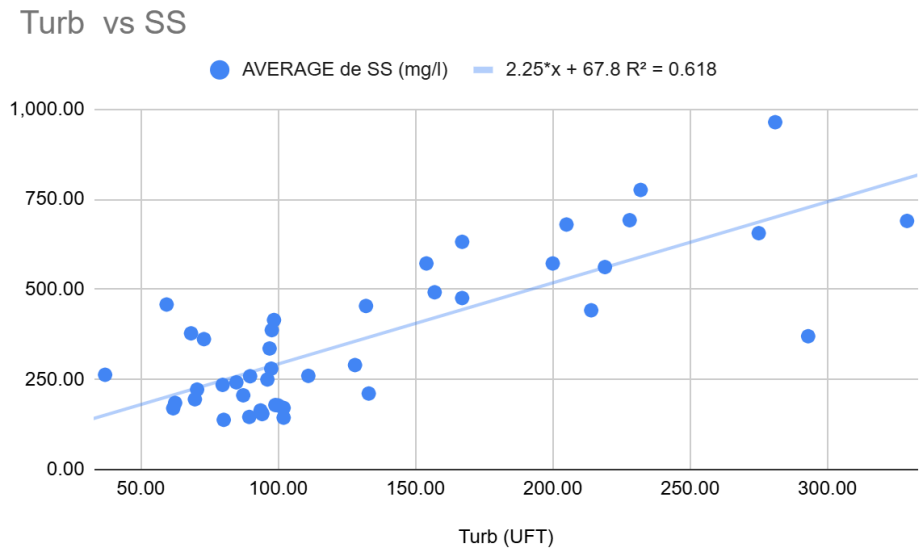


Figure 36.- Example of Rain event correlation between turbidity and suspended solids in Butarque WWTP entrance

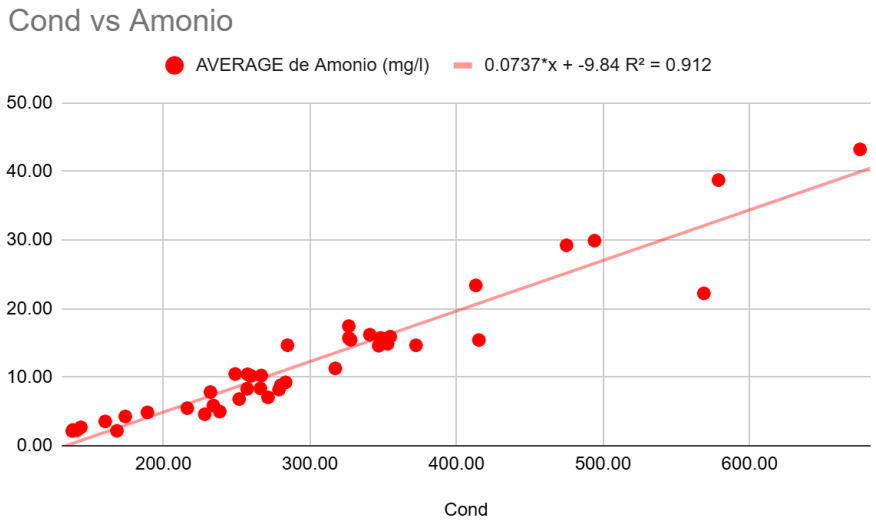


Figure 37.- Example of rain event correlation between conductivity and Ammonium in Butarque WWTP entrance

6.3.3 Mean Event Concentrations (MEC)

The other useful results obtained from the laboratory tests are the Mean Event Concentrations (MEC) for a CSO event.

To obtain the MEC values for a specific CSO discharge point these are the steps followed:

- Total discharge volume for the CSO event is obtained by multiplying discharge (m3/s) by the influence time of that discharge measurement.
- Similarly Total discharged mass pollution in the CSO event is obtained for each parameter by multiplying the concentration measured by the volume discharged in the influence time of that pollution concentration measurement.
- MEC for that CSO event is computed by dividing the total discharged mass pollution by the total volume discharged.
- MEC for a specific CSO discharge point is computed by obtaining the MEC mean of the different CSO sampling events.

Tables below show the MEC results for each location.

Table 8.- MEC values for Butarque WWTP CSO events in entrance by pass

CSO event		MEC					
Data	mm daily rain	SS (mg/l)	DQO (mg/l)	Amonio (mg/l)	Ptotal (mg/l)	Ntotal (mg/l)	DBO5 (mg/l)
11/2/2025	14.00	527.78	961.87	19.96	6.03	30.23	408.48
4/3/2025	9.00	210.97	140.59	2.84	2.18	14.33	234.86
8/3/2025	15.00	182.87	265.47	15.03	1.61	12.04	76.10
20/3/2025	21.00	267.46	215.97	7.77	1.73	10.32	85.18
Average		297.27	395.97	11.40	2.88	16.73	201.15

Table 9.- MEC values for Butarque WWTP CSO events in secondary by pass

CSO event		MEC					
Data	mm daily rain	SS (mg/l)	DQO (mg/l)	Amonio (mg/l)	Ptotal (mg/l)	Ntotal (mg/l)	DBO5 (mg/l)
19/9/2024	16.00	92.00	291.56	39.79	5.27	39.70	192.94
29/10/2024	12.00	25.11	312.07	35.78	4.72	35.45	154.81
11/2/2025	14.00	213.08	698.31	62.90	8.63	68.38	358.19
1/3/2025	10.00	124.18	313.64	47.48	6.01	34.89	157.42
7/3/2025	10.00	117.42	217.71	32.96	3.76	27.04	82.64
20/3/2025	21.00	151.08	160.54	24.42	2.61	22.16	79.33
Average		120.48	332.31	40.55	5.17	37.94	170.89

Table 10.- MEC values for Sur WWTP CSO events in entrance by pass

CSO event		MEC					
Data	mm daily rain	SS (mg/l)	DQO (mg/l)	Amonio (mg/l)	Ptotal (mg/l)	Ntotal (mg/l)	DBO5 (mg/l)
7/10/2024	5.50	652.99	1324.56	35.92	9.98	56.32	620.07
12/10/2024	12.00	354.51	539.63	24.59	6.33	34.95	253.85
16/10/2024	6.00	305.23	467.42	20.23	4.69	23.41	171.28
29/10/2024	12.00	342.12	718.69	19.43	3.53	21.78	338.69
21/1/2025	9.00	398.19	478.71	30.12	5.93	44.71	295.24
Average		410.61	705.80	26.06	6.09	36.23	335.83

Similar work was done with samples of CSO events taken in a previous project (Lastra, 2018) for other CSO discharging points in the pilot area, so the final MEC values used in the next chapter are obtained (see Table 11 and Figure 38).

Table 11.- MEC for the different CSO locations from the pilot site

CSO location	SS (mg/l)	COD (mg/l)	Ammonium (mg/l)	Ptotal (mg/l)	Ntotal (mg/l)	BOD5 (mg/l)
EDAR Sur	410.61	705.8	26.06	6.09	36.23	335.83
Entrada EDAR But	297.27	395.97	11.4	2.88	16.73	201.15
Primari EDAR But	120.48	332.31	40.55	5.17	37.94	170.89
Partidor But	325.54	616.37	18.31	5.3	23.27	329.57
Aliv Sur	135.08	308.19	13.28	3.06	17.15	163.58
Abroñigales	139.39	380.99	8.58	2.62	11.75	201.19
Average	238.06	456.61	19.7	4.19	23.85	233.7

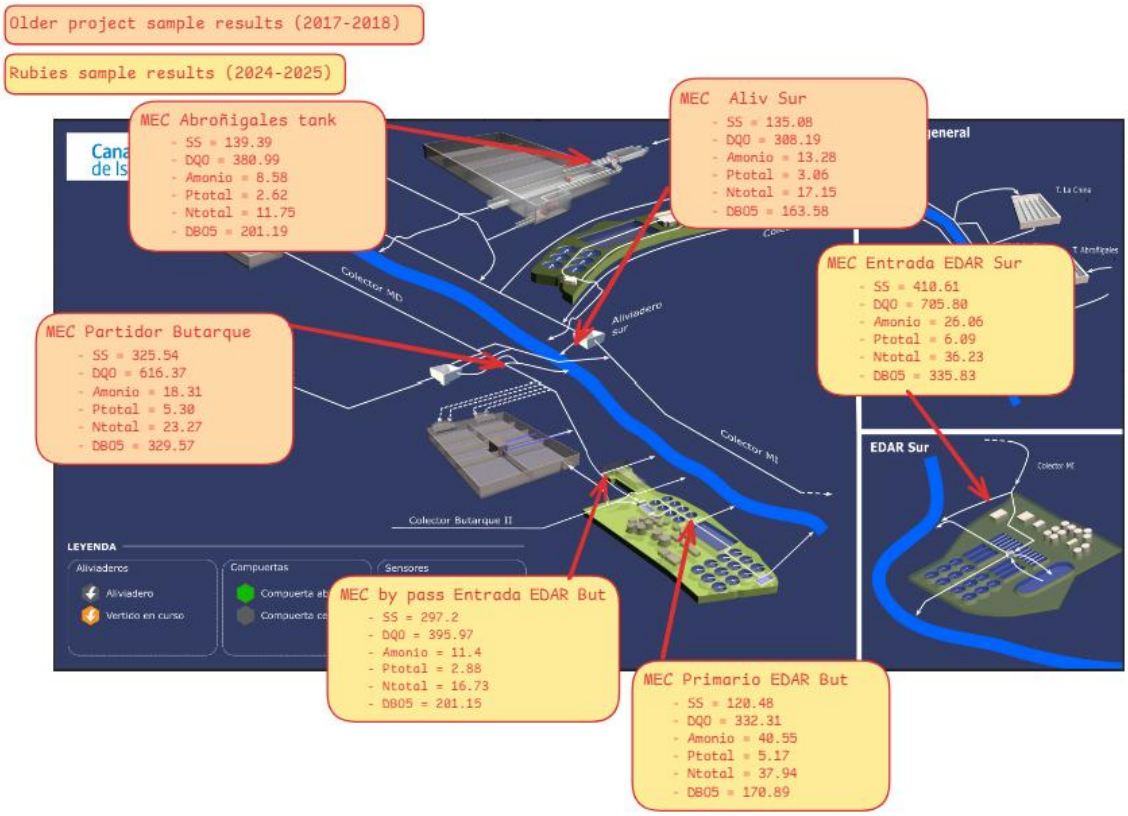


Figure 38.- MEC for the different CSO locations from the pilot site

6.4 General event results

Similar to Chapter 5.3, which calculated KPIs for CSO volume reduction discharged to the Manzanares River for each rainfall event by modelling two comparative scenarios, this section provides the results for pollution load reductions. Beyond volume reductions, we evaluate the decrease in pollution mass discharged to the river for key parameters: SS, COD, Ammonium, Total Phosphorus, Total Nitrogen, and BOD5.

This comprehensive analysis enables a more complete assessment of the environmental benefits achieved through improved operational strategies, considering in this case water quality aspects of CSO management.

6.4.1 Baseline scenario results

To determine the mass load discharged during each analyzed CSO event, the discharge volumes from each CSO point in the Baseline scenario (presented in Table 2) were multiplied by the calculated Mean Event Concentrations (MEC) from the previous section (shown in Table 11**Table 11** and Figure 38). Table 12 presents the results for Suspended Solids (SS), while Annex 4 contains similar tables for all pollution parameters across all CSO discharge points.

Table 12.- SS CSO discharged mass to the river Manzanares for the baseline scenario.

Rain Event				SWMM rules results							
				CSO							Flood
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (T)	Total (T)
08/03/2024	**11.4**	7	1.63	0.00	0.00	15.19	0.00	20.78	18.98	54.94	3.27
11/03/2024	**11.8**	8	1.48	0.00	0.00	17.17	0.00	23.47	20.27	60.91	3.24
28/03/2024	**11.8**	6	1.97	0.00	0.00	12.60	0.00	19.58	9.97	42.15	2.15
27/04/2024	**7.8**	14	0.56	0.00	0.00	9.59	0.00	6.01	1.37	16.98	0.00
08/06/2024	**4.2**	5	0.84	0.00	0.00	6.61	0.00	2.19	1.52	10.32	0.00
10/06/2024	**29.8**	8	3.73	0.69	0.00	52.13	0.00	54.08	53.14	160.04	56.67
20/09/2024	**17**	3	5.67	6.53	0.00	15.17	0.00	30.51	26.04	78.26	18.28
07/10/2024	**5.2**	3	1.73	0.00	0.00	7.95	0.00	4.80	4.35	17.09	0.00
12/10/2024	**21.9**	11	1.99	3.85	0.00	24.80	0.00	40.94	22.22	91.81	34.90
16/10/2024	**13.2**	28	0.47	0.00	0.00	22.82	0.00	24.31	15.68	62.81	2.86
29/10/2024	**23.6**	16	1.48	0.35	0.00	34.46	0.00	50.22	43.87	128.90	35.87
01/11/2024	**9.6**	1.5	6.40	0.45	0.00	26.54	0.00	12.54	15.25	54.79	2.98
20/01/2025 - 3 days	**21.4**	76	0.28	0.00	0.00	39.23	0.00	50.08	20.67	109.98	2.76
27/01/2025	**5.6**	5	1.12	0.00	0.00	8.90	0.00	3.64	2.47	15.01	0.00
29/01/2025	**5.4**	8	0.68	0.00	0.00	8.68	0.00	1.64	0.49	10.82	0.00
11/02/2025	**14.2**	7	2.03	0.00	0.00	22.38	0.00	34.85	29.94	87.17	13.37
01/03/2025	**18.2**	40	0.46	0.00	0.00	36.16	0.00	47.84	29.62	113.62	18.41
03/03/2025 - 7 days	**64.8**	168	0.39	33.71	0.00	275.73	0.00	196.00	171.99	677.44	102.52
10/03/2025 - 7 days	**45.4**	168	0.27	32.90	0.00	196.36	27.53	124.65	121.72	503.16	69.38
17/03/2025 - 7 days	**51.4**	168	0.31	28.93	0.00	201.76	11.33	157.53	133.14	532.70	60.85
03/04/2025 - 2 days	**47.4**	48	0.99	24.06	0.00	220.47	1.05	142.89	142.98	531.46	98.62
11/04/2025 - 3 days	**24.4**	98	0.25	2.68	0.00	100.10	0.00	70.08	59.75	232.61	16.20
18/04/2025 - 2 days	**12**	13	0.92	0.00	0.00	38.30	0.00	24.42	24.05	86.76	2.82
02/05/2025 - 1 days	**29**	24	1.21	6.76	0.00	76.05	0.00	79.55	71.32	233.67	48.97
03/07/2025	**5.2**	28	0.19	0.00	0.00	5.58	0.00	3.19	2.49	11.27	0.00

6.4.2 Enhanced Scenario with MPC-quality based setpoints

The enhanced scenario implementation assigns Mean Event Concentrations (MEC) to each discharge point, enabling the optimizer to compute actuator movements so that CSO discharges are prioritized for those discharging points with lower pollutant concentrations.

The optimization function can be programmed for any of the analyzed parameters, producing slightly different results depending on the target parameter (e.g., optimizing for suspended solids, ammonium, etc.). In this study, we chose to minimize SS discharges as the primary optimization target, with this optimization also decreasing CSO volumes and discharged mass for the other pollutants.

Results are presented in Table 13 for SS, while results for the other parameters are presented in Annex 4.

Table 13.- SS CSO discharged mass to the river Manzanares for the enhanced scenario with MPC – quality based setpoints

Rain Event				MPC results							
				CSO							Flood
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (T)	Total (T)
08/03/2024	**11.4**	7	1.63	0.00	0.00	0.84	0.00	15.87	14.20	**30.91**	0.11
11/03/2024	**11.8**	8	1.48	0.00	0.00	0.69	0.00	18.16	15.14	**33.99**	0.11
28/03/2024	**11.8**	6	1.97	0.00	0.00	0.44	0.00	12.16	10.83	**23.43**	2.14
27/04/2024	**7.8**	14	0.56	0.00	0.00	1.34	0.00	3.30	4.39	**9.04**	0.00
08/06/2024	**4.2**	5	0.84	0.00	0.00	0.78	0.00	1.20	3.32	**5.30**	0.00
10/06/2024	**29.8**	8	3.73	10.80	0.00	35.47	11.01	49.16	66.96	**173.40**	38.01
20/09/2024	**17**	3	5.67	0.10	0.00	0.59	0.00	24.32	21.24	**46.25**	11.84
07/10/2024	**5.2**	3	1.73	0.00	0.00	0.94	0.00	2.99	3.43	**7.35**	0.00
12/10/2024	**21.9**	11	1.99	0.31	0.00	11.14	0.00	30.73	31.68	**73.86**	26.51
16/10/2024	**13.2**	28	0.47	0.00	0.00	3.51	0.00	18.90	15.24	**37.65**	0.63
29/10/2024	**23.6**	16	1.48	2.81	0.00	20.36	11.36	42.27	43.49	**120.30**	5.71
01/11/2024	**9.6**	1.5	6.40	8.24	0.00	16.03	0.00	8.02	19.30	**51.59**	3.07
20/01/2025 - 3 days	**21.4**	76	0.28	0.00	0.00	7.30	0.00	39.09	23.80	**70.19**	0.49
27/01/2025	**5.6**	5	1.12	0.00	0.00	1.20	0.00	1.92	4.34	**7.46**	0.00
29/01/2025	**5.4**	8	0.68	0.00	0.00	0.51	0.00	0.35	5.56	**6.42**	0.00
11/02/2025	**14.2**	7	2.03	0.00	0.00	1.33	0.00	27.60	24.02	**52.95**	4.49
01/03/2025	**18.2**	40	0.46	0.00	0.00	3.14	0.00	37.91	24.59	**65.64**	7.82
03/03/2025 - 7 days	**64.8**	168	0.39	29.56	0.00	176.16	71.36	162.52	166.62	**606.22**	60.24
10/03/2025 - 7 days	**45.4**	168	0.27	51.77	0.00	130.19	58.61	118.97	129.14	**488.69**	45.29
17/03/2025 - 7 days	**51.4**	168	0.31	34.66	0.00	120.20	58.36	128.06	135.56	**476.84**	42.72
03/04/2025 - 2 days	**47.4**	48	0.99	69.87	0.00	146.82	48.53	120.92	160.86	**547.00**	58.56
11/04/2025 - 3 days	**24.4**	98	0.25	0.66	0.00	37.04	4.74	56.47	54.41	**153.32**	6.57
18/04/2025 - 2 days	**12**	13	0.92	4.01	0.00	24.72	0.00	17.16	24.53	**70.43**	1.50
02/05/2025 - 1 days	**29**	24	1.21	22.60	0.00	55.99	23.10	66.31	77.32	**245.32**	26.13
03/07/2025	**5.2**	28	0.19	0.00	0.00	0.49	0.00	2.03	2.17	**4.69**	0.00

6.4.3 KPIs results

With the previous results, KPIs reduction percentage for the pollution mass discharged through CSOs to Manzanares river can be computed. Annex 4 presents these KPIS reduction for all the pollutants and Table 14 presents it for SS.

Table 14.- KPIs SS mass discharge reduction with the enhanced MPC-quality based scenario.

Rain Event				Analysis
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	Improvement Total
08/03/2024	11.4	7	1.63	46.71%
11/03/2024	11.8	8	1.48	46.84%
28/03/2024	11.8	6	1.97	42.27%
27/04/2024	7.8	14	0.56	46.78%
08/06/2024	4.2	5	0.84	48.62%
10/06/2024	29.8	8	3.73	2.45%
20/09/2024	17	3	5.67	39.82%
07/10/2024	5.2	3	1.73	56.97%
12/10/2024	21.9	11	1.99	20.79%
16/10/2024	13.2	28	0.47	41.71%
29/10/2024	23.6	16	1.48	23.52%
01/11/2024	9.6	1.5	6.40	5.37%
20/01/2025 - 3 days	21.4	76	0.28	37.30%
27/01/2025	5.6	5	1.12	50.34%
29/01/2025	5.4	8	0.68	40.62%
11/02/2025	14.2	7	2.03	42.87%
01/03/2025	18.2	40	0.46	44.36%
03/03/2025 - 7 days	64.8	168	0.39	14.55%
10/03/2025 - 7 days	45.4	168	0.27	6.74%
17/03/2025 - 7 days	51.4	168	0.31	12.47%
03/04/2025 - 2 days	47.4	48	0.99	3.89%
11/04/2025 - 3 days	24.4	98	0.25	35.74%
18/04/2025 - 2 days	12	13	0.92	19.71%
02/05/2025 - 1 days	29	24	1.21	3.96%
03/07/2025	5.2	28	0.19	58.38%

Also, total CSO discharged volume and KPIs reduction percentage can be computed and compared with the results from the hydraulic tests in chapter 5.3 (Table 15).

Table 15.- KPIs CSO volume discharge reduction with the MPC-quality and comparison with the results with MPC-hydraulic.

Rain Event				Analysis					
				Improvement MPC quality vs rules			Improvement MPC hydraulic vs rules		
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	CSO	Flood	Total	CSO	Flood	Total
08/03/2024	11.4	7	1.63	38.01%	96.62%	41.07%	37.69%	96.43%	40.76%
11/03/2024	11.8	8	1.48	37.85%	96.54%	40.58%	37.05%	96.44%	39.81%
28/03/2024	11.8	6	1.97	44.15%	0.44%	42.36%	43.31%	0.44%	41.55%
27/04/2024	7.8	14	0.56	50.42%	#DIV/0!	50.42%	43.96%		43.96%
08/06/2024	4.2	5	0.84	53.42%	#DIV/0!	53.42%	50.43%		50.43%
10/06/2024	29.8	8	3.73	-7.46%	32.92%	2.77%	-6.62%	31.91%	3.14%
20/09/2024	17	3	5.67	34.86%	35.20%	34.92%	34.16%	35.13%	34.33%
07/10/2024	5.2	3	1.73	53.55%	#DIV/0!	53.55%	50.72%		50.72%
12/10/2024	21.9	11	1.99	24.25%	24.05%	24.20%	23.41%	24.30%	23.63%
16/10/2024	13.2	28	0.47	35.67%	78.14%	37.35%	29.82%	76.73%	31.67%
29/10/2024	23.6	16	1.48	2.80%	84.09%	19.29%	6.23%	32.78%	11.61%
01/11/2024	9.6	1.5	6.40	15.79%	-3.08%	14.77%	15.34%	-2.71%	14.36%
20/01/2025 - 3 days	21.4	76	0.28	32.51%	82.23%	33.53%	31.43%	82.65%	32.49%
27/01/2025	5.6	5	1.12	54.11%	#DIV/0!	54.11%	49.11%		49.11%
29/01/2025	5.4	8	0.68	58.24%	#DIV/0!	58.24%	57.96%		57.96%
11/02/2025	14.2	7	2.03	33.90%	66.41%	37.87%	33.48%	66.21%	37.48%
01/03/2025	18.2	40	0.46	35.59%	57.52%	38.32%	34.36%	56.55%	37.12%
03/03/2025 - 7 days	64.8	168	0.39	2.98%	41.24%	7.96%	12.30%	40.16%	15.93%
10/03/2025 - 7 days	45.4	168	0.27	-1.92%	34.73%	2.43%	3.93%	33.14%	7.40%
17/03/2025 - 7 days	51.4	168	0.31	5.32%	29.80%	7.75%	13.31%	29.92%	14.96%
03/04/2025 - 2 days	47.4	48	0.99	-5.53%	40.62%	1.76%	-3.24%	38.82%	3.40%
11/04/2025 - 3 days	24.4	98	0.25	29.25%	59.41%	31.18%	31.47%	59.93%	33.28%
18/04/2025 - 2 days	12	13	0.92	23.33%	46.68%	24.06%	19.80%	47.73%	20.68%
02/05/2025 - 1 days	29	24	1.21	-6.37%	46.64%	2.44%	-5.39%	41.58%	2.42%
03/07/2025	5.2	28	0.19	54.41%	#DIV/0!	54.41%	48.18%		48.18%

From these results the following key ideas can be highlighted:

- The average benefit from MPC-quality based scenario vs baseline scenario is about reducing 32% the discharged pollutant mass in Suspended Solids which is the parameter being optimized.
- The optimization in SS of course causes also a reduction in other pollutants as well as in CSO volumes. The average reduction for each parameter is:
  - Suspended Solids: 32% (already mentioned in the first point)
  - CSO volume: 29.8 %
  - COD: 26.7 %
  - Ammonium: 25.9%
  - Ptotal: 25.6%
  - Ntotal: 26.2%
  - BOD5: 26.9%
- Similarly to the results of the hydraulic tests, it is evident that the greatest benefits are achieved during small to medium rainfall events. For instance, during the 07/10/2024 event, with a precipitation depth of 5.2 mm, a 57% reduction in discharged SS mass was attained.
- Comparing CSO discharged volumes reduction between the MPC-quality based scenario and MPC-hydraulic based scenario (Table 15) we can see the benefit is very similar (average reduction of 30.8% vs 29.8%). We assume there are 2 main reasons for that:

- The low flexibility of the pilot area in terms of the margin of actuation, caused by the characteristics of the pilot area actuators, in terms of number, location and flow diversion capabilities. This means that even if the MPC tries to send more flows to the WWTP or to a specific CSO discharge point, this might not be possible. This flexibility will improve drastically in the coming months when the new primary treatment in Butarque WWTP will be put into operation providing an extra capacity of 5 m3/s.
- The MPC-quality based model uses the MEC in each CSO location so the more different MEC values they present the more different the operation strategies can be, in the opposite case, considering that MEC values are identical for all CSOs then there wouldn't be any operational difference between MPC-quality-based setpoints and hydraulic-based ones because all CSO points would send to the river the same pollution concentration, and the only difference would be if you could reduce the total discharge but not from which CSO point you obtain this reduction. The MEC values shown in Figure 38 provide some differences but in the same order of magnitude. A future improvement here would be to consider real time quality (with a calibrated quality model) or with quality sensors at the CSO locations and the correlations obtained, then MPC-quality-based could decide to store and treat the more polluted waters in the same event and discharge the less polluted ones, this would be a future implementation improvement. Technically it is not difficult, the main difficulty remains in installing and maintaining the quality sensors to guarantee good quality pollution data.

- Finally, it is important to mention that these results are highly dependent on the weights in the objective function to optimize (see 4.5.1 chapter), especially for long rain events where there is the option to partially empty the tanks between rain events. This can be appreciated in the scenarios that last for a week, namely 03/03/2025, 10/03/2025 and 17/03/2025, with the MPC-hydraulic-based control outperforms the MPC-quality-based control. More details about this are explained in subchapter 6.5.

6.4.4 Discharged pollution values for the KPI webtool

This section provides the explanations and justifications for the KPI values related to pollution discharged into the Manzanares River, as entered in the KPI webtool (section 2.3.6 of the webtool).

There it is asked to compute the average annual pollution (tonnes/year) for TSS and BOD5 as the start value (at the beginning of the project) and the end value (at the end of the project). In this case, we have considered values for all the Manzanares system, not only for the pilot area (see deliverable DA1.2 chapter 2.1 General pilot description)

So, these are the hypothesis considered to compute the KPIs:

- From chapter 6.4.3 (quality operational tests results) we have obtained results for the rain events for the period from March 2024 to September 2025

- To consider the average annual improvement in the pilot area we compute TSS and BOD5 reduction considering the rain events from March 2024 to March 2025
    - TSS annual reduction = 1309 – 976 = 333 tonnes /year (25.4% reduction)
    - BOD5 annual reduction = 1462-941 = 521 tonnes/year (35.6% reduction)
- Estimation of the before LIFE Rubies project average annual pollution discharged for all Manzanares system (these values were obtained in a previous project based on modelling of the rain events from 2012, 2013 and 2014): 4877 TSS tonnes /year and 4182 BOD5 tonnes/year
- We consider that in the coming 5 years, when LIFE Rubies solution is implemented in all Manzanares system as explained in the Afterlife deliverable (not only in the Pilot area as it is now) we can obtain a similar annual reduction as we have obtained in the pilot area, we consider a 30% reduction.

So, with these hypotheses the KPIs are:

- Start value:
    - The average CSO annual pollution before Life Rubies is implemented
    - This is:
        - TSS = 4877 tonnes /year
        - BOD5= 4182 tonnes /year
- End value:
    - The average CSO annual pollution once Life Rubies is implemented in the pilot area (at the end of the project)
    - The start value minus the reduction obtained from March 2024 to March 2025 results
    - This is:
        - TSS = 4877- 333= 4544 tonnes /year
        - BOD5= 4182-521= 4182 tonnes /year
- Beyond end value:
    - The average CSO annual pollution once LIFE Rubies solution will be implemented in all Manzanares system
    - Computed as the start value applying a 30% reduction
    - This is:
        - TSS = 4877·0.7 = 3414 tonnes /year
        - BOD5= 4182·0.7= 2927 tonnes /year

Some important comments to understand these results:

- Start values provided here are significantly bigger than the initial screenshot values from the proposal provided at the beginning of the project These differences are caused mainly because there only the pilot area was considered and there are less CSO points than considering all Manzanares river.
- But the reduction of discharged pollution for the pilot area presented in this deliverable (25.4% for TSS and 35.6 % for BOD5) are very similar to the ones estimated in the initial screenshot which were 30%.
- Also, we want to highlight that these percentages obtained here are a little bit different than the ones presented in the previous chapter mainly because the computation here is done for the period from March 2024 to March 2025 while the results in the previous chapter include all the analyzed period (from March 2024 until September 2025)

6.5 Detailed analysis for particular rain scenarios

To properly understand the results presented in the previous section, a set of scenarios are analyzed in detail here. The analysis is carried out through a set of plots representing the evolution of different network variables, such as rain intensity, pipe flows, tank volumes, etc. Each plot includes three cases: (i) **RULES**, (ii) **MPC (hyd)**, i.e., the MPC-hydraulic-based control; and (iii) **MPC (mass)**, i.e., the MPC-quality-based control.

6.5.1 16/10/2024 rain event

This scenario highlights the main improvement produced by the designed MPC-quality-based control.

This was a moderate / average rainfall event totaling 13.2 mm, lasting approximately 28 hours and occurring in two separate periods, with over 12 hours of no precipitation in between. The rain intensity is depicted in Figure 45.

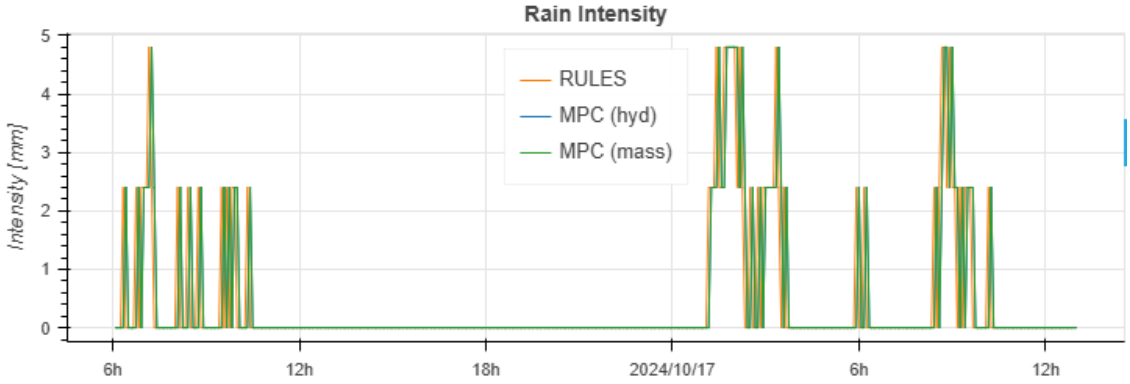


Figure 45.- Rain intensity (mm) for the 16/10/2024 scenario

The difference in performance between the hydraulic- and quality-based controls is concentrated in the management of Abroñigales tank, shown in Figure 46:

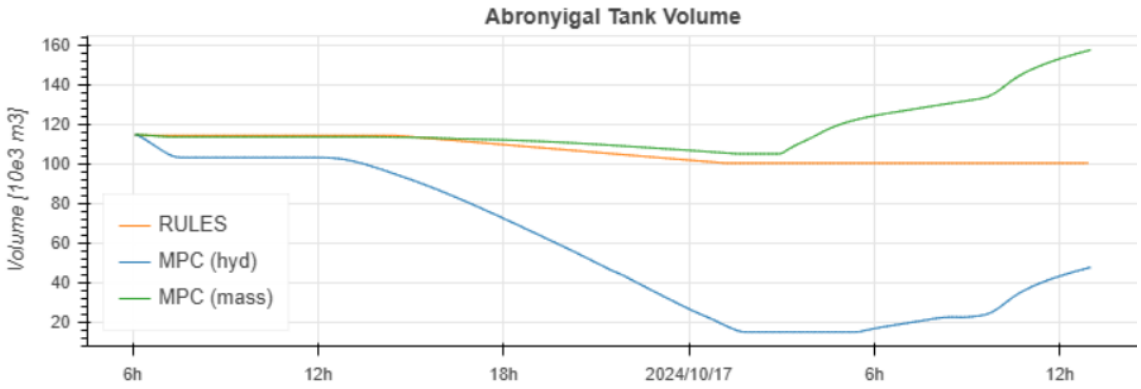


Figure **46**.- Abroñigales volume (10^3 m^3) for the 16/10/2024 scenario

- While the MPC-hydraulic-based control tends to minimize the stored volume at the tank (by letting water flow through the bypass and enabling the emptying), the MPC-quality-based control tends to maintain water in the tank, reducing in this way the total amount of CSO discharges (aiming to reduce pollution, but also reducing spilled volume as a consequence). This is mainly caused by the different relationship between the weights of the cost function (see 4.5.1 chapter) in the two control schemes: the SS values used to derive the quality-based weights are normalized with base 10, leading to a higher importance of the CSO (in mass) reduction objective with respect to the WWTP-based objective. This encourages the MPC-quality-based control to keep more water in the tank, as it is less important to send water to the WWTPs if CSO is going to be increased because of that. The total CSO distribution in terms of volume is shown in Figure 47 where it can be observed that the CSOs are concentrated at points CSO3 (Butarque WWTP entrance bypass), CSO5 (Aliviadero Sur) and CSO6 (Sur WWTP entrance bypass).

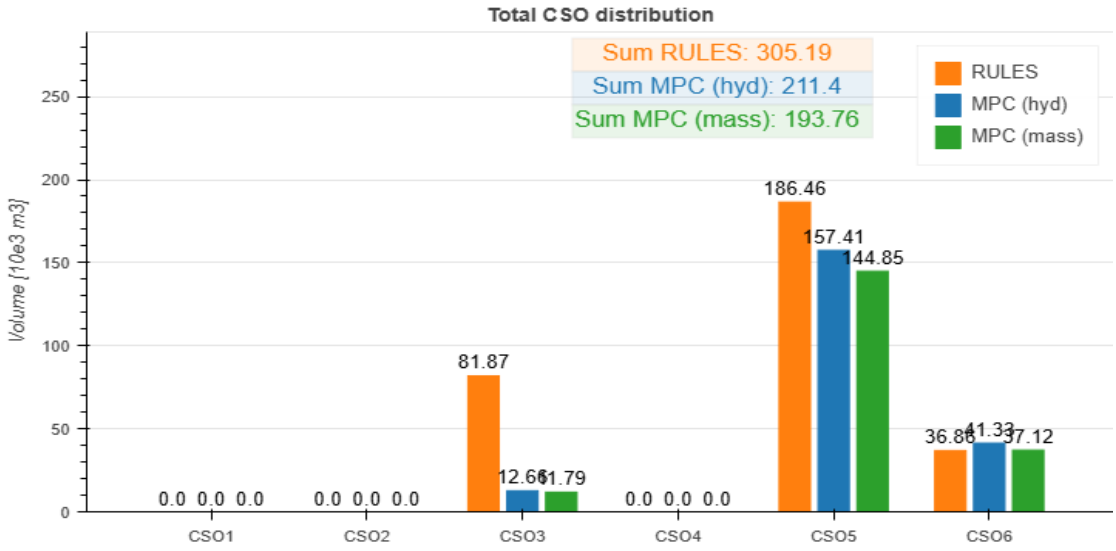


Figure **47**.- Total CSO distribution (10^3 m^3) for the 16/10/2024 scenario

The figure shows how the MPC-quality-based control achieves a CSO volume reduction with respect to the MPC-hydraulic-based control. This improvement is achieved by the storage of

water in the mentioned tank, reducing the water reaching the CSO points (mostly CSO5 and CSO6, the ones downstream Abroñigales tank). In terms of polluted mass, the CSO distribution is depicted in Figure 48.

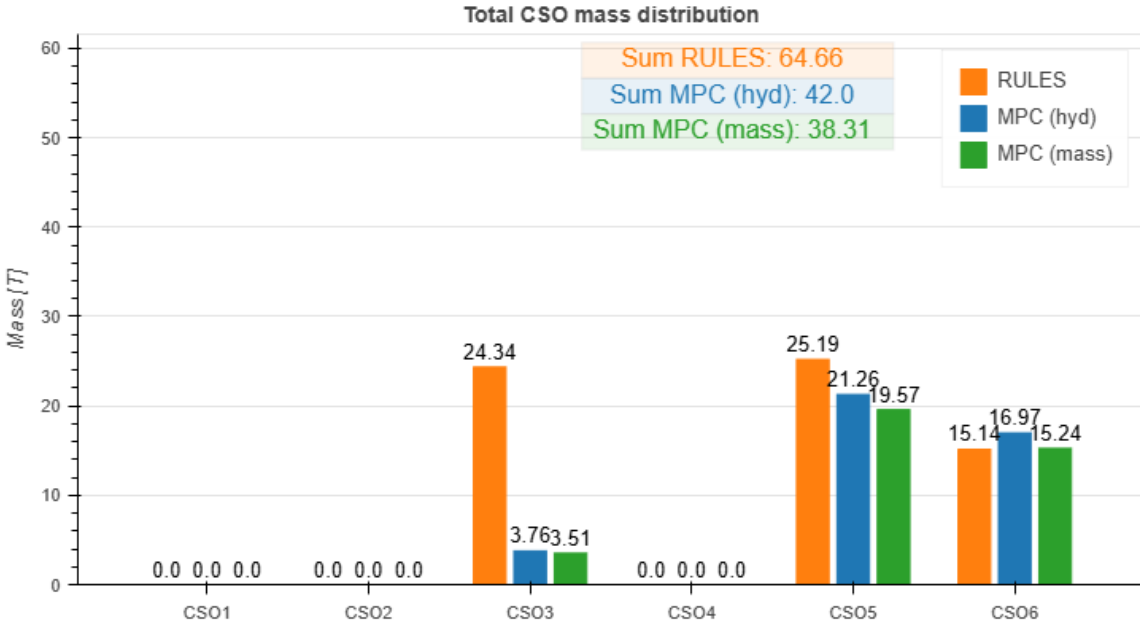


Figure **48**.- Total CSO distribution (T) for the 16/10/2024 scenario

Again, the improvement of the quality-based controller is achieved due to the massive water storage in Abroñigales.

An experiment can be performed to analyze the behavior of both methods when there is a long dry weather period after the rain ends. To this end, the simulation period for the scenario is extended two extra days, leading to the rain profile represented in Figure 49. By analyzing the same plots from the original scenario, several conclusions can be drawn about the suitability of the MPC-quality-based control method.

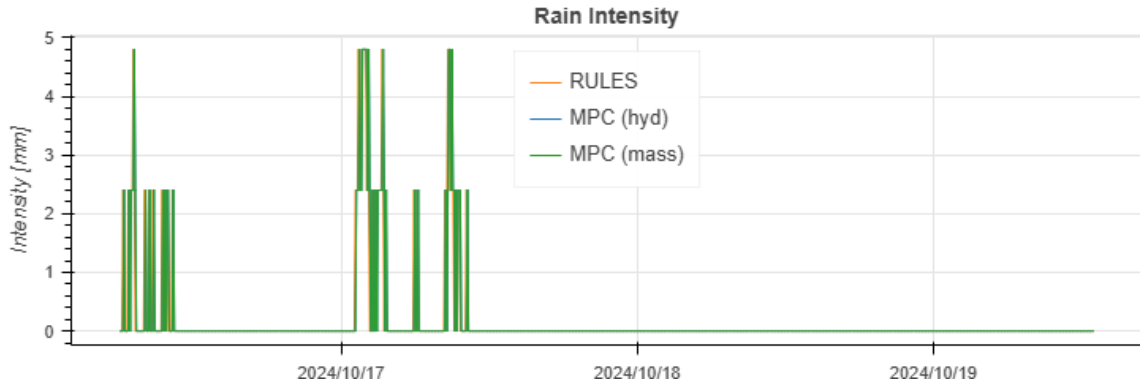


Figure **49**.- Rain intensity (mm) for the extended 16/10/2024 scenario

In this case, the evolution of the Abroñigales volume is shown in Figure 50.

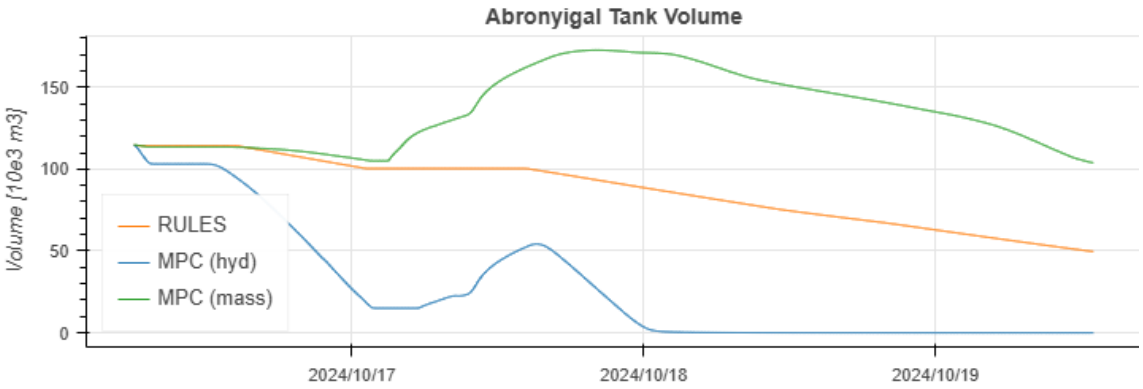


Figure 50.- Abroñigales volume (10^3 m^3) for the extended 16/10/2024 scenario

It can be appreciated how, after the rain has stopped for a while, and the release of water cannot cause extra CSO, the MPC-quality-based controller starts releasing water from the tank. This release is executed at a slow rate, avoiding possible increases of the CSO discharge. The CSO distribution in volume is shown in Figure 51. It is shown how the increase of CSO discharge in both controllers is negligible: the MPC-hydraulic-based control performs an early emptying of the tank after the rain stops, avoiding producing extra CSO afterwards, whereas the MPC-quality-based control achieves a similar effect by slowly releasing the stored water.

The CSO pollutants distribution for this extended experiment is presented in Figure 52.

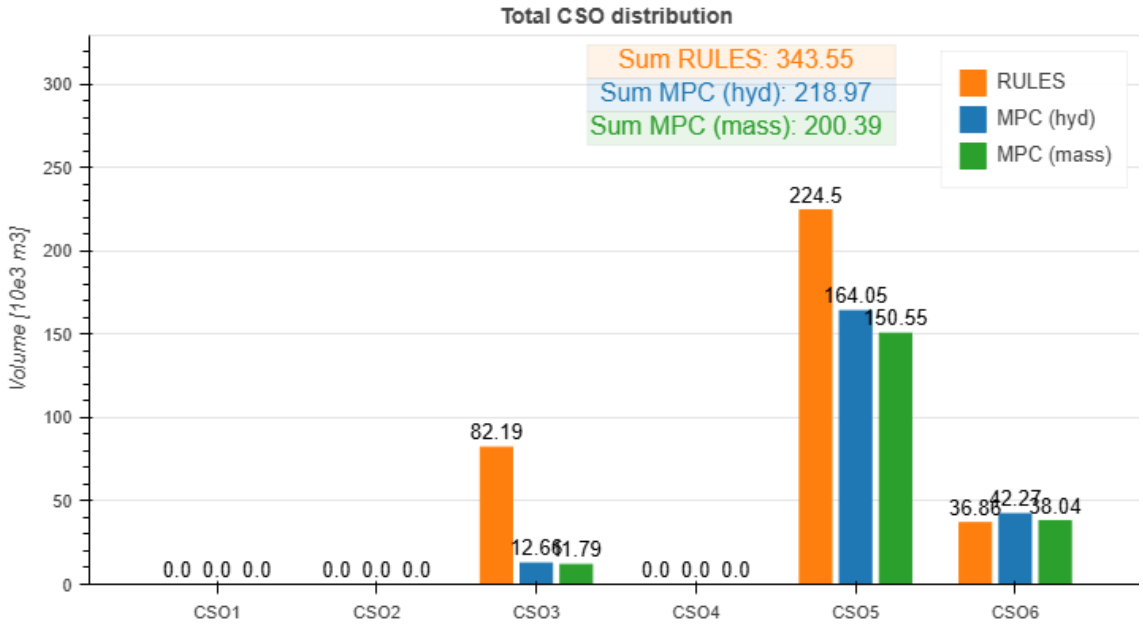


Figure 51.- Total SS CSO distribution (10^3 m^3) for the extended 16/10/2024 scenario

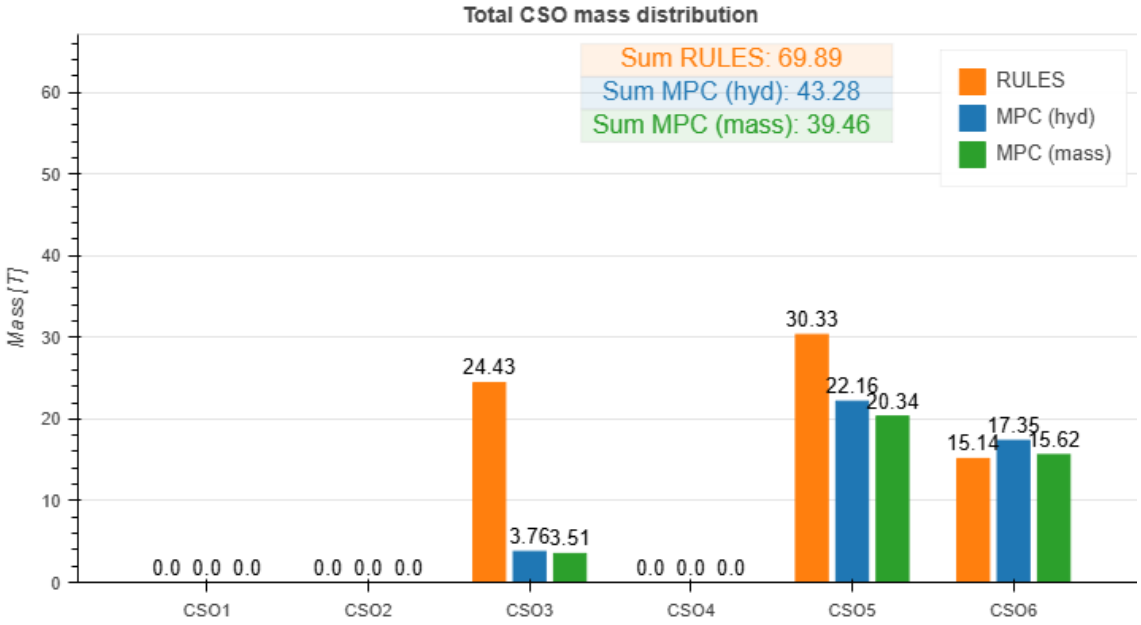


Figure 52.- Total SS CSO distribution (T) for the extended 16/10/2024 scenario

6.5.2 7 days rain event starting 03/03/2025

March 2025 was a very rainy month, with the week of March 3rd recording the highest rainfall volume, totaling 64.8 mm of precipitation. The rain intensity profile of this scenario is presented in Figure 53. It can be appreciated how the rain is quite continuous, except for a period between the 06/03/2025 at 20:00 and the 07/03/2025 at 12:00. This period is going to be referred to as **Tnr**.

In this event the performance of the MPC-quality-based controller was a bit worse with respect to the MPC-hydraulic-based control and the reasons are explained below.

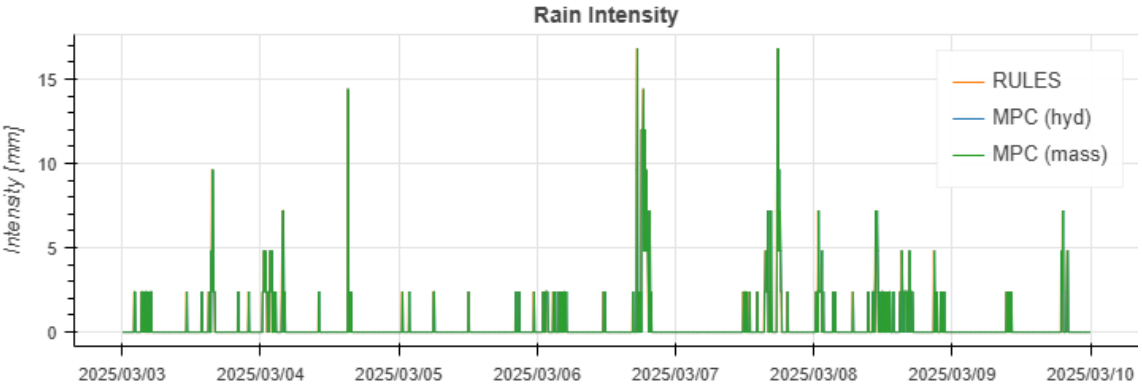


Figure 53.- Rain intensity (mm) for the 03/03/2025 scenario

In this case, the analysis of the volume at Abroñigales, depicted in Figure 54, shows a similar behavior than in the previous scenario: the MPC-quality-based controller maintains the water stored in the tank most of the duration of the scenario, leading to the tank being almost full by

the end of it. It can be appreciated how, during **Tnr**, the controller starts to reduce the tank volume, although this process is slower than the MPC-hydraulic based scenario until it stops and gets reversed when the rain returns.

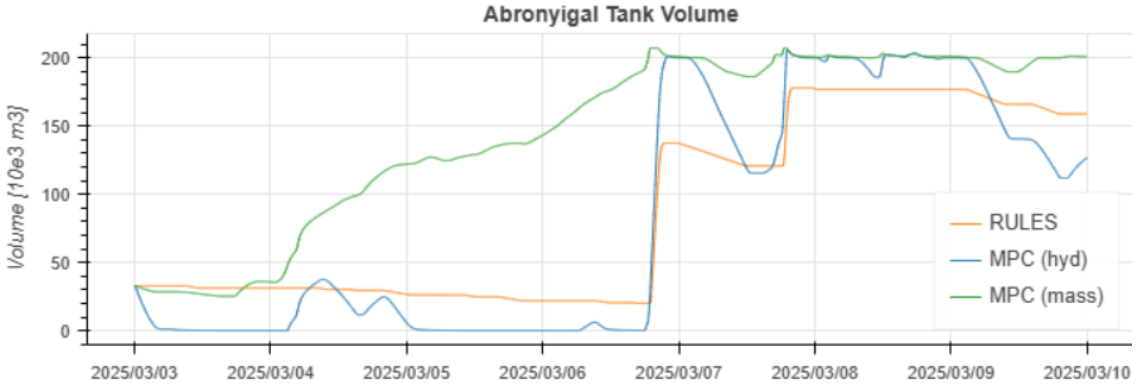


Figure 54.- Abroñigales volume (10^3 m^3) for the 03/03/2025 scenario

The study of the CSO distribution in both volume and mass is shown in Figure 55 and Figure 56 respectively.

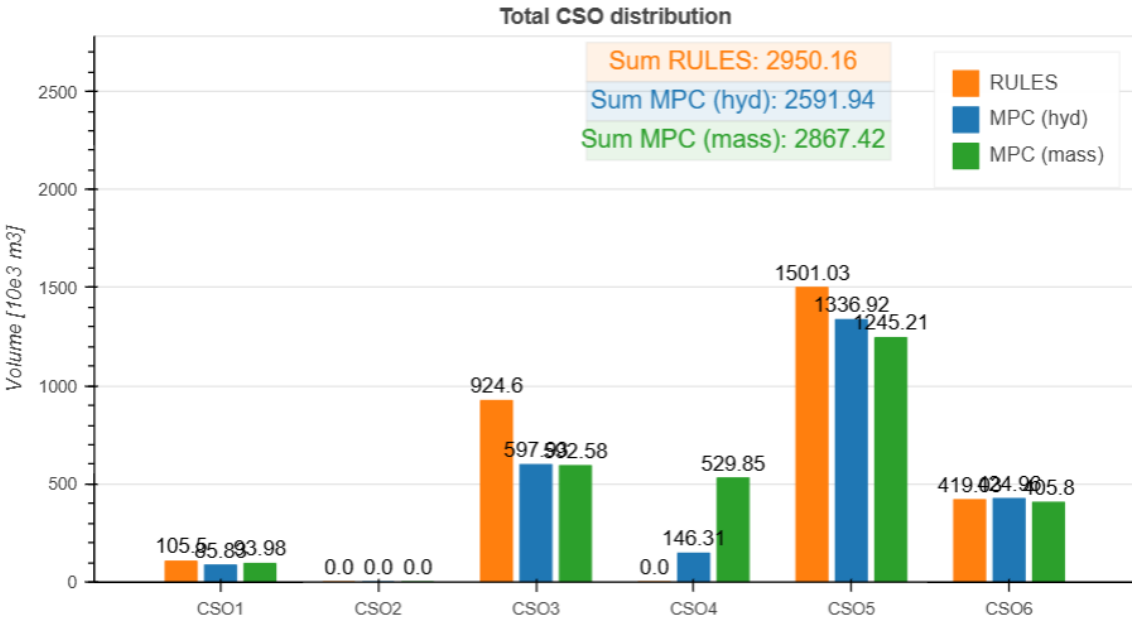


Figure 55.- Total CSO distribution (10^3 m^3) for the 03/03/2025 scenario

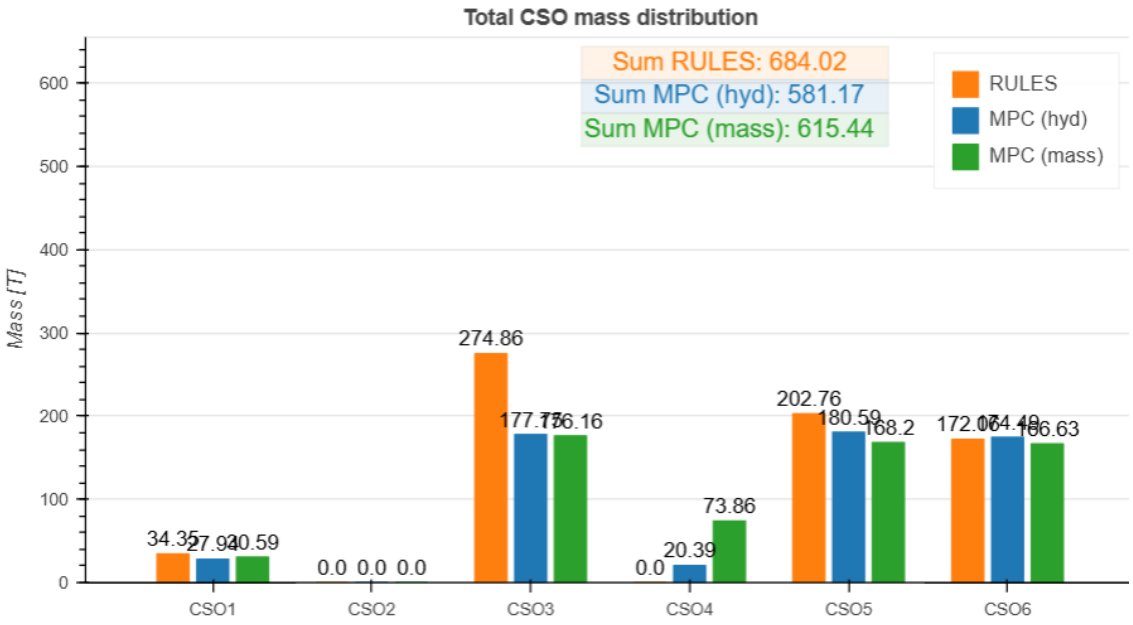


Figure 56.- Total SS CSO distribution (T) for the 03/03/2025 scenario

The results show a clear degradation of performance, with most of the increase in CSO occurring in CSO4, that is, the spilling point associated to the Abroñigales tank maximum volume. This occurs because of the MPC-quality-based controller policy of minimizing the water release of the tank: as rain does not totally stop occurring during the week, the tank is almost full during all the simulation, leading to the increase of CSO4. It is important to notice that the control actions are decided by the MPC controller considering a 30-min horizon. Therefore, the actions taken are the best for the information in that period, but that does not mean that, in the general perspective of the scenario, that decision is the best regarding the overall CSO minimization, or any other objective.

Moreover, an analysis of the water reaching the WWTP, depicted in Figure 57, shows the correlation between the intention of minimizing CSOs at all costs of the MPC-quality-based controller and the reduction of the treated water by the WWTPs.

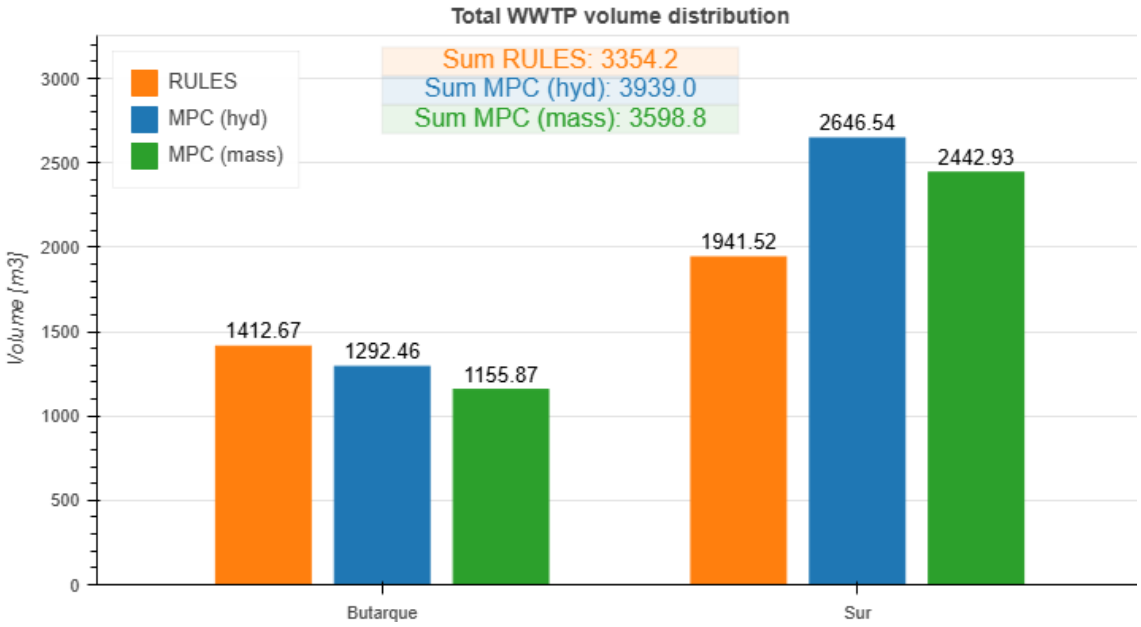
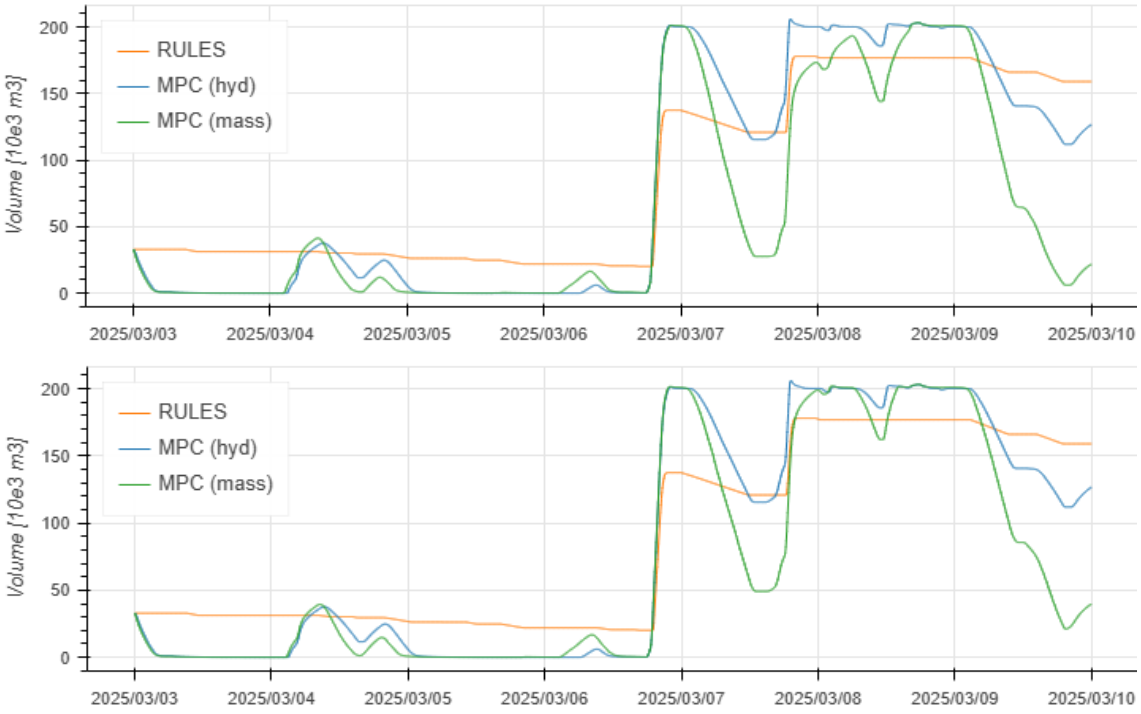


Figure 57.- Total WWTP distribution (10^3 m^3) for the 03/03/2025 scenario

This conclusion invites us to analyze the behavior of the control system when the weights of the main objectives of the cost function are modified, specifically the weight measuring the importance of the WWTP-related goal. To this end, a series of experiments are conducted by varying the value of this weight for the MPC-quality-based control, leaving the rest of configurations as default. The results of these experiments over the tank volume are shown in Figure 58. The value of a_{WWTP} takes the values of 100, 50, 25 and 10, respectively in this order and can be compared with the results of the a_{WWTP} value of 1 presented in Figure 54.



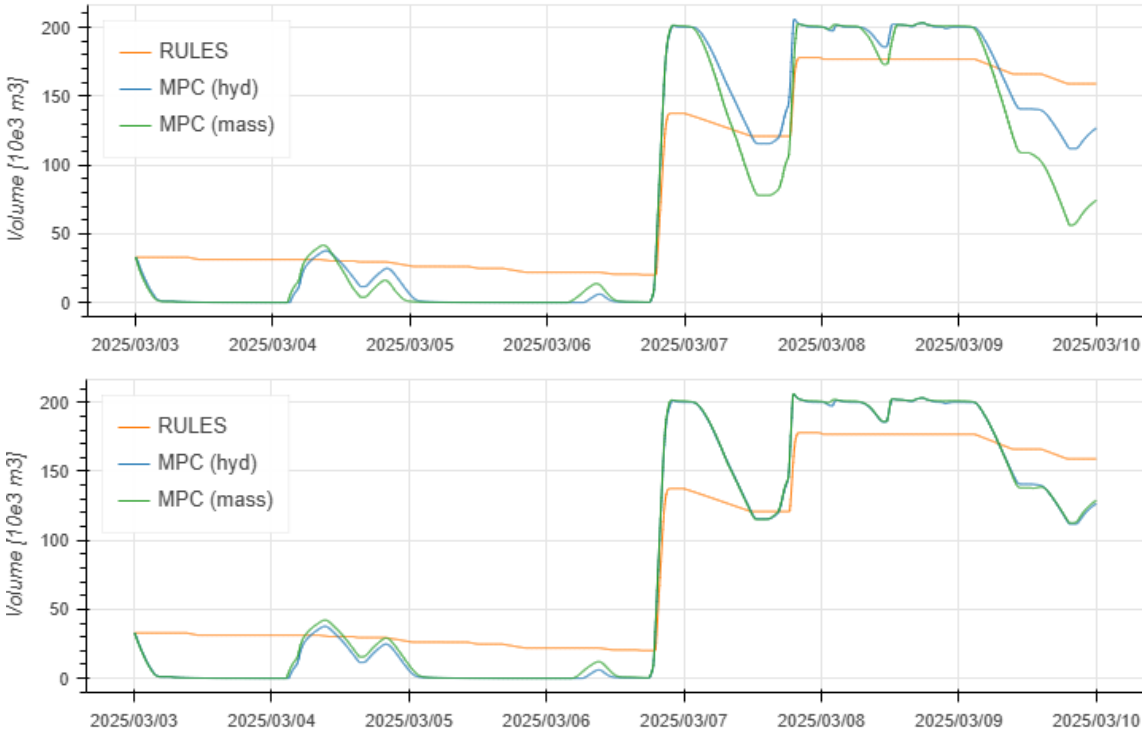


Figure 58.- Abroñigales volume (10^3 m^3), 03/03/2025 scenario – a_{WWTP} experiment

The results clearly show how increasing the WWTP-related weight makes the controller release water from the tank, with a rate depending on the actual relationship between the CSO and WWTP weights. It is remarkable that the performance when a_{WWTP} = 10 (last plot) leads to an almost identical actuation than the MPC-hydraulic-based control. Analyzing the results for this scenario in the total CSO distribution and the WWTP flows, the results in Figures 59, 60 and 61 are obtained.

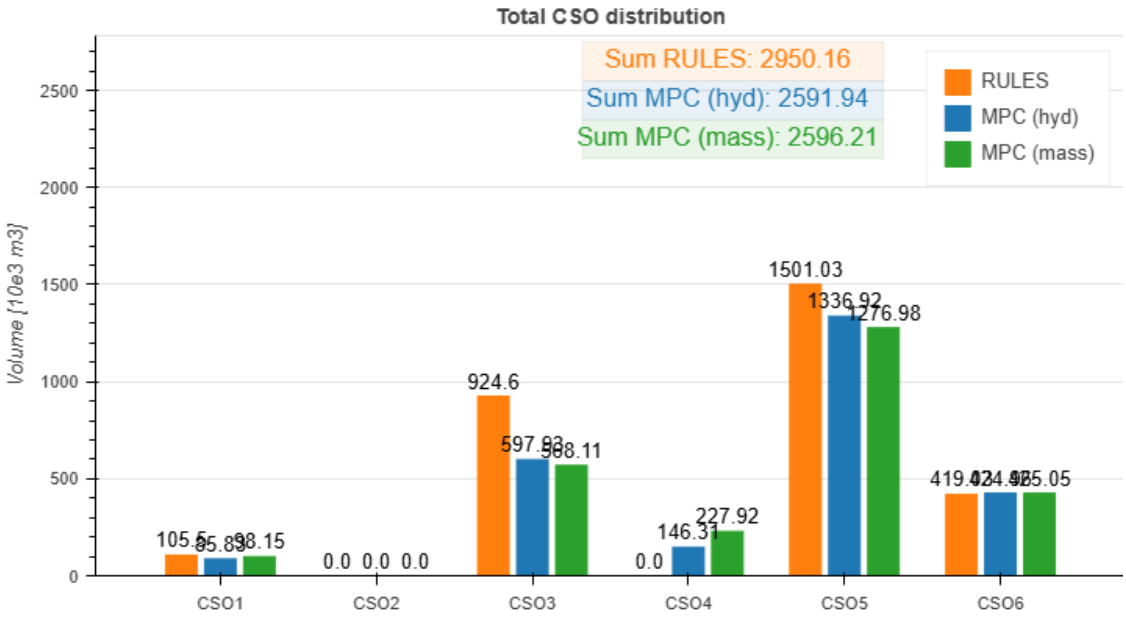


Figure 59.- Total CSO distribution (10^3 m^3) for the 03/03/2025 scenario – a_{WWTP} = 100

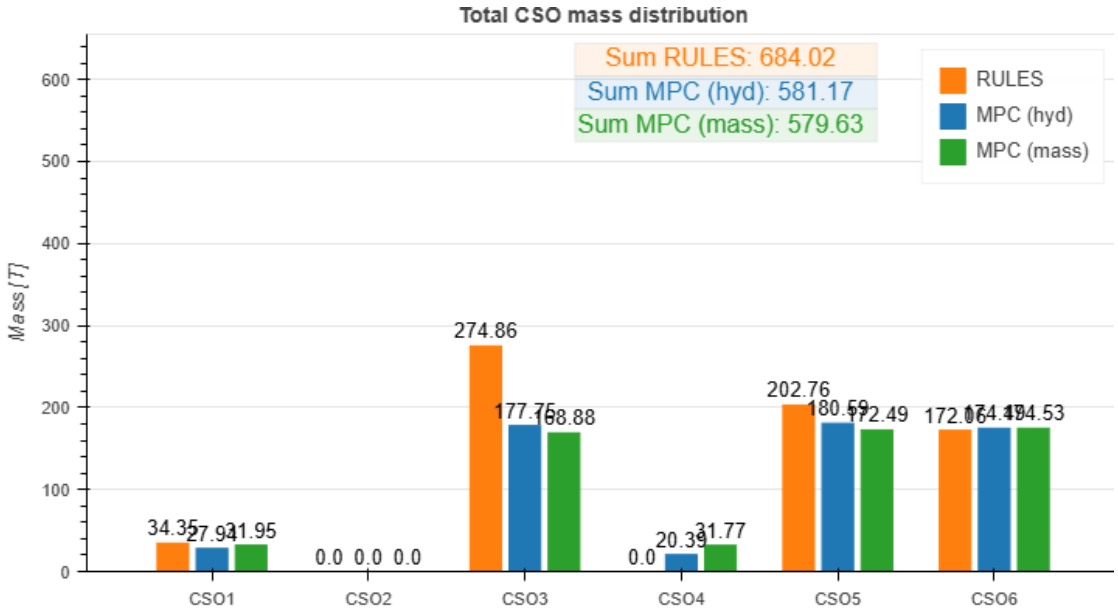


Figure 60.- Total CSO distribution (T) for the 03/03/2025 scenario – a_{WWTP} = 50

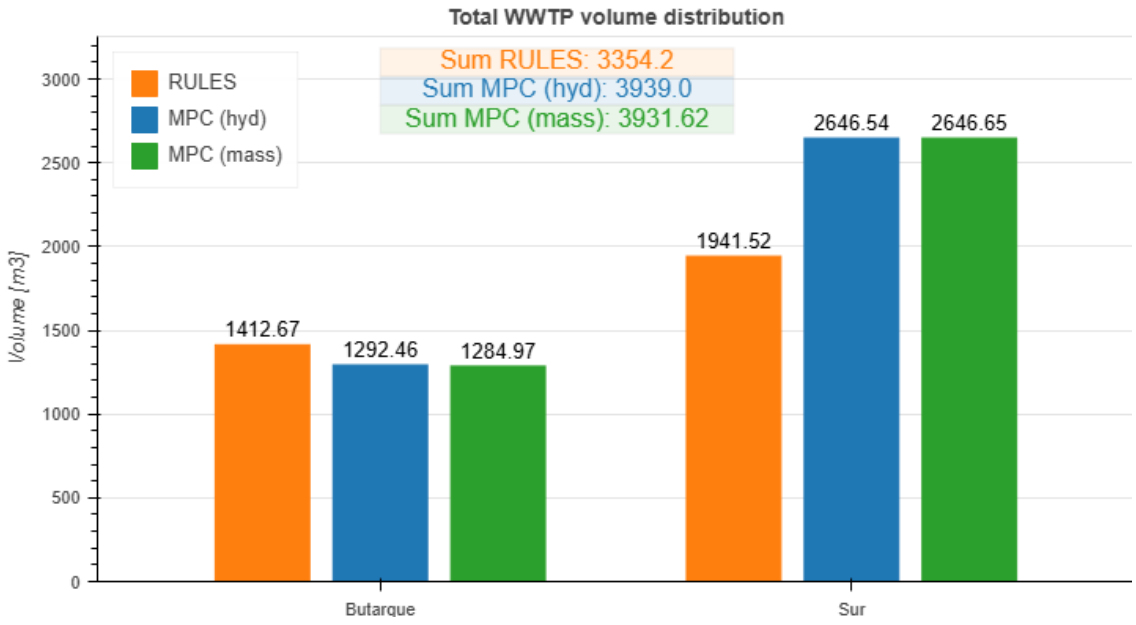


Figure 61.- Total WWTP distribution (10^3 m^3) for the 03/03/2025 scenario – a_{WWTP} = 10

These results demonstrate that the performance of the quality-based approach matches the actuation of the hydraulic-based one, and therefore the degradation in the 7-days-long scenarios could be solved by using this value of the WWTP-related weight. However, that would imply missing the CSO reduction obtained by the MPC-quality-based control (in comparison to the hydraulic-based one) in the rest of scenarios. A trade-off between the two strategies could be analyzed.

Besides, it must be highlighted that this situation is also caused by the similarity between the TSS values associated to the different CSOs, and mostly, with the overall TSS of each margin of the river. With higher differences between them, the method would be able to play with the link

between margins, generating differences in the solutions, which would be adapted to that specific pollution situations.

7 Natural environmental results

7.1 Introduction

The primary objective of the LIFE-RUBIES project is to demonstrate that real-time, pollution-based control of urban drainage systems can significantly protect receiving water bodies. While previous chapters have focused on the hydraulic and pollutant mass reduction within the sewer network and detention tanks, this section evaluates how those improvements translate into tangible benefits for the Manzanares River.

The study area is located within the water body officially designated as "ES030MSPF0427021 - Río Manzanares a su paso por Madrid". This reach extends approximately 20.58 km through the city of Madrid and Getafe, intersecting protected areas such as the Red Natura 2000. According to the official T-15 classification, the Manzanares is defined as a "low-mineralized Mediterranean-continental axis".

Due to significant historical pressures—specifically effluents from Wastewater Treatment Plants (WWTPs) lacking advanced nutrient removal and intermittent Combined Sewer Overflows (CSOs)—the water body has historically struggled to meet "Good Status" requirements. Consequently, the Third Hydrological Planning Cycle (2022-2027) for the Tajo Basin has designated this reach as a "Heavily Modified Water Body" due to extensive channelization and bank protection. The defined environmental objective is to achieve Good Ecological Potential and Good Chemical Status by 2027.

By integrating high-resolution 2D hydrodynamic modeling with biochemical kinetics, this chapter quantifies the impact of the MPC operational strategy compared to the Baseline (Rules) strategy. This comparison is essential for understanding how the optimized management of urban infrastructure can mitigate the "oxygen sag" and toxic ammonium peaks traditionally associated with intense Mediterranean rainfall events, thereby enhancing the ecological resilience of the Manzanares River.

7.2 Methodology

The numerical simulation of the Manzanares River applies the integrated subsystem approach to apply a modeling workflow designed to integrate the complex interactions between urban drainage discharges and the receiving water body's ecosystem.

7.2.1 Integrated Subsystems Approach

The river quality model is conceptualized as an integration of three interdependent subsystems, typically simplified and solved in cascade by the computational tool (see Figure 39):

1. Hydrological-Hydraulic Subsystem: Determines the transport, dispersion, and routing of water masses and pollutants through the reach.
2. Thermal Subsystem: Establishes the water temperature, which acts as a primary driver for the kinetics of biochemical reactions.

3. Biochemical Subsystem: Focuses on the transformation of compounds (e.g., nitrogen cycle, carbonaceous degradation) and the resulting mass balances.

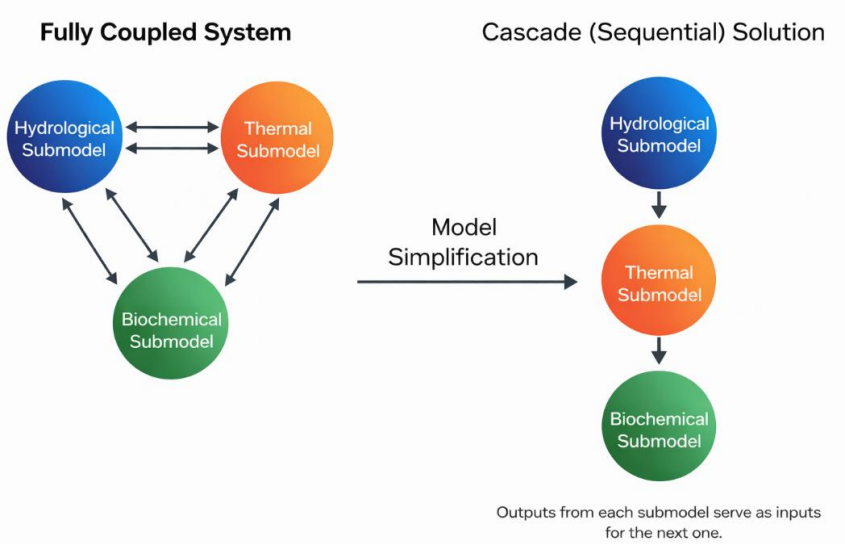


Figure 39.- River submodels and simplified cascade solution applied.

7.2.2 Chronological Modeling Workflow

To ensure the reliability of the environmental KPIs, the modeling followed a standardized chronological workflow:

- System Conceptualization: This initial phase involved schematizing the geometric-hydraulic system. The river reach was divided into discrete computational elements (a 2D mesh) to allow for the application of numerical methods. Boundary conditions were defined, specifically the "River Head" (upstream background quality) and the specific inflow points for Wastewater Treatment Plants (WWTPs) and Combined Sewer Overflows (CSOs) and specific information to define these boundary conditions are obtained.
- Establishment of the Geometric-Hydraulic Model: Using updated LiDAR cartography and digital terrain models (DTM), the physical channel was digitized to establish accurate depth and velocity profiles, which are fundamental to compute pollutant residence time.
- Pre-modeling and Sensitivity Analysis: An initial "Pre-model" was constructed using low-cost data derived from literature and previous studies (e.g., standard deoxygenation and nitrification rates). This phase allowed for a preliminary sensitivity analysis to identify which kinetic parameters most significantly influenced the resulting Dissolved Oxygen and Ammonium concentrations.
- Calibration and Adjustment: The "Initial Model" was refined through an iterative calibration process. This involved constructing a "calibration situation" where model parameters were adjusted to match real-world data collected during specific monitoring campaigns. Given the intermittent nature of storm events, the calibration focused on

non-permanent (dynamic) regimes to capture the high-frequency variations in river quality following a CSO discharge.

- Validation: To confirm the robustness of the calibrated parameters, the model was applied to independent datasets (different rainfall events) without further parameter modification. This ensured that the model could reliably predict river behavior under the varying stress levels of the representative episodes that later on will be simulated.
- Scenario Comparison (Environmental KPIs): Once validated, the model served as the engine for comparing the Baseline (Rules) and MPC-optimized scenarios. This allowed for the quantification of environmental benefits.

By following this structured methodology, the LIFE-RUBIES project ensures that the reported environmental results are not merely theoretical but are physically representative of the Manzanares River's response to optimized urban drainage management.

7.3 Definition of river environmental KPIs

To evaluate the effectiveness of the LIFE-RUBIES MPC solution, it is necessary to establish Environmental Key Performance Indicators (KPIs) that accurately reflect the ecological response of the Manzanares River to transient pollution pulses such as the ones from CSO discharges. These KPIs are derived from a combination of current Spanish hydrological planning, historical European directives, and specialized standards for intermittent discharges.

7.3.1 Regulatory Framework and Reference Values

The Manzanares River reach within the pilot area is officially designated as a "Very Modified" water body (Type T-15: Mediterranean-continental axis with low mineralization). According to the Tajo Basin Hydrological Plan (2022-2027), the following physicochemical thresholds define the "Good Ecological Potential" targeted for 2027:

- Dissolved Oxygen (DO): ≥5.0 mg/L (with saturation between 60–120%).
- Ammonium (NH_4^+): ≤0.6 mg/L.
- Nitrates (NO_3^-): ≤25.0 mg/L.
- Phosphates (PO_4^{3-}): ≤0.5 mg/L.

While these values serve as chronic baseline targets, the evaluation of storm-weather scenarios also incorporates the Real Decreto 1/2016 threshold for organic matter, which establishes a limit for BOD5 ≤10 mg/L for this specific water body.

7.3.2 Standards for Intermittent Pollution Events (UPM Approach)

Because Combined Sewer Overflows (CSOs) cause rapid, high-magnitude fluctuations that traditional steady-state standards fail to capture, the model adopts the Urban Pollution Management (UPM) framework. This approach recognizes that the survival of aquatic life–

particularly the cyprinid species (e.g., barbel and carp) prevalent in this reach–is dependent on the duration and frequency of exposure to low oxygen or high ammonium levels.

Table 16.- Examples of Fundamental Intermittent standards for dissolved oxygen – concentration / duration thresholds not to be breached more frequently than shown (UPM-FWR, 2018).

Dissolved Oxygen concentrations (mg/L)			
a) **Ecosystem suitable for sustainable salmonid fishery**			
Return period	**1 hour**	**6 hours**	**24 hours**
1 month	5.0	5.5	6.0
3 months	4.5	5.0	5.5
1 year	4.0	4.5	5.0
a) Ecosystem suitable for sustainable cyprinid fishery			
Return period	**1 hour**	**6 hours**	**24 hours**
1 month	4.0	5.0	5.5
3 months	3.5	4.5	5.0
1 year	3.0	4.0	4.5
b) Marginal cyprinid fishery ecosystem			
Return period	**1 hour**	**6 hours**	**24 hours**
1 month	3.0	3.5	4.0
3 months	2.5	3.0	3.5
1 year	2.0	2.5	3.0
Notes **1. These limits apply when the concurrent un-ionised ammonia (NH_3-N) concentration is below 0.02 mg/L.** **The following correction factors apply at higher concurrent un-ionised ammonia concentrations:** **0.02 - 0.15 mg NH_3-N/L: correction factor = + (0.97 x $\log_e$(mg NH_3-N/l) + 3.8) mg O/L** **>0.15 mg NH_3-N/L: correction factor = +2 mg O/L** **2. A correction factor of 3 mg O/L is aaded for salmonid spawning grounds.**			

Table 17.- Examples of Fundamental Intermittent standards for un-ionised ammonia- concentration / duration thresholds not to be breached more frequently than shown (UPM-FWR, 2018).

Un-ionised ammonia concentrations (mg NH_3-N/L)			
a) **Ecosystem suitable for sustainable salmonid fishery**			
Return period	**1 hour**	**6 hours**	**24 hours**
1 month	0.065	0.025	0.018
3 months	0.095	0.035	0.025
1 year	0.105	0.040	0.030
a) **Ecosystem suitable for sustainable cyprinid fishery**			
Return period	**1 hour**	**6 hours**	**24 hours**
1 month	0.150	0.075	0.030
3 months	0.225	0.125	0.050
1 year	0.250	0.150	0.065
b) **Marginal cyprinid fishery ecosystem**			
Return period	**1 hour**	**6 hours**	**24 hours**
1 month	0.175	0.100	0.050
3 months	0.250	0.150	0.080
1 year	0.300	0.200	0.140

Notes

i. **These limits apply when the concurrent dissolved oxygen concentration is above 5 mg/l. At lower concurrent dissolved oxygen concentrations the following correction factor applies:**

<5 mg/L DO, multiplicative correction factor = 0.0126 (mg DO/L)$^{2.72}$

ii. **The standards also assume that the concurrent pH is greater than 7 and temperature is greater than 5°C. For lower pH and temperatures the following correction factors apply:**

pH <7, multiplicative correction factor = 0.0003(pH)$^{4.17}$

Temperature <5°C, multiplicative correction factor = 0.5

7.3.3 Selected Environmental KPI Metric

To quantify the benefit of the MPC strategy over the Baseline rules, three primary metrics are extracted from the IberWQ simulation results for each rainfall event:

1. Magnitude of Improvement: The difference in absolute minimum and maximum concentrations reached across the entire 2D domain (e.g., the depth of the oxygen minimum).
2. Temporal Compliance (Duration): The total number of hours a specific river section remains above or below critical thresholds (e.g., hours of DO<3 mg/L).
3. Spatial Impact (River Length): The maximum longitudinal distance (in km) of the river reach that fails to meet quality standards during the transit of the pollution wave.

Based on the previous standards and reference values, we selected the thresholds shown in Table 18.

Table 18.- Main KPI selected and metrics used in the project

Parameter	Unit	1st threshold	2nd threshold
MAIN INDICATORS			
Dissolved oxygen	mg/L	3	5
BOD_5	mg/L	6	10
Ammonium nitrogen	mgN/L	0.5	7.8
SECONDARY INDICATORS			
Nitrate nitrogen	mgN/L	10	25
Organic nitrogen	mgN/L	0.2	2.2
Total nitrogen	mgN/L	10.7	35
Total phosphorus	mgP/L	0.4	0.8
Phosphates	mgP/L	0.2	0.4
OTHER INDICATORS			
Turbidity	NTU	10	20
Electrical conductivity at 20 °C	µS/cm	1000	2000
Total Suspended solids	mg/L	15	30

So, for example we specifically monitor the "Oxygen Sag" following storm events, using thresholds that represent critical physiological stress:

- Acute Hypoxia: DO<3.0 mg/L (Critical survival limit for hardy species).
- Moderate Stress: 3.0≤DO<5.0 mg/L (Sub-lethal impact zone).
- Compliance Zone: DO≥5.0 mg/L.

By applying these KPIs, the project moves beyond measuring "how much volume was discharged" to quantifying "how much the river's ecological health was protected" by the LIFE-RUBIES solution.

7.4 IBER software for river modelling

The environmental impact assessment of the LIFE-RUBIES project relies on high-fidelity numerical simulations performed with Iber+, a suite of two-dimensional (2D) modeling tools designed for free-surface flow and environmental process analysis in river systems. The choice of this software ensures a rigorous representation of the hydraulic and biochemical interactions between the urban drainage discharges and the river ecosystem.

7.4.1 IBER Hydrodynamic modeling general features

The core of the simulation is based on the 2D Shallow Water Equations (SWE), also known as the depth-averaged Saint Venant equations.

- Physical Basis: The model assumes hydrostatic pressure and a nearly uniform velocity distribution across the water depth, which is highly effective for modeling urban river reaches characterized by low slopes and channelized sections.
- Numerical Method: Iber+ uses a finite volume discretization scheme. This approach is fundamental for our study as it guarantees the conservation of mass and momentum, ensuring numerical stability even when modeling high-velocity fronts such as those produced by Combined Sewer Overflow (CSO) events.

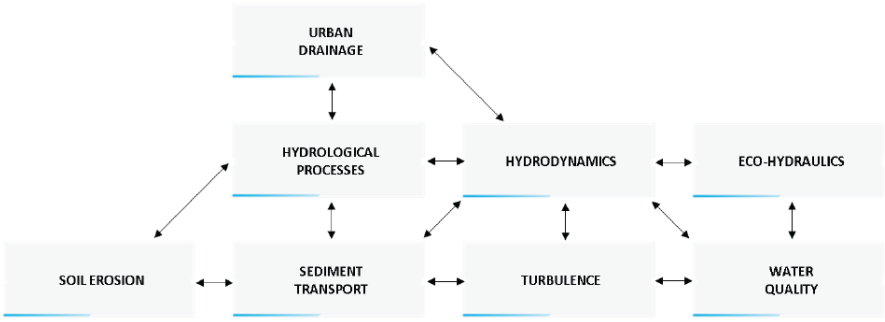


Figure 40.- Interrelationships between the main modules of IBER

7.4.2 Water Quality Module (IberWQ)

The quality of the Manzanares River is modeled using the IberWQ module, which simulates the spatial and temporal evolution of pollutants by solving a 2D depth-averaged transport equation coupled with complex biochemical reactions.

- Integrated Processes: The module tracks multiple interdependent parameters, including the complete Nitrogen cycle (Ammonium, Nitrites/Nitrates, Organic Nitrogen), the Phosphorus cycle, and carbonaceous Biochemical Oxygen Demand (BOD).
- Oxygen Dynamics: The software computes the Dissolved Oxygen (DO) balance by interrelating carbonaceous deoxygenation, nitrification, atmospheric reaeration, and sediment oxygen demand (SOD).
- Kinetic Factors: All biochemical reaction rates within IberWQ are influenced by water temperature, which acts as a primary kinetic driver. The module allows for these rates to be adjusted using correction factors or calculated based on atmospheric heat exchange data.

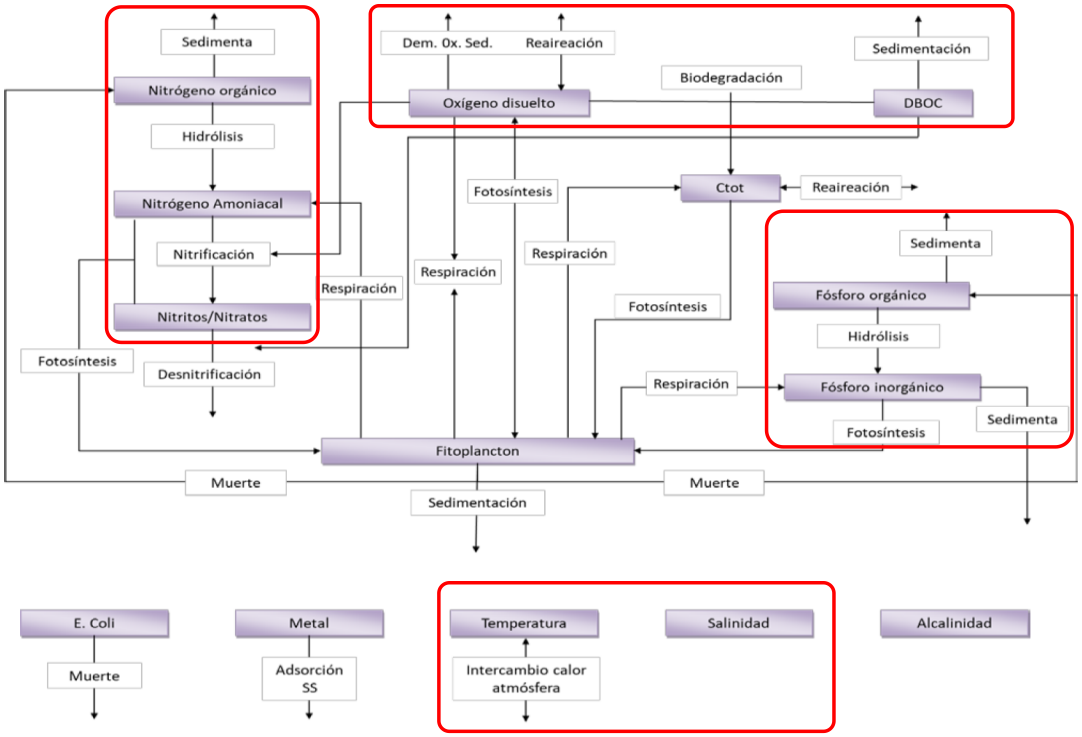


Figure 41.- IBER+ complete scheme of the water quality model. The arrows indicate the generation, destruction, or transformation of variables, and the modules used in the Manzanaes model are highlighted in red.

By integrating these subsystems, the IBER software allows for a detailed 3D-like visualization of "pollution waves" (Concentration Surfaces), providing the project with the necessary resolution to quantify the Environmental River KPIs and compare the effectiveness of the MPC versus Baseline strategies.

7.5 Background information

7.5.1 Boundary conditions upstream and temperature

The accuracy of a river quality model is heavily dependent on the definition of its boundary conditions (BCs). For the Manzanares River pilot reach, the upstream BC—or "River Head"—is established at a strategic location that simplifies hydraulic complexity while capturing the primary pollutant pressures entering the study area.

7.5.1.1 River Head Location

The upstream boundary of the model is defined at the Presa del Parque Lineal del Manzanares where there is a hydraulic jump, located just upstream of the AGMI spillway. This location was selected based on three criteria:

1. Hydraulic Homogeneity: It marks the start of a reach with representative and consistent hydraulic characteristics, avoiding the numerous small weirs and transverse obstacles found further upstream.

2. Structural Simplification: Placing the headwater here avoids the need for complex modifications to the LiDAR-derived Digital Terrain Model (DTM) that would otherwise be required to account for various urban structures between this point and the Viveros WWTP.
3. Efficiency: It reduces the modeling domain by approximately 10 km, optimizing computational time without losing critical data, as the primary upstream pressure (Viveros WWTP) is accounted for in the inflow quality.



Figure 42.- Satellite vs. modeled views of the upstream boundary

7.5.1.2 Hydraulic Boundary Conditions

The inflow at the headwater is calculated using a combination of two primary sources:

SAIH Puente de San Fernando: Real-time hydraulic data from this official gauging station provides the background baseflow of the river. Analysis of historical records shows that typical dry-weather baseflows range between 1.0 and 3.0 m^3/s.

- Viveros WWTP Effluent: Since this plant discharges between the gauging station and our headwater, its hourly discharge data is integrated into the total inflow volume.

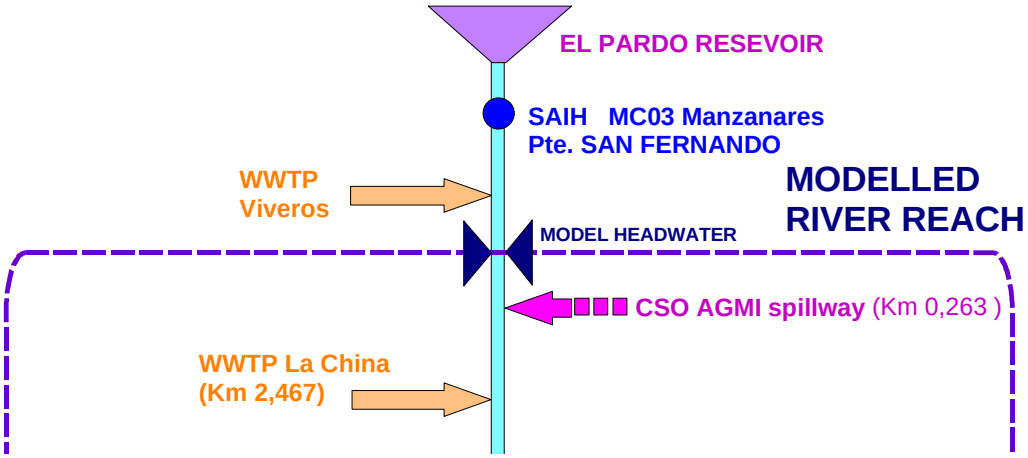


Figure 43.- Scheme of the flows in the model headwater

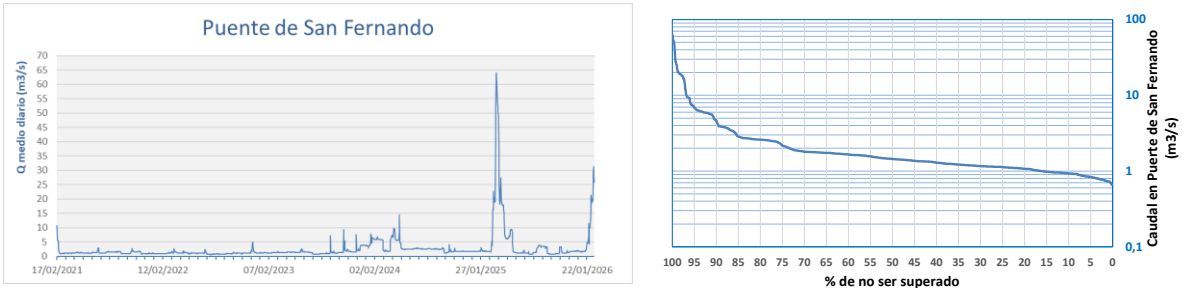


Figure 44.- Daily flows at SAIH Puente de San Fernando and probability of not having bigger flows where it can be seen that usual flows ranges are between 1 and 3 m3/s

7.5.1.3 Upstream Water Quality

The quality of the water entering the pilot reach is determined via an instantaneous mixing model (multiplying concentration by flow) between the clean background river water and the treated effluent from the Viveros WWTP.

- Background Quality: The upstream river (at Puente de San Fernando) is assumed to have low anthropogenic stress, utilizing literature-based values for "clean" surface water.
- Effluent Quality: The Viveros WWTP contribution is characterized by statistical median values derived from a two-year historical series of effluent quality data provided by Canal de Isabel II.

Table 19.- Quality values applied corresponding to a clean river

mg/L	SDT	OD	DBO	NOrg	$N\text{-}NH_4^+$	$N\text{-}NO_3^-$	P-Org	P-Inorg
Value	0,03	10,00	0,5	1,00	0,03	4,00	0,05	0,05

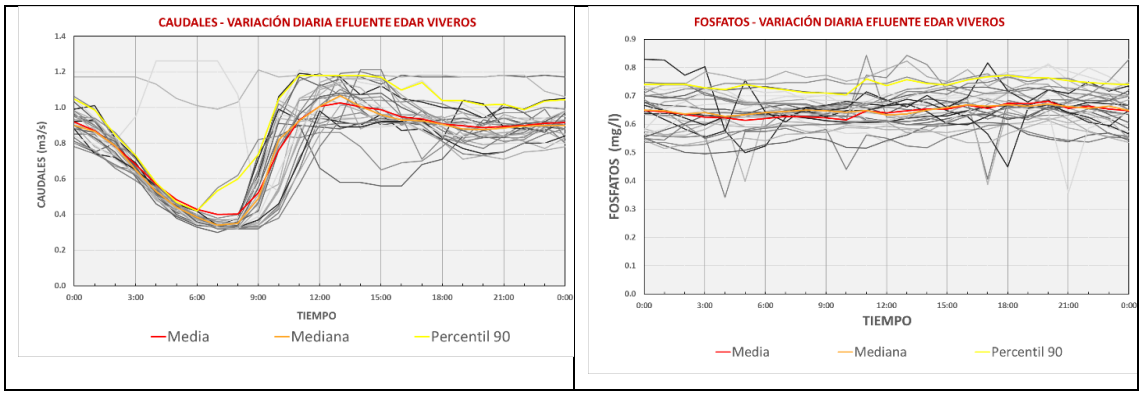


Figure 45.- Daily flow variation curves and example of a pollution parameter (phosphates) from the Viveros WWTP effluent

These assumptions provide pollutant concentrations at the model headwater as a first approach, but then during the calibration phase, attenuation factors are applied to the calculated mixture (specifically for organic matter and nitrogen fractions). These factors represent the natural transformation and degradation of pollutants occurring in the unmodeled reach between the WWTP discharge and our model headwater.

7.5.1.4 Thermal Regime

The water temperature acts as the primary kinetic driver for all biochemical reactions in the IberWQ module.

- Initial Analysis: Although the model can calculate temperature based on atmospheric heat exchange (using AEMET data for solar radiation, wind speed, and humidity), initial trials showed a lack of correspondence with real-world sensor data due to the low temporal resolution of meteorological inputs.
- Fixed Regime for Stability: To ensure a robust calibration of kinetic constants, a uniform thermal regime was adopted. For the rainfall episodes analyzed in this report, a temperature of 10°C was selected. This value is representative of winter and spring storm conditions in Madrid and serves to maximize the Dissolved Oxygen (DO) saturation capacity, providing a conservative baseline for evaluating the "oxygen sag" following CSO events.

7.5.2 River pressures: WWTPs and CSO discharges

The water body designated as "Río Manzanares a su paso por Madrid" is characterized by an exceptionally high degree of anthropogenic modification and a complex hydraulic regime. A defining feature of this reach is the high mixing ratio between natural baseflow and artificial inflows; in dry weather, treated effluents from Wastewater Treatment Plants (WWTPs) constitute a significant portion of the total flow, often exceeding the natural background discharge of the river.

This pressure is acutely aggravated during wet weather events. When rainfall occurs, the sanitation system must manage a surge in urban runoff that often exceeds the design capacity of the network and treatment facilities. This results in the discharge of untreated or partially treated sewage into the river through direct CSOs, Stormwater Detention tank overflows (such as the Abroñigales tank) or WWTP bypasses (influents that receive only partial treatment due to hydraulic bottlenecks at the biological treatment stage).

The ecological impact of these discharges is highly sensitive to the receiving water body's state. During Mediterranean *estiaje* (low-flow periods in summer), the river's dilution capacity is at its minimum, and high water temperatures can accelerate biochemical consumption of Dissolved Oxygen, leading to severe hypoxia following a CSO event.

To accurately simulate these dynamics, the river model incorporates a total of 12 significant pressure points distributed along the pilot reach. These include continuous pressures from the effluents of the La China, La Gavia, Butarque, and Sur WWTPs, as well as intermittent pressures from strategic CSO structures like Aliviadero Sur and Partidor Butarque. The longitudinal distribution of these points allows the model to capture the cumulative impact and the self-purification trajectory of the river across the 20.58 km study area.

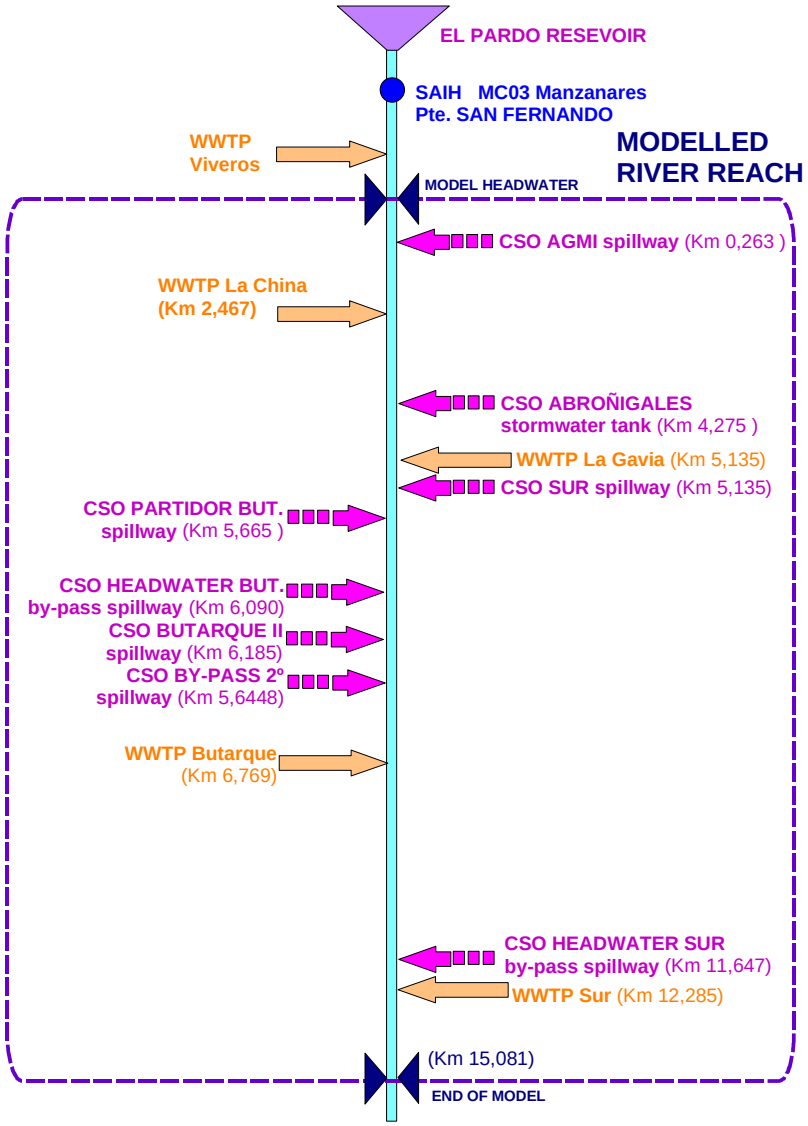


Figure 46.- Scheme of the modelled river reach and the pressures to include in the IBER model

Table 20.- Name, type of pressure and river Km from the model river head.

Name	Type	Km
AGMI	Direct CSO from sewer	0,263
EDAR China	WWTP effluent (with N and P removal)	2,467
Tanque Abroñigales	CSO from detention tank	4,275
EDAR Gavia	WWTP effluent (with N and P removal)	5,135
Aliviadero Sur	Direct CSO from sewer	5,135
Partidor Butarque	Direct CSO from sewer	5,665
Cabecera Butarque	Direct CSO from sewer with screening	6,09
Butarque II	Direct CSO from sewer with screening	6,185
Bypass 2º Butarque	CSO with primary treatment	6,443
EDAR Butarque	WWTP effluent (without N and P removal)	6,769
Cabecera EDAR Su	Direct CSO from sewer with screening	11,647
EDAR Sur	WWTP effluent (without N and P removal)	12,285

7.5.2.1 WWTP description and effluent data

To ensure the accuracy of the river quality model, it is imperative to precisely characterize the continuous anthropogenic pressures originating from WWTPs located within and upstream of the pilot reach. These facilities not only contribute significant hydraulic volumes relative to the river's natural baseflow but also establish the baseline concentrations for nutrients and organic matter in the receiving water body.

1. **Data Sources and Analysis Period**

The characterization is based on the statistical analysis of hourly historical records provided by Canal de Isabel II, covering the full year of 2024 and the period from January to May 2025. Data were primarily obtained from the Minerva monitoring stations (located at La China, La Gavia, Viveros, Sur, and Butarque WWTPs) or, where unavailable, the Atenea station at Butarque. The critical parameters integrated into the model include hydraulic flow, electrical conductivity, ammonium (NH_4^+-N), Chemical Oxygen Demand (COD/DQO), phosphates, and nitrates.

2. **Definition of Effluent Operating Scenarios**

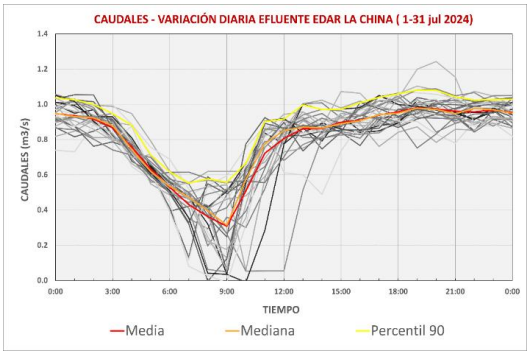
Recognizing that WWTP performance and river biochemical response vary significantly based on the hydrological regime and thermal conditions, three distinct operating scenarios were defined for the effluents:

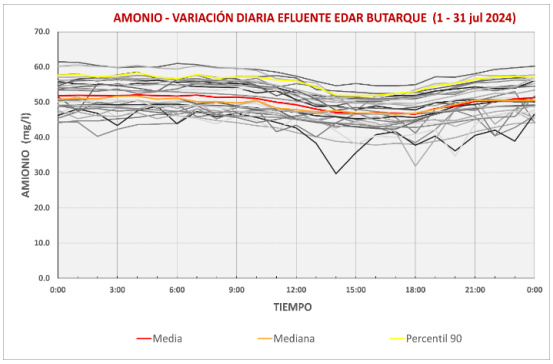
- Dry Weather Flow (DWF) Scenario - Summer: Derived from records in July 2024, representing a 31-day period with no significant precipitation. This scenario reflects conditions of maximum thermal stress and minimum river dilution capacity.
- Dry Weather Flow (DWF) Scenario - Winter: Constructed using data from December 2024 to January 2025. This represents the habitual dry-weather baseline under low-temperature regimes, which significantly impacts the kinetics of nitrification and deoxygenation in the river.
- Wet Weather Flow (WWF) Scenario: Based on a selection of 31 days with precipitation exceeding 4 mm. During these periods, treated flows at the plants increase due to urban runoff, which can dilute or modify effluent concentrations compared to dry weather.

3. Modeling Integration Methodology

For each WWTP and scenario, representative daily variation curves (hourly means and medians) were generated. This approach allows the IberWQ model to simulate the real temporal dynamics of the discharges—capturing the diurnal peaks of urban activity—rather than utilizing static average values.

It is important to highlight that the Butarque and Sur WWTPs represent the most critical pressures for the pilot reach. At present, these facilities lack advanced nitrification-denitrification processes, resulting in elevated ammonium and organic matter loads. This is evidenced by the pronounced Dissolved Oxygen sag observed in monitoring data downstream of their discharge points. Conversely, the Viveros WWTP, while located upstream of the model's physical boundary, is accounted for in the "River Head" boundary condition through an instantaneous mixing model.





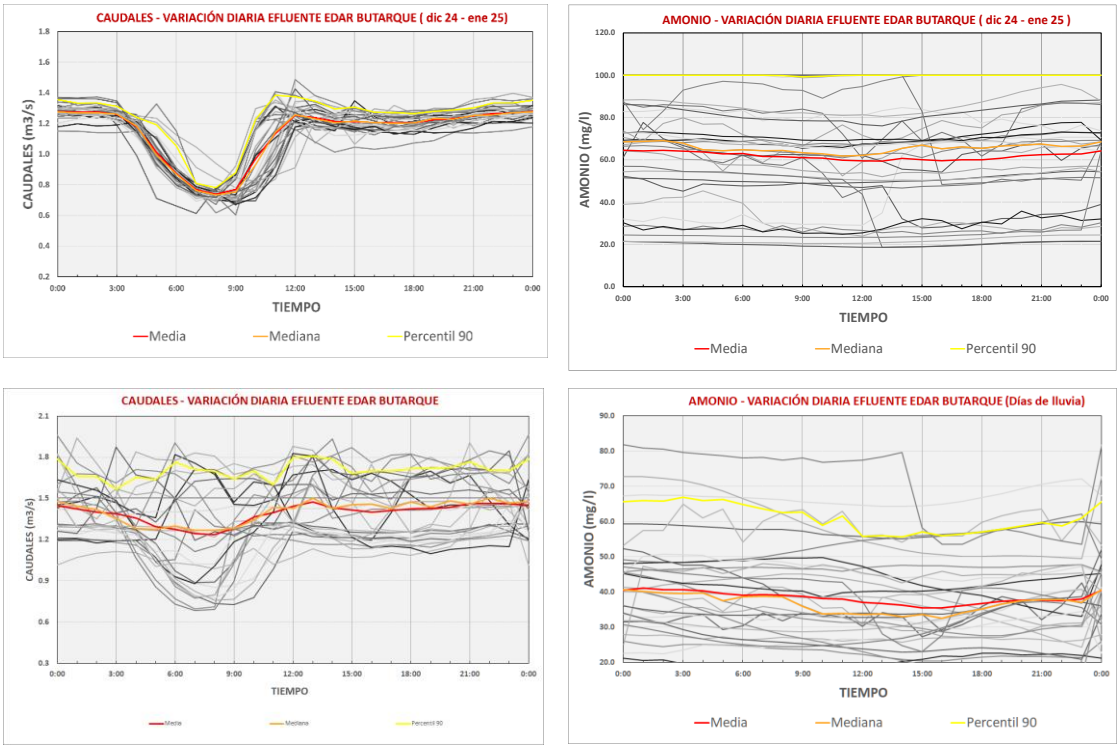


Figure 47.- Example of the analysis performed in the WWTPs. In this case it's flow and ammonium for Butarque WWTP in summer DWF (upper), winter DWF (middle) and WWF (lower)

7.5.2.2 CSO discharges for river model calibration in rain events.

The calibration of the Manzanares River quality model requires a precise characterization of the intermittent pressures exerted by Combined Sewer Overflows (CSOs) during rainfall events. Unlike scenario simulations, which use theoretical rules, the calibration phase must utilize real recorded discharge hydrographs to ensure the model accurately reproduces the observed pollutant transport and biochemical transformations.

To ensure a high-fidelity calibration, rainfall episodes were selected based on a "system integrity" approach. The ideal conditions for an episode to be considered for calibration included:

- Sensor Reliability: Full operational status of the primary CSO sensors within the CYII network (e.g., Aliviadero Sur, Partidor Butarque, and the Abroñigales detention tank) to provide accurate estimation of the discharged CSO flows.
- Receiving Water Data: Concurrent good operational status of the river quality sensors (Oliva and Butarque Río) to provide the "observed" chemical response in the river (Dissolved Oxygen, Ammonium, and Turbidity).
- Hydraulic Diversity: The selection of at least three episodes of varying magnitudes to test the model's robustness across different stress levels.

Rainfall events recorded in the pilot area between 2024 and 2025 were categorized into three distinct ranges to facilitate a comprehensive calibration: small events (Pt<10mm), medium events (10mm < Pt<20 mm) and large events (Pt>20 mm) and then based on the availability of

reliable sensor data and the quality of the resulting river response, the following episodes were prioritized for the calibration of the IberWQ model:

Table 21.- Rain events selected for river model calibration in rainy conditions.

Category	Date	Rain (Pt)	Selection criteria
Small	01/11/2024	9.6 mm	High-intensity rain with excellent sensor data integrity.
Medium	11/02/2025	14.2 mm	Representative medium event with full data coverage across all discharge points.
Large	12/10/2024	21.9 mm	Significant stress test providing high-magnitude pollution peaks for kinetic adjustment.

Finally, for each selected event, high-resolution hydraulic time series were extracted from the AQDV platform with the real CSO discharges occurred in those events. These real-world hydraulic inputs were then multiplied by the calculated Mean Event Concentrations (MEC, see (see Table 11 and Figure 38) to provide the dynamic mass loading required for the 2D river quality simulation.

This data-driven approach ensures that the model's calibration is grounded in the physical reality of the Madrid sanitation system's operation for those rain events.

7.5.2.3 CSO discharges for baseline and MPC scenario modelling

From chapters 5 and 6, we obtained CSO hydraulic and quality discharges and quality for baseline scenario and MPC scenarios for a total of 25 rain events between March 2024 and September 2025, but simulating all these rain events with the river quality model is unfeasible.

River quality modeling, particularly when accounting for complex biochemical interactions and longitudinal pollutant transport, is highly demanding in terms of computational time and post-processing analysis. Therefore, a representative subset of events between those 23 has been selected to provide the project's impact on the Manzanares river water body.

So, the 25 event events were categorized into three ranges based on total precipitation depth similarly as it was done in the previous chapter for calibration data:

- Small events (5mm < Pt < 10 mm) : There were 7 rain events here
- Medium events (10 mm < Pt < 20 mm): There were 8 rain events here
- Large event (Pt > 20 mm): There were 10 rain events although 3 of them were compound events with weekly rain

And among them these 3 events were selected to run in the river model:

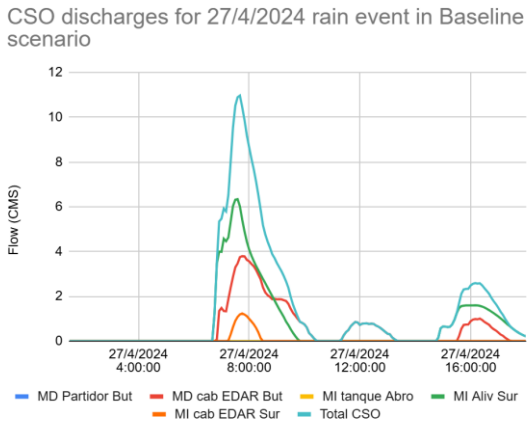
- Small event: 27/4/2024 with Pt= 7.8 mm
- Medium event: 11/2/2025 with Pt= 14.2 mm
- Big event: 10/6/2025 with Pt= 29 mm

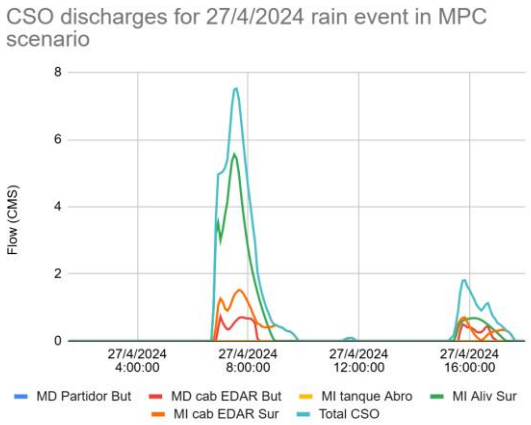
To contextualize these events within long-term climatic frequency, the return period, was calculated for each selected rain event. This analysis was done based on a 16-year historical series (2010‑2025) from the Retiro rain gauge, which provides the most centralized and prestigious meteorological record for the city of Madrid. By determining T, the frequency of these pollutant discharge events can be obtained and it can be evaluated how often each rain event is occurring.

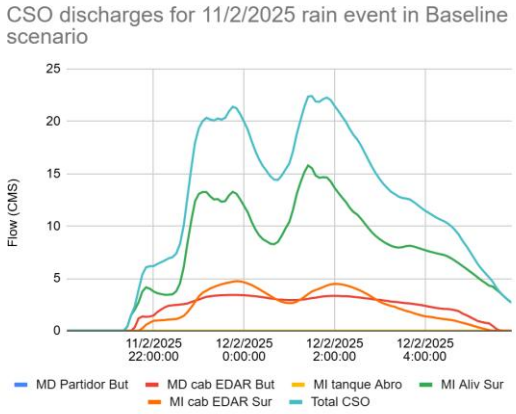
Table 22.- Hydraulic KPI of CSO reduction between MPC enhanced scenario (ID 6) and the baseline scenario (ID3)

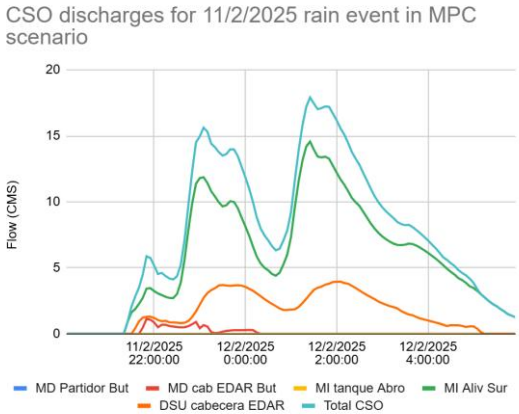
Rain event	Number of Events	Probability (events / years)	Return period (T)
>=7.8 mm	241	15.06	0.06
>=14.2 mm	103	6.43	0.15
>=29 mm	21	1.31	0.7619

The following graphs show the input CSO hydrographs for the two modelled scenarios: Baseline and MPC and the pollution provided as inputs are these flows multiplied by the MEC at each CSO point (see **Table 11** and **Figure 38**).









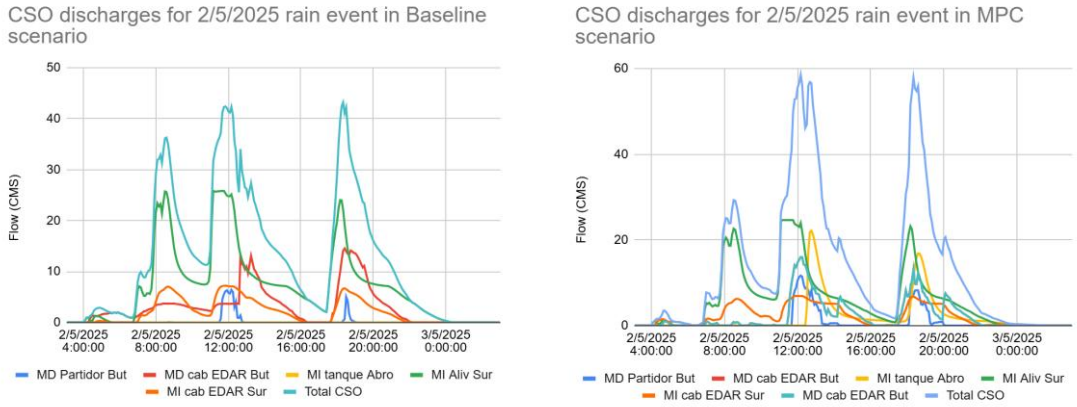


Figure 48.- CSO discharges used as input data for the river model for both scenarios: left Baseline scenario, right MPC scenario

The table below shows the total CSO discharges for each rain event. As highlighted in chapter 5.3, for big rain events such as the 2/5/2025, MPC scenario apparently discharges bigger CSO volumes than Baseline, this is because MPC reduces floods and the cost is that more water flows through the sewers and is discharged to the river.

Table 23.- Total CSO discharges for each rain and scenario

Rain event	Pt (mm)	Baseline scenario Total CSO (m3)	MPC scenario Total CSO (m3)	CSO reduction (%)
27/4/2024	7.8	81680	45775	43.96
11/2/2025	14.2	415243	276220	33.48
2/5/2025	29	1060511	1117678	-5.39

7.5.3 Summary of the river monitoring data used for calibration

To understand the physicochemical behavior of the Manzanares River and ensure the reliability of the project's environmental results, a robust monitoring framework was established. This framework provides the high-resolution temporal data necessary for dynamic model calibration and the comprehensive discrete data required to validate complex nutrient and organic matter transformations along the pilot reach.

The monitoring network is composed of two continuous monitoring stations, and 3 sections for discrete sampling.

Table 24.- Location in the river reach and ID name for the control sections

Location	Type	Km
Oliva	Continuous monitoring station Discrete sampling	3.348
Butarque Río	Continuous monitoring station Discrete sampling	6.722
Perales del Río	Discrete sampling	8.585

7.5.3.1 Sensor data (Continuous Monitoring)

Continuous monitoring is important for capturing the rapid "pollution waves" and the resulting "oxygen sag" that occur following Combined Sewer Overflow (CSO) discharges. For this project, two strategic control sections were instrumented with advanced sensor arrays (see chapter 3.2 for more details)

- La Oliva Station (Km 0.263): Located at the upstream limit of the model, this station serves as the "River Head" reference point. It characterizes the baseline quality of the water entering the pilot reach after the influence of the Viveros WWTP and mixing with the natural baseflow. It continuously measured quality data from February 2024 until July 2025).
- Butarque Río Station (Km 6.722): Positioned downstream of the La Gavia WWTP and the Butarque Partidor CSO, this station is critical for measuring the immediate environmental impact of discharges on the river's. It continuously measured quality data from November 2024 until July 2025).

Technical Specifications and Data Management:

- Monitored Parameters: Both stations used advanced sensors to record the parameters detailed in chapter 3.2.
- Temporal Resolution: Sensors were programmed to record data at 10-minute intervals, ensuring the model captures transient peaks associated with storm events.
- Data Validation: All raw data was periodically downloaded and underwent a rigorous validation process to discard erroneous measurements caused by mechanical issues (e.g., pump failures or sediment accumulation in the sensor buckets) or electronic signal drops.
- Data analysis: All validated data was then analyzed to understand the river reach behavior in normal dry weather conditions and in rainy conditions under CSO pressures (see Figure 49and Figure 50).
- Statistical analysis: To evaluate the baseline environmental state of the Manzanares River and quantify the impact of anthropogenic pressures, a comprehensive statistical analysis was performed on the high-frequency datasets recorded by the two continuous monitoring stations. This analysis allows for a direct comparison of river behavior under varying hydrological regimes and discharge conditions (see Figure 51 and Table 26).

- Box plot scenario analysis: To better correlate river quality with specific operational and climatic conditions, the data were categorized into nine discrete scenarios based on the combination of River Head Inflow (Q<3, 3<Q<10, Q>10) and Daily Accumulated Rainfall (Pd<4, 4<Pd<10, pd>10). See an example in Figure 52.

Table 25.- Sensors installed and parameters measured at each station

Parameter or Module	Sensor or Equipment	Station
Electrical conductivity	3798-sc	Oliva and Butarque Río Station
Dissolved oxygen	LDO sc	Oliva and Butarque Río Station
Turbidity	Solitax sc	Oliva and Butarque Río Station
Organic matter	Uvas-plus-sc	Oliva and Butarque Río Station
Redox potential	ORP Digital	Oliva Station
pH	pHD sc	Oliva and Butarque Río Station
Ammonium	AISE sc	Oliva and Butarque Río Station
Ammonium and nitrate	AN-ISE sc	Oliva and Butarque Río Station
Control module with display	SC1000 for 8 sensors	Oliva and Butarque Río Station

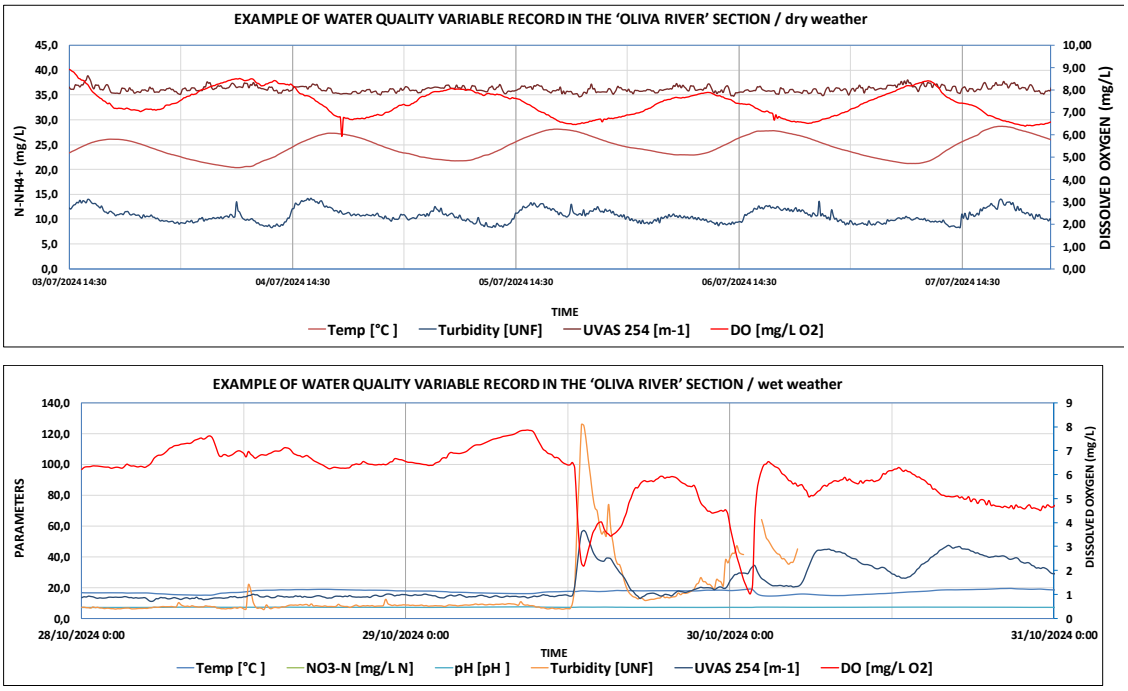


Figure 49.- Example of data records in Oliva section for dry weather (up) and wet weather (down)

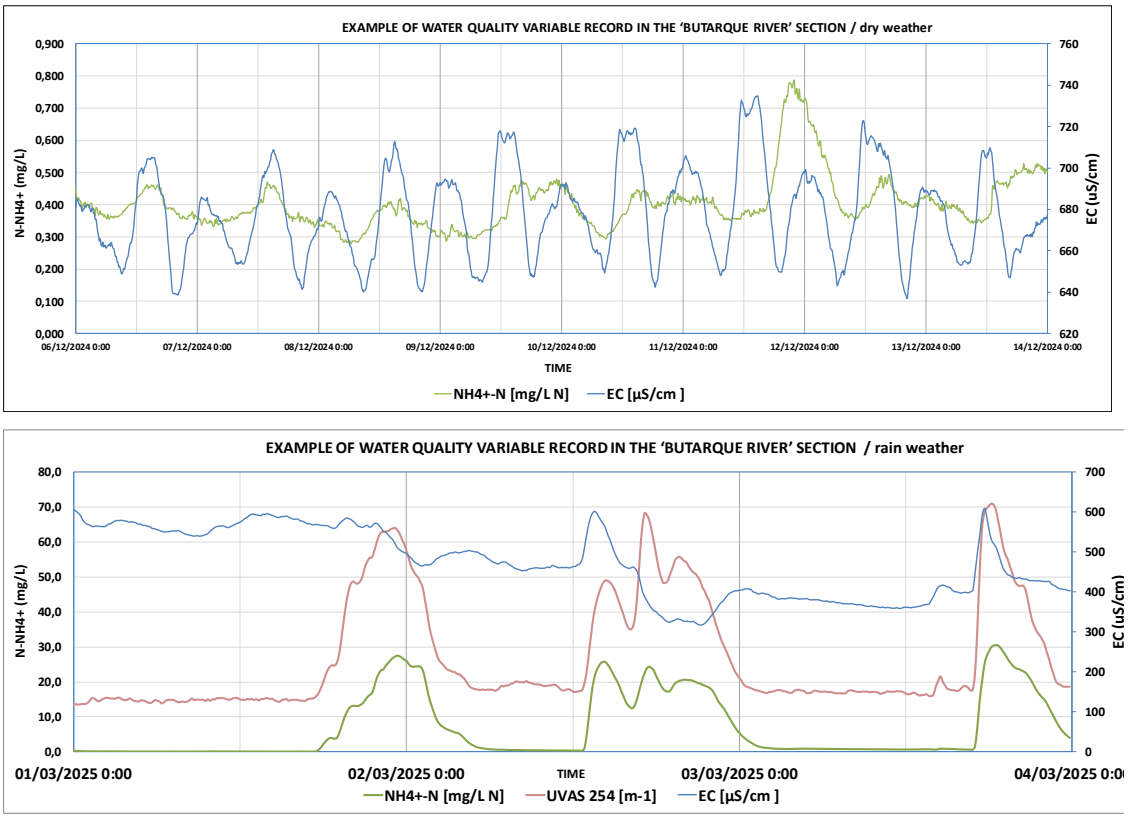


Figure 50.- Example of data records in Butarque river section for dry weather (up) and wet weather (down)

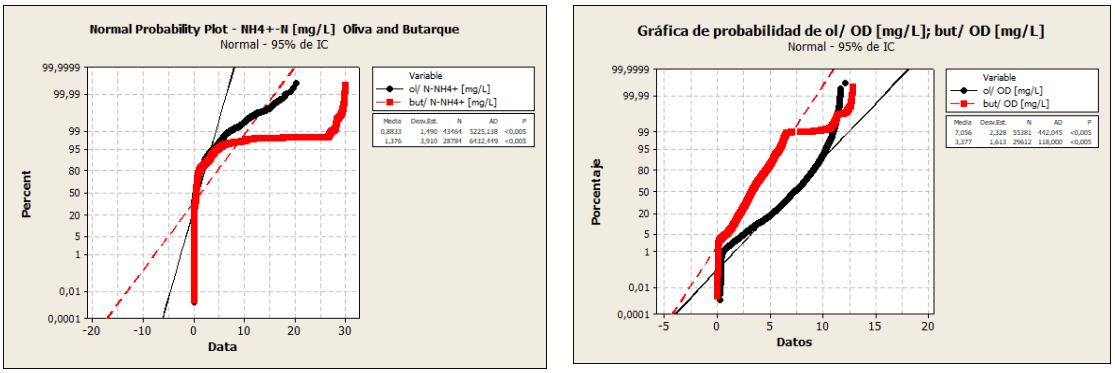


Figure 51.- Example of statistical analysis comparing the two sections for ammonium (left) and OD (right)

The following table summarizes the statistical distribution of the primary water quality parameters across the entire project monitoring period. The use of percentiles facilitates the distinction between habitual baseline quality (P50/Median) and acute pollution episodes (P95).

Table 26.- Statistical analysis of continuous monitoring parameters in both stations

Parameter	Unit	La Oliva			Butarque		
		P20	P50	P95	P20	P50	P95
Temp.	ºC	13.5	16.8	27.0	11.9	15.1	28.8
Ammonium	mgN/L	0.06	0.36	3.74	0.07	0.42	4.57
Nitrate	mgN/L	3.2	4.5	8.3	3.4	4.6	6.9
EC	µS/cm	366	444	658	392	677	936
UVAS-254	1/m	31	37	59	10	13	39
Turbidity	UFT	6	9	30	6	9	36
DO	mg/L	5.2	7.3	10.3	2.1	3.3	5.9

The comparison between the two sections highlights a clear environmental degradation as the river travels downwaters:

- Electrical Conductivity (EC): Shows a significant increasing trend, with the median (P50) rising from 444 µS/cm at La Oliva to 677 µS/cm at Butarque Río. This rise is directly attributable to the constant influx of treated effluents from the La Gavia WWTP, located between the two monitoring points.
- Dissolved Oxygen (DO): Conversely, DO levels exhibit a sharp decline. While the river arrives at La Oliva with a healthy median of 7.3 mg/L, the concentration drops to a critical median of 3.3 mg/L at Butarque Río. This confirms that the reach is under continuous organic stress, even during dry weather.
- Acute Impacts (P95-P99): The high-percentile values for Ammonium, Turbidity, and organic matter (UVAS-254) are driven by the intermittent Combined Sewer Overflow (CSO) discharges. These peaks represent the "pollution waves" that the LIFE-RUBIES solution specifically aims to mitigate.

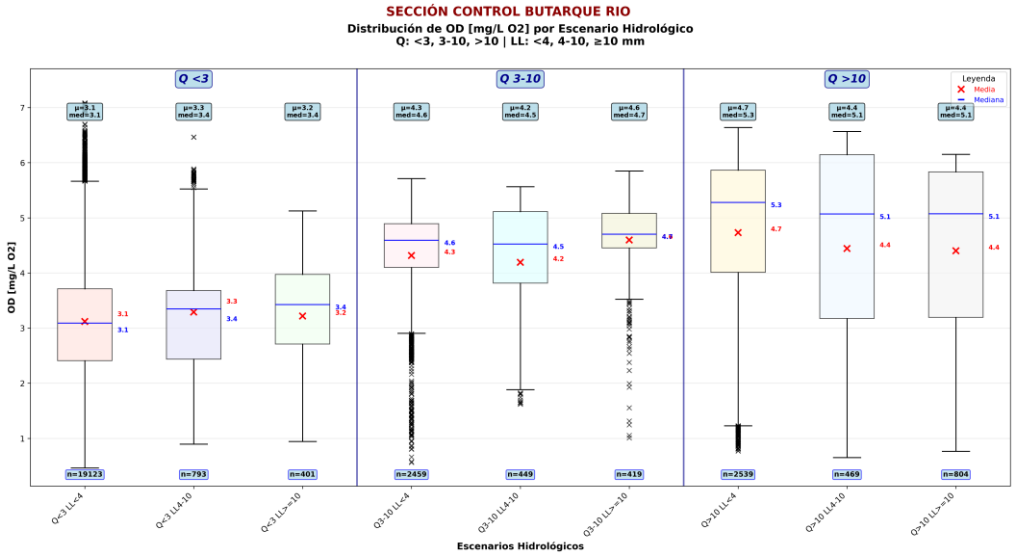


Figure 52.- Example of box plot analysis for DO in Butarque río for the 9 pre-defined scenarios

7.5.3.2 Monitoring campaigns (Discrete Sampling)

While continuous sensors track rapid fluctuations, manual monitoring campaigns provide the comprehensive analytical spectrum required for biochemical mass balances. Between July 2022 and September 2025, a series discrete sampling campaigns in dry weather and laboratory analysis were conducted under various hydrological regimes at the two fixed sensor stations (Oliva and Butarque) and a third strategic section downstream at Huertos de Perales del Río (HPR in Km 8.585). The effect of the continuous discharge from the Butarque WWTP (without nitrification-denitrification) becomes evident, with organic matter (BOD), ammoniacal and total nitrogen, and electrical conductivity showing higher average values than at the upstream sections, while the average dissolved oxygen concentration decreases.

Table 27.- Summary of the sample results obtained at the three sampling points

Parameter	Unit	LA OLIVA (n=6)			BUTARQUE RÍO (n=5)			HPR (n=6)		
		min	mean	max	min	mean	max	min	mean	max
pH		7.00	7.36	7.65	6.53	7.25	7.60	6.96	7.37	7.87
OD	mg/L	7.11	8.11	9.26	5.84	7.58	8.48	5.97	6.97	7.56
OD	%sat	87.7	92.7	105.9	72	84.3	92.5	75.2	81.9	86.3
CE	µS/cm	239	542	687	291	500	678	421	673	888
Turbidez	UFT	6	13	39	4	22	43.52	5	20	33
Residuo Seco	mg/L	173	332	428	207	327	455	261	370	435
SS	mg/L	4	19	55	10	36	62	10	26	44
CDBO5	mg/L	0.70	1.56	3.00	1.20	2.47	3.53	2.0	3.2	4.8
CDBO20	mg/L	2.50	4.04	5.60	3.80	6.16	8.25	5.6	7.6	9.5
DQO	mg/L	5	15	29	10	25	36	14	31	43
TDBO5	mg/L	2.5	3.6	5.3	4.2	5.9	11.0	6.0	26.6	41.0
$N\text{-}NH_4^+$	mg/L	0.09	0.49	1.2	0.22	0.49	0.90	5.47	13.4	26.2
$N\text{-}NO_2^-$	mg/L	0.04	0.07	0.15	0.04	0.16	0.40	0.12	0.28	0.81
$N\text{-}NO_3^-$	mg/L	0.50	4.83	7.99	0.64	3.76	5.97	0.52	3.00	5.33
NT	mg/L	3.21	6.75	8.94	3.98	6.13	7.62	9.17	18.0	30.6
PT	mg/L	0.27	0.51	0.71	0.27	0.45	0.66	0.45	0.61	0.72
$P\text{-}PO_4^{-3}$	mg/L	0.24	0.42	0.64	0.23	0.35	0.45	0.27	0.35	0.56

7.5.4 Kinetic rates

To ensure the Manzanares River quality model accurately reflects the complex biochemical processes occurring during discharge events, it was important to correctly select the kinetic rates values. These rates govern the spatial and temporal evolution of carbonaceous matter,

nitrogen, phosphorus, and dissolved oxygen within the IberWQ module. The goal here was to establish orders of magnitude and reasonable ranges for the different rates that define the model's behavior. This provides an initial, high-quality approximation of the kinetic constants and other model input variables, so that later calibration phases are based on a solid foundation and require only minor adjustments

The selection process followed these steps:

1. Literature Review: Extensive analysis of specialized manuals and scientific literature provided standard ranges for these rates
2. Integration of data from previous river modeling projects done by GEAMA (Grupo de Enxeñaría da Auga e do Medio Ambiente from Coruña University) expert team.
3. Analysis of laboratory results from samples taken at the CSO points and control sections during the LIFE-RUBIES monitoring campaigns to obtain specific kinetic rates.

The table below summarizes the initial ranges and values applied during the pre-modeling and calibration phases.

Table 28.- Kinetic rates initially applied in the river model

PARAMETERS AND RANGES	MINIMUM VALUES	MEAN VALUES	HIGH VALUES
Hydraulic parameters			
Upstream flow rate (m^3/s)	1	2.5	5
Climatology			
Temperature (°C)	10	20	30
Parameters directly related to DO			
K_2	Iber model	Iber model	Iber model
BODsed / DOS ($g/m^2 \cdot day$)	0.05	0.5	2
Parameters related to BOD			
K_1, carbonaceous deoxygenation rate (day^{-1})	0.05	0.5	2.5
vSDBO, carbonaceous organic matter sedimentation velocity (m/d)	0.05	0.25	1
Parameters related to the Nitrogen cycle			
Khn, ammonification rate (day^{-1})	0.005	0.05	0.5
Knit, nitrification rate (day^{-1})	0.02	0.25	2.5
Kdenit, denitrification rate (day^{-1})	0	0	0
vSN, nitrogenous organic matter sedimentation velocity (m/d)	0.05	0.25	1
Phosphorus cycle parameters			
Kp, hydrolysis rate (day^{-1})	0.03	0.3	3

vSPO, organic phosphorus sedimentation velocity (m/d)	0.003	0.03	1.8
vSPO, inorganic phosphorus sedimentation velocity (m/d)	0.003	0.03	1.8
Diffusion parameters			
Molecular dispersion coefficient (m^2/s)	0	0	0
Schmidt number	1	1	1

7.6 Manzanares river pre-model creation

The construction of the "Pre-model" represents the initial application of the Iber software to the Manzanares River reach without using site-specific field data. This phase serves to define the geometric-hydraulic basis of the system and verify the numerical stability of the transport equations using low-cost data derived from literature and existing cartography.

7.6.1 Channel Geometry and Digital Terrain Model (DTM)

The physical domain of the 16 km pilot reach was digitized using high-resolution geographical data to ensure accurate depth and velocity profiles.

- Topographic Data: The primary source was the LiDAR 3rd Coverage (2022-2025) from the Spanish National Geographic Institute (IGN), providing a density of 5 points/m2.
- Data Correction: During the process, inconsistencies in elevation were detected in the downstream section near the Sur WWTP. To resolve this, the model was supplemented with the IGN 2nd Coverage DTM (2015-2021) using a 2-meter grid spacing.
- Infrastructure Processing: Utilizing QGIS, urban structures such as bridges and transverse obstacles were processed. In sections where bridges obstructed the LiDAR signal, the channel geometry was extrapolated from adjacent cross-sections to ensure a continuous hydraulic profile.



Figure 53.- Aerial view of the modeled reach in the Iber+ software.

7.6.2 Hydraulic Characterization (Manning's n)

Flow resistance in the reach is governed by the Manning's roughness coefficient (n), which determines the relationship between water level and velocity, a critical factor for pollutant residence time.

Based on the river type according to the Spanish T-15 classification (defined as "low-mineralized Mediterranean-continental rivers), standard hydraulic manuals (e.g., Ven Te Chow) and the specific morphology of the channelized urban reach, a uniform Manning's n of 0.035 was adopted for the pre-model simulations.

7.6.3 Conceptualization of the Environmental Problem

The conceptualization of the Manzanares River reach as a dynamic environmental system is centered on the integration of all significant hydraulic and biochemical pressures (mainly WWTP effluents and CSO discharges), and identification of the spatial domain and the control sections.

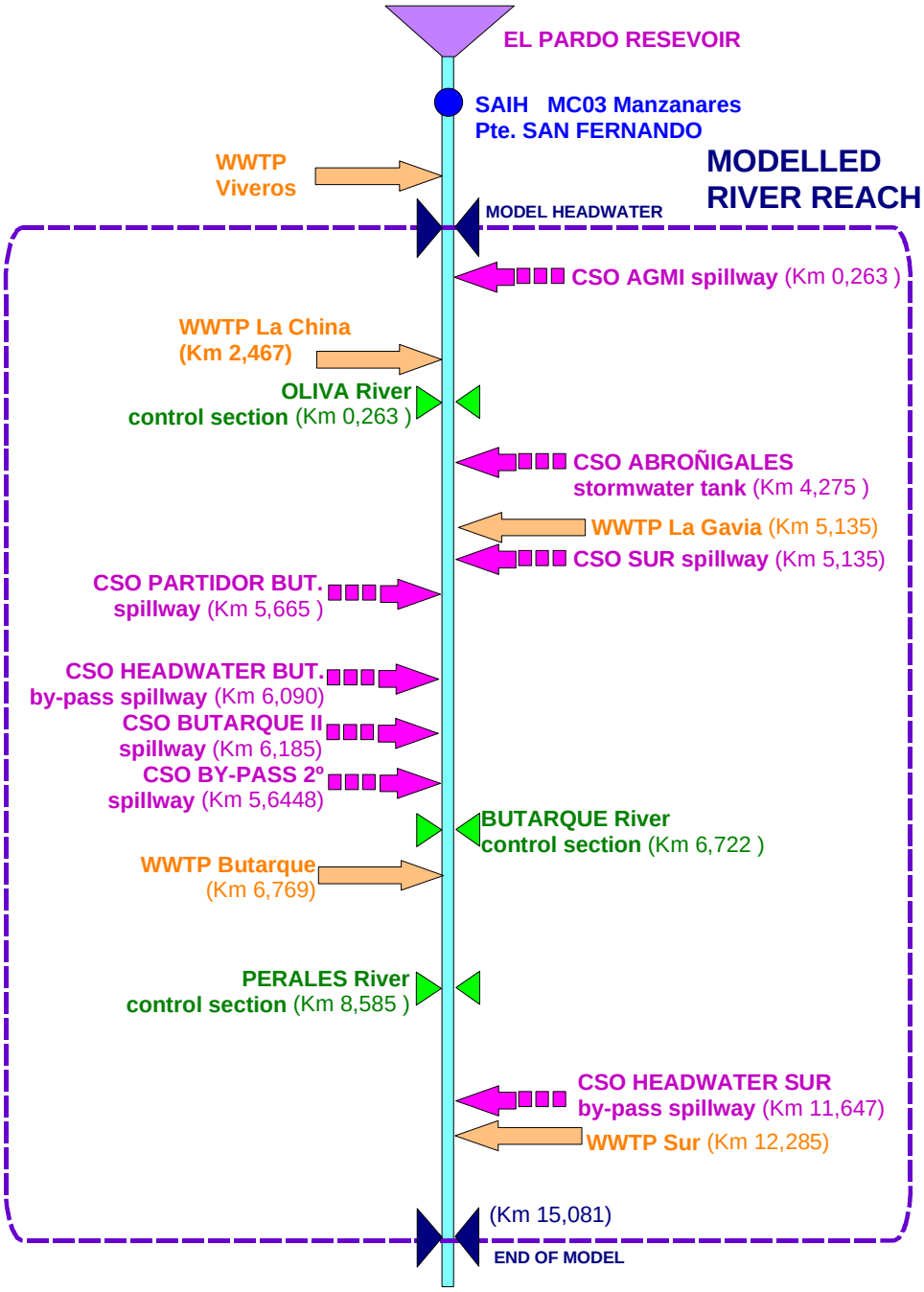


Figure 54.- Model conceptualization with all pressure inputs and the control sections.

7.6.4 Pre-model and Sensitivity Analysis

The pre-model phase was developed through the definition of "synthetic scenarios" designed to verify the correct operation of the numerical structure before initiating the formal calibration process. This approach allowed for the progressive identification and correction of inconsistencies across the hydraulic and transport subsystems.

7.6.4.1 Hydraulic Adjustment and DTM Refinement

The initial stage focused on hydraulic simulations to confirm that model outputs for discharge, flow velocities, and the extent of flooded areas maintained physical coherence. These results were cross-referenced with field observations and historical records from the SAIH gauging stations. This verification process was also instrumental in detecting elevation inconsistencies and fine-tuning the Digital Terrain Model (DTM) used for the reach.

7.6.4.2 Transport Verification via Conservative Tracers

Once the hydrodynamic response was verified, the water quality module was tested using salt pulses as a conservative tracer. These tests were essential for evaluating longitudinal transport and dispersion processes, ensuring that the IberWQ engine correctly closed mass balances across the 2D domain.

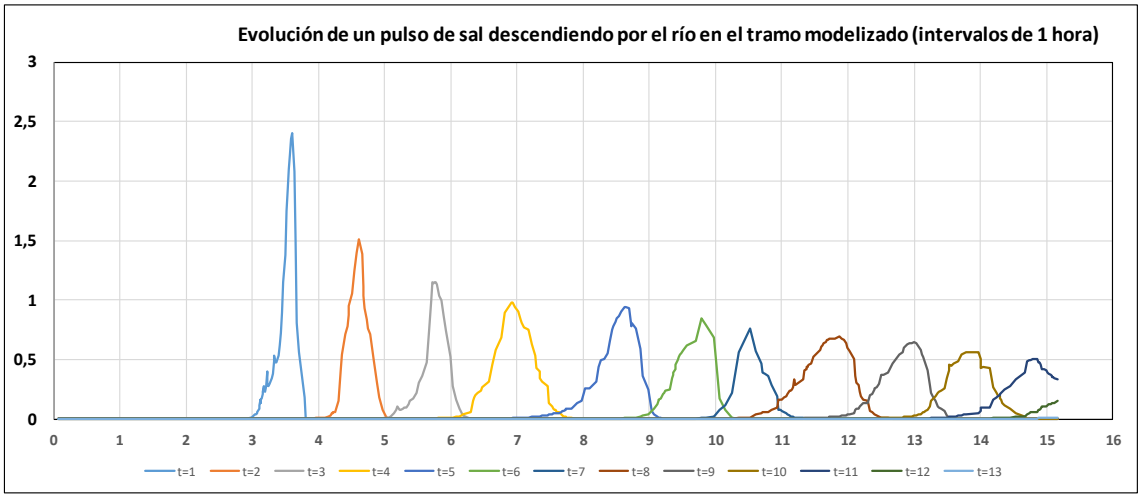


Figure 55.- Evolution of a 5 minute salt pulse in La China WWTP effluent of 1m3/s with an upstream river flow of 2.5 m3/s

7.6.4.3 Incorporation of other pollutants: Transverse Mixing and Point-Source Implementation

Finally, the rest of pollutants were included progressively into the model (BOD; N compounds, etc.). The high spatial resolution of the 2D mesh–discretizing the channel into up to 30 cells across a single section–revealed significant transverse concentration gradients when simulating point-source discharges. The model demonstrated that injecting mass at a single point creates pronounced plumes before reaching complete mixing. To mirror the physical reality of the "pollution wave" observed in the Manzanares, it was determined that discharges should be implemented at the center of the channel, and that results within the “mixing length” near the discharge points would not be considered when evaluating compliance with environmental KPIs.

4. Pre-model final tests

The pre-model phase concluded once the system demonstrated stable, consistent behavior across all simulated variables. The achievement of results aligned with expected orders of magnitude provided the necessary technical foundation to transition into the biochemical calibration and sensitivity analysis phases.

7.7 Model calibration

The calibration phase is a critical stage that ensures the model's parameters are adjusted so the simulation results align with real-world data recorded by continuous monitoring stations and discrete sampling campaigns. This process followed a hierarchical strategy, prioritizing the adjustment of independent variables (such as temperature or BOD) before addressing heavily coupled processes like Dissolved Oxygen (DO) dynamics.

7.7.1 Thermal Regime and synthetic scenarios with bibliography values

To ensure the consistency and robustness of the kinetic constants, the modeling team adopted a uniform uniform thermal regime as explained in the boundary conditions (chapter 7.5.1.4)

The initial strategy involved defining "Oxygen" and "Ammonium" synthetic scenarios to bracket the plausible ranges for kinetic rates–categorized as bad, medium and good–based on an extensive literature review (see 7.5.4 and Table 29). These ranges were intended to encompass the values within which the final calibrated parameters were expected to fall.

A significant development during this phase was the implementation of an attenuation factor for the pollutant loads entering the model headwater. This factor accounts for the natural degradation occurring in the reach between the Viveros WWTP discharge and the model's upstream boundary, significantly improving the fit with data from the Oliva monitoring station.

Table 29.- Applied initial kinetic rate values for the calibration of OD and ammonium.

Parameter	DO Bad	DO Med	DO Good	NH_4 Bad	NH_4 Med	NH_4 Good
Hydraulic parameters						
Upstream flow rate (m^3/s)	1	2.5	5	1	2.5	5
Climatology						
Temperature (º C)	30	20	10	10	20	30
Parameters directly related to DO						
K_2	Iber model					
BODsed / DOS ($g/m^2 day$)	2	0.5	0.05	0.05	0.5	2
Parameters related to BOD						
K_1,carbonaceous deoxygenation rate (day^{-1})	2.5	0.5	0.05	0.05	0.5	2.5
vSDBO, carbonaceous OM sedimentation velocity (m/d)	0.05	0.25	1	0.05	0.25	1
Nitrogen cycle parameters						
Khn, ammonification rate (day^{-1})	0.5	0.05	0.005	0.5	0.05	0.005
Knit, nitrification rate (day^{-1})	2.5	0.25	0.02	0.02	0.25	2.5
Kdenit, denitrification rate (day^{-1})	0	0	0	0	0	0

vSN, nitrogenous OM sedimentation velocity (m/d)	0.05	0.25	1	0.05	0.25	1
Phosphorus cycle parameters						
Kp, hydrolysis rate (day^{-1})	0.03	0.3	3	0.03	0.3	3
vSPO, organic P sedimentation velocity (m/d)	0.003	0.03	1.8	0.003	0.03	1.8
vSPO, inorganic P sedimentation velocity (m/d)	0.003	0.03	1.8	0.003	0.03	1.8
Diffusion parameters						
Molecular dispersion coefficient (m^2/s)	0	0	0	0	0	0
Schmidt number	1	1	1	1	1	1

7.7.2 Dry Weather Calibration (Scenarios E1–E4)

The calibration for habitual dry weather conditions utilized an iterative series of simulations (E1 through E4) to reproduce the river's baseline quality.

- Initial Adjustments: Early iterations (E1–E2) revealed that initial literature-based rates were insufficient to match the observed longitudinal degradation, requiring an increase in organic matter and nitrogen disappearance rates.
- Refinement: In scenarios E3 and E4, the modelers fine-tuned the deoxygenation (K1) and nitrification (Knit) rates while adjusting the headwater DO to 8 mg/L to reflect the high reaeration capacity of the upstream reaches.
- Final Parameters: The dry weather phase concluded by adopting a K1 of 1.1 d−1 and a Knit of 0.60 d−1 which provided a satisfactory match with the observed BOD and nutrient gradients.

Table 30.- Parameters applied during the Dry Weather calibration scenarios

PARÁMETROS Y RANGOS	CALIBRACIÓN E1	Valores en "cabecera"	CALIBRACIÓN E2	Valores en "cabecera"	CALIBRACIÓN E3	Valores en "cabecera"	CALIBRACIÓN E4	Valores en "cabecera"
Parámetros hidráulicos								
Caudal cabecera /m^3/s	2,0		2,0		2,0		2,0	
Climatología								
Temperatura (ºC)	20		20		20		20	
Parámetros directamente vinculados al OD								
K_2	Modelo Iber	OD cabecera fijado a 8, debería rendir la saturación ,mucha reaireación desde Viveros	Modelo Iber	OD cabecera fijado a 8	Modelo Iber	OD cabecera fijado a 8	Modelo Iber	OD cabecera fijado a 8
DBOsed/DOS (g/m^2·día)	0,5		0,5		0,5		0,5	
Parámetros vinculados a la DBO								
K_1 , tasa de desoxigenación carbonosa (día $^{-1}$)	0,6	DBO5 río + DBO5 Viveros x factor atenuación =	0,6	DBO5 río + DBO5 Viveros x factor atenuación =	0,7	DBO5 río + DBO5 Viveros x factor atenuación =	1.1	DBO5 río + DBO5 Viveros x factor atenuación =
$v_{s\,DBO}$ velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,25	0,5 + factor 0,5	0,25	0,5 + factor 0,5	0,25	0,5 + factor 0,4	0,5	0,5 + factor 0,4
Parámetros vinculados al ciclo del Nitrógeno								
K_{ao} , tasa de amonificación (día $^{-1}$)	0,05	0,025 Norg refractario de EDAR	0,05	0,025 Norg refractario de EDAR	0,05	0,025 Norg refractario de EDAR	0,05	0,025 Norg refractario de EDAR
K_{nit} , tasa de nitrificación (día $^{-1}$)	0,5	Cabecera	0,5	Cabecera	0,60	Cabecera	0,60	Cabecera
K_{desnit} , tasa de desnitrificación (día $^{-1}$)	0	(N-NH4+ río) + (N-NH4+ Viveros) =	0	(N-NH4+ río) + (N-NH4+ Viveros) =	0	(N-NH4+ río) + (N-NH4+ Viveros) =	0	(N-NH4+ río) + (N-NH4+ Viveros) =
$v_{s\,N}$, velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,25	0,5 + factor 0,7	0,25	0,5 + factor 0,7	0,25	0,5 + factor 0,6	0,25	0,5 + factor 0,6
Parámetros del ciclo del Fósforo								
K_p , tasa de hidrólisis (día $^{-1}$)	0,3		0,3		0,3		0,3	
$v_{s\,PO}$, velocidad de sedimentación del fósforo orgánico (m/d)	0,03		0,03		0,03		0,03	
$v_{s\,PIN}$, velocidad de sedimentación del fósforo inorgánico (m/d)	0,03		0,03		0,03		0,03	

7.7.3 Wet Weather Calibration (Storm Events TLL-1–TLL-3D)

Calibrating the model for rain events is more complex due to the intermittent and high-magnitude nature of CSO discharges. Three real episodes were used for this phase (see chapter 7.5.2.2).

The calibration is carried out iteratively by comparing the simulated outputs with the observed time series at the control sections. Adjustable parameters include, among others, the kinetic constants (BOD degradation, nitrification, ammonification), the sedimentation/resuspension velocities of particulate fractions, and the partitioning between biodegradable and refractory fractions in the CSO inputs.

The calibration process against real rainfall events was carried out progressively through scenarios TLL-1 to TLL-3D, starting from the kinetic constants obtained under dry-weather conditions and mainly adjusting the upstream boundary conditions to match the actual river flows on the selected days.

Table 31.- Applied values during the wet weather calibration iteration process

PARÁMETROS Y RANGOS	ESCENARIO TLL-1 20241012	ESCENARIO TLL-2 20241101	ESCENARIO TLL-3A 01/03/25 - 03/03/25	ESCENARIO TLL-3B 01/03/25 - 03/03/25	Valores en "cabecera" Escenarios 1 ,2, 3A y 3B	ESCENARIO TLL-3C 01/03/25 - 03/03/25	Valores en "cabecera"	ESCENARIO TLL-3D 01/03/25 - 03/03/25	Valores en "cabecera"
Parámetros hidráulicos									
Caudal cabecera /m^3/s	4,1	2,22	01/03 1,4 02/03 1,35 03/03 1,35	01/03 1,4 02/03 1,35 03/03 1,35		01/03 1,4 02/03 1,35 03/03 1,35		01/03 1,4 02/03 1,35 03/03 1,35	
Climatología									
Temperatura (ºC)	20	20	20	10		10		10	
Parámetros directamente vinculados al OD									
K_2	Modelo Iber	Modelo Iber	Modelo Iber	Modelo Iber	OD cabecera fijado a 8	Modelo Iber	OD cabecera fijado a 11	Modelo Iber	OD cabecera fijado a 10
DBOsed/DOS (g/m^2·día)	0,5	0,5	0,5	0,5		0,5		0,5	
Parámetros vinculados a la DBO									
K_1 , tasa de desoxigenación carbonosa (día $^{-1}$)	1,1	1,1	1,1	1,1	DBO5 río + DBO5 Viveros x factor atenuación =	1,1	DBO5 río + DBO5 Viveros x factor atenuación =	1,1	DBO5 río + DBO5 Viveros x factor atenuación =
$v_{s,DBO}$ velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,5	0,5	0,5	0,5	0,5 + factor 0,4	0,5	0,5 + factor 0,4	0,5	0,5 + factor 0,4
Parámetros vinculados al cido del Nitrógeno									
K_{Nit} , tasa de amonificación (día $^{-1}$)	0,5	0,5	0,5	0,5	0,025 Norg refractario de EDAR	0,5	0,025 Norg refractario de EDAR	0,5	0,025 Norg refractario de EDAR
K_{Nit} , tasa de nitrificación (día $^{-1}$)	0,60	0,6	0,6	0,6	Cabecera	0,6	Cabecera	0,6	Cabecera
K_{desnit} , tasa de desnitrificación (día $^{-1}$)	0	0	0	0	(N-NH4+ río) + (N-NH4+ Viveros) =	0	(N-NH4+ río) + (N-NH4+ Viveros) =	0	(N-NH4+ río) + (N-NH4+ Viveros) =
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenada (m/d)	0,5	0,5	0,5	0,5	0,5 + factor 0,8	0,5	0,5 + factor 0,6	0,5	0,5 + factor 0,8
Parámetros del ciclo del Fósforo									
K_p , tasa de hidrólisis (día $^{-1}$)	0,3	0,3	0,3	0,3		0,3		0,3	
Vspo , Vspi : velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,06	0,06	0,03	0,03		0,03		0,03	

By concluding these iterative stages, the model demonstrated a stable and consistent response across the diverse range of hydrological and pollutant stresses typical of the Manzanares River. The calibrated tool is now considered reliable for evaluating the environmental benefits of the LIFE-RUBIES management strategies.

7.8 River model runs for both scenarios

Once finished the calibration process detailed in the previous section, the Iber+ numerical model is used to evaluate the environmental efficacy of the LIFE-RUBIES solution by performing a comparative analysis between two distinct operational configurations:

- Baseline (Rules) Scenario: Represents the "Business as Usual" (BAU) state, utilizing the current Canal de Isabel II management protocols and static operational rules.
- MPC Scenario: Employs the real-time setpoints generated by the PBMPC controller, designed to minimize both urban flooding and pollutant mass discharge.

The simulation framework focuses on the three representative rainfall episodes categorized in Section 7.5.2.3, which provide a comprehensive spectrum of rain events occurring in Madrid: the 7.8 mm (Small), 14.2 mm (Medium), and 29.0 mm (Large) events.

For each simulation, the hydraulic CSO hydrographs specific to each scenario–extracted from the sewer-side SWMM models–are coupled with identical pollutant loadings based on the Mean Event Concentrations (MEC) calculated for each discharge point. This methodology ensures that any observed improvements in river quality (e.g., mitigation of the "oxygen sag" or reduction in ammonium peaks) are directly attributable to the optimized management of the urban drainage infrastructure.

7.9 River model main results

7.9.1 Results summary sheet and KPIs

To standardize the environmental impact assessment of the LIFE-RUBIES solution, the simulation results for the pilot reach of the Manzanares River have been consolidated into two distinct types of technical summary sheets. These sheets are designed to provide both a quantitative mass-based verification and a high-resolution dynamic analysis of pollutant transport and biochemical transformation along the river reach.

7.9.1.1 Mass balance summary sheets

The primary function of the Mass Balance sheets is to ensure the physical integrity of the model by verifying the principle of mass conservation across the pilot reach.

In the first 3 tables this mass balance is done on a daily basis for all the model evaluated parameters (BOD5, TN, Org-N, NH4-N, etc.) with:

- Inflow Accounting: It identifies the total mass load (in kg) entering the system from three primary sources: "River Head" (river upstream), "WWTPs" (WWTP effluents of La Gavia, Butarque and Sur WWTPs), and "CSO discharges" (overflows from the sewer network during rain events).
- Outflow accounting: It identifies the total mass load getting out of the river reach at its most downstream section.
- With the previous values differences between input and output mass is computed and also the quantity remaining in the river reach at the end of each day and its variation.

Then a graph summarizing the variation for each parameter and each day is included.

Finally a last table highlights for the total model run the CSO input and the CSO output highlighting the differences as the CSO mass removed for each parameter, either by sedimentation processes or by biochemical reactions.

The figure below provides an example of this mass balance summary sheet

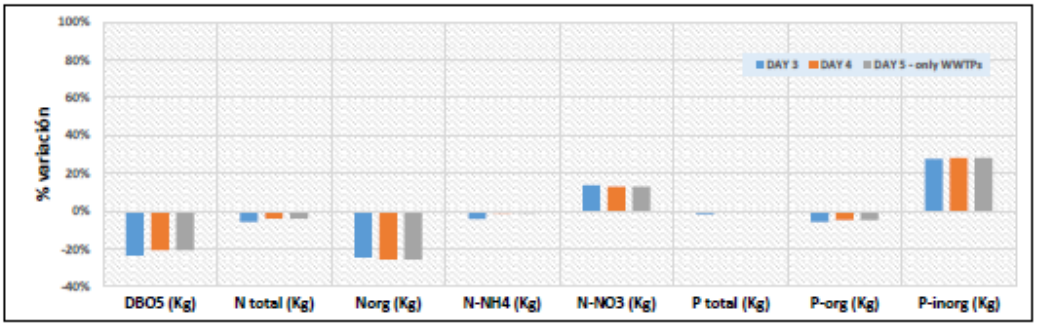
MASS BALANCE

Model scenario: 7.8 mm - RULES

DAY 3	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	215	2156	429	11	1716	43	21	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	15500	1481	394	1087	0	259	233	26
TOTAL INFLOWS	20650	26397	5300	17249	3849	858	757	101
OUTFLOW DAY 3	15756	24882	3999	16511	4372	843	714	129
Difference	-4894	-1515	-1301	-738	524	-15	-43	28
% left	76.30%	94.26%	75.46%	95.72%	113.61%	98.24%	94.32%	127.57%
% variation	-23.70%	-5.74%	-24.54%	-4.28%	13.61%	-1.76%	-5.68%	27.57%

DAY 4	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	207	2080	414	10	1655	41	21	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	0	0	0	0	0	0	0	0
TOTAL INFLOWS	5142	24840	4891	16161	3788	597	523	75
OUTFLOW DAY 4	4082	23867	3642	15957	4267	593	498	96
Difference	-1060	-973	-1249	-204	479	-4	-25	21
% left	79.38%	96.08%	74.47%	98.74%	112.65%	99.31%	95.22%	128.01%
% variation	-20.62%	-3.92%	-25.53%	-1.26%	12.65%	-0.69%	-4.78%	28.01%

DAY 5 - only WWTPs	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	207	2080	414	10	1655	41	21	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	0	0	0	0	0	0	0	0
TOTAL INFLOWS	5142	24840	4891	16161	3788	597	523	75
OUTFLOW DAY 5	4082	23867	3642	15957	4267	593	498	96
Difference	-1060	-973	-1249	-204	479	-4	-25	21
% left	79.38%	96.08%	74.47%	98.74%	112.65%	99.31%	95.22%	128.01%
% variation	-20.62%	-3.92%	-25.53%	-1.26%	12.65%	-0.69%	-4.78%	28.01%



CSO Mass Balances	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
CSO mass discharged on DAY 3	15499.7	1480.7	393.7	1087.0	0.0	259.4	233.4	25.9
CSO mass outflow on DAY 3 (day 3 minus day 5)	11673.5	1015.5	356.7	553.5	105.3	249.9	216.2	33.7
CSO mass outflow on DAY 4 (day 4 minus day 5)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total CSO mass discharged over Days 3 and 4	11673.5	1015.5	356.7	553.5	105.3	249.9	216.2	33.7
CSO mass removed on Days 3–4	-3826.2	2496.2	-36.9	-533.5	105.3	-9.5	-17.2	7.8
% CSO mass removed on Days 3–4	-24.7%	-31.4%	-9.4%	-49.1%		-3.6%	-7.4%	30.0%

Figure 56.- Example of mass balance summary sheet for Rules or Baseline scenario and 7.8 mm rain event.

7.9.1.2 Dynamic parameter Analysis summary sheet

These sheets provide a technical visualization of the spatial and temporal evolution of specific pollutants, such as Ammonium, BOD, and Dissolved Oxygen (DO).

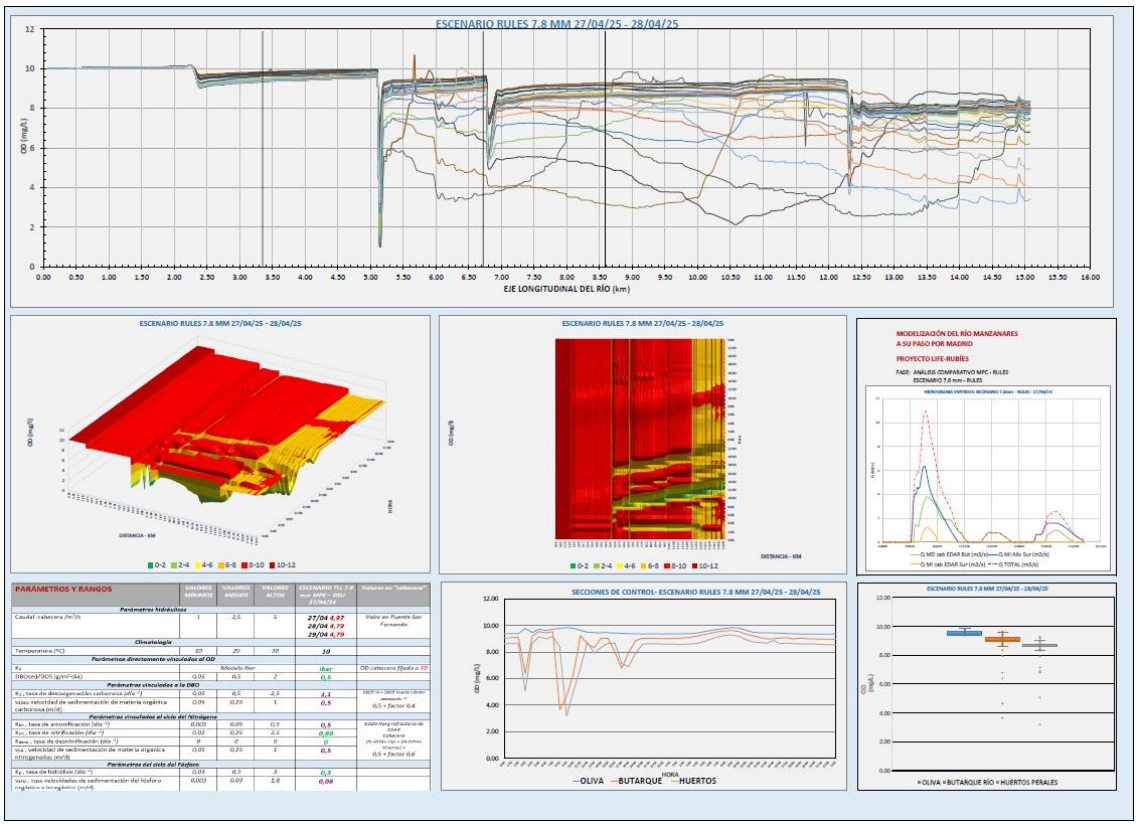


Figure 57.- Example of dynamic parameter analysis sheet for the 7.8 mm rain event for the baseline scenario and DO parameter

Each sheet integrates the following graphical components from the upper left to the down right side:

1. Longitudinal River Axis Profiles: These graphs show snapshots of the pollutant concentration along the river reach at specific time intervals, helping to identify the point of maximum impact and the river's self-purification capacity.
2. 3D Surface Visualization (Concentration Surface): This plot represents the concentration of the parameter across the longitudinal distance (km) and time (hours). It allows for the visual identification of "pollution peaks" or oxygen minimums and the duration following a CSO event.
3. 2D plot for pollution concentration: Similar to the previous one but in 2D
4. Discharge Hydrographs: At the base of each sheet, the input CSO hydrographs are plotted, giving a general idea of the CSO amount discharged to the river.
5. Modeling Parameters and Ranges Table: To maintain full transparency and traceability, each sheet documents the specific boundary conditions and kinetic rates ranges (from bibliography) and values applied in the Iber model. This includes the "River Head" flow (m3/s), water temperature, and coefficients such as carbonaceous deoxygenation rates (k_1), nitrification rates (k_{nit}), and sedimentation velocities.

6. Control Section Time Series: High-resolution temporal evolution is extracted for critical monitoring points, including Oliva (upstream the river reach), Butarque river (at the middle) , and Huertos de Perales (at the model reach end), allowing for a direct comparison of peak concentrations and recovery times between management scenarios.
7. Box plots: It provides a comprehensive statistical breakdown of the pollutant concentrations recorded at the strategic cross sections across the entire simulation period, by providing central tendency (mean and median representing the general quality baseline), concentration variability (interquartile ranges indicating how long the river section remained under pollution stress) and acute peaks

By using this dual methodology, we can confirm that the model is hydraulically consistent while simultaneously quantifying the real-world ecological benefit of the PBMPC controller in protecting the Manzanares River ecosystem by comparing with the current baseline operation strategy.

7.9.2 Baseline scenario results

The Baseline Scenario represents the "Business as Usual" (BAU) operational state of the Madrid combined sewer system, utilizing the original Canal de Isabel II (CYII) management protocols and rules. This section analyzes the modeling results to characterize the hydraulic and biochemical impact of untreated Combined Sewer Overflows (CSOs) on the Manzanares River pilot reach.

In the subchapters below some general comments and some interesting graphs are highlighted. The results summary sheets described in the previous chapter are included in annex 5.

7.9.2.1 Analysis of the Small Rain Event (7.8 mm – 27/04/2024)

- Mass Balance: The mass balance for this episode shows a total BOD5 inflow of 20650 kg, with CSOs contributing 15,500 kg (approx. 75% of the total organic load). The total Phosphorus (TP) inflow reaches 858 kg, primarily driven by the WWTP effluents and CSO discharges. On the other side main TN input is 26397 kg and is mainly driven by the WWTP effluents while CSO is only 1481 kg, this important contribution for WWTP is because they don't have nitrification / denitrification processes so while these are not implemented any CSO benefit in relation to TN is almost null as long as the WWTP processes are not improved.
- Parameter Evolution:
    - OD: River has a stable background concentration of 10 mg /l approx.. reflecting high quality conditions. As the simulation progresses the CSO discharges of BOD5 produces a significant biochemical demand causing oxygen drop seen in downstream sections (Butarque and Huertos de Perales), later on OD recovers to normal DWF values. The 3D surface plot illustrates that this depletion is not instantaneous but travels as a "valley" of low oxygen that tracks the movement of the pollutant wave downstream.

- BOD5: The mass balance for the 7.8 mm event reveals that CSOs are the dominant source of organic stress, contributing 15500 kg out of a total inflow of 20650 kg. Under standard rules, these discharges occur in high-concentration pulses. The 3D and the longitudinal axis profiles show that BOD concentrations spike from a near-zero DWF baseline to significant peaks above 100 as the wave passes through the reach (see Figure 58).
- Ammonium: Ammonium serves as a critical indicator of acute environmental impact due to its potential toxicity. The temporal evolution at Butarque control sections shows distinct peaks that correlate directly with the CSO discharges, but Huertos de Perales section happens the opposite, since WWTP don't have denitrification, the DWF concentration here is around 8 mg/l and CSO discharges can dilute this high concentrations to 6 mg/l (see Figure 58).

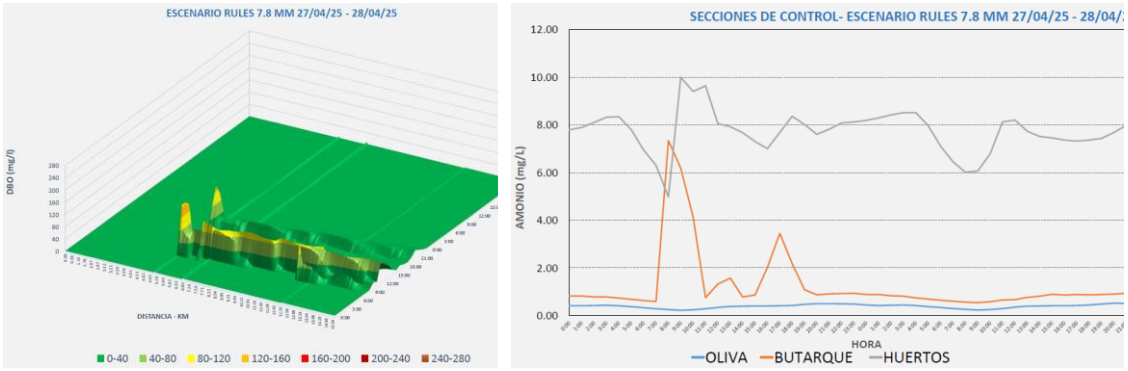


Figure 58.- Example of parameter evolution results for the small rain event. Left BOD, right Ammonium

7.9.2.2 Analysis of the Medium Rain Event (14.2 mm – 11/02/2025)

- Mass Balance Insights: The total organic load increases significantly, with BOD5 inflows reaching 28,802 kg. The CSO contribution rises to 23,419 kg, highlighting that even moderate rains generate substantial untreated discharges under standard management. Total Nitrogen inflows are recorded at 27,133 kg, with the WWTPs contributing with an 83% and CSO only with 10 %.
- Parameter Evolution:
  - BOD5 and OD: The 3D surface plot illustrates a clearly defined "pollution wave" traveling from the upstream limit where CSOs occur to the end of the reach, showing peaks in case of BOD reaching 130 mg/l and the opposite, a valley in case of OD with below 2 mg/l values.
  - Amonium: The 3D plot shows that river baseline values are in the downstream end of the river reach are around 25 mg/l and CSO cause a valley in the DWF values due to dilution reaching 17 to 20 mg/l

7.9.2.3 Analysis of the Large Rain Event (29 mm – 02/05/2025)

- Mass Balance Insights: The scale of the environmental impact is evident in the mass balance, where the total BOD5 inflow increases to 221962 kg, of which 216344 kg originate directly from CSOs. Similarly, the Ammonium inflow exceeds 32,163 kg. An important difference of -15,653 kg in Ammonium is observed between inflow and outflow, which means significant nitrification processes and sedimentation within the river reach occur during the 3-day simulation.
- Parameter Evolution:
  - BOD5 and OD: The 3D surface plot shows a similar behavior as the previous event but with higher peaks for BOD and lower values in OD.
  - Amonium: Similar results as the previous events but here since here more CSOs pollution is discharged the dilution for the background DWF values is bigger as seen in the 3D plot results or the box analysis for the Huertos de Perales cross section where the box has significantly lower values than in the other events.
- Parameter sheets for this episode show Ammonium concentrations peaking above 30 mg/l at downstream sections. The longitudinal axis demonstrates that the river remains in a highly degraded state for the majority of the episode, with peak BOD5 levels reaching their maximum near the Huertos section. The DO profiles show critical depletion, with large sections of the river reach experiencing a severe drop in oxygen levels that persists until the hydraulic wave of the storm recedes

7.9.3 MPC scenario results and comparison with the baseline scenario

The MPC Scenario evaluates the environmental impact of the LIFE-RUBIES solution, where actuator setpoints are computed in real-time to minimize pollutant mass discharge and urban flooding.

In the subchapters below some general comments and some interesting graphs are highlighted.

7.9.3.1 Analysis of the Small Rain Event (7.8 mm – 27/04/2024)

- Mass Balance: For this low-intensity event, the MPC controller significantly reduces the organic stress on the river. The total BOD inflow is recorded at 13745 kg, a substantial decrease from the 20650 kg observed in the Baseline scenario. Combined Sewer Overflows (CSOs) contribute 8055 kg, representing only 58.6% of the total organic load, compared to 75% in the baseline. Similar reductions in CSO discharges are obtained for the other parameters, but the ammonium or TN CSO reduction is only representing around 1% compared with the total input (mainly coming from WWTPs inflows) so the benefits of these improvements will not be seen in the river quality for these other parameters.

CSO Mass Balances	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
Rules CSO mass input	15499.7	1480.7	393.7	1087.0	0.0	259.4	233.4	25.9
MPC CSO mass input	8054.7	846.8	240.5	606.3	0.0	142.6	128.4	14.3
CSO discharge improvement	7445.0	633.9	153.1	480.8	0.0	116.7	105.0	11.7
Rules total input (River Head+WWTPs+CSO)	30933.9	76077.3	15081.5	49571.9	11423.9	2053.2	1802.6	250.5
% CSO discharge improvement vs total river input	24.1%	0.8%	1.0%	1.0%	0.0%	5.7%	5.8%	4.7%

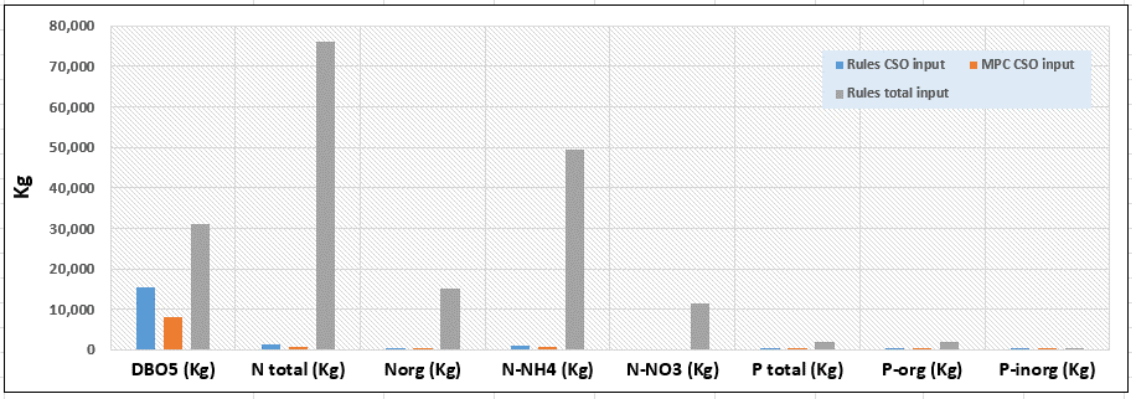


Figure 59.- CSO Mass pollution discharge comparison between baseline (rules) scenario input and MPC scenario for 7.8 mm event

- Parameter Evolution: The dynamic evolution of OD shows a much shallower oxygen sag than the baseline, with the river maintaining higher saturation levels throughout the episode (for example in Huertos cross section OD has values around 3 in Manzanares , while in MPC they are around 5 mg/l. Opposite graphs are obtained for BOD with peaks of 100 in baseline while in MPC the peaks are around 70. For the other parameters the differences are minimal.

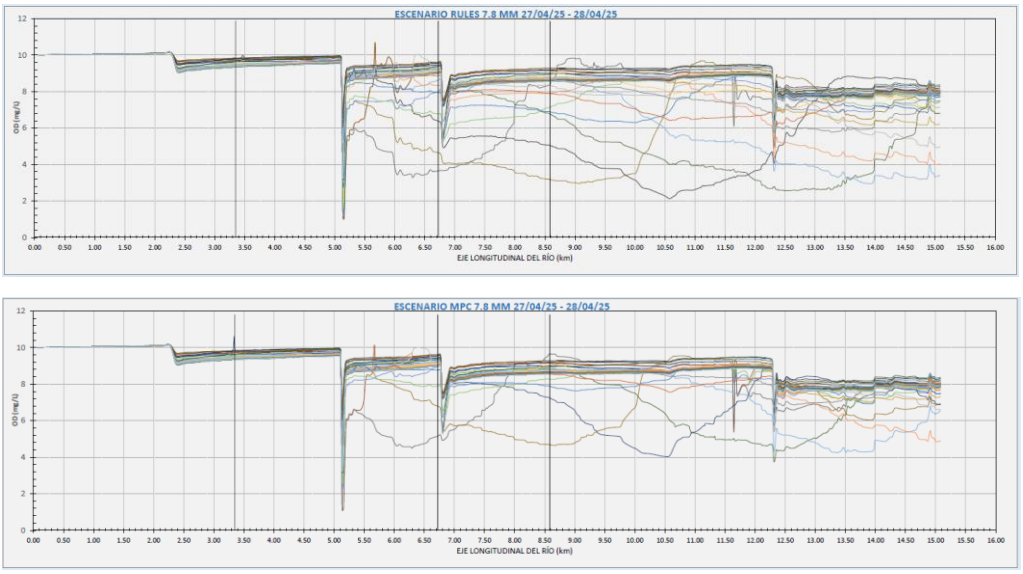


Figure 60.- Evolution of OD through the river reach where it can be seen than in MPC (graph below) values are never below 4 while in rules scenario for several Km and periods of time the values are below 4 (graph above)

7.9.3.2 Analysis of the Medium Rain Event (14.2 mm – 11/02/2025)

- Mass Balance: Total BOD inflow is 21707 kg, with CSOs contributing 16324 kg. This represents a 30% reduction in organic load compared to the baseline's 23419 kg from CSOs. For other parameters reduction is smaller as seen in the figure below.

CSO Mass Balances	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
Rules CSO mass input	82894.0	8436.0	2163.6	6272.3	0.0	1470.4	1323.4	147.0
MPC CSO mass input	54169.8	5717.0	1408.3	4308.7	0.0	998.7	898.8	99.9
CSO discharge improvement	28724.2	2719.0	755.3	1963.6	0.0	471.8	424.6	47.2
Rules total input (River Head+WWTPs+CSO)	99041.6	82666.2	17162.9	54989.0	10514.2	3604.3	3231.8	372.5
% CSO discharge improvement vs total river input	29.0%	3.3%	4.4%	3.6%	0.0%	13.1%	13.1%	12.7%

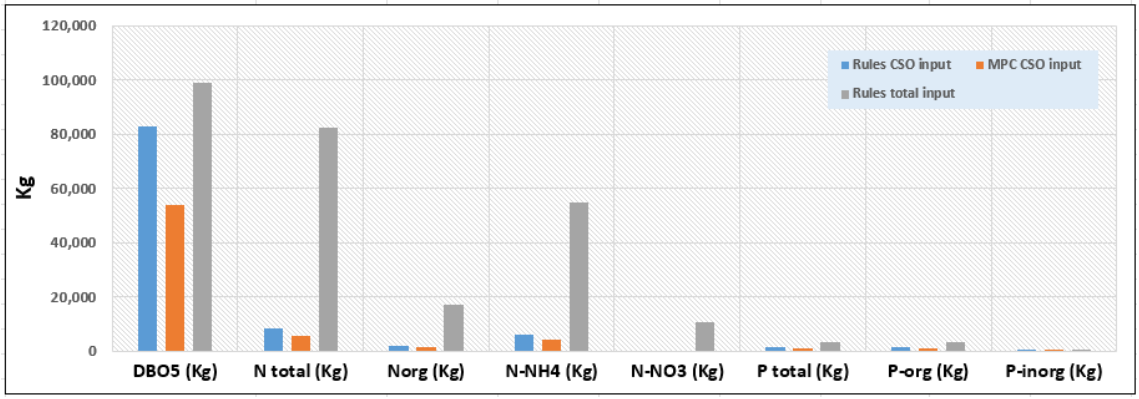


Figure 61.- CSO Mass pollution discharge comparison between baseline (rules) scenario input and MPC scenario for 14.2 mm event

- Parameter Evolution: The OD profiles show that while an oxygen sag occurs, the duration of critical hypoxia (OD < 2 mg/l) is highly reduced in comparison with the baseline scenario. The 3D surface plots for BOD5 illustrate a more controlled "pollution wave" that travels through the 16 km reach without the extreme concentration spikes seen under the baseline rules. For the other parameters no significant differences can be observed.

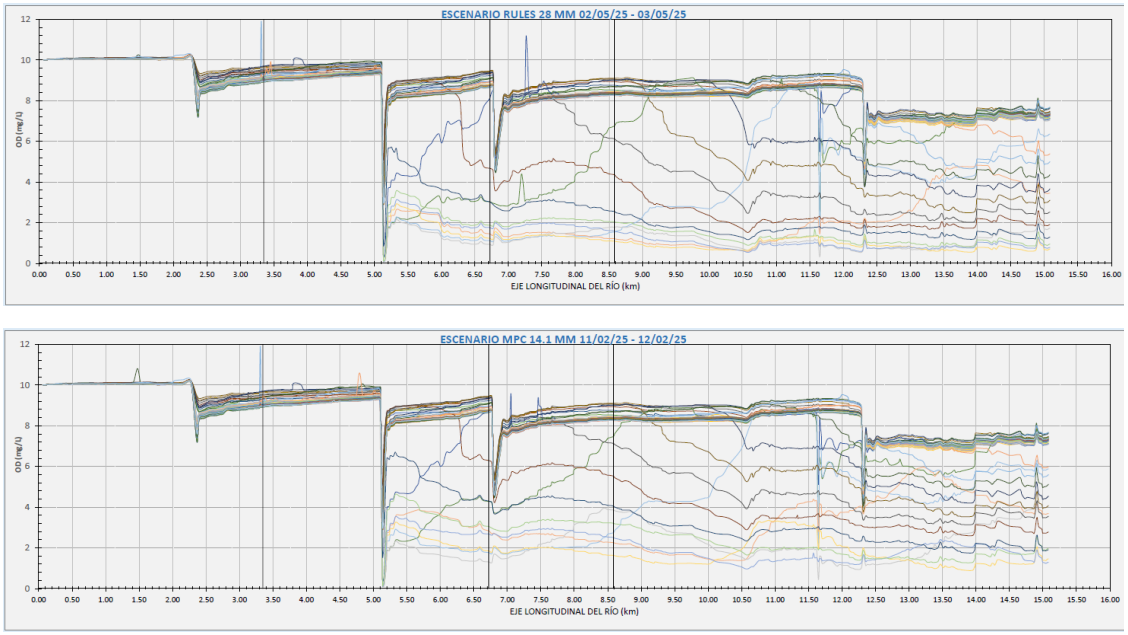


Figure 62.- Evolution of OD through the river reach where it can be than critical hypoxia (OD < 2 mg/l) is reached much more often and during more kilometers in in rules (graph above) than in the MPC scenario.

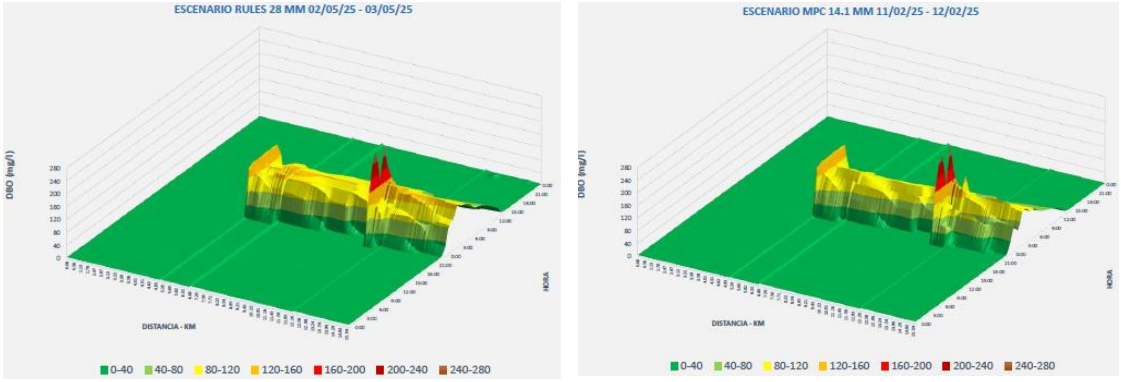


Figure 63.- BOD5 surface plots where it can be seen that in rules scenario (left) concentrations are higher than in MPC (right)

7.9.3.3 Analysis of the Large Rain Event (29 mm – 02/05/2025)

- Mass Balance: This event demonstrates the performance when the system reaches its hydraulic limit. As mentioned previously the CSO volumes are increased to reduce floods. This increase in CSO volumes has a small impact to the pollution mass discharged (10% in case of BOD5 and smaller for the other parameters) as seen in the table below.

CSO Mass Balances	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
Rules CSO mass input	216380.5	21505.2	5589.5	15915.6	0.0	3770.0	3393.0	377.0
MPC CSO mass input	240799.2	22210.6	5740.0	16470.6	0.0	4045.7	3641.1	404.6
CSO discharge improvement	-24418.6	-705.5	-150.5	-555.0	0.0	-275.6	-248.1	-27.6
Rules total input (River Head+WWTPs+CSO)	233204.8	102533.7	21941.9	64666.2	15925.5	6039.3	5369.3	670.1
% CSO discharge improvement vs total river input	-10.5%	-0.7%	-0.7%	-0.9%	0.0%	-4.6%	-4.6%	-4.1%

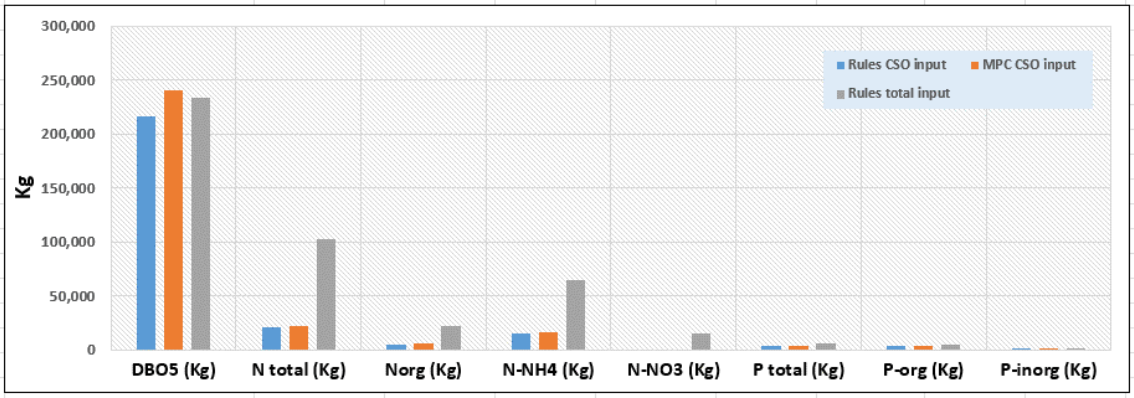


Figure 64.- CSO Mass pollution discharge comparison between baseline (rules) scenario input and MPC scenario for 29 mm event.

- Parameter Evolution: The minimum differences in the mass pollution discharges don't provide any difference in the pollution concentration in the river as highlighted for example for OD in the control cross sections (figure below)



Figure 65.- OD comparison between rules scenario (left) and MPC scenario (right) where no significant differences can be appreciated

7.9.4 KPI scenario comparison

In this chapter the scenario comparison for the three rain events is done based on the main KPIs indicators defined in chapter 7.3.3. These are for DO, BOD5 and ammonium in terms of:

- Magnitude of Improvement: Difference in absolute minimum and maximum concentrations.
- Temporal compliance: The total number of hours a specific river section remains above or below critical thresholds.

- Spatial impact: The maximum longitudinal distance (in km) of the river reach that fails at some instance of the simulation results to meet quality standards during the transit of the pollution wave.

Table 32.- KPI minimum and maximum concentration values for the different rain events and both scenarios

Event	Parameter	Rules scenario	MPC scenario
Small (7.8 mm)	Minimum OD	2.13	4.04
	Maximum BOD	102	145
	Maximum Ammonium	20.13	19.86
Medium (14.2 mm)	Minimum OD	0.32	0.44
	Maximum BOD	163.99	162.93
	Maximum Ammonium	26.39	26.39
Large (29 mm)	Minimum OD	0.18	0.18
	Maximum BOD	183.72	183.72
	Maximum Ammonium	18.14	18.14

Table 33.- KPI temporal compliance (in hours) for the different rain events and both scenarios

Event	Parameter	Parameter limit	Rules	MPC	Difference MPC vs Rules
Small (7.8 mm)	OD	<3	2	0	**-2**
		>=3 and <5	2	2	**0**
		>=5	68	70	**2**
	Ammonium	<0.5	72	72	**0**
		>=0.5 and <7.8	0	0	**0**
		>=7.8	72	72	**0**
	BOD_5	<6	72	72	**0**
		>=6 and <10	2	1	**-1**
		>=10	11	10	**-1**
Medium (14.2 mm)	OD	<3	8	7	**-1**
		>=3 and <5	5	5	**0**
		>=5	59	60	**1**
	Ammonium	<0.5	72	72	**0**
		>=0.5 and <7.8	0	0	**0**
		>=7.8	72	72	**0**
	BOD_5	<6	72	72	**0**
		>=6 and <10	39	39	**0**
		>=10	15	15	**0**

Large (29 mm)	OD	<3	14	14	**0**
		>=3 and <5	3	3	**0**
		>=5	55	55	**0**
	Ammonium	<0.5	72	72	**0**
		>=0.5 and <7.8	0	0	**0**
		>=7.8	72	72	**0**
	BOD_5	<6	72	72	**0**
		>=6 and <10	2	2	**0**
		>=10	23	23	**0**

Table 34.- KPI spatial impact (in Km of river reach) for the different rain events and both scenarios

Event	Parameter	Parameter limit	Rules	MPC	Difference MPC vs Rules
Small (7.8 mm)	OD	<3	1.379	0.0	**-1.329**
		>=3 and <5	3.116	1.555	**-1.561**
		>=5	10.525	13.415	**2.89**
	Ammonium	<0.5	5.044	5.044	**0**
		>=0.5 and <7.8	4.408	4.408	**0**
		>=7.8	8.312	8.312	**0**
	BOD_5	<6	14.99	14.99	**0**
		>=6 and <10	0.245	0.517	**0.272**
		>=10	8.097	8.312	**0.215**
Medium (14.2 mm)	OD	<3	9.976	9.525	**-0.451**
		>=3 and <5	0	0.451	**0.451**
		>=5	5.044	5.044	**0**
	Ammonium	<0.5	5.01	5.01	**0**
		>=0.5 and <7.8	3.479	3.479	**0**
		>=7.8	9.976	9.976	**0**
	BOD_5	<6	14.85	14.85	**0**
		>=6 and <10	0	0	**0**
		>=10	9.995	9.995	**0**
Large (29 mm)	OD	<3	9.777	9.777	**0**
		>=3 and <5	1.043	1.043	**0**
		>=5	4.2	4.2	**0**
	Ammonium	<0.5	6.658	6.658	**0**
		>=0.5 and <7.8	1.163	1.163	**0**
		>=7.8	9.657	9.657	**0**
	BOD_5	<6	15.02	15.02	**0**
		>=6 and <10	0	0	**0**
		>=10	10.82	10.82	**0**

From the tables above the following conclusions can be obtained, some of them were already mentioned on the analysis of the results from previous chapters:

- No major conclusions can be drawn from the minimum and maximum KPI concentration values. Except for the minimum dissolved oxygen (DO), where the rules-based scenario yields 2.13 compared to 4.04 under MPC, the remaining values are very similar. This is because introducing high mass loads into a single 2D model cell produces comparable extreme values in both scenarios. In fact, these minimum and maximum concentrations are not representative of the actual river reach conditions until sufficient mixing has occurred downstream of the discharge point.
- For the large rain event (29 mm) there are no significant differences in river quality between baseline scenario and MPC scenario for none of the quality parameters.
- In general, for all rain events there are no significant differences for the river ammonium concentrations between both scenarios. This is because WWTP have no denitrification processes so the CSO ammonium that can be reduced by the MPC scenario represents a small amount in comparison to the total ammonium reaching the river through the WWTP effluents.
- Bigger differences can be observed in OD (and BOD since they are related) for small and medium rain events.
    - For small rain events the hours with OD values below 3 mg/l are reduced from 2 to 0, and the river length decreased by 1.3 Km. Values above 5 mg/l increased by 2 hours (from 68 to 70 hours) and the river length increased by 2.89 Km. This means that for small rain events (the ones that occur more frequently) hypoxia is avoided with the MPC scenario.
    - For medium rain events the hours with OD values below 3 mg/l are reduced from 8 to 7 and the river length reduced by 0.5 Km. OD values above 5 mg/l is increased by 1 hour although the distance affected remains the same.

7.10Main conclusions

The comparison across representative rainfall episodes reveals that the MPC strategy provides a significant environmental "shaving" of acute pollution peaks, particularly during small-to-medium events:

- Mitigation of Hypoxia: In the 7.8 mm rain event, the duration of critical hypoxia (Dissolved Oxygen < 3 mg/L) is avoided, while the river length maintaining healthy DO levels (> 5 mg/L) is increased in hours and Km

The results for the 29 mm large-scale event highlight the operational priorities of the MPC controller. At this hydraulic threshold, the controller prioritizes the prevention of urban flooding, which occasionally results in CSO volumes slightly higher (approx. 5-10%) than the rules-based scenario to ensure public safety. Consequently, in extreme events, the environmental benefit in terms of river quality is neutral, as both scenarios experience significant ecological stress.

A key finding of the scenario comparison is that Ammonium concentrations in the river are less responsive to CSO management than organic matter or DO. This is due to the high continuous background pressure from the Sur and Butarque WWTPs, which currently lack advanced nutrient removal. This baseline pressure frequently overshadows the improvements made in the sewer network, suggesting that the full ecological potential of the reach will require the integration of the LIFE-RUBIES solution with future WWTP upgrades.

The successful implementation of the MPC controller in the pilot area serves as a definitive "proof of concept" for the LIFE-RUBIES solution. The modeling results confirm that centralized, real-time management is fundamentally superior to static, rules-based operation for protecting the Manzanares River by using the available tank storage more efficiently (Abroñigales and Butarque tanks). But these results are achieved within a pilot reach characterized by limited hydraulic flexibility and a restricted number of operational actuators.

The transition from this pilot phase to the full-scale implementation across the entire Manzanares sanitation system optimizing larger detention volumes (as envisioned in the After-LIFE Plan) is expected to provide greater river quality benefits across all the urban Manzanares reach.

8 Improvements in Canal operation strategy

Since the project's inception in late 2021, several areas for improvement were identified in the management of the Manzanares system, particularly concerning the pilot zone actuators. Besides the need to implement a real time operation tool for system management during rain episodes, another significant enhancement opportunity layed in increasing coordination levels among the various departments and subcontracted companies involved in the pilot zone's management.

It is to be highlighted that Canal de Isabel operation structure in a certain way uneases a coordinated operation of the drainage system, as the different kinds of infrastructures comprised are managed by separate Areas. In addition, maintenance and operation tasks of these elements is subcontracted by Canal to private companies. Therefore, coordination is demanded among the following agents:

- CYII Areas
    - Operation and Conservation Areas: Responsible for the sewer network and stormwater tanks operation and maintenance. . Two different areas are involved (one operates the interceptor, tributary sewers and tanks located in the left bank of the Manzanares river while those elements located in the right bank are managed by another Area). Moreover, as stated before, each tank is managed and maintained by a different subcontracted company, with Canal conservation Area coordinating operations and conveying instructions during incidents and rain events.
    - WWTPs Operation Area: Responsible for WWTP management and effluent quality compliance. Here also, each WWTP is operated and maintained by a different subcontracted company.
- Subcontracted companies: 4 subcontracted companies are in charge of the management, maintenance and operation of Butarque tank, Abroñigales tank, Butarque WWTP and Sur WWTP.

At the project's outset, each stakeholder operated the infrastructure for which they were responsible with limited, compartmentalized information, relevant only to their direct management scope. The existence of independent SCADA Systems in each WWTP with only limited data sharing within Canal de Isabel central SCADA uneased the possibility of accomplishing centralized operation procedure.

In this sense, the LIFE-RUBIES project and AQDV implementation have successfully facilitated information sharing among operators, providing a comprehensive system-wide operational view. However, despite the existence of this platform, Canal still needs to update integration work which remains pending, particularly regarding the sharing of key operational signal data from Butarque WWTP. At the time being, successful integration has been achieved with Sur WWTP most important sensors, which are now visible in Canal central SCADA and consequently in AQDV. It is expected that in the close future Butarque WWTP sensing will also be incorporated to Canal´s principal SCADA.

A second major improvement area addressed communication of operational actions. Before the engagement of Canal to the Life Rubies project, tank filling operations were in a certain way automated through basic established protocols and PID-controlled setpoints. However, tank emptying remained as a complete manual process, requiring telephone coordination between Canal different Tank operators and WWTP staff during working hours to determine operational status, emptying priorities, and deciding setpoints which were communicated again by phone to tank operators. Although general protocols and logical emptying sequences existed, the process relied heavily on manual intervention. Currently, while operator supervision remains necessary, particularly during WWTP operational issues or anticipated rainfall events, and some manual telephone coordination is still required, significant improvements have been achieved through the LIFE-RUBIES project.

Besides these general operation benefits obtained from the implementation of the AQDV solution, particular operation rules have been modified, based upon the setpoints suggested by the optimizer during the simulations accomplished. In the following subchapter, some detailed explanations and examples of the most important improvements achieved are described.

8.1 Reduction of CSO discharges in right margin interceptor by improving Butarque tank filling operations

Early analysis of rainfall events revealed significant improvement opportunities in Butarque tank filling operations. A consistent pattern was observed across most of the analyzed rain events: Combined Sewer Overflows (CSOs) were occurring from Right Bank discharge points (either through Partidor Butarque Divider or, more frequently, through the Butarque WWTP head bypass) before or during tank filling operations. While achieving ideal management - preventing any overflow before tank capacity was reached - presented challenges, simulations accomplished with the use of the AQDV optimizer algorithm evidenced that there was substantial room for improvement. This optimization potential was communicated during initial operator meetings, emphasizing the need for earlier and more complete tank utilization.

In order to achieve a quicker response in Butarque tank filling operations, progressive improvements were achieved through the implementation of two key measures:

- PID Level Sensor Adjustment: The activation threshold for Butarque tank inlet gates was lowered from its initial setting of 2.75m to 2.5m in the Left Bank collector level sensor PID controller, enabling opening earlier the gates and start filling the tank
- Butarque´s WWTP Head Bypass Gate Control: Previously, the WWTP head bypass gate operated as a safety mechanism, being always open. Consequently, when Left Bank interceptor inflow exceeded WWTP capacity, there were river discharges concurrent with tank filling. The revised strategy maintains this gate closed until either the tank reaches full capacity or collector levels indicate a flooding risk.

The synergistic implementation of these operational modifications has yielded remarkable results. Recent rainfall events in 2025 demonstrate achievement of ideal management

conditions, with no Left Bank interceptor discharges occurring before Butarque tank reaches full capacity.

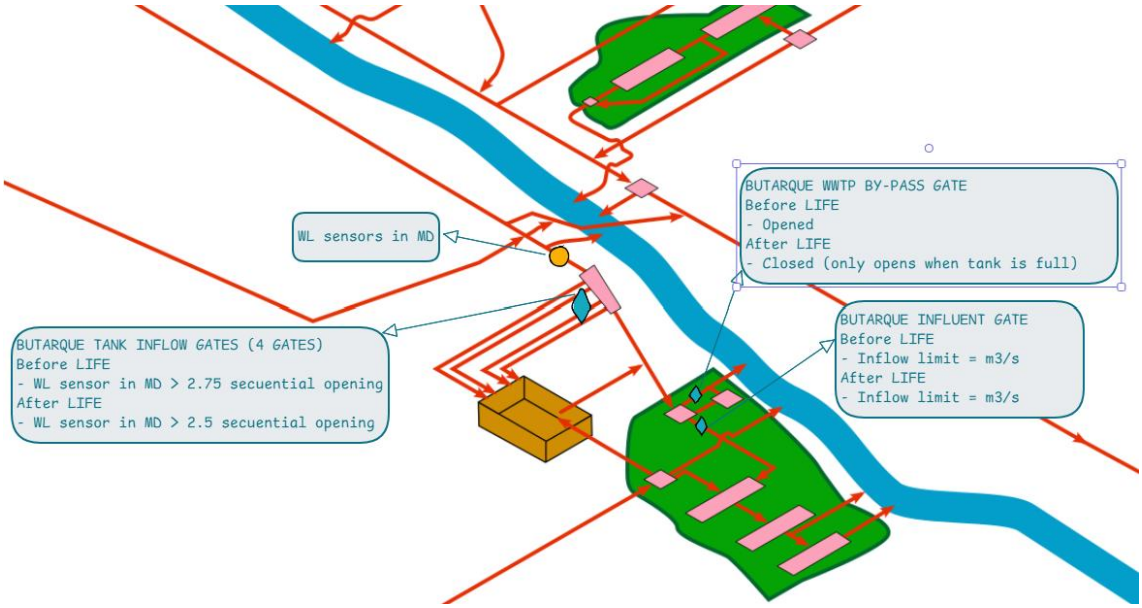


Figure 66.- Description of the three main improvements in Butarque tank filling to reduce CSO discharges from right margin interceptor

The following two rainfall events demonstrate the improvement in system management:

- Event of June 8, 2024: With a rainfall of 4.2 mm, the Butarque tank only filled to 23% of its volume, yet there was discharge at the plant head with a maximum flow of 4 m^3/s. (see Figure 67).
- Event of March 1-4, 2025: Multiple rainfall intervals totaling more than 25 mm, during which the Butarque tank filled gradually, and CSO discharges did not begin until the tank was nearly full (around 95% capacity), first discharging at Partidor Butarque Divider and after at Butarque´s WWTP head by pass (see Figure 68)

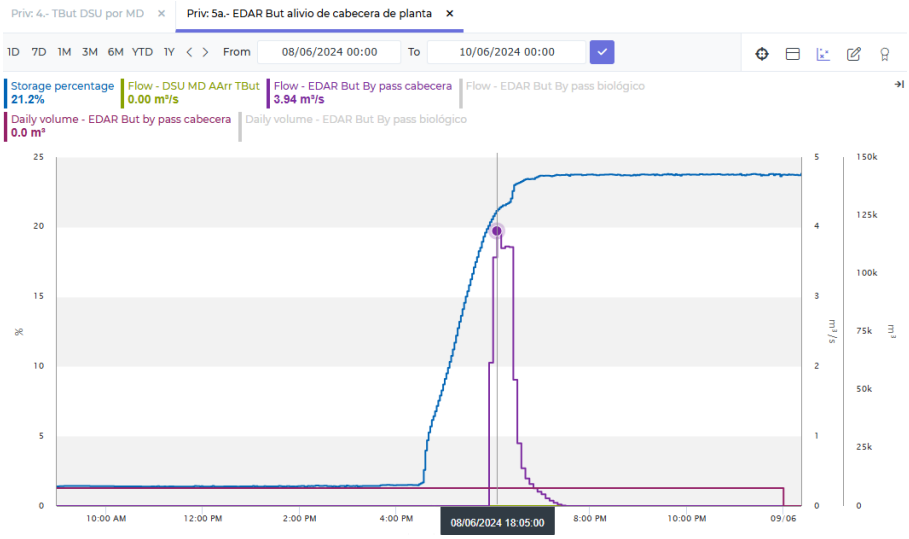


Figure 67.- Filling tank operation for the 8/6/2024 rain event where there is CSO for a small rain event even if the tank is only at 23%



Figure 68.- Filling tank operation for the 1/3/2025 rain event where there is no CSO until the tank is filled at 95 %

8.2 Reduction of CSO discharges in left margin Aliviadero Sur by improving Abroñigales tank filling.

The same strategy of maximizing tank filling that was applied to Butarque tank was attempted in Abroñigales tank. Still, there is a significant structural difference between these two storage elements. While Butarque Tank directly diverts flow from the main right margin interceptor, Abroñigales Tank intercepts a tributary branch of the left margin interceptor. This means that only part of the flow which runs down the left bank interceptor can be derived to the tank.

Consequently, CSO at Sur overflow point can occur despite any improvement in the tank filling procedure.

The optimal management strategy for Abroñigales tank would ensure that, during rainfall events, even if overflow is occurring at Sur CSO point due to excess flow in the interceptor collector, the tank should retain as much water as possible without any bypass. This approach aims to better utilize the tank's volume, which at the project's start was rarely filled to full capacity, only during severe rainfall events.

The figure below illustrates the scheme of Butarque´s inlet structure.

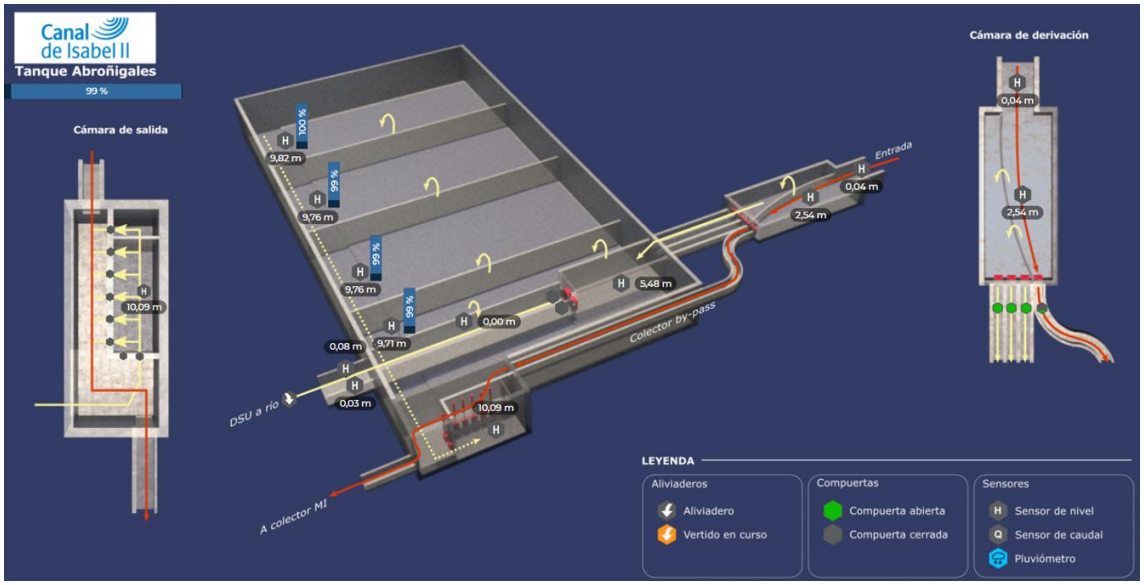


Figure 69.- Scheme of Abroñigales Tank inlet structure.

Tank filling is achieved by means of a lateral weir situated in the inlet chamber. During rain events, in order to speed up tank filling operation, water level in this chamber may be increased by means of closing the gates which connect the tributary sewer to the main interceptor. However, operators were reluctant to implement this solution, citing valid concerns about the high debris content in the flow at this chamber. They argued that closing the gate above a certain threshold could lead to solid accumulation, potentially preventing the gate from reopening when needed.

To cope with this circumstance, a structural modification of the infrastructure was adopted. the solution implemented consisted of lowering the overflow level at the tank's inlet chamber while maintaining the bypass gate fixed at 20% opening. This modification enhanced a quicker tank filling procedure while addressing operational concerns about gate functionality. Looking forward, operators plan to gradually reduce this opening percentage further without compromising gate operation.



Figure 70.- Abroñigales tank Inlet chamber with the lateral weir crest which has been lowered to increase tank filling and also added screening .

8.3 Improving Tank emptying times

While improvements achieved in tank filling procedures were significant, it was tank emptying which presented the greatest opportunity for optimization. The rapid and controlled emptying of an anti-CSO tank is as crucial as its proper filling strategy, if not more so. When a tank remains full or partially full during a rainfall event, this already filled storage capacity is unavailable for management. The worst-case scenario - a rainfall event occurring with a full tank - effectively nullifies the tank's purpose, resulting in all excess flow beyond WWTP capacity being discharged to the river. In addition, if wastewater remains stored for a long time, its quality can deteriorate significantly, a situation that causes odor problems as well as the generation of toxic gases. Furthermore, to achieve the treatment of this water, WWTP have to intensify its treatment processes. At the project's start, tank emptying management was highly conservative, characterized by very slow emptying times. The reasons for adopting these criteria were the following:

- Spanish legislative framework admits discharges during wet weather but strongly forbids CSO in dry weather.
- Madrid City Council's has deployed monitoring cameras at discharge points, with authority to impose fines for improper system management, especially for discharges outside of the rain event time span.
- As a consequence, Canal operators adopted a very cautious approach to avoid rapid tank emptying that could trigger river discharges.

This said, the slow emptying rates were not solely due to operational decisions but also resulted from technical constraints:

- Abroñigales tank emptying gates and Butarque tank pumping station lacked remote control capabilities, so they needed to be operated manually. This situation had a very negative impact on the streamline of the tank emptying procedure.
- Manual operation was limited to working hours and therefore, in general, night-time hours were not utilized for tank emptying, despite this being the timeframe when WWTPs have the most available treatment capacity.
- Abroñigales tank's eight gravity-emptying gates were typically operated at minimal capacity (one or two gates at 10% opening as a maximum)
- Butarque tank's 6.5 m^3/s pumping capacity is restricted to 1 m^3/s maximum until the new primary treatment at Butarque WWTP becomes operational.
- Emptying of Butarque and Abroñigales tank need to be accomplished in coordination with the unloading of two other tanks located upstream and out of the scope of the Project Pilot Area but whose discharges are sent to the same WWTPs.

Throughout the project, emphasis was placed on optimizing emptying procedures, particularly during night hours when dry weather WWTP inflow is lower. Key improvements included the following:

- Correlation was established between flow capacity of Sur WWTP (situated immediately downstream of the pilot area and thus receiving all flows which exceed the system treatment capacity) and water level at the left margin interceptor in a monitoring point located at the end of the study area. Enhanced Emptying Protocol was achieved using this reference: If the level is above 1.55 no emptying is allowed, if it is below 1.4 both tanks can be emptied and in between only Abroñigales is emptied. These levels correlate with the maximum acceptable flow at Sur WWTP during wet weather conditions.
- Despite the benefits obtained after implementing the above-mentioned protocol, the procedure was improved considering also as an input variable water level at the retention basin located in Sur WWTP. The capacity of this element is close to 63.000 m3. It stores treated water in primary decantation during peak flow hours and discharges to biological treatment during minimum flow hours. Thanks to the attenuation capacity of this detention element, the above established water level thresholds in the left bank interceptor could be occasionally surpassed, thus enabling greater flexibility in the tank emptying procedure.

During the project development, remote control implementation for Abroñigales emptying gates and Butarque pumping station was partially achieved. This new situation has reduced the requirement of physical presence at the tanks. Due to these improvements tank emptying times have significantly reduced by:

- Utilizing night hours for Butarque tank pumping
- Optimizing Abroñigales gate operations with increased opening percentages and number of gates in use.

Figure 71 and **Figure 72** compare two similar tank-emptying events demonstrating this improvement in evacuating efficiency achieved through the implemented changes:

- 19/1/2024 Event:
    - Butarque tank at 100% capacity and Abroñigales at 45% capacity
    - Emptying duration: Over 10 days characterized by intermittent operation with several nighttime stops.
- 12/1/2025 Event:
    - Butarque tank at 85% capacity and Abroñigales at 55% capacity
    - Emptying duration: 3 days (Butarque) and 6 days (Abroñigales) with continuous operation without stops
    - In Abroñigales graph, changes in slope which can be observed correspond to increases in gate openings.

After the achievements reached, Canal de Isabel, is keen on improving emptying procedures. For this reason, two significant actuations are to be implemented in the short term:

- Remote Scheduled Tank Emptying so that operators will be able to pre-program specific times and flow rates for pumping stations and schedule gate positions in advance. This is being implemented across major Manzanares system tanks: Arroyofresno (already operational since June 2025), Butarque, China and Abroñigales.
- Advanced control system integration by developing PID-based automations for emptying the tanks depending on water level sensor at left margin interceptor before Sur WWTP and considering water level in Sur WWTP retention basin.

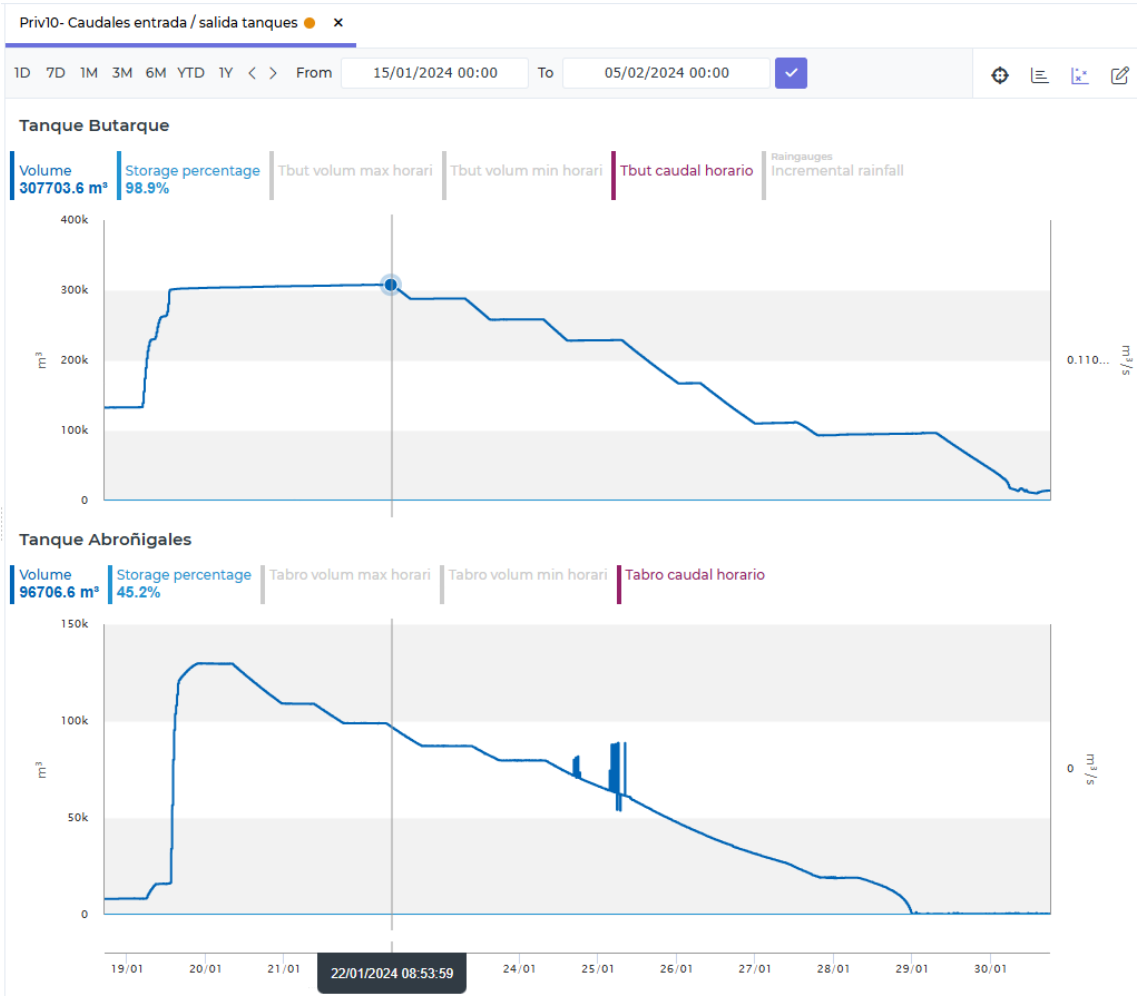


Figure 71.- Butarque and Abroñigales tank emptying for 19/1/2024 rain event. It can be observed that the tank emptying process stops daily during the evening/night hours and resumes between 8:00 and 9:00 in the morning



Figure 72.- Butarque and Abroñigales tank emptying for 12/6/2025 rain event. It can be observed that there are no longer nocturnal stops in the emptying process, and that the emptying slope in Abroñigales tank varies due to increasing the opening gates percentage.

9 Conclusions and next steps

9.1 Introduction

This chapter provides a short summary and the main ideas and conclusions of the deliverable (subchapter 9.2). Additionally, some recommendations are described to be developed and implemented once the LIFE-RUBIES project finishes (subchapter 9.3).

9.2 Conclusions

In this deliverable, the work done for implementing, configuring, testing and evaluating AQDV benefits to provide a better operational management in the pilot area that can reduce the impacts of CSO discharges in the Manzanares river has been explained.

The main conclusions of this work are highlighted below:

- AQDV in Madrid has been implemented and configured since October 2023
  - It works getting real time data from sensors and radar rain forecast as baseline information for launching an hydraulic model that provides the required information about the system foreseen evolution so that actuators setpoints (gates positions and pump flows) are calculated in order to reduce CSO pollution mass discharged and its impact on the Manzanares river.
  - This AQDV operation strategy has been evaluated for one year and a half (from March 2024 until September 2025) by means of real time monitoring (especially during rain events to evaluate AQDV setpoints suggestions in comparison with the real system operation), post-rain event analysis (doing a comparative analysis between AQDV-proposed and operator-implemented actuator management and identifying operation problems and potential improvements) and continuous communication with Canal operators (to discuss about the project progress and gather improvements and feedback from operators) and finally KPI analysis for each rain event in this period (thanks to scenario modelling)
- KPI results have been obtained for this year and a half period:
  - 3 scenarios were compared:
    - Baseline scenario model where before LIFE project operational protocols are implemented
    - Enhanced MPC hydraulic-based scenario modelling
    - Enhanced MPC quality -based scenario modelling
  - The main results evidence that important improvements can be obtained by implementing the AQDV LIFE RUBIES MPC solution (around a 30% reduction in CSO volume discharge, 34 % reduction in SS mass discharge.

- The 2D river quality modeling confirms that these reductions translate into a direct mitigation of acute stress episodes; for small rainfall events, the duration of critical hypoxia (DO < 3 mg/L) was reduced from 2 hours to zero, while the river length maintaining healthy oxygen levels (> 5 mg/L) increased by 2.89 km
- The main benefit is obtained thanks to the implementation of the MPC hydraulic solution, while the quality based MPC solution provides some small extra benefit with regards to the hydraulic optimization (between 1 and 2% extra benefit depending on the indicator parameter).

- Apart of the model based KPIs improvements described, the project has provided real enhancements of Canal Isabel II operational strategy:
  - There has been an important improvement of integrated management, as AQDV provides a system-wide operational view facilitating the information sharing between operators.
  - Also, direct improvements in operational actions have been achieved. As for example, better tank filling operations for Butarque and Abroñigales tanks (which means reduction of CSO discharges) or improvements in tanks emptying procedures (so in case new rain events come the system storage capacity is fully operational to avoid or reduce CSO discharges).

9.3 Next steps

In deliverable **DE2.1 : After LIFE Plan - Exploitation Plan of LIFE RUBIES** more detail is provided about the scale-up plans in Madrid. In the short term, Canal is defining technical specifications for a public tender within the DREINCAM project, focused on extending the scope area of the drainage system where to implement a digital based solution for real time operation of the infrastructure based on quality criteria. Despite the expectancy of the results obtained in the Rubies project, further implementations of the solution deployed cannot be guaranteed as they need to be addressed by means of public bidding exercises because of being Canal a public entity.

Besides this future bidding process, Canal is addressing other tasks searching for a better operation of the Manzanares system:

- In the coming months, a new primary treatment at the Butarque WWTP with an extra capacity of 5 m^3/s will be put into operation, allowing the Butarque tank to be emptied much faster (right now it can only be emptied at 1 m^3/s in order not to exceed the nominal capacity of the Treatment Plant). With this new configuration, tank emptying speed will be significantly increased, thus leading to a clear reduction of CSO volumes.
- Improving the remote-control capabilities of the Manzanares system actuators
- Installation of new sensors (and sometimes redundant ones in important points) so that a better real-time knowledge about the operating condition of the sanitation system is obtained.

Other more specific improvements that were highlighted during the project implementation and will be considered by Canal de Isabel for a future enhancement of the system operation are listed here:

- Implement some raingauges sensors in the Manzanares system catchment (at least 4) which can provide real time 5-minutes detailed rain data.
- Improve robustness of the water level sensor located in Aliviadero Sur, if necessary, by installing a redundant one. This is a key sensor to evaluate CSO discharges and throughout the project duration its malfunctioning has been evidenced on several occasions.
- Connect Butarque WWTP SCADA main tags with the Canal Isabel II SCADA so that real time data from the WWTP can be used for real time computation of the Manzanares system actuators in a similar way as it has been done during the LIFE Rubies project with the Sur WWTP data.
- Improve Canal Isabel II operational protocols with the real time WWTP available capacity to treat the extra runoff flows.
- Improve the current Manzanares system model by checking and validating sewer cross sections and slopes and thus improve the calibration of the model.
- Installation and maintenance of quality sensors (turbidity and conductivity) in the CSO points so that real time quality values can be used to compute the actuator setpoints with the aid of pollutant correlations instead of using the more simplified approach of the MEC values.

ANNEX 1. - Examples of the documents related with the methodology for the operational tests results. Analysis of 11/4/2025 rain event

- Annex 1.1.- Mails for weather monitoring and event preparation
- Annex 1.2.- Post-rain event analysis report and summary mail for CYII operators
- Annex 1.3.- Presentation for the ROC 7 meeting of 5/5/2025 with CYII operators
- Annex 1.4.- Calibration report
- Annex 1.5.- Hydraulic KPI report

ANNEX 1.1.- Mails for weather monitoring and event preparation

- 7/4/2025 at 08:08.- First mail sent:

Descarga datos de pluvia y previsión de lluvia para sábado 12/4 Usuarios externos

Resume este correo electrónico

Sunyer Roqueta, David <david.sunyer@aquatec.es>
para Alejandro, Abraham, Juan, Joaquín

7 abr 2025, 8:08 a.m.

Buenos días,

Abraham cuando puedas durante esta semana descargas los datos de los pluviómetros que así haremos los informes de las lluvias de estas últimas semanas por favor?

Además las previsiones marcan posibles lluvias el sábado 12/4 y domingo. Estaremos atentos y si te parece Alejandro podemos dejar los tomamuestras preparados el viernes e intentar coger muestras en la entrada de la EDAR (aunque si durante la semana van vaciando el tanque quizás no se vierta por aquí) y en primario de EDAR Butarque y llevarlas a analizar el lunes 14 de abril?

Lo comentamos mañana en la reunión y vamos siguiendo las previsiones de lluvia.



Saludos,

D

- 11/4/2025 06:50 Mail confirming forecast predictions

Sunyer Roqueta, David <david.sunyer@aquatec.es>
para Alejandro, Juan, Joaquín, Abraham

Confirmadas las previsiones, lluvias empiezan hoy y duran todo el fin de semana:

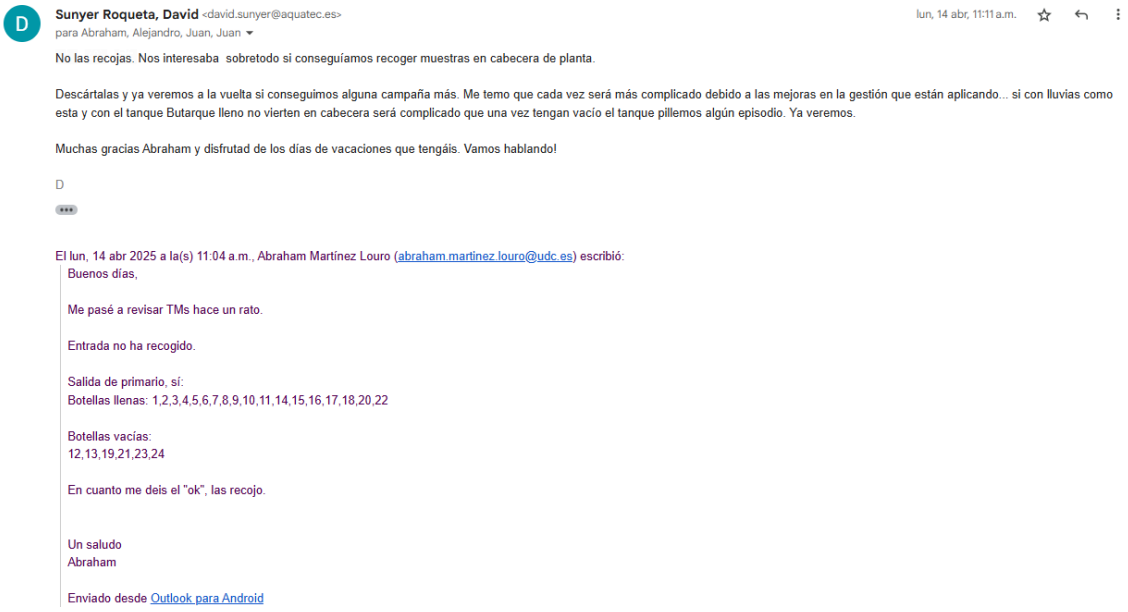


A ver si abren la compuerta de by pass de entrada de EDAR y nos permiten "cazar" alguna muestra.

Saludos,

D

➢ Mail confirming some water samplers were obtained but discarded



Sunyer Roqueta, David <david.sunyer@aquatec.es> lun, 14 abr, 11:11 a.m.
para Abraham, Alejandro, Juan, Juan

No las recojas. Nos interesaba sobretodo si conseguíamos recoger muestras en cabecera de planta.

Descártalas y ya veremos a la vuelta si conseguimos alguna campaña más. Me temo que cada vez será más complicado debido a las mejoras en la gestión que están aplicando... si con lluvias como esta y con el tanque Butarque lleno no vierten en cabecera será complicado que una vez tengan vacío el tanque pillemos algún episodio. Ya veremos.

Muchas gracias Abraham y disfrutad de los días de vacaciones que tengáis. Vamos hablando!

D

El lun, 14 abr 2025 a la(s) 11:04 a.m., Abraham Martínez Louro (abraham.martinez.louro@udc.es) escribió:

> Buenos días,
>
> Me pasé a revisar TMs hace un rato.
>
> Entrada no ha recogido.
>
> Salida de primario, sí:
> Botellas llenas: 1,2,3,4,5,6,7,8,9,10,11,14,15,16,17,18,20,22
>
> Botellas vacías:
> 12,13,19,21,23,24
>
> En cuanto me deis el "ok", las recojo.
>
> Un saludo
> Abraham
>
> Enviado desde Outlook para Android

ANNEX 1.2.- Mails for weather monitoring and event preparation

Análisis de episodios de lluvia del 11 al 13/4/2025 con AQDV UD

LIFE RUBIES









suez · suez le lyre · MEL Métropole Européenne de Lille · CSIC · CETAQUA Water Technology Centre · AQUATEC · Canal de Isabel II · Université de Lille · cnrs · LASIRE

Document Title : Análisis de episodios de lluvia del XX/XX/2024 con AQDV UD	
Partner responsible : AQUATEC	
Authors : AQUATEC, CANAL DE ISABEL II	Date: Mayo de 2023

Modifications (dates)
16/4/2025: Versión 1 y análisis episodio 11/4/2025 (Andrés Crocianelli)

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3. Resumen de dudas y respuestas del Canal 11

1. Introducción

1.1. Objetivos del documento

Este es un documento de trabajo para analizar los episodios de lluvia que se van produciendo, con los siguientes objetivos:

- Comprobar (y corregir si es necesario) la recepción correcta de los datos de los sensores y actuadores del Canal
- Comprobar y entender la gestión actual del Canal en lo referente al llenado y vaciado de los tanques de Butarque y Abroñigales, los actuadores asociados maximizando los caudales enviados a las depuradoras evitando al máximo los vertidos de DSU al río Manzanares.
- Pensar junto con el Canal formas de mejorar esta gestión para aplicar en AQDV
- Empezar a mostrar el AQDV al Canal y mejorar conjuntamente la vista de los sinópticos para que sean lo más claros y útiles posibles.

El documento se estructurará en un capítulo para cada episodio de lluvia analizado y cada uno de ellos tendrá los siguientes subapartados:

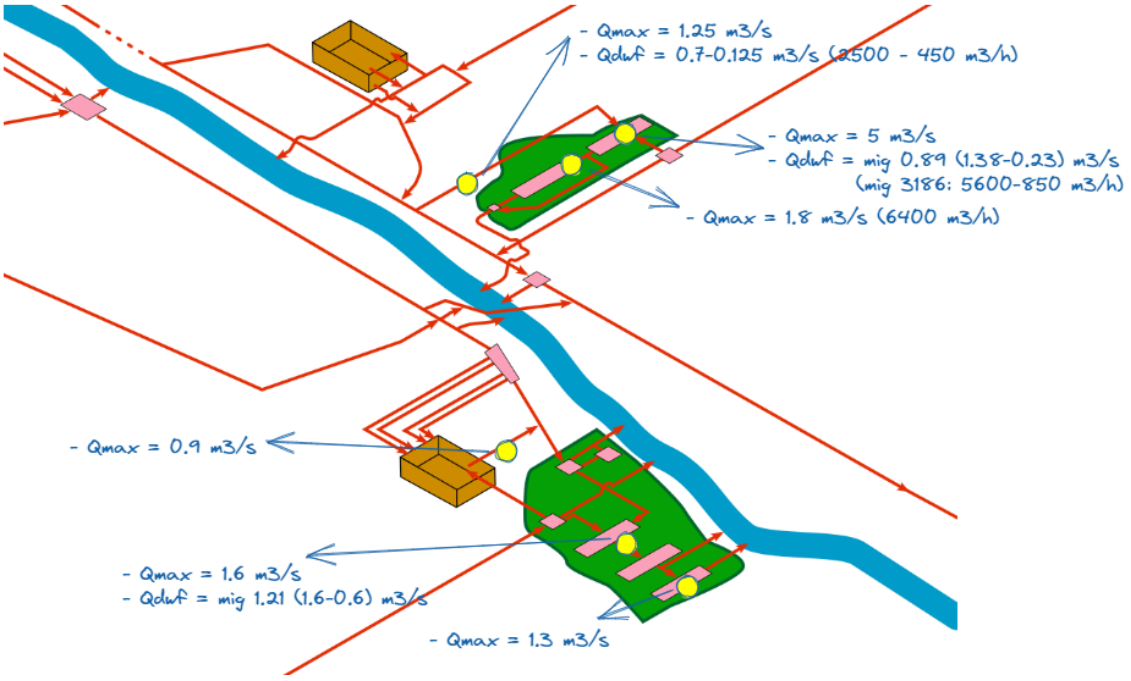
- Descripción general del episodio
- Análisis de la lluvia
- Gestión del tanque Butarque
- Funcionamiento EDAR Butarque
- Gestión de tanque Abroñigales
- Funcionamiento EDAR La Gavia
- Análisis del resto de sensores y actuadores
- Conclusiones y principales dudas

1.2. Resumen de caudales de tiempo seco y caudales máximos en tiempo de lluvia

En este apartado se resumen los caudales máximos en diferentes tramos de la zona de estudio. Estos valores se obtienen tanto de la información obtenida del análisis de los sensores como de la información recopilada de entrevistas con personal del Canal o documentos de éste.

En el siguiente gráfico se presenta:

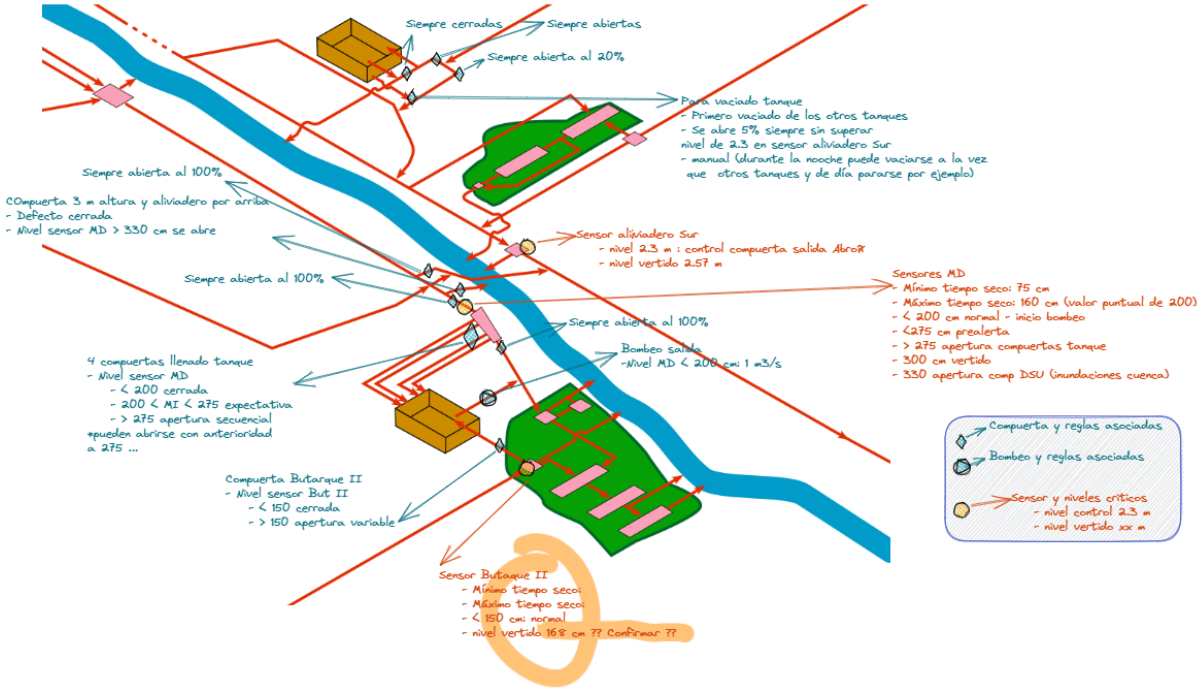
- Qmax: Caudal máximo admisible en tiempo de lluvia
- Qdwf: Caudal máximo, mínimo y medio de tiempo seco



Los caudales máximos en primario y secundario de las depuradoras serán los que se intentan optimizar en tiempo de lluvia para reducir los caudales vertidos a río sin tratamiento (descargas del sistema unitario o DSU).

1.3. Resumen de la gestión actual del Canal

La siguiente figura intenta resumir la gestión actual que hace Canal sobre los actuadores de la zona de estudio. Este resumen se ha obtenido a partir de la información recopilada en estos meses previos.



En función de estas instrucciones reglas es como se analizan los episodios de los apartados siguientes y en función del debate y los comentarios que se vayan obteniendo se irá actualizando este esquema - resumen.

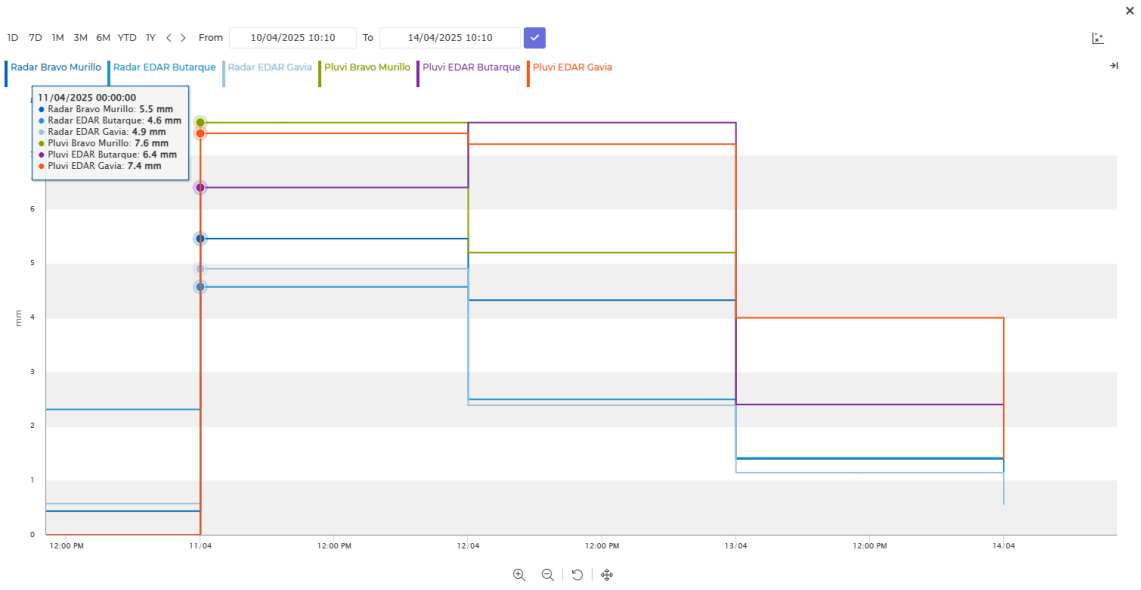
2. Episodio 11/4/2025 (3 días)

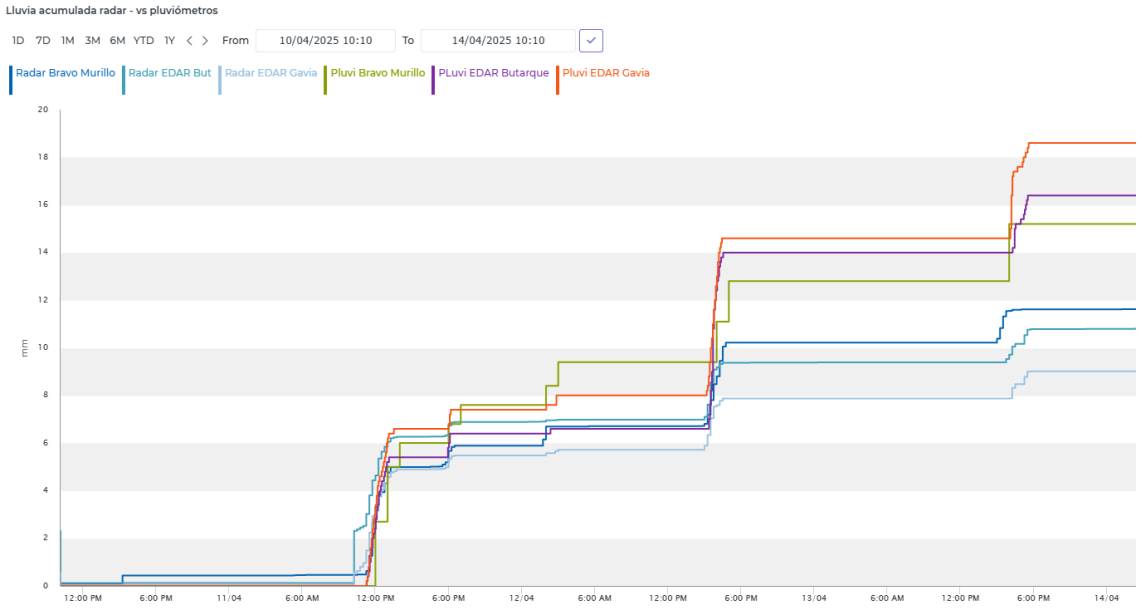
2.1. Descripción general del episodio

- Lluvia
  - Entre 10 y 15 mm totales de viernes a domingo con 3 instantes de mayor intensidad que provocan vertidos
- Llenado de tanques
  - Tanque Butarque ya estaba lleno al inicio de los episodios
  - Tanque ABroñigales empezaba alrededor del 23% al inicio de los episodios y solo se llena hasta el 29% con el episodio del 11/4 a las 13h. En los episodios sucesivos no se llena nada
    - La compuerta de by pass se mantiene fija al 25%
    - Me sorprende que se llena poco quizás y más teniendo las compuertas de la cámara Convenio cerradas y desviando aguas hacia aquí? Imagino que ya está bien me decías que el ayuntamiento está trabajando en el punto de vertido al río, pero igulamente con la compuerta al 25% pensaba que entraría más agua
- DSU
  - Hay DSU por Partidor Butarque. Volumen = 141000 m3
  - Por Butarque II. Volumen = 294000 m3
  - Cabecera de planta EDAR Butarque sin DSU
  - Aliviadero de emergencia de tanque Abroñigales., Sin DSU lógicamente
  - En aliviadero Sur. Volumen = 233000 m3
  - En cabecera de EDAR Sur. Volumen = 350000 m3
- Vaciado de tanques
  - Los días posteriores hay más lluvia y la previsión es que continue lloviendo con lo que hay pocas opciones de vaciarlos
  - Solo Abroñigales se vacía lentamente en algún periodo con caudal máximo de 0.3 m3/s (Ahora por ejemplo)
  - Como siempre parece que hay alguna opción de vaciar antes los tanques (la balsa de EDAR Sur está bajando nivel y caudal tratado inferior a 4 m3/s) sobretodo si estuviera automatizado, por ejemplo:
    - 13/4/2025 entre la 01:00 y hasta las 16:00 y el mismo periodo aprox. del 14/4

2.2. Análisis de la lluvia

- Bravo Murillo: 15.2 mm 3 dies
  - 2025/04/11 >> 7.6
  - 2025/04/12 >> 5.2
  - 2025/04/13 >> 2.4
- AEMET Retiro: 19.4 mm
  - 2025/04/11 >> 8.7 mm
  - 2025/04/12 >> 7.1
  - 2025/04/13 >> 3.6
- Datos UdC
  - EDAR Butarque: 16.4mm
    - 2025/04/11 >> 6.4
    - 2025/04/12 >> 7.6
    - 2025/04/13 >> 2.4
  - EDAR Gavia: 18.6mm
    - 2025/04/11 >> 7.4 mm
    - 2025/04/12 >> 7.2
    - 2025/04/13 >> 4
- Radar Canal Pluviómetro (pluviómetro virtual) (los 3 días)
  - Bravo Murillo: 11.2 mm
  - EDAR But 8.5 mm
  - EDAR Gavia: 8.4 mm
- Comprobación radar - pluvis
  - Multiplicar por 1.5 - 2 aprox.





2.3. Gestión del tanque Butarque

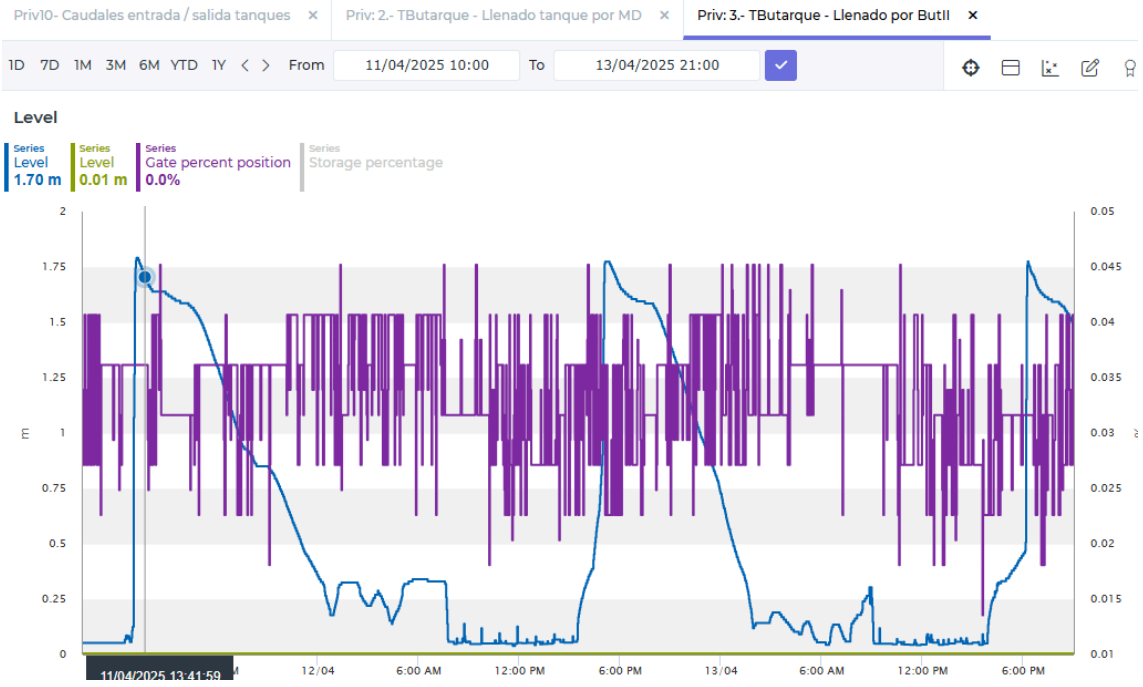
2.3.1. Llenado tanque por MD

- Volumen inicial tanque 100%
- Niveles MD aar1 i aar 2 TBut >> Miden lo mismo ok
- Apertura y cierre compuertas
    - Todas cerradas al tener tanque lleno
- Tanque se mantiene lleno todo el episodio y los días posteriores



2.3.2. Llenado tanque por Butarque II

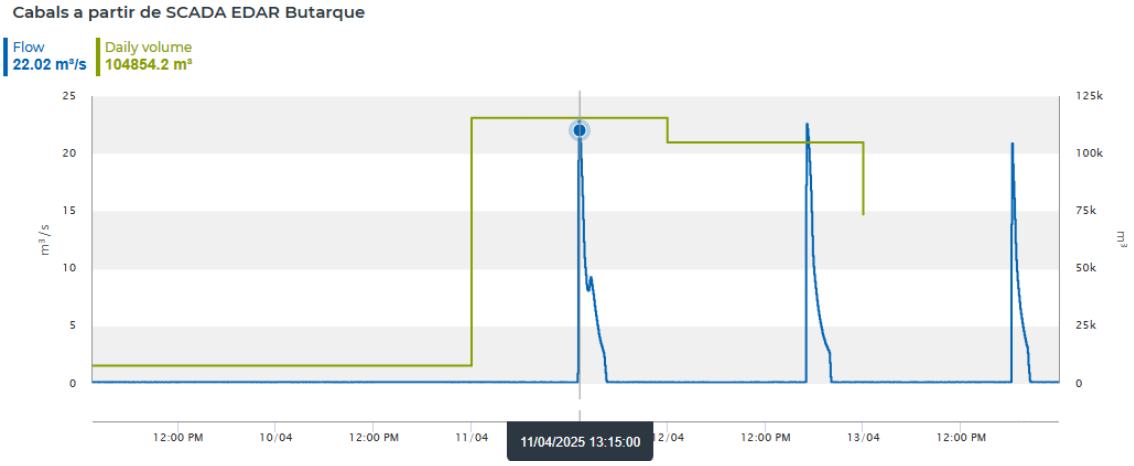
- Con tanque lleno la compuerta se mantiene cerrada



2.3.3. DSU

- 3 instantes de DSU
- DSU por MD
    - Cuando nivel llega a 3.3 m se abre compuerta de DSU
    - Volumen total = 141000 m3
    - Qmax = 12.6 m3/s
- DSU per But II
    - Según SCADA de EDAR Butarque
    - Volumen total = 294000 m3
    - Qmax = 22 m3/s
- DSU en cabecera de EDAR
    - **Sin DSU**
    - Compuerta cerrada





2.4. Gestión de tanque Abroñigales

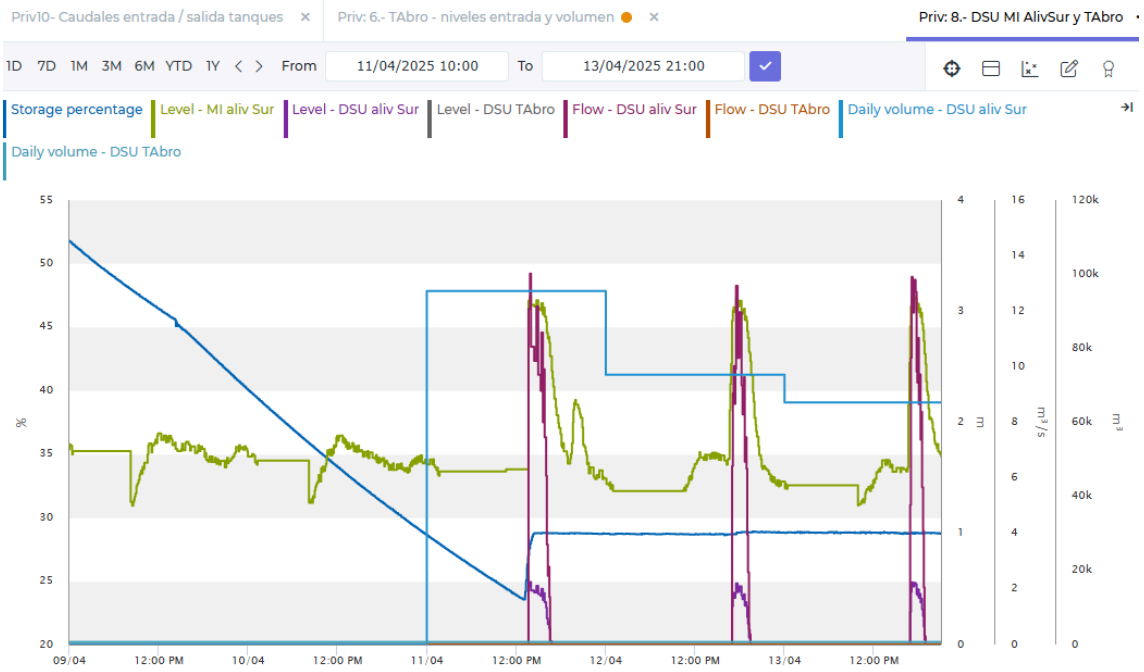
2.4.1. Llenado de tanque

- Empieza alrededor del 23 % y se iba vaciando hasta el episodio del 11/4 a las 13h que se llena aunque muy poco hasta 29%
    - Caudal máximo de llenado 2.8 m3/s
- La posición de compuerta se mantiene constante al 25%
- **Se llena muy poco? Se intenta evitar imagino porque estan trabajando Ayto en la salida de DSU del tanque?**



2.4.2. DSU en aliviadero Sur

- DSU en aliv Sur (informe Priv 8)
  - Volumen total = 233000 m3
  - Qmax = 13.3 m3/s



2.5. EDARS

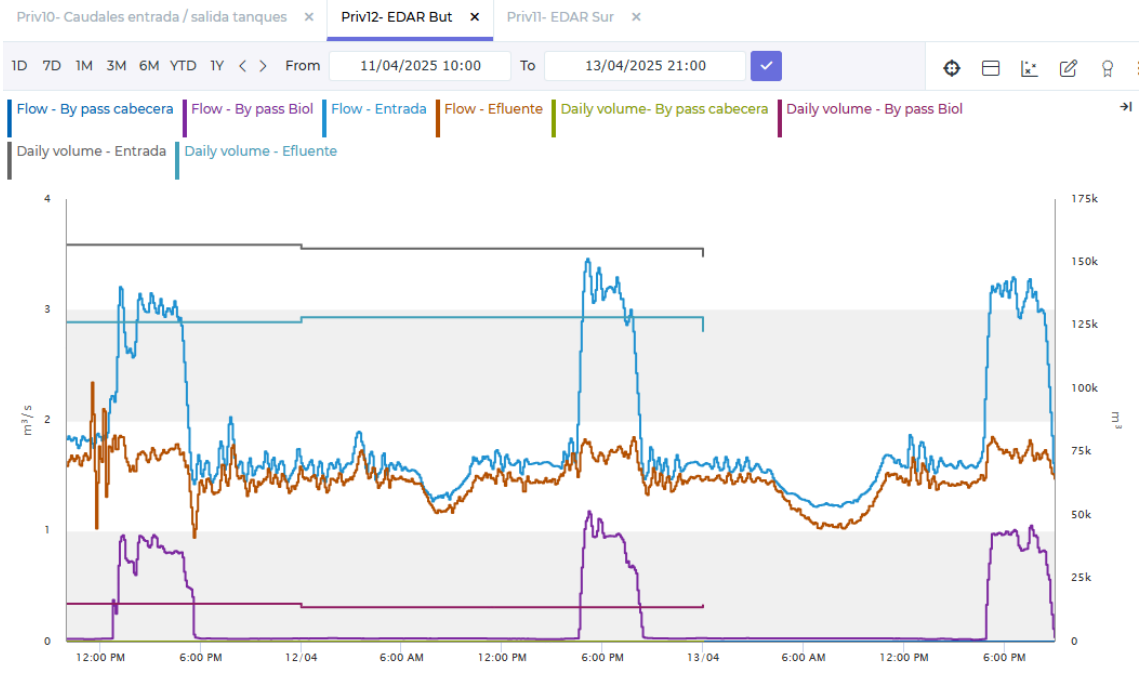
2.5.1. Funcionamiento EDAR Sur

- Nivel entrada sube superando la cota de alivio de cabecera de planta (2.43m) en varios episodios
- Estimación del caudal de vertido de cabecera a partir de cota de aliviadero 2.43:
    - Volumen total = 350000 m3
    - Qmax = 13 m3/s
- Balsa de laminación se llena en paralelo al vertido de cabecera, luego ya queda llena
- By pass de secundario
    - Mientras se llena la balsa de laminación se vierte con caudal menos de 1 m3/s
- Caudal de tratamiento en momento de vertidos = 5 m3/s aprox.



2.5.2. Funcionamiento EDAR Butarque

- Sin DSU en cabecera de planta
- DSU en by pass de secundario (Volumen = 43000 m3)
- Caudal de tratamiento en momento de vertidos = 1.8 aprox. m3/s



2.6. Vaciado de tanques y gestión árbol de decisión AQDV

2.6.1. Tanque Butarque

- Tanque lleva lleno desde inicios de marzo
- Los días posteriores hay más lluvia y continua habiendo previsión de lluvia con lo que no hay opción de vaciarl

2.6.2. Tanque Abroñigales

- Hay pequeños periodos de vaciado
- Caudal máximo de vaciado 0.3 m3/s



2.6.3. Gestión árbol de decisión AQDV

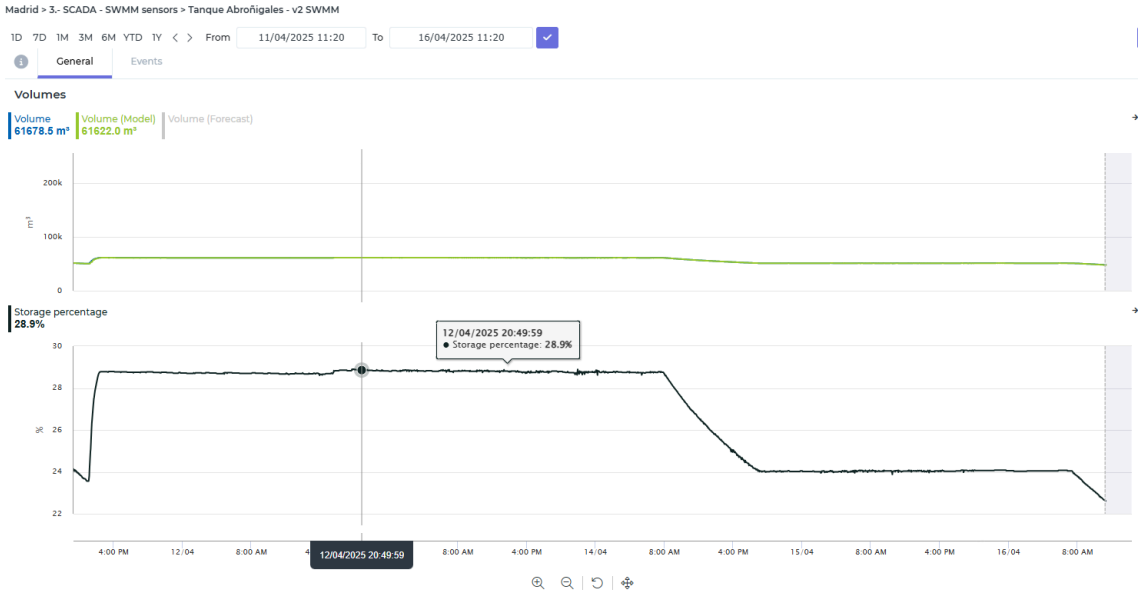
- Se analizan los posibles momentos de vaciado según decision tree (estrategia 4)
    - Hay varios momentos en que se podría vaciar porque balsa bajando nivel y caudal tratado menor de 4 m3/s
    - Por ejemplo
        - 13/4/2025 entre la 01:00 y hasta las 16:00
        - Mismo periodo del 14/4 aprox.
- **Solo de haberlo tenido automatizado se hubiera podido vaciar**



2.7. Comparació sensors Canal vs SWMM

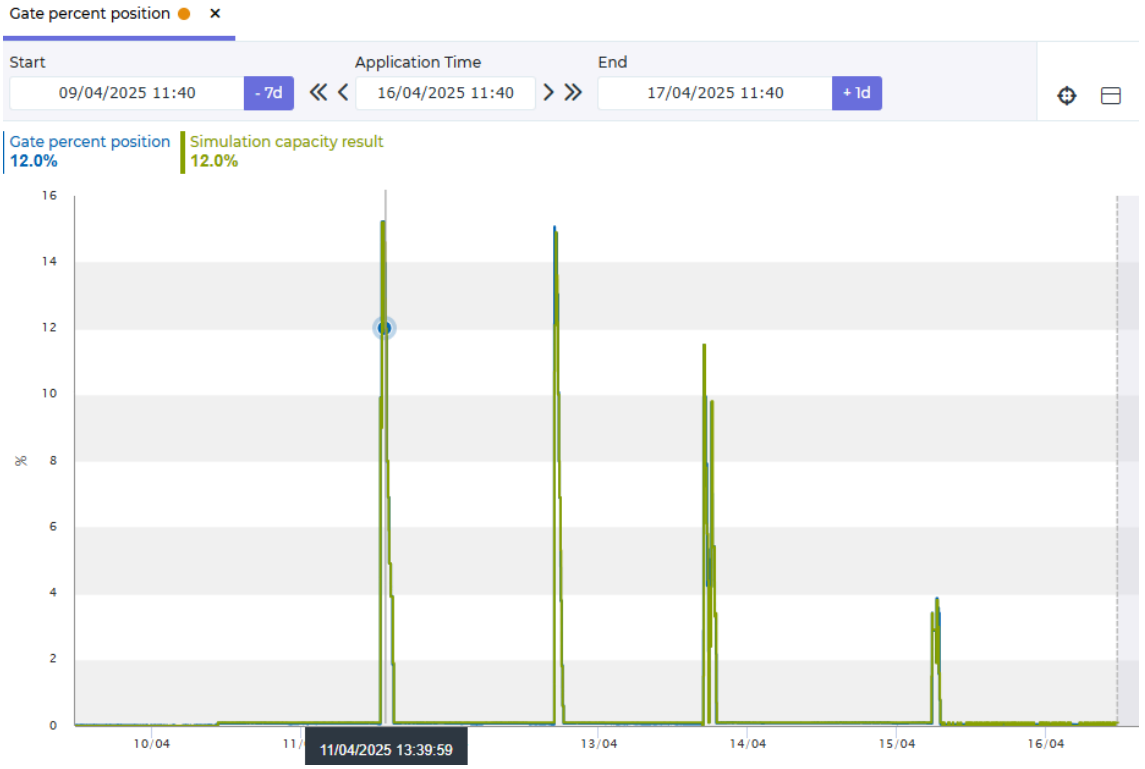
2.7.1. Tanques

- SWMM coge los valores reales de los niveles del tanque en cada iteración



2.7.2. Posiciones de compuerta

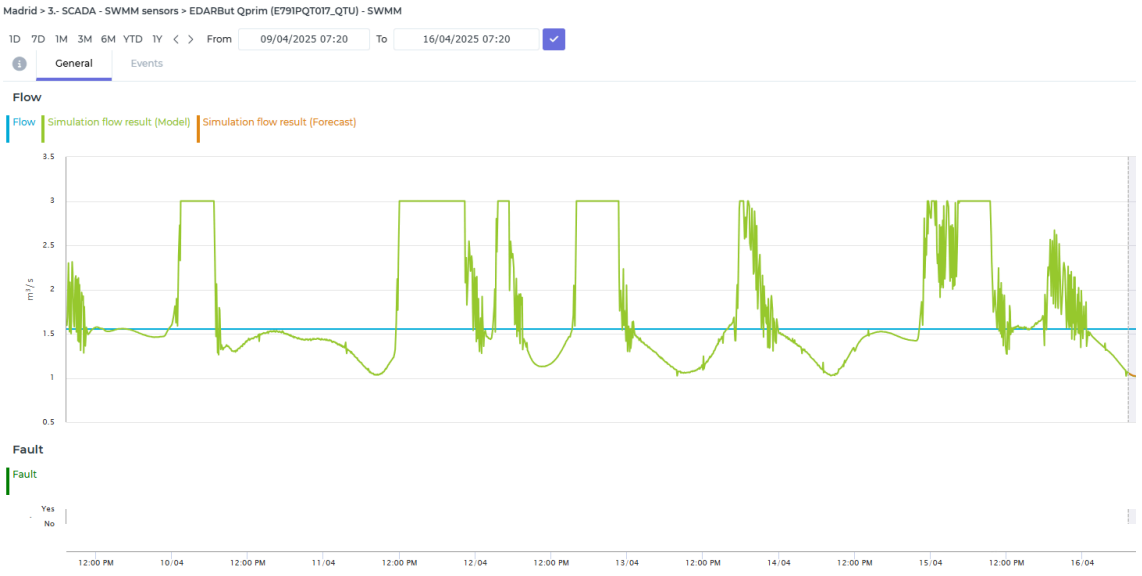
- Movimiento de las compuerta de DSU en Partidor coge la del SCADA por eso coincide perfectamente

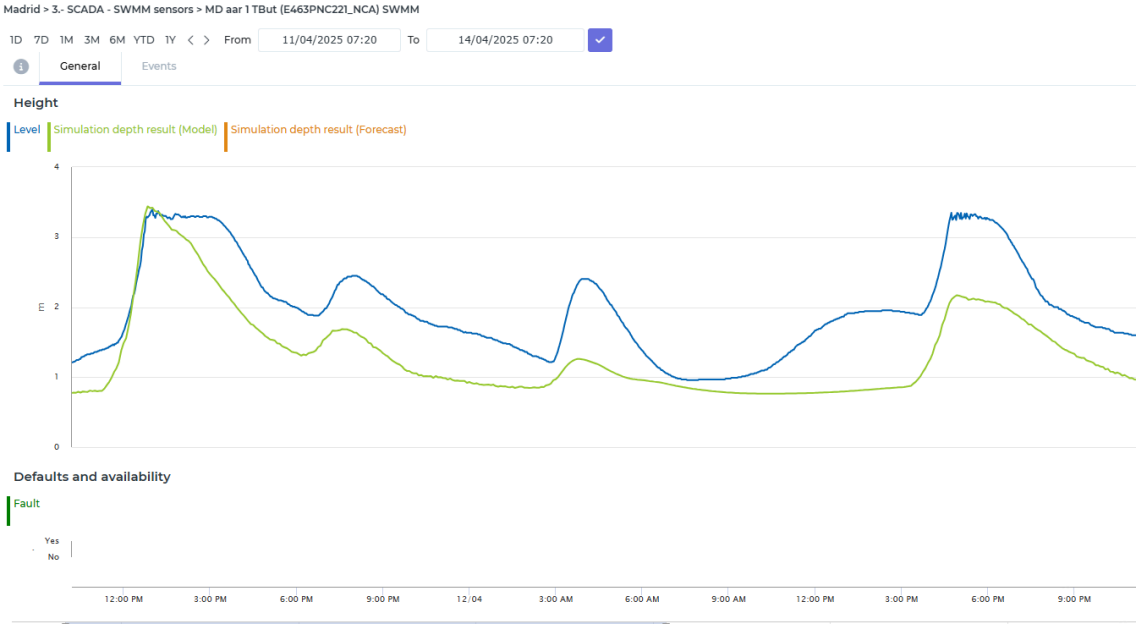


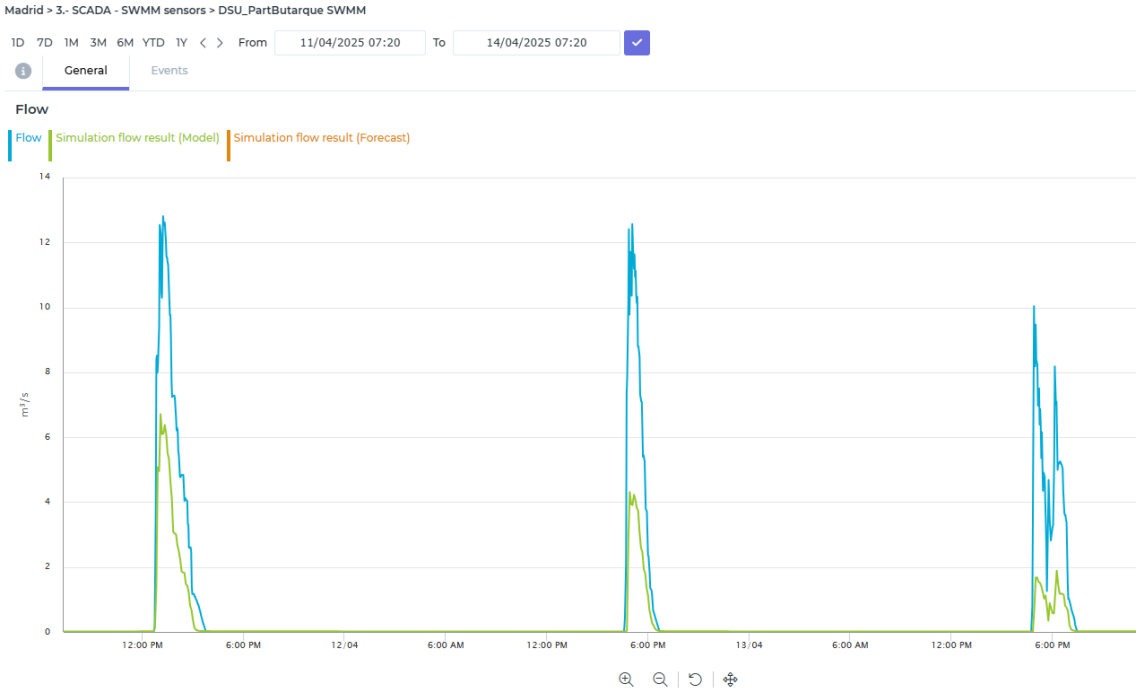
2.7.3. Margen derecho

- El sensor de caudal de entrada a la EDAR no funciona estos días

- Llos niveles del SWMM son muy inferiores a los reales
- DSU en Partidor es menor en el modelo porque los niveles del colector son menores

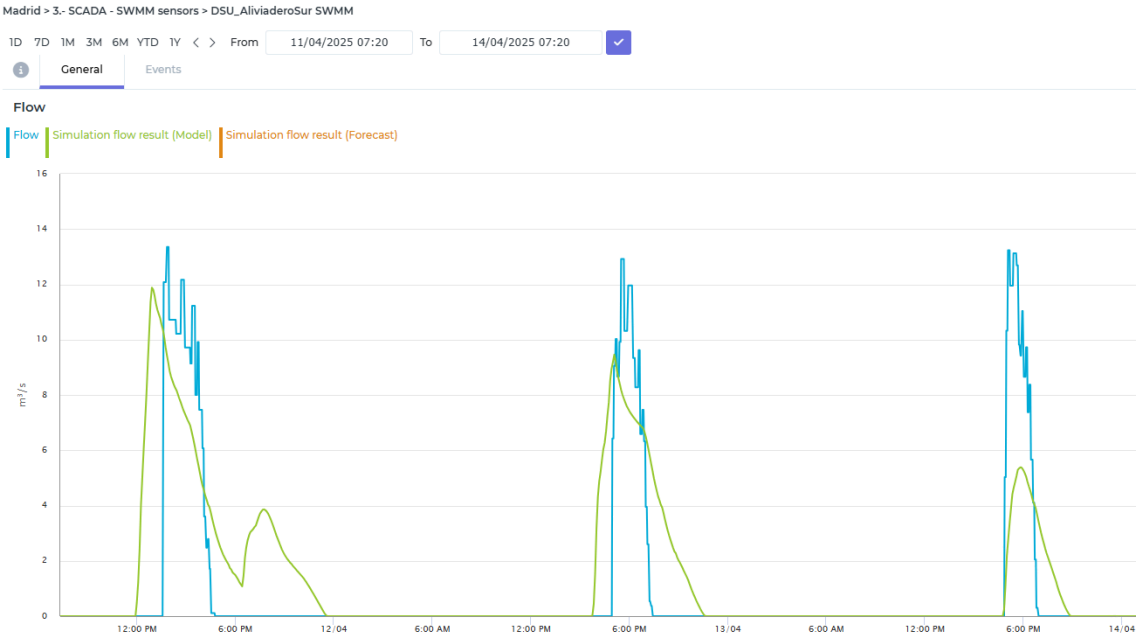






2.7.4. Margen izquierdo

- En aliviadero Sur los niveles y caudales vertidos también son menores apesar que el sensor no termina de funcionar correctamente



3. Resumen de dudas y respuestas del Canal

- Tanque Abro parece que se llena poco
- Como siempre opciones de apurar el vaciado si estuviera más automatizado

Sunyer Roqueta, David <david.sunyer@aquatec.es>

Episodios de lluvia del viernes 14/4 al domingo 16/4

Sunyer Roqueta, David <david.sunyer@aquatec.es> 16 de abril de 2025, 1:02 p.m.
Para: "Carrasco Mínguez, Alejandro" <acarrasco@canal.madrid>, "Navarro Madrid, Antonio" <anavarro@canal.madrid>, "Sánchez Sánchez de Pedro, Moisés" <msanchez.sanchez@canal.madrid>, "Exojo Lopez-Tello, Virginia" <vexojo@canal.madrid>

Buenos días,

Os paso el resumen de estos últimos episodios. No ahy grandes dudas, más o menos es lo mismo, quizás si que me ha sorprendido un poco que el tanque Abroñigales se ha llenado poco.

- Lluvia
  - Entre 10 y 15 mm totales (según la zona) de viernes a domingo con 3 instantes de mayor intensidad que provocan vertidos.
- Llenado de tanques
  - Tanque Butarque ya estaba lleno al inicio de los episodios
  - Tanque ABroñigales los días previos estaba vaciándose y empezaba alrededor del 23% al inicio de los episodios. Solo se llena hasta el 29% con el episodio del 11/4 a las 13h. En los episodios sucesivos no se llena nada
    - La compuerta de by pass se mantiene fija al 25%
    - Me sorprende que se llena poco quizás, y más teniendo las compuertas de la cámara Convenio cerradas y desviando aguas hacia aquí? Imagino que ya está bien me decías que el ayuntamiento está trabajando en el punto de vertido al río, pero igualmente con la compuerta al 25% pensaba que entraría más agua
- DSU
  - Hay DSU por Partidor Butarque. Volumen = 141000 m3
  - Por Butarque II. Volumen = 294000 m3
  - Cabecera de planta EDAR Butarque sin DSU
  - Aliviadero de emergencia de tanque Abroñigales., Sin DSU lógicamente
  - En aliviadero Sur. Volumen = 233000 m3
  - En cabecera de EDAR Sur. Volumen = 350000 m3
- Vaciado de tanques
  - Los días posteriores hay más lluvia y la previsión es que continúe lloviendo con lo que hay pocas opciones de vaciarlos
  - Solo Abroñigales se vacía lentamente en algún periodo con caudal máximo de 0.3 m3/s (Ahora por ejemplo)
  - Como siempre parece que hay alguna opción de vaciar antes los tanques (la balsa de EDAR Sur está bajando nivel y caudal tratado inferior a 4 m3/s) sobretodo si estuviera automatizado, por ejemplo:
    - 13/4/2025 entre la 01:00 y hasta las 16:00 y el mismo periodo aprox. del 14/4



Nada más os deseo una feliz semana santa a ver si las lluvias os dejan descansar un poco y disfrutar de estos días.

Saludos,

D

David Sunyer Roqueta

Direcció de Resiliència i Canvi Climàtic

✉ david.sunyer@aquatec.es

AQUATEC

Annex 1.3.- Presentation for the ROC 7 meeting of 5/5/2025 with CYII operators

life-rubies.eu



Reunión operadores Canal (ROC 7)

05/05/2025

ÍNDICE:

1.- OBJETIVOS DE LA REUNIÓN

2.- ESTADO DEL PROYECTO Y PRÓXIMAS TAREAS

3.- ANÁLISIS DE EPISODIOS PASADOS

4.- MEJORAS EN LA GESTIÓN DEL TANQUE BUTARQUE

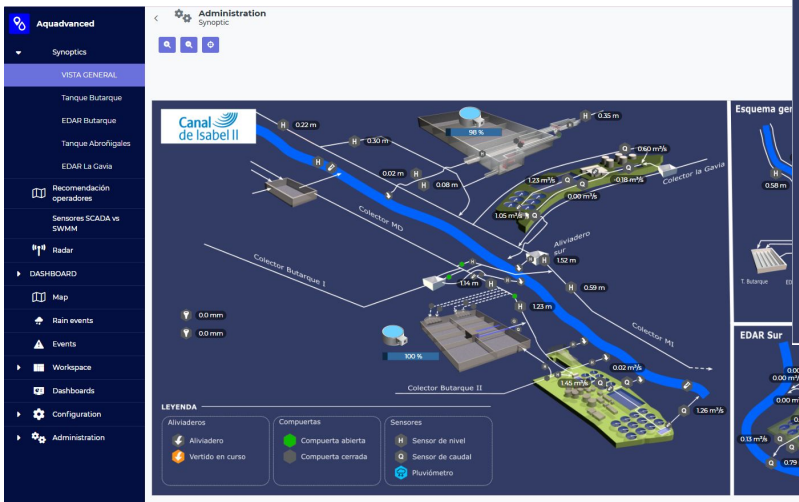
5.- DEBATE, USO Y MEJORAS DE LA HERRAMIENTA

1. Objetivos de la reunión

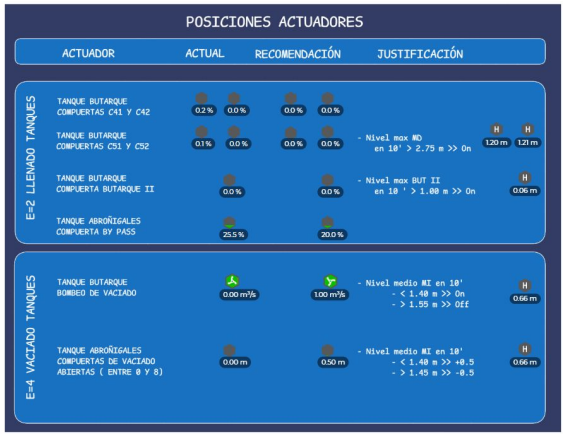
- Breve descripción general del proyecto
- Informar del estado del proyecto y próximas tareas
- Cambios y mejoras en la gestión en los últimos años
- Breve análisis de los episodios de marzo / abril y resolución de dudas de gestión
- Debate, uso y mejoras de la herramienta

2. Breve descripción general del proyecto

- Presentación general
  -
- Visión de la herramienta
  - Acceso
    -
      - **Usuario: life-user**
      - **Contraseña: edmU23K8TFN!3ukTjp5afaqSov6**
  - Visor de datos e información radar
  - Árbol de decisión para consignas de operacion
  - Comparativa radar vs pluvis
  - Modelo SWMM
  - …







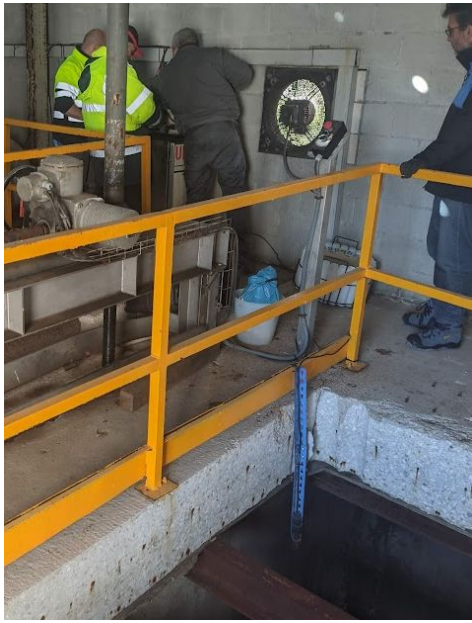
3. Estado del proyecto y próximas tareas

- **Instalación de sensores en el sistema**
  - **Derivador Butarque cambiado a Entrada EDAR Butarque**
    - Complicado mantenimiento y hacer campañas allí
      - Por emplazamiento
      - Sobretodo por necesidad de coordinarnos con Valentín que están siempre liados
    - Se modificó emplazamiento a cabecera de planta Butarque
    - Objetivo el mismo (estimar calidad de todo el MD)
    - Pendiente:
      - mejorar la instalación todo en mismo pozo









3. Estado del proyecto y próximas tareas

- Instalación de sensores en el sistema
    - Pluviómetros (EDAR Gavia y EDAR Butarque)
    - Cabecera EDAR Butarque (tomamuestras y turbidímetro)
    - EDAR Butarque (tomamuestras y turbidímetro)
    - EDAR Sur
        - Anteriormente >> tomamuestras y turbidímetro
        - Actualmente >> Turbidímetro (pendiente de conexión con SCADA o poder descargar mediciones)
    - 2 Estaciones de calidad en río

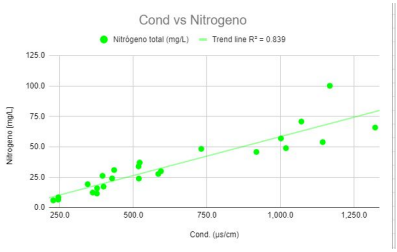


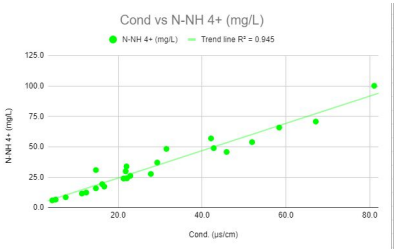


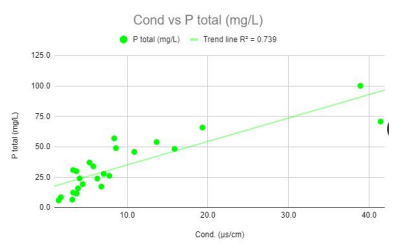


3. Estado del proyecto y próximas tareas

- **Campañas de muestreo**
  - **Objetivo:**
    - Tener unas dos campañas de tiempo seco y tres de tiempo de lluvia
    - Correlacionar las mediciones en tiempo real de:
      - Turbidez con contaminación no soluble (SS, ST, DBO, DQO)
      - Conductividad con contaminación soluble (Nitrógeno, Amonio, Ptotal=)
  - **Hecho:**
    - Todas las campañas gracias a los numerosos episodios de lluvia de marzo
  - **Pendiente:**
    - Aprovechar instalaciones y hacer alguna más



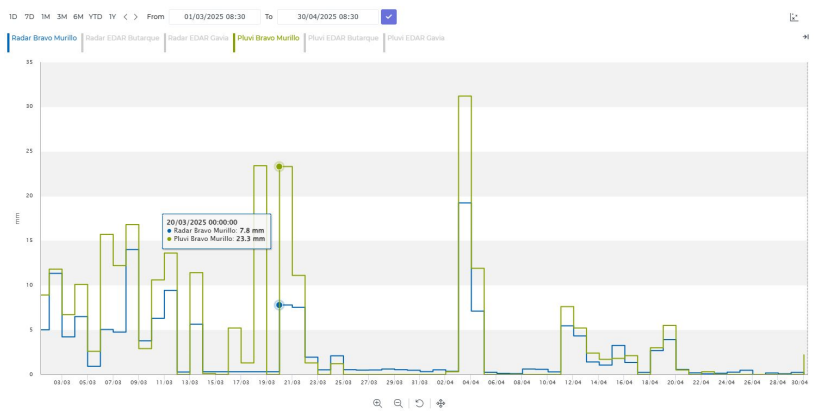




Data	Partidor	Entrada EDAR But	Primario EDAR Butarque	EDAR Sur	Río Oliva	Río Butarque
19/09/2024			X			
07/10/2024				X		
09/10/2024	X					
12/10/2024				X		
16/10/2024				X	X	
29/10/2024			X	X		
20/01/2025					X	
21/01/2025				X		
27/01/2025					X	
11/02/2025		X	X			
01/03/2025			X			
04/03/2025		X				
06/03/2025					X	X
07/03/2025			X			
08/03/2025		X				
11/03/2025					X	X
18/03/2025					X	X
20/03/2025		X	X			
03/04/2025					X	X
Total	1	4	6	5	7	4

3. Estado del proyecto y próximas tareas

- **Configuración del AQDV**
  - **Radar Canal**
    - Entra ya en AQDV (problema desde miércoles pasado)
    - Se puede comparar con datos de pluvis
    - En general subestima la lluvia >> Factor entre 1.5 -2 normal mayor para lluvias pequeñas
  - **Módulo MPC para optimizar consignas**
    - Testeos offline realizados
    - Configurando el módulo en AQDV
  - **Modelo SWMM**
    - Objetivo comparar gestión real, la teórica de los protocolos del Canal y las mejoras en gestión con MPC

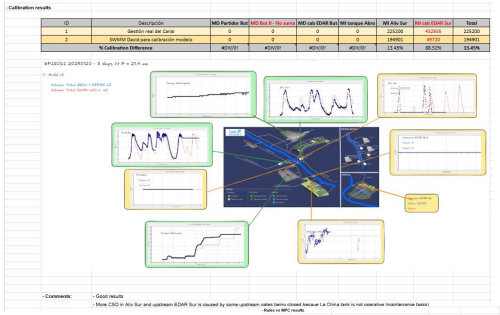


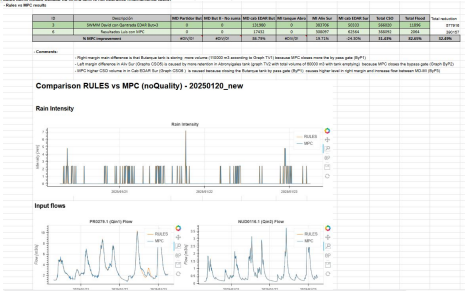


3. Estado del proyecto y próximas tareas

- **Cálculo KPIs comparando gestión teórica del Canal con MPC**
  - **Hecho comparación hidráulica por episodios**
    - Informe de gestión (lo que os mando
    - Con datos de pluvis pasar el modelo
    - Ajuste y calibración del modelo con los datos de los sensores
    - Pasar el episodio con modelo y MPC que calcula nuevos DSU
    - Hacer la comparativa
  - **Pendiente**
    - Ir recalculando para los nuevos futuros episodios
    - Hacer cálculo de KPIs con calidad y carga contaminante vertida a río

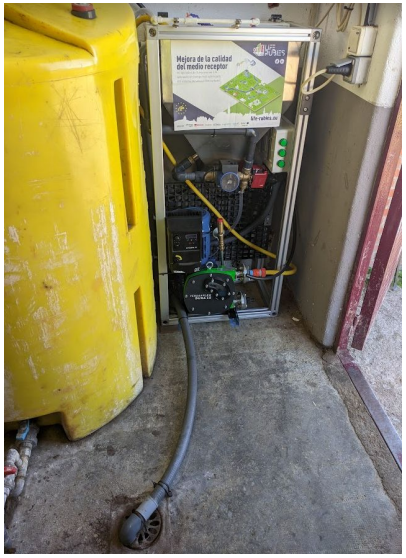
Rain Event				SWMM rules results								MPC results								Improvement		
				CSO						Flood		CSO						Flood				
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (m3)	Total (m3)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (m3)	Total (m3)	CSO	Flood	Total
08/03/2024	11.4	7	1.63	0	0	51083	0	159203	46220	256506		0	0	5134	0	121867	32817	159819		37.69%		
11/03/2024	11.8	8	1.48	0	0	57774	0	179810	49371	286955		0	0	5171	0	139363	36104	180638		37.05%		
28/03/2024	11.8	6	1.97	0	0	42371	0	150052	24277	216700		0	0	3224	0	93531	26096	122851		43.31%		
27/04/2024	7.8	14	0.56	0	0	32261	0	46075	3344	81680		0	0	5166	0	27268	13341	45775		43.96%		
08/06/2024	4.2	5	0.84	0	0	22223	0	16778	3705	42706		0	0	3040	0	9474	8372	20886		51.09%		
10/06/2024	29.8	8	3.73	2204	0	175351	0	414347	129427	721329	244692	22228	0	127406	75637	380465	163316	769052	166609	-6.62%	31.91%	3.14%
20/09/2024	17	3	5.67	20767	0	51037	0	233790	63417	369011		65	0	4075	0	186497	52306	242942		34.16%		
07/10/2024	5.2	3	1.73	0	0	26732	0	36756	10592	74080		0	0	4031	0	23122	9355	36509		50.72%		
12/10/2024	21.9	11	1.99	12245	0	83423	0	313645	54122	463435	150680	475	0	57996	0	238061	78116	374647	114115	19.16%	24.27%	20.41%
16/10/2024	13.2	28	0.47	0	0	76750	0	186278	38185	301213		0	0	12662	0	157407	41326	211395		29.82%		
29/10/2024	23.6	16	1.48	1097	0	115926	0	384775	106843	608641	154863	6973	0	59412	55276	333136	115927	570723	104103	6.23%	32.78%	11.61%
01/11/2024	9.6	1.5	6.40	1440	0	89294	0	96088	37141	223963		22548	0	59167	0	63911	43987	189612		15.34%		
20/01/2025 - 3 days rain	21.4	76	0.28	0	0	131980	0	383706	50333	566020	11896	0	0	17432	0	308097	62564	388092	2064	31.42%	82.65%	32.49%
27/01/2025	5.6	5	1.12	0	0	29937	0	27906	7211	65054		0	0	5429	0	15029	12044	32503		50.04%		
29/01/2025	5.4	8	0.68	0	0	29209	0	12577	1199	42985		0	0	1644	0	2709	13718	18072		57.96%		
11/02/2025	14.2	7	2.03	0	0	75274	0	267050	72919	415243		0	0	7488	0	211493	57239	276220		33.48%		
01/03/2025	18.2	40	0.46	0	0	121643	0	366547	72140	560330		0	0	13647	0	291576	62558	367780		34.36%		
03/03/2025 - 7 days	64.8	168	0.39	107188	0	927532	0	1501777	418868	2955366	442662	85825	0	597930	146308	1336917	424964	2591944	264896	12.30%	40.16%	15.93%
10/03/2025 - 7 days	45.4	168	0.27	104605	0	660558	204433	955048	296432	2221076	299597	155880	0	463536	254299	953295	306862	2133871	200305	3.93%	33.14%	7.40%
17/03/2025 - 7 days	51.4	168	0.31	91985	0	678701	84149	1207019	324264	2386118		73852	0	453454	184112	1034189	322955	2068562		13.31%		
03/04/2025 - 2 days	47.4	48	0.99	76502	0	741655	7818	1094817	348222	2269013	425818	213911	0	517331	255055	973163	383123	2342583	260496	-3.24%	38.82%	3.40%



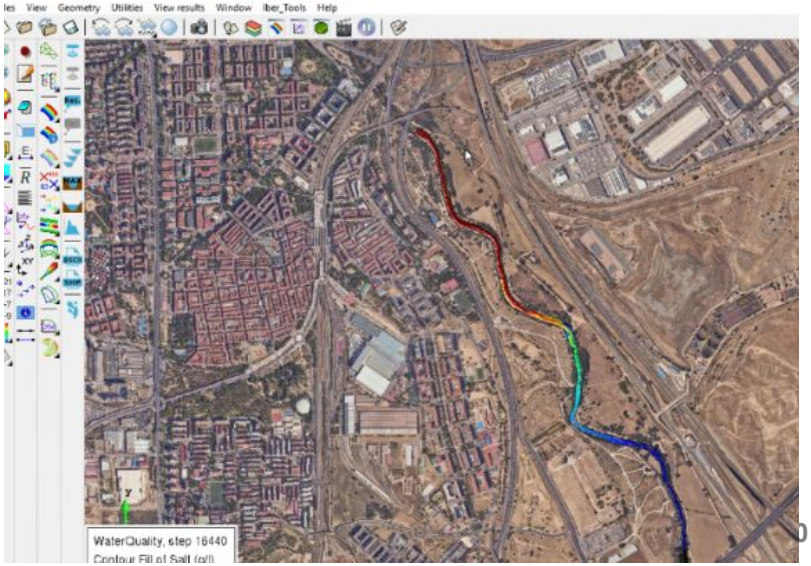


3. Estado del proyecto y próximas tareas

- **Estudio del impacto en el río**
  - **Hecho:**
    - Estación de calidad de Oliva funcionando correctamente
    - Estación de calidad de EDAR Butarque funcionando correctamente
  - **Trabajando:**
    - Campañas en el río para calidad
    - Estimación caudal en río a partir de estaciones de aforo o continuidad con conductividad
    - Preparar modelo del río en el tramo de estudio







4. Análisis de episodios y dudas

4.1.- Resumen

Episodio		Tanques (% llenado inicio y final)		Volumen de vertidos a río DSU (m3)						
Fecha	Lluvia (mm)	Tanque But	Tanque Abro	MD Part But	MI Aliv Sur	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total
01/03/2025	18.2	0% - 90%	0% - 15%	0	0	0	0	361963	415300	**777263**
03/03/2025 - 7 days	64.8	90% - 100%	15% - 100%	783870	44042	243759	67218	58312	1070701	**2267902**
10/03/2025 - 7 days	45.4	100% - 100%	100% - 100%	706860	29681	0	90727	254071	1256033	**2337372**
17/03/2025 - 7 days	51.4	70% - 100%	48% - 100%	978145	26179	76413	881062	1733962	1354181	**5049942**
03/04/2025 - 2 days	47.4	61% - 100%	0 % - 100%	567682	5040	0	12558	894055	1072413	**2551748**
11/04/2025 - 3 días	10-15 mm	100% - 100%	23% - 29%	141000	294000	0	0	233000	350000	**1018000**
18/4/2025 - 2 días	8.5 - 16 mm	100% - 100 %	13% - 16%	97000	240000	0	0	76000	190000	**603000**
2/5/2025 - Pendiente	36 mm	17% - 100 %	1% - 100%	Falta	Falta	Falta	Falta	Falta	Falta	**Falta**
DSU Totales				**3274557**	**638942**	**320172**	**1051565**	**3611363**	**5708628**	**14605227**

- **Comentarios generales y dudas**
  - 2 meses extremadamente lluviosos
  - Se ve la importancia de vaciar cuanto antes los tanques para estar mejor preparado para las siguientes lluvias
  - Aunque con tanta lluvia hay poco margen para vaciar y con los tanques llenos la gestión está muy limitada

4. Análisis de episodios y dudas

4.2.- Dudas

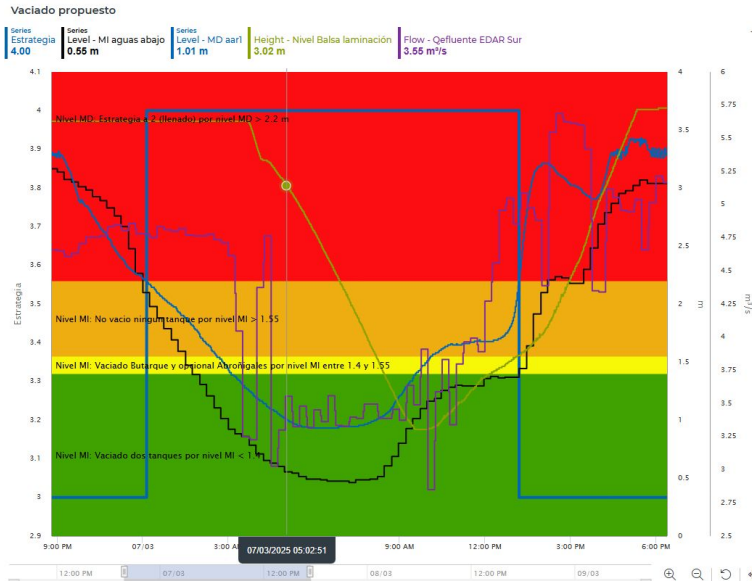
- **Vaciado de tanques general**
  - **Ideas generales**
    - Complejo porque falta información del sistema aguas arriba
    - Depende del funcionamiento de EDAR Sur
    - Otros factores:
      - Falta automatización (fin de semana y noches sin operadores…)
      - Problema para evitar descebar la bomba
      - …
  - **Cuando se puede vaciar?**
    - Niveles en MI bajos
    - Niveles en balsa EDAR Sur bajos o bajando (por debajo de 3.6 m)
    - Caudal tratado por EDAR Sur < 4 m3/s / el máximo a tratar es 5 m3/s
  - **Momentos en que esto se puede optimizar?**
    - Lluvia 2/5 y vaciado de este finde

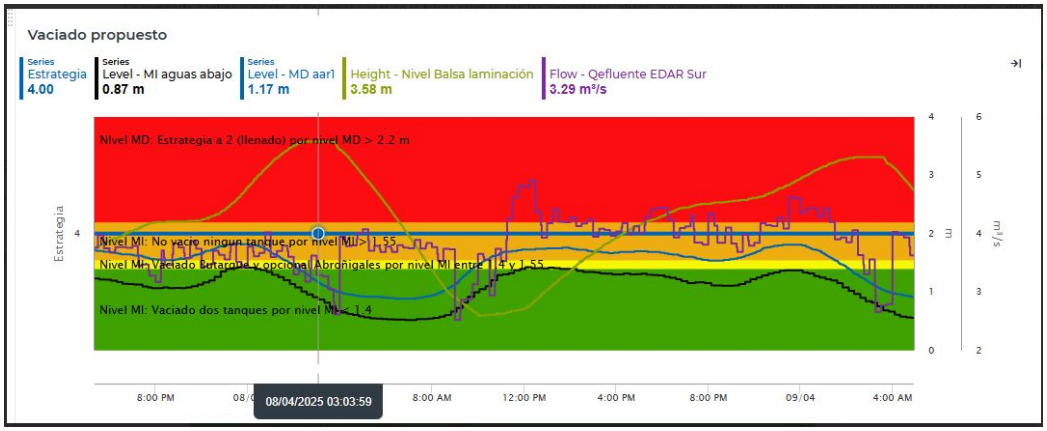


4. Análisis de episodios y dudas

4.2.- Dudas / mejoras

- Vaciado de tanques general
  - Momentos en que esto se puede optimizar / mejorar?
    - 7/3 entre 03:00 y las 13:00





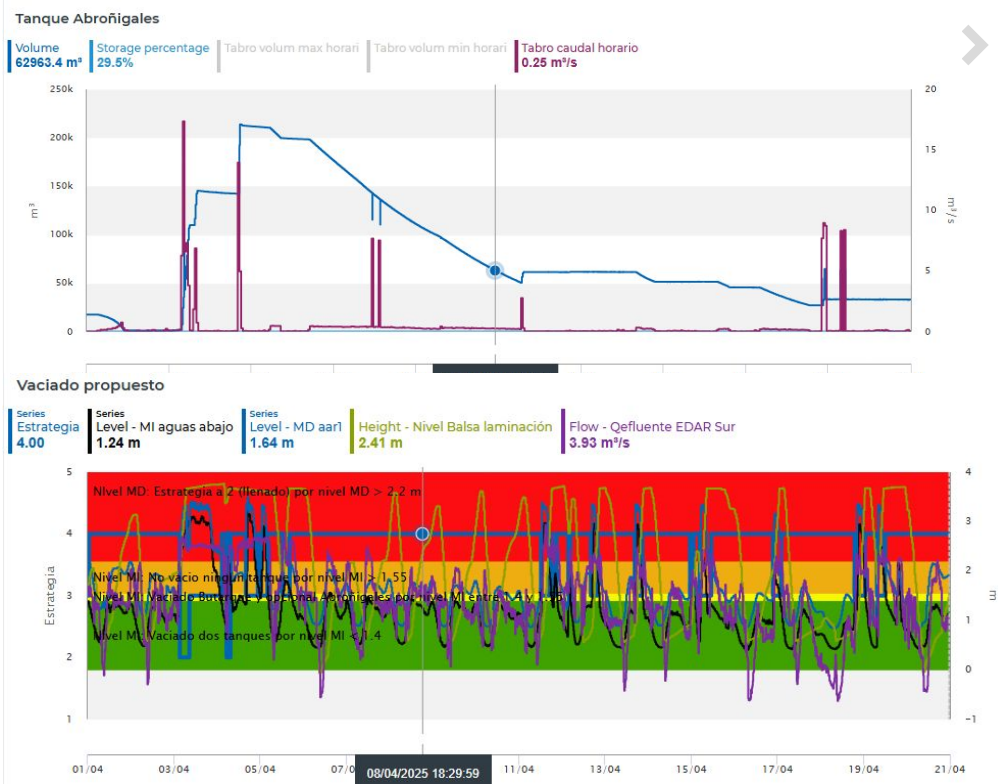
- 8/4 a partir de las 03:00
- …

4. Análisis de episodios y dudas

4.2.- Dudas

- Vaciado de tanque Abroñigales
  - Muy lento abriendo solo dos compuertas al 10%
    - Caudales de vaciado 0.25 m3/s
  - Opción abrir más porcentaje o más compuertas?
  - Ejemplo : 01/04/2025 00:00 - 21/04/2025 00:00





4. Análisis de episodios y dudas

4.2.- Dudas

- Sensación que se llena poco el tanque Abroñigales (Informe Priv8) ??
  - Y más con las compuertas de cámara Convenio desviando aguas aquí
  - Mucho tiempo en funcionamiento raro por obras primero de las rejas de entrada y luego en punto de DSU a río y en EDAR / Tanque la China
  - Se aprovecha para modificar cota de alivio en entrada tanque para que entre más agua
    - Intentar cerrar al máximo compuerta de by pass
  - Como está ahora? Resuelto todo?

Episodio		Tanques (% llenado inicio y final)		Volumen de vertidos a río DSU (m3)						
Fecha	Lluvia (mm)	Tanque But	Tanque Abro	MD Part But	MI Aliv Sur	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total
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18/4/2025 - 2 días	8.5 - 16 mm	100% - 100 %	13% - 16%	97000	240000	0	0	76000	190000	603000
2/5/2025 - Pendiente	36 mm	17% - 100 %	1% - 100%	Falta	Falta	Falta	Falta	Falta	Falta	Falta
DSU Totales				3274557	638942	320172	1051565	3611363	5708628	14605227

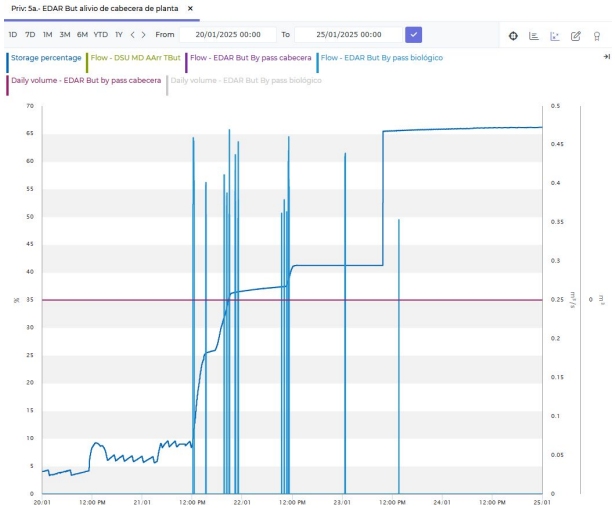
5. Mejoras en la gestión de tanque Butarque

- **LLENADO DE TANQUE BUTARQUE (Informe Priv5a)**
  - **Antes**
    - Se producía DSU en cabecera de planta mientras se llenaba tanque
  - **Cambio de gestión:**
    - Compuerta de by pass de cabecera cerrada solo se abre cuando nivel en MD muy alto con riesgo de inundación (nivel 3.6 m)
    - Antes de verter por cabecera:
      - Tanque Butarque lleno (compuertas se abren cuando nivel 2.5 m)
      - Se abre la compuerta de DSU de partidor (3.3 m)
  - **Ejemplo 9/2/2024 14 mm**



5. Mejoras en la gestión de tanque Butarque

- **LLENADO DE TANQUE BUTARQUE (Informe Priv5a)**
  - **Actualmente**
    - sin DSU en MD a no ser que tanque esté lleno
  - **Ejemplos**
    - **20/1/2025 21.4 mm**
    - **1/3/2025**
    - **Otros con tanque lleno se vierte antes por Partidor (18/4/2025)**



Episodio		Tanques (% llenado inicio y final)		Volumen de vertidos a río DSU (m3)						
Fecha	Lluvia (mm)	Tanque But	Tanque Abro	MD Part But	MI Aliv Sur	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total
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03/03/2025 - 7 days	64.8	90% - 100%	15% - 100%	783870	44042	243759	67218	58312	1070701	2267902
10/03/2025 - 7 days	45.4	100% - 100%	100% - 100%	706860	29681	0	90727	254071	1256033	2337372
17/03/2025 - 7 days	51.4	70% - 100%	48% - 100%	978145	26179	76413	881062	1733962	1354181	5049942
03/04/2025 - 2 days	47.4	61% - 100%	0 % - 100%	567682	5040	0	12558	894055	1072413	2551748
11/04/2025 - 3 días	10-15 mm	100% - 100%	23% - 29%	141000	294000	0	0	233000	350000	1018000
18/4/2025 - 2 días	8.5 - 16 mm	100% - 100 %	13% - 16%	97000	240000	0	0	76000	190000	603000
2/5/2025 - Pendiente	36 mm	17% - 100 %	1% - 100%	Falta	Falta	Falta	Falta	Falta	Falta	Falta
DSU Totales				3274557	638942	320172	1051565	3611363	5708628	14605227

6. Debate uso y mejoras de la herramienta

- **Prueba piloto de herramienta para ayudar a la gestión del sismte**
  - **Conscientes que no aporta más información que el SCADA que tenéis**
  - **Falta información importante para vuestra gestión:**
    - Sobretodo información del sistema aguas arriba?
      - Tanques?
      - EDARs?
      - Otros?
- **Mejoras a la herramienta actual para que os fuera más útil?**
  - **Información en más "tiempo real" >> Herramienta en vuestro servidor y mejorar sistema de conexión SCADA - AQDV**
  - **Mejora de la lluvia radar y su previsión?**
  - **Instalación de pluviómetros con información 5 minutal**
  - **Implementar los protocolos de decisión (vaciado de tanques en función de nivel de balsa de laminación en EDAR Sur por ejemplo?)**
  - **Sacar informes automáticos diarios o post episodio de funcionamiento del sistema??**
  - **Otros??**

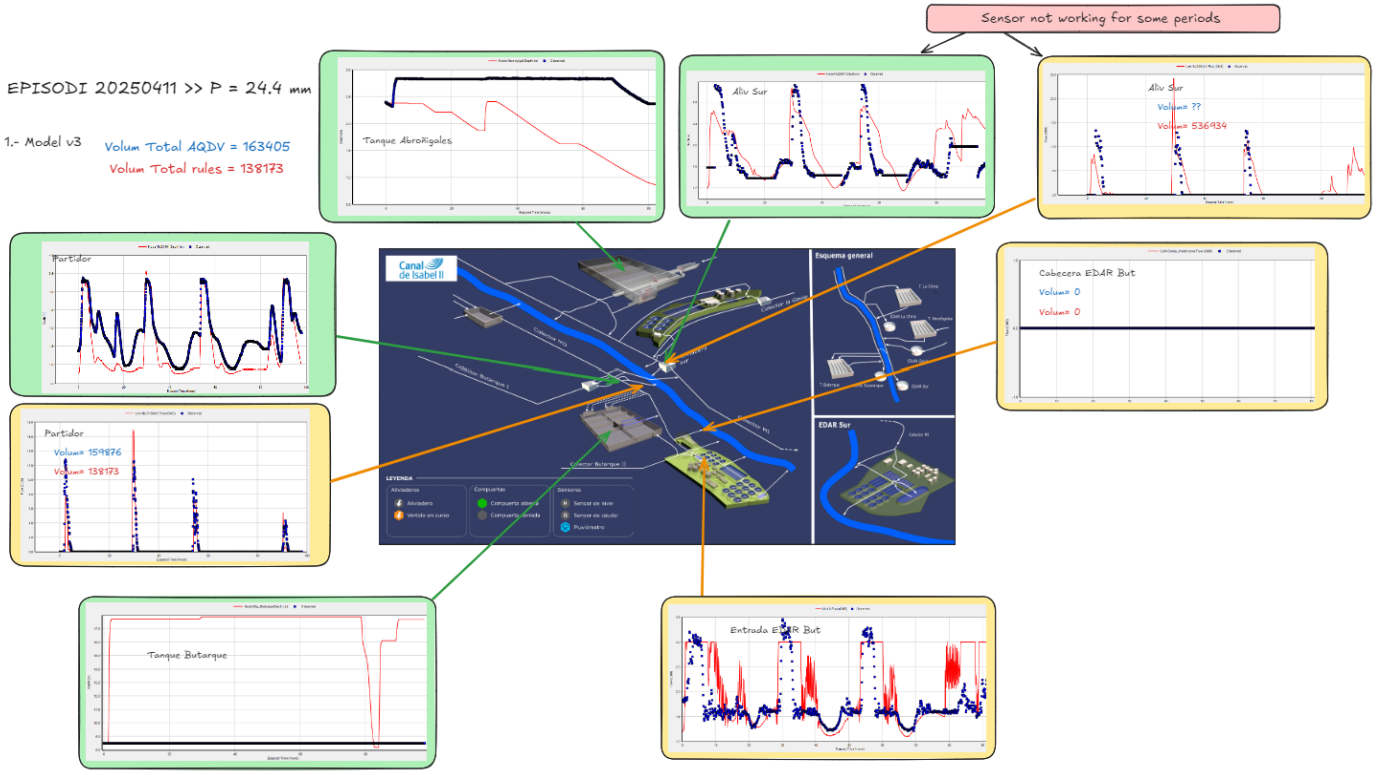
Annex 1.4.- Calibration report

RAIN EVENT DATA

Date	11/04/2025 - 3 days
Rain (mm)	24.4
Duration (h)	98
Link to folder	20250411- 3 dies

- Calibration results

ID	Descripción	MD Partidor But	MD But II - No suma	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total
1	Gestión real del Canal	159876	0	0	3529	233525	419579	163405
2	SWMM David para calibración modelo	138173	0	0	0	536934	258322	138173
% Calibration Difference		13.57%	#DIV/0!	#DIV/0!	100.00%	-129.93%	38.43%	**15.44%**



- Comments:

- Applied changes: Closing the by pass gate in by pass EDAR Butarque
- In tanque Abroñigales flow getting in is not correct, might be because of the rain or maybe because of the upstream gates not correctly modelled
- Aliv Sur sensor is not working for some periods during the rain
- Not bad calibration results

Annex 1.5.- Hydraulic KPI report

RAIN EVENT DATA

Date	11/04/2025 - 3 days
Rain (mm)	24.4
Duration (h)	98
Link to folder	20250411- 3 dies

- Rules vs MPC results

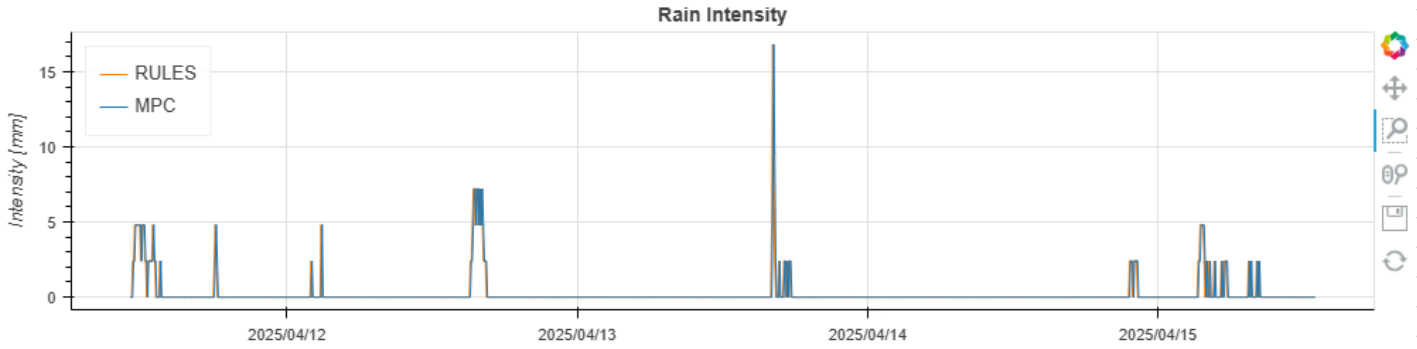
ID	Descripción	MD Partidor But	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	Total CSO	Total Flood	Total reduction
3	SWMM David con Qentrada EDAR But=3	8511	336736	0	536959	1027721	69940	1097661
6	Resultados Luis con MPC	0	136673	0	445329	704315	28024	732339
% MPC improvement		100.00%	59.41%	#DIV/0!	17.06%	**31.47%**	**59.93%**	**33.28%**

- Comments:

- Important differences in CSO are mainly caused because MPC is able to empty the tanks in the periods btween rains so it can store more volume reducing CSOs to the river (see TV1 and TV2)
- In MI there is more water getting in the pilot area (see Qin4), this is because upstream floodings are reduced

Comparison RULES vs MPC (noQuality) - 20250411_PluviEDARGavia_new

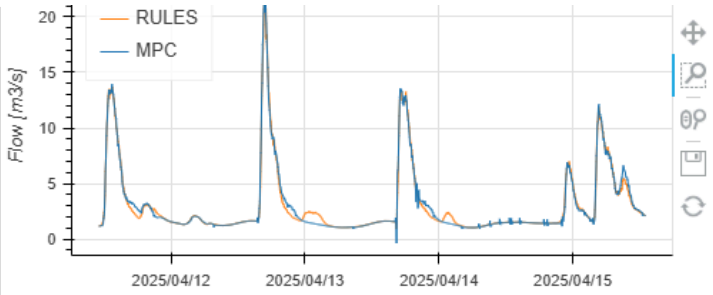
Rain Intensity

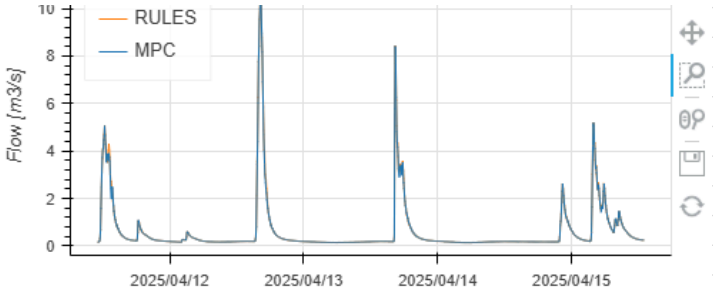


Input flows

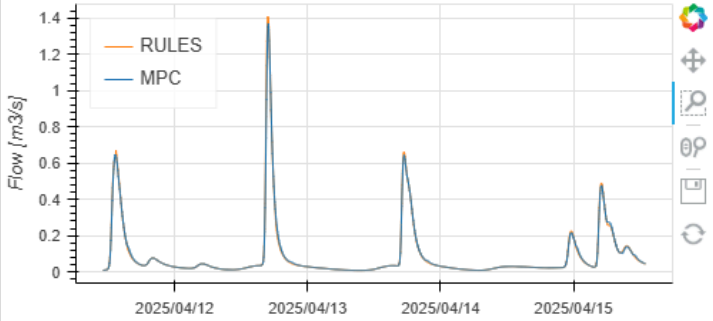




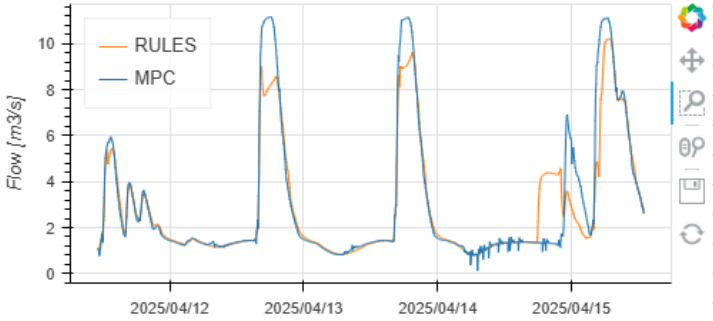




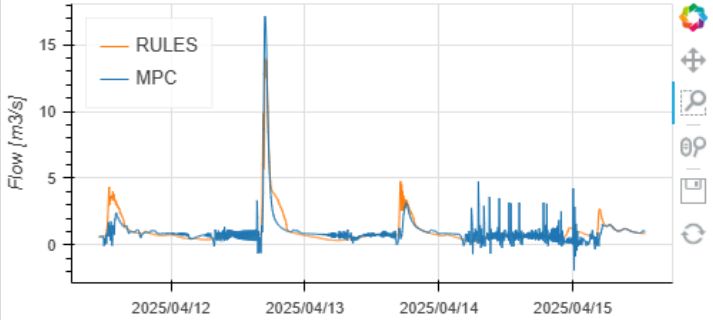
XXXX003210.1 (Qin3) Flow



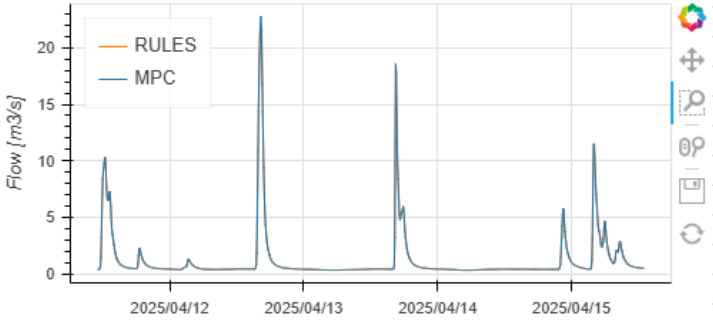
PR0059.1 (Qin4) Flow



XXXX003086.1 (Qin5) Flow

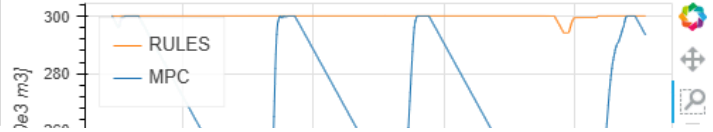


XXXX002806.1 (Qin6) Flow

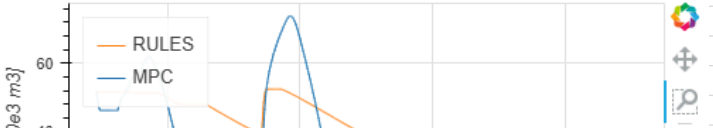


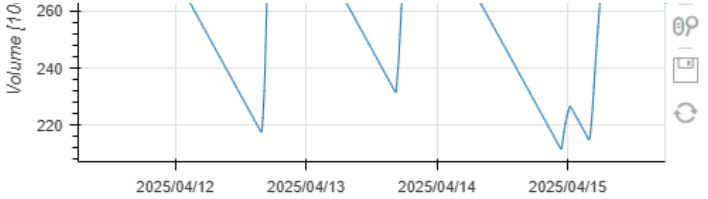
Tank Volumes (Butarque & Abronyigal)

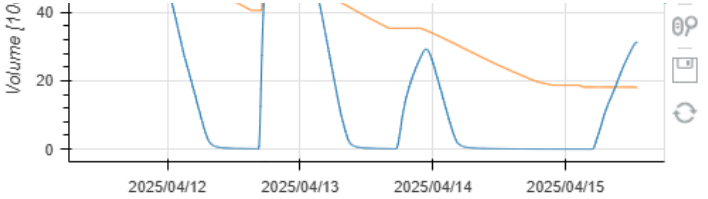
Butarque Tank Volume



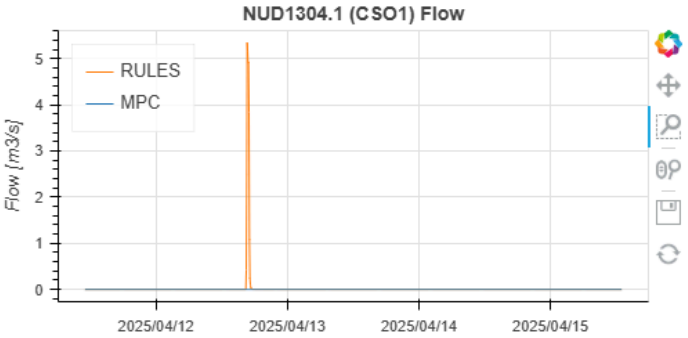
Abronyigal Tank Volume

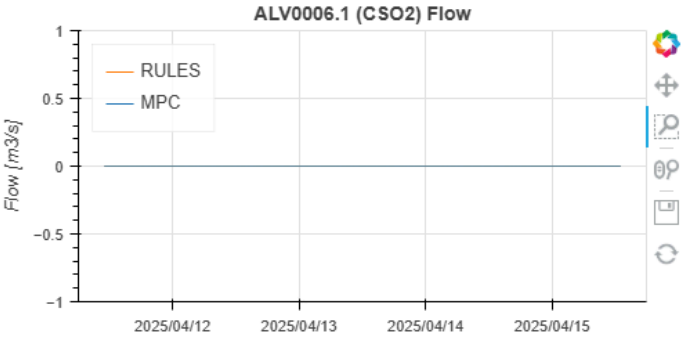


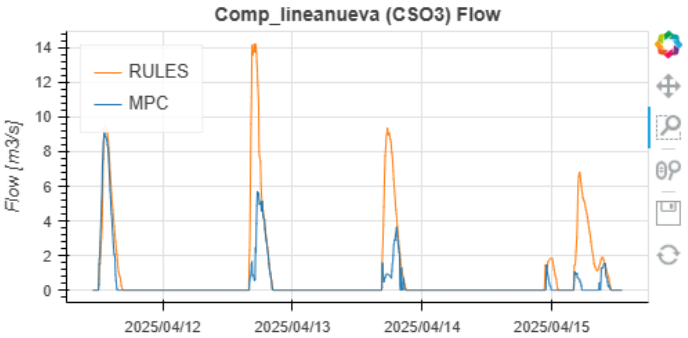

Volume [10
260
240
220
2025/04/12
2025/04/13
2025/04/14
2025/04/15

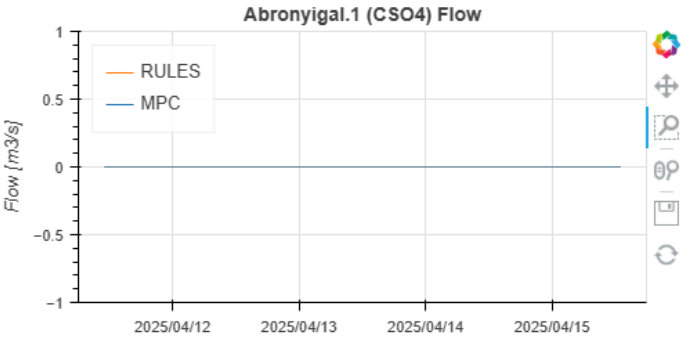

Volume [10
40
20
0
2025/04/12
2025/04/13
2025/04/14
2025/04/15

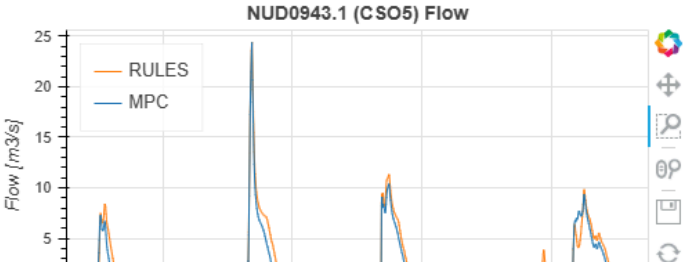
CSO Flows

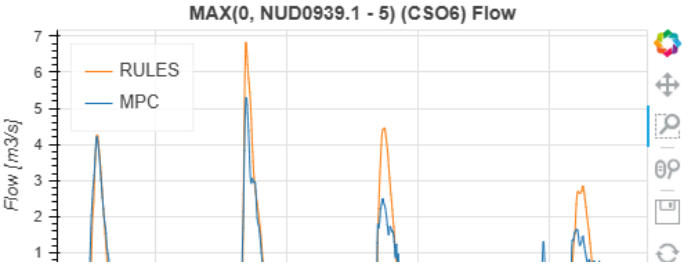

NUD1304.1 (CSO1) Flow
RULES
MPC
Flow [m3/s]
5
4
3
2
1
0
2025/04/12
2025/04/13
2025/04/14
2025/04/15


ALV0006.1 (CSO2) Flow
RULES
MPC
Flow [m3/s]
1
0.5
0
−0.5
−1
2025/04/12
2025/04/13
2025/04/14
2025/04/15


Comp_lineanueva (CSO3) Flow
RULES
MPC
Flow [m3/s]
14
12
10
8
6
4
2
0
2025/04/12
2025/04/13
2025/04/14
2025/04/15


Abronyigal.1 (CSO4) Flow
RULES
MPC
Flow [m3/s]
1
0.5
0
−0.5
−1
2025/04/12
2025/04/13
2025/04/14
2025/04/15

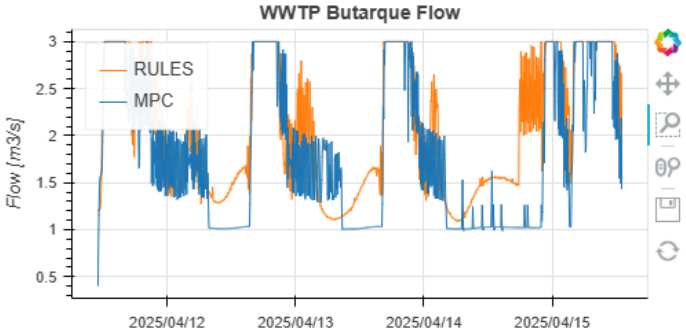

NUD0943.1 (CSO5) Flow
RULES
MPC
Flow [m3/s]
25
20
15
10
5

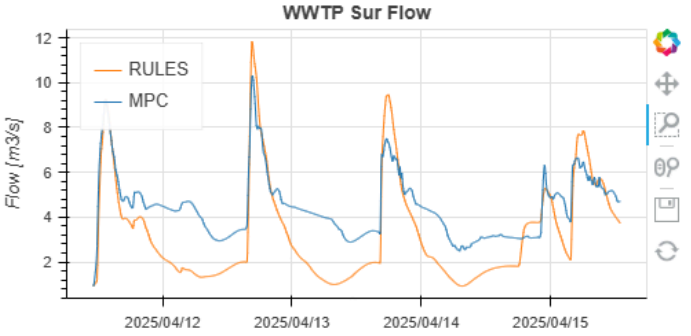

MAX(0, NUD0939.1 - 5) (CSO6) Flow
RULES
MPC
Flow [m3/s]
7
6
5
4
3
2
1



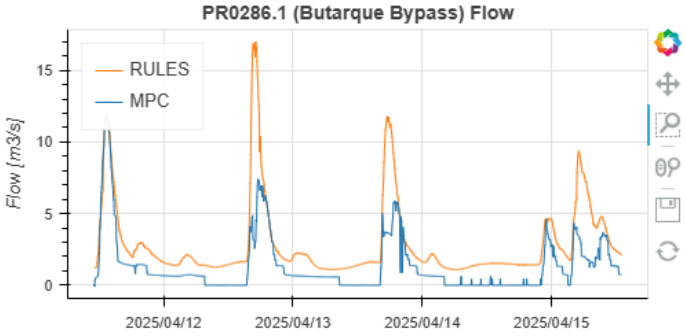


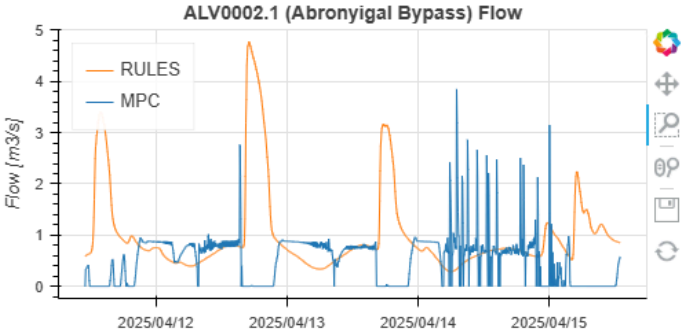
WWTP Flows (Butarque & Sur)



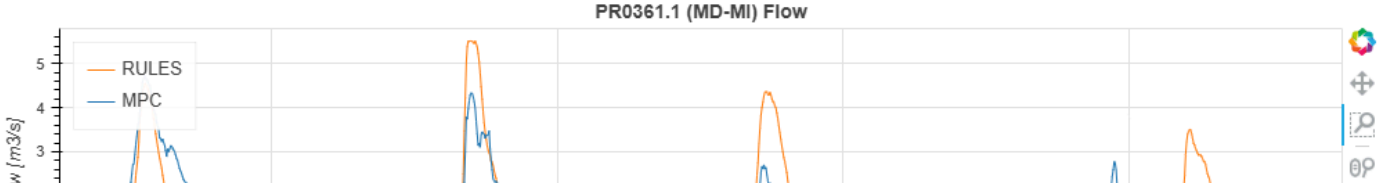


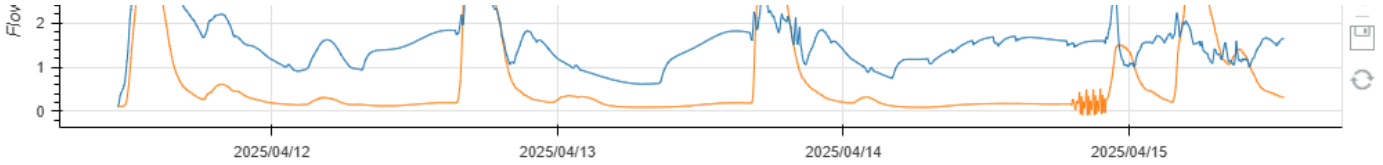
Bypasses (Butarque & Abronyigal) Flows



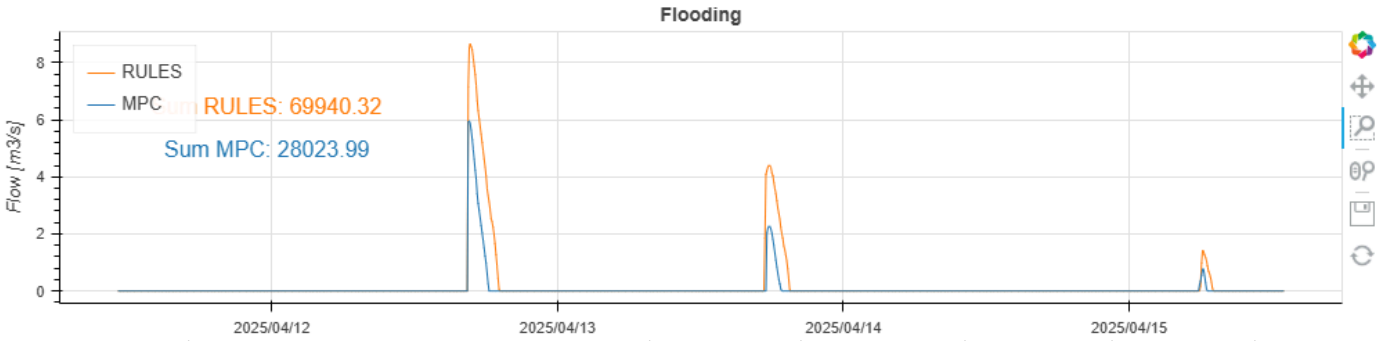


MD-MI Flow




Flow
2
1
0
2025/04/12
2025/04/13
2025/04/14
2025/04/15

Floodings


Flooding
RULES
MPC
Sum RULES: 69940.32
Sum MPC: 28023.99
Flow [m3/s]
8
6
4
2
0
2025/04/12
2025/04/13
2025/04/14
2025/04/15

Graph location to compare MPC and SWMM Rules



Annex 2. - Monitoring sampling campaign results

- Annex 2.1.- Sampling results for Dry Weather Flow Campaigns
- Annex 2.2.- Sampling results for Rain Event Campaigns

Annex 2.1.- Sampling results for Dry Weather Flow Campaigns

Proyecto	TS / TLL	ID muestra	Fecha/hora	Ubicación	Turb (UFT)	Cond (µs/cm)	SS (mg/l)	DQO (mg/l)	Amonio (mg/l)	Ptotal (mg/l)	N total (mg/l)	DBO5 (mg/l)	Comentari	Link excel
Rubies	Tiempo se...	TS_C_PRM_240409_01	9/4/2024 15:00:00	1ario EDAR Butarque	119.00	1,374.50	98.00	380.00	82.88	9.75	92.10	217.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx
Rubies	Tiempo se...	TS_C_PRM_240409_02	9/4/2024 19:00:00	1ario EDAR Butarque	158.00	1,303.70	175.00	475.00	72.86	8.44	77.80	293.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx
Rubies	Tiempo se...	TS_C_PRM_240409_03	9/4/2024 23:00:00	1ario EDAR Butarque	194.00	1,261.10	192.50	515.00	67.01	9.58	71.20	357.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx
Rubies	Tiempo se...	TS_C_PRM_240409_04	10/4/2024 3:00:00	1ario EDAR Butarque	172.00	1,189.60	210.00	504.00	66.28	7.92	66.60	332.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx
Rubies	Tiempo se...	TS_C_PRM_240409_05	10/4/2024 7:00:00	1ario EDAR Butarque	134.00	1,228.40	175.00	569.00	67.96	7.92	73.20	124.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx
Rubies	Tiempo se...	TS_C_PRM_240409_06	10/4/2024 11:00:00	1ario EDAR Butarque	91.00	1,376.70	88.95	383.00	69.40	8.46	78.00	170.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_01	07/06/2024 12:07	1ario EDAR Butarque	69.70	1,342.80	81.00	263.00	67.18	7.32	64.80	135.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_02	07/06/2024 12:37	1ario EDAR Butarque	79.90	1,370.10	56.00	241.00	71.57	7.68	67.60	121.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_03	07/06/2024 13:07	1ario EDAR Butarque	79.00	1,377.40	53.00	245.00	72.63	9.54	71.40	124.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_04	07/06/2024 13:37	1ario EDAR Butarque	72.80	1,393.10	63.00	301.00	74.62	8.56	74.80	135.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_05	07/06/2024 14:07	1ario EDAR Butarque	66.40	1,409.30	59.00	279.00	75.64	8.64	74.60	138.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_06	07/06/2024 14:37	1ario EDAR Butarque	53.10	1,397.80	59.00	291.00	74.84	8.62	75.40	152.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_07	07/06/2024 15:07	1ario EDAR Butarque	74.00	1,321.50	73.00	300.00	66.39	8.42	70.20	155.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_08	07/06/2024 15:37	1ario EDAR Butarque	93.80	1,293.40	78.00	324.00	62.67	8.46	69.60	174.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_09	07/06/2024 16:07	1ario EDAR Butarque	83.60	1,272.30	87.00	321.00	60.04	8.18	67.40	183.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_10	07/06/2024 16:37	1ario EDAR Butarque	89.71	1,262.80	87.00	335.00	60.01	8.26	67.20	174.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_11	07/06/2024 17:07	1ario EDAR Butarque	94.10	1,252.80	73.00	336.00	59.97	8.40	66.20	191.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PRM_240608_12	07/06/2024 17:37	1ario EDAR Butarque	105.00	1,231.50	91.00	358.00	61.03	8.46	66.20	200.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TS_C_PRM_240707_01	7/7/2024 1:30:00	1ario EDAR Butarque	116.01	1,161.70	105.00	444.00	56.57	7.86	69.00	256.00	Campaña TS3	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_PRM_240707_02	7/7/2024 5:30:00	1ario EDAR Butarque	97.80	1,155.80	81.00	388.00	58.80	7.62	69.00	244.00	Campaña TS3	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_PRM_240707_03	7/7/2024 9:30:00	1ario EDAR Butarque	84.90	1,229.70	68.00	323.00	60.87	7.86	71.40	203.00	Campaña TS3	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_PRM_240707_04	7/7/2024 13:30:00	1ario EDAR Butarque	74.10	1,352.50	75.00	312.00	69.60	9.12	80.70	182.00	Campaña TS3	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_PRM_240707_05	7/7/2024 17:30:00	1ario EDAR Butarque	117.01	1,318.00	104.00	466.00	72.06	9.69	83.70	251.00	Campaña TS3	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_PRM_240707_06	7/7/2024 21:30:00	1ario EDAR Butarque	141.00	1,235.60	118.00	506.00	59.04	13.44	69.90	110.00	Campaña TS3	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240714_01	14/7/2024 1:30:00	EDAR Sur	119.00	902.00	203.00	628.00	54.88	7.65	59.40	349.00	Campaña TS4	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240714_02	14/7/2024 5:30:00	EDAR Sur	107.00	942.00	192.00	586.00	60.58	8.10	64.80	349.00	Campaña TS4	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240714_03	14/7/2024 9:30:00	EDAR Sur	54.60	965.40	136.00	326.00	62.81	6.48	57.00	138.00	Campaña TS4	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240714_04	14/7/2024 13:30:00	EDAR Sur	144.00	1,079.90	225.00	646.00	82.36	11.04	86.40	369.00	Campaña TS4	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240714_05	14/7/2024 17:30:00	EDAR Sur	172.00	944.90	267.00	808.00	68.15	10.14	70.20	450.00	Campaña TS4	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240714_06	14/7/2024 21:30:00	EDAR Sur	151.00	919.70	247.00	738.00	61.92	8.40	60.30	459.00	Campaña TS4	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240722_01	22/7/2024 1:30:00	EDAR Sur	115.00	900.20	246.00	694.00	56.29	7.58	59.80	318.00	Campaña TS5	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240722_02	22/7/2024 5:30:00	EDAR Sur	81.50	984.30	228.00	482.00	56.85	7.16	43.80	248.00	Campaña TS5	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240722_03	22/7/2024 9:30:00	EDAR Sur	50.10	997.20	132.00	364.00	55.68	5.56	53.20	127.00	Campaña TS5	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240722_04	22/7/2024 13:30:00	EDAR Sur	125.00	1,048.60	318.00	666.00	73.68	11.02	77.80	338.00	Campaña TS5	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240722_05	22/7/2024 17:30:00	EDAR Sur	156.00	963.80	270.00	680.00	59.99	8.42	67.20	228.00	Campaña TS5	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_SUR_240722_06	22/7/2024 21:30:00	EDAR Sur	140.00	938.40	252.00	666.00	58.32	7.62	62.60	374.00	Campaña TS5	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_PAR_240410_01	10/4/2024 17:00:00	Partidor Butarque	301.00	1,152.00	308.00	935.00	51.44	8.43	63.60	526.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx
Rubies	Tiempo se...	TS_C_PAR_240410_02	10/4/2024 21:00:00	Partidor Butarque	273.00	1,111.90	328.00	873.00	53.37	8.40	66.60	498.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx
Rubies	Tiempo se...	TS_C_PAR_240410_03	11/4/2024 1:00:00	Partidor Butarque	268.00	1,034.60	350.00	786.00	54.18	8.37	68.10	495.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx
Rubies	Tiempo se...	TS_C_PAR_240410_04	11/4/2024 5:00:00	Partidor Butarque	210.00	1,114.60	347.50	645.00	53.82	7.68	63.90	422.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx
Rubies	Tiempo se...	TS_C_PAR_240410_05	11/4/2024 9:00:00	Partidor Butarque	150.00	1,350.10	295.00	614.00	80.99	10.86	92.10	324.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx
Rubies	Tiempo se...	TS_C_PAR_240410_06	11/4/2024 13:00:00	Partidor Butarque	284.00	1,297.00	436.67	812.00	90.41	12.90	104.40	428.00	Campaña TS1	CampañaTS 1 (9 y 10 abril 2024).xlsx

Proyecto	TS / TLL	ID muestra	Fecha/hora	Ubicación	Turb (UFT)	Cond (µs/cm)	SS (mg/l)	DQO (mg/l)	Amonio (mg/l)	Ptotal (mg/l)	N total (mg/l)	DBO5 (mg/l)	Comentari	Link excel
Rubies	Tiempo se...	TLL_C_PAR_240608_01	07/06/2024 11:27	Partidor Butarque	146.00	1,401.70	336.00	755.00	108.99	14.25	107.10	400.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PAR_240608_02	07/06/2024 11:37	Partidor Butarque	187.00	1,401.50	368.00	508.00	106.86	11.31	98.70	411.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PAR_240608_03	07/06/2024 11:47	Partidor Butarque	110.00	1,391.10	354.00	607.00	100.30	11.79	96.60	436.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PAR_240608_04	07/06/2024 11:57	Partidor Butarque	194.00	1,405.70	282.00	657.00	95.56	12.24	99.30	383.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PAR_240608_05	07/06/2024 12:07	Partidor Butarque	180.00	1,463.20	304.00	740.00	92.41	11.91	95.70	377.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PAR_240608_06	07/06/2024 12:17	Partidor Butarque	208.00	1,457.70	316.00	700.00	86.83	11.58	85.50	372.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PAR_240608_07	07/06/2024 12:27	Partidor Butarque	145.00	1,332.90	304.00	745.00	81.49	11.28	76.40	377.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PAR_240608_08	07/06/2024 12:47	Partidor Butarque	148.00	1,267.60	282.00	740.00	75.14	10.44	72.60	434.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PAR_240608_09	07/06/2024 13:07	Partidor Butarque	106.00	1,266.40	284.00	583.00	69.97	9.20	69.60	430.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PAR_240608_10	07/06/2024 13:27	Partidor Butarque	125.00	1,244.90	264.00	673.00	66.58	9.10	65.80	355.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PAR_240608_11	07/06/2024 13:47	Partidor Butarque	121.00	1,257.10	238.18	599.00	61.04	8.80	60.60	402.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TLL_C_PAR_240608_12	07/06/2024 14:07	Partidor Butarque	159.00	1,330.70	424.00	631.00	72.66	10.29	76.20	597.00	Campaña TS2	CampañaTS2 (7 junio 2024) .xlsx
Rubies	Tiempo se...	TS_C_PAR_240728_01	28/7/2024 1:30:00	Partidor Butarque	262.01	939.10	606.00	203.00	52.35	4.10	39.00	591.00	Campaña TS6	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_PAR_240728_02	28/7/2024 5:30:00	Partidor Butarque	187.01	963.60	310.00	226.00	53.36	4.83	25.50	169.00	Campaña TS6	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_PAR_240728_03	28/7/2024 9:30:00	Partidor Butarque	179.00	1,126.80	420.00	141.00	65.94	5.90	53.00	254.00	Campaña TS6	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_PAR_240728_04	28/7/2024 13:30:00	Partidor Butarque	274.00	1,194.90	622.00	342.00	76.56	7.94	62.20	872.00	Campaña TS6	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_PAR_240728_05	28/7/2024 17:30:00	Partidor Butarque	262.00	936.90	310.00	317.00	51.70	5.97	48.00	321.00	Campaña TS6	Campaña TS3_4_5_6 (julio 7_14_...
Rubies	Tiempo se...	TS_C_PAR_240728_06	28/7/2024 21:30:00	Partidor Butarque	394.00	936.60	870.00	628.00	56.52	6.00	47.00	535.00	Campaña TS6	Campaña TS3_4_5_6 (julio 7_14_...

Annex 2.2.- Sampling results for Rain Event Campaigns

Proyecto	TS / TLL	ID muestra	Fecha/hora	Ubicación	Turb (UFT)	Cond (µs/cm)	SS (mg/l)	DQO (mg/l)	Amonio (mg/l)	Ptotal (mg/l)	N total (mg/l)	DBO5 (mg/l)	Comentari	Link excel
Rubies	Tiempo llu...	TLL_C_PRM_240919_11	19/9/2024 21:36:00	1ario EDAR Butarque	57.90	634.30	69.00	189.00	21.10	3.97	30.00	132.00	Campaña TLL1	Campaña TLL1 (19 set 2024).xlsx
Rubies	Tiempo llu...	TLL_C_PRM_241029_11	30/10/2024 1:40:00	1ario EDAR Butarque	71.50	574.80	30.00	272.00	28.37	4.02	28.56		Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250307_10	7/3/2025 18:51:00	1ario EDAR Butarque	82.70	538.30	108.00	209.00	32.50	3.42	23.60	59.10	Campaña 7/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_241029_10	30/10/2024 1:20:00	1ario EDAR Butarque	85.10	708.10	15.00	172.00	35.52	4.86	34.80	149.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250301_11	1/3/2025 22:56:00	1ario EDAR Butarque	85.60	601.70	115.00	257.00	42.57	5.22	30.60	129.00	Campaña 1/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_BUT_250320_12	20/3/2025 23:31:00	1ario EDAR Butarque	89.70	468.90	144.00	105.60	19.61	1.99	16.60	57.80	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250307_09	7/3/2025 18:36:00	1ario EDAR Butarque	90.70	585.90	131.00	228.00	37.57	3.86	27.20	92.80	Campaña 7/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250307_11	7/3/2025 19:06:00	1ario EDAR Butarque	91.40	490.80	111.00	195.00	27.37	3.04	21.80	76.00	Campaña 7/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_241029_9	30/10/2024 1:00:00	1ario EDAR Butarque	93.10	750.00	18.00	325.00	38.41	5.10	42.30	121.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_240919_10	19/9/2024 21:16:00	1ario EDAR Butarque	97.50	795.10	106.00	286.00	40.67	4.93	39.60	169.00	Campaña TLL1	Campaña TLL1 (19 set 2024).xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250307_02	7/3/2025 16:51:00	1ario EDAR Butarque	97.70	844.00	120.00	165.80	48.52	5.76	45.40	81.60	Campaña 7/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250301_10	1/3/2025 22:42:00	1ario EDAR Butarque	97.71	637.00	125.00	305.00	47.17	5.50	35.60		Campaña 1/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_240919_9	19/9/2024 20:56:00	1ario EDAR Butarque	98.00	1,014.00	81.00	363.00	55.71	6.30	46.20	236.00	Campaña TLL1	Campaña TLL1 (19 set 2024).xlsx
Rubies	Tiempo llu...	TLL_C_PRM_241029_8	30/10/2024 0:40:00	1ario EDAR Butarque	98.10	795.60	19.00	321.00	40.71	5.49	39.60	45.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250307_07	7/3/2025 18:06:00	1ario EDAR Butarque	101.00	684.60	123.00	244.00	40.01	4.18	31.40	121.00	Campaña 7/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250307_04	7/3/2025 17:20:00	1ario EDAR Butarque	101.01	790.70	134.00	173.40	43.81	5.40	40.80	84.40	Campaña 7/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250307_03	7/3/2025 17:06:00	1ario EDAR Butarque	101.02	810.90	101.00	302.00	45.98	5.50	42.80	73.20	Campaña 7/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250301_08	1/3/2025 22:12:00	1ario EDAR Butarque	102.00	694.40	131.00	336.00	49.19	6.78	34.00	158.00	Campaña 1/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_241029_6	30/10/2024 0:00:00	1ario EDAR Butarque	102.01	834.90	14.00	334.00	41.71	5.79	40.50	87.20	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250301_06	1/3/2025 21:41:00	1ario EDAR Butarque	103.00	773.10	135.00	359.00	54.38	6.22	39.60	180.00	Campaña 1/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250211_02	11/2/2025 22:35:00	1ario EDAR Butarque	103.01	1,133.20	172.00	574.00	64.29	8.13	64.60	349.00	Campaña 11/02/2025	campañas_febrero_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_241029_7	30/10/2024 0:20:00	1ario EDAR Butarque	104.00	829.60	19.00	361.00	42.50	5.61	47.10	211.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250307_05	7/3/2025 17:36:00	1ario EDAR Butarque	104.01	760.50	131.00	304.00	41.83	5.18	38.80	84.40	Campaña 7/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_BUT_250320_07	20/3/2025 22:15:00	1ario EDAR Butarque	105.01	731.30	130.00	278.00	32.33	3.54	31.30	26.70	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250301_09	1/3/2025 22:27:00	1ario EDAR Butarque	105.02	665.90	124.00	322.00	48.46	5.90	35.60	163.00	Campaña 1/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_241029_5	29/10/2024 23:50:00	1ario EDAR Butarque	106.00	833.10	20.00	335.00	50.62	5.79	44.10		Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_BUT_250320_11	20/3/2025 23:16:00	1ario EDAR Butarque	106.01	482.90	162.00	133.80	21.11	2.30	18.50	76.10	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250307_01	7/3/2025 16:36:00	1ario EDAR Butarque	108.00	865.90	121.00	316.00	51.80	5.86	46.00	101.00	Campaña 7/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250307_08	7/3/2025 18:20:00	1ario EDAR Butarque	108.01	638.70	123.00	201.00	39.17	4.14	31.00	110.00	Campaña 7/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_241029_3	29/10/2024 23:30:00	1ario EDAR Butarque	111.00	843.00	15.00	467.00	51.98	5.91	48.90	203.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_241029_2	29/10/2024 23:20:00	1ario EDAR Butarque	113.00	855.60	22.00	396.00	52.87	6.03	45.00	225.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_241029_4	29/10/2024 23:40:00	1ario EDAR Butarque	113.01	845.80	22.00	362.00	51.94	5.79	50.70	225.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250307_06	7/3/2025 17:51:00	1ario EDAR Butarque	113.02	721.30	139.00	306.00	38.57	5.58	35.40	92.80	Campaña 7/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_240919_1	19/9/2024 18:56:00	1ario EDAR Butarque	114.00	1,202.40	149.00	441.00	69.14	7.38	54.90	262.00	Campaña TLL1	Campaña TLL1 (19 set 2024).xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250211_01	11/2/2025 22:20:00	1ario EDAR Butarque	114.01	1,135.00	248.00	804.00	61.71	9.06	71.60	366.00	Campaña 11/02/2025	campañas_febrero_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_240919_8	19/9/2024 20:36:00	1ario EDAR Butarque	116.00	1,098.00	105.00	418.00	61.28	6.84	51.30	267.00	Campaña TLL1	Campaña TLL1 (19 set 2024).xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250301_07	1/3/2025 21:57:00	1ario EDAR Butarque	116.01	744.60	134.00	469.00	54.05	7.47	38.20	191.00	Campaña 1/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_BUT_250320_09	20/3/2025 22:46:00	1ario EDAR Butarque	116.02	598.10	136.00	199.00	26.68	2.79	23.70	108.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_BUT_250320_10	20/3/2025 23:01:00	1ario EDAR Butarque	116.03	532.00	170.00	104.60	23.60	2.53	19.80	90.20	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_240919_7	19/9/2024 20:16:00	1ario EDAR Butarque	117.00	1,157.60	100.00	408.00	66.03	7.41	52.80	273.00	Campaña TLL1	Campaña TLL1 (19 set 2024).xlsx
Rubies	Tiempo llu...	TLL_C_PRM_240919_6	19/9/2024 19:56:00	1ario EDAR Butarque	121.00	1,160.70	110.00	409.00	66.56	7.44	54.90	273.00	Campaña TLL1	Campaña TLL1 (19 set 2024).xlsx
Rubies	Tiempo llu...	TLL_C_BUT_250320_08	20/3/2025 22:31:00	1ario EDAR Butarque	124.00	664.00	220.00	189.00	30.06	3.04	27.40	124.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx

Proyecto	TS / TLL	ID muestra	Fecha/hora	Ubicación	Turb (UFT)	Cond (µs/cm)	SS (mg/l)	DQO (mg/l)	Amonio (mg/l)	Ptotal (mg/l)	N total (mg/l)	DBO5 (mg/l)	Comentari	Link excel
Rubies	Tiempo llu...	TLL_C_BUT_250320_02	20/3/2025 21:01:00	1ario EDAR Butarque	126.00	1,006.40	135.00	362.00	44.32	4.94	46.00	159.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_241029_1	29/10/2024 23:10:00	1ario EDAR Butarque	127.00	840.90	24.00	603.00	51.69	6.06	51.90	217.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_BUT_250320_01	20/3/2025 20:46:00	1ario EDAR Butarque	127.01	1,017.80	134.00	346.00	43.75	4.98	47.60		Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_240919_2	19/9/2024 19:06:00	1ario EDAR Butarque	128.00	1,220.30	123.00	453.00	73.57	7.56	57.60	304.00	Campaña TLL1	Campaña TLL1 (19 set 2024).xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250301_05	1/3/2025 21:27:00	1ario EDAR Butarque	132.00	795.50	132.00	406.00	53.32	7.95	43.60	225.00	Campaña 1/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_240919_3	19/9/2024 19:16:00	1ario EDAR Butarque	134.01	1,214.70	130.00	495.00	72.12	7.02	56.40	309.00	Campaña TLL1	Campaña TLL1 (19 set 2024).xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250301_04	1/3/2025 21:12:00	1ario EDAR Butarque	134.02	844.10	148.00	415.00	63.41	8.04	47.40	242.00	Campaña 1/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_BUT_250320_06	20/3/2025 22:01:00	1ario EDAR Butarque	135.00	818.80	174.00	322.00	37.35	4.40	37.40	144.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_BUT_250320_03	20/3/2025 21:15:00	1ario EDAR Butarque	137.00	981.50	147.00	366.00	42.93	5.02	44.40		Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_240919_5	19/9/2024 19:36:00	1ario EDAR Butarque	140.00	1,158.20	156.00	509.00	65.88	7.41	54.30	298.00	Campaña TLL1	Campaña TLL1 (19 set 2024).xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250301_03	1/3/2025 20:57:00	1ario EDAR Butarque	142.00	860.10	150.00	465.00	60.99	8.40	50.10	250.00	Campaña 1/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_240919_4	19/9/2024 19:26:00	1ario EDAR Butarque	142.01	1,201.10	128.00	438.00	68.91	7.44	54.30	324.00	Campaña TLL1	Campaña TLL1 (19 set 2024).xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250301_02	1/3/2025 20:42:00	1ario EDAR Butarque	142.02	879.40	154.00	449.00	59.98	8.52	51.90	253.00	Campaña 1/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_BUT_250320_05	20/3/2025 21:46:00	1ario EDAR Butarque	147.00	893.60	169.00	346.00	40.14	4.80	41.00	159.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_BUT_250320_04	20/3/2025 21:31:00	1ario EDAR Butarque	153.00	944.10	179.00	372.00	41.13	4.92	43.20	200.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PRM_250301_01	1/3/2025 20:27:00	1ario EDAR Butarque	160.00	913.40	186.00	536.00	65.81	9.33	54.00	273.00	Campaña 1/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_241007_05	7/10/2024 18:15:00	EDAR Sur	163.00	662.80	918.00	1,806.00	38.62	11.58	54.60		Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241007_01	7/10/2024 17:35:00	EDAR Sur	176.00	735.70	892.00	1,604.00	39.10	12.00	59.10	789.00	Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241007_02	7/10/2024 17:45:00	EDAR Sur	134.00	725.30	856.00	1,340.00	39.63	11.52	67.50	620.00	Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241007_04	7/10/2024 18:05:00	EDAR Sur	232.00	677.00	838.00	1,060.00	40.38	12.84	51.90		Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241007_03	7/10/2024 17:55:00	EDAR Sur	210.00	770.70	770.00	1,492.00	42.52	12.09	81.90	834.00	Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241007_06	7/10/2024 18:25:00	EDAR Sur	199.00	620.80	708.00	1,560.00	35.41	11.31	56.00	693.00	Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241007_07	7/10/2024 18:45:00	EDAR Sur	132.00	594.40	654.00	1,404.00	34.00	9.51	43.35	699.00	Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_250121_08	21/1/2025 13:16:00	EDAR Sur	197.00	527.30	620.00	670.00	32.82	6.86	48.62	374.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_241007_11	7/10/2024 20:05:00	EDAR Sur	150.00	581.30	558.00	768.00	31.44	6.03	46.50	366.00	Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_250121_06	21/1/2025 12:36:00	EDAR Sur	227.00	717.30	552.00	444.00	53.57	8.36	66.60	478.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_241007_12	7/10/2024 20:25:00	EDAR Sur	188.00	557.40	538.00	1,368.00	28.91	7.47	45.00	349.00	Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_250121_07	21/1/2025 12:56:00	EDAR Sur	216.00	622.20	526.00	1,144.00	42.98	9.96	70.93	436.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_241007_09	7/10/2024 19:25:00	EDAR Sur	133.00	616.20	520.00	1,190.00	33.66	8.61	58.20	394.00	Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241012_2	12/10/2024 6:03:00	EDAR Sur	103.02	554.00	508.00	750.00	32.54	8.49	45.30	377.00	Campaña 12/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_250121_09	21/1/2025 13:36:00	EDAR Sur	209.00	504.30	478.00	720.00	29.67	6.24	44.00	360.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_241012_3	12/10/2024 6:13:00	EDAR Sur	103.03	463.10	463.33	636.00	26.42	7.05	38.70	293.00	Campaña 12/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241007_10	7/10/2024 19:45:00	EDAR Sur	147.00	581.40	462.00	1,034.00	31.51	7.26	52.20		Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_250121_05	21/1/2025 12:26:00	EDAR Sur	221.00	784.60	458.33	618.00	61.08	9.79	76.92	425.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_250121_03	21/1/2025 12:06:00	EDAR Sur	182.00	879.00	445.45	506.00	71.04	10.49	87.58	360.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_250121_01	21/1/2025 11:46:00	EDAR Sur	174.00	894.00	428.00	456.00	71.65	10.69	78.92	312.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_241016_7	16/10/2024 10:19:00	EDAR Sur	166.00	495.00	427.50	636.00	30.20	6.50	35.80	340.00	Campaña 16/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241016_6	16/10/2024 10:13:00	EDAR Sur	147.01	479.80	405.00	782.00	30.62	7.40	34.80	300.00	Campaña 16/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241012_1	12/10/2024 5:53:00	EDAR Sur	112.00	535.80	404.00	720.00	36.14	7.92	50.10	366.00	Campaña 12/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241016_4	16/10/2024 5:19:00	EDAR Sur	161.00	459.60	395.00	622.00	27.06	6.36	31.60	330.00	Campaña 16/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_250121_02	21/1/2025 11:56:00	EDAR Sur	222.00	889.00	376.36	348.00	73.80	10.59	82.58	287.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_241016_5	16/10/2024 9:09:00	EDAR Sur	145.00	468.50	375.00	1,028.00	29.26	6.56	35.20	300.00	Campaña 16/10/2024	Campañas de 19set 2024 a 16oc...

Proyecto	TS / TLL	ID muestra	Fecha/hora	Ubicación	Turb (UFT)	Cond (µs/cm)	SS (mg/l)	DQO (mg/l)	Amonio (mg/l)	Ptotal (mg/l)	N total (mg/l)	DBO5 (mg/l)	Comentari	Link excel
Rubies	Tiempo llu...	TLL_C_SUR_250121_04	21/1/2025 12:16:00	EDAR Sur	147.03	850.60	375.00	856.00	67.69	11.72	93.24	394.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_241012_5	12/10/2024 6:33:00	EDAR Sur	107.01	474.30	373.33	450.00	23.50	5.58	33.90	270.00	Campaña 12/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_250121_10	21/1/2025 13:56:00	EDAR Sur	204.00	467.40	366.67	602.00	25.65	6.59	45.95	276.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_241012_4	12/10/2024 6:23:00	EDAR Sur	130.00	433.00	353.33	630.00	23.51	7.35	34.50	254.00	Campaña 12/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241029_3	29/10/2024 15:46:00	EDAR Sur	120.00	376.20	348.33	471.00	19.04	3.18	21.15		Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_241016_8	16/10/2024 10:30:00	EDAR Sur	86.20	216.50	345.00	250.00	12.69	3.44	15.52	90.00	Campaña 16/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241029_1	29/10/2024 15:26:00	EDAR Sur	152.00	380.60	343.33	728.00	19.44	3.54	21.78	338.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_250121_11	21/1/2025 14:16:00	EDAR Sur	180.00	465.90	338.33	328.00	25.43	4.80	37.30	242.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_241016_3	16/10/2024 5:13:00	EDAR Sur	117.00	339.10	325.00	504.00	20.58	4.48	23.40	170.00	Campaña 16/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241029_7	29/10/2024 16:36:00	EDAR Sur	132.01	392.80	309.09	292.00	18.04	3.03	21.48	225.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_241029_6	29/10/2024 16:16:00	EDAR Sur	121.00	388.10	304.62	529.00	18.25	3.21	24.66	237.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_241029_2	29/10/2024 15:36:00	EDAR Sur	142.00	385.40	303.08	533.00	20.12	3.63	21.99	468.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_241029_5	29/10/2024 16:06:00	EDAR Sur	136.00	378.40	293.33	391.00	18.58	2.98	23.01	220.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_250121_12	21/1/2025 14:36:00	EDAR Sur	181.00	476.00	290.00	195.00	25.51	4.36	35.96	214.00	Campaña 21/01/2025	resultados_campañas_enero_rub...
Rubies	Tiempo llu...	TLL_C_SUR_241029_8	29/10/2024 16:56:00	EDAR Sur	148.00	402.40	288.33	280.00	17.73	2.85	22.44		Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_241029_4	29/10/2024 15:56:00	EDAR Sur	159.00	371.10	283.33	414.00	18.11	3.15	20.88	248.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_241016_2	16/10/2024 5:08:00	EDAR Sur	92.70	272.30	282.50	261.00	18.84	3.42	19.58	120.00	Campaña 16/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241007_08	7/10/2024 19:05:00	EDAR Sur	219.00	642.70	268.00	1,158.00	35.51	8.55	60.60	586.00	Campaña 7/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241012_6	12/10/2024 6:43:00	EDAR Sur	112.01	422.60	253.33	448.00	21.33	5.34	30.00	205.00	Campaña 12/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241016_1	16/10/2024 5:00:00	EDAR Sur	103.01	253.00	250.00	348.00	14.98	3.90	19.72	130.00	Campaña 16/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241029_11	29/10/2024 17:56:00	EDAR Sur	119.01	522.60	226.15	266.00	22.19	2.82	24.42	205.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_241029_10	29/10/2024 17:36:00	EDAR Sur	122.00	496.70	212.00	297.00	20.14	2.98	24.54	197.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_241029_9	29/10/2024 17:16:00	EDAR Sur	113.00	424.80	210.00	344.00	18.81	2.84	22.89	141.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_241012_7	12/10/2024 7:03:00	EDAR Sur	87.30	379.40	193.33	312.00	18.26	4.23	24.57	115.00	Campaña 12/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_SUR_241029_12	29/10/2024 18:16:00	EDAR Sur	147.02	547.00	181.11	431.00	25.04	3.33	28.20	220.00	Campaña 29/10/2024	Campaña 29 octubre.xlsx
Rubies	Tiempo llu...	TLL_C_SUR_241016_9	16/10/2024 13:42:00	EDAR Sur	85.30	357.60	82.50	160.00	18.30	3.42	18.62	100.00	Campaña 16/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_ENB_250211_01	11/2/2025 22:28:00	Entrada EDAR Butar...	281.00	763.00	964.00	5,994.00	45.67				Campaña 11/02/2025	campañas_febrero_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250211_02	11/2/2025 22:32:00	Entrada EDAR Butar...	293.00	675.40	370.00	2,290.00	43.22	12.99	68.10		Campaña 11/02/2025	campañas_febrero_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250211_03	11/2/2025 22:36:00	Entrada EDAR Butar...	329.00	578.80	690.00	1,665.00	38.74	11.16	59.94	828.00	Campaña 11/02/2025	campañas_febrero_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250211_04	11/2/2025 22:48:00	Entrada EDAR Butar...	232.00	475.10	776.00	1,455.00	29.23	10.22	47.29	648.00	Campaña 11/02/2025	campañas_febrero_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250211_05	11/2/2025 22:54:00	Entrada EDAR Butar...	275.00	494.20	656.00	2,871.00	29.91	8.66	49.95	603.00	Campaña 11/02/2025	campañas_febrero_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250211_06	11/2/2025 23:09:00	Entrada EDAR Butar...	154.00	413.20	572.00	828.00	23.38	6.46	32.43	507.00	Campaña 11/02/2025	campañas_febrero_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250211_07	11/2/2025 23:29:00	Entrada EDAR Butar...	167.00	326.51	476.00	634.00	17.45	5.16	23.91	361.00	Campaña 11/02/2025	campañas_febrero_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250211_08	11/2/2025 23:39:00	Entrada EDAR Butar...	132.00	327.80	454.00	582.00	15.44	4.73	23.41	299.00	Campaña 11/02/2025	campañas_febrero_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250304_01	4/3/2025 2:00:00	Entrada EDAR Butar...	128.00	372.40	290.00	1,054.94	14.65	4.14	19.38	231.00	Campaña 4/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250304_02	4/3/2025 2:06:00	Entrada EDAR Butar...	98.50	346.90	415.00	346.00	14.59	3.64	18.20	115.00	Campaña 4/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250304_03	4/3/2025 2:16:00	Entrada EDAR Butar...	96.90	266.20	336.00	283.00	8.36	2.98	13.76	98.50	Campaña 4/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250304_04	4/3/2025 2:26:00	Entrada EDAR Butar...	37.00	232.10	263.00	308.00	7.83	2.78	11.76	81.60	Campaña 4/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250304_05	4/3/2025 2:36:00	Entrada EDAR Butar...	89.80	189.10	259.00	336.00	4.86	2.46	8.98	61.90	Campaña 4/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250304_06	4/3/2025 2:46:00	Entrada EDAR Butar...	96.10	174.00	250.00	240.00	4.27	2.14	10.40	90.00	Campaña 4/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250304_07	4/3/2025 2:56:00	Entrada EDAR Butar...	70.50	160.30	222.00	171.00	3.54	2.14	5.88	45.00	Campaña 4/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250304_08	4/3/2025 3:16:00	Entrada EDAR Butar...	84.80	143.70	242.00	176.00	2.69	2.04	6.83	39.40	Campaña 4/3/2025	resultados_marzo_rubies.xlsx

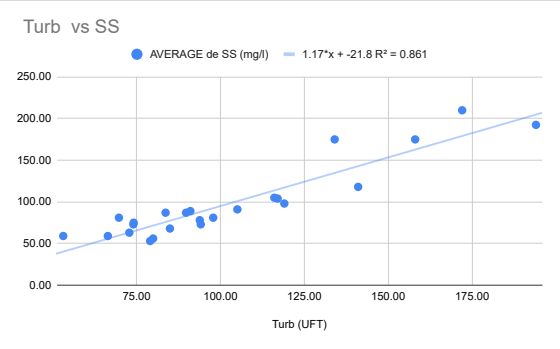
Proyecto	TS / TLL	ID muestra	Fecha/hora	Ubicación	Turb (UFT)	Cond (µs/cm)	SS (mg/l)	DQO (mg/l)	Amonio (mg/l)	Ptotal (mg/l)	N total (mg/l)	DBO5 (mg/l)	Comentari	Link excel
Rubies	Tiempo llu...	TLL_C_ENB_250304_09	4/3/2025 3:36:00	Entrada EDAR Butar...	97.50	141.00	280.00	190.00	2.25	1.99	5.78	73.20	Campaña 4/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250304_10	4/3/2025 3:41:00	Entrada EDAR Butar...	79.80	138.30	235.00	164.00	2.31	1.91	4.64	50.60	Campaña 4/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250304_11	4/3/2025 4:01:00	Entrada EDAR Butar...	69.70	137.80	195.00	63.40	2.15	1.51	3.52	33.80	Campaña 4/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250304_12	4/3/2025 4:12:00	Entrada EDAR Butar...	62.50	168.30	185.00	100.60	2.17	2.22	19.62	366.00	Campaña 4/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_01	20/3/2025 21:16:00	Entrada EDAR B...	214.00	568.80	442.00	748.00	22.22	5.72	32.80	357.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_02	20/3/2025 21:25:00	Entrada EDAR B...	157.00	415.30	492.00	624.00	15.41	4.54	25.40	366.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_03	20/3/2025 21:38:00	Entrada EDAR B...	205.00	283.40	680.00	630.00	9.24	4.60	21.00	245.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_04	20/3/2025 21:48:00	Entrada EDAR B...	200.00	251.70	572.00	548.00	6.81	3.52	19.14	169.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_05	20/3/2025 21:58:00	Entrada EDAR B...	228.00	234.10	692.00	331.00	5.87	2.61	13.30		Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_06	20/3/2025 22:08:00	Entrada EDAR B...	167.01	216.30	632.00	503.00	5.48	3.30	14.70	242.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_07	20/3/2025 22:18:00	Entrada EDAR B...	219.00	228.20	562.00	383.00	4.59	3.45	14.40	86.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_08	20/3/2025 22:28:00	Entrada EDAR B...	59.40	238.50	458.00	377.00	4.98	2.56	13.60	81.70	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_09	20/3/2025 22:48:00	Entrada EDAR B...	68.30	271.40	378.00	233.00	7.06	2.00	9.99	77.50	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_10	20/3/2025 23:08:00	Entrada EDAR B...	102.01	278.90	144.00	225.00	8.19	1.62	9.86	60.60	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_11	20/3/2025 23:28:00	Entrada EDAR B...	73.00	280.10	362.00	185.00	8.82	1.62	10.50	24.00	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250320_12	20/3/2025 23:48:00	Entrada EDAR B...	61.80	257.20	170.00	154.00	8.30	1.32	8.98	74.70	Campaña 20/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_01	8/3/2025 12:39:00	Entrada EDAR B...	133.00	284.70	211.00	394.00	14.66	3.24	18.72	129.00	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_02	8/3/2025 12:49:00	Entrada EDAR B...	97.7	249.00	387.00	147.00	10.46	2.16	12.18	50.60	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_03	8/3/2025 12:59:00	Entrada EDAR B...	87.30	257.50	206.00	131.00	10.42	1.98	12.16	59.10	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_04	8/3/2025 13:08:00	Entrada EDAR B...	93.60	259.50	164.00	150.00	10.22	1.93	11.94	86.00	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_05	8/3/2025 13:18:00	Entrada EDAR B...	94.20	266.80	154.00	125.00	10.24	1.91	13.32	73.30	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_06	8/3/2025 13:35:00	Entrada EDAR B...	111.00	317.30	260.00	45.70	11.28	1.64	11.12	55.00	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_07	8/3/2025 13:45:00	Entrada EDAR B...	99.00	353.00	179.00	207.00	14.86	1.97	12.64	92.80	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_08	8/3/2025 13:56:00	Entrada EDAR B...	102.00	348.30	171.00	206.00	15.73	1.98	12.82	87.20	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_09	8/3/2025 14:02:00	Entrada EDAR B...	94.21	340.90	156.00	217.00	16.19	1.96	13.90	92.80	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_10	8/3/2025 14:12:00	Entrada EDAR B...	89.50	326.50	146.00	246.00	15.70	1.90	12.44	92.80	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_11	8/3/2025 14:32:00	Entrada EDAR B...	80.20	349.00	138.00	245.00	14.92	1.92	13.90	104.00	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_ENB_250308_12	8/3/2025 14:42:00	Entrada EDAR B...	100.00	354.80	178.00	301.00	15.91	1.43	11.60	73.20	Campaña 8/3/2025	resultados_marzo_rubies.xlsx
Rubies	Tiempo llu...	TLL_C_PAR_241009_04	9/10/2024 15:39:00	Partidor Butarque	222.00	697.70	688.00	332.00	34.04	4.82	34.20	518.00	Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_PAR_241009_01	9/10/2024 15:09:00	Partidor Butarque	275.00	894.20	620.00	1,052.00	46.62	9.30	58.80	952.00	Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_PAR_241009_03	9/10/2024 15:29:00	Partidor Butarque	280.00	795.60	572.00	378.00	39.16	5.46	41.20	521.00	Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_PAR_241009_06	9/10/2024 15:55:00	Partidor Butarque	203.00	599.70	568.00	284.00	27.21	4.16	27.80	504.00	Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_PAR_241009_05	9/10/2024 15:49:00	Partidor Butarque	221.01	634.00	564.00	296.00	30.55	4.34	31.00	512.00	Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_PAR_241009_02	9/10/2024 15:19:00	Partidor Butarque	237.00	838.60	556.00	972.00	43.41	8.94	54.00	518.00	Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_PAR_241009_07	9/10/2024 16:01:00	Partidor Butarque	172.00	567.10	500.00	279.00	25.66	3.82	27.40	492.00	Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_PAR_241009_08	9/10/2024 16:07:00	Partidor Butarque	208.01	564.70	436.00	274.00	26.20	3.70	26.60	459.00	Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_PAR_241009_09	9/10/2024 16:17:00	Partidor Butarque	159.01	526.20	400.00	778.00	23.83	6.84	37.80		Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_PAR_241009_11	9/10/2024 16:46:00	Partidor Butarque	163.00	432.60	396.00	554.00	16.98	4.77	26.82	273.00	Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_PAR_241009_10	9/10/2024 16:27:00	Partidor Butarque	137.00	485.30	324.00	812.00	20.96	3.25	33.30	346.00	Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...
Rubies	Tiempo llu...	TLL_C_PAR_241009_12	9/10/2024 16:52:00	Partidor Butarque	124.00	415.70	296.00	500.00	16.26	4.71	26.76	295.00	Campaña 9/10/2024	Campañas de 19set 2024 a 16oc...

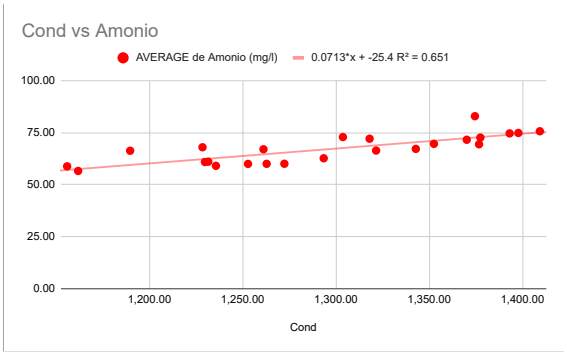
Annex 3. - Sampling data correlation results

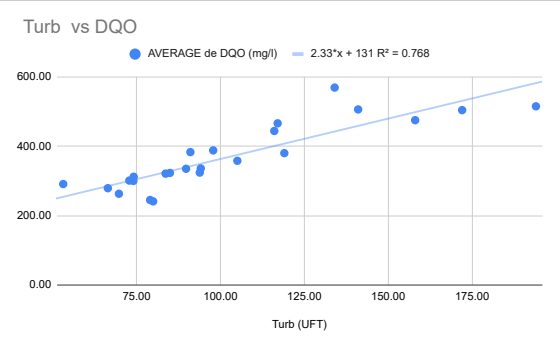
DRY WEATHER FLOW CORRELATIONS IN BUTARQUE WWTP AFTER PRIMARY TREATMENT

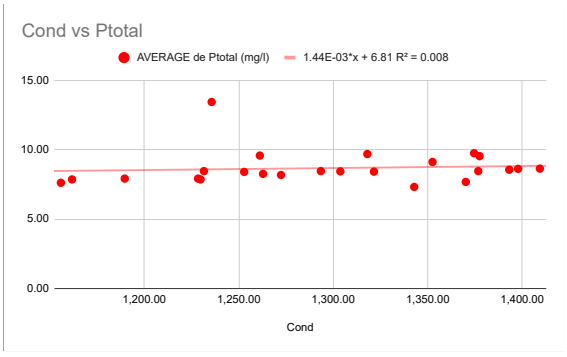
Turb (UFT)	COUNT de Turb	AVERAGE de SS	AVERAGE de DQ	AVERAGE de DB
53.10	1	59.00	291.00	152.00
66.40	1	59.00	279.00	138.00
69.70	1	81.00	263.00	135.00
72.80	1	63.00	301.00	135.00
74.00	1	73.00	300.00	155.00
74.10	1	75.00	312.00	182.00
79.00	1	53.00	245.00	124.00
79.90	1	56.00	241.00	121.00
83.60	1	87.00	321.00	183.00
84.90	1	68.00	323.00	203.00
89.71	1	87.00	335.00	174.00
91.00	1	88.95	383.00	170.00
93.80	1	78.00	324.00	174.00
94.10	1	73.00	336.00	191.00
97.80	1	81.00	388.00	244.00
105.00	1	91.00	358.00	200.00
116.01	1	105.00	444.00	256.00
117.01	1	104.00	466.00	251.00
119.00	1	98.00	380.00	217.00
134.00	1	175.00	569.00	124.00
141.00	1	118.00	506.00	110.00
158.00	1	175.00	475.00	293.00
172.00	1	210.00	504.00	332.00
194.00	1	192.50	515.00	357.00
Suma total	**24**	**97.94**	**369.13**	**192.54**

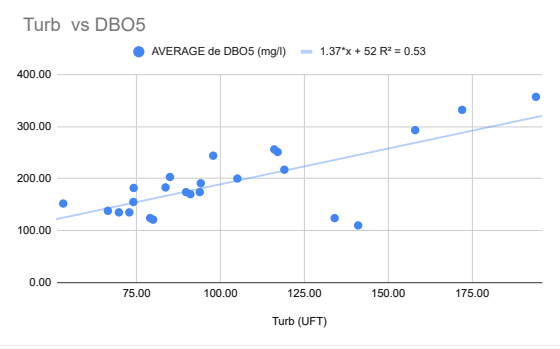
Cond (µs/cm)	COUNT de Cond	AVERAGE de Am	AVERAGE de Pt	AVERAGE de N
1,155.80	1	58.80	7.62	69.00
1,161.70	1	56.57	7.86	69.00
1,189.60	1	66.28	7.92	66.60
1,228.40	1	67.96	7.92	73.20
1,229.70	1	60.87	7.86	71.40
1,231.50	1	61.03	8.46	66.20
1,235.60	1	59.04	13.44	69.90
1,252.80	1	59.97	8.40	66.20
1,261.10	1	67.01	9.58	71.20
1,262.80	1	60.01	8.26	67.20
1,272.30	1	60.04	8.18	67.40
1,293.40	1	62.67	8.46	69.60
1,303.70	1	72.86	8.44	77.80
1,318.00	1	72.06	9.69	83.70
1,321.50	1	66.39	8.42	70.20
1,342.80	1	67.18	7.32	64.80
1,352.50	1	69.60	9.12	80.70
1,370.10	1	71.57	7.68	67.60
1,374.50	1	82.88	9.75	92.10
1,376.70	1	69.40	8.46	78.00
1,377.40	1	72.63	9.54	71.40
1,393.10	1	74.62	8.56	74.80
1,397.80	1	74.84	8.62	75.40
1,409.30	1	75.64	8.64	74.60
Suma total	**24**	**67.08**	**8.68**	**72.42**

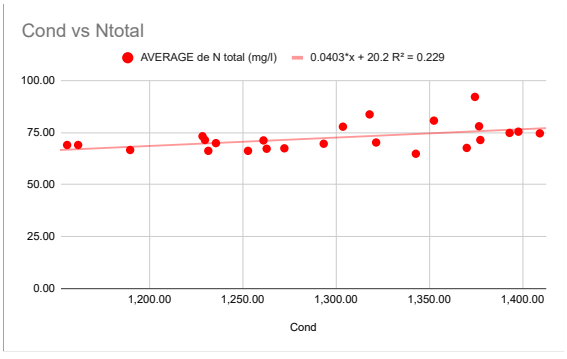








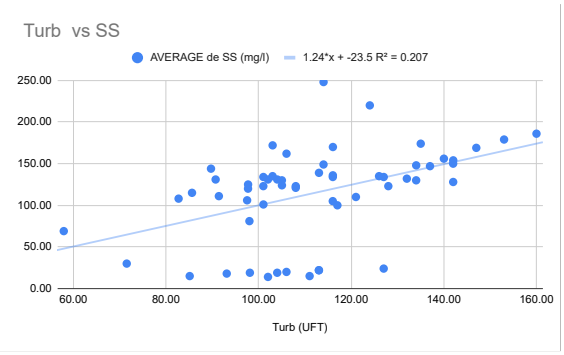


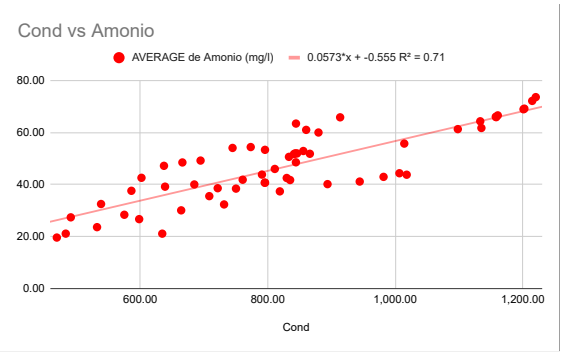


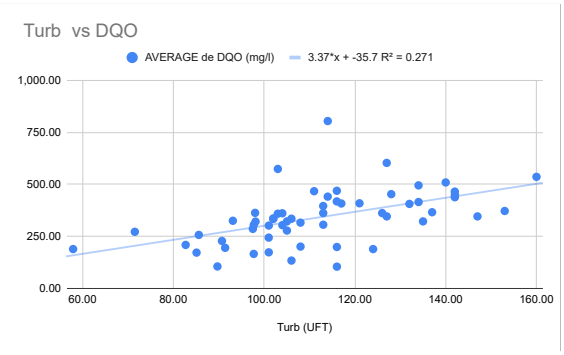
RAIN EVENTS CORRELATIONS IN BUTARQUE WWTP AFTER PRIMARY TREATMENT

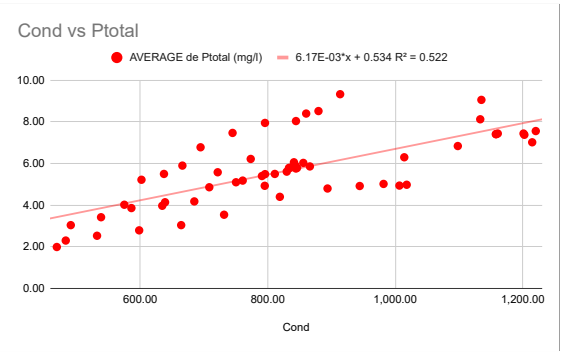
Turb (UFT)	COUNT de Turb	AVERAGE de SS	AVERAGE de DI	AVERAGE de DI
57.90	1	69.00	189.00	132.00
71.50	1	30.00	272.00	#DIV/0!
82.70	1	108.00	209.00	59.10
85.10	1	15.00	172.00	149.00
85.60	1	115.00	257.00	129.00
89.70	1	144.00	105.60	57.80
90.70	1	131.00	228.00	92.80
91.40	1	111.00	195.00	76.00
93.10	1	18.00	325.00	121.00
97.50	1	106.00	286.00	169.00
97.70	1	120.00	165.80	81.60
97.71	1	125.00	305.00	#DIV/0!
98.00	1	81.00	363.00	236.00
98.10	1	19.00	321.00	45.00
101.00	1	123.00	244.00	121.00
101.01	1	134.00	173.40	84.40
101.02	1	101.00	302.00	73.20
102.00	1	131.00	336.00	158.00
102.01	1	14.00	334.00	87.20
103.00	1	135.00	359.00	180.00
103.01	1	172.00	574.00	349.00
104.00	1	19.00	361.00	211.00
104.01	1	131.00	304.00	84.40
105.01	1	130.00	278.00	26.70
105.02	1	124.00	322.00	163.00
106.00	1	20.00	335.00	#DIV/0!
106.01	1	162.00	133.80	76.10
108.00	1	121.00	316.00	101.00
108.01	1	123.00	201.00	110.00
111.00	1	15.00	467.00	203.00
113.00	1	22.00	396.00	225.00
113.01	1	22.00	362.00	225.00
113.02	1	139.00	306.00	92.80
114.00	1	149.00	441.00	262.00
114.01	1	248.00	804.00	366.00
116.00	1	105.00	418.00	267.00
116.01	1	134.00	469.00	191.00
116.02	1	136.00	199.00	108.00
116.03	1	170.00	104.60	90.20
117.00	1	100.00	408.00	273.00
121.00	1	110.00	409.00	273.00
124.00	1	220.00	189.00	124.00
126.00	1	135.00	362.00	159.00
127.00	1	24.00	603.00	217.00
127.01	1	134.00	346.00	#DIV/0!
128.00	1	123.00	453.00	304.00
132.00	1	132.00	406.00	225.00
134.01	1	130.00	495.00	309.00
134.02	1	148.00	415.00	242.00
135.00	1	174.00	322.00	144.00
137.00	1	147.00	366.00	#DIV/0!
140.00	1	156.00	509.00	298.00
142.00	1	150.00	465.00	250.00
142.01	1	128.00	438.00	324.00
142.02	1	154.00	449.00	253.00
147.00	1	169.00	346.00	159.00
153.00	1	179.00	372.00	200.00
160.00	1	186.00	536.00	273.00
Suma total	**58**	**115.02**	**341.76**	**174.16**

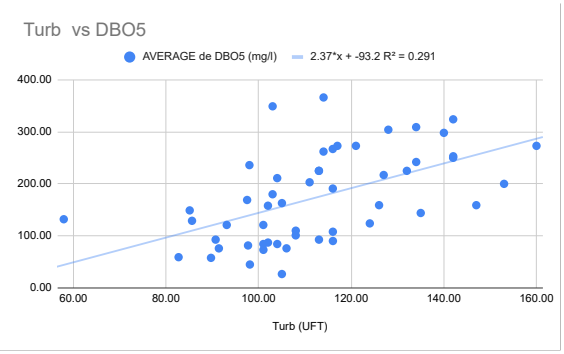
Cond (µs/cm)	COUNT de Cond	AVERAGE de Ar	AVERAGE de Pt	AVERAGE de N
468.90	1	19.61	1.99	16.60
482.90	1	21.11	2.30	18.50
490.80	1	27.37	3.04	21.80
532.00	1	23.60	2.53	19.80
538.30	1	32.50	3.42	23.60
574.80	1	28.37	4.02	28.56
585.90	1	37.57	3.86	27.20
598.10	1	26.68	2.79	23.70
601.70	1	42.57	5.22	30.60
634.30	1	21.10	3.97	30.00
637.00	1	47.17	5.50	35.60
638.70	1	39.17	4.14	31.00
664.00	1	30.06	3.04	27.40
665.90	1	48.46	5.90	35.60
684.60	1	40.01	4.18	31.40
694.40	1	49.19	6.78	34.00
708.10	1	35.52	4.86	34.80
721.30	1	38.57	5.58	35.40
731.30	1	32.33	3.54	31.30
744.60	1	54.05	7.47	38.20
750.00	1	38.41	5.10	42.30
760.50	1	41.83	5.18	38.80
773.10	1	54.38	6.22	39.60
790.70	1	43.81	5.40	40.80
795.10	1	40.67	4.93	39.60
795.50	1	53.32	7.95	43.60
795.60	1	40.71	5.49	39.60
810.90	1	45.98	5.50	42.80
818.80	1	37.35	4.40	37.40
829.60	1	42.50	5.61	47.10
833.10	1	50.62	5.79	44.10
834.90	1	41.71	5.79	40.50
840.90	1	51.69	6.06	51.90
843.00	1	51.98	5.91	48.90
844.00	1	48.52	5.76	45.40
844.10	1	63.41	8.04	47.40
845.80	1	51.94	5.79	50.70
855.60	1	52.87	6.03	45.00
860.10	1	60.99	8.40	50.10
865.90	1	51.80	5.86	46.00
879.40	1	59.98	8.52	51.90
893.60	1	40.14	4.80	41.00
913.40	1	65.81	9.33	54.00
944.10	1	41.13	4.92	43.20
981.50	1	42.93	5.02	44.40
1,006.40	1	44.32	4.94	46.00
1,014.00	1	55.71	6.30	46.20
1,017.80	1	43.75	4.98	47.60
1,098.00	1	61.28	6.84	51.30
1,133.20	1	64.29	8.13	64.60
1,135.00	1	61.71	9.06	71.60
1,157.60	1	66.03	7.41	52.80
1,158.20	1	65.88	7.41	54.30
1,160.70	1	66.56	7.44	54.90
1,201.10	1	68.91	7.44	54.30
1,202.40	1	69.14	7.38	54.90
1,214.70	1	72.12	7.02	56.40
1,220.30	1	73.57	7.56	57.60
Suma total	**58**	**46.94**	**5.65**	**41.44**

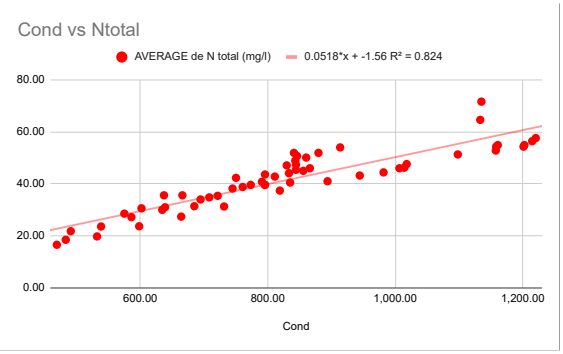

Turb vs SS
AVERAGE de SS (mg/l)
1.24*x + -23.5 R² = 0.207
250.00
200.00
150.00
100.00
50.00
0.00
60.00
80.00
100.00
120.00
140.00
160.00
Turb (UFT)


Cond vs Amonio
AVERAGE de Amonio (mg/l)
0.0573*x + -0.555 R² = 0.71
80.00
60.00
40.00
20.00
0.00
600.00
800.00
1,000.00
1,200.00
Cond


Turb vs DQO
AVERAGE de DQO (mg/l)
3.37*x + -35.7 R² = 0.271
1,000.00
750.00
500.00
250.00
0.00
60.00
80.00
100.00
120.00
140.00
160.00
Turb (UFT)


Cond vs Ptotal
AVERAGE de Ptotal (mg/l)
6.17E-03*x + 0.534 R² = 0.522
10.00
8.00
6.00
4.00
2.00
0.00
600.00
800.00
1,000.00
1,200.00
Cond

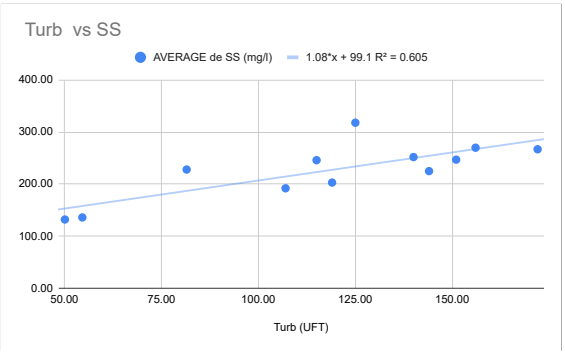

Turb vs DBO5
AVERAGE de DBO5 (mg/l)
2.37*x + -93.2 R² = 0.291
400.00
300.00
200.00
100.00
0.00
60.00
80.00
100.00
120.00
140.00
160.00
Turb (UFT)

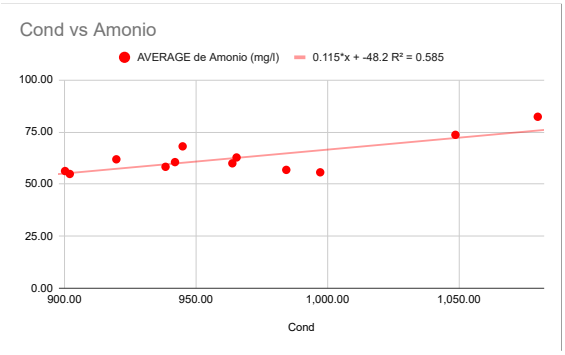

Cond vs Ntotal
AVERAGE de N total (mg/l)
0.0518*x + -1.56 R² = 0.824
80.00
60.00
40.00
20.00
0.00
600.00
800.00
1,000.00
1,200.00
Cond

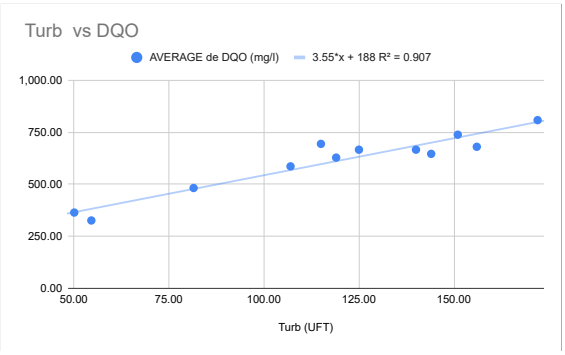
DRY WEATHER FLOW CORRELATIONS IN SUR WWTP ENTRANCE

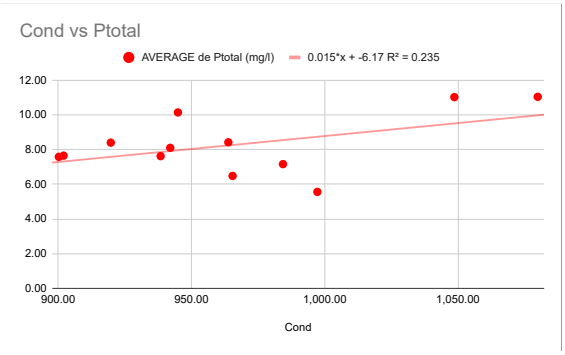
Turb (UFT)	COUNT de Turb	AVERAGE de SS	AVERAGE de DI	AVERAGE de DI
50.10	1	132.00	364.00	127.00
54.60	1	136.00	326.00	138.00
81.50	1	228.00	482.00	248.00
107.00	1	192.00	586.00	349.00
115.00	1	246.00	694.00	318.00
119.00	1	203.00	628.00	349.00
125.00	1	318.00	666.00	338.00
140.00	1	252.00	666.00	374.00
144.00	1	225.00	646.00	369.00
151.00	1	247.00	738.00	459.00
156.00	1	270.00	680.00	228.00
172.00	1	267.00	808.00	450.00
Suma total	**12**	**226.33**	**607.00**	**312.25**

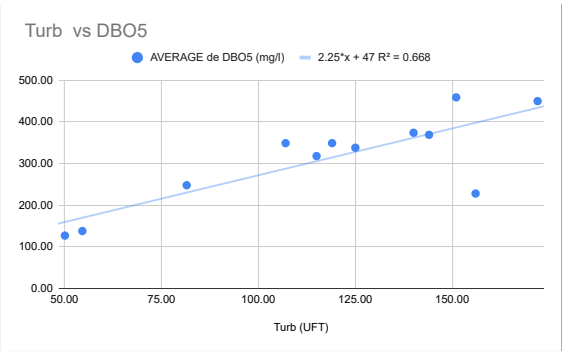
Cond (µs/cm)	COUNT de Cond	AVERAGE de Ar	AVERAGE de Pt	AVERAGE de N
900.20	1	56.29	7.58	59.80
902.00	1	54.88	7.65	59.40
919.70	1	61.92	8.40	60.30
938.40	1	58.32	7.62	62.60
942.00	1	60.58	8.10	64.80
944.90	1	68.15	10.14	70.20
963.80	1	59.99	8.42	67.20
965.40	1	62.81	6.48	57.00
984.30	1	56.85	7.16	43.80
997.20	1	55.68	5.56	53.20
1,048.60	1	73.68	11.02	77.80
1,079.90	1	82.36	11.04	86.40
Suma total	**12**	**62.63**	**8.26**	**63.54**

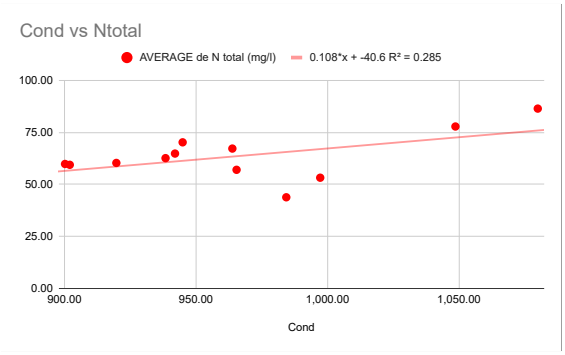








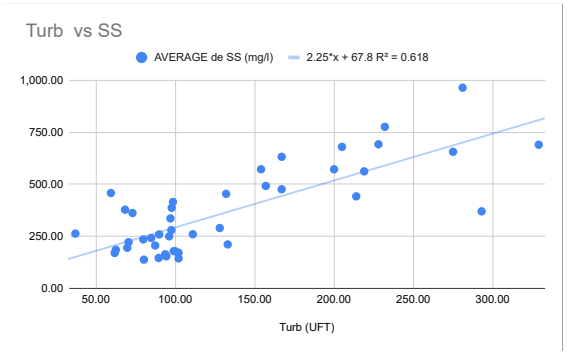


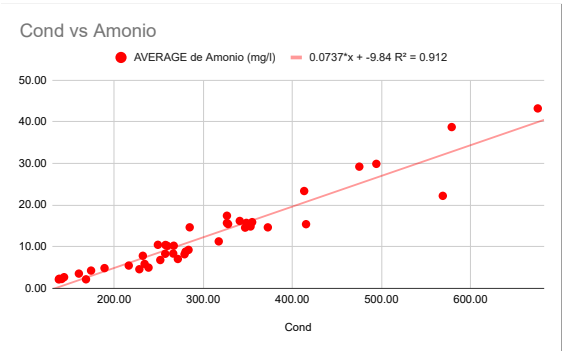


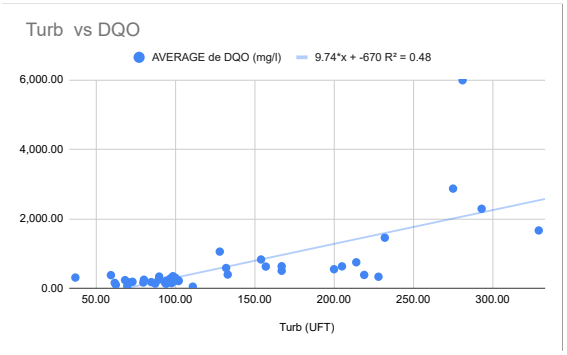
RAIN EVENTS CORRELATION IN BUTARQUE WWTP ENTRANCE

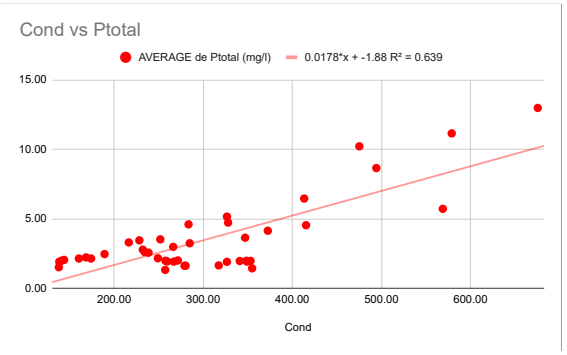
Turb (UFT)	COUNT de Turb	AVERAGE de S	AVERAGE de D	AVERAGE de D
37.00	1	263.00	308.00	81.60
59.40	1	458.00	377.00	81.70
61.80	1	170.00	154.00	74.70
62.50	1	185.00	100.60	366.00
68.30	1	378.00	233.00	77.50
69.70	1	195.00	63.40	33.80
70.50	1	222.00	171.00	45.00
73.00	1	362.00	185.00	24.00
79.80	1	235.00	164.00	50.60
80.20	1	138.00	245.00	104.00
84.80	1	242.00	176.00	39.40
87.30	1	206.00	131.00	59.10
89.50	1	146.00	246.00	92.80
89.80	1	259.00	336.00	61.90
93.60	1	164.00	150.00	86.00
94.20	1	154.00	125.00	73.30
94.21	1	156.00	217.00	92.80
96.10	1	250.00	240.00	90.00
96.90	1	336.00	283.00	98.50
97.50	1	280.00	190.00	73.20
97.7	1	387.00	147.00	50.60
98.50	1	415.00	346.00	115.00
99.00	1	179.00	207.00	92.80
100.00	1	178.00	301.00	73.20
102.00	1	171.00	206.00	87.20
102.01	1	144.00	225.00	60.60
111.00	1	260.00	45.70	55.00
128.00	1	290.00	1,054.94	231.00
132.00	1	454.00	582.00	299.00
133.00	1	211.00	394.00	129.00
154.00	1	572.00	828.00	507.00
157.00	1	492.00	624.00	366.00
167.00	1	476.00	634.00	361.00
167.01	1	632.00	503.00	242.00
200.00	1	572.00	548.00	169.00
205.00	1	680.00	630.00	245.00
214.00	1	442.00	748.00	357.00
219.00	1	562.00	383.00	86.00
228.00	1	692.00	331.00	#DIV/0!
232.00	1	776.00	1,455.00	648.00
275.00	1	656.00	2,871.00	603.00
281.00	1	964.00	5,994.00	#DIV/0!
293.00	1	370.00	2,290.00	#DIV/0!
329.00	1	690.00	1,665.00	828.00
Suma total	**44**	**365.09**	**616.08**	**178.3243902**

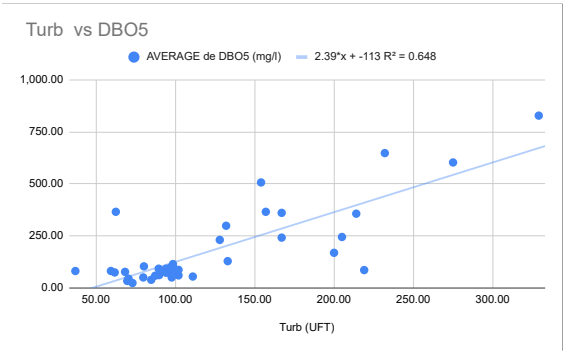
Cond (µs/cm)	COUNT de Con	AVERAGE de Ar	AVERAGE de Pt	AVERAGE de N
137.80	1	2.15	1.51	3.52
138.30	1	2.31	1.91	4.64
141.00	1	2.25	1.99	5.78
143.70	1	2.69	2.04	6.83
160.30	1	3.54	2.14	5.88
168.30	1	2.17	2.22	19.62
174.00	1	4.27	2.14	10.40
189.10	1	4.86	2.46	8.98
216.30	1	5.48	3.30	14.70
228.20	1	4.59	3.45	14.40
232.10	1	7.83	2.78	11.76
234.10	1	5.87	2.61	13.30
238.50	1	4.98	2.56	13.60
249.00	1	10.46	2.16	12.18
251.70	1	6.81	3.52	19.14
257.20	1	8.30	1.32	8.98
257.50	1	10.42	1.98	12.16
259.50	1	10.22	1.93	11.94
266.20	1	8.36	2.98	13.76
266.80	1	10.24	1.91	13.32
271.40	1	7.06	2.00	9.99
278.90	1	8.19	1.62	9.86
280.10	1	8.82	1.62	10.50
283.40	1	9.24	4.60	21.00
284.70	1	14.66	3.24	18.72
317.30	1	11.28	1.64	11.12
326.50	1	15.70	1.90	12.44
326.51	1	17.45	5.16	23.91
327.80	1	15.44	4.73	23.41
340.90	1	16.19	1.96	13.90
346.90	1	14.59	3.64	18.20
348.30	1	15.73	1.98	12.82
349.00	1	14.92	1.92	13.90
353.00	1	14.86	1.97	12.64
354.80	1	15.91	1.43	11.60
372.40	1	14.65	4.14	19.38
413.20	1	23.38	6.46	32.43
415.30	1	15.41	4.54	25.40
475.10	1	29.23	10.22	47.29
494.20	1	29.91	8.66	49.95
568.80	1	22.22	5.72	32.80
578.80	1	38.74	11.16	59.94
675.40	1	43.22	12.99	68.10
763.00	1	45.67	#DIV/0!	#DIV/0!
Suma total	**44**	**13.19**	**3.493323256**	**18.23696512**

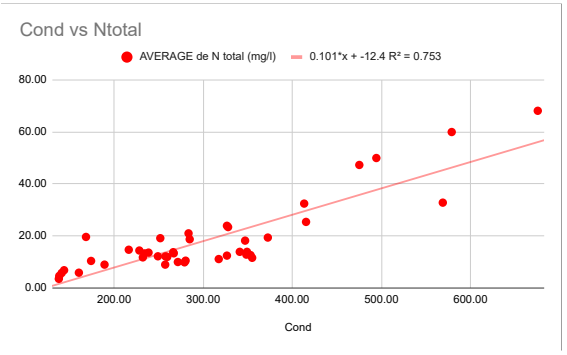

Turb vs SS
AVERAGE de SS (mg/l)
2.25*x + 67.8 R² = 0.618
1,000.00
750.00
500.00
250.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Turb (UFT)


Cond vs Amonio
AVERAGE de Amonio (mg/l)
0.0737*x + -9.84 R² = 0.912
50.00
40.00
30.00
20.00
10.00
0.00
200.00
300.00
400.00
500.00
600.00
Cond


Turb vs DQO
AVERAGE de DQO (mg/l)
9.74*x + -670 R² = 0.48
6,000.00
4,000.00
2,000.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Turb (UFT)


Cond vs Ptotal
AVERAGE de Ptotal (mg/l)
0.0178*x + -1.88 R² = 0.639
15.00
10.00
5.00
0.00
200.00
300.00
400.00
500.00
600.00
Cond

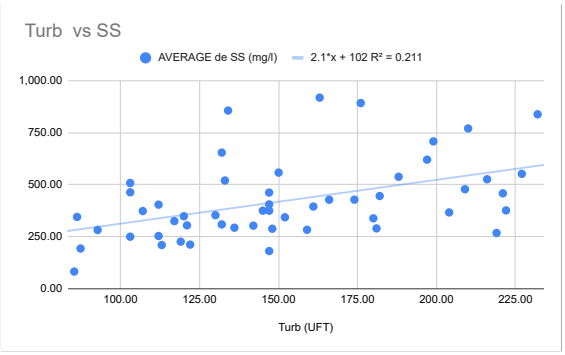

Turb vs DBO5
AVERAGE de DBO5 (mg/l)
2.39*x + -113 R² = 0.648
1,000.00
750.00
500.00
250.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Turb (UFT)

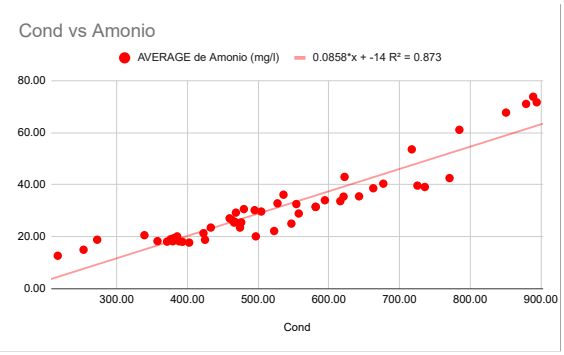

Cond vs Ntotal
AVERAGE de N total (mg/l)
0.101*x + -12.4 R² = 0.753
80.00
60.00
40.00
20.00
0.00
200.00
300.00
400.00
500.00
600.00
Cond

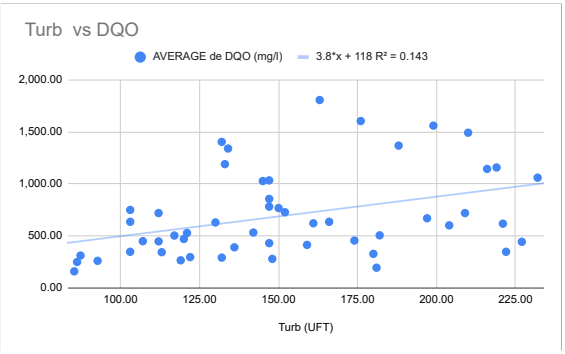
RAIN EVENTS CORRELATIONS IN SUR WWTP ENTRANCE

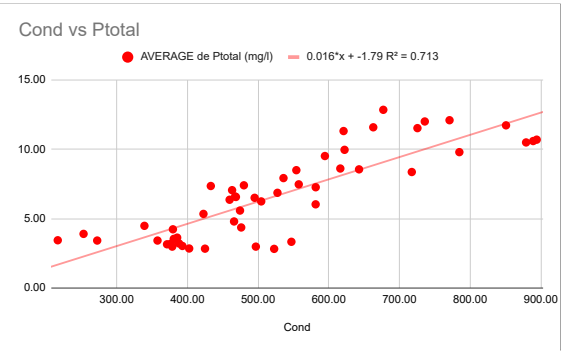
Turb (UFT)	COUNT de Turb	AVERAGE de S	AVERAGE de D	AVERAGE de D
85.30	1	82.50	160.00	100.00
86.20	1	345.00	250.00	90.00
87.30	1	193.33	312.00	115.00
92.70	1	282.50	261.00	120.00
103.01	1	250.00	348.00	130.00
103.02	1	508.00	750.00	377.00
103.03	1	463.33	636.00	293.00
107.01	1	373.33	450.00	270.00
112.00	1	404.00	720.00	366.00
112.01	1	253.33	448.00	205.00
113.00	1	210.00	344.00	141.00
117.00	1	325.00	504.00	170.00
119.01	1	226.15	266.00	205.00
120.00	1	348.33	471.00	#DIV/0!
121.00	1	304.62	529.00	237.00
122.00	1	212.00	297.00	197.00
130.00	1	353.33	630.00	254.00
132.00	1	654.00	1,404.00	699.00
132.01	1	309.09	292.00	225.00
133.00	1	520.00	1,190.00	394.00
134.00	1	856.00	1,340.00	620.00
136.00	1	293.33	391.00	220.00
142.00	1	303.08	533.00	468.00
145.00	1	375.00	1,028.00	300.00
147.00	1	462.00	1,034.00	#DIV/0!
147.01	1	405.00	782.00	300.00
147.02	1	181.11	431.00	220.00
147.03	1	375.00	856.00	394.00
148.00	1	288.33	280.00	#DIV/0!
150.00	1	558.00	768.00	366.00
152.00	1	343.33	728.00	338.00
159.00	1	283.33	414.00	248.00
161.00	1	395.00	622.00	330.00
163.00	1	918.00	1,806.00	#DIV/0!
166.00	1	427.50	636.00	340.00
174.00	1	428.00	456.00	312.00
176.00	1	892.00	1,604.00	789.00
180.00	1	338.33	328.00	242.00
181.00	1	290.00	195.00	214.00
182.00	1	445.45	506.00	360.00
188.00	1	538.00	1,368.00	349.00
197.00	1	620.00	670.00	374.00
199.00	1	708.00	1,560.00	693.00
204.00	1	366.67	602.00	276.00
209.00	1	478.00	720.00	360.00
210.00	1	770.00	1,492.00	834.00
216.00	1	526.00	1,144.00	436.00
219.00	1	268.00	1,158.00	586.00
221.00	1	458.33	618.00	425.00
222.00	1	376.36	348.00	287.00
227.00	1	552.00	444.00	478.00
232.00	1	838.00	1,060.00	#DIV/0!
Suma total	**52**	**422.60**	**695.85**	**335.0425532**

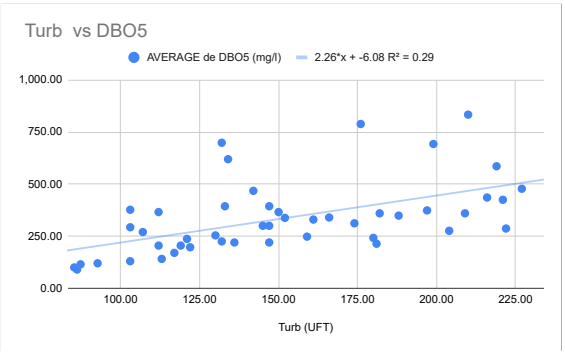
Cond (µs/cm)	COUNT de Cond	AVERAGE de Ar	AVERAGE de Pt	AVERAGE de N
216.50	1	12.69	3.44	15.52
253.00	1	14.98	3.90	19.72
272.30	1	18.84	3.42	19.58
339.10	1	20.58	4.48	23.40
357.60	1	18.30	3.42	18.62
371.10	1	18.11	3.15	20.88
376.20	1	19.04	3.18	21.15
378.40	1	18.58	2.98	23.01
379.40	1	18.26	4.23	24.57
380.60	1	19.44	3.54	21.78
385.40	1	20.12	3.63	21.99
388.10	1	18.25	3.21	24.66
392.80	1	18.04	3.03	21.48
402.40	1	17.73	2.85	22.44
422.60	1	21.33	5.34	30.00
424.80	1	18.81	2.84	22.89
433.00	1	23.51	7.35	34.50
459.60	1	27.06	6.36	31.60
463.10	1	26.42	7.05	38.70
465.90	1	25.43	4.80	37.30
467.40	1	25.65	6.59	45.95
468.50	1	29.26	6.56	35.20
474.30	1	23.50	5.58	33.90
476.00	1	25.51	4.36	35.96
479.80	1	30.62	7.40	34.80
495.00	1	30.20	6.50	35.80
496.70	1	20.14	2.98	24.54
504.30	1	29.67	6.24	44.00
522.60	1	22.19	2.82	24.42
527.30	1	32.82	6.86	48.62
535.80	1	36.14	7.92	50.10
547.00	1	25.04	3.33	28.20
554.00	1	32.54	8.49	45.30
557.40	1	28.91	7.47	45.00
581.30	1	31.44	6.03	46.50
581.40	1	31.51	7.26	52.20
594.40	1	34.00	9.51	43.35
616.20	1	33.66	8.61	58.20
620.80	1	35.41	11.31	56.00
622.20	1	42.98	9.96	70.93
642.70	1	35.51	8.55	60.60
662.80	1	38.62	11.58	54.60
677.00	1	40.38	12.84	51.90
717.30	1	53.57	8.36	66.60
725.30	1	39.63	11.52	67.50
735.70	1	39.10	12.00	59.10
770.70	1	42.52	12.09	81.90
784.60	1	61.08	9.79	76.92
850.60	1	67.69	11.72	93.24
879.00	1	71.04	10.49	87.58
889.00	1	73.80	10.59	82.58
894.00	1	71.65	10.69	78.92
Suma total	**52**	**31.37**	**6.70**	**42.58**

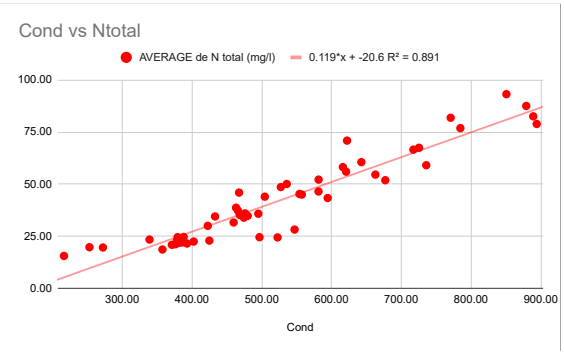

Turb vs SS
AVERAGE de SS (mg/l)
2.1*x + 102 R² = 0.211
1,000.00
750.00
500.00
250.00
0.00
100.00
125.00
150.00
175.00
200.00
225.00
Turb (UFT)


Cond vs Amonio
AVERAGE de Amonio (mg/l)
0.0858*x + -14 R² = 0.873
80.00
60.00
40.00
20.00
0.00
300.00
400.00
500.00
600.00
700.00
800.00
900.00
Cond


Turb vs DQO
AVERAGE de DQO (mg/l)
3.8*x + 118 R² = 0.143
2,000.00
1,500.00
1,000.00
500.00
0.00
100.00
125.00
150.00
175.00
200.00
225.00
Turb (UFT)


Cond vs Ptotal
AVERAGE de Ptotal (mg/l)
0.016*x + -1.79 R² = 0.713
15.00
10.00
5.00
0.00
300.00
400.00
500.00
600.00
700.00
800.00
900.00
Cond


Turb vs DBO5
AVERAGE de DBO5 (mg/l)
2.26*x + -6.08 R² = 0.29
1,000.00
750.00
500.00
250.00
0.00
100.00
125.00
150.00
175.00
200.00
225.00
Turb (UFT)


Cond vs Ntotal
AVERAGE de N total (mg/l)
0.119*x + -20.6 R² = 0.891
100.00
75.00
50.00
25.00
0.00
300.00
400.00
500.00
600.00
700.00
800.00
900.00
Cond

Annex 4.- KPI results for the quality operational tests

0.- Discharged CSO volumes (comparing with MPC-quality based strategy)

Rain Event				SWMM rules results								MPC results								Analysis		
				CSO							Flood	CSO							Flood	Improvement MPC quality vs rules		
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (m3)	Total (T)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (m3)	Total (m3)	CSO	Flood	Total
08/03/2024	**11.4**	7	1.63	0.00	0.00	51082.77	0.00	159202.98	46220.25	256506.00	14135.05	0.00	0.00	2828.06	0.00	121609.38	34581.64	**159019.08**	**478.23**	**38.01%**	**96.62%**	**41.07%**
11/03/2024	**11.8**	8	1.48	0.00	0.00	57773.82	0.00	179810.01	49371.24	286955.07	13995.92	0.00	0.00	2316.37	0.00	139147.37	36875.82	**178339.56**	**483.99**	**37.85%**	**96.54%**	**40.58%**
28/03/2024	**11.8**	6	1.97	0.00	0.00	42371.16	0.00	150051.82	24277.38	216700.36	9287.37	0.00	0.00	1464.90	0.00	93170.26	26387.11	**121022.27**	**9246.75**	**44.15%**	**0.44%**	**42.36%**
27/04/2024	**7.8**	14	0.56	0.00	0.00	32260.59	0.00	46074.63	3344.31	81679.53	0.00	0.00	0.00	4521.42	0.00	25273.88	10699.04	**40494.34**	**0.00**	**50.42%**	**#DIV/0!**	**50.42%**
08/06/2024	**4.2**	5	0.84	0.00	0.00	22223.04	0.00	16778.01	3704.91	42705.96	0.00	0.00	0.00	2636.08	0.00	9164.84	8089.61	**19890.53**	**0.00**	**53.42%**	**#DIV/0!**	**53.42%**
10/06/2024	**29.8**	8	3.73	2203.86	0.00	175351.17	0.00	414347.16	129426.72	721328.91	244691.77	34321.61	0.00	119319.22	81770.00	376678.37	163072.60	**775161.80**	**164131.62**	**-7.46%**	**32.92%**	**2.77%**
20/09/2024	**17**	3	5.67	20766.54	0.00	51037.35	0.00	233790.28	63416.52	369010.69	78924.19	328.12	0.00	1972.84	0.00	186339.29	51732.87	**240373.12**	**51142.13**	**34.86%**	**35.20%**	**34.92%**
07/10/2024	**5.2**	3	1.73	0.00	0.00	26732.40	0.00	36756.00	10591.53	74079.93	0.00	0.00	0.00	3148.78	0.00	22918.20	8346.34	**34413.32**	**0.00**	**53.55%**	**#DIV/0!**	**53.55%**
12/10/2024	**21.9**	11	1.99	12245.34	0.00	83423.37	0.00	313644.69	54122.05	463435.45	150679.90	997.21	0.00	87470.89	0.00	235422.02	77150.65	**401040.77**	**114448.57**	**13.46%**	**24.05%**	**16.06%**
16/10/2024	**13.2**	28	0.47	0.00	0.00	76750.47	0.00	186277.68	38185.26	301213.41	12369.68	0.00	0.00	11794.26	0.00	144846.88	37115.25	**193756.39**	**2703.84**	**35.67%**	**78.14%**	**37.35%**
29/10/2024	**23.6**	16	1.48	1097.43	0.00	115925.85	0.00	384774.75	106843.05	608641.08	154863.23	8931.71	0.00	68489.06	84363.65	323896.63	105919.80	**591600.85**	**24641.53**	**2.80%**	**84.09%**	**19.29%**
01/11/2024	**9.6**	1.5	6.40	1439.97	0.00	89294.10	0.00	96088.35	37140.60	223963.03	12864.15	26194.53	0.00	53933.59	0.00	61463.81	47006.22	**188598.15**	**13260.60**	**15.79%**	**-3.08%**	**14.77%**
20/01/2025 - 3 days	**21.4**	76	0.28	0.00	0.00	131979.72	0.00	383706.48	50333.40	566019.60	11896.09	0.00	0.00	24569.89	0.00	299493.23	57961.58	**382024.70**	**2113.90**	**32.51%**	**82.23%**	**33.53%**
27/01/2025	**5.6**	5	1.12	0.00	0.00	29937.39	0.00	27906.09	6021.90	63865.38	0.00	0.00	0.00	4032.33	0.00	14715.73	10560.85	**29308.91**	**0.00**	**54.11%**	**#DIV/0!**	**54.11%**
29/01/2025	**5.4**	8	0.68	0.00	0.00	29208.90	0.00	12577.20	1198.90	42985.00	0.00	0.00	0.00	1720.92	0.00	2689.16	13542.03	**17952.11**	**0.00**	**58.24%**	**#DIV/0!**	**58.24%**
11/02/2025	**14.2**	7	2.03	0.00	0.00	75274.17	0.00	267049.87	72918.81	415242.85	57741.84	0.00	0.00	4463.74	0.00	211488.59	58510.90	**274463.23**	**19392.64**	**33.90%**	**66.41%**	**37.87%**
01/03/2025	**18.2**	40	0.46	0.00	0.00	121643.31	0.00	366547.14	72140.04	560330.49	79499.91	0.00	0.00	10562.23	0.00	290448.68	59896.97	**360907.88**	**33768.12**	**35.59%**	**57.52%**	**38.32%**
03/03/2025 - 7 days	**64.8**	168	0.39	107188.29	0.00	927532.32	0.00	1501777.02	418868.07	2955365.71	442662.49	93980.48	0.00	592578.90	529854.00	124206.08	405801.88	**1746421.34**	**260103.06**	**40.91%**	**41.24%**	**40.95%**
10/03/2025 - 7 days	**45.4**	168	0.27	104605.41	0.00	660557.67	204432.72	955048.23	296432.29	2221076.32	299597.29	164595.02	0.00	437967.19	435161.35	911580.52	314506.71	**2263810.79**	**195549.24**	**-1.92%**	**34.73%**	**2.43%**
17/03/2025 - 7 days	**51.4**	168	0.31	91984.92	0.00	678701.01	84148.95	1207019.49	324264.02	2386118.39	262732.09	110209.95	0.00	404334.11	433292.84	981226.13	330146.09	**2259209.12**	**184443.51**	**5.32%**	**29.80%**	**7.75%**
03/04/2025 - 2 days	**47.4**	48	0.99	76501.89	0.00	741654.63	7817.90	1094816.73	348222.18	2269013.33	425818.40	222128.63	0.00	493908.50	360316.03	926484.14	391763.93	**2394601.23**	**252865.76**	**-5.53%**	**40.62%**	**1.76%**
11/04/2025 - 3 days	**24.4**	98	0.25	8511.21	0.00	336735.78	0.00	536959.32	145514.61	1027720.92	69940.32	2097.86	0.00	124608.42	35169.74	432686.39	132509.80	**727072.21**	**28387.10**	**29.25%**	**59.41%**	**31.18%**
18/04/2025 - 2 days	**12**	13	0.92	0.00	0.00	128836.32	0.00	187097.13	58560.60	374494.05	12184.06	12744.49	0.00	83172.04	0.00	131469.46	59753.03	**287139.02**	**6496.05**	**23.33%**	**46.68%**	**24.06%**
02/05/2025 - 1 days	**29**	24	1.21	21492.51	0.00	255817.14	0.00	609514.35	173687.34	1060511.34	211460.94	71844.06	0.00	188349.26	171492.08	508087.34	188302.69	**1128075.43**	**112831.26**	**-6.37%**	**46.64%**	**2.44%**

1.- Suspended Solids

Rain Event				SWMM rules results								MPC results								Analysis		
				CSO							Flood	CSO							Flood	Improvement		
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (T)	Total (T)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (T)	Total (T)	CSO	Flood	Total
08/03/2024	**11.4**	7	1.63	0.00	0.00	15.19	0.00	20.78	0.00	35.96	2.77	0.00	0.00	0.84	0.00	15.87	0.00	**16.71**	0.09	**53.53%**	**96.62%**	**56.61%**
11/03/2024	**11.8**	8	1.48	0.00	0.00	17.17	0.00	23.47	0.00	40.64	2.74	0.00	0.00	0.69	0.00	18.16	0.00	**18.85**	0.09	**53.62%**	**96.54%**	**56.33%**
28/03/2024	**11.8**	6	1.97	0.00	0.00	12.60	0.00	19.58	0.00	32.18	1.82	0.00	0.00	0.44	0.00	12.16	0.00	**12.60**	1.81	**60.86%**	**0.44%**	**57.63%**
27/04/2024	**7.8**	14	0.56	0.00	0.00	9.59	0.00	6.01	0.00	15.60	0.00	0.00	0.00	1.34	0.00	3.30	0.00	**4.64**	0.00	**70.25%**	**#DIV/0!**	**70.25%**
08/06/2024	**4.2**	5	0.84	0.00	0.00	6.61	0.00	2.19	0.00	8.80	0.00	0.00	0.00	0.78	0.00	1.20	0.00	**1.98**	0.00	**77.49%**	**#DIV/0!**	**77.49%**
10/06/2024	**29.8**	8	3.73	0.69	0.00	52.13	0.00	54.08	0.00	106.90	47.91	10.80	0.00	35.47	11.01	49.16	0.00	**106.44**	32.14	**0.43%**	**32.92%**	**10.48%**
20/09/2024	**17**	3	5.67	6.53	0.00	15.17	0.00	30.51	0.00	52.22	15.45	0.10	0.00	0.59	0.00	24.32	0.00	**25.01**	10.01	**52.10%**	**35.20%**	**48.24%**
07/10/2024	**5.2**	3	1.73	0.00	0.00	7.95	0.00	4.80	0.00	12.74	0.00	0.00	0.00	0.94	0.00	2.99	0.00	**3.93**	0.00	**69.18%**	**#DIV/0!**	**69.18%**
12/10/2024	**21.9**	11	1.99	3.85	0.00	24.80	0.00	40.94	0.00	69.59	29.50	0.31	0.00	26.00	0.00	30.73	0.00	**57.04**	22.41	**18.03%**	**24.05%**	**19.82%**
16/10/2024	**13.2**	28	0.47	0.00	0.00	22.82	0.00	24.31	0.00	47.13	2.42	0.00	0.00	3.51	0.00	18.90	0.00	**22.41**	0.53	**52.45%**	**78.14%**	**53.70%**
29/10/2024	**23.6**	16	1.48	0.35	0.00	34.46	0.00	50.22	0.00	85.03	30.32	2.81	0.00	20.36	11.36	42.27	0.00	**76.80**	4.82	**9.67%**	**84.09%**	**29.23%**
01/11/2024	**9.6**	1.5	6.40	0.45	0.00	26.54	0.00	12.54	0.00	39.54	2.52	8.24	0.00	16.03	0.00	8.02	0.00	**32.29**	2.60	**18.32%**	**-3.08%**	**17.04%**
20/01/2025 - 3 days rain	**21.4**	76	0.28	0.00	0.00	39.23	0.00	50.08	0.00	89.31	2.33	0.00	0.00	7.30	0.00	39.09	0.00	**46.39**	0.41	**48.06%**	**82.23%**	**48.93%**
27/01/2025	**5.6**	5	1.12	0.00	0.00	8.90	0.00	3.64	0.00	12.54	0.00	0.00	0.00	1.20	0.00	1.92	0.00	**3.12**	0.00	**75.13%**	**#DIV/0!**	**75.13%**
29/01/2025	**5.4**	8	0.68	0.00	0.00	8.68	0.00	1.64	0.00	10.32	0.00	0.00	0.00	0.51	0.00	0.35	0.00	**0.86**	0.00	**91.65%**	**#DIV/0!**	**91.65%**
11/02/2025	**14.2**	7	2.03	0.00	0.00	22.38	0.00	34.85	0.00	57.23	11.31	0.00	0.00	1.33	0.00	27.60	0.00	**28.93**	3.80	**49.45%**	**66.41%**	**52.25%**
01/03/2025	**18.2**	40	0.46	0.00	0.00	36.16	0.00	47.84	0.00	84.00	15.57	0.00	0.00	3.14	0.00	37.91	0.00	**41.05**	6.61	**51.13%**	**57.52%**	**52.13%**
03/03/2025 - 7 days	**64.8**	168	0.39	33.71	0.00	275.73	0.00	196.00	0.00	505.45	86.67	29.56	0.00	176.16	71.36	16.21	0.00	**293.29**	50.93	**41.97%**	**41.24%**	**41.87%**
10/03/2025 - 7 days	**45.4**	168	0.27	32.90	0.00	196.36	27.53	124.65	0.00	381.45	58.66	51.77	0.00	130.19	58.61	118.97	0.00	**359.55**	38.29	**5.74%**	**34.73%**	**9.60%**
17/03/2025 - 7 days	**51.4**	168	0.31	28.93	0.00	201.76	11.33	157.53	0.00	399.56	51.44	34.66	0.00	120.20	58.36	128.06	0.00	**341.28**	36.11	**14.58%**	**29.80%**	**16.32%**
03/04/2025 - 2 days	**47.4**	48	0.99	24.06	0.00	220.47	1.05	142.89	0.00	388.48	83.37	69.87	0.00	146.82	48.53	120.92	0.00	**386.14**	49.51	**0.60%**	**40.62%**	**7.67%**
11/04/2025 - 3 days	**24.4**	98	0.25	2.68	0.00	100.10	0.00	70.08	0.00	172.86	13.69	0.66	0.00	37.04	4.74	56.47	0.00	**98.91**	5.56	**42.78%**	**59.41%**	**44.00%**
18/04/2025 - 2 days	**12**	13	0.92	0.00	0.00	38.30	0.00	24.42	0.00	62.72	2.39	4.01	0.00	24.72	0.00	17.16	0.00	**45.89**	1.27	**26.83%**	**46.68%**	**27.56%**
02/05/2025 - 1 days	**29**	24	1.21	6.76	0.00	76.05	0.00	79.55	0.00	162.36	41.40	22.60	0.00	55.99	23.10	66.31	0.00	**168.00**	22.09	**-3.47%**	**46.64%**	**6.71%**

2.- DQO

Rain Event				SWMM rules results								MPC results								Analysis		
				CSO							Flood	CSO							Flood	Improvement		
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (T)	Total (T)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (m3)	Total (m3)	CSO	Flood	Total
08/03/2024	**11.4**	7	1.63	0.00	0.00	20.23	0.00	49.39	0.00	69.61	5.57	0.00	0.00	1.12	0.00	37.72	0.00	**38.84**	0.19	**44.20%**	**96.62%**	**48.08%**
11/03/2024	**11.8**	8	1.48	0.00	0.00	22.88	0.00	55.78	0.00	78.66	5.51	0.00	0.00	0.92	0.00	43.17	0.00	**44.08**	0.19	**43.96%**	**96.54%**	**47.40%**
28/03/2024	**11.8**	6	1.97	0.00	0.00	16.78	0.00	46.55	0.00	63.33	3.66	0.00	0.00	0.58	0.00	28.90	0.00	**29.48**	3.64	**53.44%**	**0.44%**	**50.55%**
27/04/2024	**7.8**	14	0.56	0.00	0.00	12.77	0.00	14.29	0.00	27.07	0.00	0.00	0.00	1.79	0.00	7.84	0.00	**9.63**	0.00	**64.42%**	**#DIV/0!**	**64.42%**
08/06/2024	**4.2**	5	0.84	0.00	0.00	8.80	0.00	5.20	0.00	14.00	0.00	0.00	0.00	1.04	0.00	2.84	0.00	**3.89**	0.00	**72.25%**	**#DIV/0!**	**72.25%**
10/06/2024	**29.8**	8	3.73	1.37	0.00	69.43	0.00	128.54	0.00	199.34	96.37	21.29	0.00	47.25	31.36	116.85	0.00	**216.75**	64.64	**-8.73%**	**32.92%**	**4.84%**
20/09/2024	**17**	3	5.67	12.88	0.00	20.21	0.00	72.52	0.00	105.62	31.08	0.20	0.00	0.78	0.00	57.81	0.00	**58.79**	20.14	**44.34%**	**35.20%**	**42.26%**
07/10/2024	**5.2**	3	1.73	0.00	0.00	10.59	0.00	11.40	0.00	21.99	0.00	0.00	0.00	1.25	0.00	7.11	0.00	**8.36**	0.00	**61.99%**	**#DIV/0!**	**61.99%**
12/10/2024	**21.9**	11	1.99	7.60	0.00	33.03	0.00	97.30	0.00	137.93	59.34	0.62	0.00	34.64	0.00	73.03	0.00	**108.29**	45.07	**21.49%**	**24.05%**	**22.26%**
16/10/2024	**13.2**	28	0.47	0.00	0.00	30.39	0.00	57.79	0.00	88.18	4.87	0.00	0.00	4.67	0.00	44.93	0.00	**49.60**	1.06	**43.75%**	**78.14%**	**45.55%**
29/10/2024	**23.6**	16	1.48	0.68	0.00	45.90	0.00	119.36	0.00	165.95	60.99	5.54	0.00	27.12	32.35	100.48	0.00	**165.49**	9.70	**0.28%**	**84.09%**	**22.80%**
01/11/2024	**9.6**	1.5	6.40	0.89	0.00	35.36	0.00	29.81	0.00	66.06	5.07	16.25	0.00	21.36	0.00	19.07	0.00	**56.67**	5.22	**14.21%**	**-3.08%**	**12.98%**
20/01/2025 - 3 days rain	**21.4**	76	0.28	0.00	0.00	52.26	0.00	119.03	0.00	171.29	4.69	0.00	0.00	9.73	0.00	92.91	0.00	**102.64**	0.83	**40.08%**	**82.23%**	**41.20%**
27/01/2025	**5.6**	5	1.12	0.00	0.00	11.85	0.00	8.66	0.00	20.51	0.00	0.00	0.00	1.60	0.00	4.57	0.00	**6.16**	0.00	**69.96%**	**#DIV/0!**	**69.96%**
29/01/2025	**5.4**	8	0.68	0.00	0.00	11.57	0.00	3.90	0.00	15.47	0.00	0.00	0.00	0.68	0.00	0.83	0.00	**1.52**	0.00	**90.20%**	**#DIV/0!**	**90.20%**
11/02/2025	**14.2**	7	2.03	0.00	0.00	29.81	0.00	82.84	0.00	112.65	22.74	0.00	0.00	1.77	0.00	65.61	0.00	**67.37**	7.64	**40.19%**	**66.41%**	**44.60%**
01/03/2025	**18.2**	40	0.46	0.00	0.00	48.17	0.00	113.71	0.00	161.88	31.31	0.00	0.00	4.18	0.00	90.10	0.00	**94.28**	13.30	**41.76%**	**57.52%**	**44.31%**
03/03/2025 - 7 days	**64.8**	168	0.39	66.50	0.00	367.28	0.00	465.87	0.00	899.65	174.34	58.31	0.00	234.65	203.19	38.53	0.00	**534.67**	102.44	**40.57%**	**41.24%**	**40.68%**
10/03/2025 - 7 days	**45.4**	168	0.27	64.90	0.00	261.56	78.40	296.27	0.00	701.13	117.99	102.12	0.00	173.42	166.88	282.78	0.00	**725.20**	77.01	**-3.43%**	**34.73%**	**2.06%**
17/03/2025 - 7 days	**51.4**	168	0.31	57.07	0.00	268.75	32.27	374.43	0.00	732.52	103.47	68.37	0.00	160.11	166.16	304.39	0.00	**699.03**	72.64	**4.57%**	**29.80%**	**7.69%**
03/04/2025 - 2 days	**47.4**	48	0.99	47.46	0.00	293.68	3.00	339.63	0.00	683.76	167.70	137.81	0.00	195.58	138.17	287.41	0.00	**758.97**	99.59	**-11.00%**	**40.62%**	**-0.83%**
11/04/2025 - 3 days	**24.4**	98	0.25	5.28	0.00	133.34	0.00	166.57	0.00	305.19	27.55	1.30	0.00	49.34	13.49	134.23	0.00	**198.36**	11.18	**35.01%**	**59.41%**	**37.03%**
18/04/2025 - 2 days	**12**	13	0.92	0.00	0.00	51.02	0.00	58.04	0.00	109.06	4.80	7.91	0.00	32.93	0.00	40.78	0.00	**81.62**	2.56	**25.15%**	**46.68%**	**26.06%**
02/05/2025 - 1 days	**29**	24	1.21	13.33	0.00	101.30	0.00	189.08	0.00	303.71	83.28	44.57	0.00	74.58	65.76	157.62	0.00	**342.53**	44.44	**-12.78%**	**46.64%**	**0.01%**

3.- Amonio

Rain Event				SWMM rules results								MPC results								Analysis		
				CSO							Flood	CSO							Flood	Improvement		
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (T)	Total (T)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (m3)	Total (m3)	CSO	Flood	Total
08/03/2024	**11.4**	7	1.63	0.00	0.00	0.58	0.00	2.16	0.00	2.74	0.25	0.00	0.00	0.03	0.00	1.65	0.00	**1.68**	0.01	**38.65%**	**96.62%**	**43.50%**
11/03/2024	**11.8**	8	1.48	0.00	0.00	0.66	0.00	2.44	0.00	3.10	0.25	0.00	0.00	0.03	0.00	1.89	0.00	**1.92**	0.01	**38.21%**	**96.54%**	**42.53%**
28/03/2024	**11.8**	6	1.97	0.00	0.00	0.48	0.00	2.04	0.00	2.52	0.16	0.00	0.00	0.02	0.00	1.26	0.00	**1.28**	0.16	**49.15%**	**0.44%**	**46.16%**
27/04/2024	**7.8**	14	0.56	0.00	0.00	0.37	0.00	0.63	0.00	0.99	0.00	0.00	0.00	0.05	0.00	0.34	0.00	**0.39**	0.00	**60.27%**	**#DIV/0!**	**60.27%**
08/06/2024	**4.2**	5	0.84	0.00	0.00	0.25	0.00	0.23	0.00	0.48	0.00	0.00	0.00	0.03	0.00	0.12	0.00	**0.15**	0.00	**67.90%**	**#DIV/0!**	**67.90%**
10/06/2024	**29.8**	8	3.73	0.04	0.00	2.00	0.00	5.62	0.00	7.66	4.33	0.64	0.00	1.36	0.72	5.11	0.00	**7.83**	2.91	**-2.19%**	**32.92%**	**10.49%**
20/09/2024	**17**	3	5.67	0.39	0.00	0.58	0.00	3.17	0.00	4.14	1.40	0.01	0.00	0.02	0.00	2.53	0.00	**2.56**	0.91	**38.27%**	**35.20%**	**37.50%**
07/10/2024	**5.2**	3	1.73	0.00	0.00	0.30	0.00	0.50	0.00	0.80	0.00	0.00	0.00	0.04	0.00	0.31	0.00	**0.35**	0.00	**56.83%**	**#DIV/0!**	**56.83%**
12/10/2024	**21.9**	11	1.99	0.23	0.00	0.95	0.00	4.26	0.00	5.44	2.67	0.02	0.00	1.00	0.00	3.20	0.00	**4.21**	2.03	**22.55%**	**24.05%**	**23.04%**
16/10/2024	**13.2**	28	0.47	0.00	0.00	0.87	0.00	2.53	0.00	3.40	0.22	0.00	0.00	0.13	0.00	1.97	0.00	**2.10**	0.05	**38.28%**	**78.14%**	**40.69%**
29/10/2024	**23.6**	16	1.48	0.02	0.00	1.32	0.00	5.22	0.00	6.56	2.74	0.17	0.00	0.78	0.74	4.40	0.00	**6.08**	0.44	**7.33%**	**84.09%**	**29.94%**
01/11/2024	**9.6**	1.5	6.40	0.03	0.00	1.02	0.00	1.30	0.00	2.35	0.23	0.49	0.00	0.61	0.00	0.83	0.00	**1.94**	0.23	**17.45%**	**-3.08%**	**15.63%**
20/01/2025 - 3 days rain	**21.4**	76	0.28	0.00	0.00	1.50	0.00	5.21	0.00	6.71	0.21	0.00	0.00	0.28	0.00	4.07	0.00	**4.35**	0.04	**35.27%**	**82.23%**	**36.70%**
27/01/2025	**5.6**	5	1.12	0.00	0.00	0.34	0.00	0.38	0.00	0.72	0.00	0.00	0.00	0.05	0.00	0.20	0.00	**0.25**	0.00	**65.88%**	**#DIV/0!**	**65.88%**
29/01/2025	**5.4**	8	0.68	0.00	0.00	0.33	0.00	0.17	0.00	0.50	0.00	0.00	0.00	0.02	0.00	0.04	0.00	**0.06**	0.00	**88.86%**	**#DIV/0!**	**88.86%**
11/02/2025	**14.2**	7	2.03	0.00	0.00	0.86	0.00	3.62	0.00	4.48	1.02	0.00	0.00	0.05	0.00	2.87	0.00	**2.92**	0.34	**34.83%**	**66.41%**	**40.70%**
01/03/2025	**18.2**	40	0.46	0.00	0.00	1.39	0.00	4.98	0.00	6.36	1.41	0.00	0.00	0.12	0.00	3.94	0.00	**4.06**	0.60	**36.14%**	**57.52%**	**40.01%**
03/03/2025 - 7 days	**64.8**	168	0.39	2.01	0.00	10.57	0.00	20.38	0.00	32.96	7.84	1.76	0.00	6.76	4.64	1.69	0.00	**14.84**	4.61	**54.97%**	**41.24%**	**52.33%**
10/03/2025 - 7 days	**45.4**	168	0.27	1.96	0.00	7.53	1.79	12.96	0.00	24.24	5.30	3.08	0.00	4.99	3.81	12.37	0.00	**24.26**	3.46	**-0.07%**	**34.73%**	**6.18%**
17/03/2025 - 7 days	**51.4**	168	0.31	1.72	0.00	7.74	0.74	16.38	0.00	26.58	4.65	2.06	0.00	4.61	3.80	13.32	0.00	**23.79**	3.27	**10.50%**	**29.80%**	**13.38%**
03/04/2025 - 2 days	**47.4**	48	0.99	1.43	0.00	8.45	0.07	14.86	0.00	24.82	7.54	4.16	0.00	5.63	3.16	12.58	0.00	**25.52**	4.48	**-2.84%**	**40.62%**	**7.28%**
11/04/2025 - 3 days	**24.4**	98	0.25	0.16	0.00	3.84	0.00	7.29	0.00	11.29	1.24	0.04	0.00	1.42	0.31	5.87	0.00	**7.64**	0.50	**32.30%**	**59.41%**	**34.98%**
18/04/2025 - 2 days	**12**	13	0.92	0.00	0.00	1.47	0.00	2.54	0.00	4.01	0.22	0.24	0.00	0.95	0.00	1.78	0.00	**2.97**	0.12	**25.88%**	**46.68%**	**26.94%**
02/05/2025 - 1 days	**29**	24	1.21	0.40	0.00	2.92	0.00	8.27	0.00	11.59	3.74	1.34	0.00	2.15	1.50	6.90	0.00	**11.89**	2.00	**-2.58%**	**46.64%**	**9.43%**

4.- Ptotal

Rain Event				SWMM rules results								MPC results								Analysis		
				CSO							Flood	CSO							Flood	Improvement		
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (T)	Total (T)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (m3)	Total (m3)	CSO	Flood	Total
08/03/2024	**11.4**	7	1.63	0.00	0.00	0.15	0.00	0.50	0.00	0.64	0.05	0.00	0.00	0.01	0.00	0.38	0.00	**0.39**	0.00	**39.86%**	**96.62%**	**44.13%**
11/03/2024	**11.8**	8	1.48	0.00	0.00	0.17	0.00	0.56	0.00	0.73	0.05	0.00	0.00	0.01	0.00	0.43	0.00	**0.44**	0.00	**39.45%**	**96.54%**	**43.26%**
28/03/2024	**11.8**	6	1.97	0.00	0.00	0.12	0.00	0.47	0.00	0.59	0.03	0.00	0.00	0.00	0.00	0.29	0.00	**0.29**	0.03	**50.07%**	**0.44%**	**47.33%**
27/04/2024	**7.8**	14	0.56	0.00	0.00	0.09	0.00	0.14	0.00	0.24	0.00	0.00	0.00	0.01	0.00	0.08	0.00	**0.09**	0.00	**61.22%**	**#DIV/0!**	**61.22%**
08/06/2024	**4.2**	5	0.84	0.00	0.00	0.06	0.00	0.05	0.00	0.12	0.00	0.00	0.00	0.01	0.00	0.03	0.00	**0.04**	0.00	**68.94%**	**#DIV/0!**	**68.94%**
10/06/2024	**29.8**	8	3.73	0.01	0.00	0.51	0.00	1.29	0.00	1.81	0.91	0.19	0.00	0.34	0.22	1.17	0.00	**1.92**	0.61	**-6.22%**	**32.92%**	**6.86%**
20/09/2024	**17**	3	5.67	0.11	0.00	0.15	0.00	0.73	0.00	0.99	0.29	0.00	0.00	0.01	0.00	0.58	0.00	**0.59**	0.19	**40.49%**	**35.20%**	**39.28%**
07/10/2024	**5.2**	3	1.73	0.00	0.00	0.08	0.00	0.11	0.00	0.19	0.00	0.00	0.00	0.01	0.00	0.07	0.00	**0.08**	0.00	**58.01%**	**#DIV/0!**	**58.01%**
12/10/2024	**21.9**	11	1.99	0.07	0.00	0.24	0.00	0.98	0.00	1.28	0.56	0.01	0.00	0.25	0.00	0.73	0.00	**0.99**	0.42	**22.80%**	**24.05%**	**23.18%**
16/10/2024	**13.2**	28	0.47	0.00	0.00	0.22	0.00	0.58	0.00	0.80	0.05	0.00	0.00	0.03	0.00	0.45	0.00	**0.48**	0.01	**39.48%**	**78.14%**	**41.58%**
29/10/2024	**23.6**	16	1.48	0.01	0.00	0.33	0.00	1.20	0.00	1.54	0.57	0.05	0.00	0.20	0.22	1.01	0.00	**1.48**	0.09	**3.85%**	**84.09%**	**25.66%**
01/11/2024	**9.6**	1.5	6.40	0.01	0.00	0.26	0.00	0.30	0.00	0.56	0.05	0.14	0.00	0.16	0.00	0.19	0.00	**0.49**	0.05	**13.49%**	**-3.08%**	**12.19%**
20/01/2025 - 3 days rain	**21.4**	76	0.28	0.00	0.00	0.38	0.00	1.19	0.00	1.57	0.04	0.00	0.00	0.07	0.00	0.93	0.00	**1.00**	0.01	**36.32%**	**82.23%**	**37.57%**
27/01/2025	**5.6**	5	1.12	0.00	0.00	0.09	0.00	0.09	0.00	0.17	0.00	0.00	0.00	0.01	0.00	0.05	0.00	**0.06**	0.00	**66.84%**	**#DIV/0!**	**66.84%**
29/01/2025	**5.4**	8	0.68	0.00	0.00	0.08	0.00	0.04	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.01	0.00	**0.01**	0.00	**89.20%**	**#DIV/0!**	**89.20%**
11/02/2025	**14.2**	7	2.03	0.00	0.00	0.22	0.00	0.83	0.00	1.05	0.21	0.00	0.00	0.01	0.00	0.66	0.00	**0.67**	0.07	**35.98%**	**66.41%**	**41.14%**
01/03/2025	**18.2**	40	0.46	0.00	0.00	0.35	0.00	1.14	0.00	1.49	0.29	0.00	0.00	0.03	0.00	0.90	0.00	**0.93**	0.13	**37.36%**	**57.52%**	**40.69%**
03/03/2025 - 7 days	**64.8**	168	0.39	0.58	0.00	2.68	0.00	4.67	0.00	7.93	1.64	0.51	0.00	1.71	1.41	0.39	0.00	**4.01**	0.96	**49.36%**	**41.24%**	**47.97%**
10/03/2025 - 7 days	**45.4**	168	0.27	0.56	0.00	1.91	0.54	2.97	0.00	5.99	1.11	0.89	0.00	1.26	1.16	2.84	0.00	**6.15**	0.72	**-2.69%**	**34.73%**	**3.16%**
17/03/2025 - 7 days	**51.4**	168	0.31	0.50	0.00	1.96	0.22	3.76	0.00	6.43	0.97	0.59	0.00	1.17	1.15	3.05	0.00	**5.97**	0.68	**7.24%**	**29.80%**	**10.20%**
03/04/2025 - 2 days	**47.4**	48	0.99	0.41	0.00	2.14	0.02	3.41	0.00	5.98	1.58	1.20	0.00	1.42	0.96	2.88	0.00	**6.47**	0.94	**-8.14%**	**40.62%**	**2.04%**
11/04/2025 - 3 days	**24.4**	98	0.25	0.05	0.00	0.97	0.00	1.67	0.00	2.69	0.26	0.01	0.00	0.36	0.09	1.35	0.00	**1.81**	0.11	**32.64%**	**59.41%**	**34.99%**
18/04/2025 - 2 days	**12**	13	0.92	0.00	0.00	0.37	0.00	0.58	0.00	0.95	0.05	0.07	0.00	0.24	0.00	0.41	0.00	**0.72**	0.02	**24.74%**	**46.68%**	**25.74%**
02/05/2025 - 1 days	**29**	24	1.21	0.12	0.00	0.74	0.00	1.90	0.00	2.75	0.78	0.39	0.00	0.54	0.46	1.58	0.00	**2.97**	0.42	**-7.94%**	**46.64%**	**4.16%**

5.- Ntotal

Rain Event				SWMM rules results								MPC results								Analysis		
				CSO							Flood	CSO							Flood	Improvement		
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (T)	Total (T)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (m3)	Total (m3)	CSO	Flood	Total
08/03/2024	**11.4**	7	1.63	0.00	0.00	0.85	0.00	2.83	0.00	3.68	0.29	0.00	0.00	0.05	0.00	2.16	0.00	**2.21**	0.01	**40.06%**	**96.62%**	**44.19%**
11/03/2024	**11.8**	8	1.48	0.00	0.00	0.97	0.00	3.19	0.00	4.16	0.29	0.00	0.00	0.04	0.00	2.47	0.00	**2.51**	0.01	**39.67%**	**96.54%**	**43.34%**
28/03/2024	**11.8**	6	1.97	0.00	0.00	0.71	0.00	2.66	0.00	3.37	0.19	0.00	0.00	0.02	0.00	1.65	0.00	**1.68**	0.19	**50.23%**	**0.44%**	**47.57%**
27/04/2024	**7.8**	14	0.56	0.00	0.00	0.54	0.00	0.82	0.00	1.36	0.00	0.00	0.00	0.08	0.00	0.45	0.00	**0.52**	0.00	**61.38%**	**#DIV/0!**	**61.38%**
08/06/2024	**4.2**	5	0.84	0.00	0.00	0.37	0.00	0.30	0.00	0.67	0.00	0.00	0.00	0.04	0.00	0.16	0.00	**0.21**	0.00	**69.12%**	**#DIV/0!**	**69.12%**
10/06/2024	**29.8**	8	3.73	0.05	0.00	2.93	0.00	7.36	0.00	10.34	5.02	0.83	0.00	2.00	0.99	6.69	0.00	**10.50**	3.37	**-1.57%**	**32.92%**	**9.70%**
20/09/2024	**17**	3	5.67	0.50	0.00	0.85	0.00	4.15	0.00	5.50	1.62	0.01	0.00	0.03	0.00	3.31	0.00	**3.35**	1.05	**39.16%**	**35.20%**	**38.26%**
07/10/2024	**5.2**	3	1.73	0.00	0.00	0.45	0.00	0.65	0.00	1.10	0.00	0.00	0.00	0.05	0.00	0.41	0.00	**0.46**	0.00	**58.21%**	**#DIV/0!**	**58.21%**
12/10/2024	**21.9**	11	1.99	0.30	0.00	1.40	0.00	5.57	0.00	7.26	3.09	0.02	0.00	1.46	0.00	4.18	0.00	**5.67**	2.35	**21.93%**	**24.05%**	**22.56%**
16/10/2024	**13.2**	28	0.47	0.00	0.00	1.28	0.00	3.31	0.00	4.59	0.25	0.00	0.00	0.20	0.00	2.57	0.00	**2.77**	0.06	**39.69%**	**78.14%**	**41.71%**
29/10/2024	**23.6**	16	1.48	0.03	0.00	1.94	0.00	6.83	0.00	8.80	3.18	0.22	0.00	1.15	1.03	5.75	0.00	**8.14**	0.51	**7.49%**	**84.09%**	**27.82%**
01/11/2024	**9.6**	1.5	6.40	0.03	0.00	1.49	0.00	1.71	0.00	3.23	0.26	0.63	0.00	0.90	0.00	1.09	0.00	**2.62**	0.27	**18.86%**	**-3.08%**	**17.20%**
20/01/2025 - 3 days rain	**21.4**	76	0.28	0.00	0.00	2.21	0.00	6.81	0.00	9.02	0.24	0.00	0.00	0.41	0.00	5.32	0.00	**5.73**	0.04	**36.50%**	**82.23%**	**37.70%**
27/01/2025	**5.6**	5	1.12	0.00	0.00	0.50	0.00	0.50	0.00	1.00	0.00	0.00	0.00	0.07	0.00	0.26	0.00	**0.33**	0.00	**67.01%**	**#DIV/0!**	**67.01%**
29/01/2025	**5.4**	8	0.68	0.00	0.00	0.49	0.00	0.22	0.00	0.71	0.00	0.00	0.00	0.03	0.00	0.05	0.00	**0.08**	0.00	**89.25%**	**#DIV/0!**	**89.25%**
11/02/2025	**14.2**	7	2.03	0.00	0.00	1.26	0.00	4.74	0.00	6.00	1.18	0.00	0.00	0.07	0.00	3.75	0.00	**3.83**	0.40	**36.18%**	**66.41%**	**41.17%**
01/03/2025	**18.2**	40	0.46	0.00	0.00	2.04	0.00	6.51	0.00	8.54	1.63	0.00	0.00	0.18	0.00	5.16	0.00	**5.33**	0.69	**37.57%**	**57.52%**	**40.77%**
03/03/2025 - 7 days	**64.8**	168	0.39	2.58	0.00	15.52	0.00	26.66	0.00	44.76	9.08	2.26	0.00	9.91	6.45	2.20	0.00	**20.83**	5.34	**53.46%**	**41.24%**	**51.40%**
10/03/2025 - 7 days	**45.4**	168	0.27	2.52	0.00	11.05	2.49	16.95	0.00	33.01	6.15	3.97	0.00	7.33	5.29	16.18	0.00	**32.77**	4.01	**0.74%**	**34.73%**	**6.07%**
17/03/2025 - 7 days	**51.4**	168	0.31	2.22	0.00	11.35	1.02	21.43	0.00	36.02	5.39	2.66	0.00	6.76	5.27	17.42	0.00	**32.11**	3.78	**10.86%**	**29.80%**	**13.32%**
03/04/2025 - 2 days	**47.4**	48	0.99	1.84	0.00	12.41	0.10	19.44	0.00	33.78	8.74	5.35	0.00	8.26	4.38	16.45	0.00	**34.45**	5.19	**-1.97%**	**40.62%**	**6.78%**
11/04/2025 - 3 days	**24.4**	98	0.25	0.21	0.00	5.63	0.00	9.53	0.00	15.37	1.44	0.05	0.00	2.08	0.43	7.68	0.00	**10.24**	0.58	**33.35%**	**59.41%**	**35.58%**
18/04/2025 - 2 days	**12**	13	0.92	0.00	0.00	2.16	0.00	3.32	0.00	5.48	0.25	0.31	0.00	1.39	0.00	2.33	0.00	**4.03**	0.13	**26.37%**	**46.68%**	**27.26%**
02/05/2025 - 1 days	**29**	24	1.21	0.52	0.00	4.28	0.00	10.82	0.00	15.62	4.34	1.73	0.00	3.15	2.09	9.02	0.00	**15.99**	2.32	**-2.37%**	**46.64%**	**8.28%**

6.- DBO5

Rain Event				SWMM rules results								MPC results								Analysis		
				CSO							Flood	CSO							Flood	Improvement		
Date	Rain (mm)	Duration (h)	Rain Average (mm/h)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (T)	Total (T)	MD Partidor But	MD But II	MD cab EDAR But	MI tanque Abro	MI Aliv Sur	MI cab EDAR Sur	Total (m3)	Total (m3)	CSO	Flood	Total
08/03/2024	**11.4**	7	1.63	0.00	0.00	10.28	0.00	27.26	0.00	37.53	3.00	0.00	0.00	0.57	0.00	20.82	0.00	**21.39**	0.10	**43.01%**	**96.62%**	**46.98%**
11/03/2024	**11.8**	8	1.48	0.00	0.00	11.62	0.00	30.78	0.00	42.41	2.97	0.00	0.00	0.47	0.00	23.82	0.00	**24.29**	0.10	**42.72%**	**96.54%**	**46.25%**
28/03/2024	**11.8**	6	1.97	0.00	0.00	8.52	0.00	25.69	0.00	34.21	1.97	0.00	0.00	0.29	0.00	15.95	0.00	**16.25**	1.96	**52.51%**	**0.44%**	**49.68%**
27/04/2024	**7.8**	14	0.56	0.00	0.00	6.49	0.00	7.89	0.00	14.38	0.00	0.00	0.00	0.91	0.00	4.33	0.00	**5.24**	0.00	**63.58%**	**#DIV/0!**	**63.58%**
08/06/2024	**4.2**	5	0.84	0.00	0.00	4.47	0.00	2.87	0.00	7.34	0.00	0.00	0.00	0.53	0.00	1.57	0.00	**2.10**	0.00	**71.41%**	**#DIV/0!**	**71.41%**
10/06/2024	**29.8**	8	3.73	0.76	0.00	35.27	0.00	70.94	0.00	106.97	51.94	11.84	0.00	24.00	17.22	64.49	0.00	**117.55**	34.84	**-9.89%**	**32.92%**	**4.10%**
20/09/2024	**17**	3	5.67	7.16	0.00	10.27	0.00	40.03	0.00	57.46	16.75	0.11	0.00	0.40	0.00	31.90	0.00	**32.41**	10.86	**43.59%**	**35.20%**	**41.69%**
07/10/2024	**5.2**	3	1.73	0.00	0.00	5.38	0.00	6.29	0.00	11.67	0.00	0.00	0.00	0.63	0.00	3.92	0.00	**4.56**	0.00	**60.95%**	**#DIV/0!**	**60.95%**
12/10/2024	**21.9**	11	1.99	4.22	0.00	16.78	0.00	53.70	0.00	74.70	31.98	0.34	0.00	17.60	0.00	40.31	0.00	**58.25**	24.29	**22.03%**	**24.05%**	**22.63%**
16/10/2024	**13.2**	28	0.47	0.00	0.00	15.44	0.00	31.89	0.00	47.33	2.63	0.00	0.00	2.37	0.00	24.80	0.00	**27.17**	0.57	**42.59%**	**78.14%**	**44.46%**
29/10/2024	**23.6**	16	1.48	0.38	0.00	23.32	0.00	65.88	0.00	89.57	32.87	3.08	0.00	13.78	17.76	55.45	0.00	**90.08**	5.23	**-0.56%**	**84.09%**	**22.16%**
01/11/2024	**9.6**	1.5	6.40	0.50	0.00	17.96	0.00	16.45	0.00	34.91	2.73	9.04	0.00	10.85	0.00	10.52	0.00	**30.41**	2.81	**12.90%**	**-3.08%**	**11.74%**
20/01/2025 - 3 days rain	**21.4**	76	0.28	0.00	0.00	26.55	0.00	65.69	0.00	92.24	2.53	0.00	0.00	4.94	0.00	51.28	0.00	**56.22**	0.45	**39.05%**	**82.23%**	**40.20%**
27/01/2025	**5.6**	5	1.12	0.00	0.00	6.02	0.00	4.78	0.00	10.80	0.00	0.00	0.00	0.81	0.00	2.52	0.00	**3.33**	0.00	**69.16%**	**#DIV/0!**	**69.16%**
29/01/2025	**5.4**	8	0.68	0.00	0.00	5.88	0.00	2.15	0.00	8.03	0.00	0.00	0.00	0.35	0.00	0.46	0.00	**0.81**	0.00	**89.95%**	**#DIV/0!**	**89.95%**
11/02/2025	**14.2**	7	2.03	0.00	0.00	15.14	0.00	45.72	0.00	60.86	12.26	0.00	0.00	0.90	0.00	36.21	0.00	**37.11**	4.12	**39.03%**	**66.41%**	**43.62%**
01/03/2025	**18.2**	40	0.46	0.00	0.00	24.47	0.00	62.76	0.00	87.22	16.87	0.00	0.00	2.12	0.00	49.73	0.00	**51.85**	7.17	**40.55%**	**57.52%**	**43.30%**
03/03/2025 - 7 days	**64.8**	168	0.39	36.97	0.00	186.58	0.00	257.12	0.00	480.67	93.96	32.42	0.00	119.20	111.57	21.27	0.00	**284.45**	55.21	**40.82%**	**41.24%**	**40.89%**
10/03/2025 - 7 days	**45.4**	168	0.27	36.08	0.00	132.87	43.05	163.51	0.00	375.52	63.59	56.77	0.00	88.10	91.63	156.07	0.00	**392.57**	41.51	**-4.54%**	**34.73%**	**1.14%**
17/03/2025 - 7 days	**51.4**	168	0.31	31.73	0.00	136.52	17.72	206.65	0.00	392.62	55.77	38.02	0.00	81.33	91.24	167.99	0.00	**378.58**	39.15	**3.58%**	**29.80%**	**6.84%**
03/04/2025 - 2 days	**47.4**	48	0.99	26.39	0.00	149.19	1.65	187.44	0.00	364.66	90.38	76.62	0.00	99.35	75.87	158.62	0.00	**410.46**	53.67	**-12.56%**	**40.62%**	**-2.00%**
11/04/2025 - 3 days	**24.4**	98	0.25	2.94	0.00	67.74	0.00	91.93	0.00	162.60	14.85	0.72	0.00	25.07	7.41	74.08	0.00	**107.27**	6.03	**34.03%**	**59.41%**	**36.15%**
18/04/2025 - 2 days	**12**	13	0.92	0.00	0.00	25.92	0.00	32.03	0.00	57.95	2.59	4.40	0.00	16.73	0.00	22.51	0.00	**43.64**	1.38	**24.70%**	**46.68%**	**25.64%**
02/05/2025 - 1 days	**29**	24	1.21	7.41	0.00	51.46	0.00	104.35	0.00	163.23	44.88	24.78	0.00	37.89	36.11	86.99	0.00	**185.77**	23.95	**-13.81%**	**46.64%**	**-0.77%**

Annex 5.- River model result summary sheet for the 3 rain events and 2 scenarios modelled.

- Annex 5.1.- Results for small rain event (7.8 mm) and rules scenario
- Annex 5.2.- Results for small rain event (7.8 mm) and MPC scenario
- Annex 5.3.- Results for small medium event (14.2 mm) and rules scenario
- Annex 5.4.- Results for medium event (14.2 mm) and MPC scenario
- Annex 5.5.- Results for large event (28 mm) and rules scenario
- Annex 5.6.- Results for large event (28 mm) and MPC scenario

Annex 5.1.- Results for small rain event (7.8 mm) and rules scenario

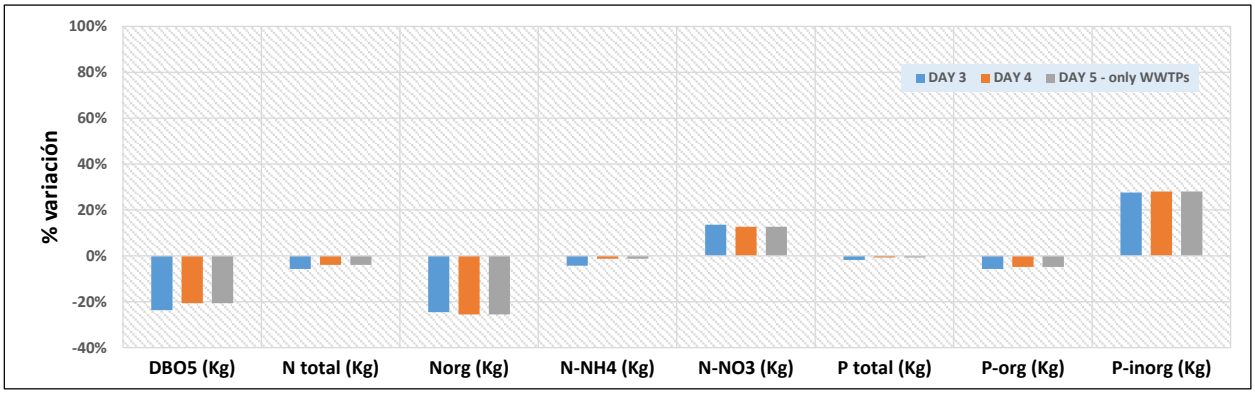
MASS BALANCE

Model scenario: 7.8 mm - RULES

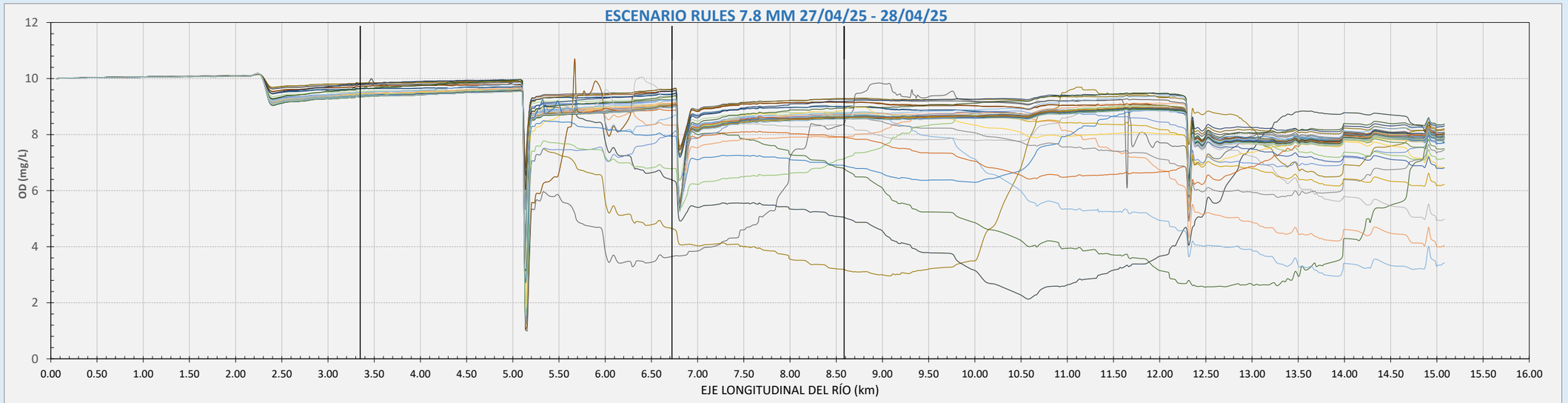
DAY 3	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	215	2156	429	11	1716	43	21	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	15500	1481	394	1087	0	259	233	26
TOTAL INFLOWS	**20650**	**26397**	**5300**	**17249**	**3849**	**858**	**757**	**101**
OUTFLOW DAY 3	**15756**	**24882**	**3999**	**16511**	**4372**	**843**	**714**	**129**
Difference	-4894	-1515	-1301	-738	524	-15	-43	28
% left	76.30%	94.26%	75.46%	95.72%	113.61%	98.24%	94.32%	127.57%
% variation	**-23.70%**	**-5.74%**	**-24.54%**	**-4.28%**	**13.61%**	**-1.76%**	**-5.68%**	**27.57%**

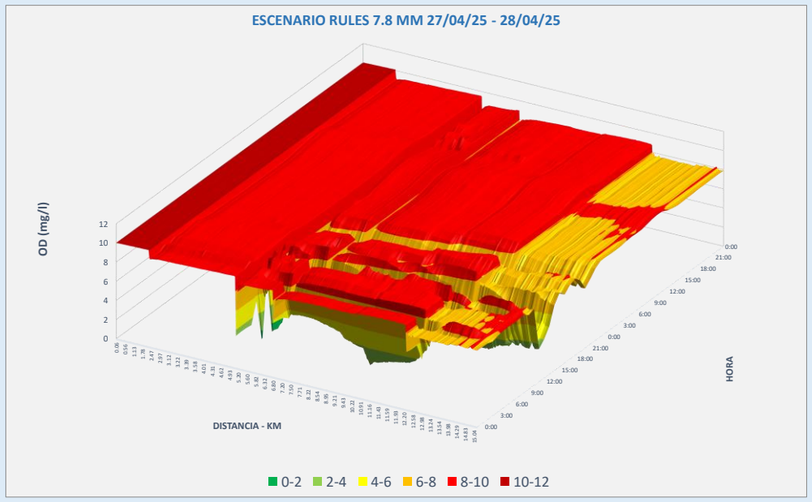
DAY 4	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	207	2080	414	10	1655	41	21	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	0	0	0	0	0	0	0	0
TOTAL INFLOWS	**5142**	**24840**	**4891**	**16161**	**3788**	**597**	**523**	**75**
OUTFLOW DAY 4	**4082**	**23867**	**3642**	**15957**	**4267**	**593**	**498**	**96**
Difference	-1060	-973	-1249	-204	479	-4	-25	21
% left	79.38%	96.08%	74.47%	98.74%	112.65%	99.31%	95.22%	128.01%
% variation	**-20.62%**	**-3.92%**	**-25.53%**	**-1.26%**	**12.65%**	**-0.69%**	**-4.78%**	**28.01%**

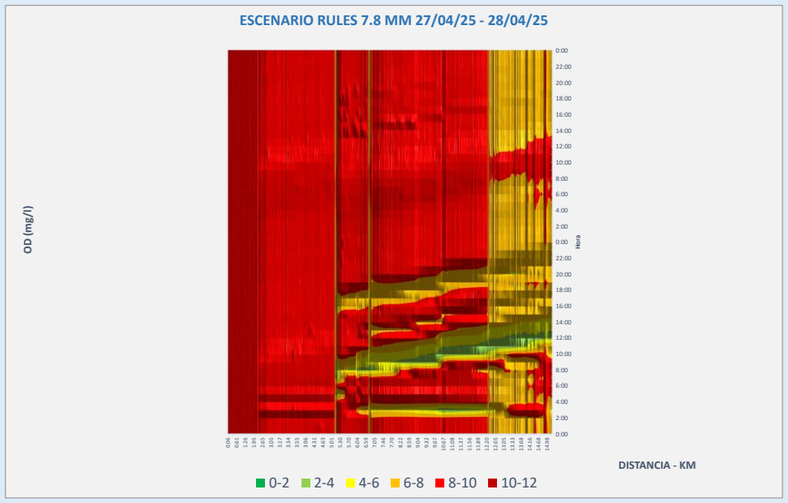
DAY 5 - only WWTPs	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	207	2080	414	10	1655	41	21	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	0	0	0	0	0	0	0	0
TOTAL INFLOWS	**5142**	**24840**	**4891**	**16161**	**3788**	**597**	**523**	**75**
OUTFLOW DAY 5	**4082**	**23867**	**3642**	**15957**	**4267**	**593**	**498**	**96**
Difference	-1060	-973	-1249	-204	479	-4	-25	21
% left	79.38%	96.08%	74.47%	98.74%	112.65%	99.31%	95.22%	128.01%
% variation	**-20.62%**	**-3.92%**	**-25.53%**	**-1.26%**	**12.65%**	**-0.69%**	**-4.78%**	**28.01%**



CSO Mass Balances	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
CSO mass discharged on DAY 3	15499.7	1480.7	393.7	1087.0	0.0	259.4	233.4	25.9
CSO mass outflow on DAY 3 (day 3 minus day 5)	11673.5	1015.5	356.7	553.5	105.3	249.9	216.2	33.7
CSO mass outflow on DAY 4 (day 4 minus day 5)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total CSO mass discharged over Days 3 and 4	11673.5	1015.5	356.7	553.5	105.3	249.9	216.2	33.7
CSO mass removed on Days 3–4	-3826.2	2496.2	-36.9	-533.5	105.3	-9.5	-17.2	7.8
% CSO mass removed on Days 3–4	-24.7%	-31.4%	-9.4%	-49.1%		-3.6%	-7.4%	30.0%



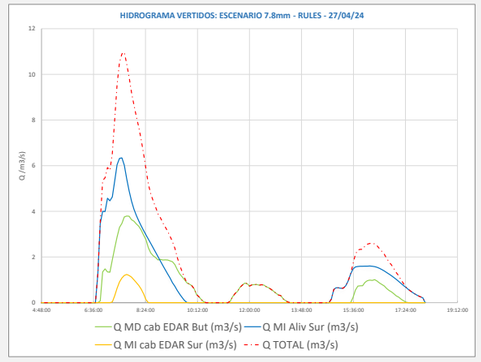




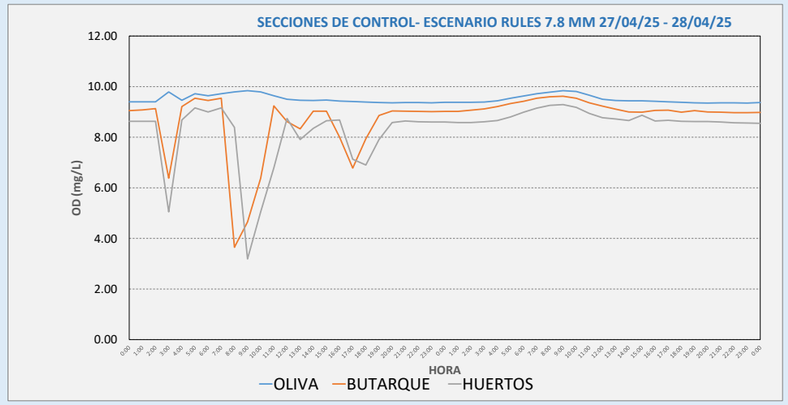
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

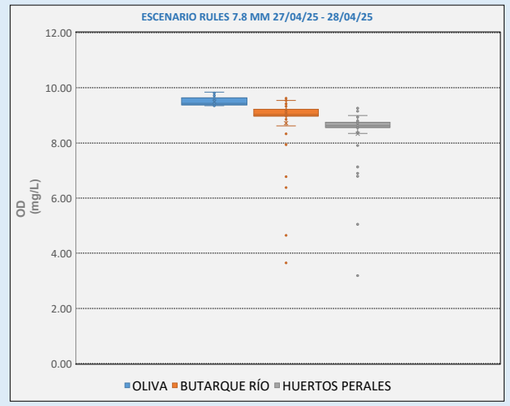
PROYECTO LIFE-RUBÍES

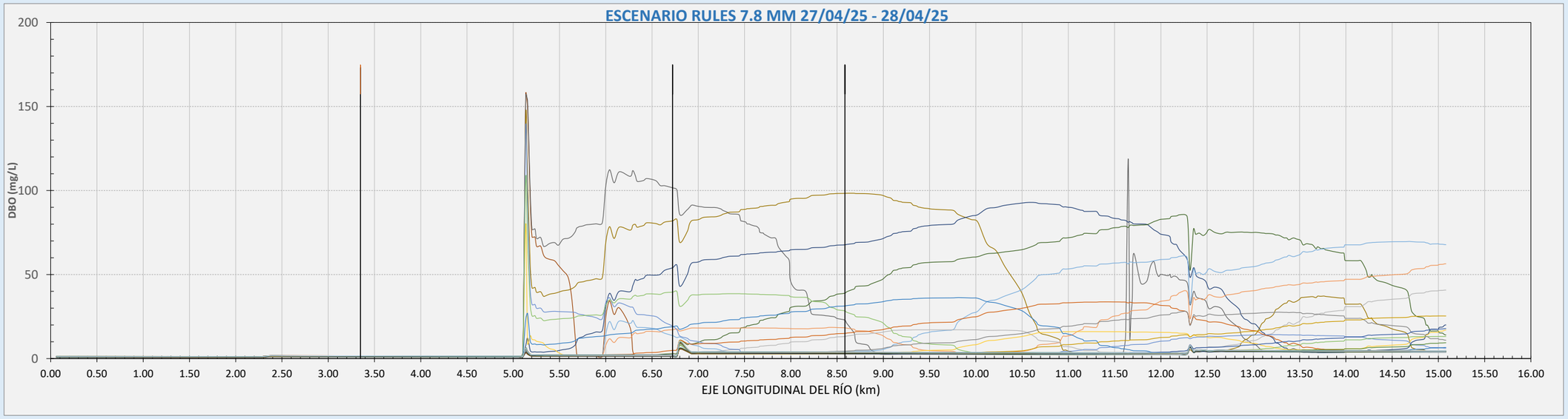
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - RULES

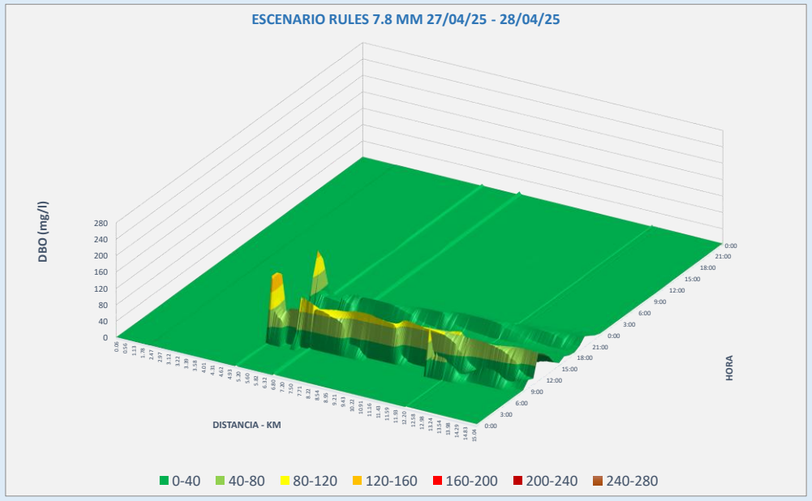


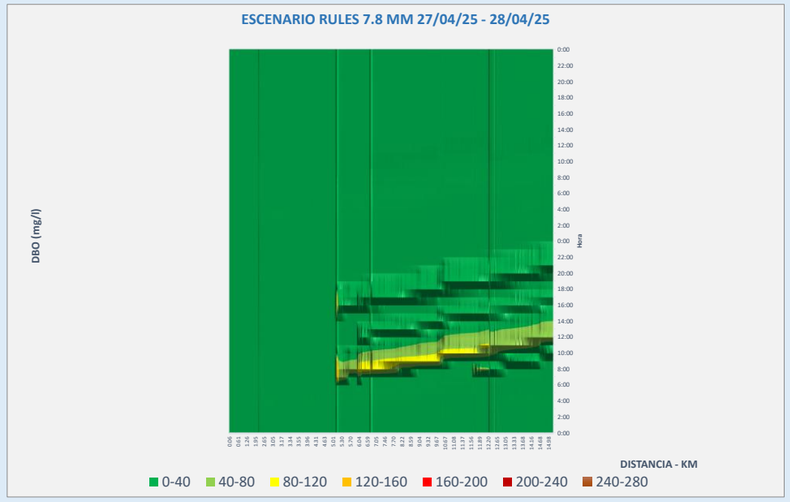
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***27/04 4,97 28/04 4,79 29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2-día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	







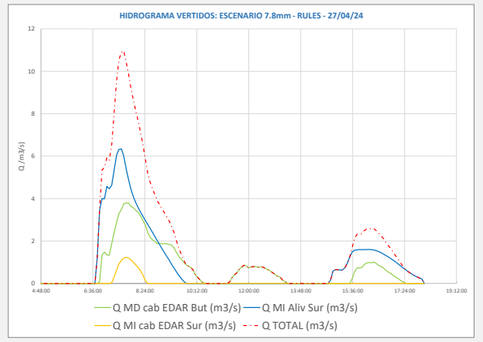




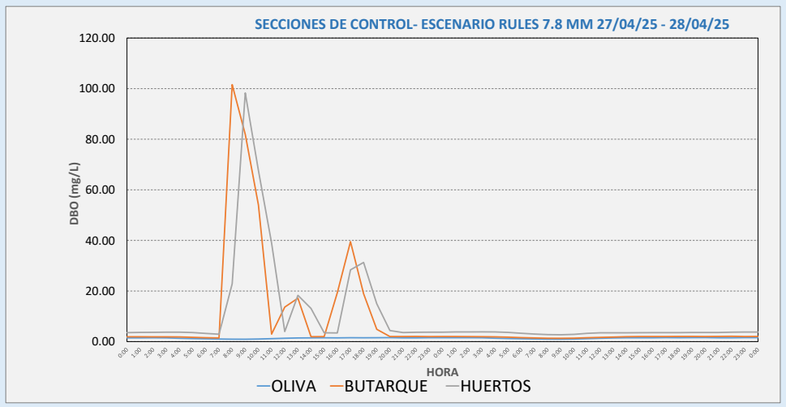
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

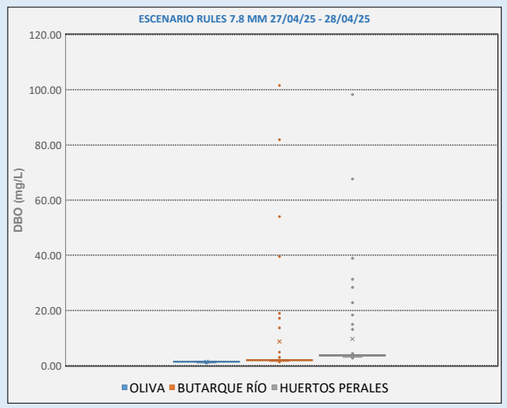
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - RULES

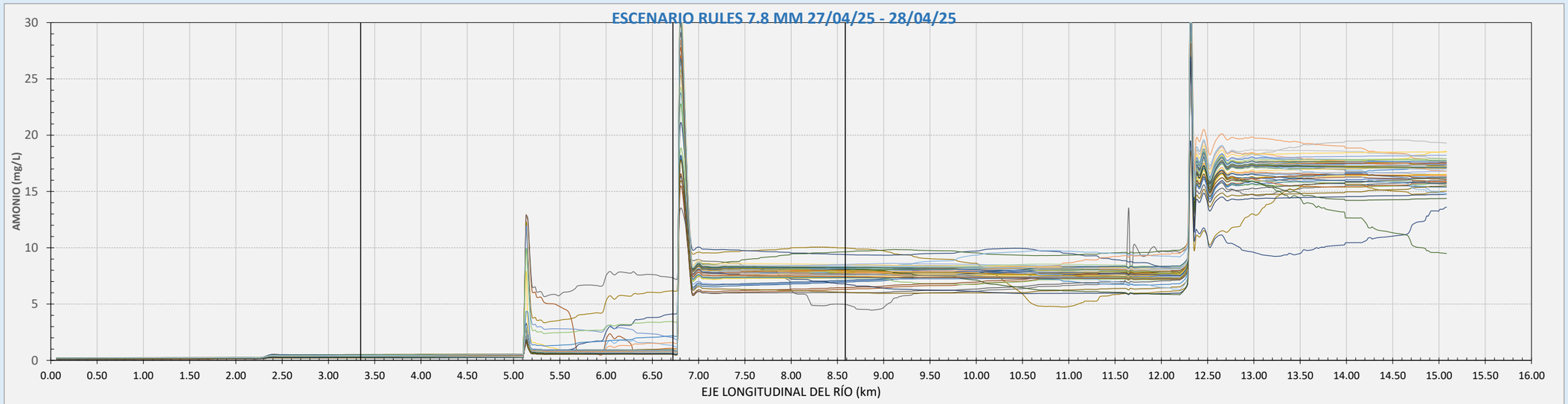


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**27/04 4,97** **28/04 4,79** **29/04 4,79**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m^2·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

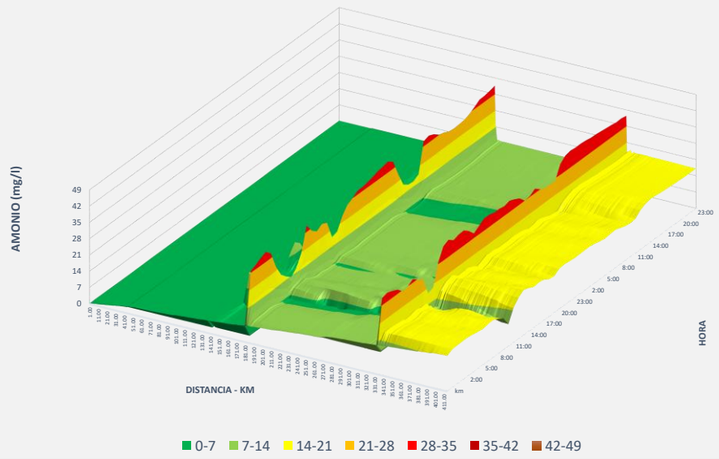




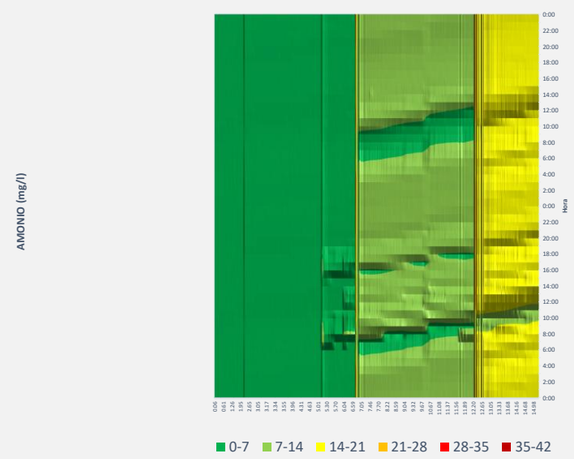
ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25



ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25



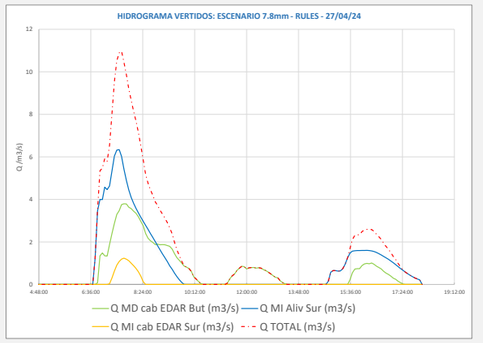
ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25



MODELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

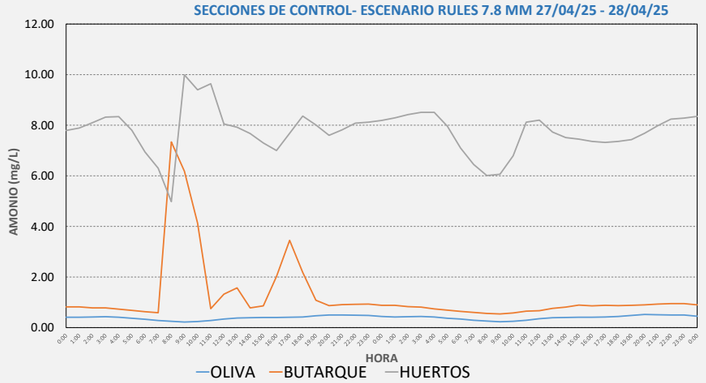
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - RULES

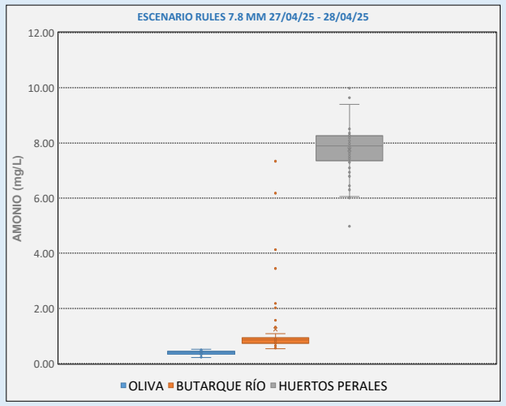


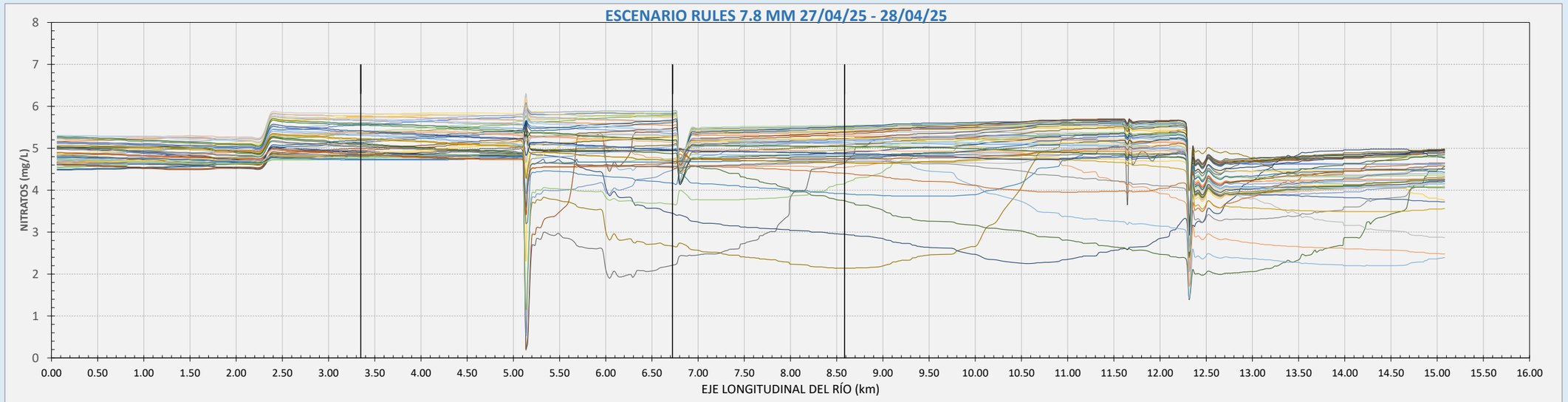
PARÁMETROS Y RANGOS	VALORES MINIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***27/04 4,97*** ***28/04 4,79*** ***29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijada a* ***10***
DBOsed/DOS (g/m^2·día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	

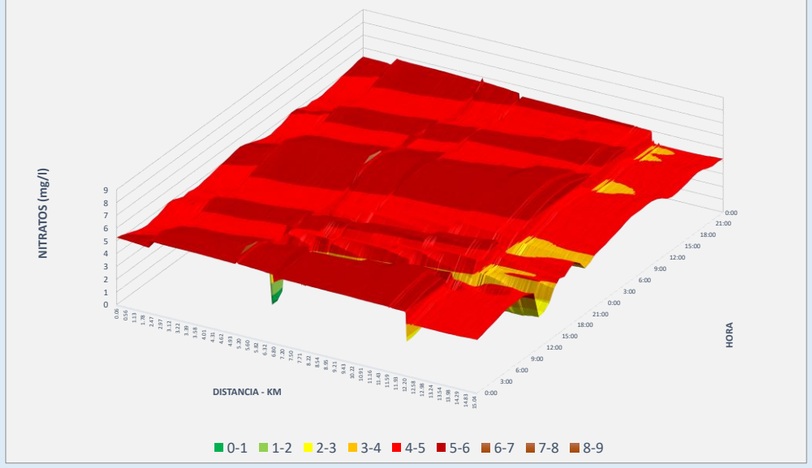
SECCIONES DE CONTROL- ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25

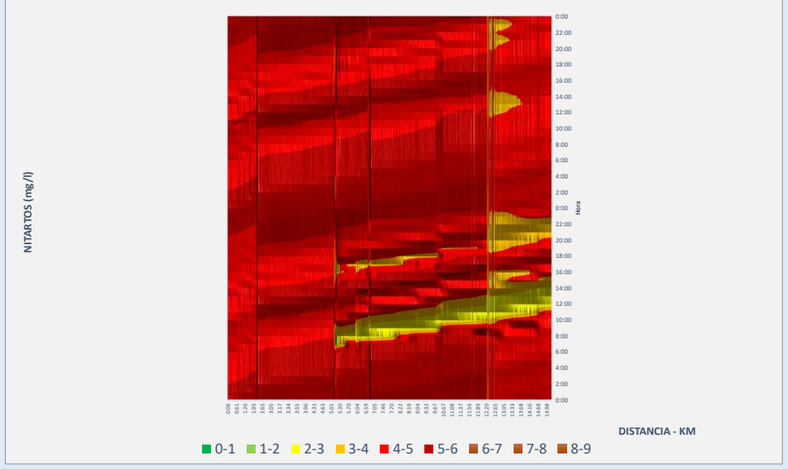


ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25





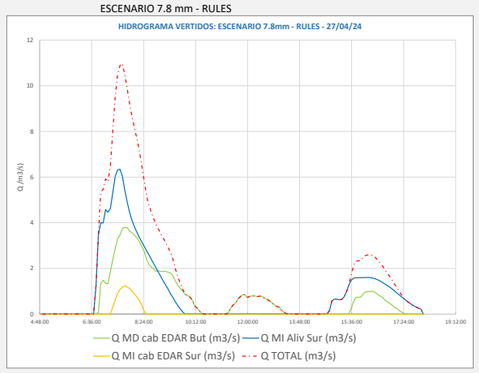




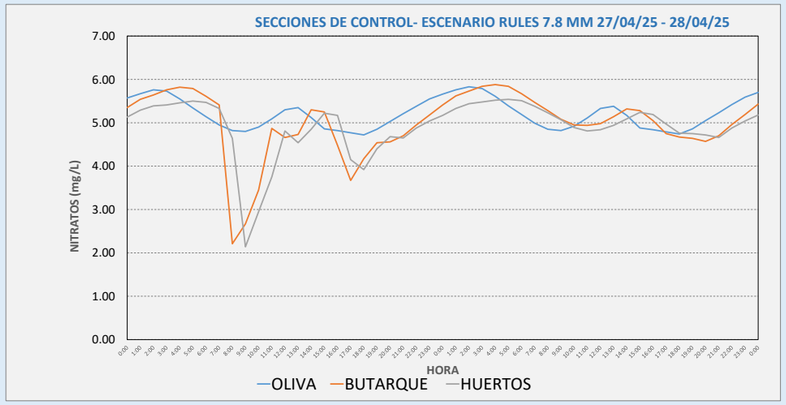
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

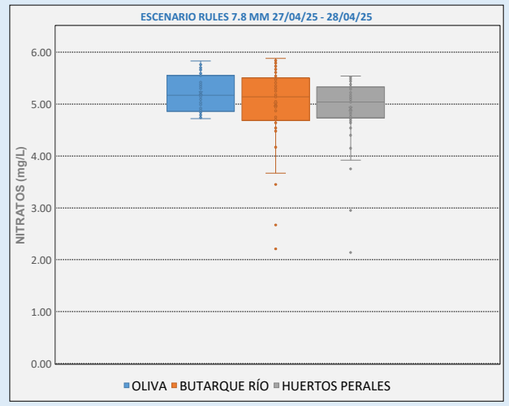
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - RULES

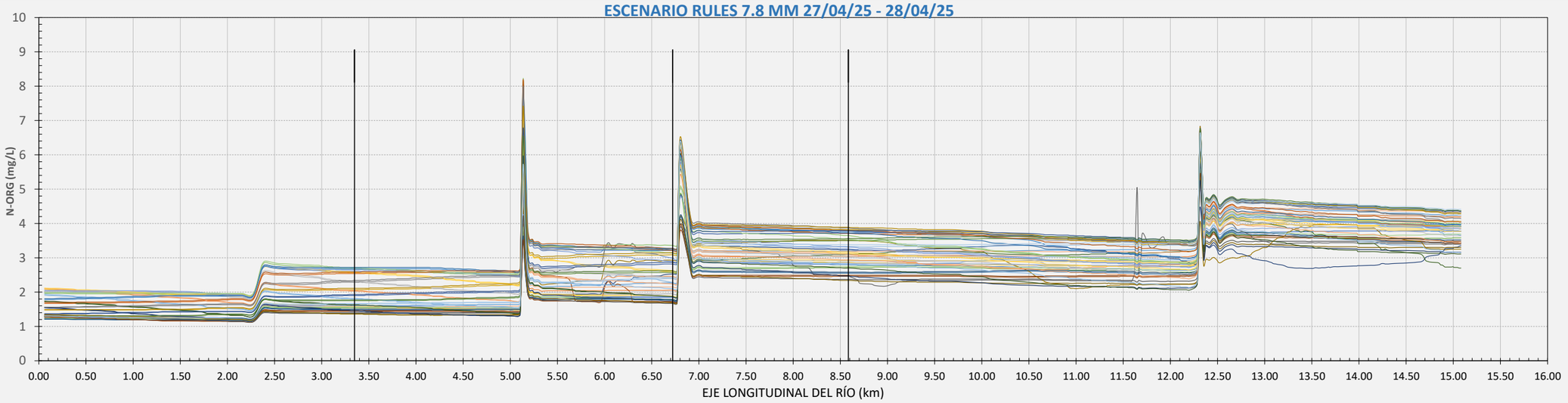


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**27/04 4,97** **28/04 4,79** **29/04 4,79**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractaria de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

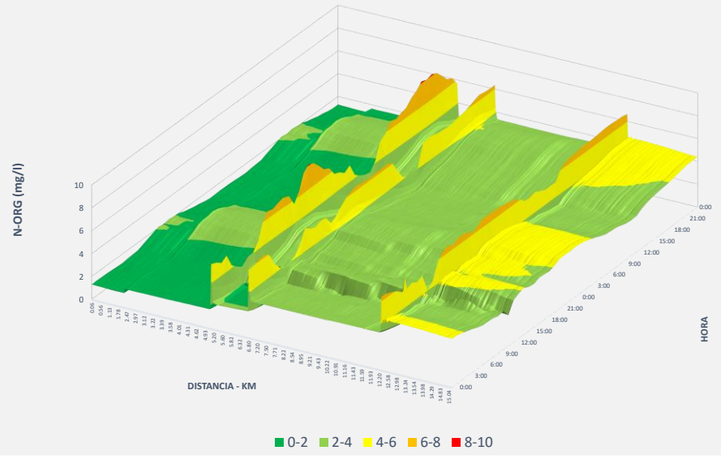




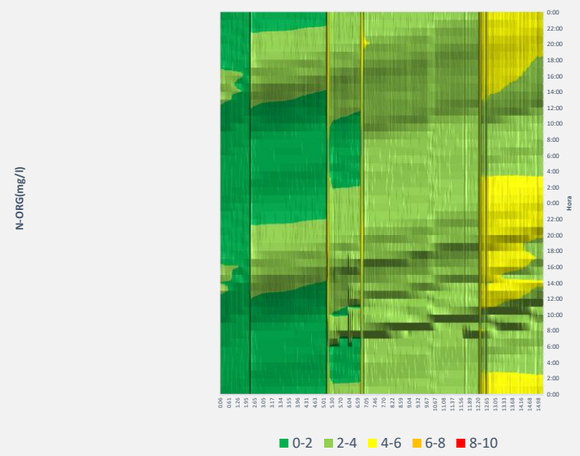
ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25



ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25



ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25



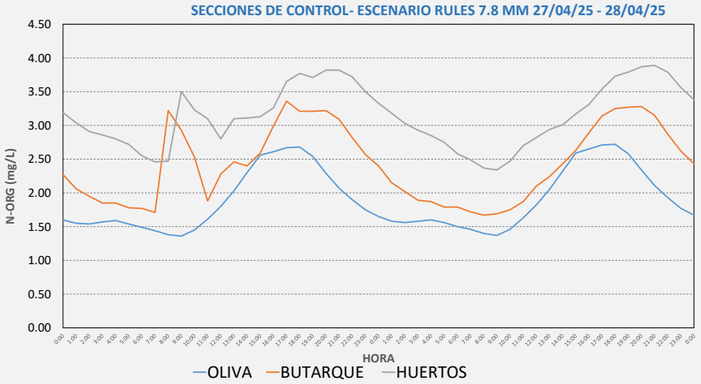
MODELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

PROYECTO LIFE-RUBÍES

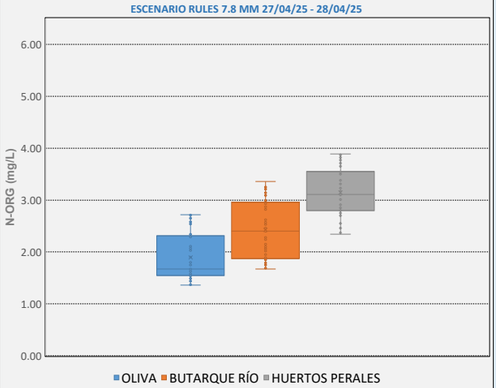
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - RULES

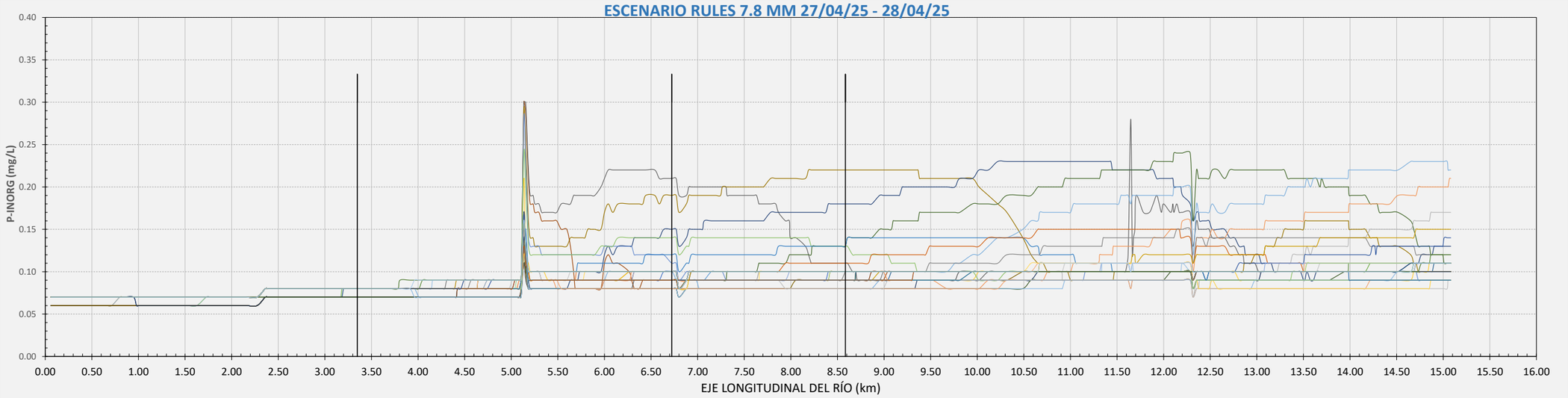
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***27/04 4,97*** ***28/04 4,79*** ***29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2·día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR* *Cabecera (N-NH4+ río) + (N-NH4+ Viveros) =* *0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	

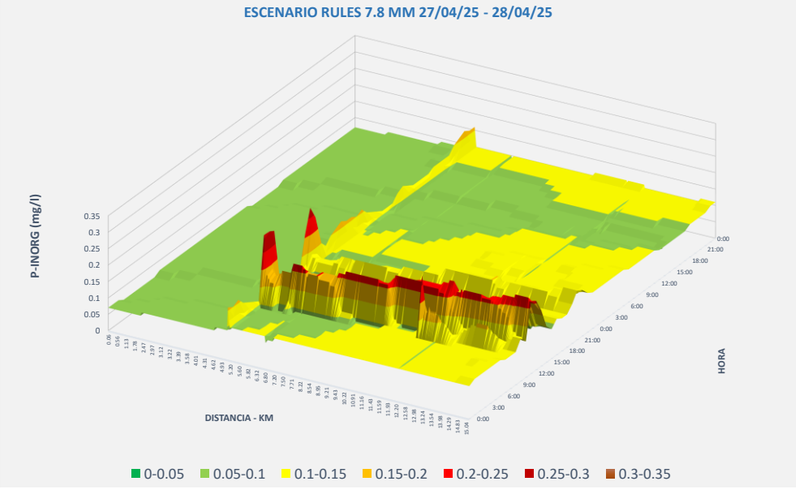
SECCIONES DE CONTROL- ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25

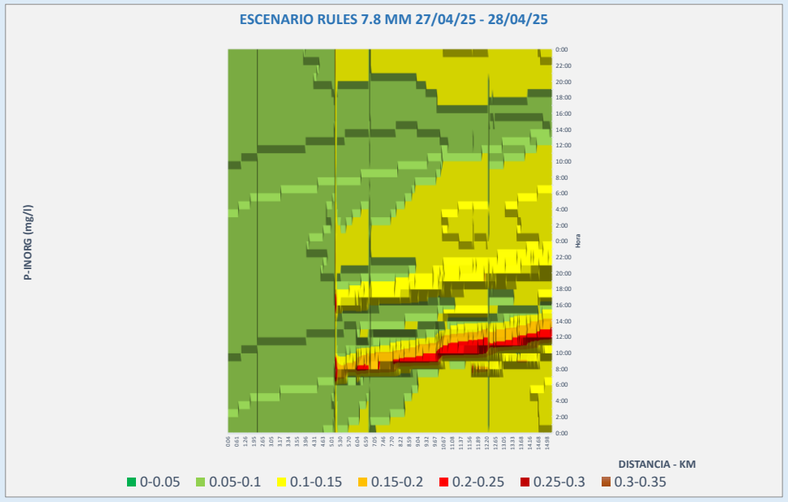


ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25





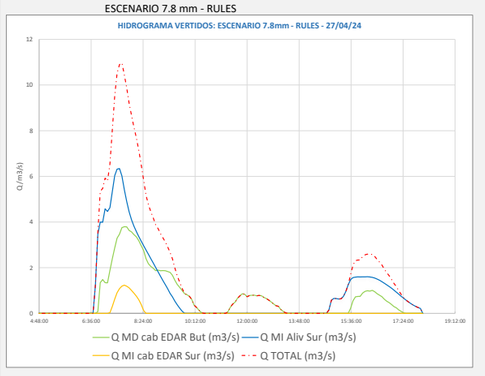




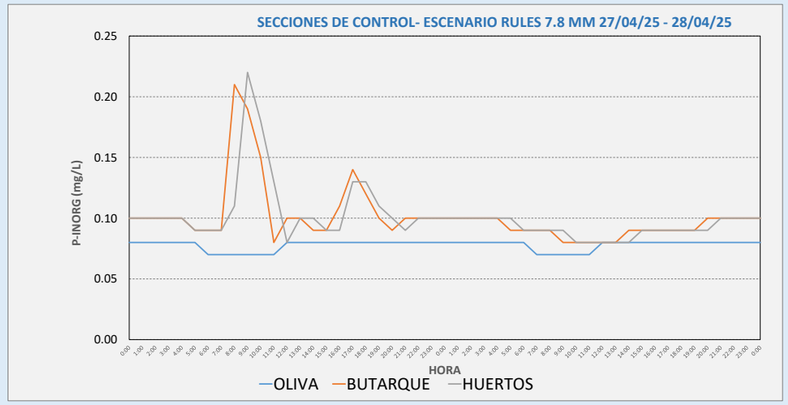
MPInELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

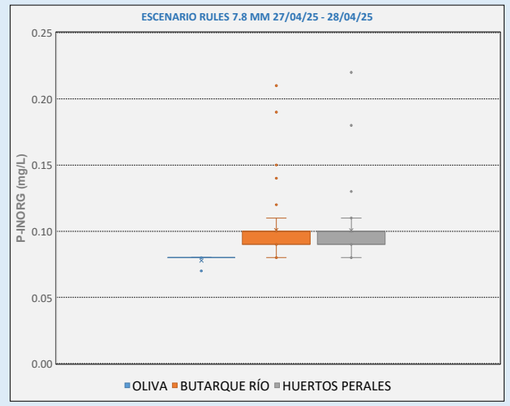
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - RULES

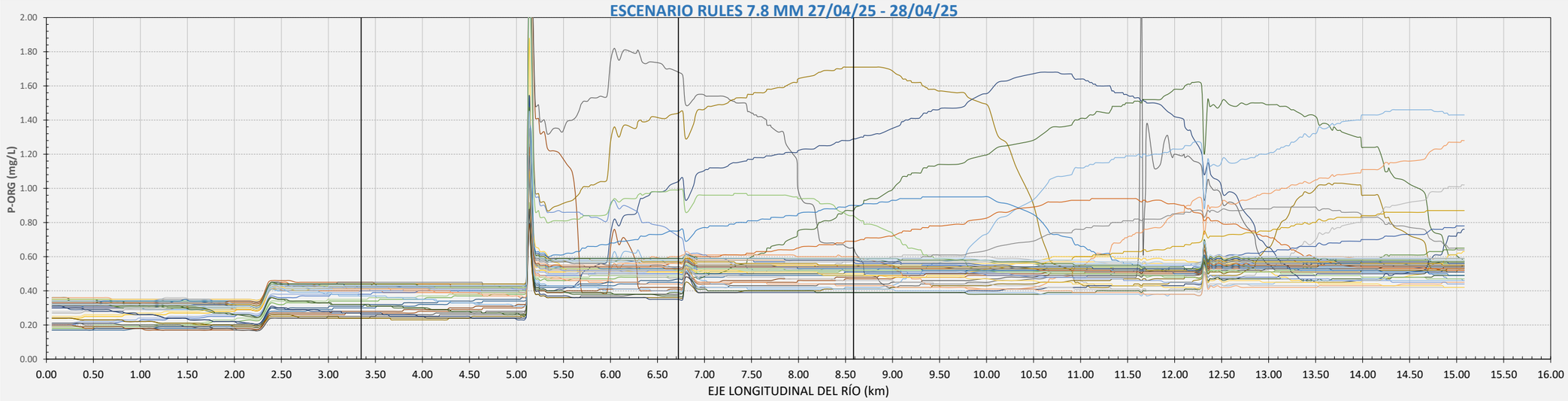


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m³/s	1	2,5	5	**27/04 4,97** **28/04 4,79** **29/04 4,79**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m²-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día⁻¹)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación =
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	0,5 + factor 0,4
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día⁻¹)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día⁻¹)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día⁻¹)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día⁻¹)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

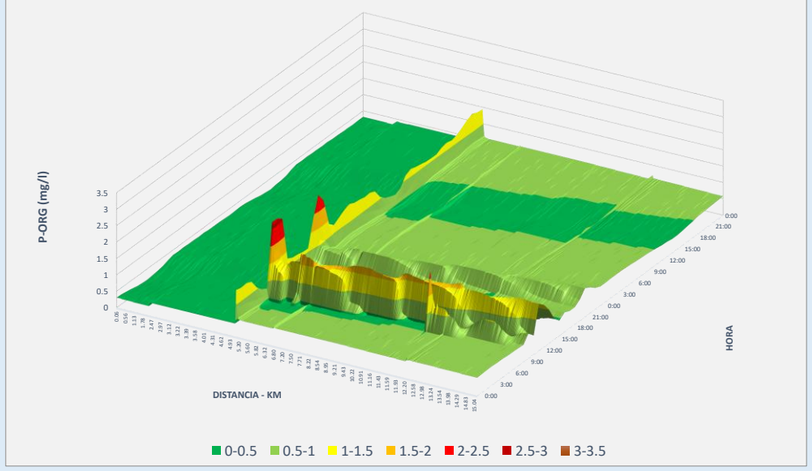




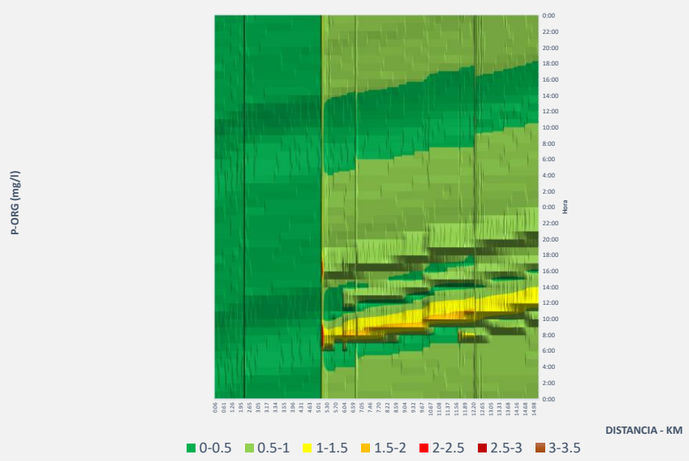
ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25



ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25



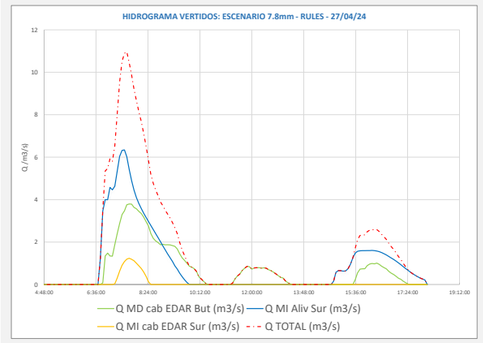
ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25



MODELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

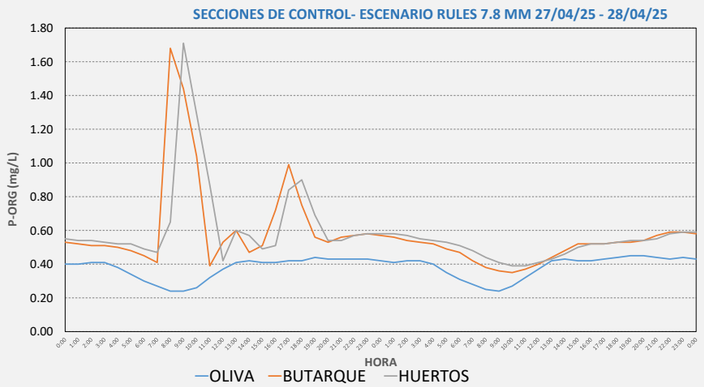
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - RULES

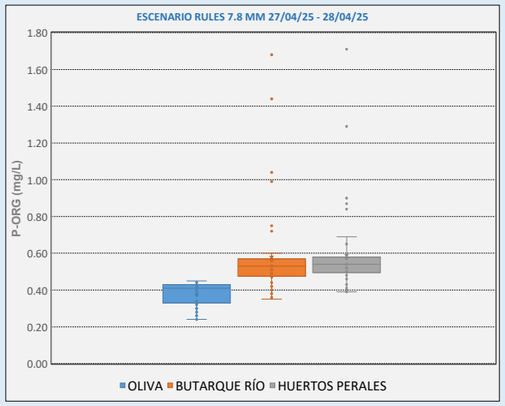


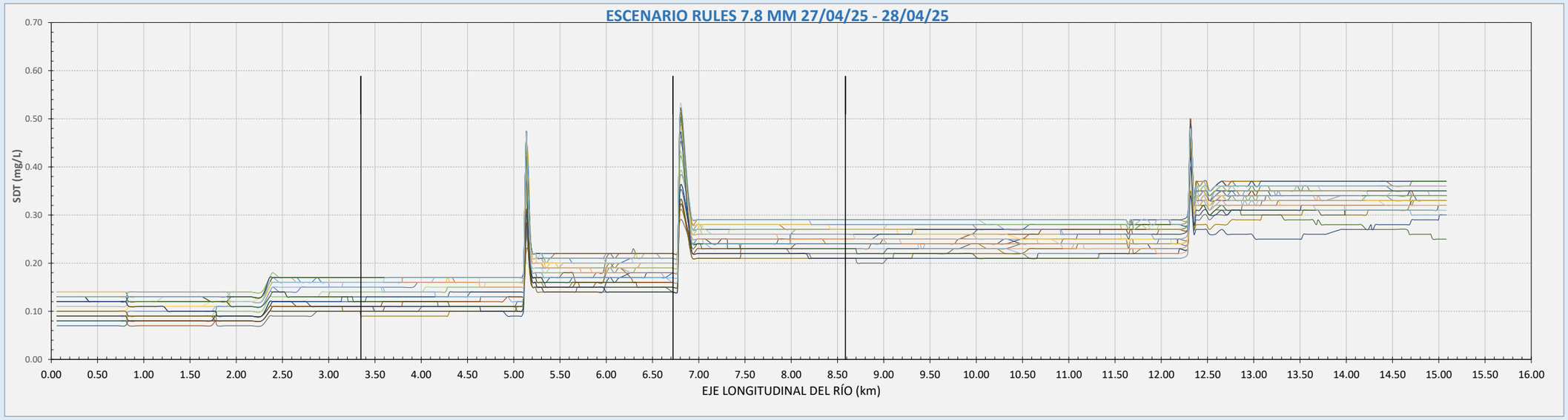
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m³/s	*1*	*2,5*	*5*	***27/04 4,97*** ***28/04 4,79*** ***29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m²-día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día⁻¹)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día⁻¹)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR* *Cabecera (N-NH4+ río) + (N-NH4+ Viveros) =* *0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día⁻¹)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día⁻¹)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día⁻¹)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	

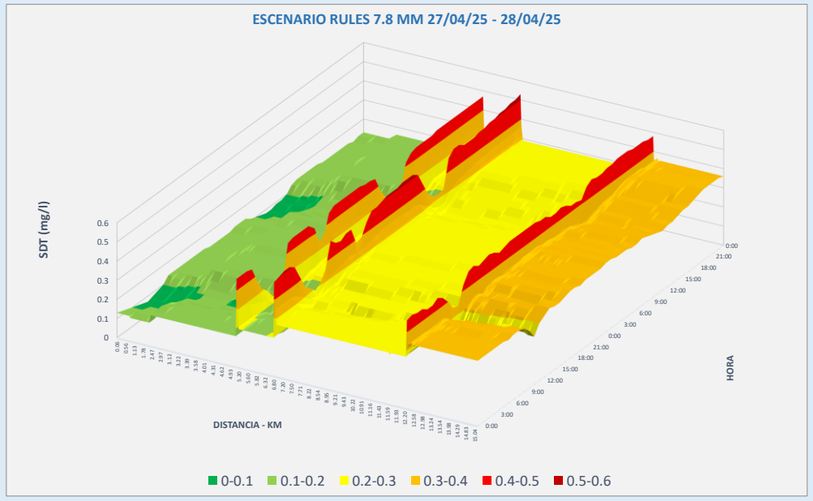
SECCIONES DE CONTROL- ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25

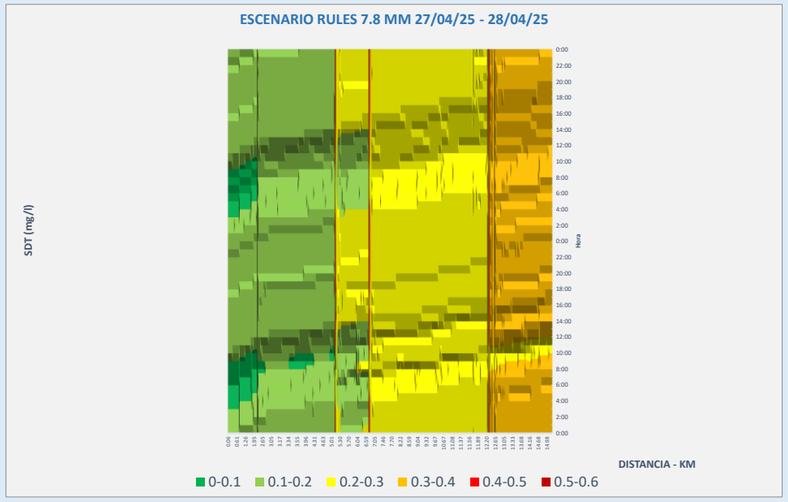


ESCENARIO RULES 7.8 MM 27/04/25 - 28/04/25





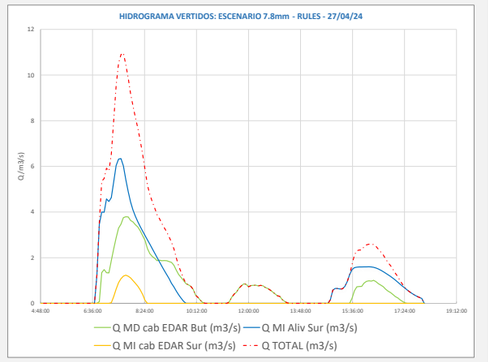




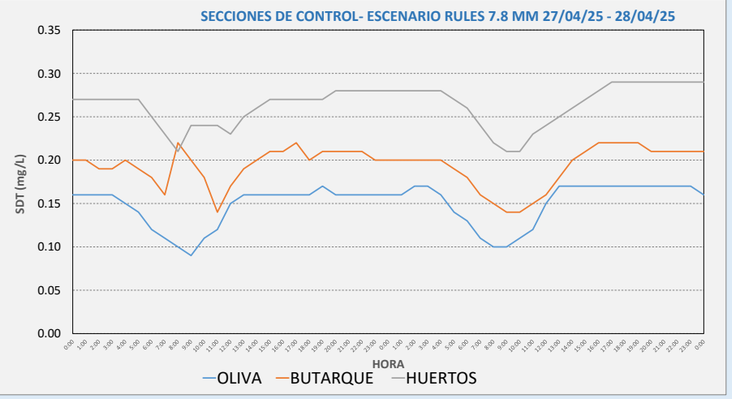
MSaltELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

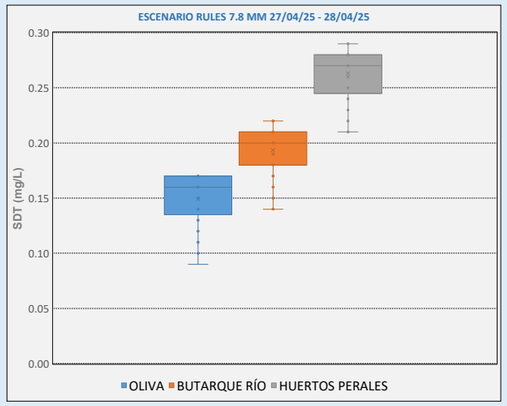
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - RULES



PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***27/04 4,97 28/04 4,79 29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2·día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	





Annex 5.2.- Results for small rain event (7.8 mm) and MPC scenario

Mass_Balance-E1-MPC-7.8mm 2
ESCENARIO_7.8_mm_-_MPC__OD 3
ESCENARIO_7.8_mm_-_MPC__DBO 4
ESCENARIO_7.8_mm_-_MPC__Amonio 5
ESCENARIO_7.8_mm_-_MPC__Nitratos 6
ESCENARIO_7.8_mm_-_MPC__NOrg 7
ESCENARIO_7.8_mm_-_MPC__PIn 8
ESCENARIO_7.8_mm_-_MPC__POrg 9
ESCENARIO_7.8_mm_-_MPC__SDT 10

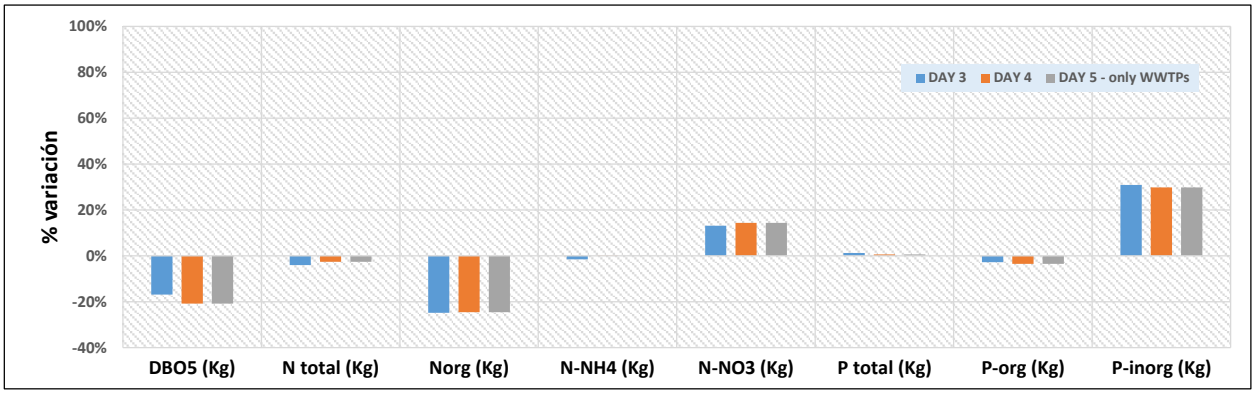
MASS BALANCE

Model scenario: 7.8 mm - MPC

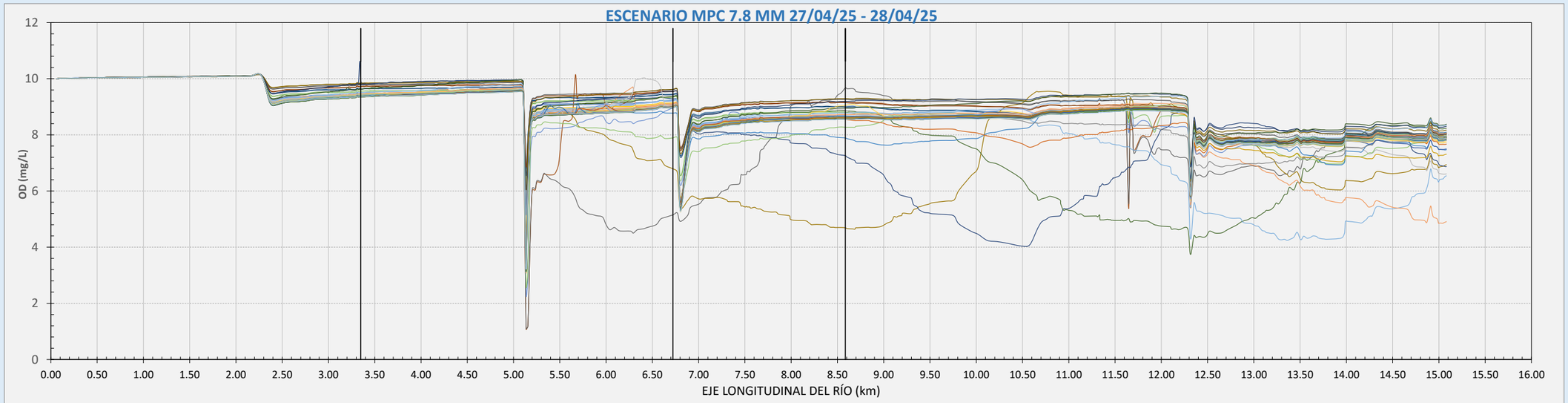
DAY 3	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	215	2156	429	11	1716	43	21	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	8055	847	241	606	0	143	128	14
TOTAL INFLOWS	**13745**	**25809**	**5136**	**16825**	**3849**	**754**	**663**	**91**
OUTFLOW DAY 3	**10974**	**24733**	**3869**	**16511**	**4354**	**751**	**634**	**117**
Difference	-2231	-1030	-1278	-257	505	9	-18	28
% left	83.11%	96.00%	75.17%	98.47%	113.12%	101.27%	97.20%	130.89%
% variation	**-16.89%**	**-4.00%**	**-24.83%**	**-1.53%**	**13.12%**	**1.27%**	**-2.80%**	**30.89%**

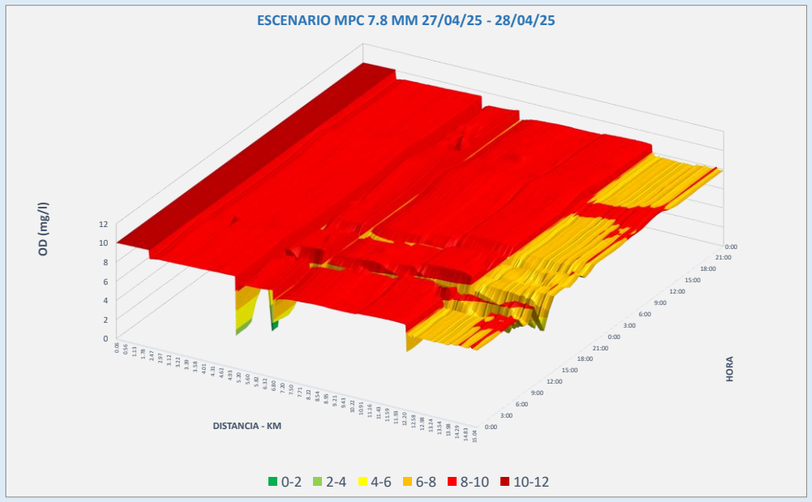
DAY 4	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	207	2080	414	10	1655	41	21	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	0	0	0	0	0	0	0	0
TOTAL INFLOWS	**5142**	**24840**	**4891**	**16161**	**3788**	**597**	**523**	**75**
OUTFLOW DAY 4	**4071**	**24196**	**3689**	**16174**	**4332**	**601**	**505**	**97**
Difference	-1071	-644	-1201	13	545	4	-18	22
% left	79.16%	97.41%	75.43%	100.08%	114.38%	100.66%	96.50%	129.83%
% variation	**-20.84%**	**-2.59%**	**-24.57%**	**0.08%**	**14.38%**	**0.66%**	**-3.50%**	**29.83%**

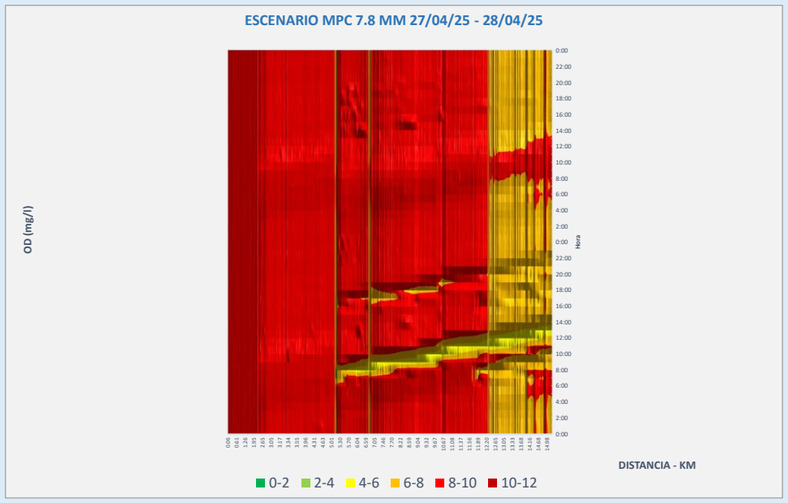
DAY 5 - only WWTPs	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	207	2080	414	10	1655	41	21	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	0	0	0	0	0	0	0	0
TOTAL INFLOWS	**5142**	**24840**	**4891**	**16161**	**3788**	**597**	**523**	**75**
OUTFLOW DAY 5	**4071**	**24196**	**3689**	**16174**	**4332**	**601**	**505**	**97**
Difference	-1071	-644	-1201	13	545	4	-18	22
% left	79.16%	97.41%	75.43%	100.08%	114.38%	100.66%	96.50%	129.83%
% variation	**-20.84%**	**-2.59%**	**-24.57%**	**0.08%**	**14.38%**	**0.66%**	**-3.50%**	**29.83%**



CSO Mass Balances	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
CSO mass discharged on DAY 3	8054.7	846.8	240.5	606.3	0.0	142.6	128.4	14.3
CSO mass outflow on DAY 3 (day 3 minus day 5)	6903.1	537.4	179.4	336.8	21.2	149.7	129.2	20.5
CSO mass outflow on DAY 4 (day 4 minus day 5)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total CSO mass discharged over Days 3 and 4	6903.1	537.4	179.4	336.8	21.2	149.7	129.2	20.5
CSO mass removed on Days 3–4	-1151.6	1384.2	-61.1	-269.5	21.2	7.0	0.8	6.2
% CSO mass removed on Days 3–4	-14.3%	-36.5%	-25.4%	-44.4%		4.9%	0.6%	43.4%



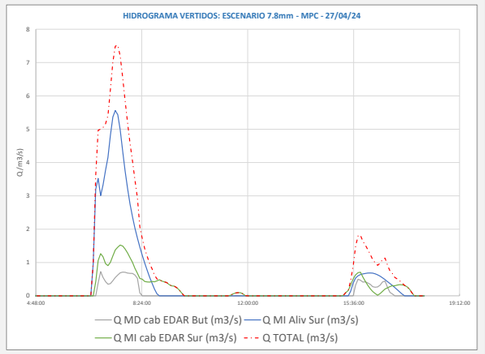




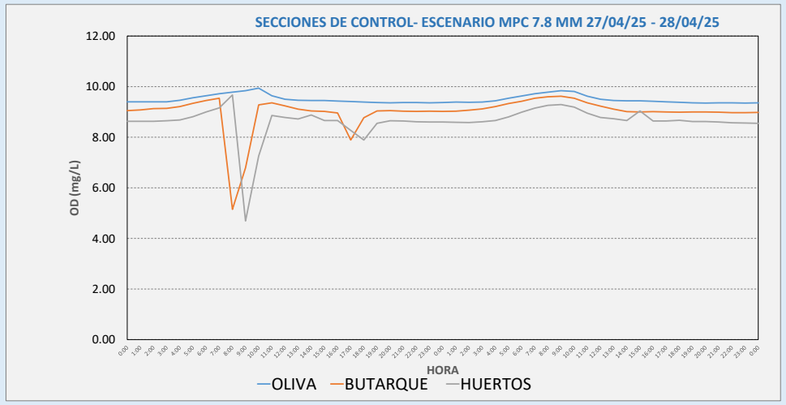
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

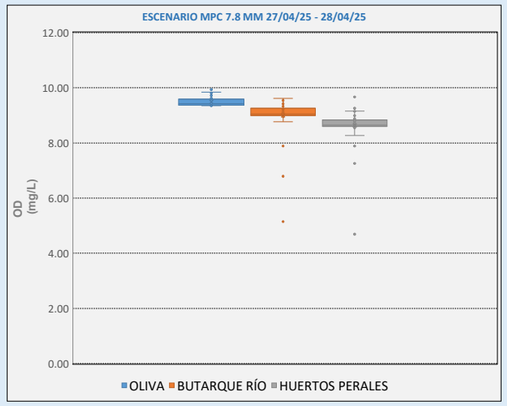
PROYECTO LIFE-RUBÍES

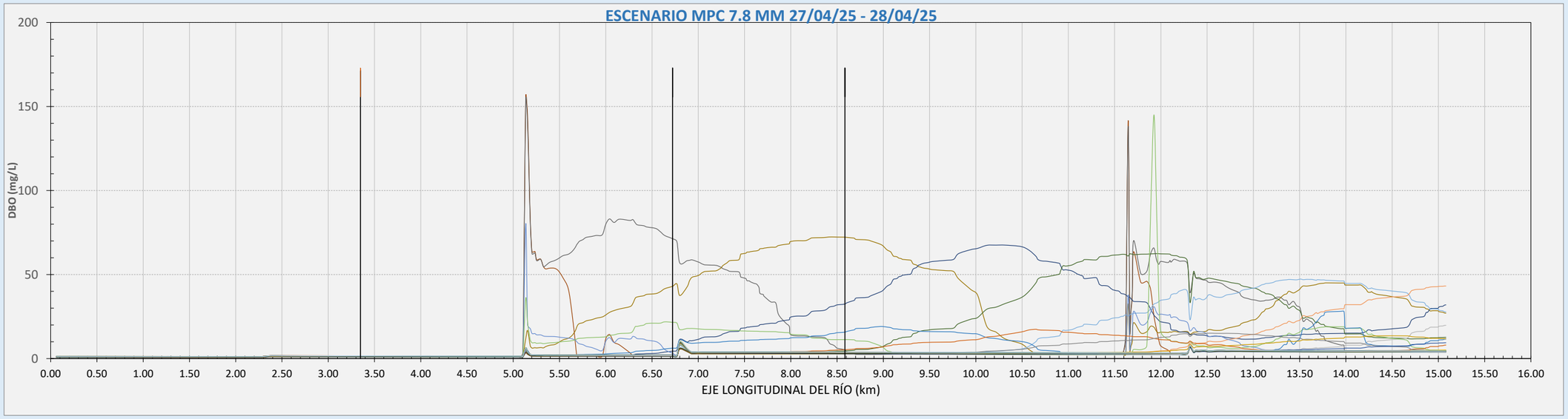
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - MPC

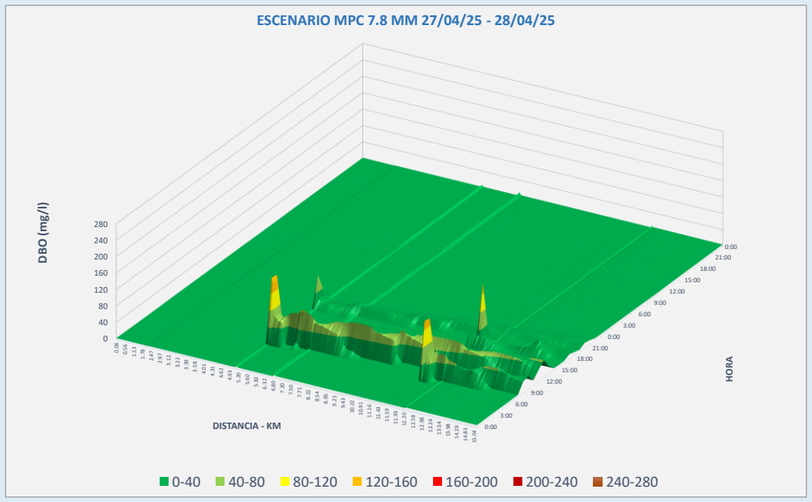


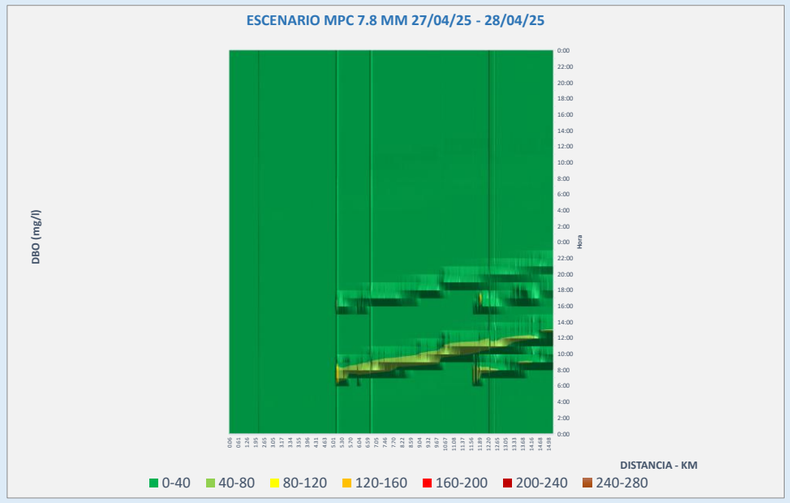
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***27/04 4,97 28/04 4,79 29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2-día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	







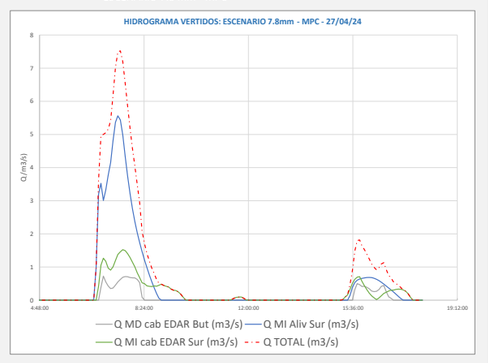




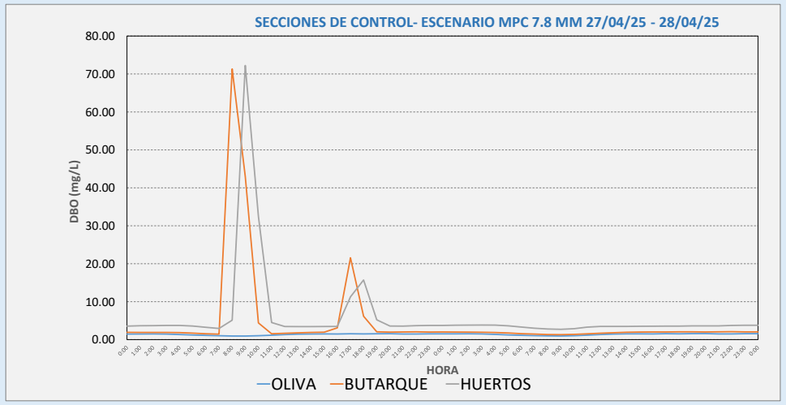
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

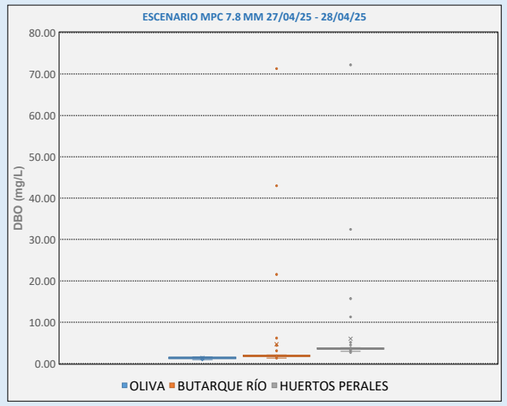
PROYECTO LIFE-RUBÍES

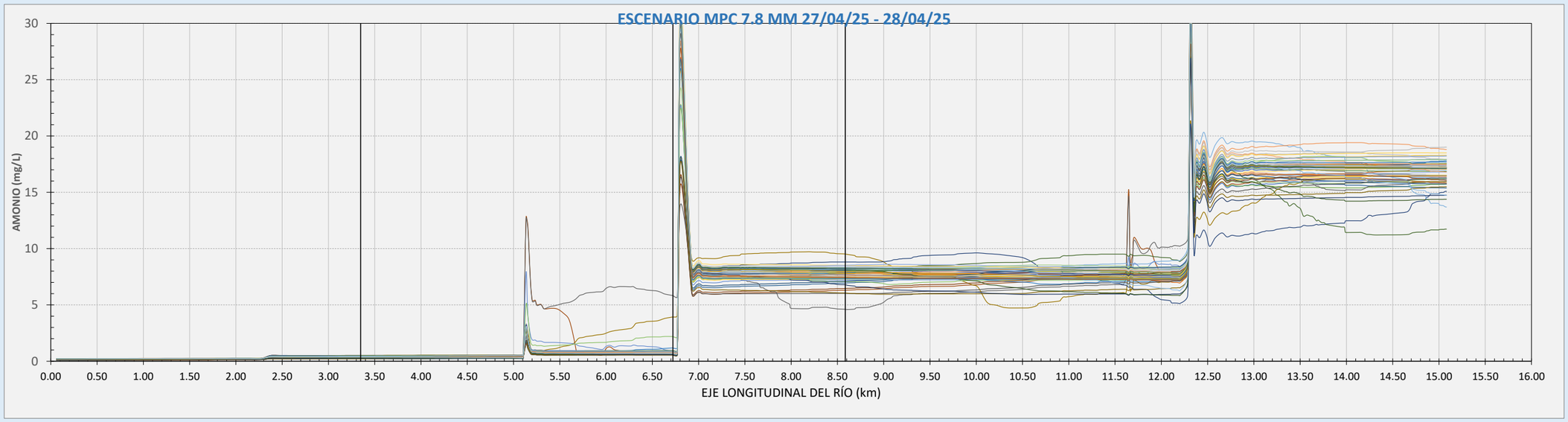
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - MPC

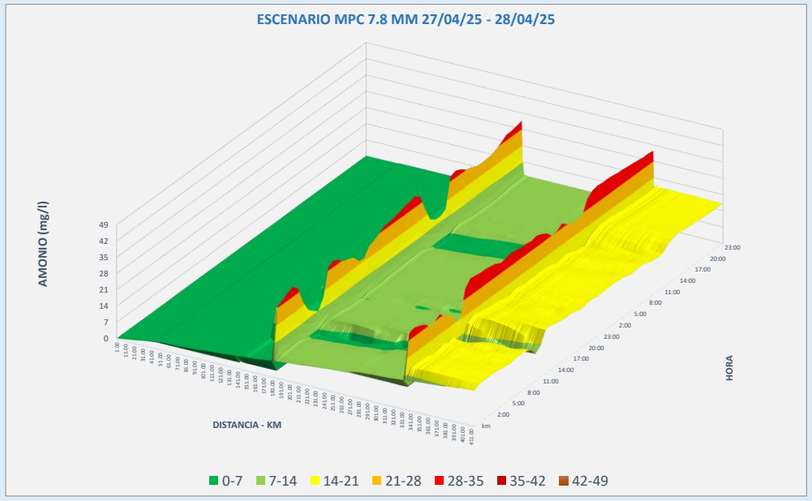


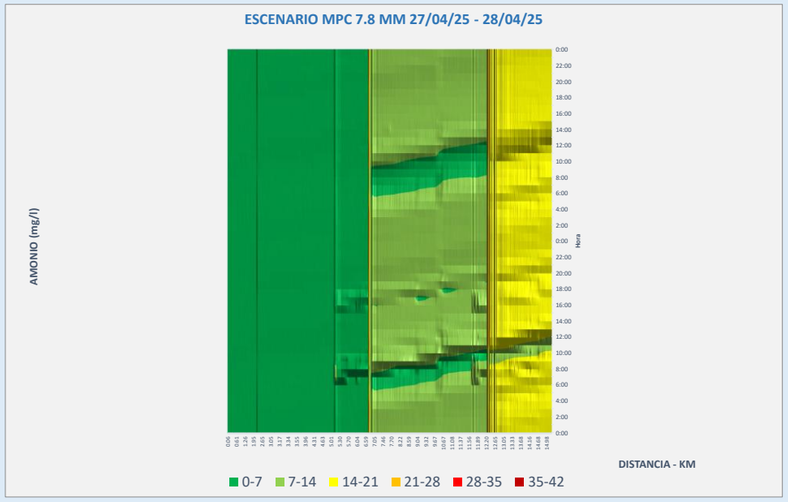
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***27/04 4,97 28/04 4,79 29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2-día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	







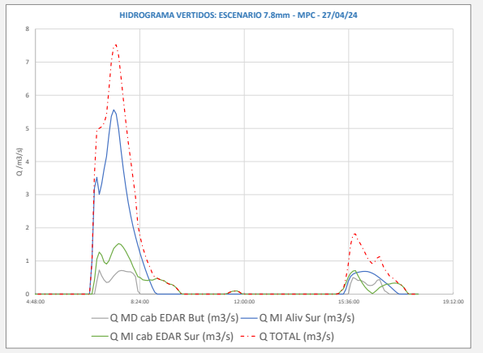




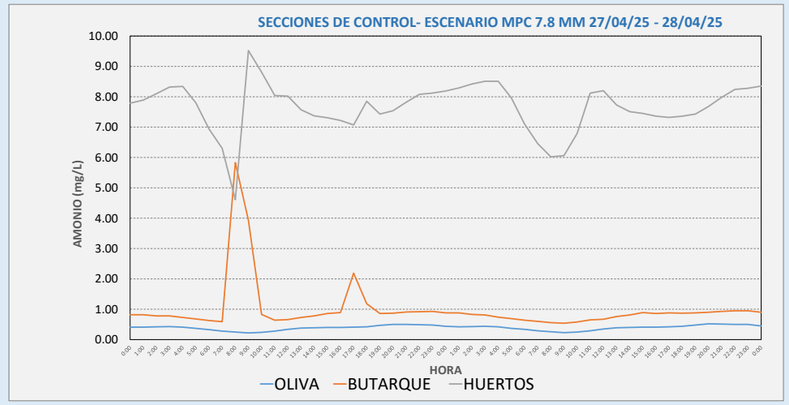
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

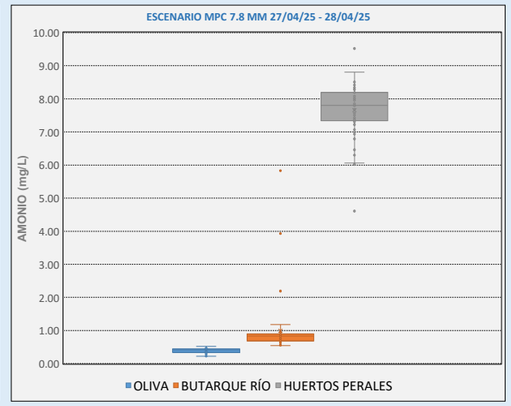
PROYECTO LIFE-RUBÍES

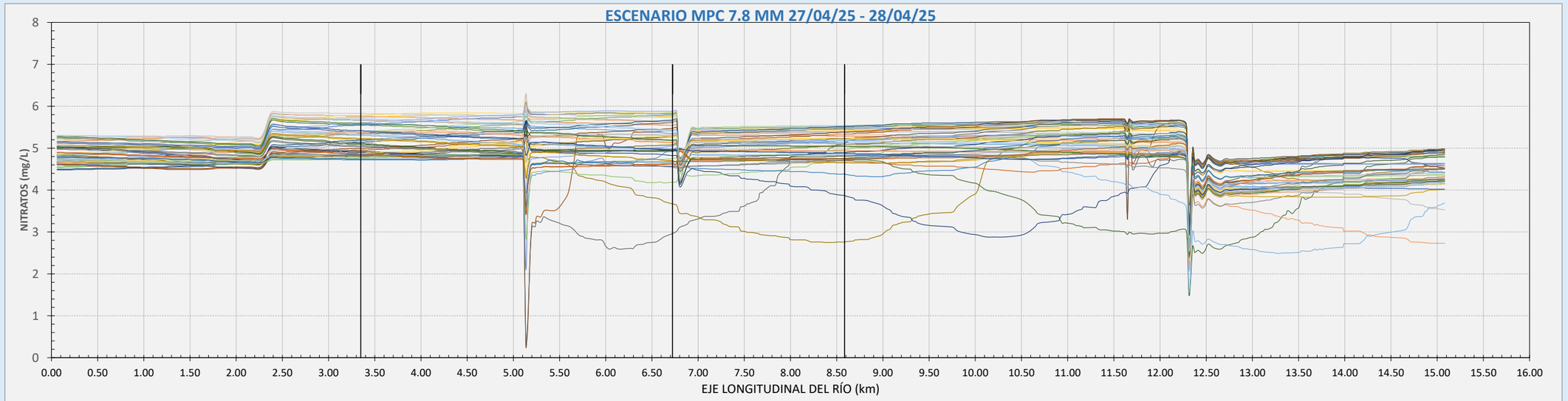
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - MPC

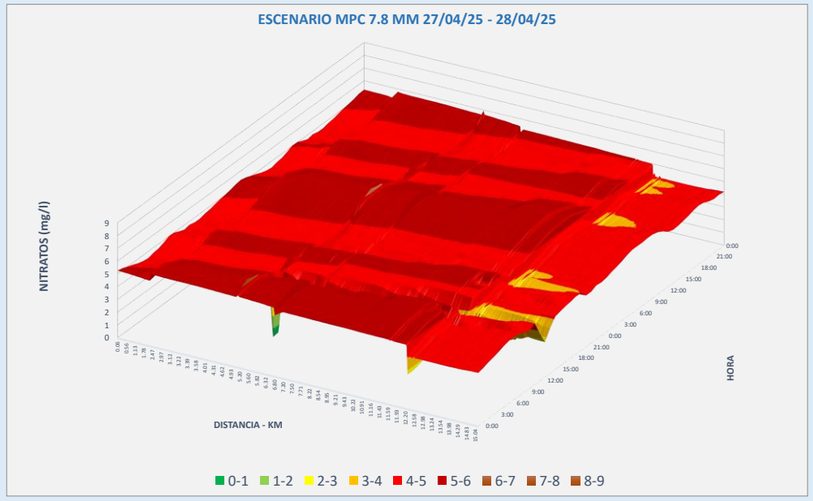


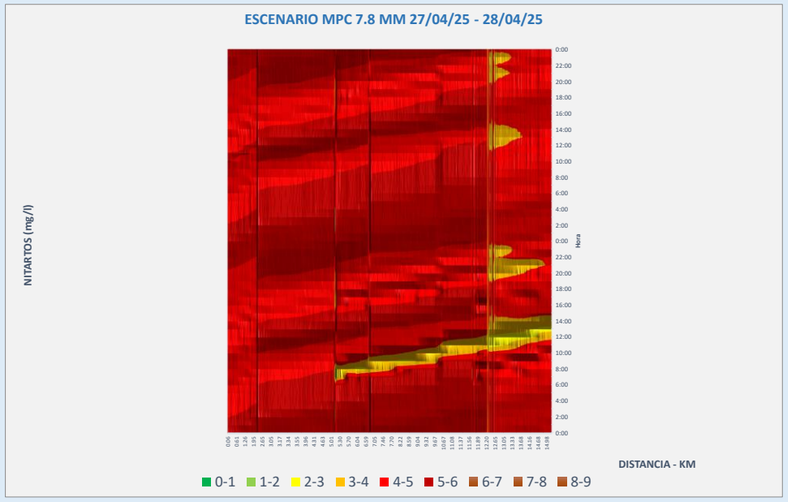
PARÁMETROS Y RANGOS	VALORES MINIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**27/04 4,97** **28/04 4,79** **29/04 4,79**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijada a **10**
DBOsed/DOS (g/m^2·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	







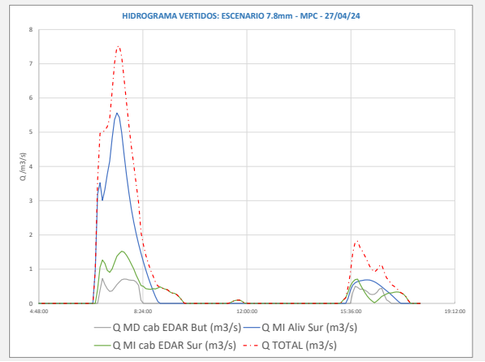




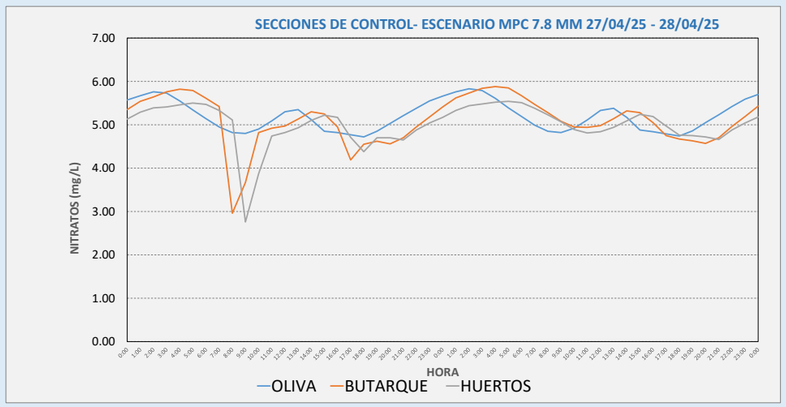
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

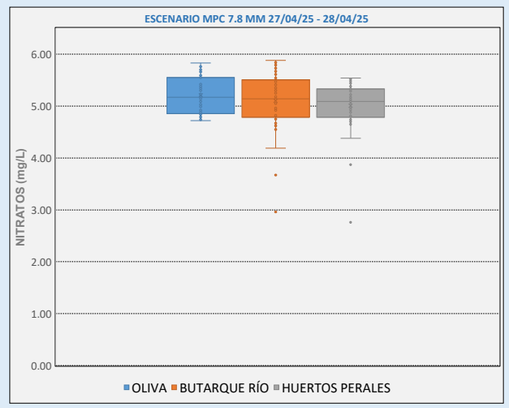
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - MPC

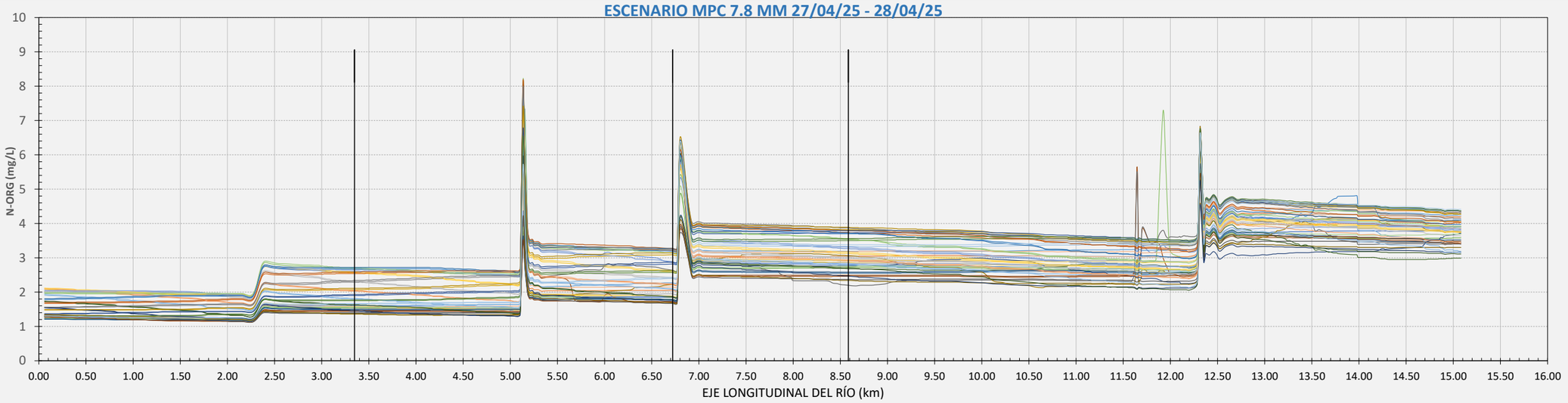


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**27/04 4,97** **28/04 4,79** **29/04 4,79**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractaria de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

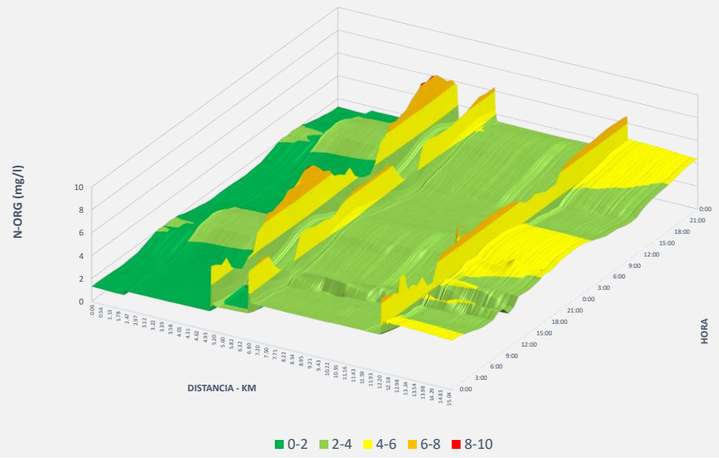




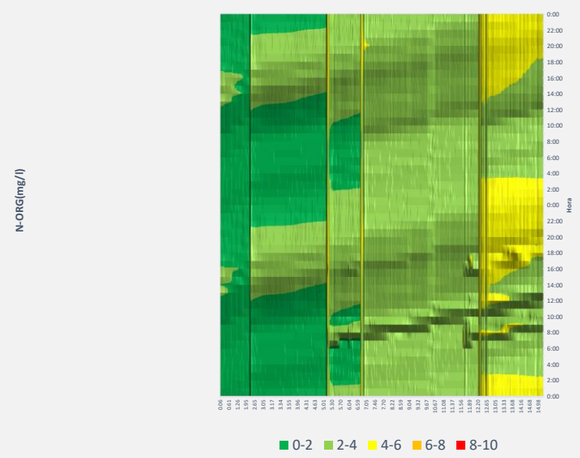
ESCENARIO MPC 7.8 MM 27/04/25 - 28/04/25



ESCENARIO MPC 7.8 MM 27/04/25 - 28/04/25



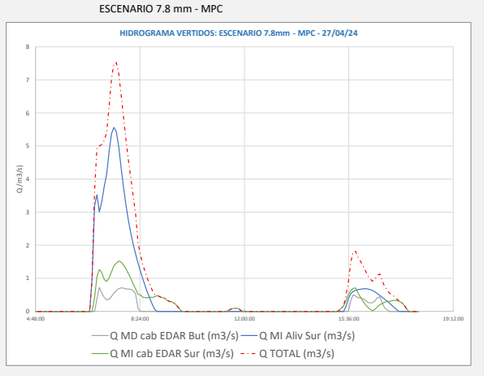
ESCENARIO MPC 7.8 MM 27/04/25 - 28/04/25



MODELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

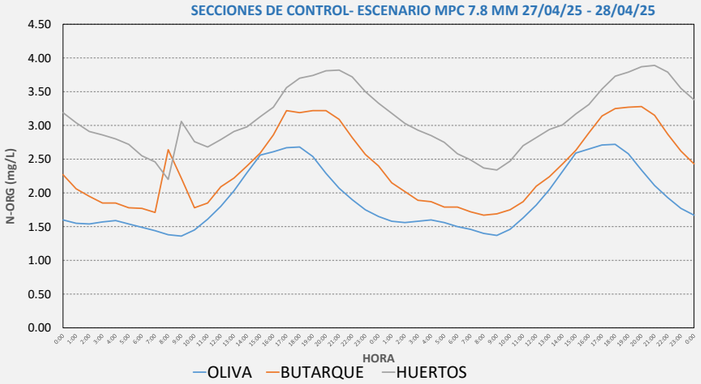
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - MPC

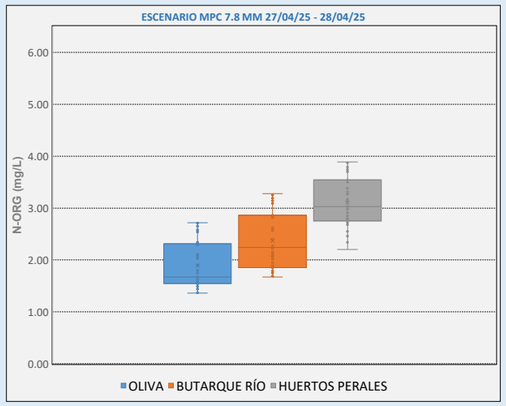


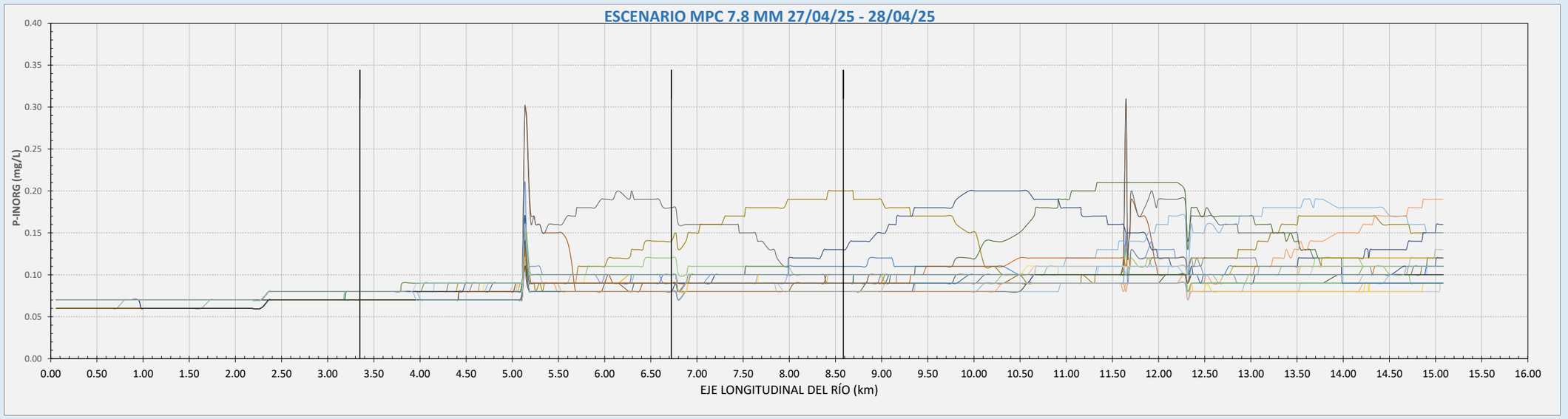
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**27/04 4,97** **28/04 4,79** **29/04 4,79**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m^2·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

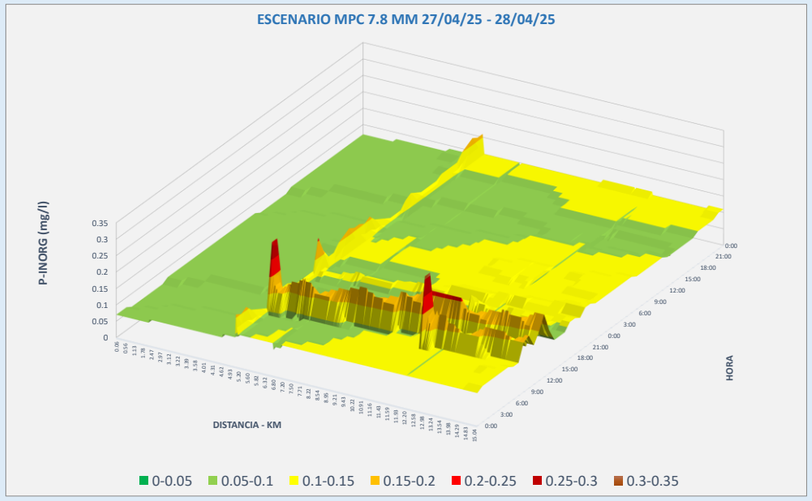
SECCIONES DE CONTROL- ESCENARIO MPC 7.8 MM 27/04/25 - 28/04/25

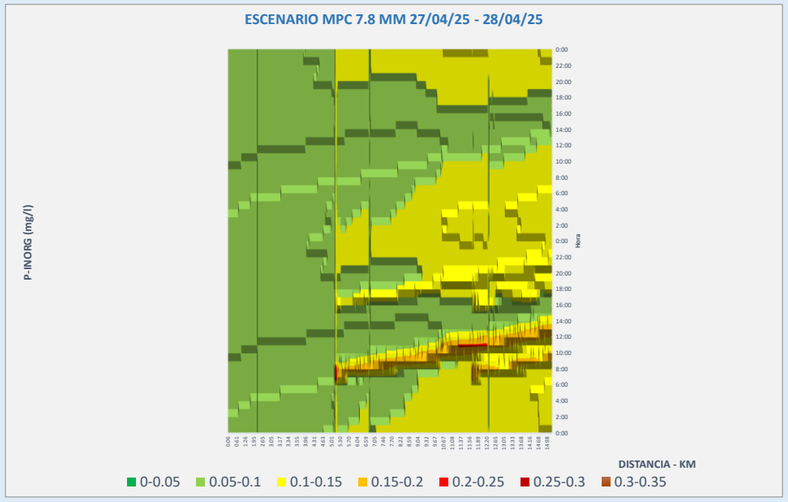


ESCENARIO MPC 7.8 MM 27/04/25 - 28/04/25





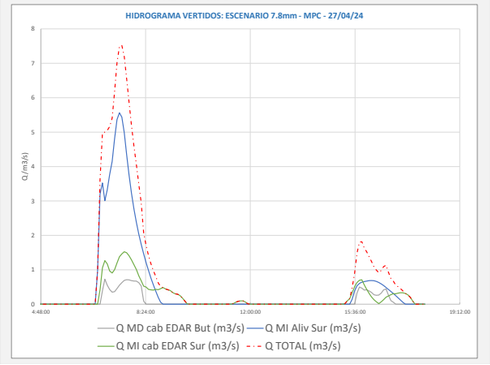




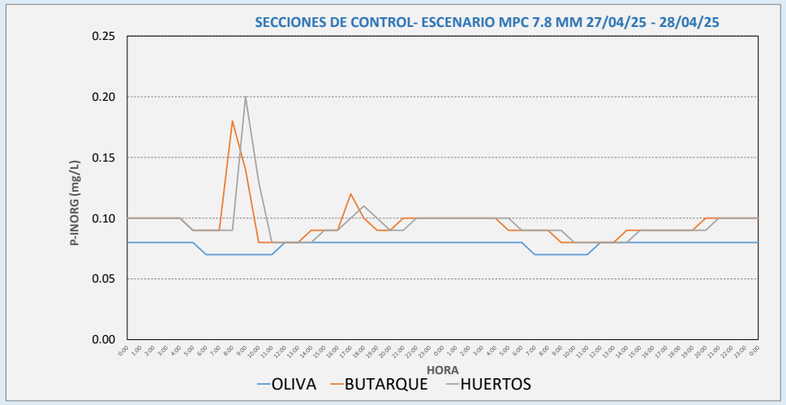
MPInELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

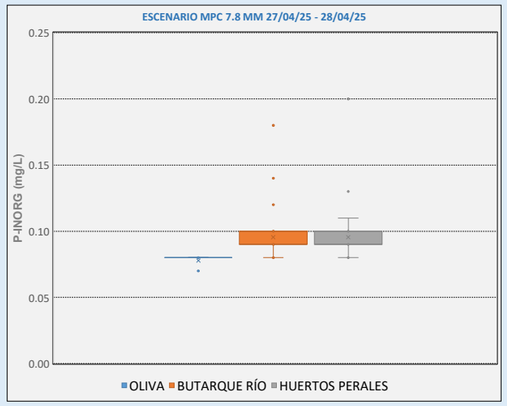
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - MPC

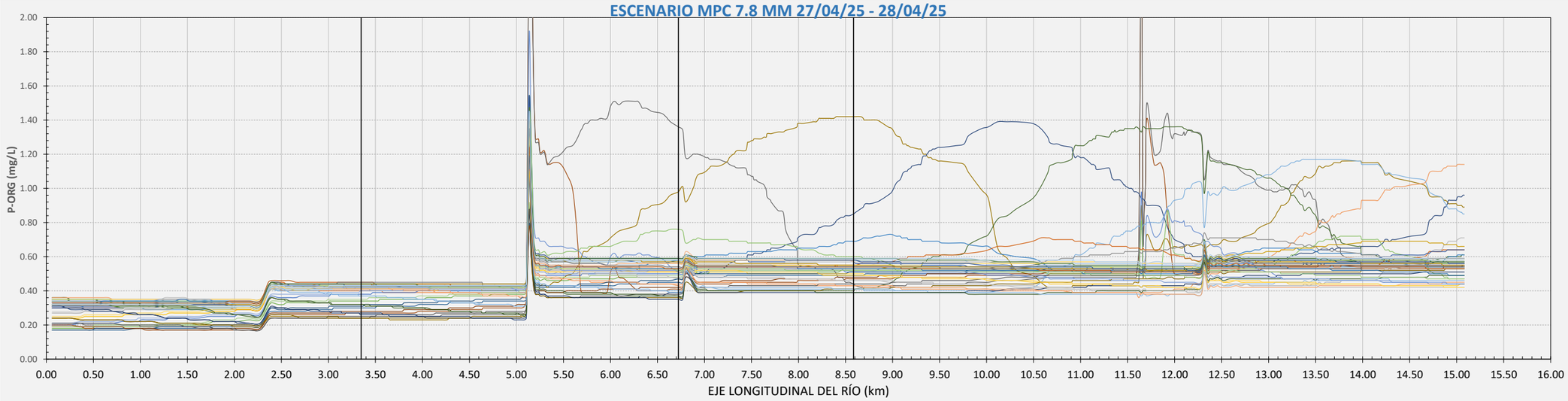


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***27/04 4,97*** ***28/04 4,79*** ***29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2-día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR* *Cabecera (N-NH4+ río) + (N-NH4+ Viveros) =* *0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	

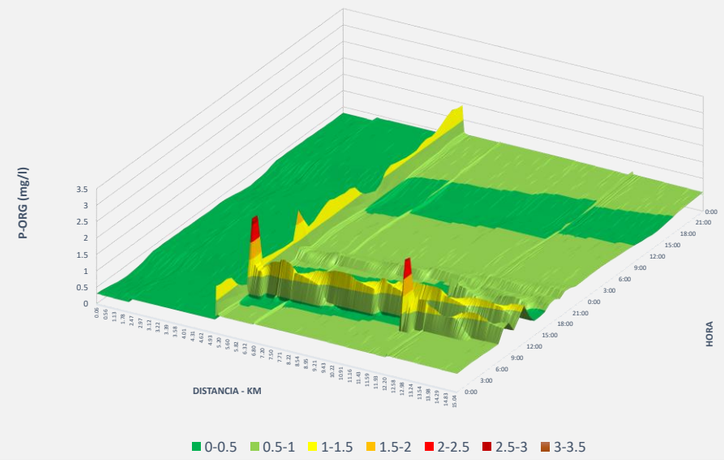




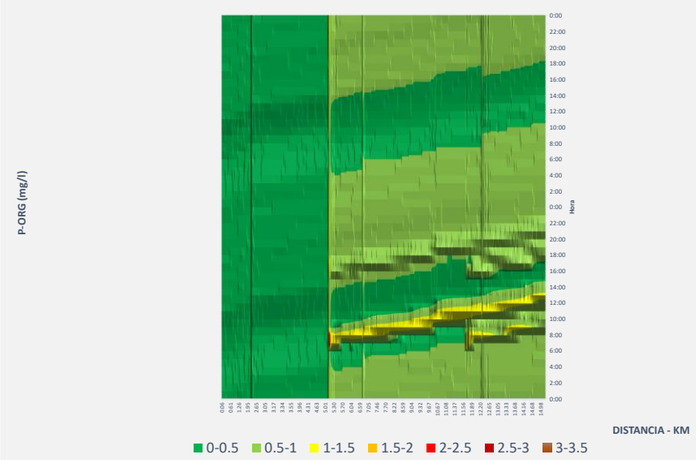
ESCENARIO MPC 7.8 MM 27/04/25 - 28/04/25



ESCENARIO MPC 7.8 MM 27/04/25 - 28/04/25



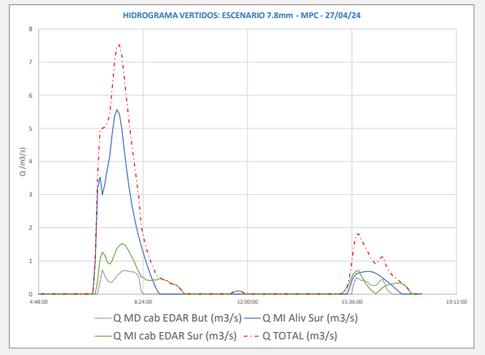
ESCENARIO MPC 7.8 MM 27/04/25 - 28/04/25



MODELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

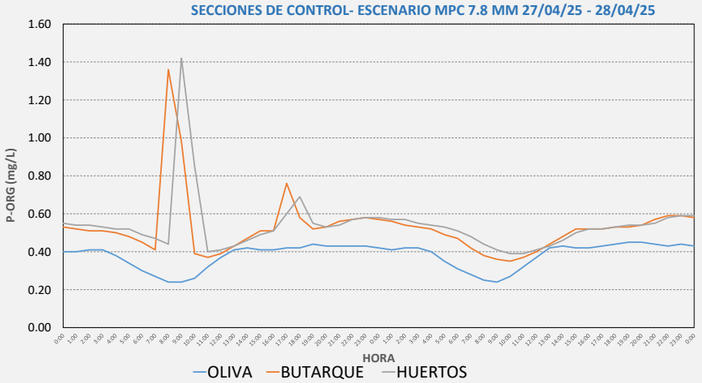
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 7.8 mm - MPC

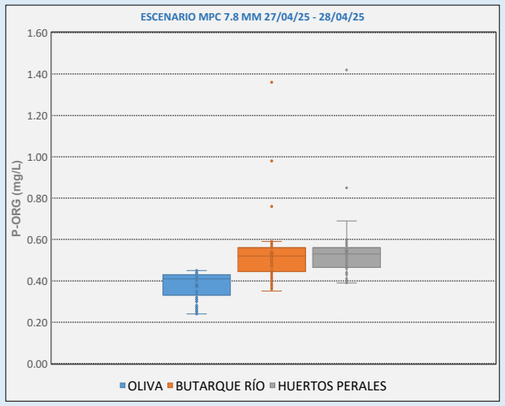


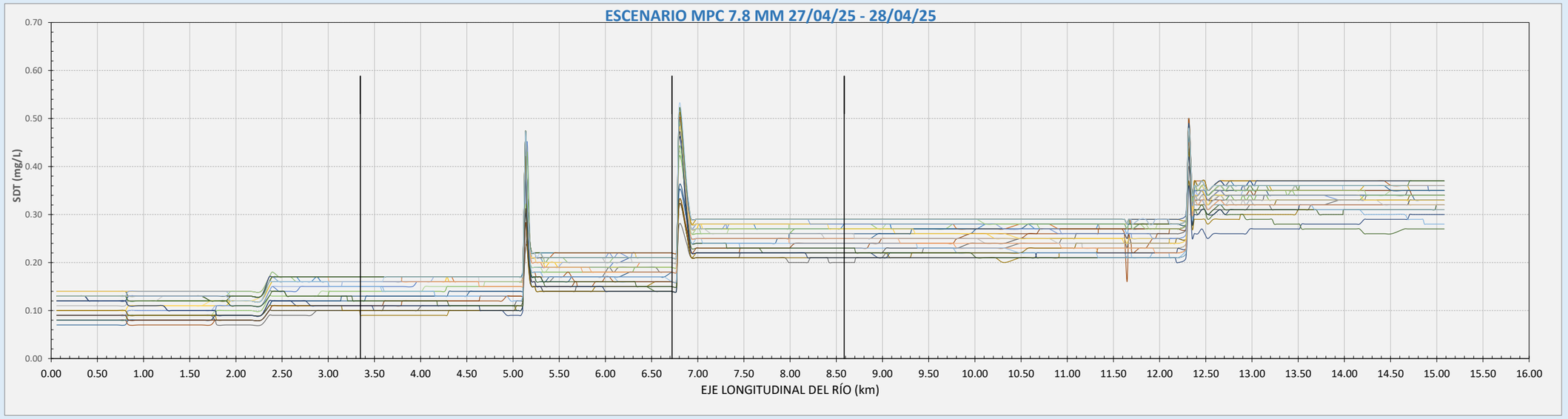
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m³/s	*1*	*2,5*	*5*	***27/04 4,97*** ***28/04 4,79*** ***29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m²-día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día⁻¹)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día⁻¹)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR* *Cabecera (N-NH4+ río) + (N-NH4+ Viveros) =* *0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día⁻¹)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día⁻¹)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día⁻¹)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	

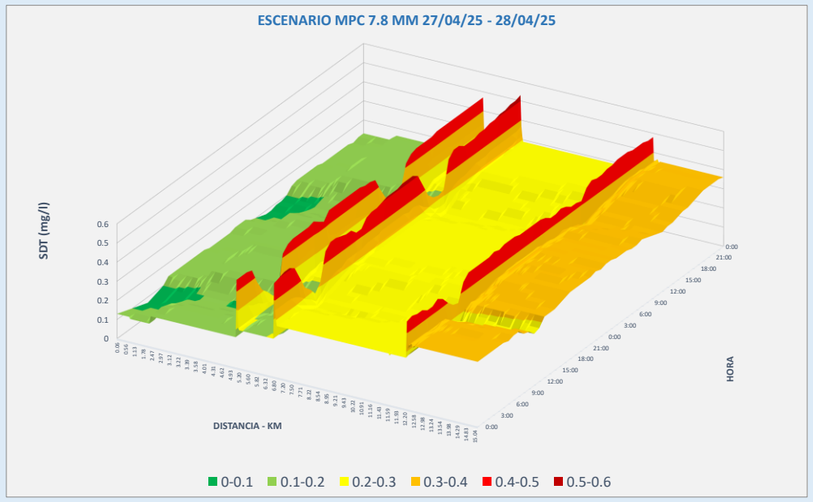
SECCIONES DE CONTROL- ESCENARIO MPC 7.8 MM 27/04/25 - 28/04/25

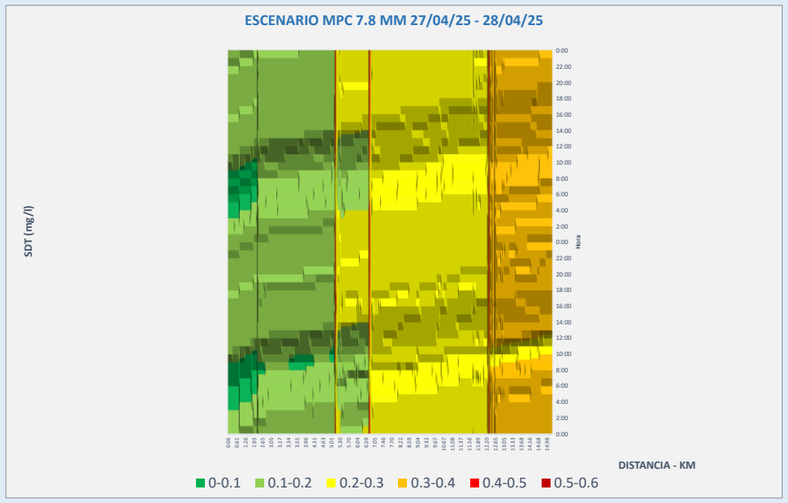


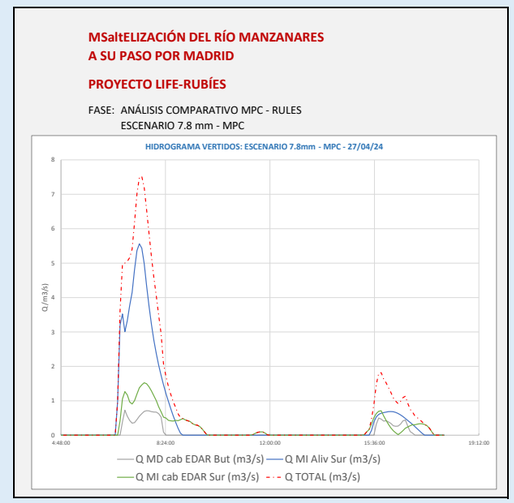
ESCENARIO MPC 7.8 MM 27/04/25 - 28/04/25



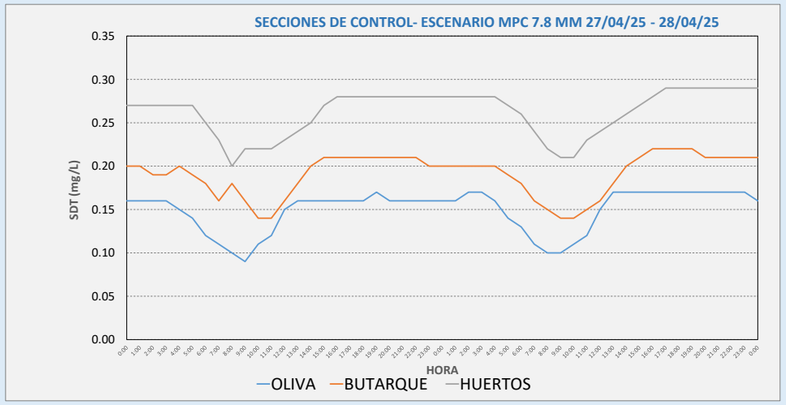


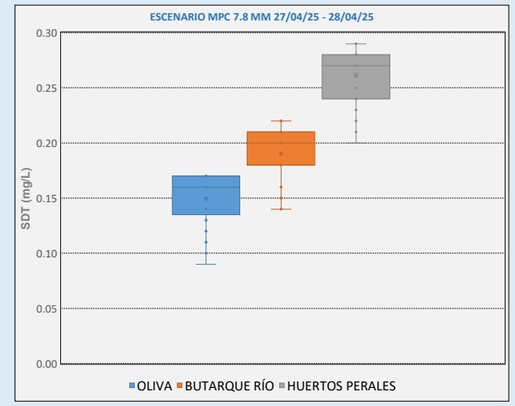






PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***27/04 4,97*** ***28/04 4,79*** ***29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2·día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR* *Cabecera (N-NH4+ río) + (N-NH4+ Viveros) =* *0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	





Annex 5.3.- Results for small medium event (14.2 mm) and rules scenario

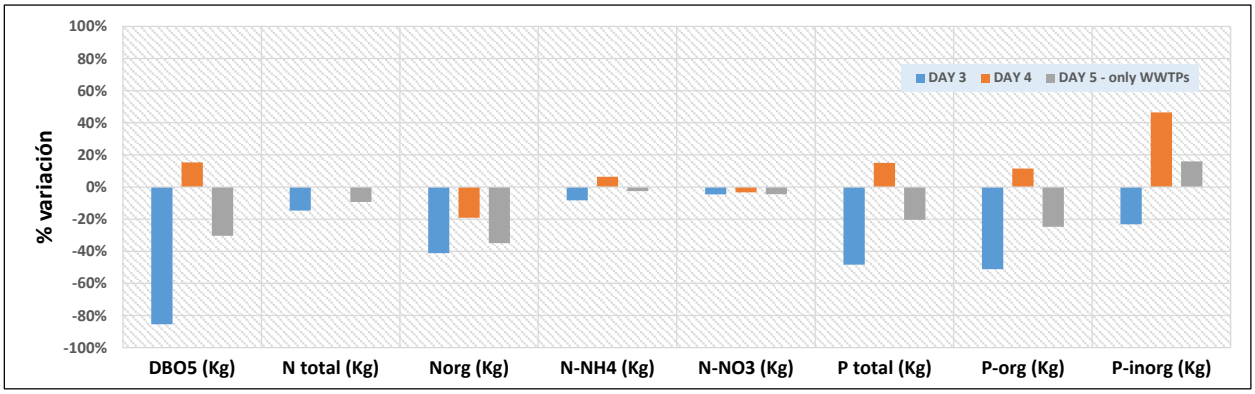
MASS BALANCE

Model scenario: 14.2 mm - RULES

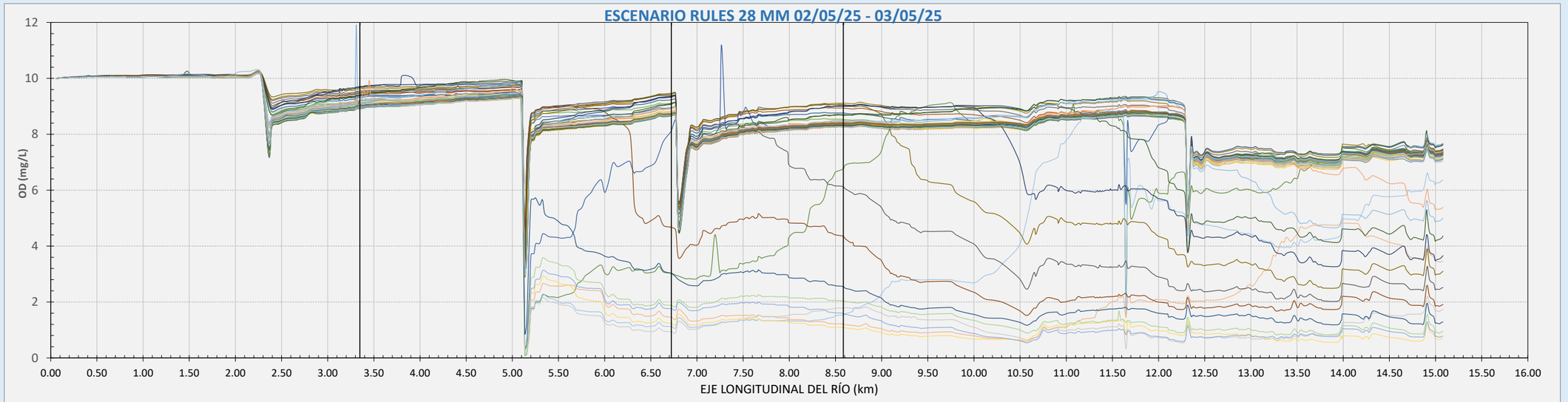
DAY 3	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	448	1995	525	88	1382	155	134	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	23419	2377	612	1765	0	414	373	41
TOTAL INFLOWS	**28802**	**27133**	**5614**	**18004**	**3514**	**1126**	**1009**	**117**
OUTFLOW DAY 3	**4198**	**23162**	**3300**	**16511**	**3351**	**582**	**492**	**90**
Difference	-24604	-3971	-2315	-1493	-163	-544	-517	-27
% left	14.58%	85.36%	58.77%	91.70%	95.36%	51.70%	48.80%	76.81%
% variation	**-85.42%**	**-14.64%**	**-41.23%**	**-8.30%**	**-4.64%**	**-48.30%**	**-51.20%**	**-23.19%**

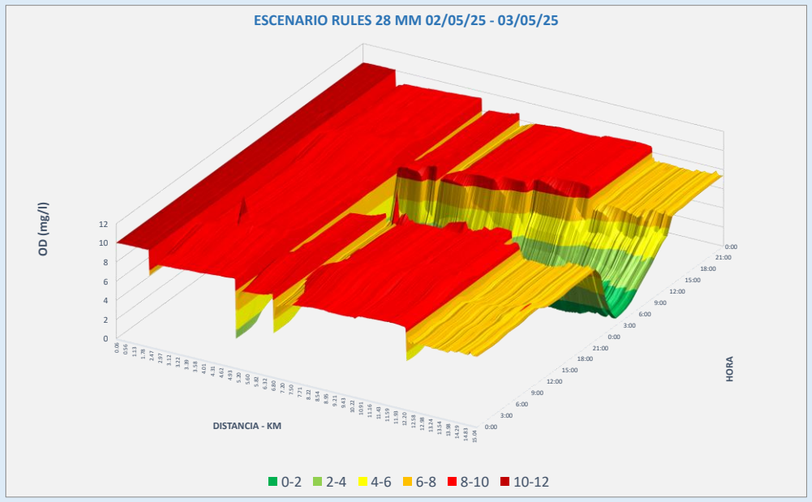
DAY 4	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	447	1978	522	88	1369	155	134	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	59475	6058	1551	4507	0	1056	951	106
TOTAL INFLOWS	**64857**	**30797**	**6550**	**20746**	**3501**	**1767**	**1587**	**181**
OUTFLOW DAY 4	**74752**	**30761**	**5296**	**22080**	**3384**	**2033**	**1768**	**265**
Difference	9894	-36	-1254	1334	-116	266	182	84
% left	115.26%	99.88%	80.86%	106.43%	96.67%	115.02%	111.45%	146.41%
% variation	**15.26%**	**-0.12%**	**-19.14%**	**6.43%**	**-3.33%**	**15.02%**	**11.45%**	**46.41%**

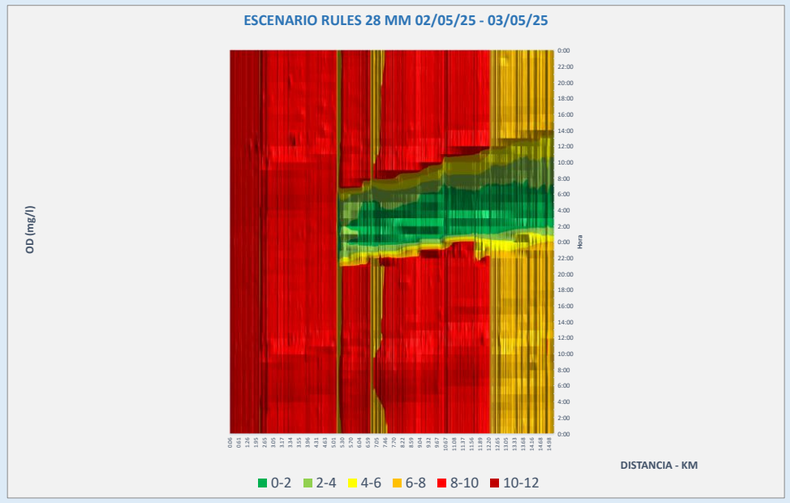
DAY 5 - only WWTPs	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	447	1976	521	88	1367	155	134	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	0	0	0	0	0	0	0	0
TOTAL INFLOWS	**5382**	**24736**	**4998**	**16239**	**3499**	**711**	**636**	**75**
OUTFLOW DAY 5	**3747**	**22427**	**3254**	**15829**	**3344**	**566**	**479**	**87**
Difference	-1635	-2309	-1744	-409	-155	-145	-157	12
% left	69.62%	90.67%	65.10%	97.48%	95.57%	79.55%	75.26%	115.93%
% variation	**-30.38%**	**-9.33%**	**-34.90%**	**-2.52%**	**-4.43%**	**-20.45%**	**-24.74%**	**15.93%**



CSO Mass Balances	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
CSO mass discharged on DAY 3	23418.5	2377.5	612.1	1765.4	0.0	414.2	372.8	41.4
CSO mass outflow on DAY 3 (day 3 minus day 5)	451.5	734.4	45.9	681.5	7.0	16.3	13.7	2.6
CSO mass outflow on DAY 4 (day 4 minus day 5)	71005.2	8333.5	2042.5	6250.8	40.2	1467.2	1289.6	177.5
Total CSO mass discharged over Days 3 and 4	71456.7	9067.8	2088.4	6932.2	47.2	1483.5	1303.4	180.1
CSO mass removed on Days 3–4	48038.2	11445.3	1476.2	5166.9	47.2	1069.3	930.5	138.7
% CSO mass removed on Days 3–4	205.1%	281.4%	241.2%	292.7%		258.1%	249.6%	334.9%



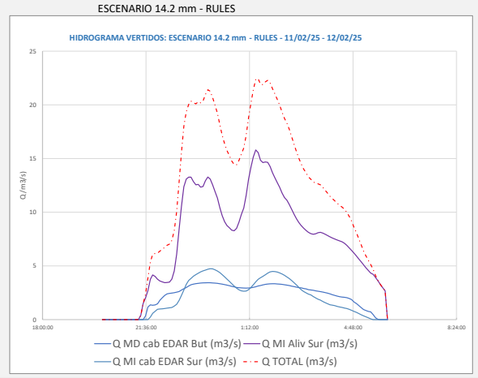




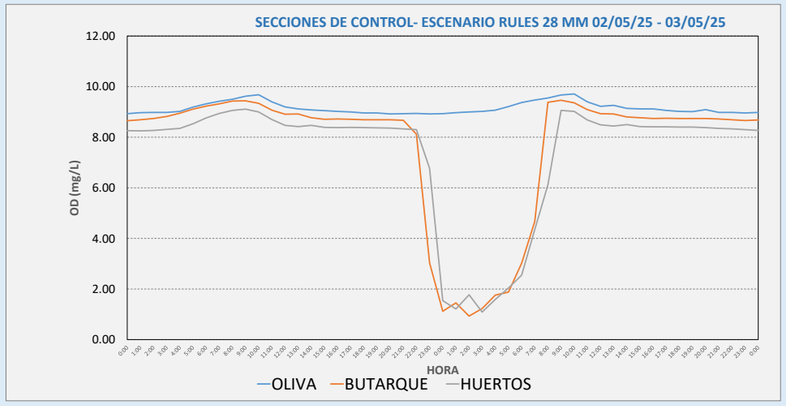
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

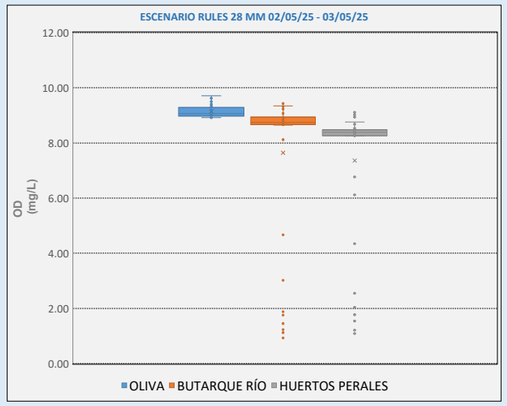
PROYECTO LIFE-RUBÍES

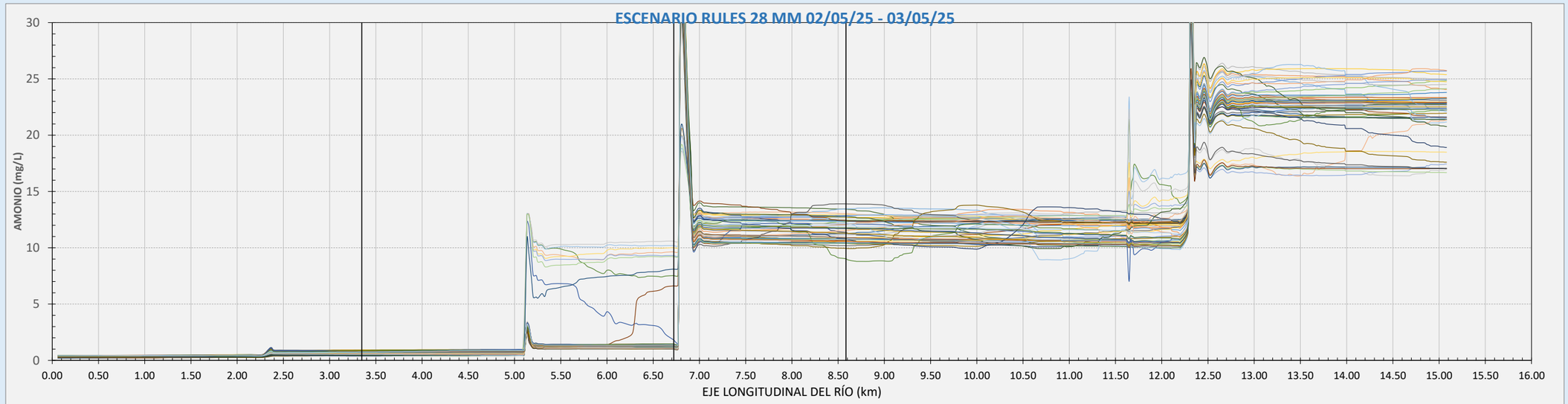
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - RULES

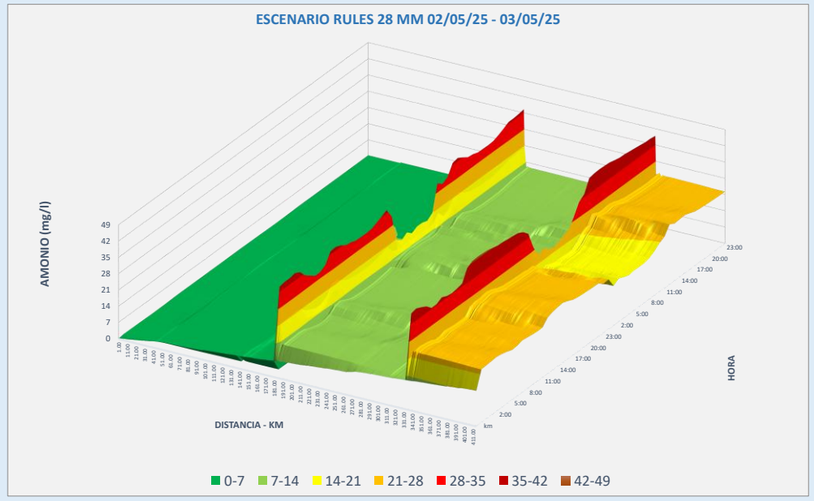


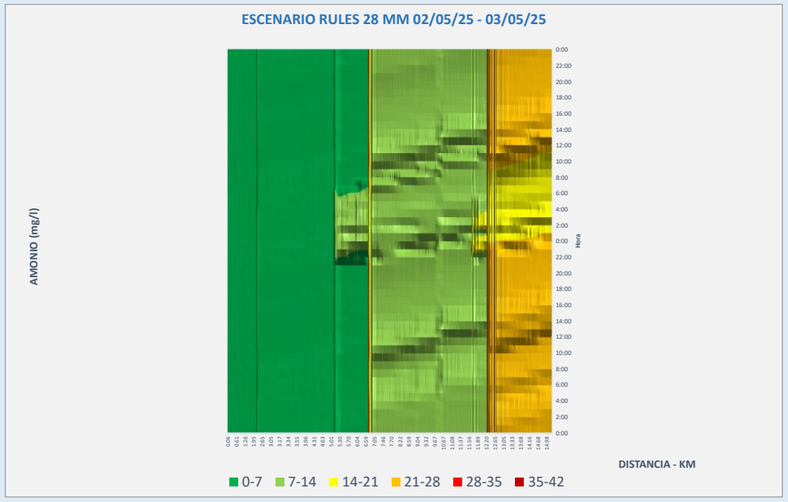
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**27/04 4,97** **28/04 4,79** **29/04 4,79**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	







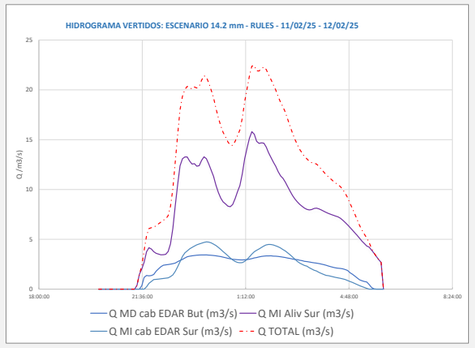




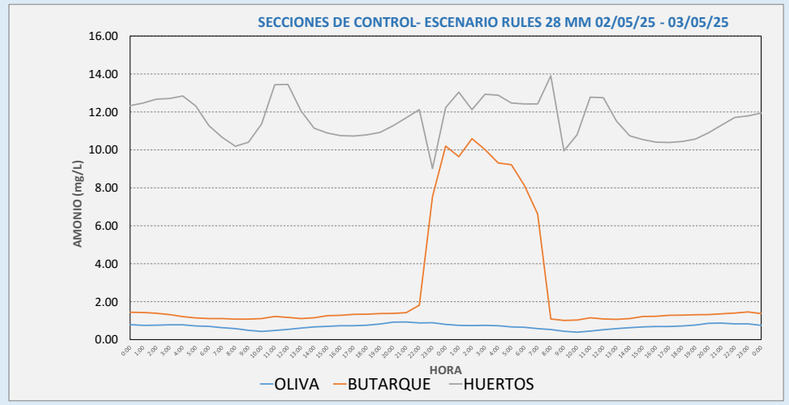
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

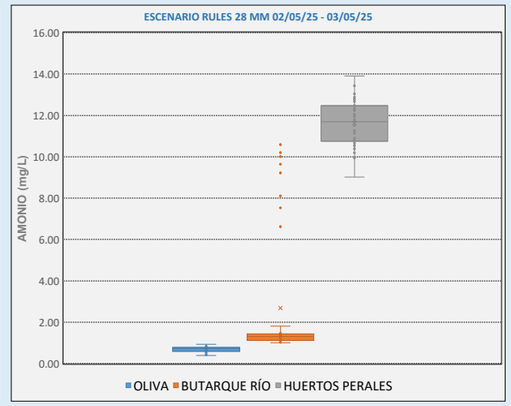
PROYECTO LIFE-RUBÍES

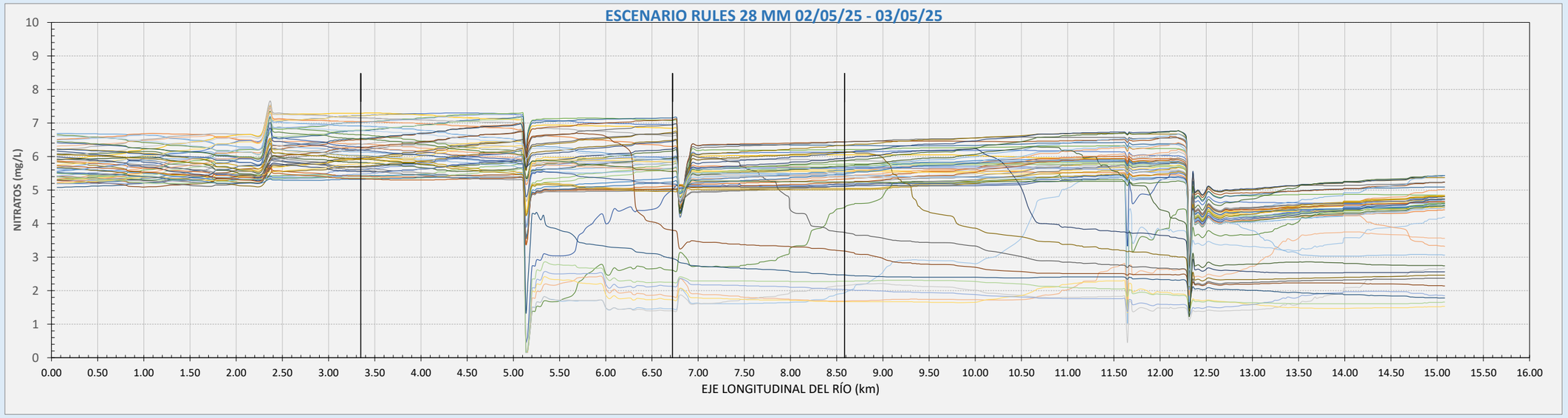
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - RULES

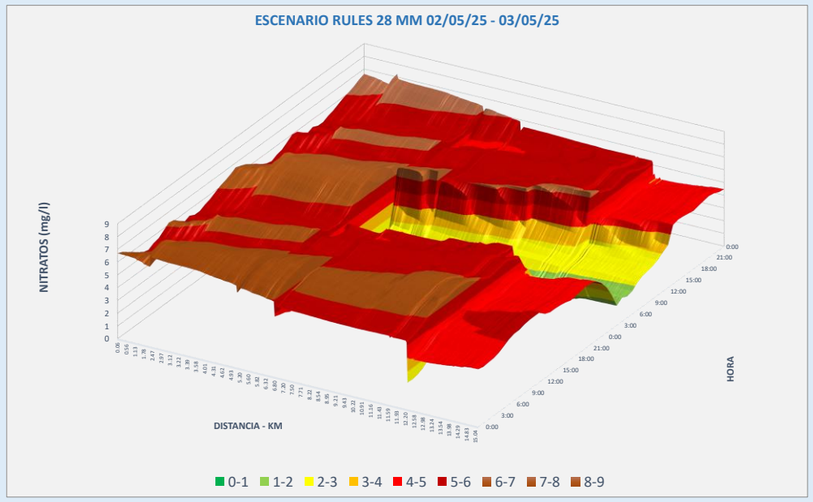


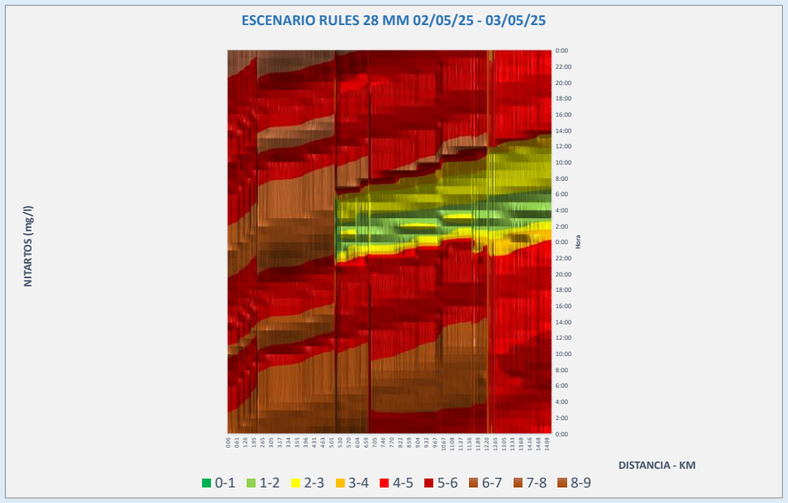
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***27/04 4,97*** ***28/04 4,79*** ***29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijada a 10*
DBOsed/DOS (g/m^2·día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	







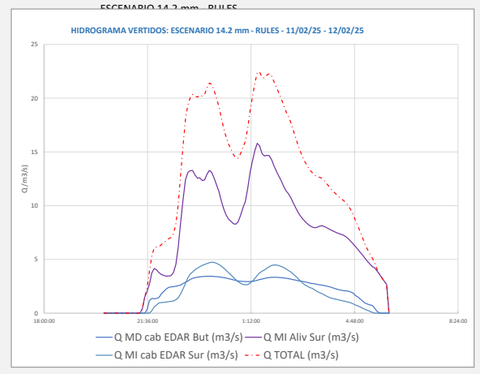




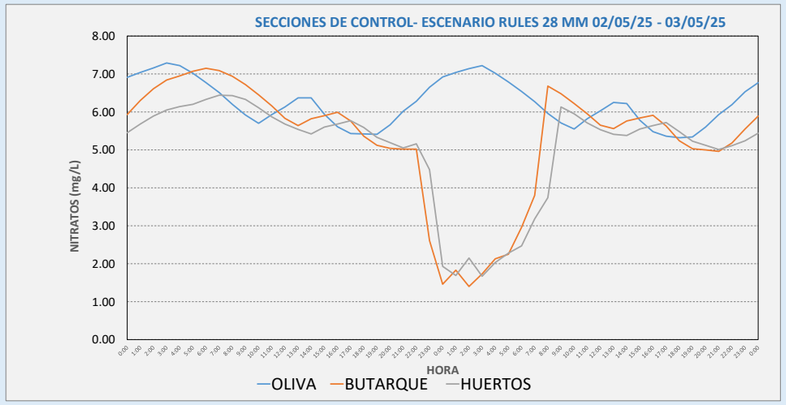
MODELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

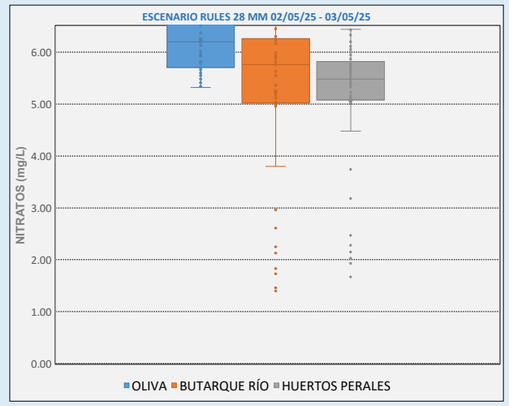
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - RULES

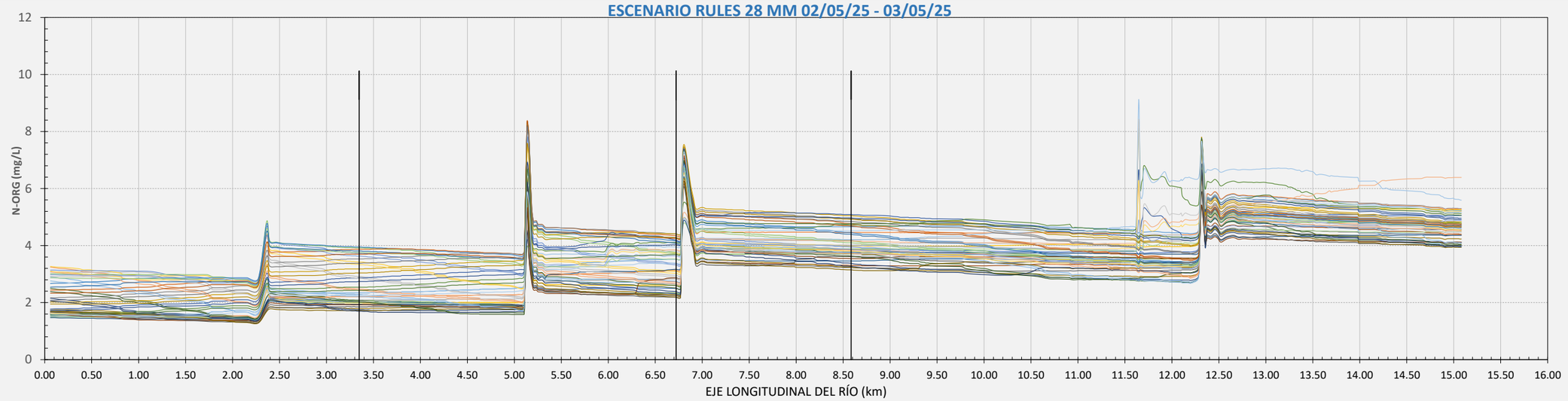


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**27/04 4,97** **28/04 4,79** **29/04 4,79**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractaria de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

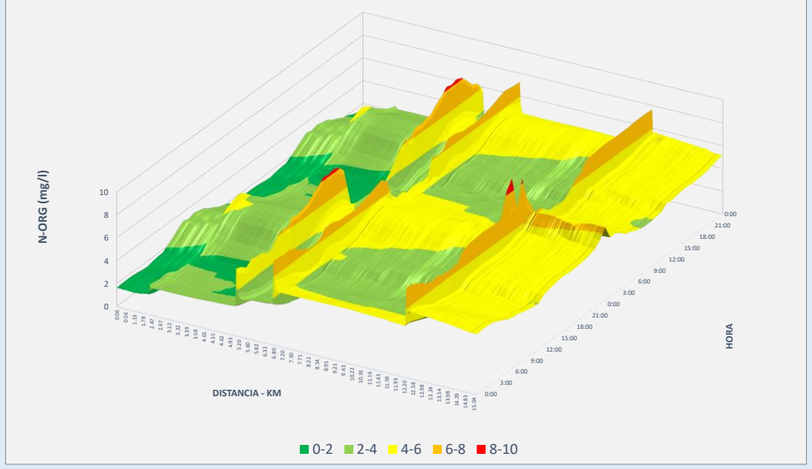




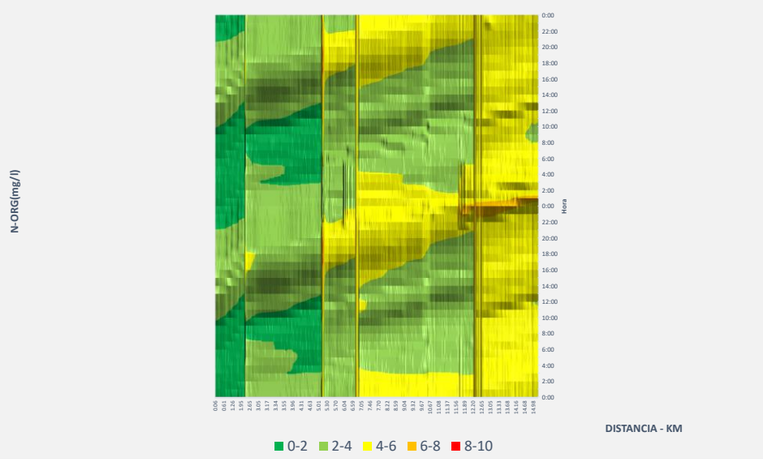
ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



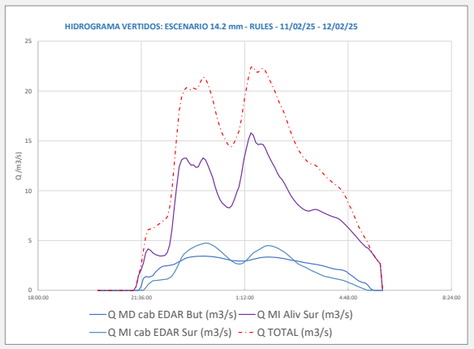
ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



MODELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

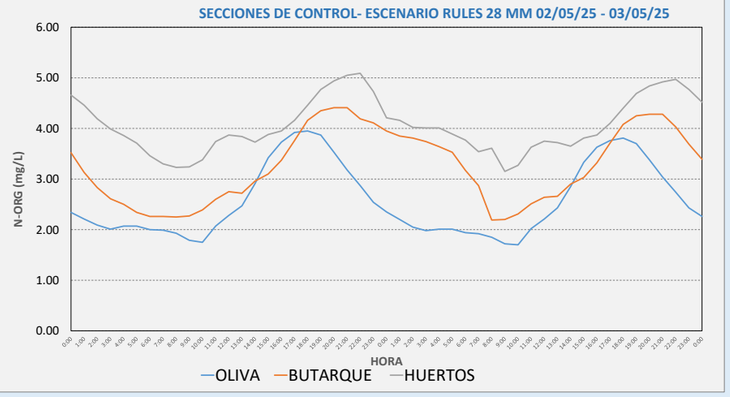
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - RULES

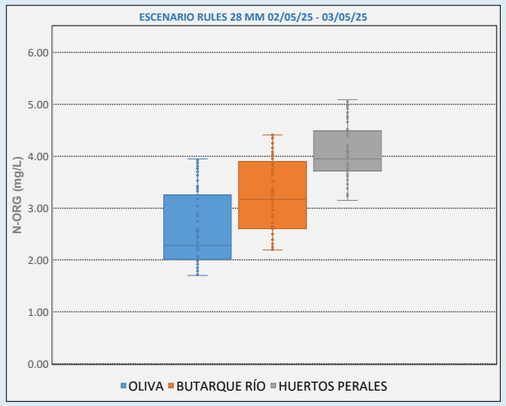


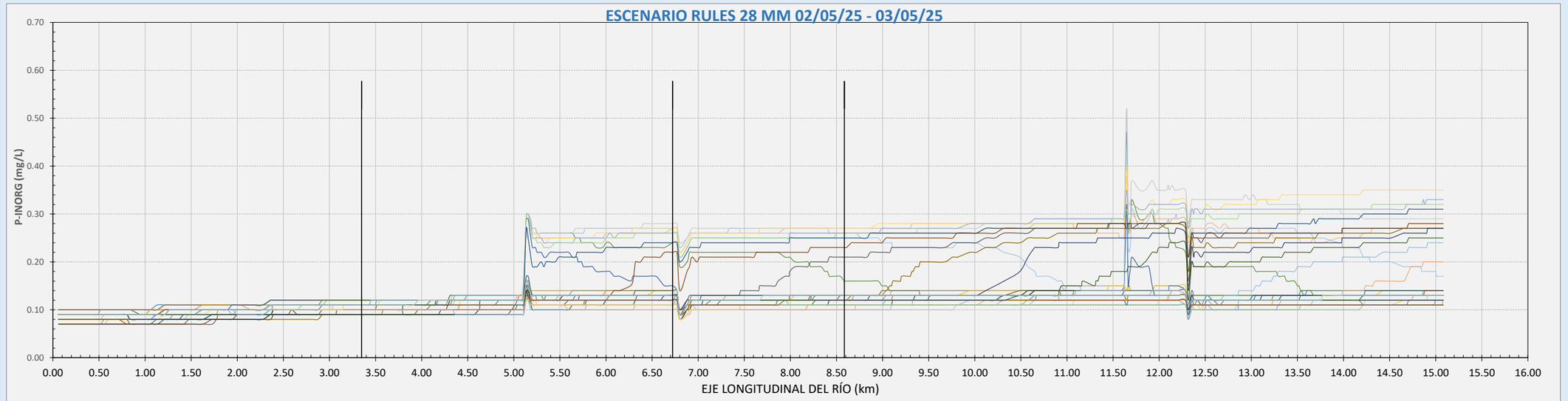
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**27/04 4,97** **28/04 4,79** **29/04 4,79**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

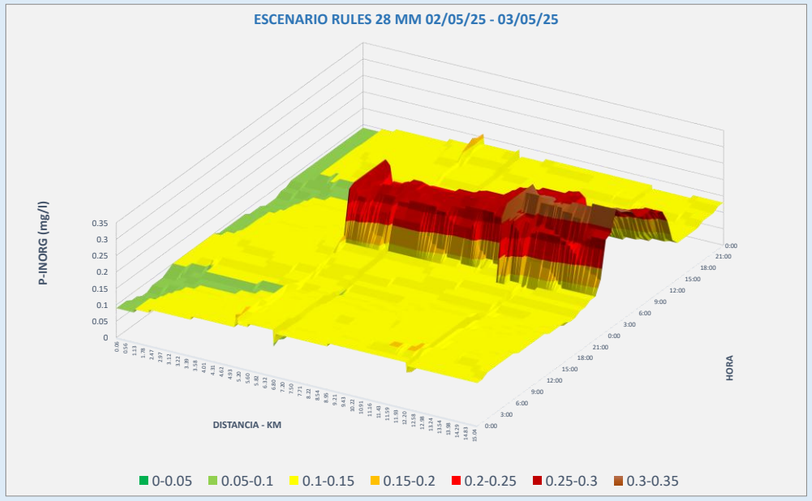
SECCIONES DE CONTROL- ESCENARIO RULES 28 MM 02/05/25 - 03/05/25

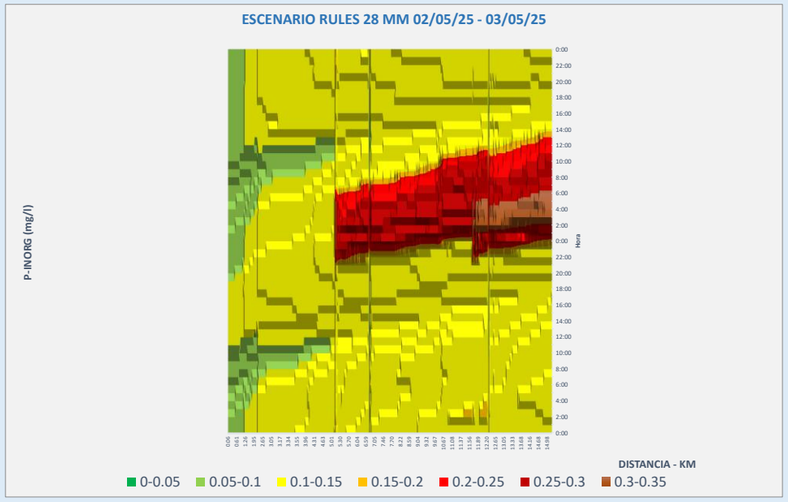


ESCENARIO RULES 28 MM 02/05/25 - 03/05/25





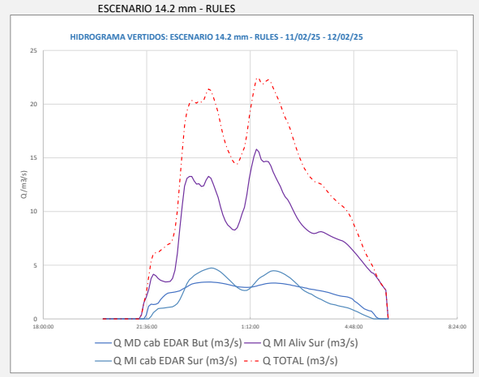




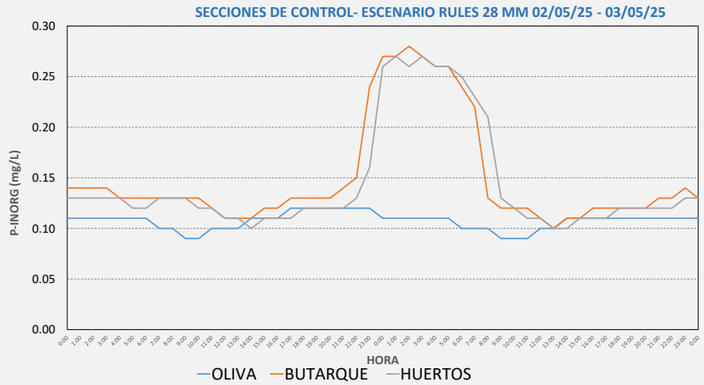
MPInELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

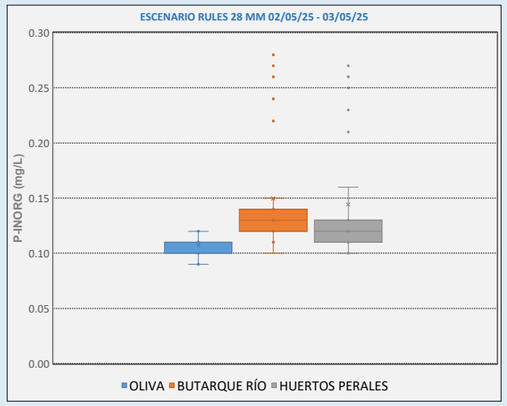
PROYECTO LIFE-RUBÍES

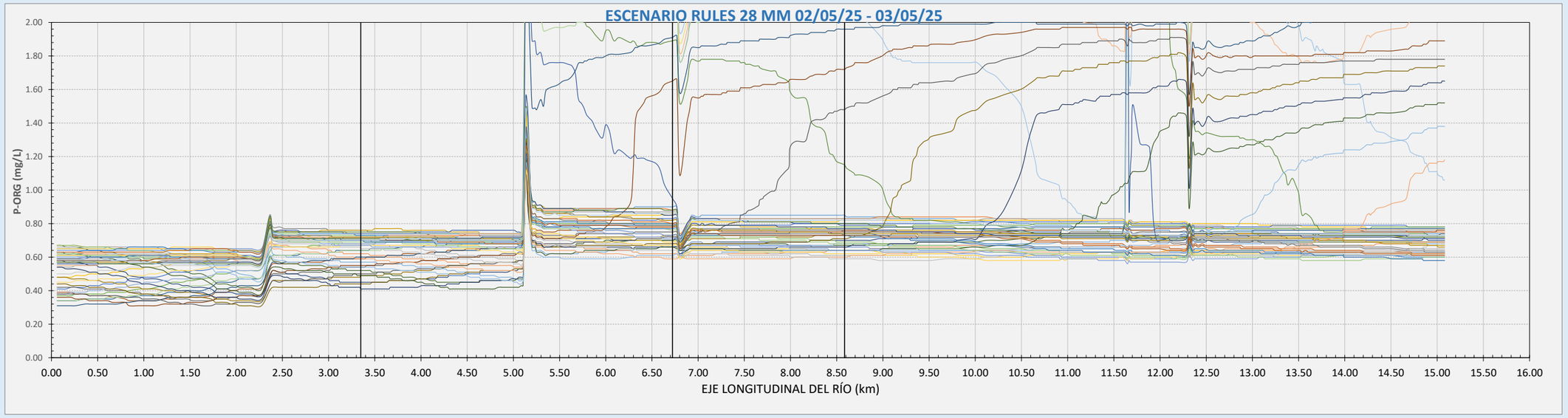
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - RULES

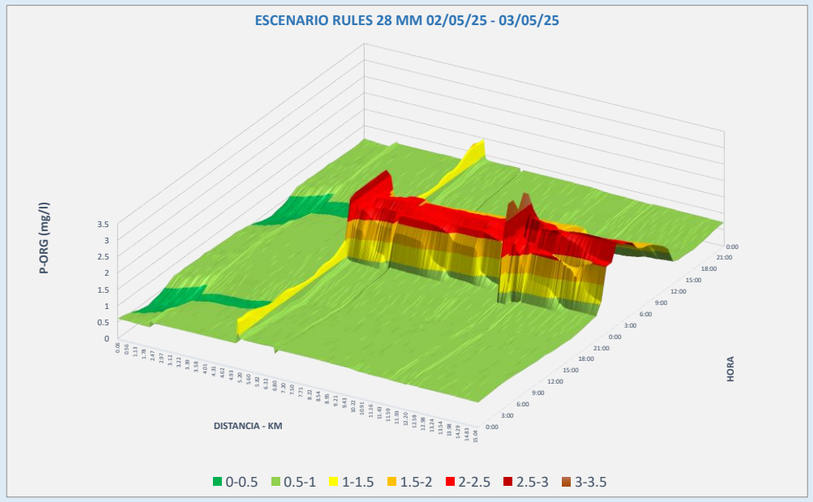


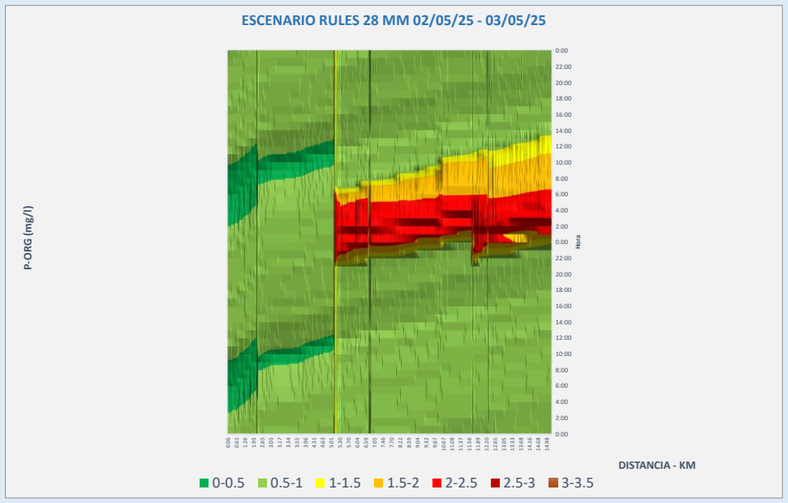
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***27/04 4,97*** ***28/04 4,79*** ***29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2·día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) =* *0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	







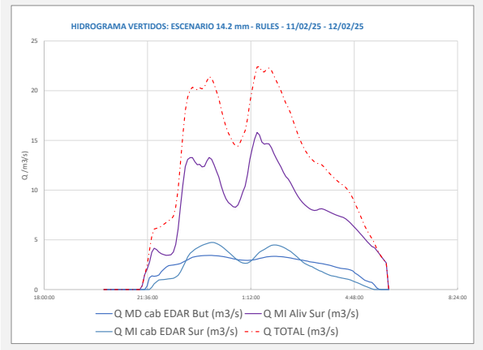




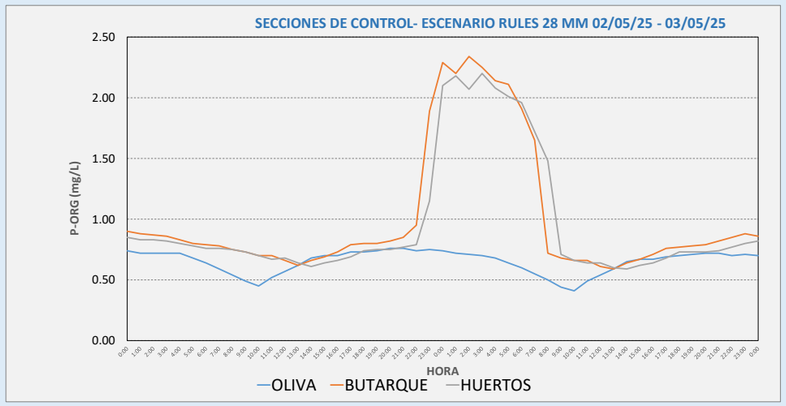
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

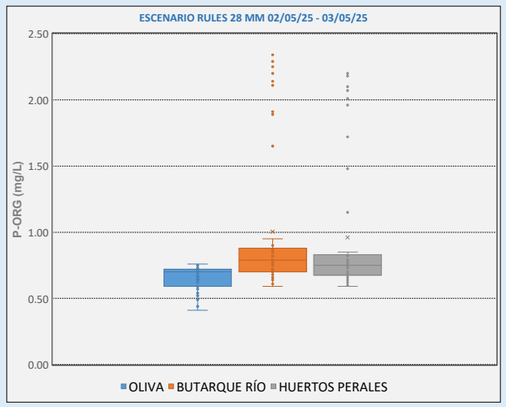
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - RULES

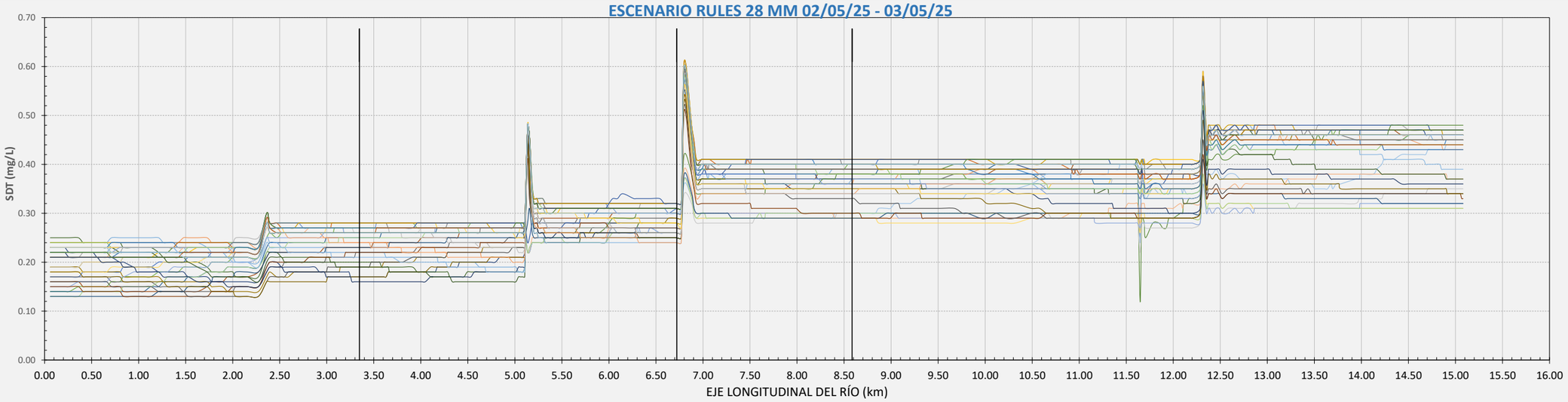


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**27/04 4,97** **28/04 4,79** **29/04 4,79**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

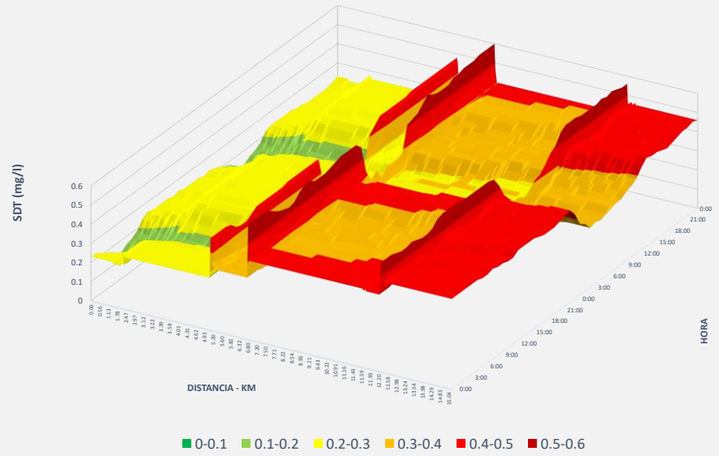




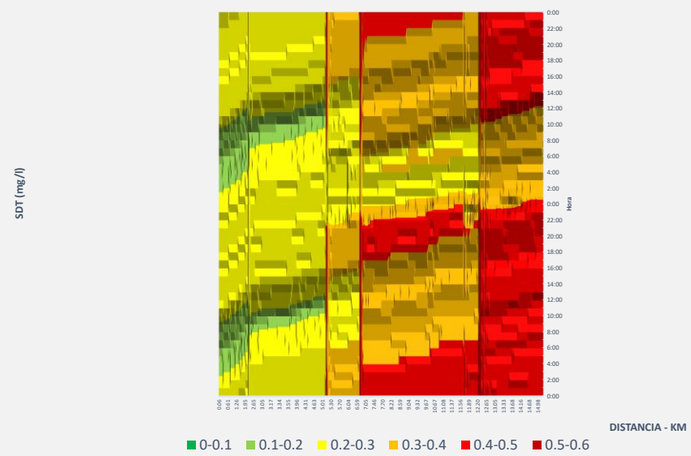
ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



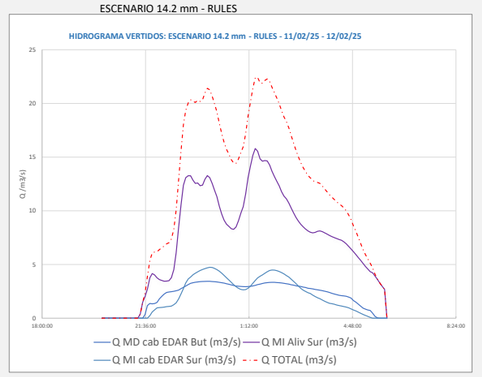
ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



MSaltELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

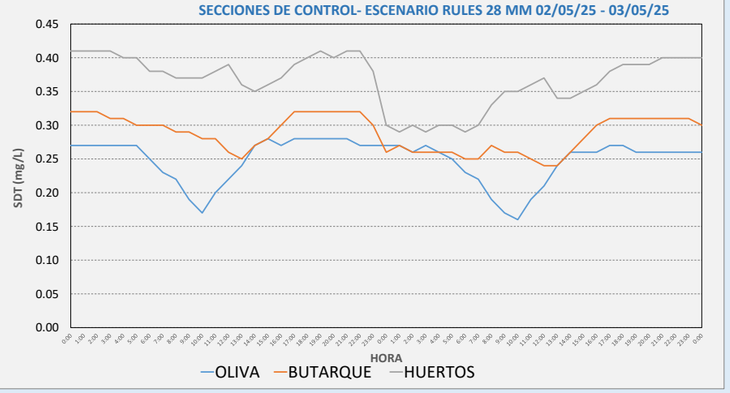
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - RULES

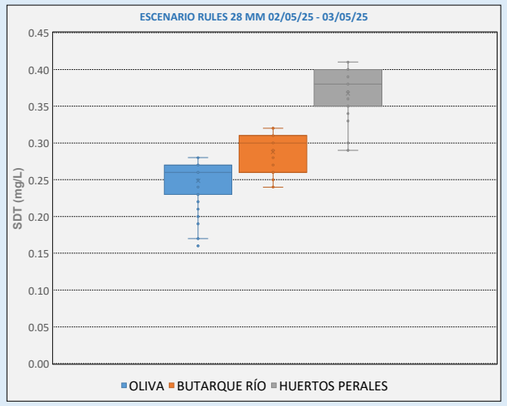


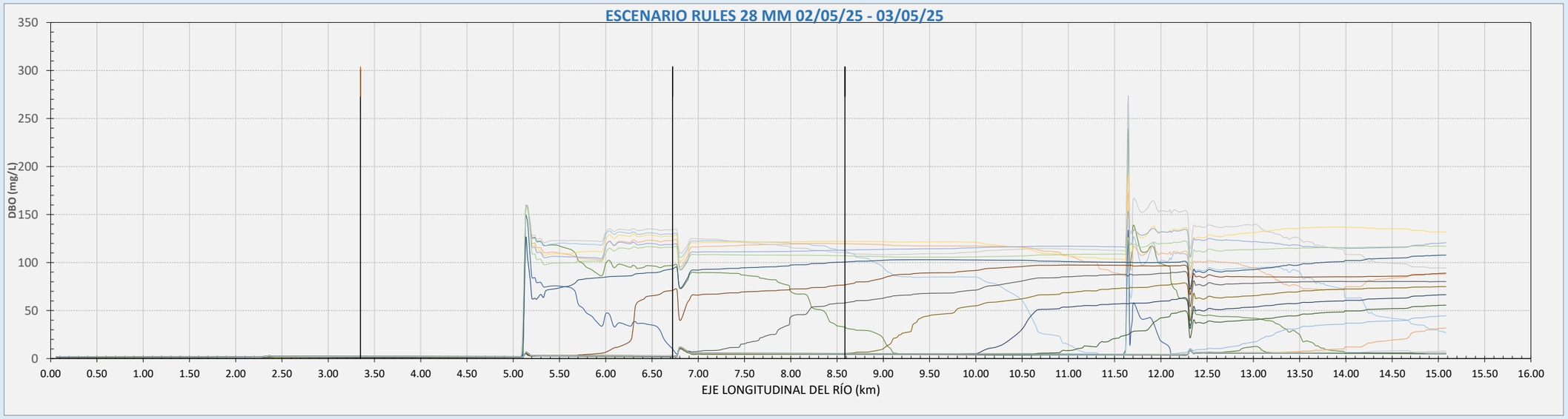
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***27/04 4,97*** ***28/04 4,79*** ***29/04 4,79***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2·día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR* *Cabecera (N-NH4+ río) + (N-NH4+ Viveros) =* *0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	

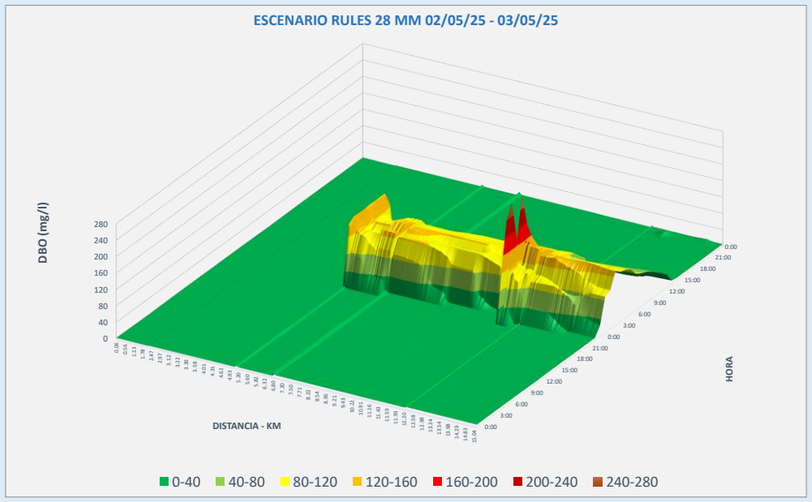
SECCIONES DE CONTROL- ESCENARIO RULES 28 MM 02/05/25 - 03/05/25

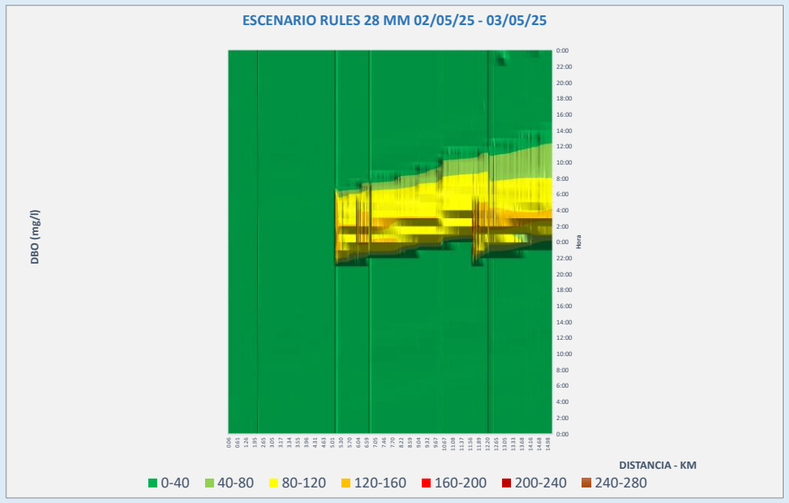


ESCENARIO RULES 28 MM 02/05/25 - 03/05/25





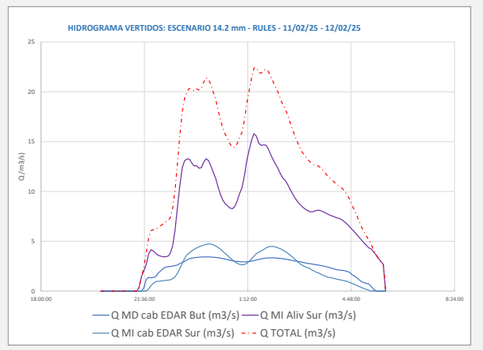




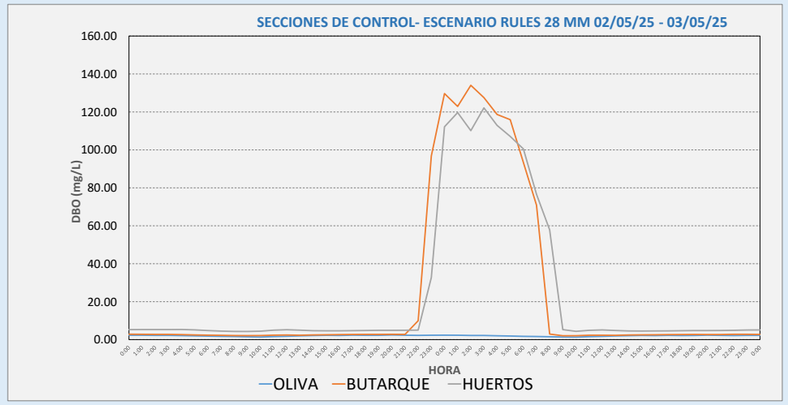
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

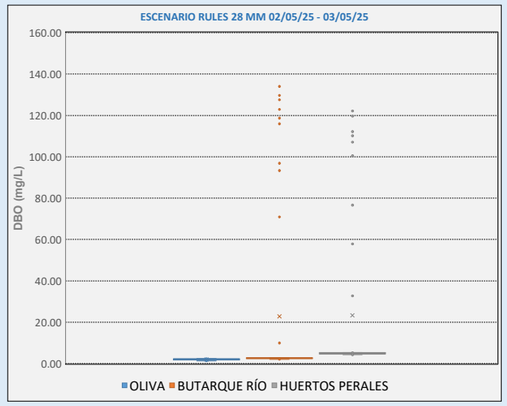
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - RULES



PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 7.8 mm MPC – DSU 27/04/24	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**27/04 4,97** **28/04 4,79** **29/04 4,79**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{nn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	





Annex 5.4.- Results for medium event (14.2 mm) and MPC scenario

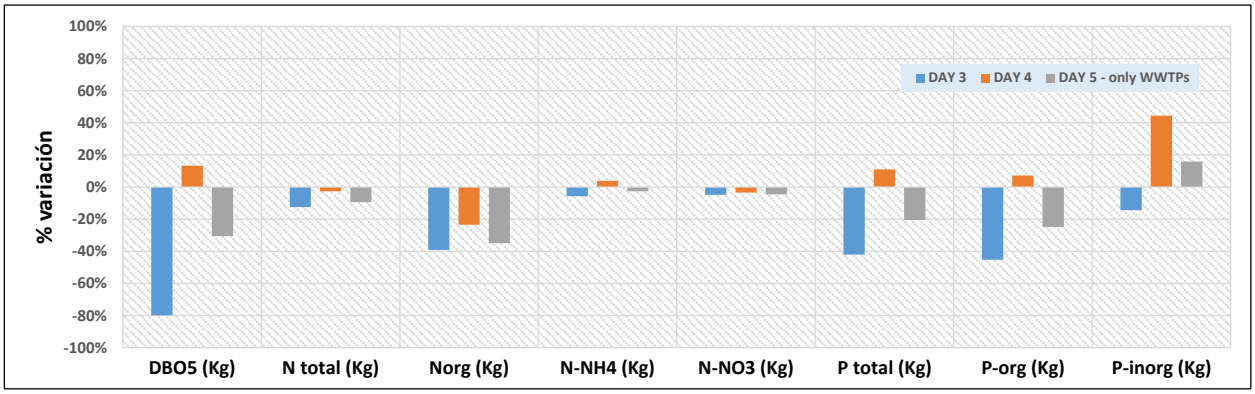
MASS BALANCE

Model scenario: 14.2 mm - MPC

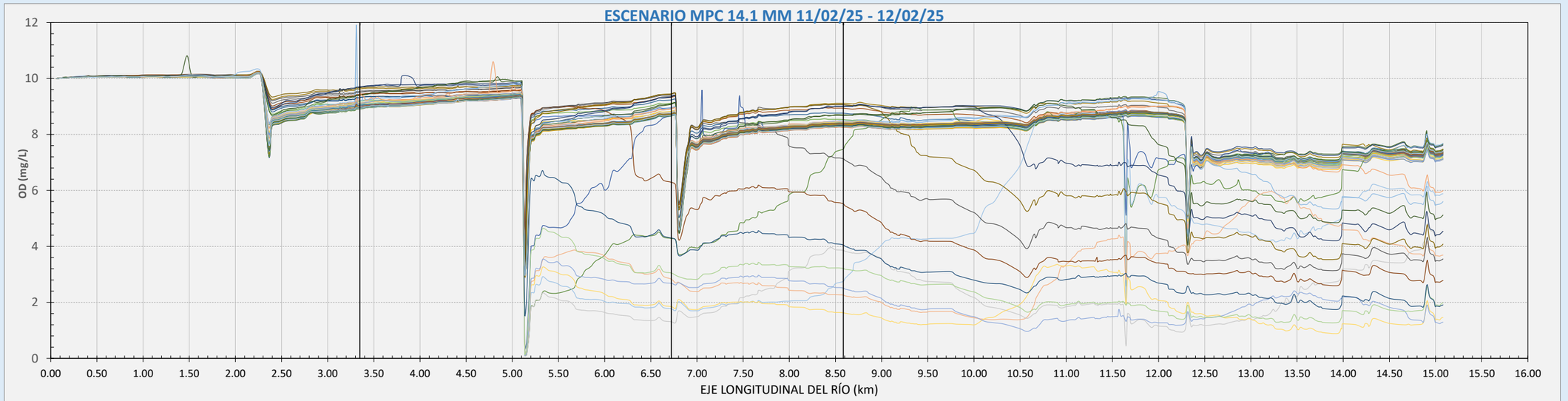
DAY 3	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	448	1995	525	88	1382	155	134	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	16324	1710	425	1285	0	299	269	30
TOTAL INFLOWS	**21707**	**26465**	**5427**	**17524**	**3514**	**1010**	**905**	**105**
OUTFLOW DAY 3	**4368**	**23157**	**3301**	**16511**	**3346**	**585**	**495**	**90**
Difference	-17339	-3308	-2127	-1013	-169	-425	-410	-15
% left	20.12%	87.50%	60.82%	94.22%	95.20%	57.93%	54.73%	85.54%
% variation	**-79.88%**	**-12.50%**	**-39.18%**	**-5.78%**	**-4.80%**	**-42.07%**	**-45.27%**	**-14.46%**

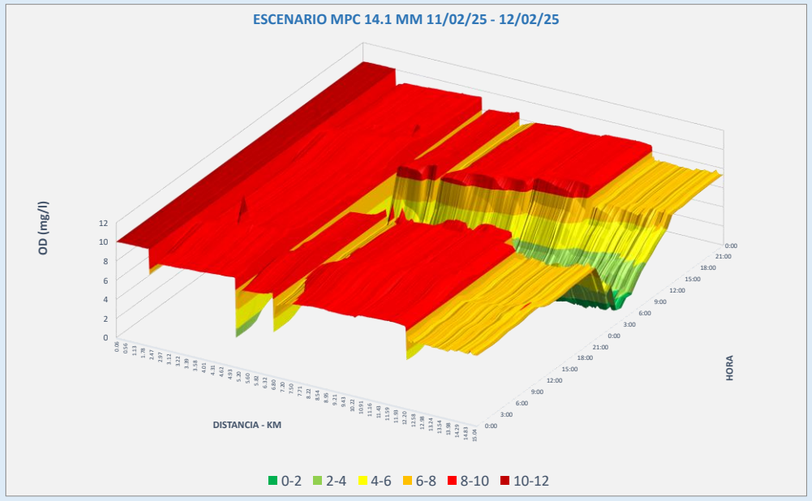
DAY 4	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	447	1978	522	88	1369	155	134	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	37846	4007	983	3024	0	700	630	70
TOTAL INFLOWS	**43228**	**28745**	**5982**	**19263**	**3501**	**1411**	**1266**	**145**
OUTFLOW DAY 4	**48965**	**27972**	**4581**	**20010**	**3381**	**1566**	**1357**	**210**
Difference	5737	-773	-1401	747	-120	155	91	64
% left	113.27%	97.31%	76.58%	103.88%	96.58%	110.99%	107.16%	144.44%
% variation	**13.27%**	**-2.69%**	**-23.42%**	**3.88%**	**-3.42%**	**10.99%**	**7.16%**	**44.44%**

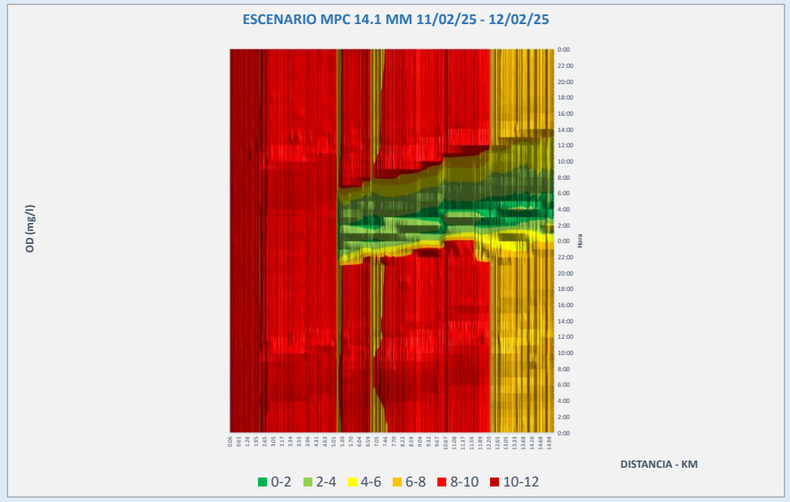
DAY 5 - only WWTPs	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	447	1976	521	88	1367	155	134	21
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	0	0	0	0	0	0	0	0
TOTAL INFLOWS	**5382**	**24736**	**4998**	**16239**	**3499**	**711**	**636**	**75**
OUTFLOW DAY 5	**3734**	**22404**	**3250**	**15814**	**3340**	**565**	**478**	**87**
Difference	-1648	-2332	-1749	-425	-159	-146	-158	12
% left	69.38%	90.57%	65.02%	97.38%	95.47%	79.44%	75.15%	115.79%
% variation	**-30.62%**	**-9.43%**	**-34.98%**	**-2.62%**	**-4.53%**	**-20.56%**	**-24.85%**	**15.79%**



CSO Mass Balances	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
CSO mass discharged on DAY 3	16323.7	1709.9	425.0	1284.9	0.0	298.5	268.7	29.9
CSO mass outflow on DAY 3 (day 3 minus day 5)	634.1	753.0	50.8	697.1	5.2	20.2	17.2	3.0
CSO mass outflow on DAY 4 (day 4 minus day 5)	45231.3	5568.1	1331.5	4196.0	40.6	1001.5	878.9	122.7
Total CSO mass discharged over Days 3 and 4	45865.3	6321.1	1382.3	4893.0	45.8	1021.7	896.1	125.7
CSO mass removed on Days 3–4	29541.7	8031.1	957.3	3608.1	45.8	723.2	627.4	95.8
% CSO mass removed on Days 3–4	181.0%	269.7%	225.3%	280.8%		242.3%	233.5%	321.0%



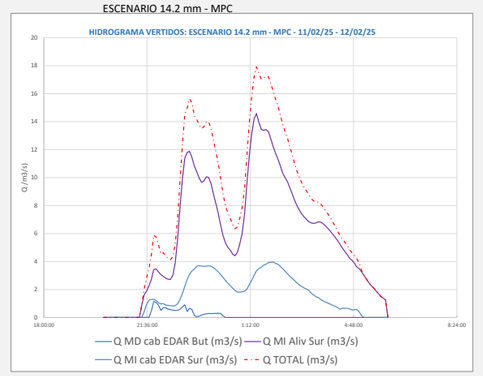




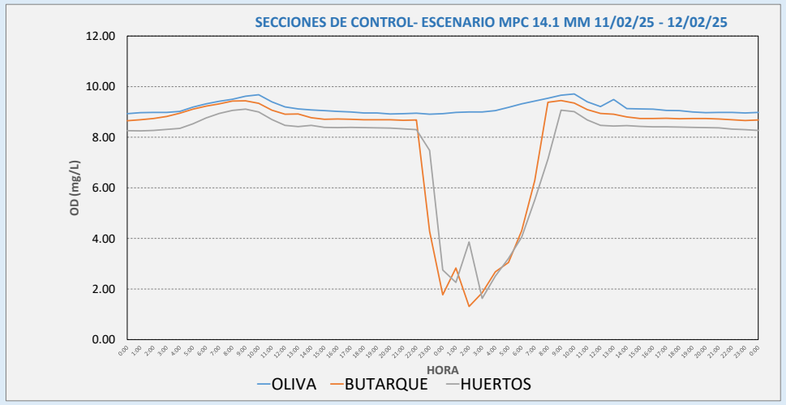
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

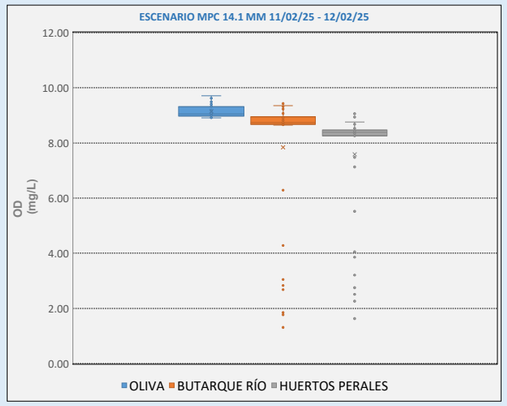
PROYECTO LIFE-RUBÍES

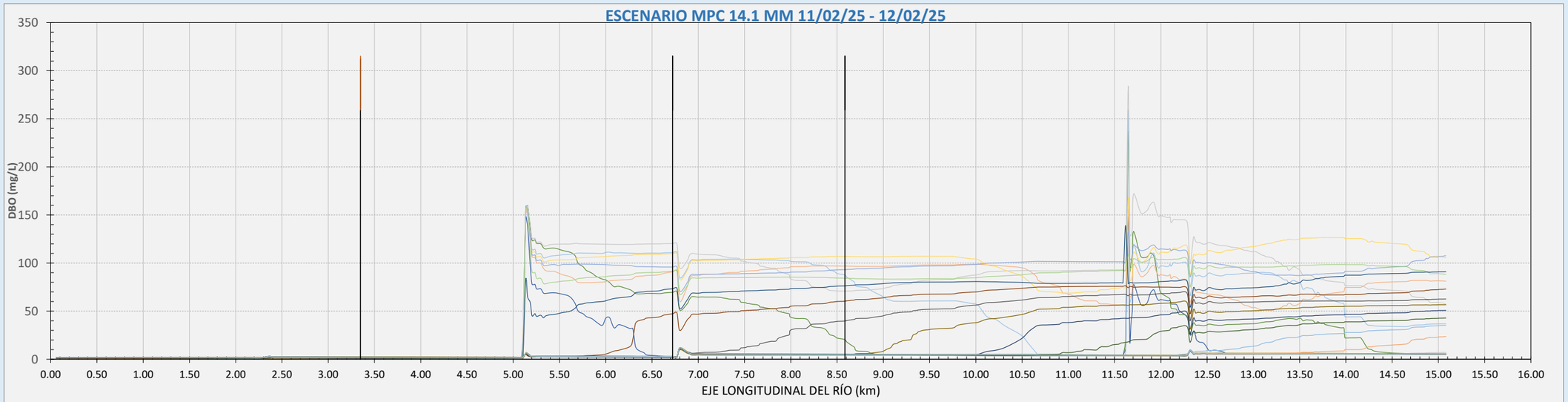
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - MPC

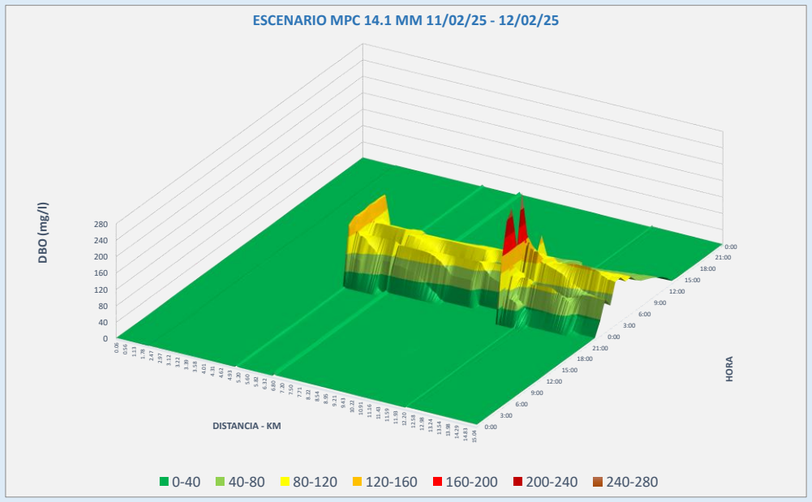


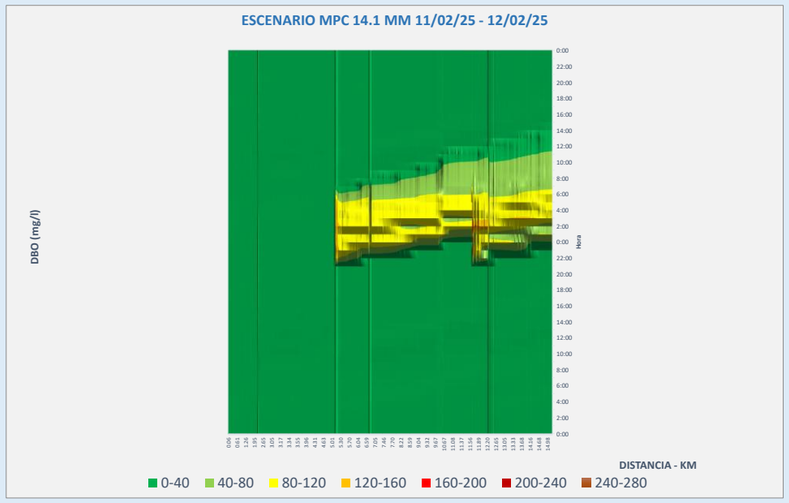
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 14.2 mm – DSU 11/02/25 – 12/02/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**11/02 1,78** **12/02 2,01** **13/02 1,87**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m^2·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	







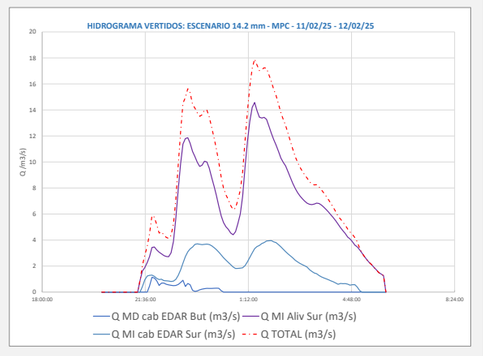




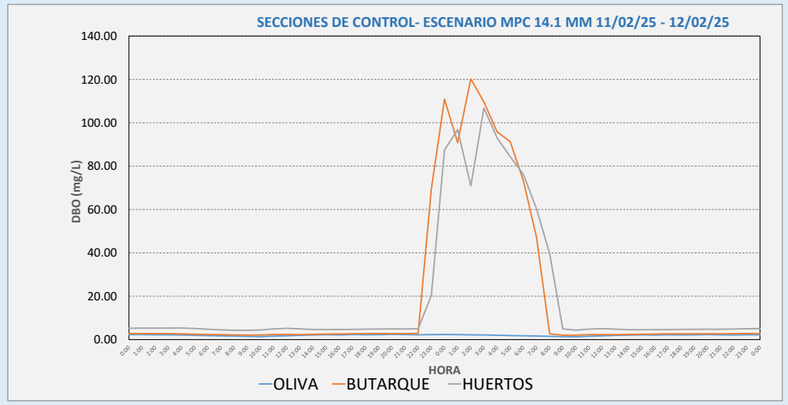
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

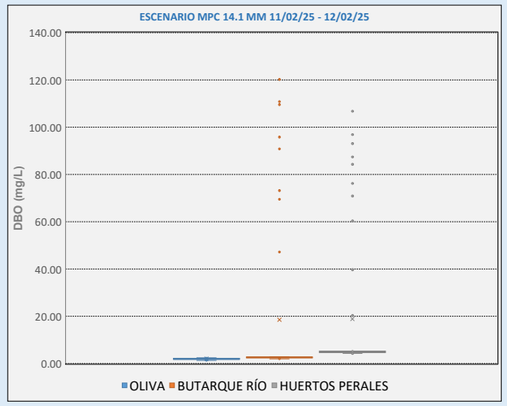
PROYECTO LIFE-RUBÍES

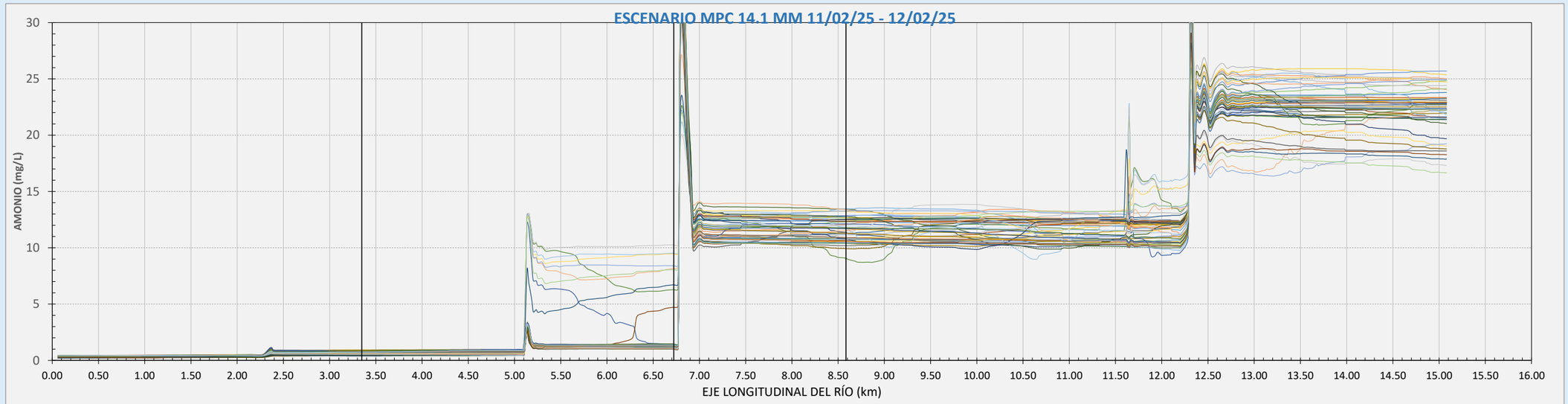
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - MPC

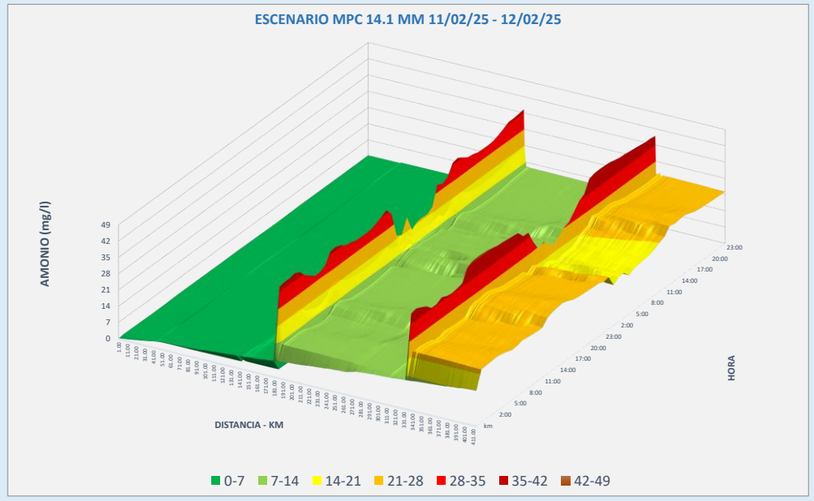


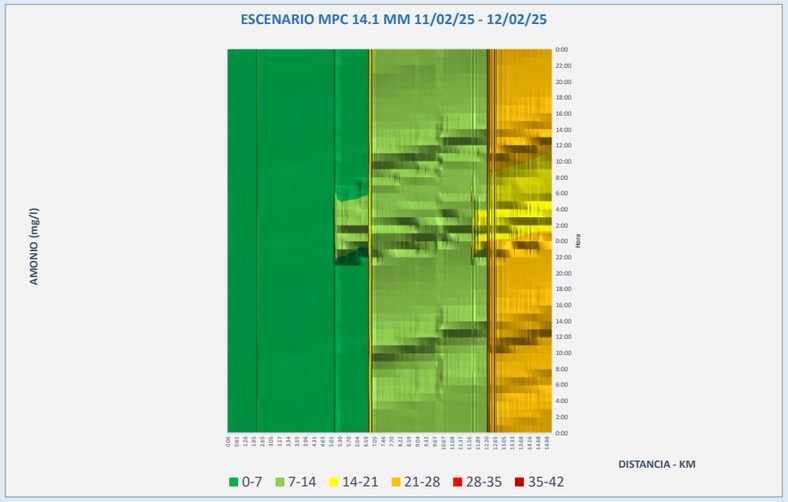
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 14.2 mm – DSU 11/02/25 – 12/02/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m³/s	1	2,5	5	**11/02 1,78** **12/02 2,01** **13/02 1,87**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m²·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día⁻¹)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día⁻¹)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día⁻¹)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día⁻¹)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día⁻¹)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	







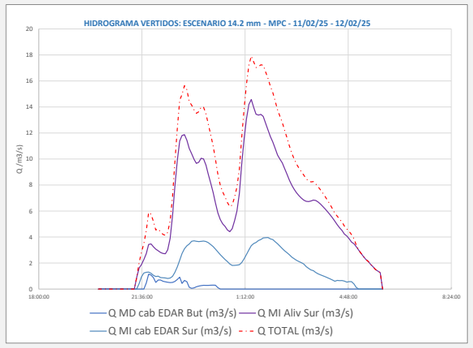




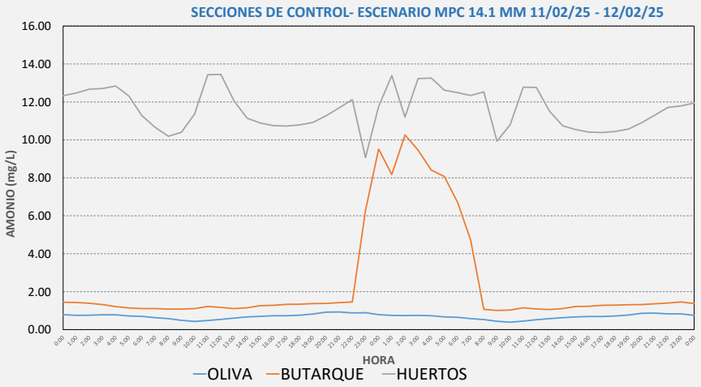
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

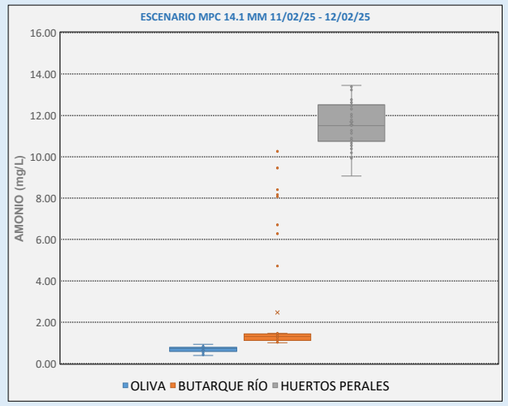
PROYECTO LIFE-RUBÍES

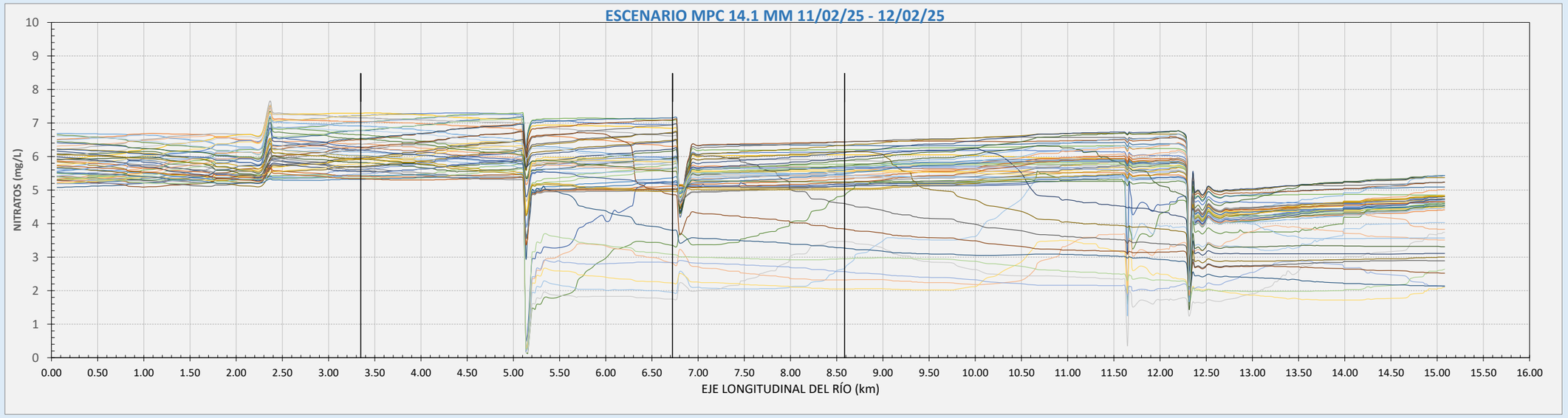
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - MPC

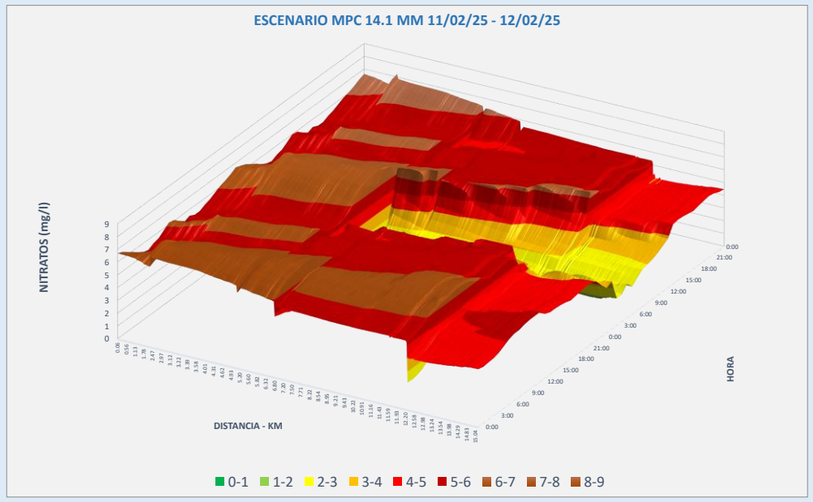


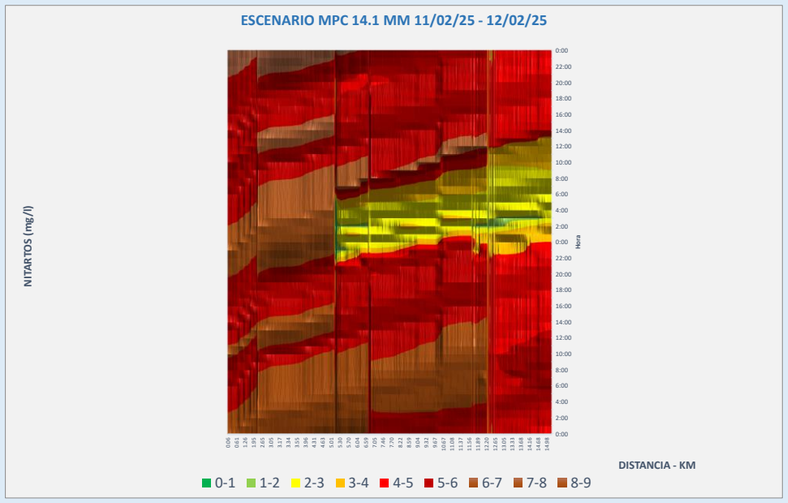
PARÁMETROS Y RANGOS	VALORES MINIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 14.2 mm – DSU 11/02/25 – 12/02/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m³/s	*1*	*2,5*	*5*	***11/02 1,78 12/02 2,01 13/02 1,87***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijada a 10*
DBOsed/DOS (g/m²·día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día⁻¹)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día⁻¹)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día⁻¹)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día⁻¹)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día⁻¹)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	







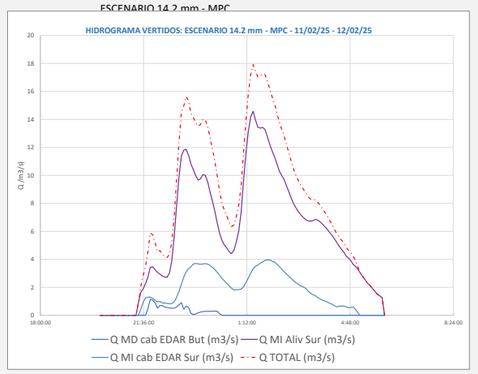




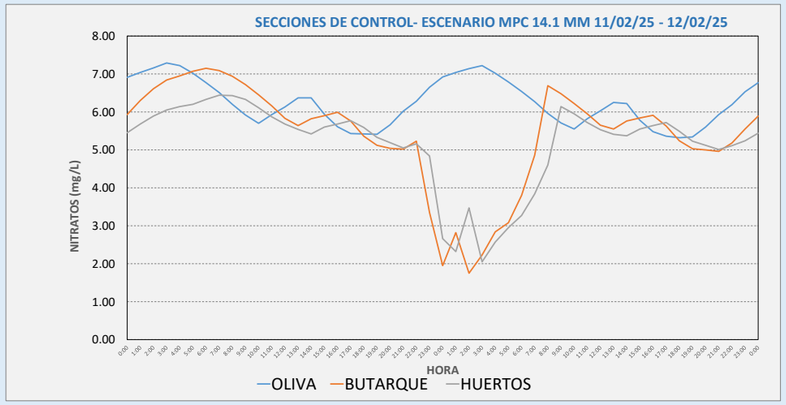
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

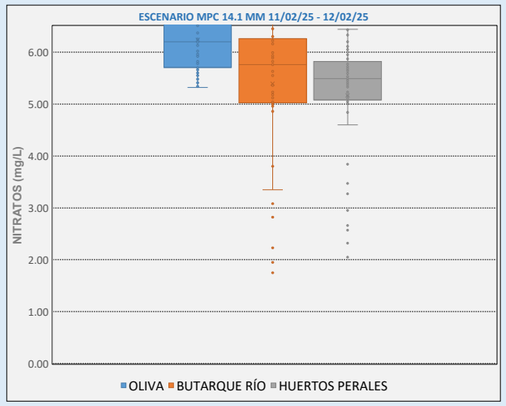
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - MPC

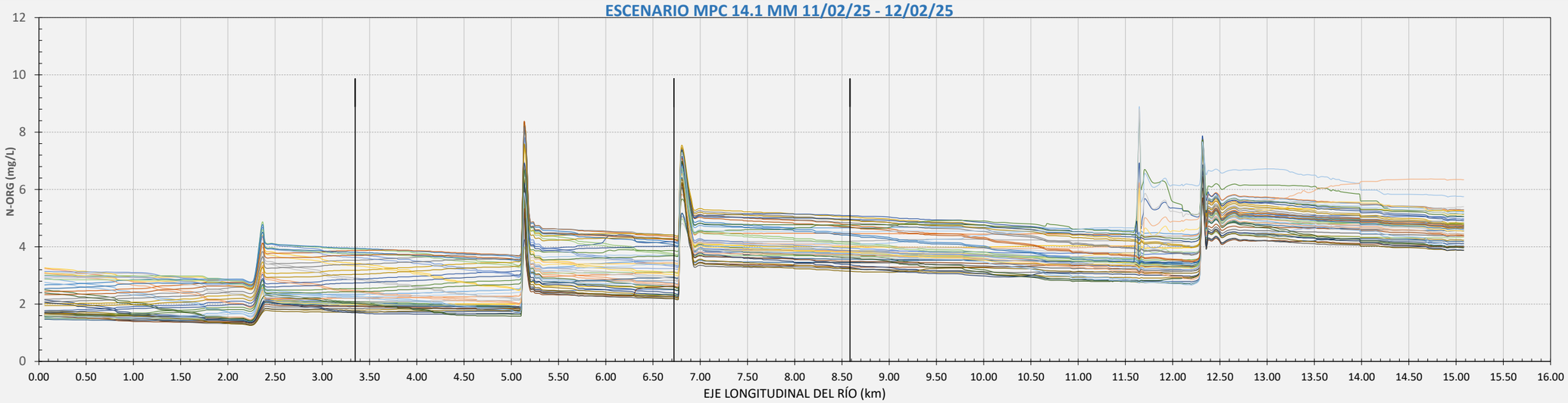


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 14.2 mm – DSU 11/02/25 – 12/02/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m³/s	1	2,5	5	**11/02 1,78** **12/02 2,01** **13/02 1,87**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m²·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día⁻¹)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{sDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día⁻¹)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día⁻¹)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día⁻¹)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día⁻¹)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

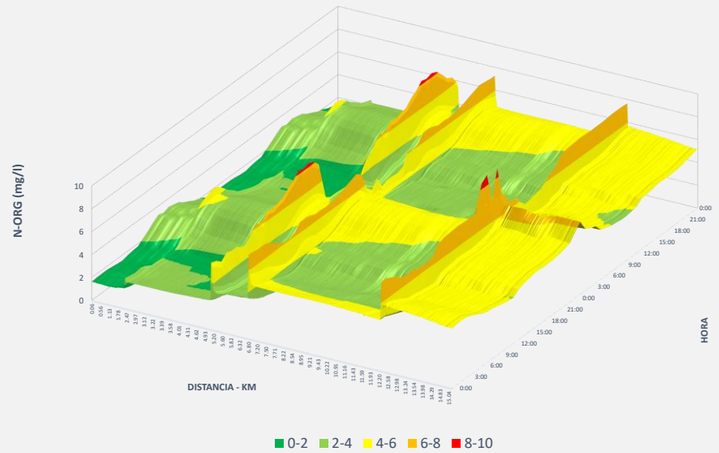




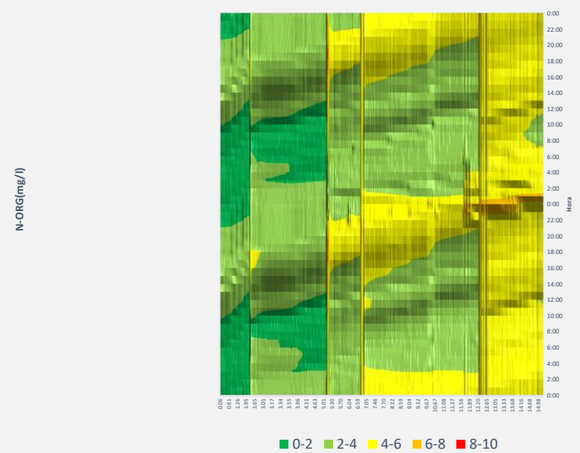
ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



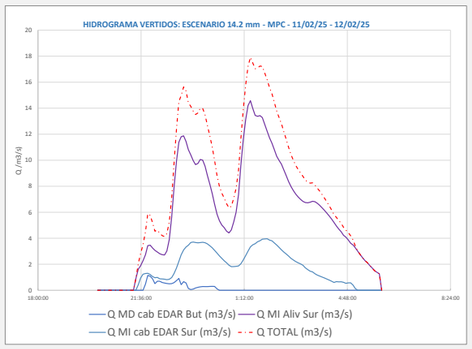
ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



MODELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

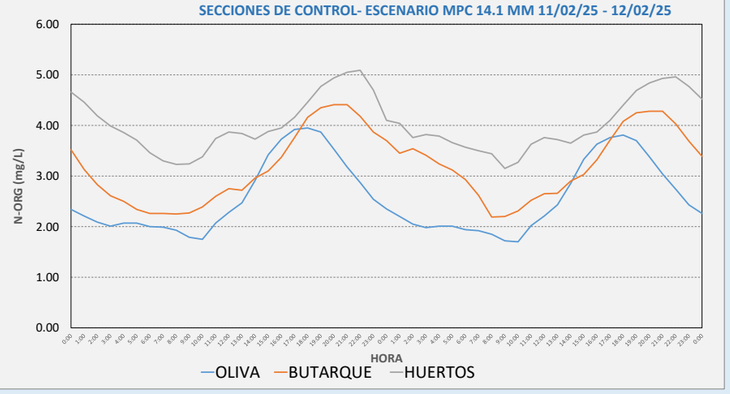
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - MPC

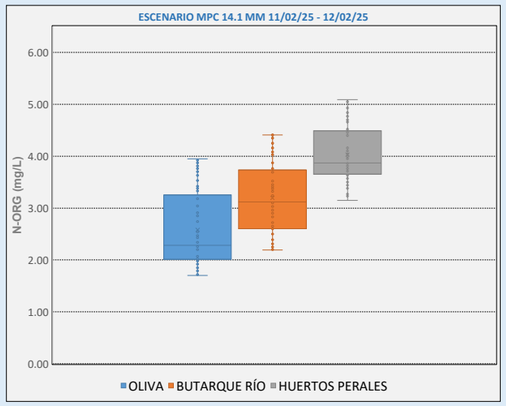


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 14.2 mm – DSU 11/02/25 – 12/02/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**11/02 1,78** **12/02 2,01** **13/02 1,87**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

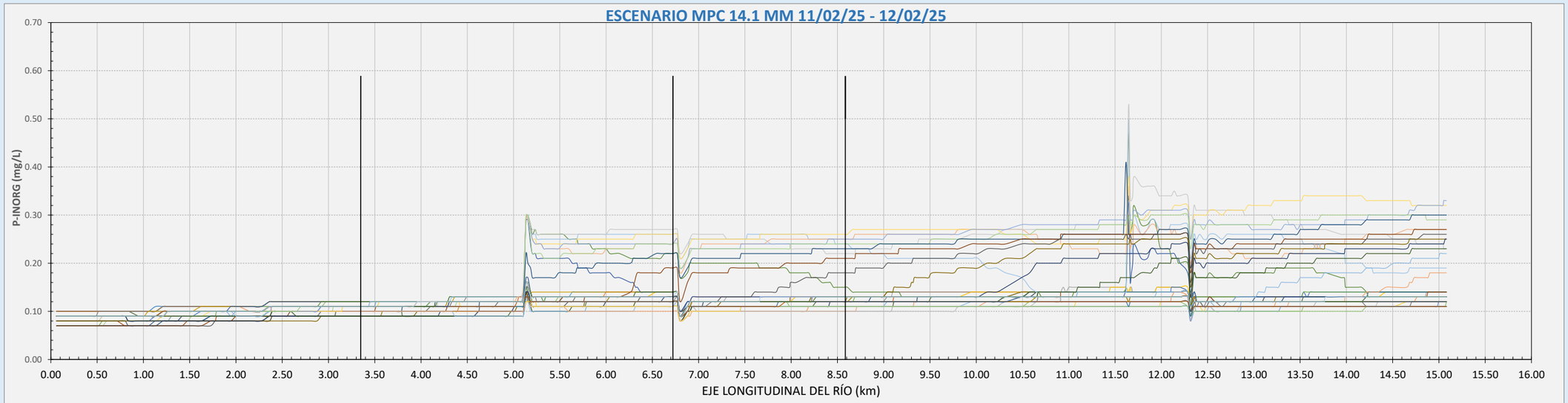
SECCIONES DE CONTROL- ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



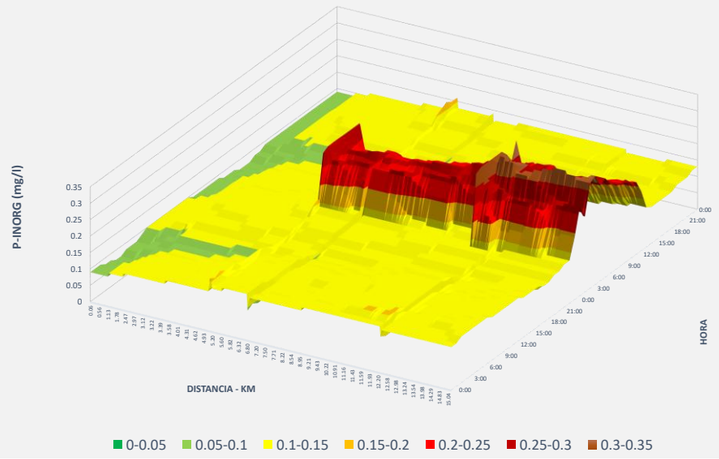
ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



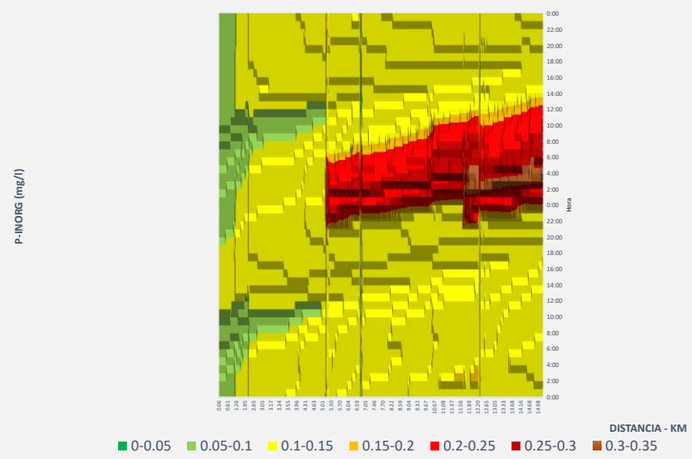
ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



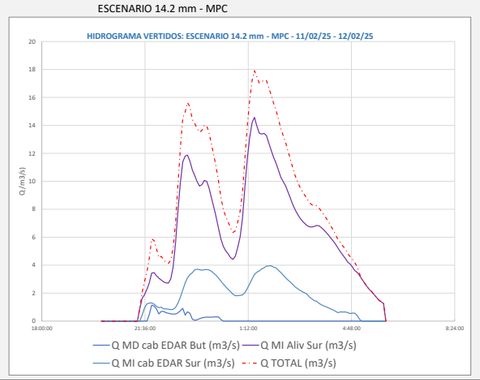
ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



MPInELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

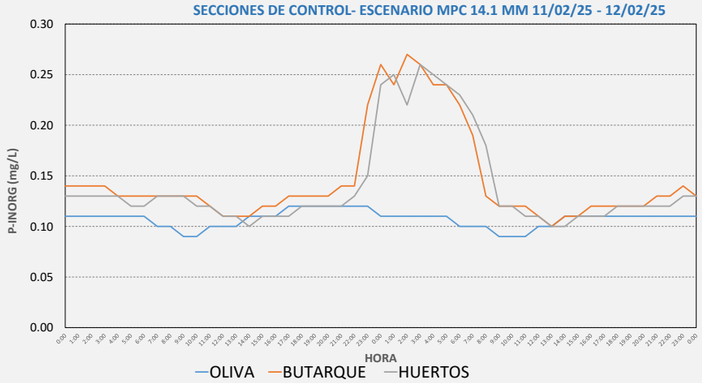
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - MPC

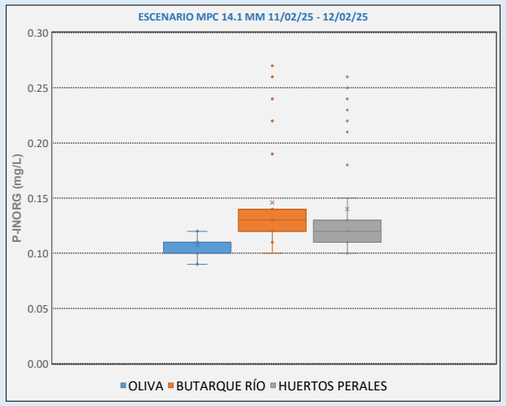


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 14.2 mm – DSU 11/02/25 – 12/02/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**11/02 1,78** **12/02 2,01** **13/02 1,87**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m^2·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

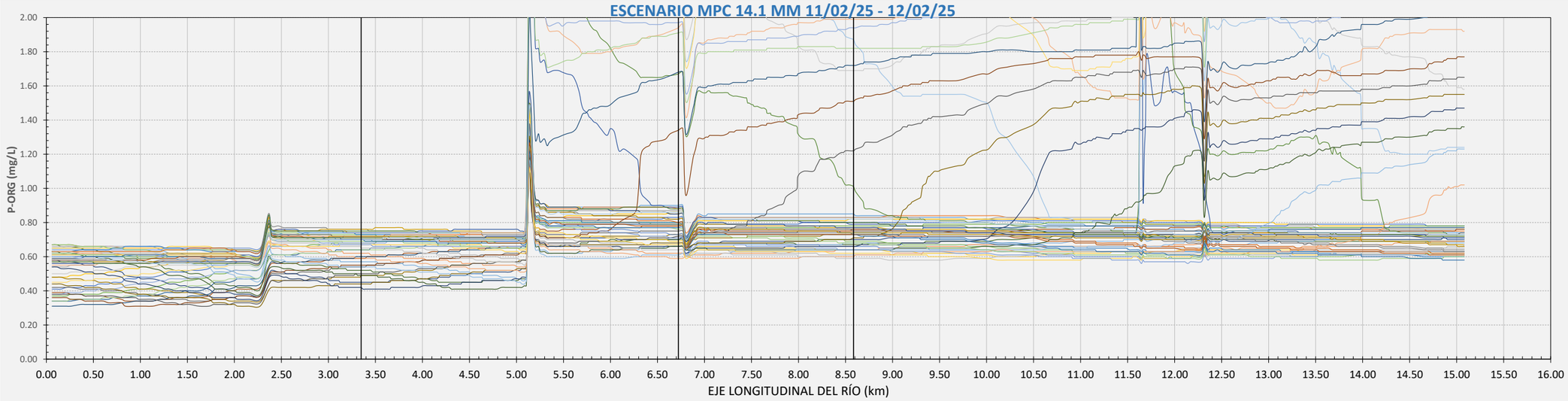
SECCIONES DE CONTROL- ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



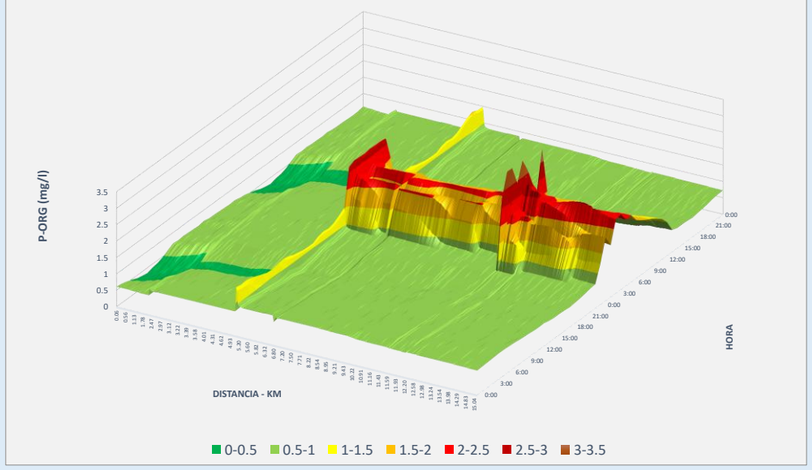
ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



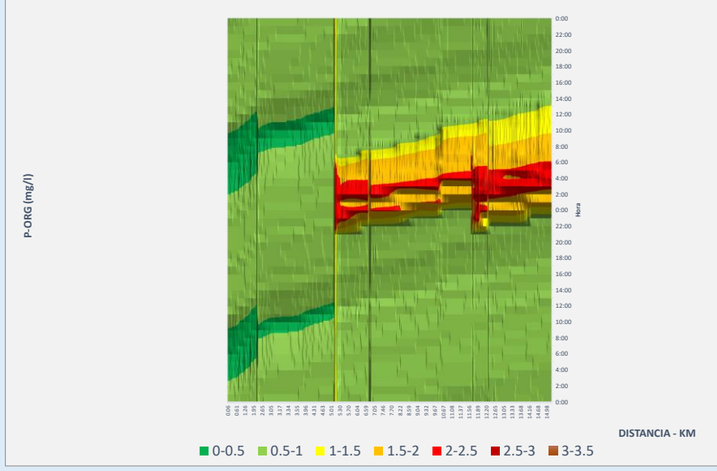
ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



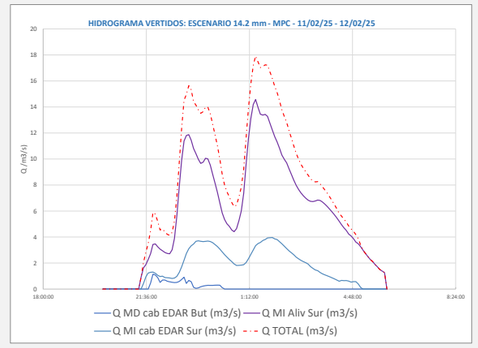
ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

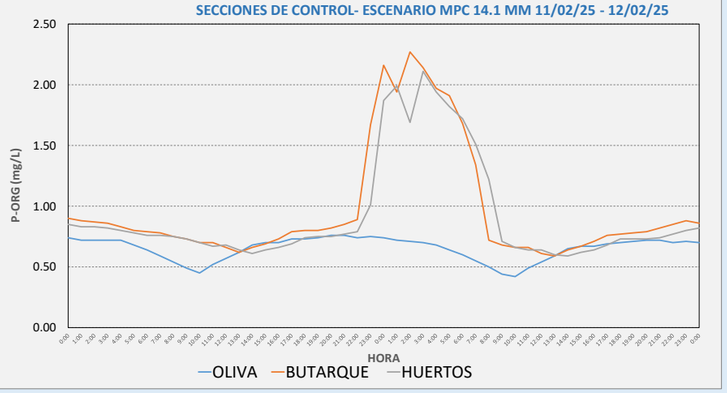
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - MPC

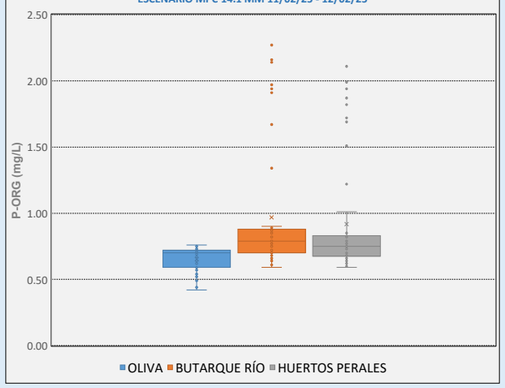


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 14.2 mm – DSU 11/02/25 – 12/02/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	**11/02 1,78** **12/02 2,01** **13/02 1,87**	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	**10**	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2-día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) =* *0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	

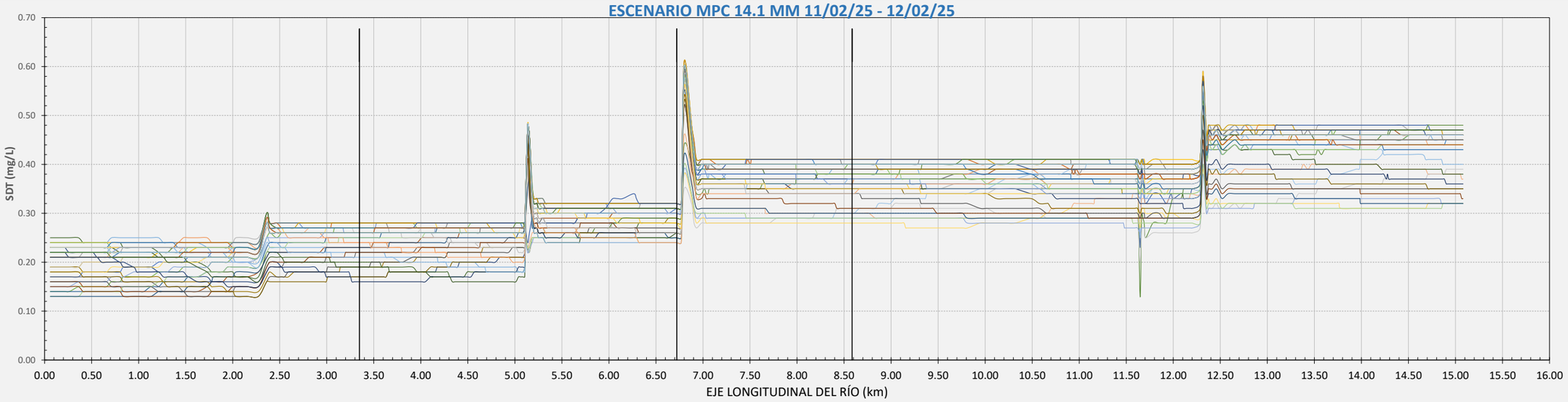
SECCIONES DE CONTROL- ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



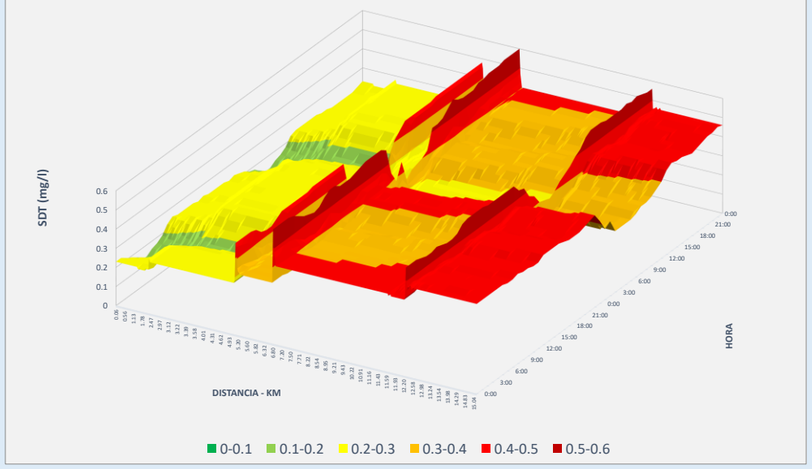
ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



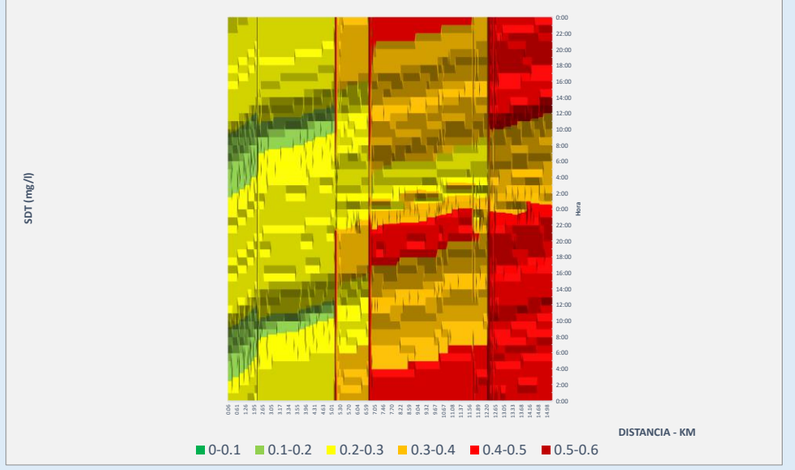
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ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



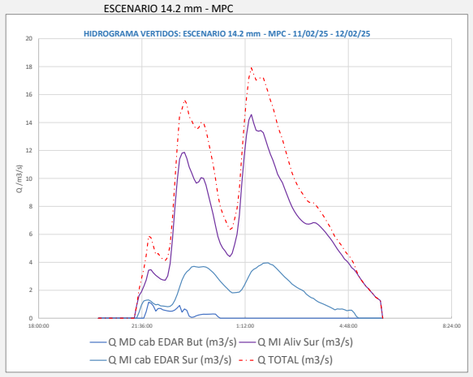
ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



MSaltELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

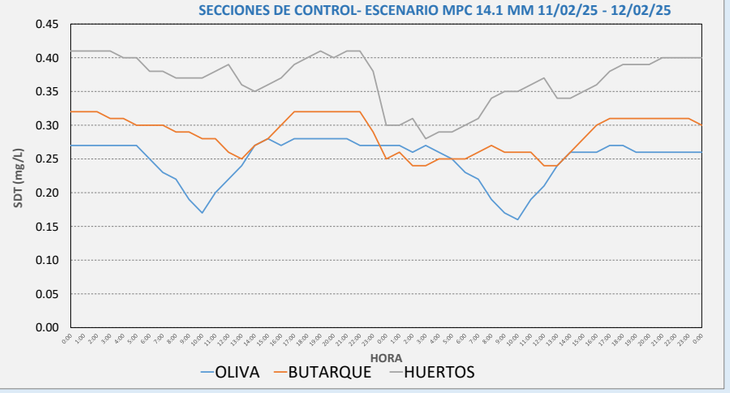
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 14.2 mm - MPC

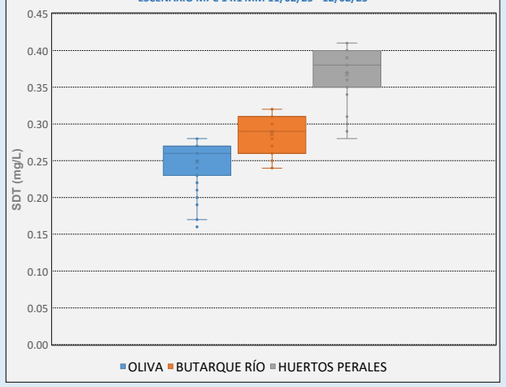


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 14.2 mm – DSU 11/02/25 – 12/02/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**11/02 1,78** **12/02 2,01** **13/02 1,87**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

SECCIONES DE CONTROL- ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



ESCENARIO MPC 14.1 MM 11/02/25 - 12/02/25



Annex 5.5.- Results for large event (28 mm) and rules scenario

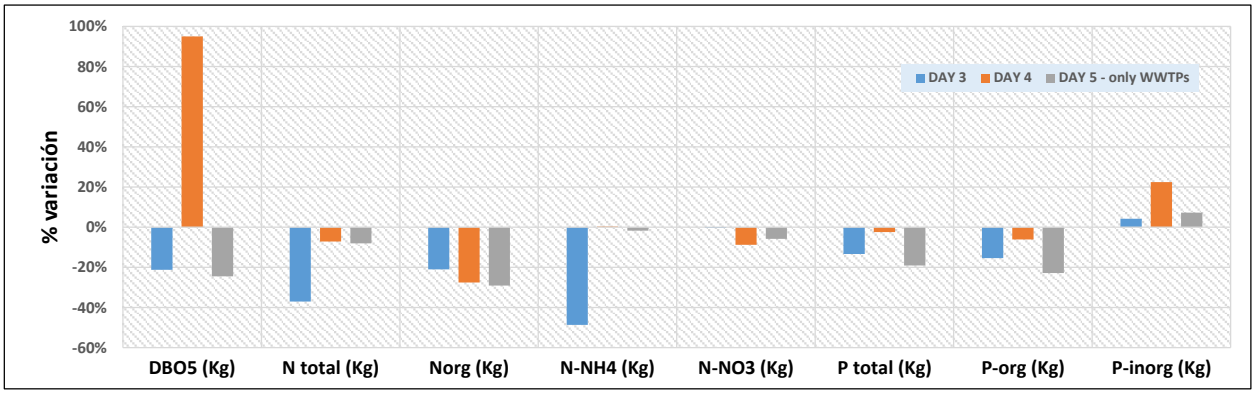
MASS BALANCE

Model scenario: 28 mm - RULES

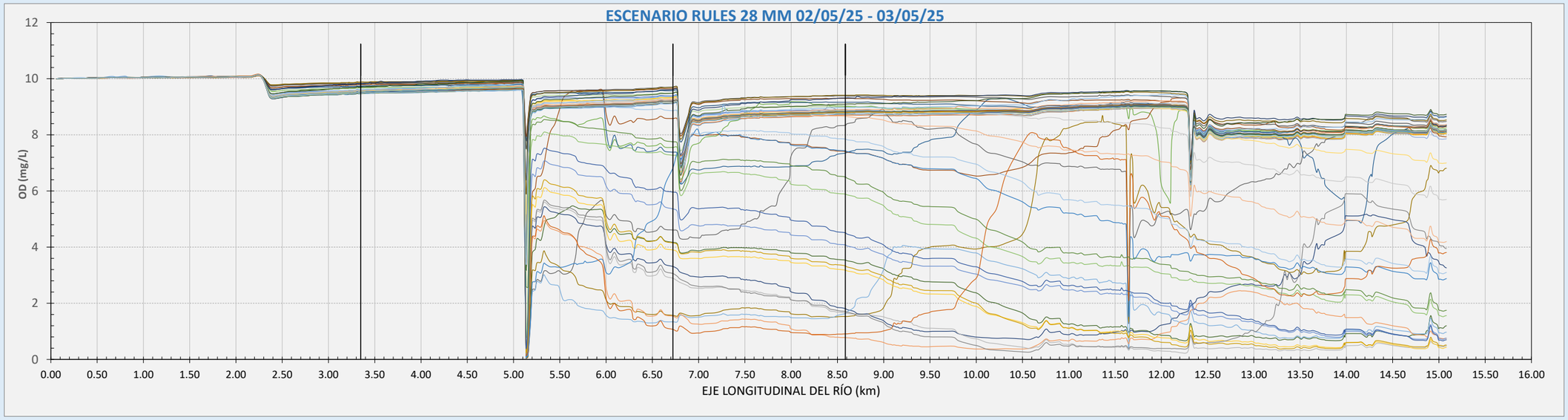
DAY 3	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	683	4347	993	100	3254	202	158	45
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	216344	21501	5589	15913	0	3769	3392	377
TOTAL INFLOWS	**221962**	**48609**	**11059**	**32163**	**5387**	**4528**	**4052**	**476**
OUTFLOW DAY 3	**174851**	**30609**	**8731**	**16511**	**5367**	**3924**	**3428**	**496**
Difference	-47111	-18000	-2328	-15653	-20	-604	-624	20
% left	78.78%	62.97%	78.95%	51.33%	99.63%	86.66%	84.60%	104.20%
% variation	**-21.22%**	**-37.03%**	**-21.05%**	**-48.67%**	**-0.37%**	**-13.34%**	**-15.40%**	**4.20%**

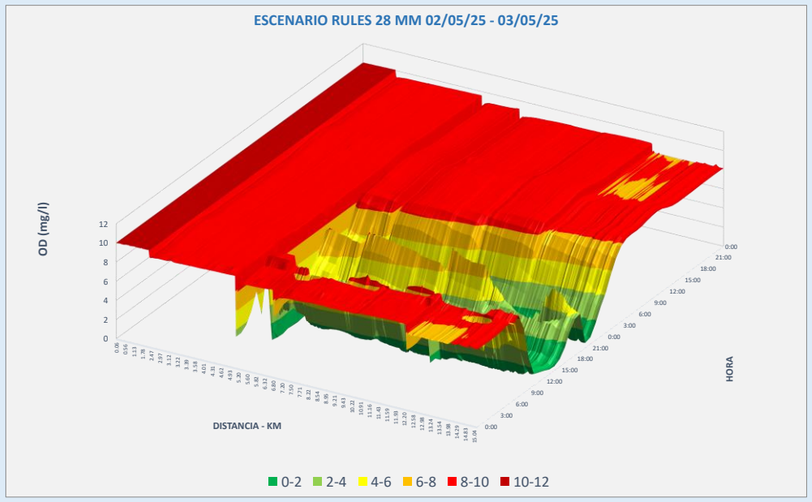
DAY 4	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	674	4260	976	99	3185	201	157	44
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	37	4	1	3	0	1	1	0
TOTAL INFLOWS	**5646**	**27024**	**5454**	**16253**	**5317**	**757**	**659**	**98**
OUTFLOW DAY 4	**11011**	**25097**	**3951**	**16298**	**4848**	**739**	**619**	**120**
Difference	5365	-1927	-1503	45	-469	-18	-40	22
% left	195.03%	92.87%	72.44%	100.28%	91.18%	97.59%	93.90%	122.48%
% variation	**95.03%**	**-7.13%**	**-27.56%**	**0.28%**	**-8.82%**	**-2.41%**	**-6.10%**	**22.48%**

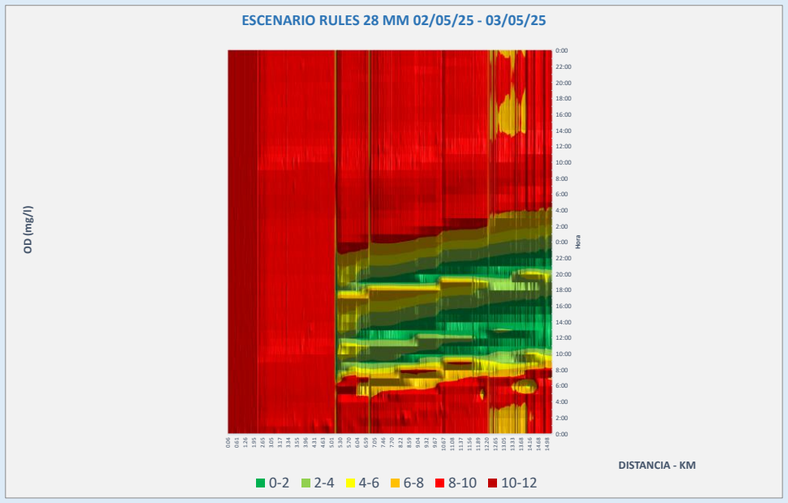
DAY 5 - only WWTPs	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	662	4141	952	99	3090	198	156	43
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	0	0	0	0	0	0	0	0
TOTAL INFLOWS	**5597**	**26901**	**5429**	**16250**	**5222**	**754**	**658**	**97**
OUTFLOW DAY 5	**4228**	**24728**	**3849**	**15962**	**4917**	**611**	**507**	**104**
Difference	-1369	-2173	-1580	-288	-305	-144	-151	7
% left	75.54%	91.92%	70.89%	98.23%	94.15%	80.97%	77.11%	107.23%
% variation	**-24.46%**	**-8.08%**	**-29.11%**	**-1.77%**	**-5.85%**	**-19.03%**	**-22.89%**	**7.23%**



CSO Mass Balances	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
CSO mass discharged on DAY 3	216343.9	21501.3	5588.7	15912.7	0.0	3769.4	3392.4	376.9
CSO mass outflow on DAY 3 (day 3 minus day 5)	170622.1	5881.0	4882.1	549.0	450.0	3313.2	2921.2	392.0
CSO mass outflow on DAY 4 (day 4 minus day 5)	6782.6	369.2	101.7	336.2	-68.7	128.4	112.1	16.3
Total CSO mass discharged over Days 3 and 4	177404.7	6250.2	4983.7	885.2	381.3	3441.5	3033.3	408.2
CSO mass removed on Days 3–4	-38939.3	27751.5	-604.9	-15027.4	381.3	-327.8	-359.1	31.3
% CSO mass removed on Days 3–4	-18.0%	-70.9%	-10.8%	-94.4%		-8.7%	-10.6%	8.3%



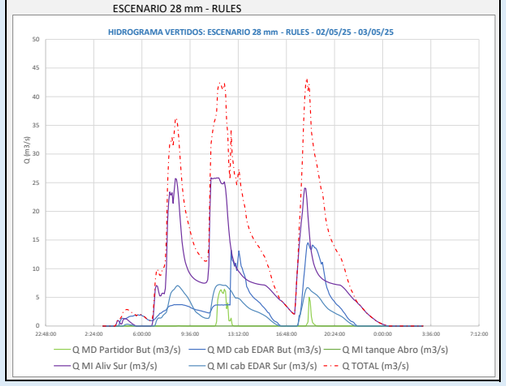




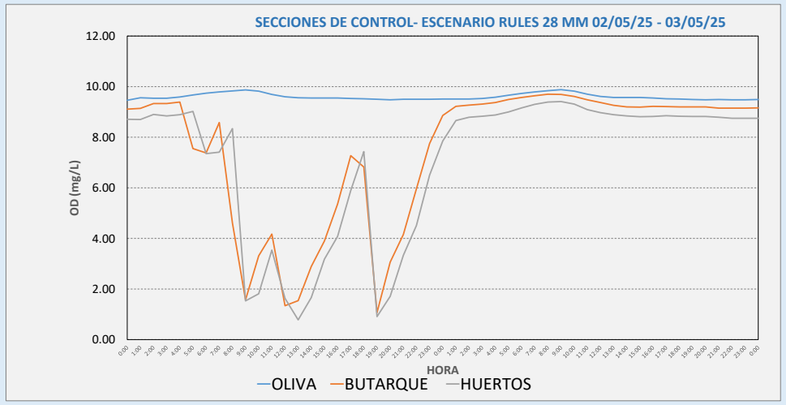
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

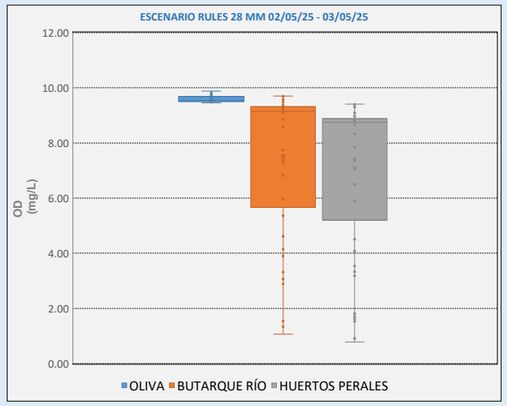
PROYECTO LIFE-RUBÍES

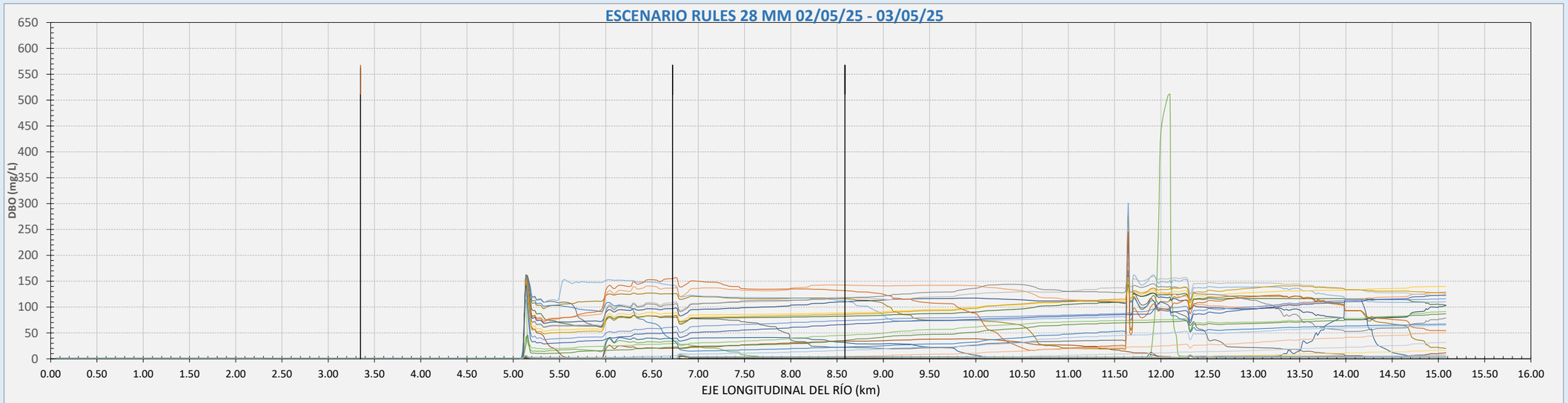
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - RULES

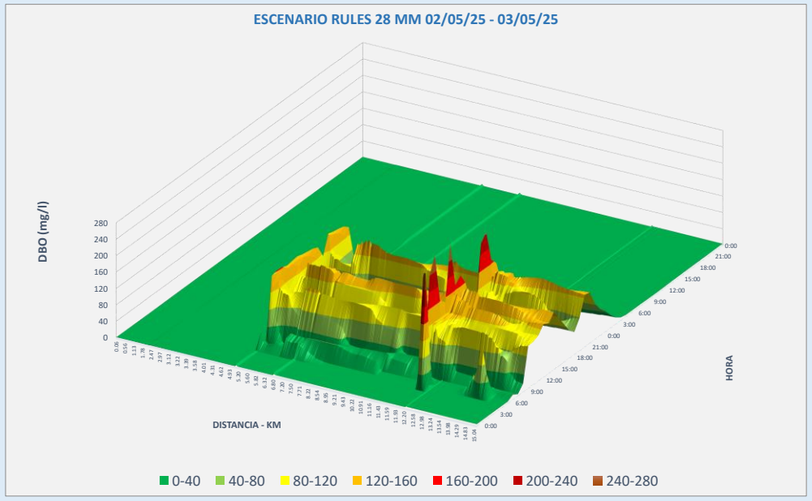


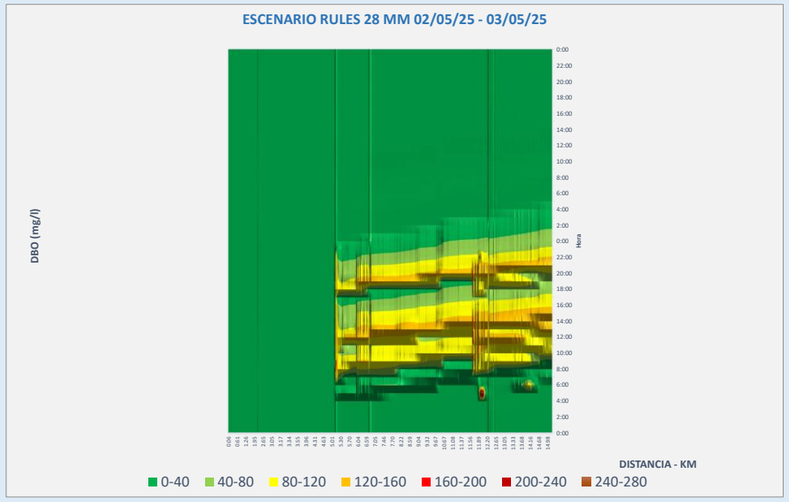
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***02/05 7,25*** ***03/05 7,05*** ***04/05 6,77***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2-día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR* *Cabecera (N-NH4+ río) + (N-NH4+ Viveros) =* *0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	







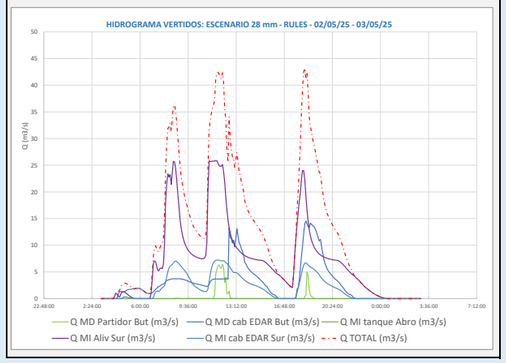




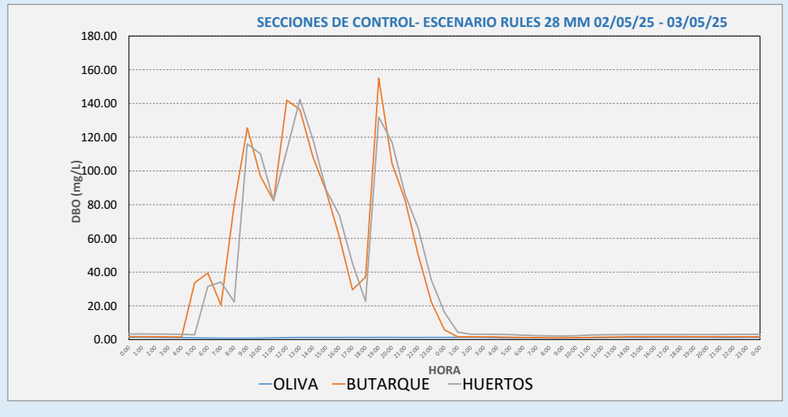
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

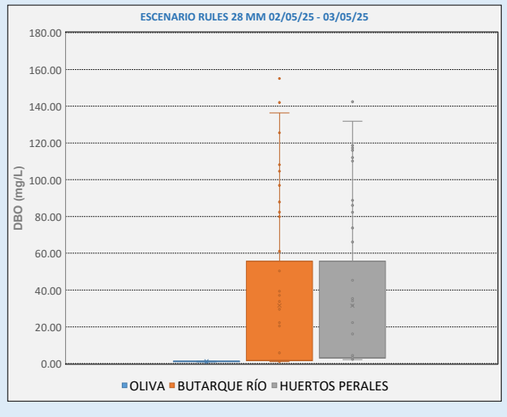
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - RULES

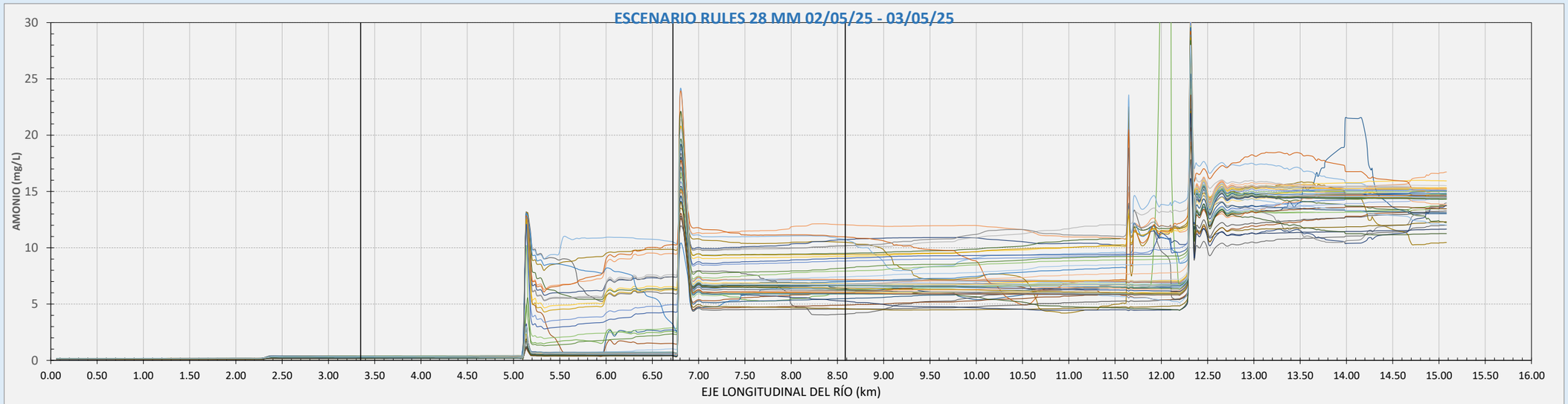


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***02/05 7,25*** ***03/05 7,05*** ***04/05 6,77***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2-día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	

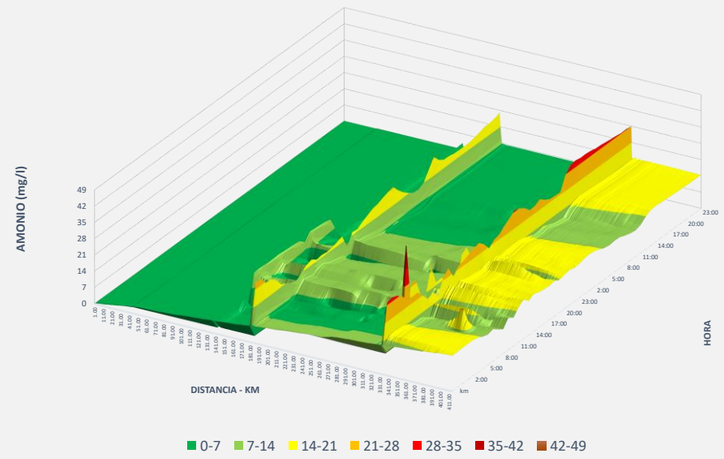




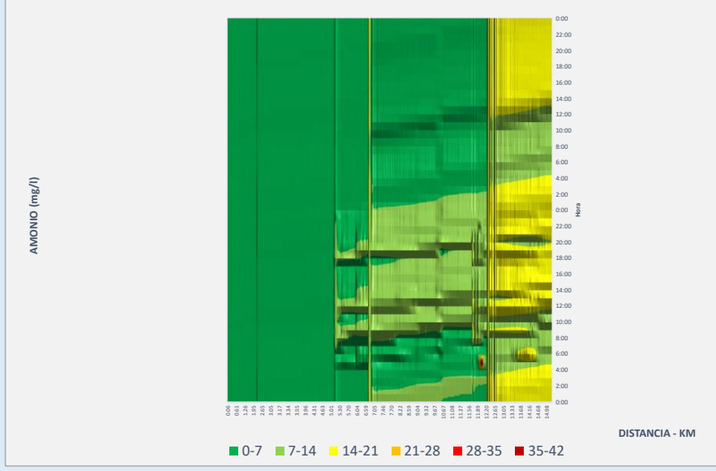
ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



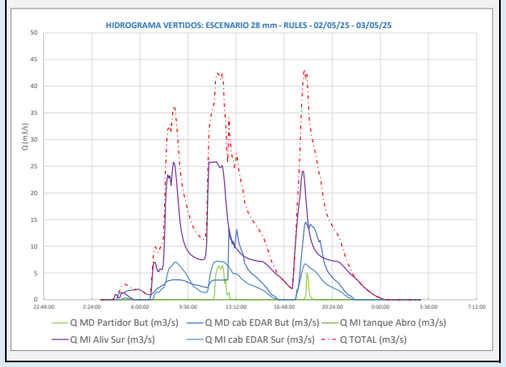
ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



MODELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

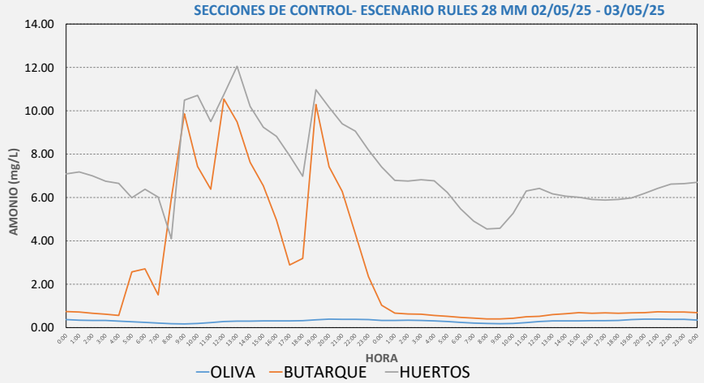
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - RULES

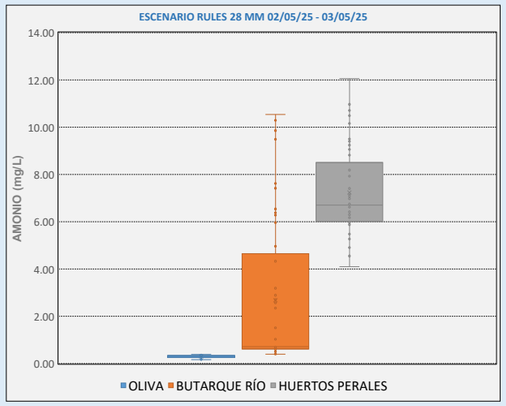


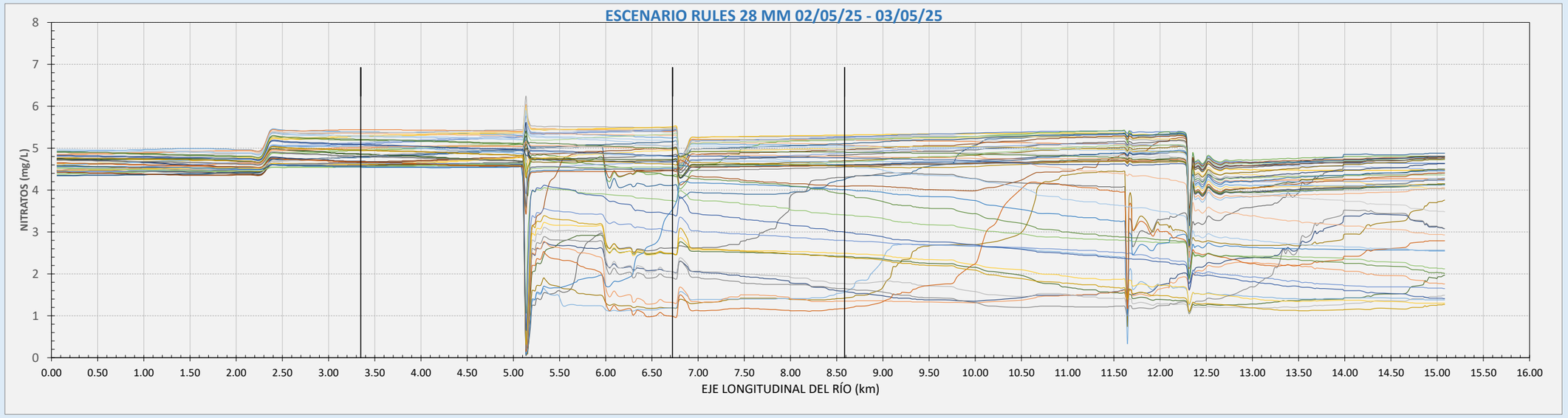
PARÁMETROS Y RANGOS	VALORES MINIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**02/05 7,25** **03/05 7,05** **04/05 6,77**	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	*OD cabecera fijada a 10*
DBOsed/DOS (g/m^2·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	*DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

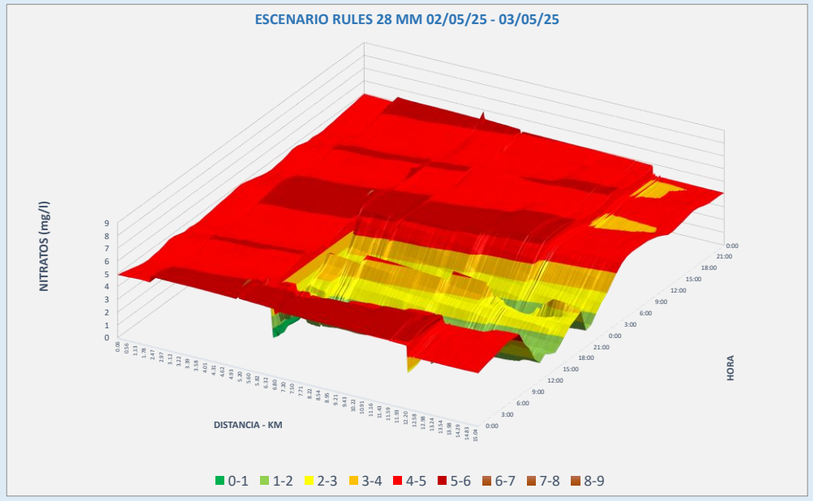
SECCIONES DE CONTROL- ESCENARIO RULES 28 MM 02/05/25 - 03/05/25

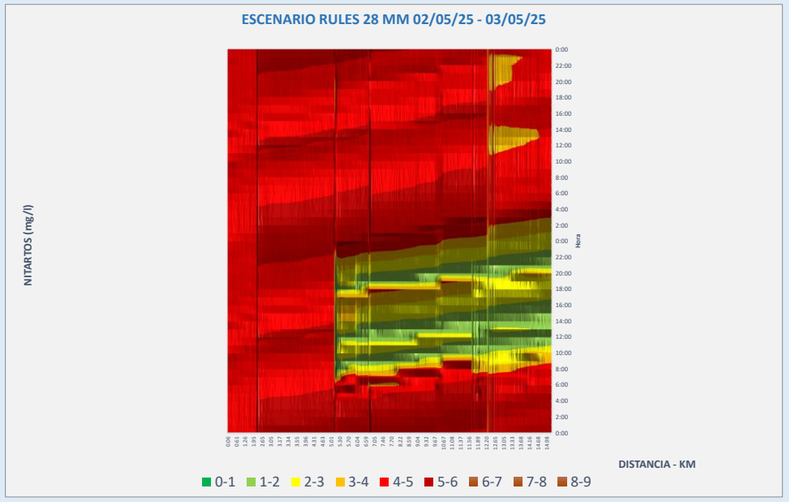


ESCENARIO RULES 28 MM 02/05/25 - 03/05/25







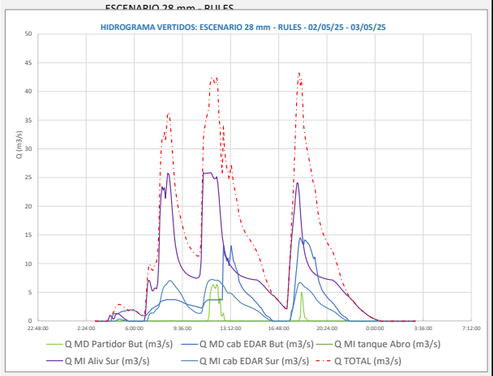


MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

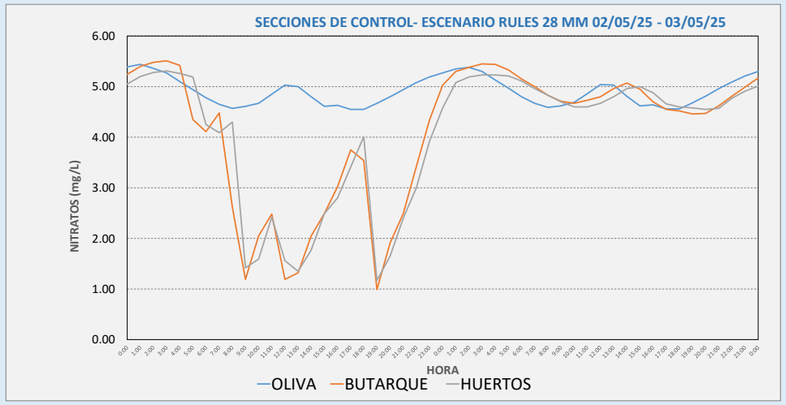
PROYECTO LIFE-RUBÍES

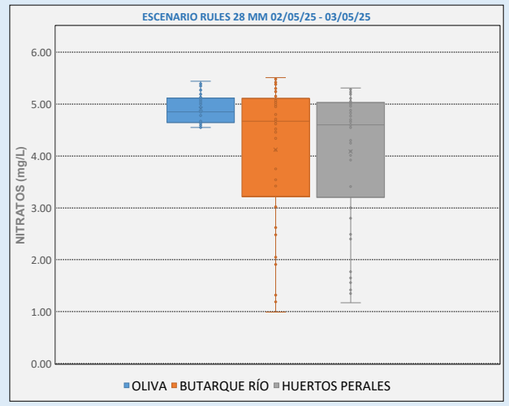
FASE: ANÁLISIS COMPARATIVO MPC - RULES

ESCENARIO 28 mm - RULES

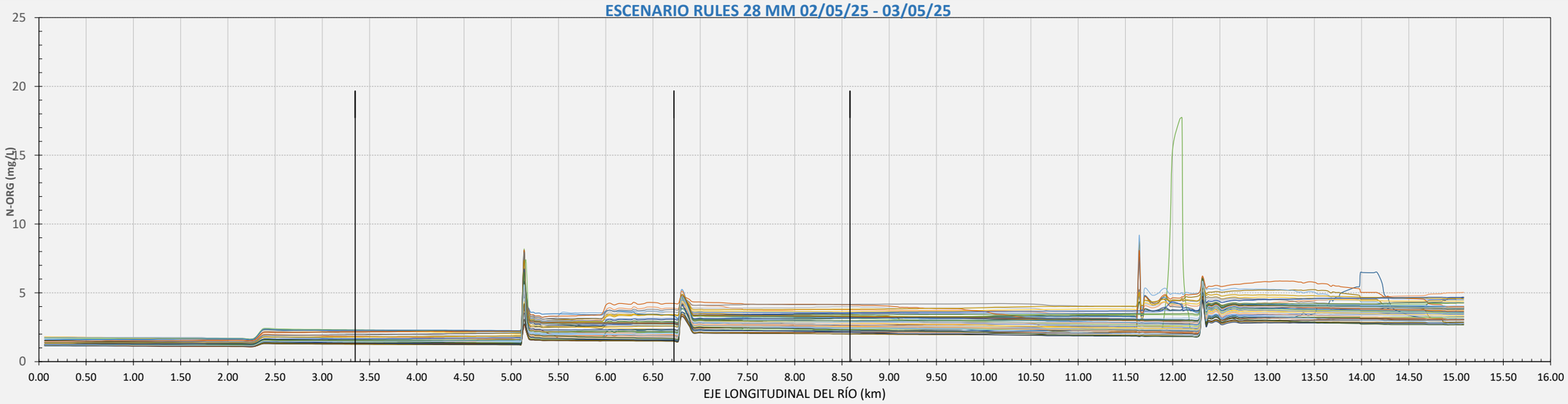


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	**02/05 7,25** **03/05 7,05** **04/05 6,77**	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2-día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación =* *0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractaria de EDAR* *Cabecera (N-NH4+ río) + (N-NH4+ Viveros) =* *0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	

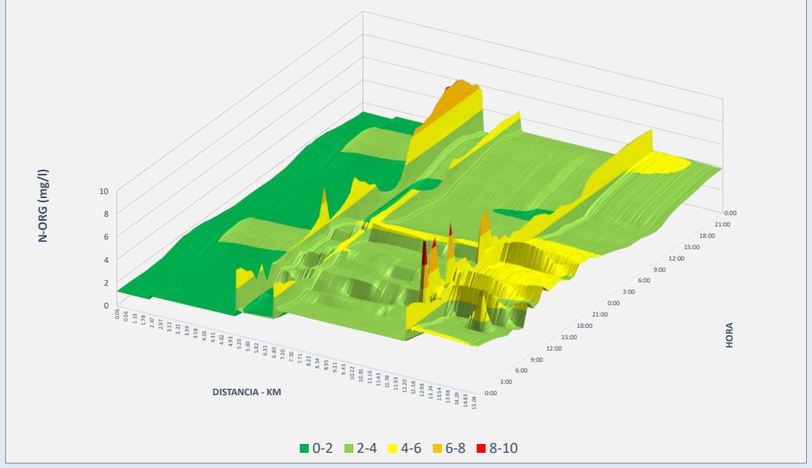




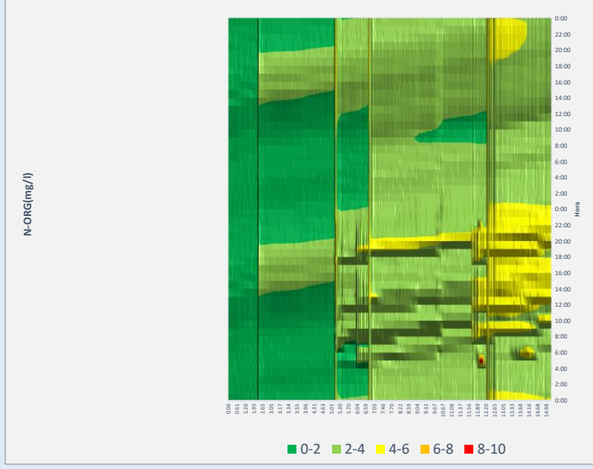
ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



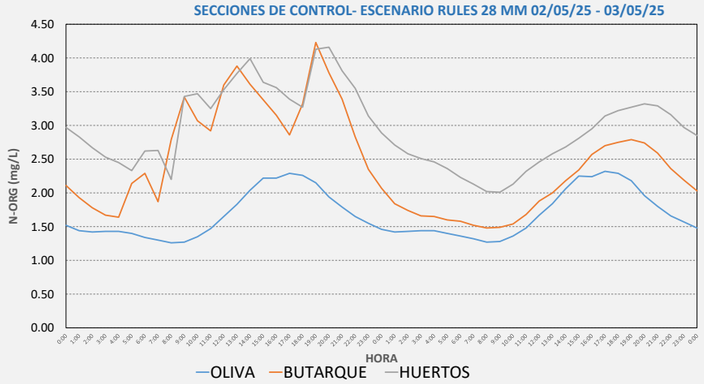
MODELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

PROYECTO LIFE-RUBÍES

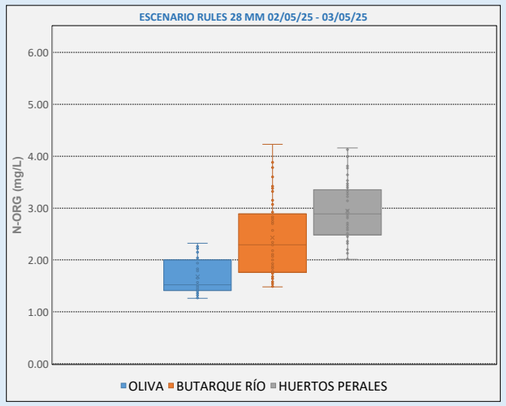
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - RULES

PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***02/05 7,25*** ***03/05 7,05*** ***04/05 6,77***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2·día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	

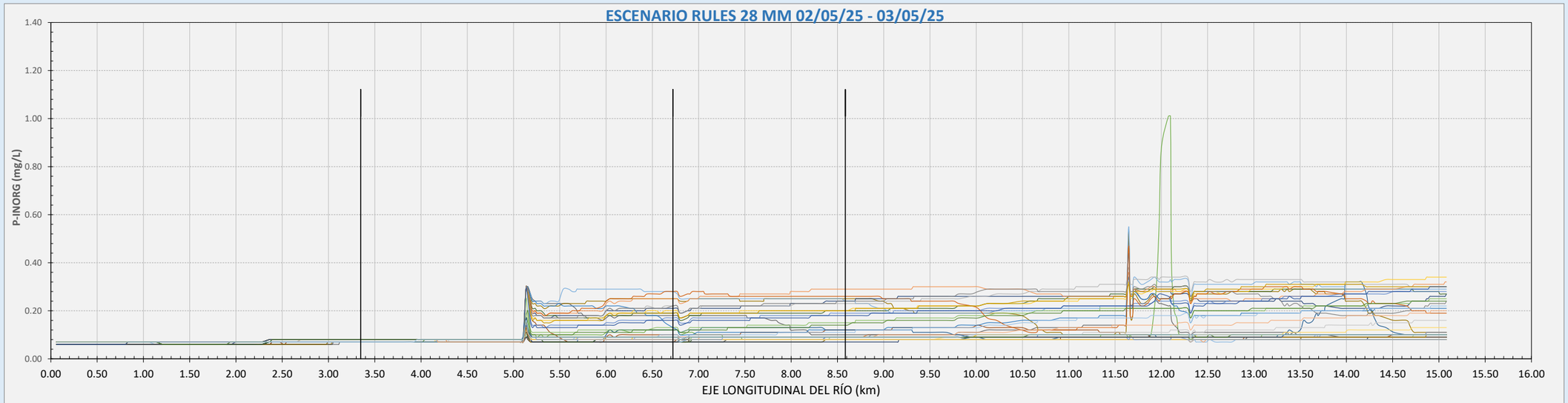
SECCIONES DE CONTROL- ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



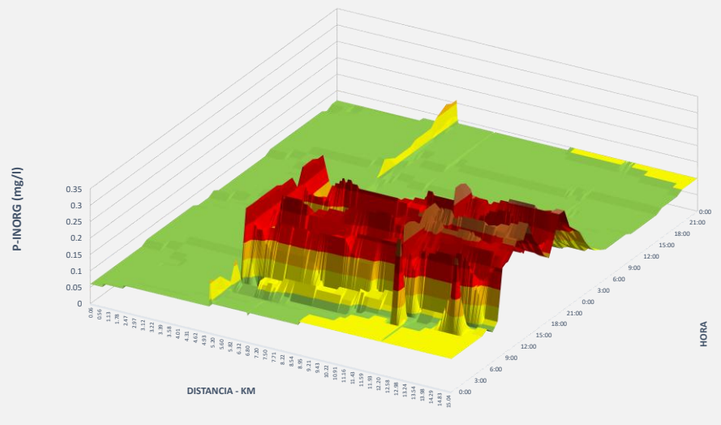
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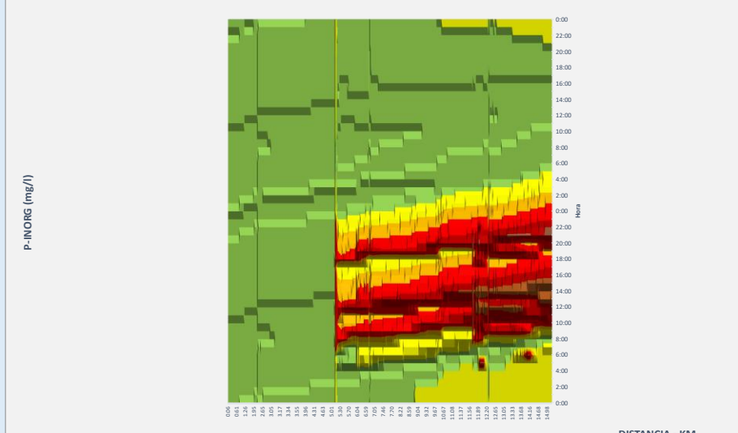
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ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



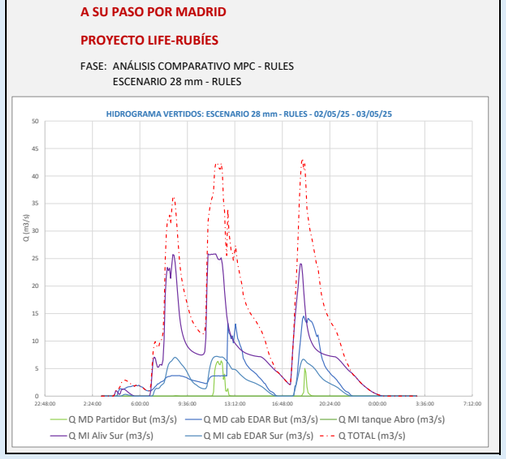
ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

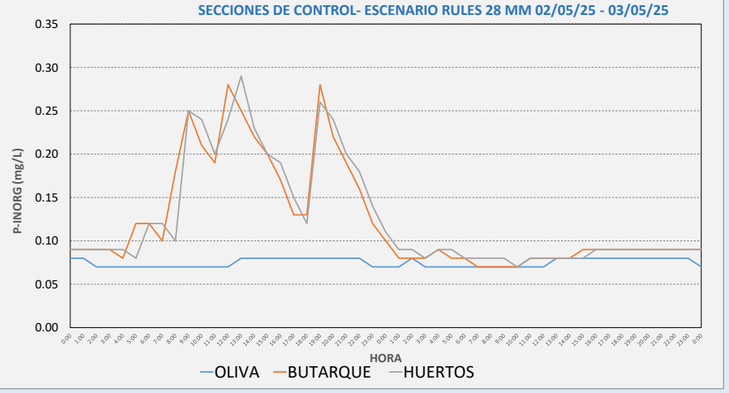
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - RULES

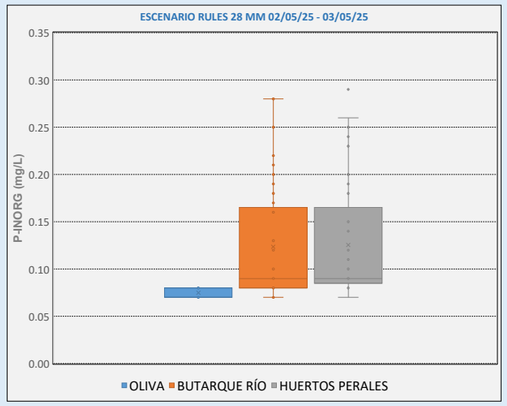


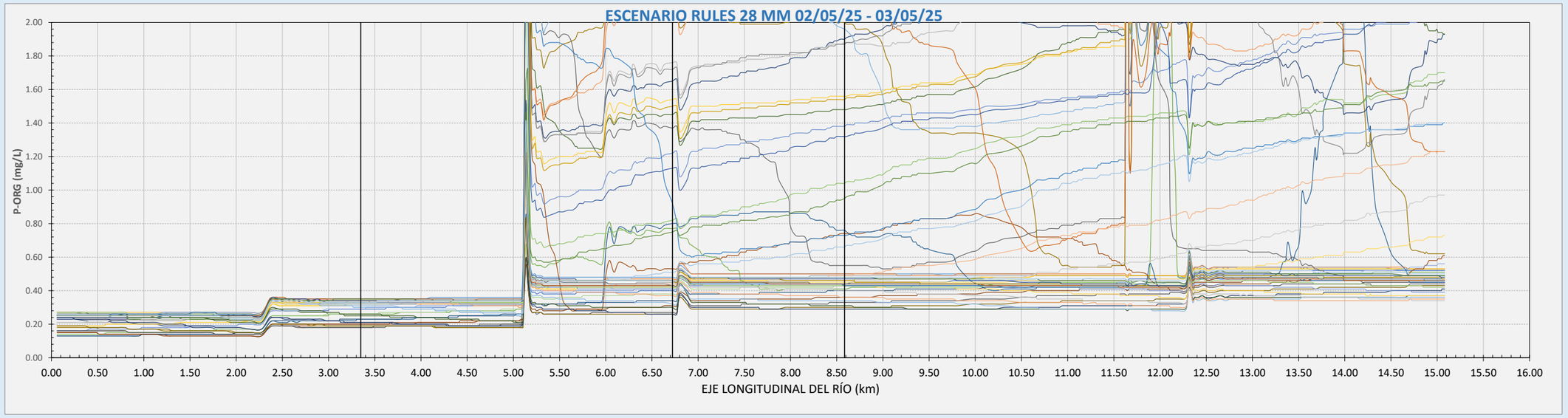
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***02/05 7,25 03/05 7,05 04/05 6,77***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2-día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractaria de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	

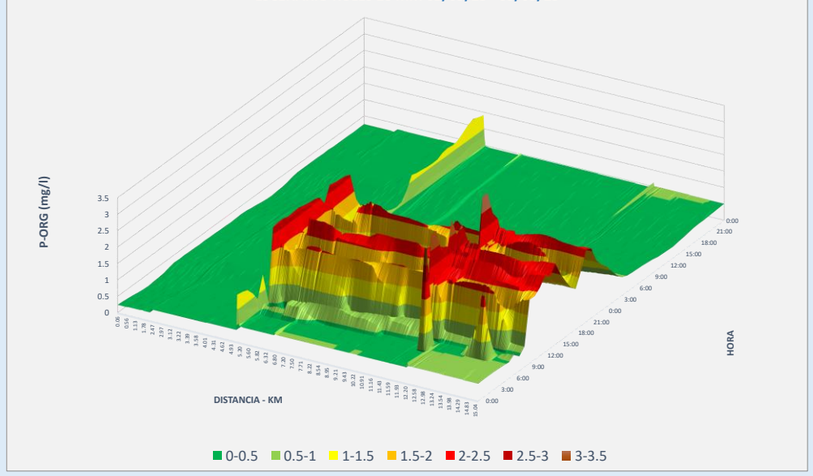
SECCIONES DE CONTROL- ESCENARIO RULES 28 MM 02/05/25 - 03/05/25

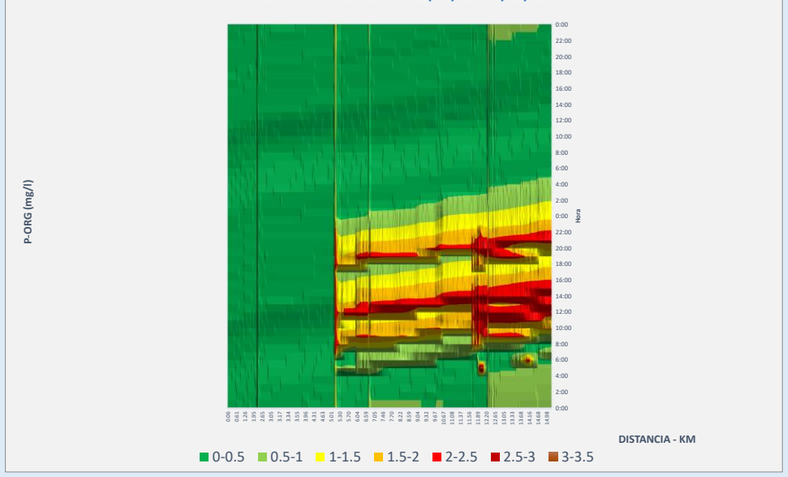


ESCENARIO RULES 28 MM 02/05/25 - 03/05/25





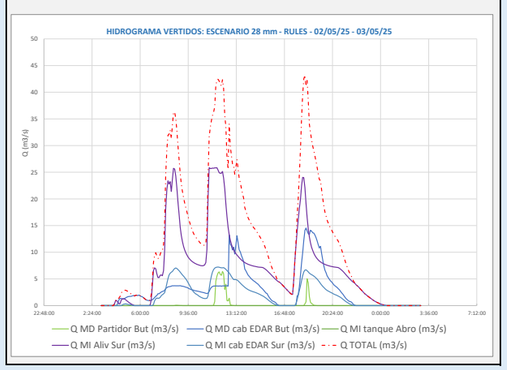




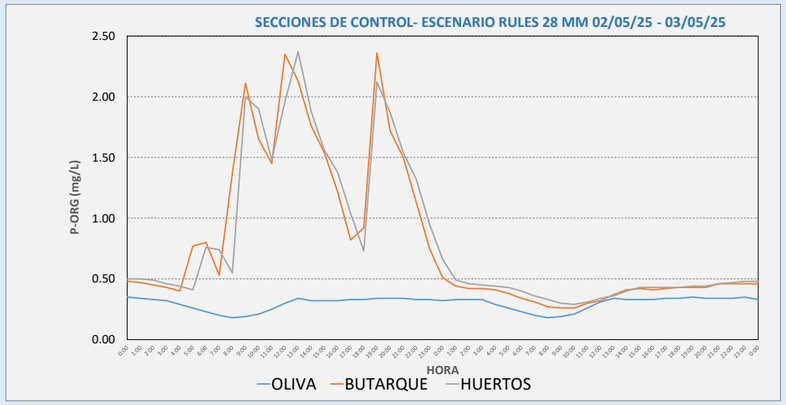
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

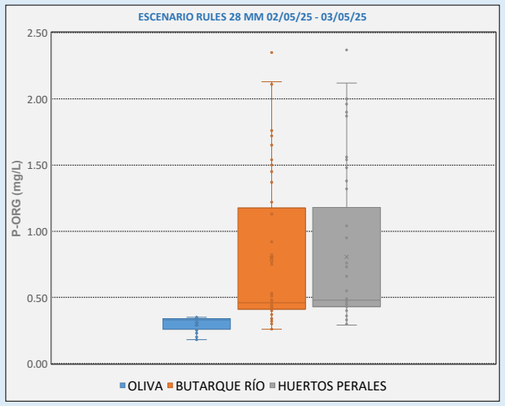
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - RULES

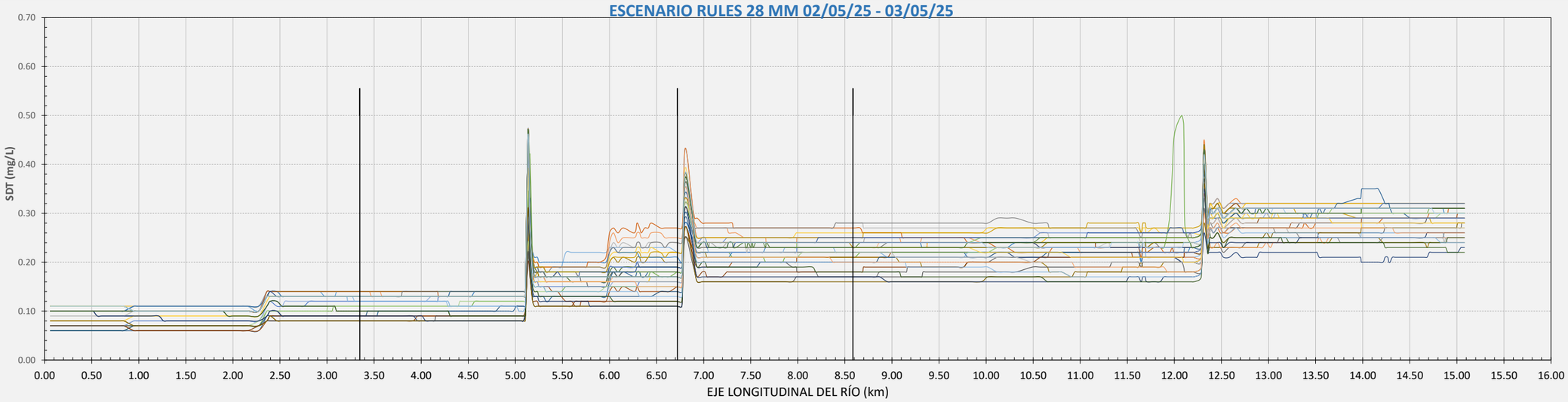


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**02/05 7,25** **03/05 7,05** **04/05 6,77**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

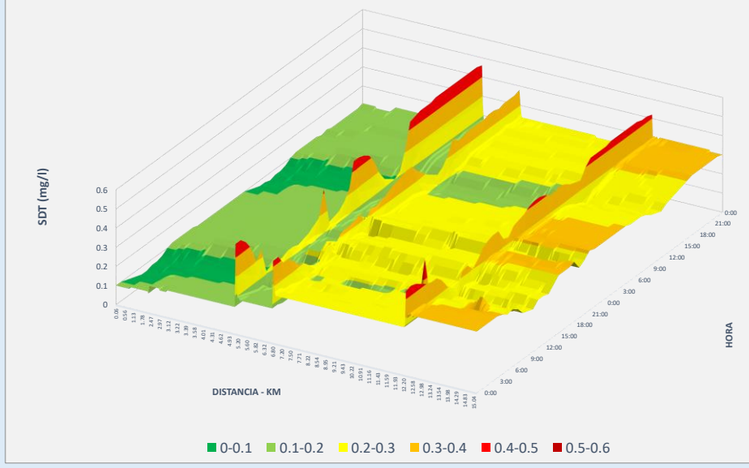




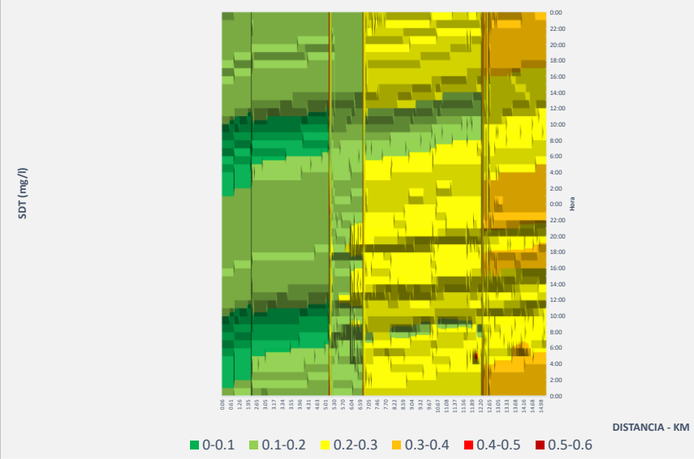
ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



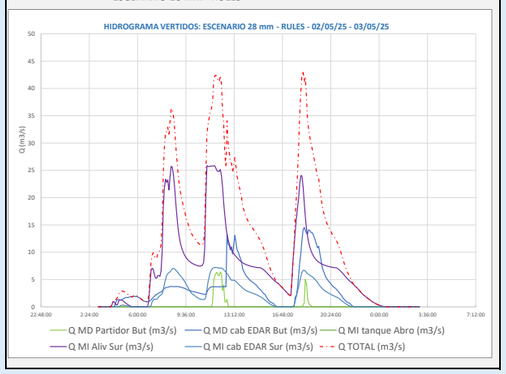
ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

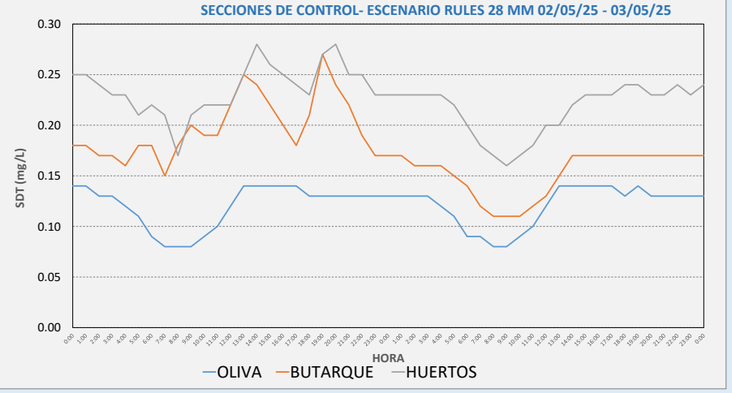
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - RULES

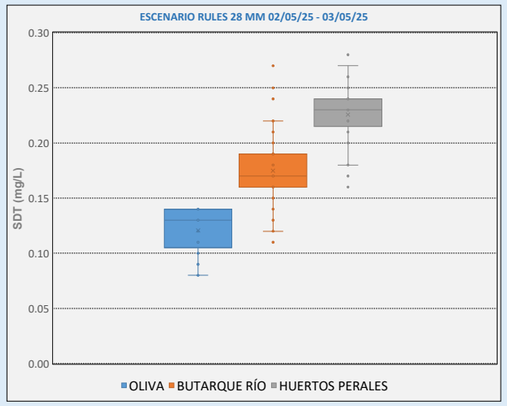


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**02/05 7,25** **03/05 7,05** **04/05 6,77**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m^2·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

SECCIONES DE CONTROL- ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



ESCENARIO RULES 28 MM 02/05/25 - 03/05/25



Annex 5.6.- Results for large event (28 mm) and MPC scenario

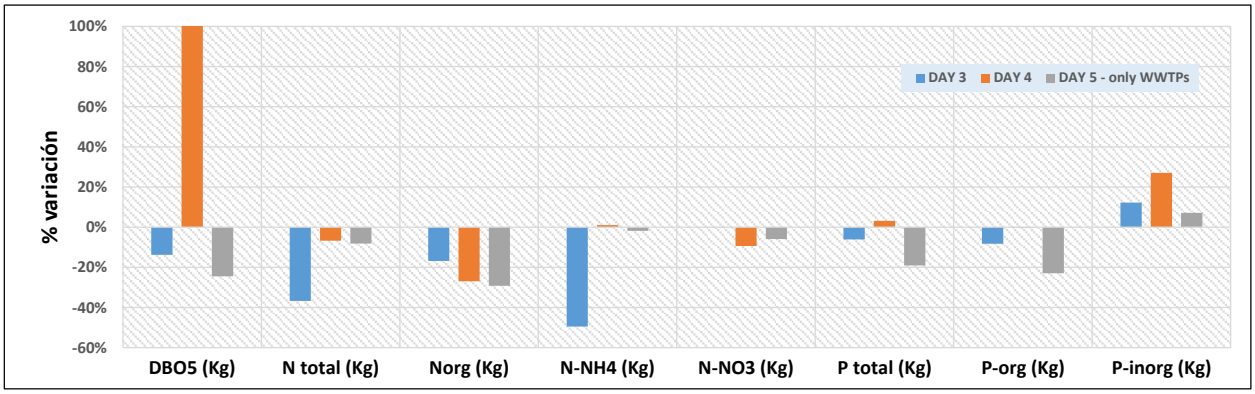
MASS BALANCE

Model scenario: 28 mm - MPC

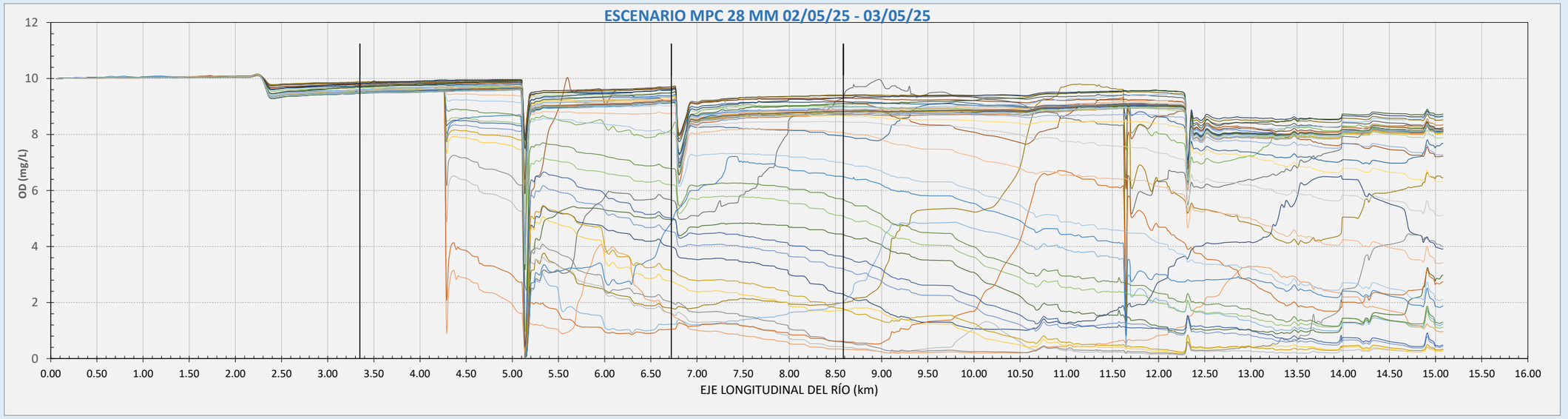
DAY 3	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	683	4347	993	100	3254	202	158	45
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	240584	22198	5737	16461	0	4043	3639	404
TOTAL INFLOWS	**246202**	**49306**	**11207**	**32712**	**5387**	**4801**	**4298**	**503**
OUTFLOW DAY 3	**212184**	**31218**	**9315**	**16511**	**5392**	**4507**	**3943**	**565**
Difference	-34018	-18088	-1892	-16201	5	-294	-356	62
% left	86.18%	63.31%	83.12%	50.47%	100.09%	93.88%	91.73%	112.25%
% variation	**-13.82%**	**-36.69%**	**-16.88%**	**-49.53%**	**0.09%**	**-6.12%**	**-8.27%**	**12.25%**

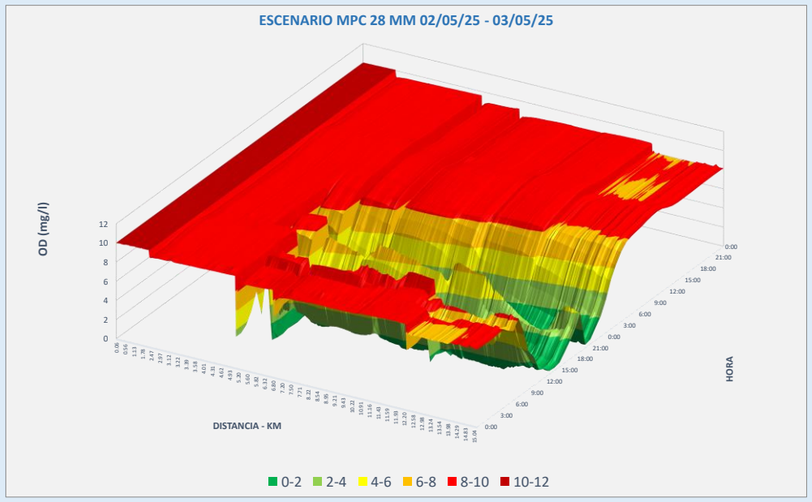
DAY 4	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	674	4260	976	99	3185	201	157	44
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	215	13	3	9	0	3	3	0
TOTAL INFLOWS	**5824**	**27033**	**5456**	**16259**	**5317**	**759**	**661**	**98**
OUTFLOW DAY 4	**14093**	**25225**	**3987**	**16419**	**4819**	**784**	**659**	**125**
Difference	8269	-1807	-1469	160	-498	24	-2	26
% left	241.98%	93.31%	73.07%	100.98%	90.64%	103.21%	99.68%	127.02%
% variation	**141.98%**	**-6.69%**	**-26.93%**	**0.98%**	**-9.36%**	**3.21%**	**-0.32%**	**27.02%**

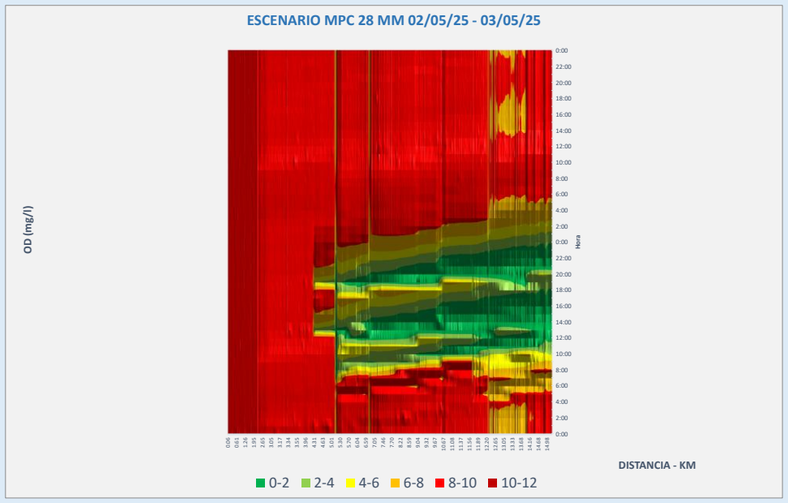
DAY 5 - only WWTPs	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
River head	662	4141	952	99	3090	198	156	43
WWTPs	4935	22760	4477	16151	2132	556	502	54
CSO discharges	0	0	0	0	0	0	0	0
TOTAL INFLOWS	**5597**	**26901**	**5429**	**16250**	**5222**	**754**	**658**	**97**
OUTFLOW DAY 5	**4224**	**24700**	**3845**	**15944**	**4911**	**610**	**507**	**103**
Difference	-1373	-2201	-1584	-305	-311	-144	-151	7
% left	75.47%	91.82%	70.82%	98.12%	94.04%	80.88%	77.03%	107.11%
% variation	**-24.53%**	**-8.18%**	**-29.18%**	**-1.88%**	**-5.96%**	**-19.12%**	**-22.97%**	**7.11%**



CSO Mass Balances	BOD5 (Kg)	TN (Kg)	Org-N (Kg)	NH4-N (Kg)	NO3-N (Kg)	TP (Kg)	Org-P (Kg)	Inorg-P (Kg)
CSO mass discharged on DAY 3	240584.2	22198.1	5736.6	16461.5	0.0	4042.9	3638.6	404.3
CSO mass outflow on DAY 3 (day 3 minus day 5)	207959.3	6517.7	5470.4	566.5	480.9	3897.2	3436.1	461.1
CSO mass outflow on DAY 4 (day 4 minus day 5)	9868.9	525.3	141.8	475.1	-91.6	173.7	152.6	21.1
Total CSO mass discharged over Days 3 and 4	217828.1	7043.0	5612.2	1041.6	389.2	4071.0	3588.8	482.2
CSO mass removed on Days 3–4	-22756.1	29241.0	-124.4	-15419.9	389.2	28.1	-49.8	77.9
% CSO mass removed on Days 3–4	-9.5%	-68.3%	-2.2%	-93.7%		0.7%	-1.4%	19.3%



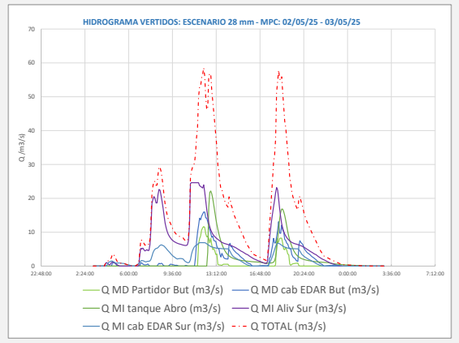




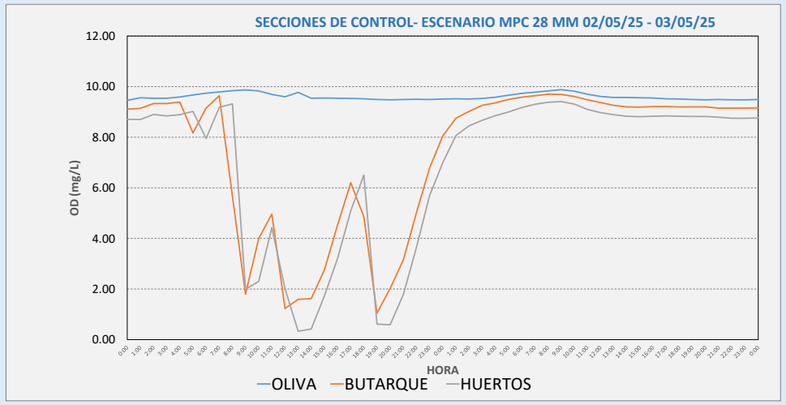
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

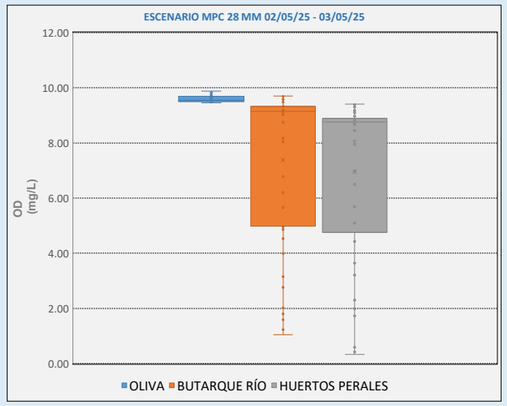
PROYECTO LIFE-RUBÍES

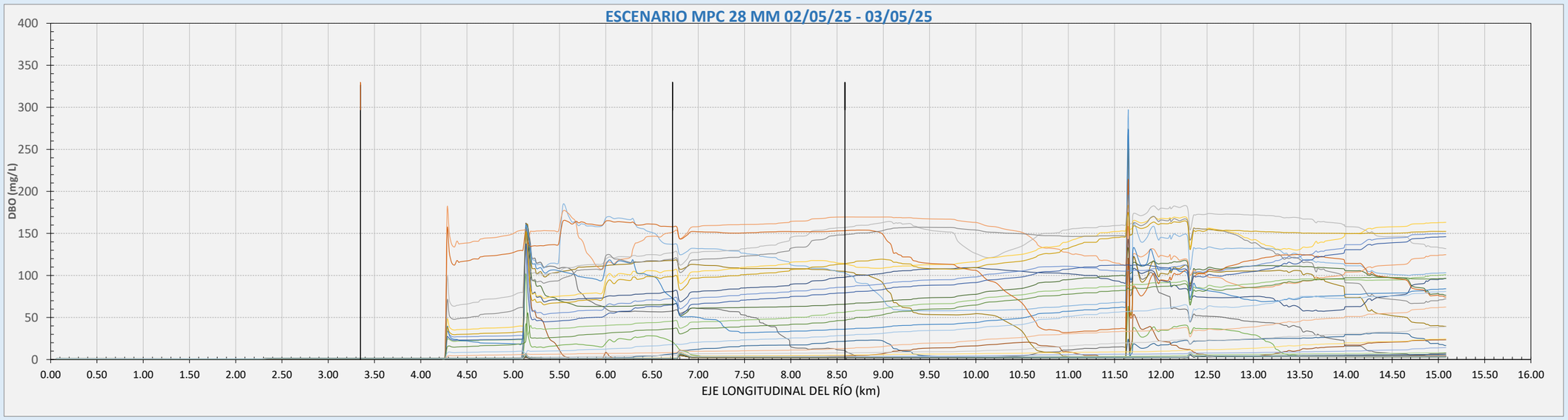
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - MPC

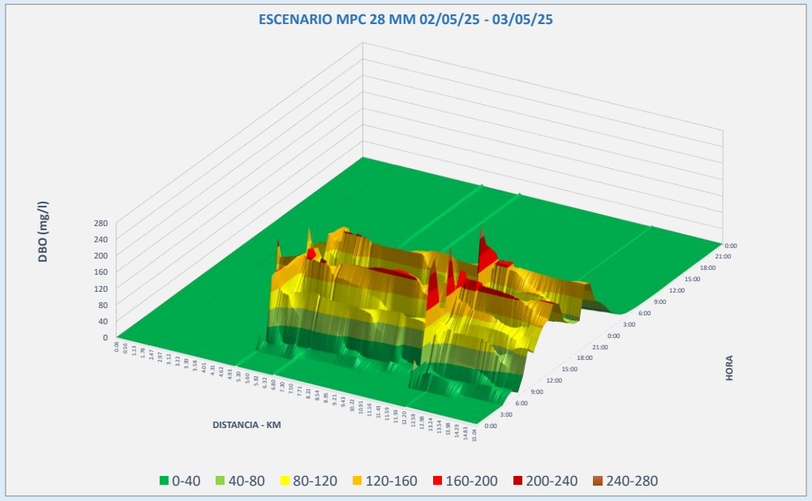


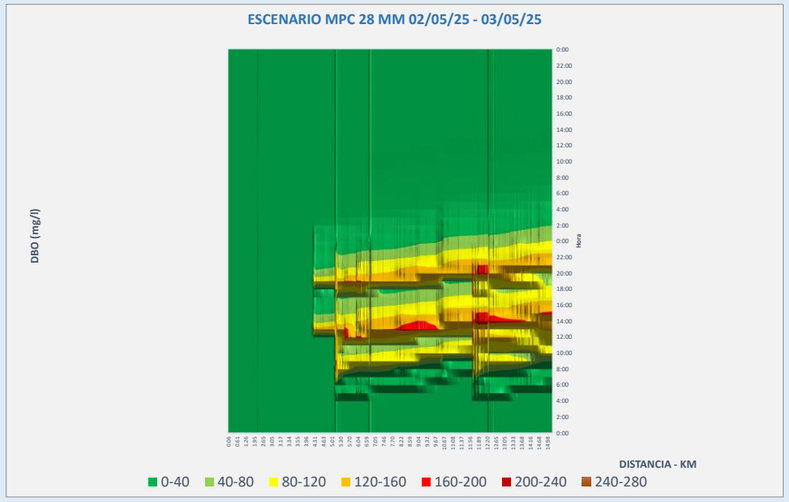
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm MPC – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**02/05 7,25** **03/05 7,05** **04/05 6,77**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{nn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	







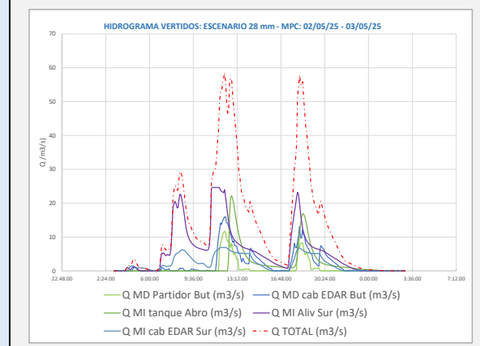




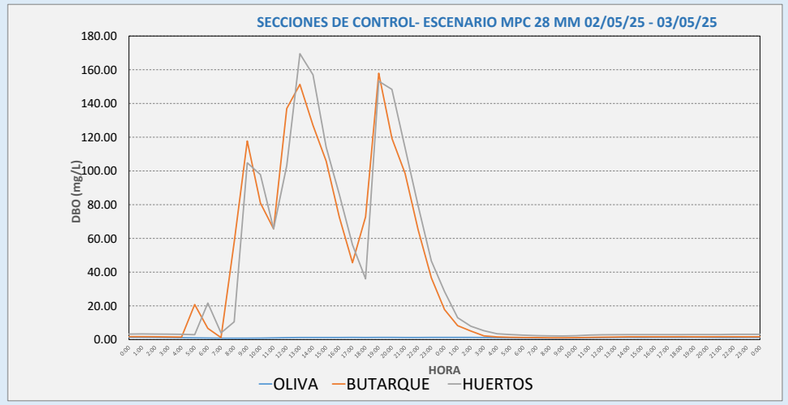
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

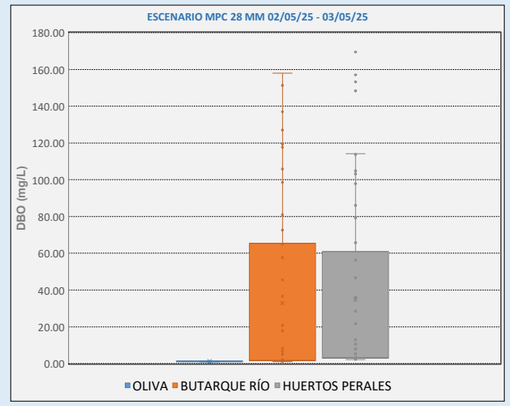
PROYECTO LIFE-RUBÍES

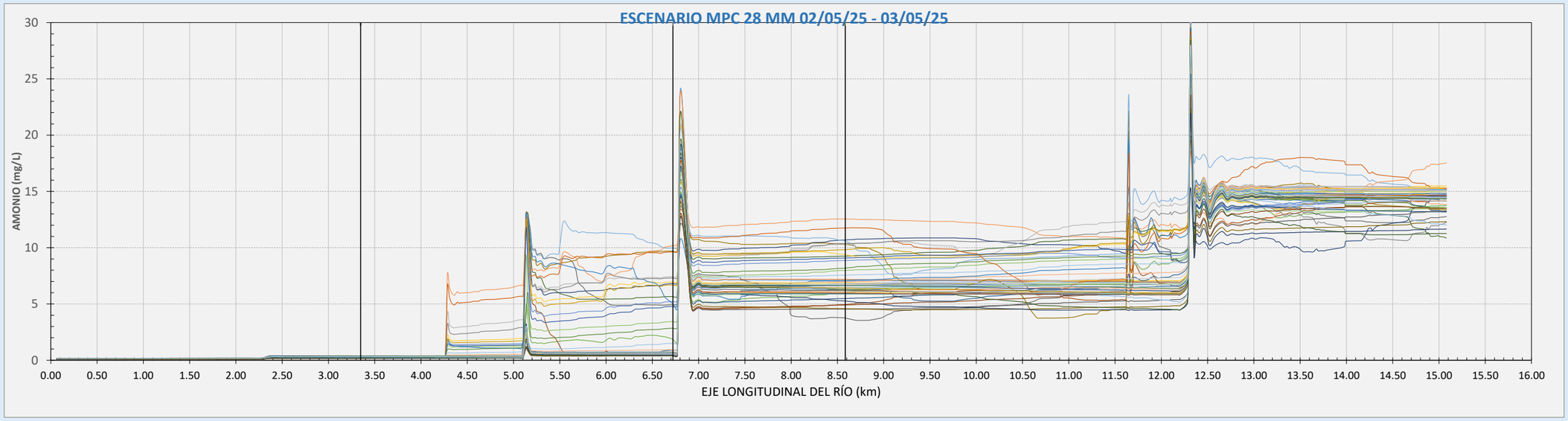
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - MPC

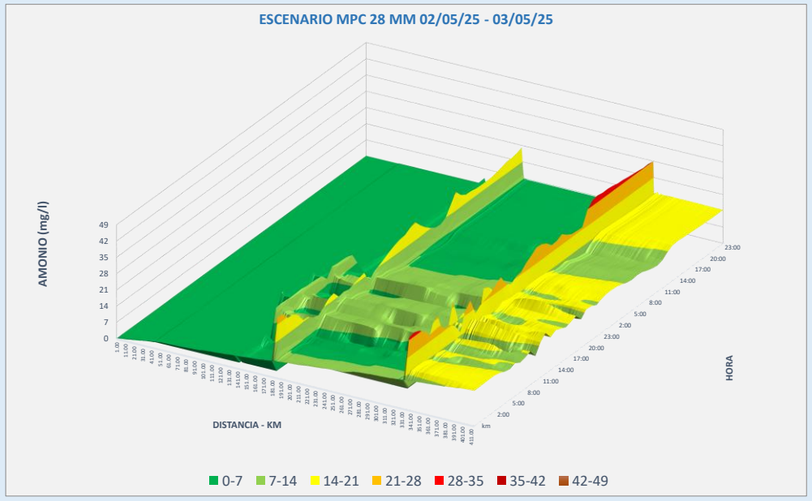


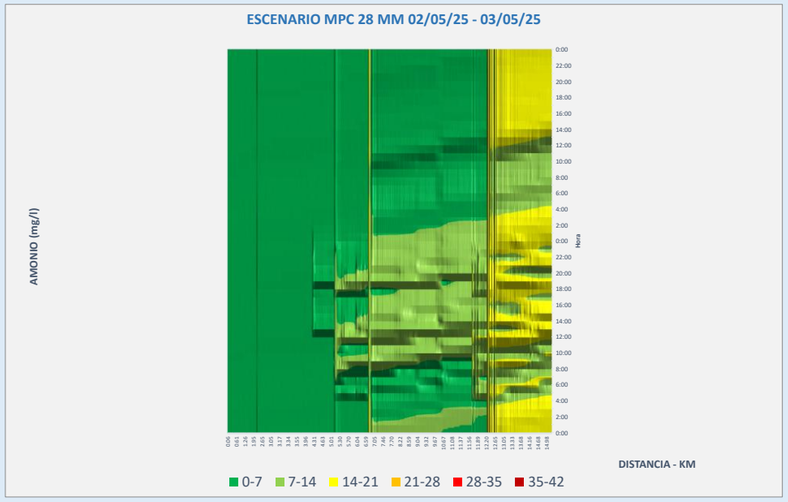
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm MPC – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**02/05 7,25** **03/05 7,05** **04/05 6,77**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m^2·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	







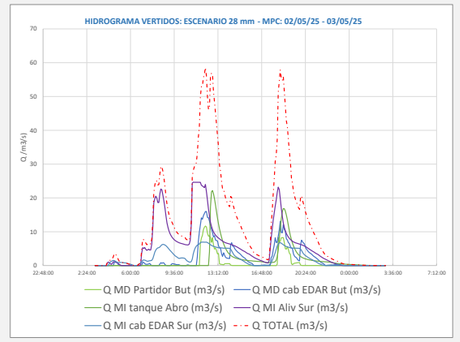




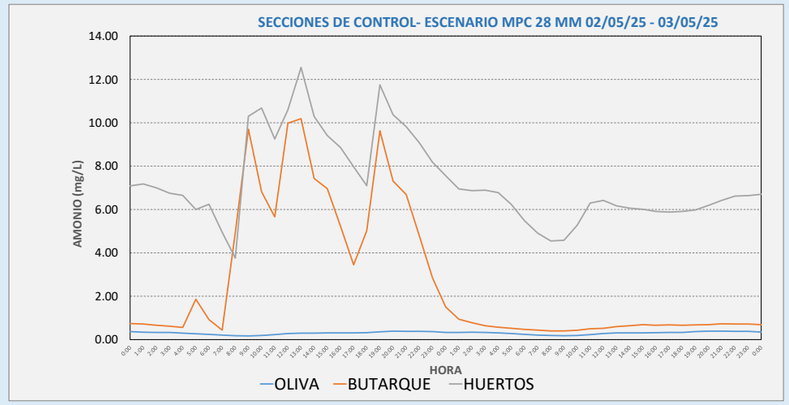
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

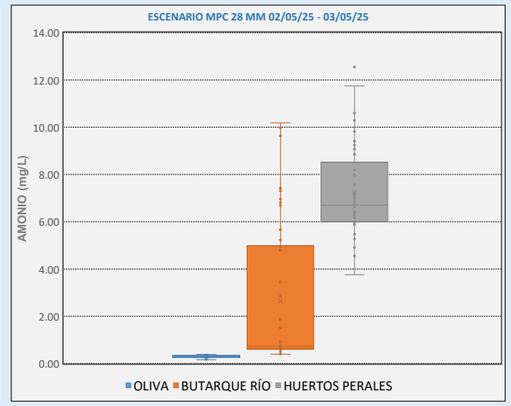
PROYECTO LIFE-RUBÍES

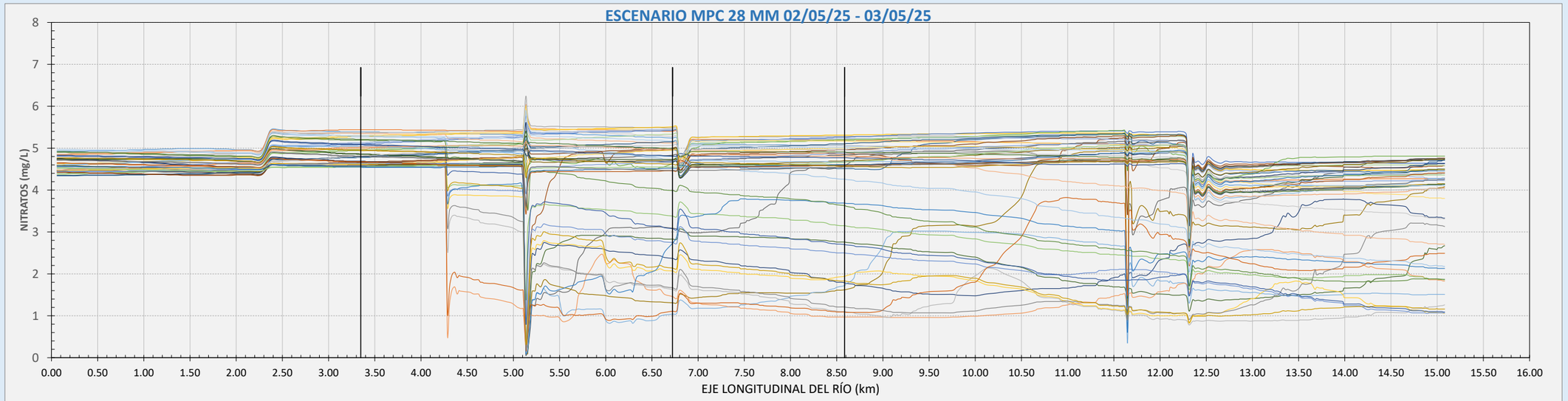
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - MPC

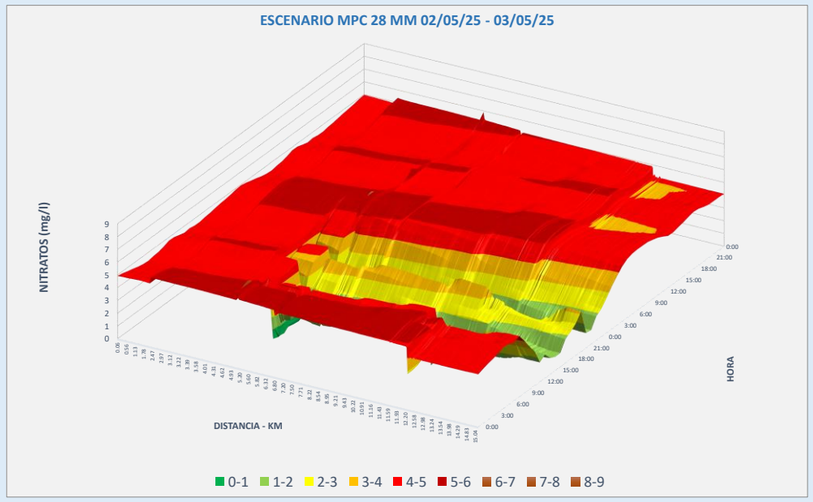


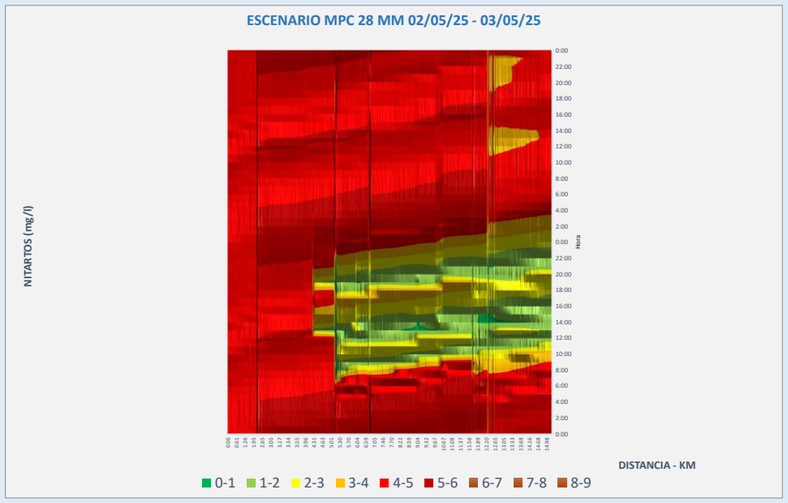
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm MPC – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	*1*	*2,5*	*5*	***02/05 7,25 03/05 7,05 04/05 6,77***	*Valor en Puente San Fernando*
Climatología					
Temperatura (ºC)	*10*	*20*	*30*	***10***	
Parámetros directamente vinculados al OD					
K_2	*Modelo Iber*			***Iber***	*OD cabecera fijado a 10*
DBOsed/DOS (g/m^2·día)	*0,05*	*0,5*	*2*	***0,5***	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	*0,05*	*0,5*	*2,5*	***1,1***	*DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4*
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	*0,005*	*0,05*	*0,5*	***0,5***	*0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6*
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	*0,02*	*0,25*	*2,5*	***0,60***	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	*0*	*0*	*0*	***0***	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	*0,05*	*0,25*	*1*	***0,5***	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	*0,03*	*0,3*	*3*	***0,3***	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	*0,003*	*0,03*	*1,8*	***0,06***	







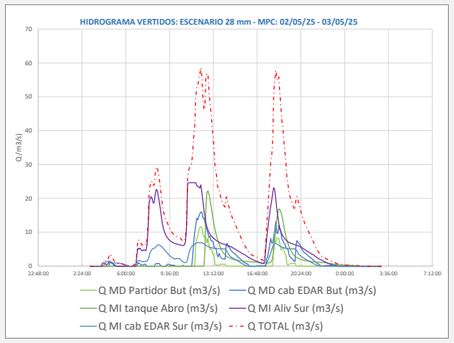




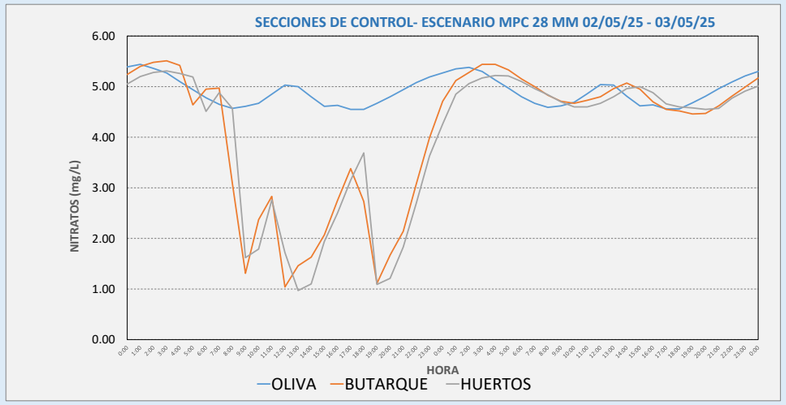
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

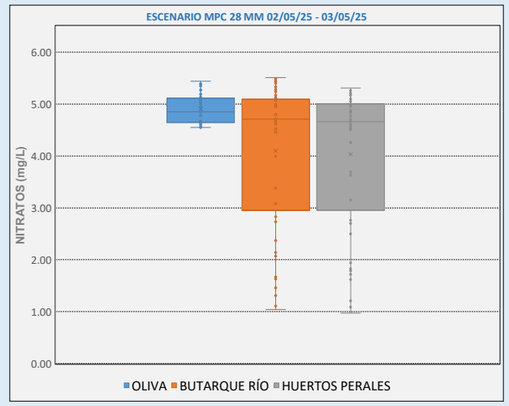
PROYECTO LIFE-RUBÍES

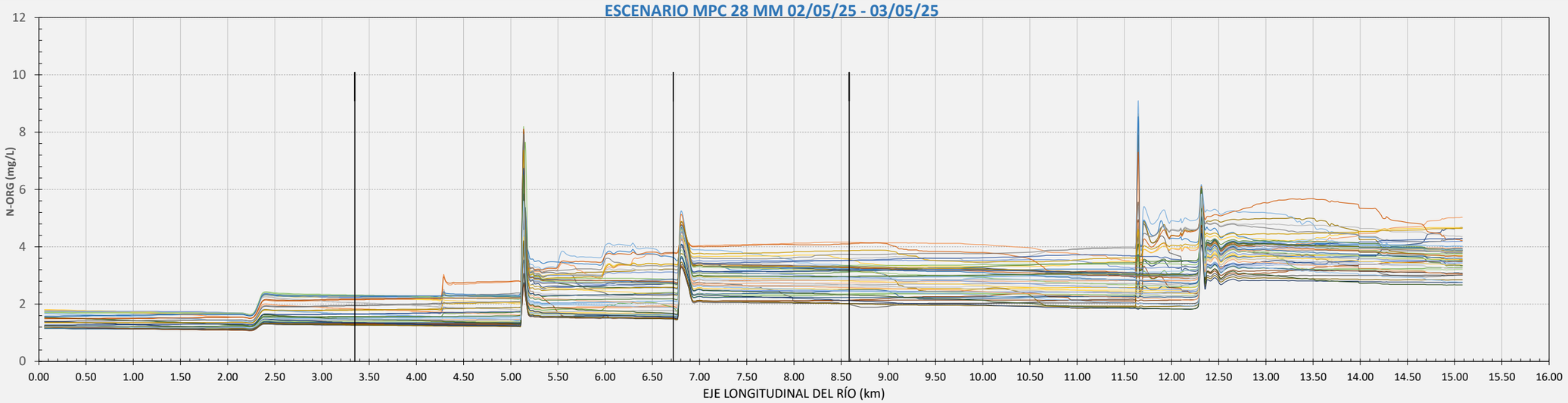
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - MPC

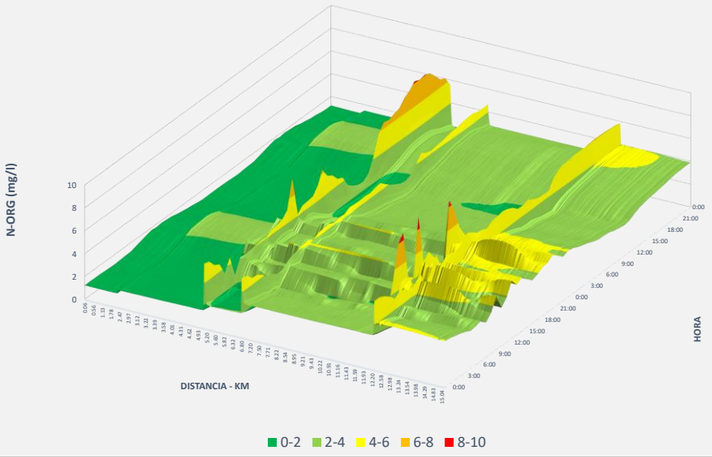


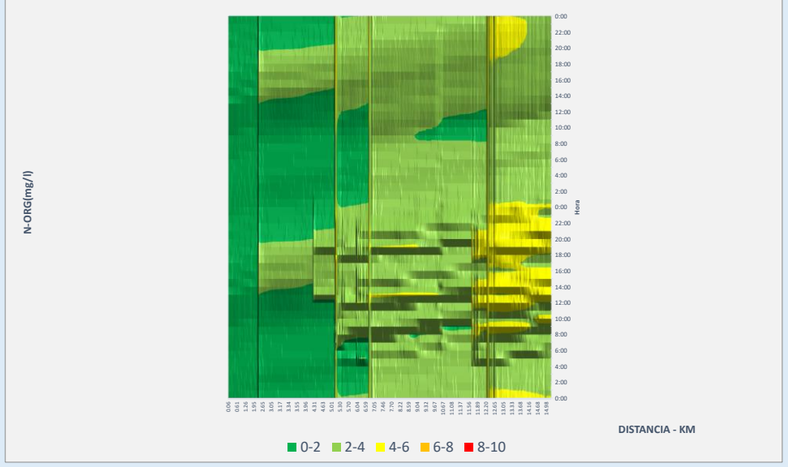
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm MPC – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**02/05 7,25** **03/05 7,05** **04/05 6,77**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m^2·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{sDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	







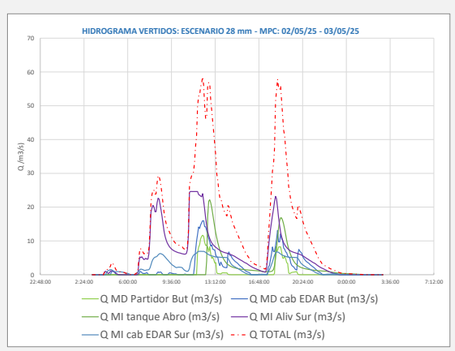




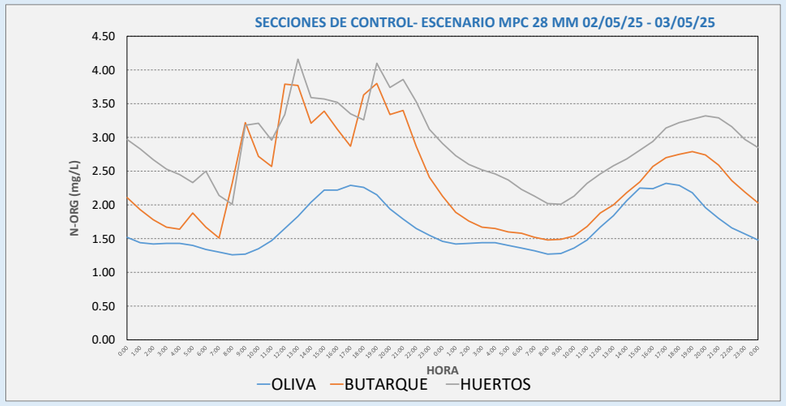
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

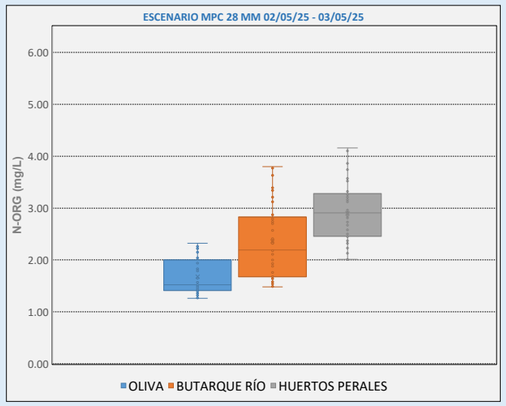
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - MPC

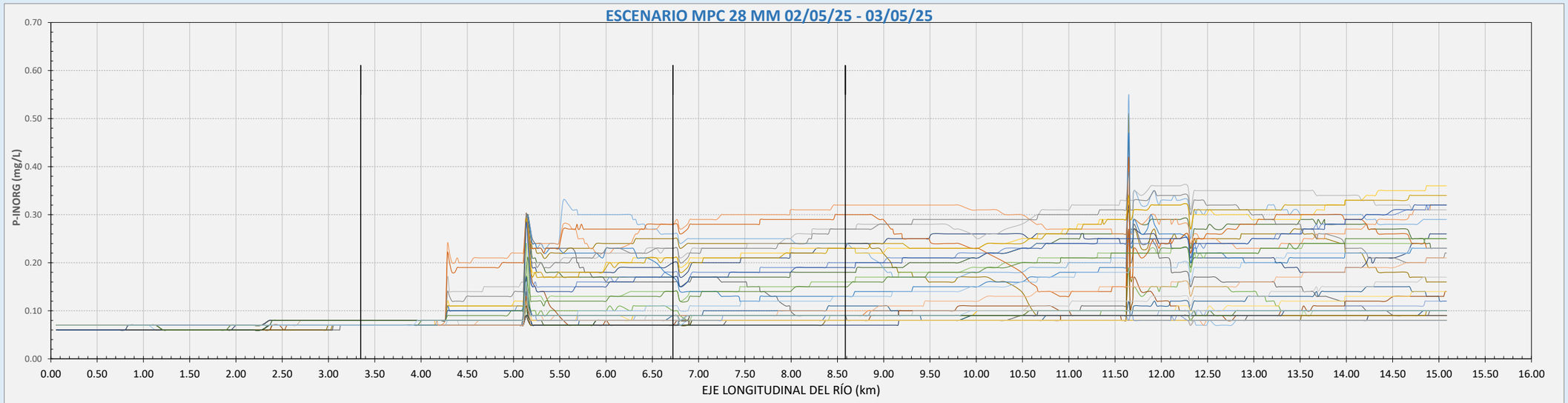


PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm MPC – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m³/s	1	2,5	5	**02/05 7,25** **03/05 7,05** **04/05 6,77**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m²·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día⁻¹)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día⁻¹)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día⁻¹)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día⁻¹)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día⁻¹)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

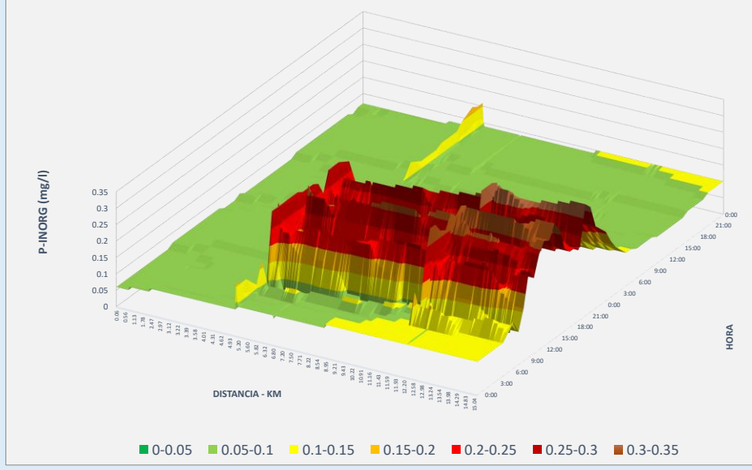




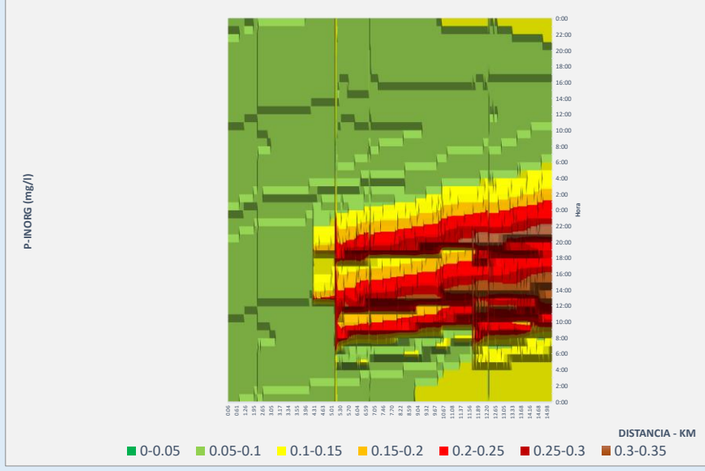
ESCENARIO MPC 28 MM 02/05/25 - 03/05/25



ESCENARIO MPC 28 MM 02/05/25 - 03/05/25



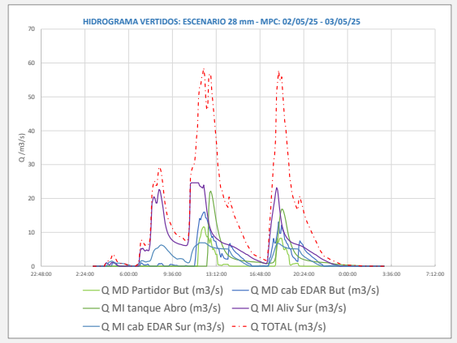
ESCENARIO MPC 28 MM 02/05/25 - 03/05/25



MPInELIZACIÓN DEL RÍO MANZANARES
A SU PASO POR MADRID

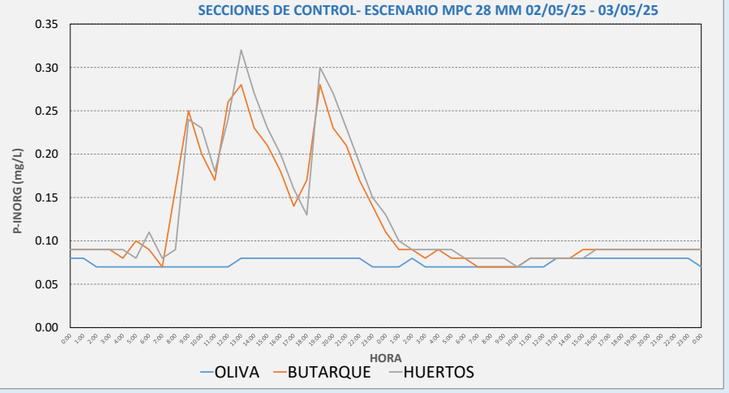
PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - MPC

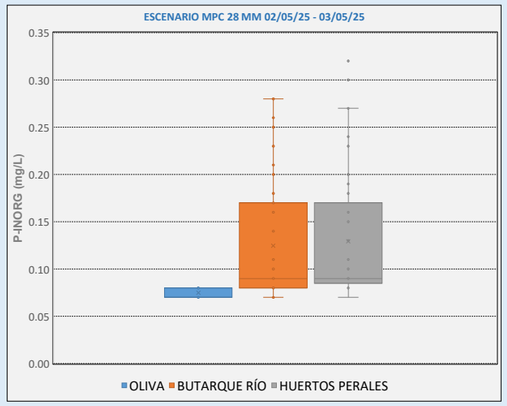


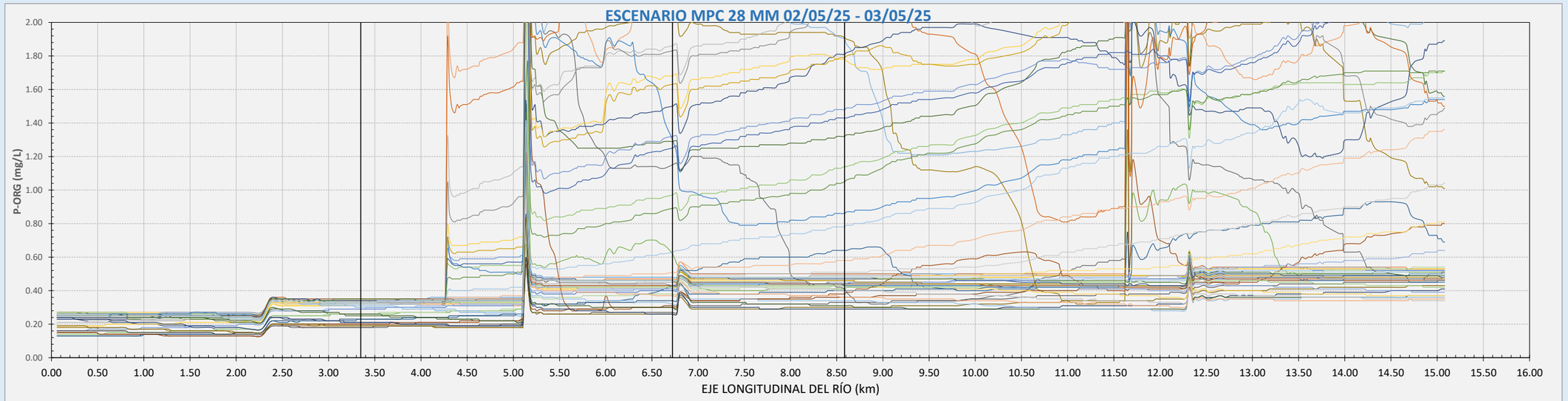
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm MPC – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**02/05 7,25** **03/05 7,05** **04/05 6,77**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m^2·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

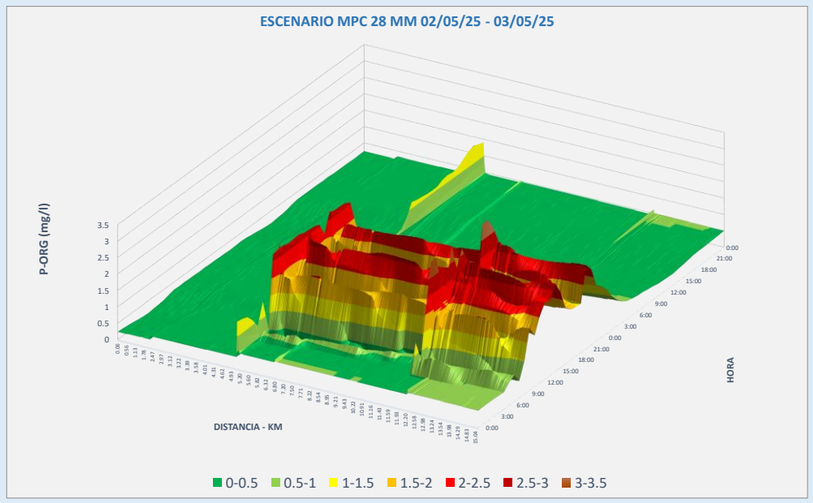
SECCIONES DE CONTROL- ESCENARIO MPC 28 MM 02/05/25 - 03/05/25

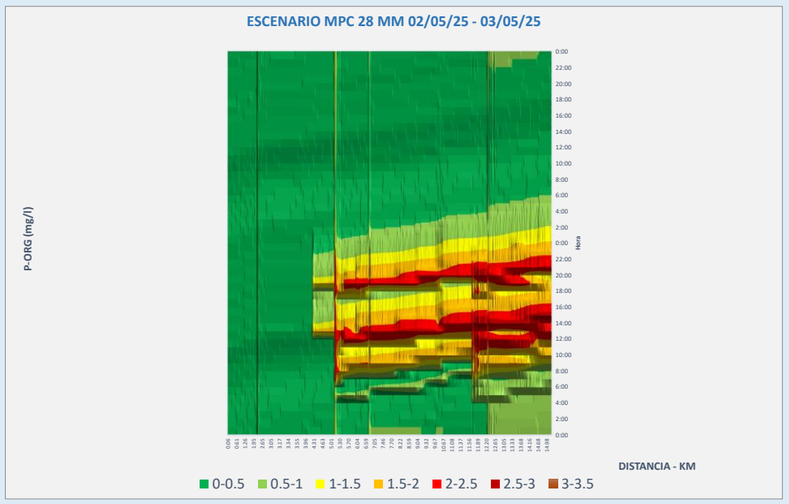


ESCENARIO MPC 28 MM 02/05/25 - 03/05/25





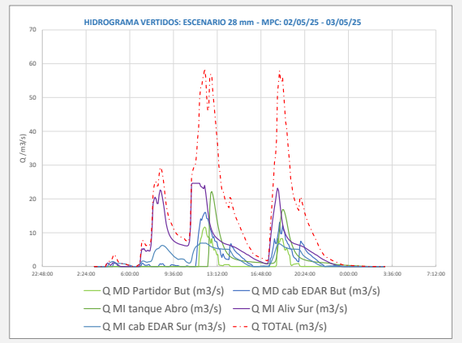




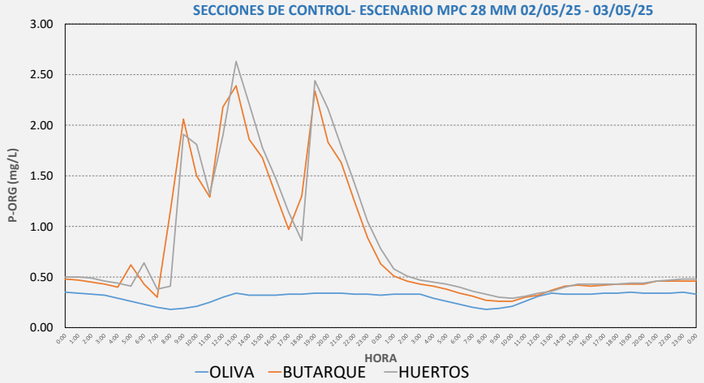
MODELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

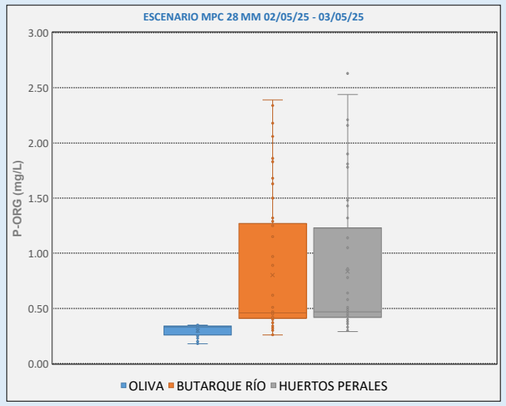
PROYECTO LIFE-RUBÍES

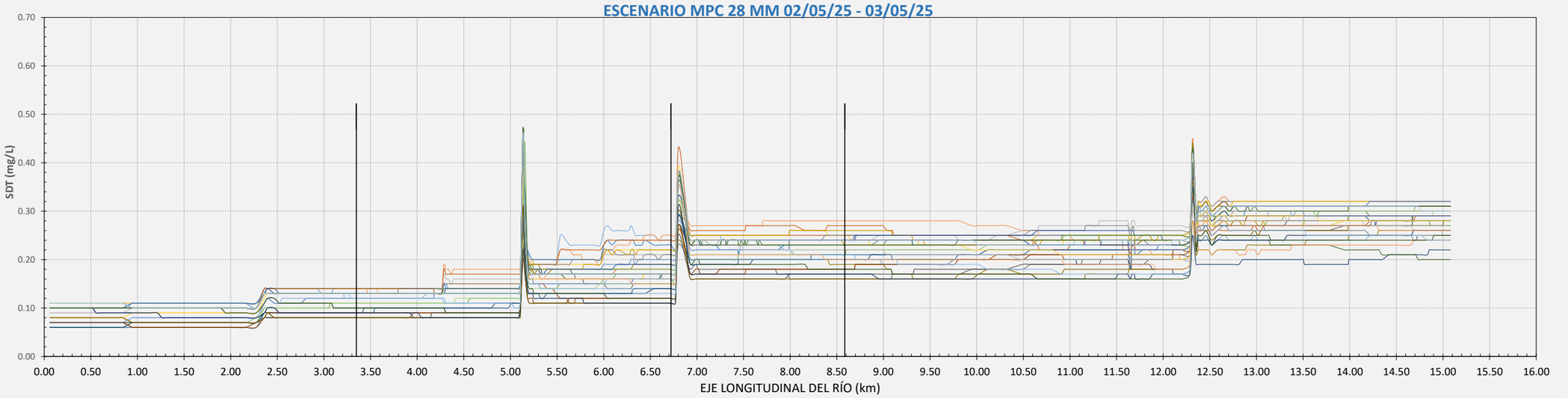
FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - MPC

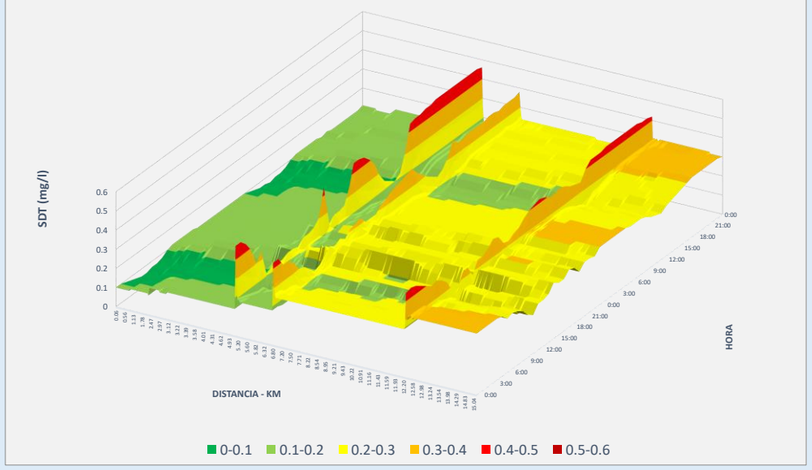


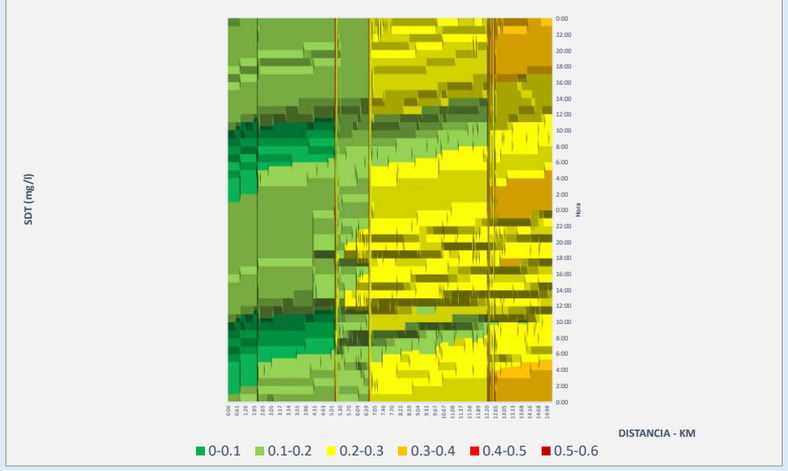
PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm MPC – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m³/s	1	2,5	5	**02/05 7,25** **03/05 7,05** **04/05 6,77**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a 10
DBOsed/DOS (g/m²·día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día⁻¹)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día⁻¹)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día⁻¹)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día⁻¹)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_p , tasa de hidrólisis *(día⁻¹)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	







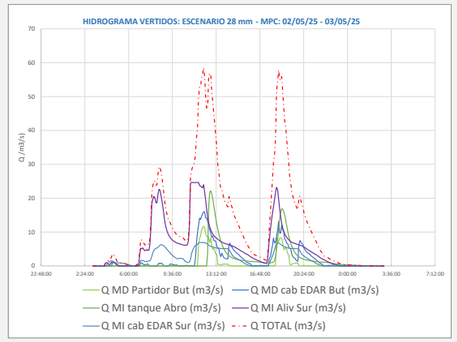




MSaltELIZACIÓN DEL RÍO MANZANARES A SU PASO POR MADRID

PROYECTO LIFE-RUBÍES

FASE: ANÁLISIS COMPARATIVO MPC - RULES
ESCENARIO 28 mm - MPC



PARÁMETROS Y RANGOS	VALORES MÍNIMOS	VALORES MEDIOS	VALORES ALTOS	ESCENARIO TLL 28 mm MPC – DSU 02/05/25 – 03/05/25	Valores en "cabecera"
Parámetros hidráulicos					
Caudal cabecera /m^3/s	1	2,5	5	**02/05 7,25** **03/05 7,05** **04/05 6,77**	Valor en Puente San Fernando
Climatología					
Temperatura (ºC)	10	20	30	**10**	
Parámetros directamente vinculados al OD					
K_2	Modelo Iber			**Iber**	OD cabecera fijado a **10**
DBOsed/DOS (g/m^2-día)	0,05	0,5	2	**0,5**	
Parámetros vinculados a la DBO					
K_1 , tasa de desoxigenación carbonosa *(día $^{-1}$)*	0,05	0,5	2,5	**1,1**	DBO5 río + DBO5 Viveros x factor atenuación = 0,5 + factor 0,4
v_{SDBO} velocidad de sedimentación de materia orgánica carbonosa (m/d)	0,05	0,25	1	**0,5**	
Parámetros vinculados al ciclo del Nitrógeno					
K_{hn} , tasa de amonificación *(día $^{-1}$)*	0,005	0,05	0,5	**0,5**	0,025 Norg refractario de EDAR Cabecera (N-NH4+ río) + (N-NH4+ Viveros) = 0,5 + factor 0,6
K_{nit} , tasa de nitrificación *(día $^{-1}$)*	0,02	0,25	2,5	**0,60**	
K_{denit} , tasa de desnitrificación *(día $^{-1}$)*	0	0	0	**0**	
v_{SN} , velocidad de sedimentación de materia orgánica nitrogenadas (m/d)	0,05	0,25	1	**0,5**	
Parámetros del ciclo del Fósforo					
K_P , tasa de hidrólisis *(día $^{-1}$)*	0,03	0,3	3	**0,3**	
v_{SPO} , v_{SPIN} velocidades de sedimentación del fósforo orgánico e inorgánico (m/d)	0,003	0,03	1,8	**0,06**	

