



**Sustainable Water  
Integrated Management (SWIM) -  
Support Mechanism**



Project funded by  
the European Union

*Water is too precious to waste*

**TWO DAYS TRAINING ON THE OPERATION AND MANAGEMENT OF WWTPS**

9-10 September, Murcia

**Control of Maintenance and Operation of WWTPs**

*Presented by: Juan Marco Perez Garcia*

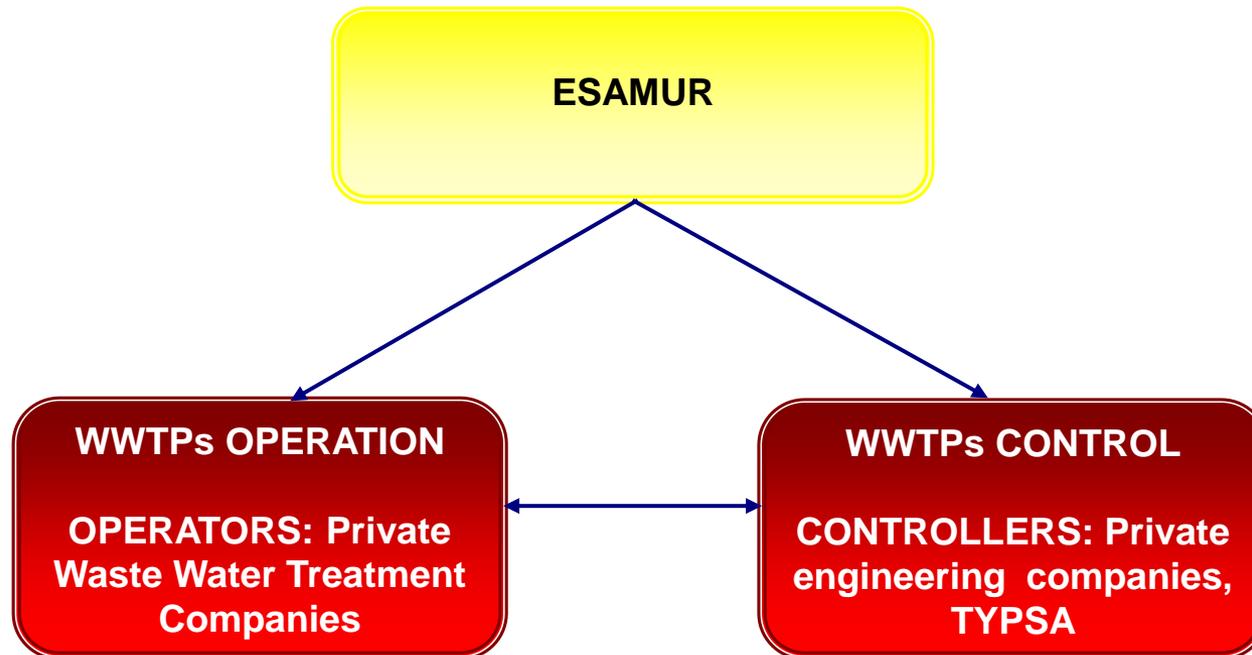
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# Regional Agency for Wastewater Treatment and Sanitation (ESAMUR)

- ▶ **The Regional Agency for Wastewater Treatment and Sanitation (ESAMUR)** is a public regional company created by the regional law 3/2000, July 12, being part of the Agriculture and Water Department of the Regional Government of Murcia.
- ▶ **ESAMUR** collects and manages the economic resources obtained through a **Sanitation Tax**, applying them to the operation, maintenance and control of all the public WWTPs and sanitation facilities.
- ▶ **ESAMUR** does not operate directly the facilities, awarding these tasks to private companies by public bidding.
- ▶ **ESAMUR** has divided the Region in two operating and control zones exerting the control of the operation through two private engineering companies, one for each zone.

# Regional Agency for Wastewater Treatment and Sanitation (ESAMUR)



# Regional Agency for Wastewater Treatment and Sanitation (ESAMUR)

## □ Payments to WWTPs operation contractors:

The analysis and flows data gathered by the controller are used by ESAMUR to pay the WWTPs operation contractors.

Retribution = Fixed + Variable

Fixed part = € / d x d / month

Variable = V x C x Q ; V = € / m<sup>3</sup>; Q = m<sup>3</sup> / month; C = quality coefficient

C depends on the contaminant load reduction:

Example:  $C = 0,3 \times (RSS/98) + 0,5 \times (RDQO/98) + 0,2 \times (RNt/90)$

# Main Wastewater Treatment Regulations

## □ European Regulations:

- Council Directive of 21 May 1991 concerning **urban waste water treatment (91/271/EEC)**.
- Council Directive of 12 June 1986 on the protection of the environment, and in particular of the soil, when **sewage sludge is used in agriculture (86/278/EEC)**.
- **Directive 2000/60/EC** of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (water framework Directive).

## □ Spanish regulations:

- RD 509/1996 and RD 1310/1990 which incorporates into national law 91/271/EEC and 86/278/EEC Directives.
- RD 1620/2007, of December 7, which establishes the juridical framework for treated wastewater reuse.

# Main Wastewater Treatment Regulations

- RD 1290/2012, of May 23, which modifies RD 849/1986 and RD 509/1996, approving the hydraulic public domain regulation → discharge consents.
- Ley 34/2007, of November 15, on the air quality and protection of atmosphere → consent for activity potentially contaminant of the atmosphere.
- RD 9/2005, of January 14, which lists the activities potentially contaminant of soil → report on soil status.
- Ley 16/2002, July 1, on the prevention and control of contamination → annual environmental declaration.

# WWTPs Operation and Maintenance

## □ Works included:

- All works necessary to guarantee the optimal operation of all the facilities and their elements (WWTPs, pump stations, mains sewer pipes).
- The OPERATOR is responsible for:
  - Process control
  - Compliance with discharge concentration limits
  - Electromechanical and general maintenance
  - Health and Safety procedures
  - Staff

# Control of WWTPs Operation

## □ Works included:

### ○ In general:

- Supervision and control of the public wastewater treatment facilities: WWTPs, pumping Stations, main sewer systems and submarine outfalls.
- Evaluation and supervision of costs and quality of the contractors service.

### ○ Specifically:

- Supervision and control of the maintenance and operation of the facilities.
- Analytical control of processes, water and sludge.
- Control of compliance with environmental regulations
- Monthly reports, technical sheets, upgrade proposals

# Control of WWTPs Operation

- ▶ Types of work:
  - Analytical work
  - Field work
  - Office work
  - Experimental work
  - Supervision and control of submarine outfalls

# Control of WWTPs Operation

- Number of facilities to control
  - Zone 1 (south, Guadalentín and Northwest):
    - 45 WWTPs
    - 28 pumping stations
    - Main sewer pipes and force mains
    - 2 submarine outfalls
  - Zone 2 (Vega Media, Levante and Vega Alta)
    - 43 WWTPs
    - 18 Pumping Stations
    - Main sewer pipes and force mains
- Annual Wastewater Volume and Contaminant Load (2012)
  - 109,406,674 m<sup>3</sup>
  - 54,593 tm BOD<sub>5</sub>
  - 8,425 tm total N

# Control of WWTPs Operation

## □ Wastewater treatment magnitudes:

		2012
<b>Treated wastewater volumen</b>	Hm <sup>3</sup>	109,4
<b>Sludge (dry mass &gt;14%)</b>	1000 x Tn	141,4
<b>Organic load received (BOD<sub>5</sub>)</b>	1000 x Tn	45,9
<b>Organic Load removed (BOD<sub>5</sub>)</b>	1000 x Tn	45,3
<b>Equivalent population</b>	1000 x PE	2.090
<b>Average removal achieved</b>	%	98,7%
<b>Energy consumed</b>	Gwh	55,0
<b>Energy Ratio</b>	(Kwh/m <sup>3</sup> )	0,50

# Control of WWTPs Operation

- Work magnitudes:
  - 1,435 technical visits.
  - 3,758 water line samples.
  - 1,658 sludge line samples.
  - 2,850 microbiological samples.
  - 850 mixed liquor samples.



# Control of WWTPs Operation: Analytical control

- Analytical control:
  - The sampling frequency depends on the treated load (1 p.e = 60 g of BOD5/d). There are 5 types of analysis plans:

Anlytical Plan	p.e.
Type 1	> 100,000
Type 2	50,000–100,000
Type 3	10,000–50,000
Type 4	2,000–10,000
Type 5	< 2,000

# Control of WWTPs Operation: Analytical Plan

## □ Analytical plan (W:Weekly, BW:Byweekly, M:Monthly)

Influent					
PARAMETER	Type 1	Type 2	Type 3	Type 4	Type 5
pH in situ	W	BW	BW	BW	M
SST	W	BW	BW	BW	M
BOD5	W	BW	BW	BW	M
COD	W	BW	BW	BW	M
N total	W	BW	BW	BW	M
P total	W	BW	BW	BW	M
<b>SSV</b>	W	BW	BW	BW	M
<b>Conductivity</b>	W	BW	BW	BW	M
<b>NO<sub>3</sub><sup>-</sup></b>	W	BW	BW	M	M
<b>TKN</b>	W	BW	BW	M	M

Effluent					
Parameter	Type 1	Type 2	Type 3	type 4	Tipo 5
pH in situ	W	BW	BW	BW	M
TURBIDITY	W	BW	BW	BW	M
SST	W	BW	BW	BW	M
BOD5	W	BW	BW	BW	M
COD	W	BW	BW	BW	M
N TOTAL	W	BW	BW	BW	M
NTK	W	BW	BW	BW	M
P TOTAL	W	BW	BW	BW	M
CONDUCTIVTY	W	BW	BW	BW	M
NO <sub>3</sub> <sup>-</sup>	W	BW	BW	BW	M
NH4-N	W	BW	BW	BW	M
E. coli	W	BW	BW	BW	M

# Control of WWTPs Operation: Analytical Plan

Effluent disinfection					
Parameter	Type 1	Type 2	Type 3	Type 4	Type 5
Transmittance	W	BW	BW	BW	M
Chlorine	W	BW	BW	BW	M

Dry sludge					
PARAMETER	Type 1	Type 2	Type 3	Type 4	Type 5
DRY MATTER	W	BW	BW	BW	M
VOLATILE MATTER	W	BW	BW	BW	M

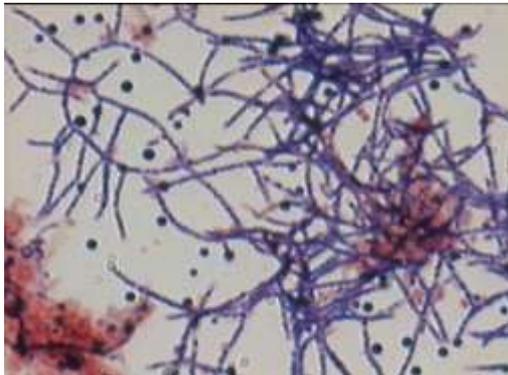
Thickened sludge					
PARAMETER	Type 1	Type 2	Type 3	Type 4	Type 5
DRY MATTER	M	M	M	M	M
VOLATILE MATTER	M	M	M	M	M

Recirculated sludge					
PARAMETER	Type 1	Type 2	Type 3	Type 4	Type 5
TSS	M	M	M	M	M
VSS	M	M	M	M	M

ANEROBIC DIGESTION					
PARÁMETRO	Tipo 1	Tipo 2	Tipo 3	Tipo 4	Tipo 5
Volatile Fatty Acids	M	M	M	M	M
Alcalinity	M	M	M	M	M
Volatile matter before digestion	M	M	M	M	M
Volatile matter after digestion	M	M	M	M	M
Dry matter before digestion	M	M	M	M	M
Dry matter after digestion	M	M	M	M	M
SH <sub>2</sub> in biogas	M	M	M	M	M
CH <sub>4</sub> in biogas	M	M	M	M	M

# Control of WWTPs Operation: Analytical Plan

Mixed Liquor					
PARÁMETRO	Type 1	Type 2	Type 3	Type 4	Type 5
Microscopic examination	M	M	M	M	<b>M</b>
MLSST (mg/l)	M	M	M	M	<b>M</b>
MLSSV (%)	M	M	M	M	<b>M</b>



Nocardia spp. 1000X Tinción de Gram



Vorticellas 100X Contraste de fases

# Control of WWTPs Operation: Field work

## □ Field Work:

### ○ Sites Visits frequency:

Analytical Plan	Eq. p	Frequency
Type 1	>100,000	W
Type 2	50,000–100,000	BW
Type 3	10,000–50,000	BW
Type 4	2,000–10,000	M
Type 5	<2,000	M

### ○ Site visits objectives:

- Follow up of the daily operation and maintenance of the facilities.
- Control of the treatment process.
- Collection of information, like power consumption and flow rates.

# Control of WWTPs Operation: Field work

- Field work description:
  - Supervision of the Electromechanical maintenance.
  - Detection of maintenance, operation and process problems.



Predictive maintenance by measuring vibrations of a blower



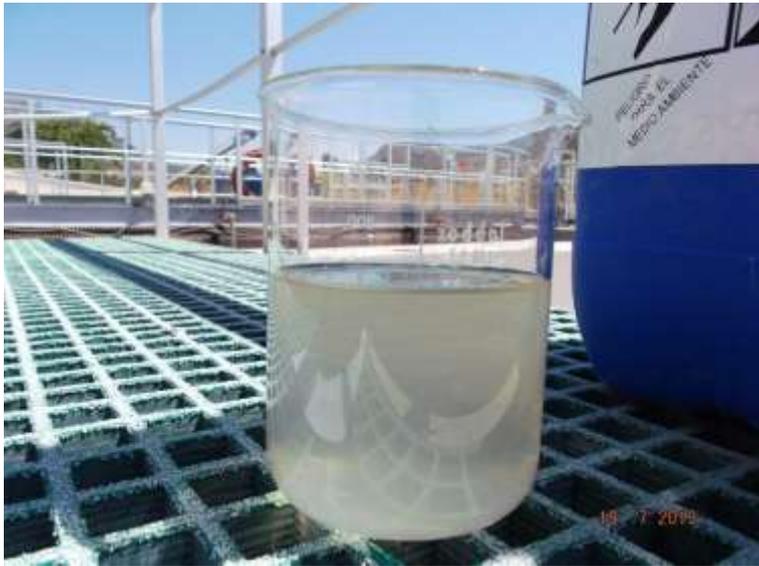
Preventive maintenance of a centrifuge

# Control of WWTPs Operation: Field work



Filamentous foaming in a biological reactor and secondary sedimentation tank.

# Control of WWTPs Operation: Field work



Turbid effluent because of aeration deficit and submersible aerator clogged with fibers.

# Control of WWTPs Operation: Field work



Clogging of flat membranes and formation of sludge cake

# Control of WWTPs Operation: Field work

- Control of the general visual aspect of the facilities



WWTPs of Caravaca and Alhama located in the Murcia Region

# Control of WWTPs Operation: Field work

- Control and assessment of improvement work done by the contractor in the facility



Sand filters refurbishment work.



Change of the cover of a pretreatment building

# Control of WWTPs Operation: Field work

- Study and assessment of the possible environmental impacts caused by generation of odors, noise and other factors.



Measuring noise and odors (H<sub>2</sub>S)

# Control of WWTPs Operation: Field work

- Control of the effluent discharge point and sludge management.



Load of sludge for transport to composting plant



Discharge point into an irrigation pond

# Control of WWTPs Operation: Field work



Direct application of sludge to agriculture

# Control of WWTPs Operation: Field work

- Energy consumption optimization, paying special attention to aeration systems.



Checking the operation off the air diffusers and detail of a clogged one

# Control of WWTPs Operation: Field work



Cleaning up membrane diffusers and rotary blowers.

# Control of WWTPs Operation: Office work

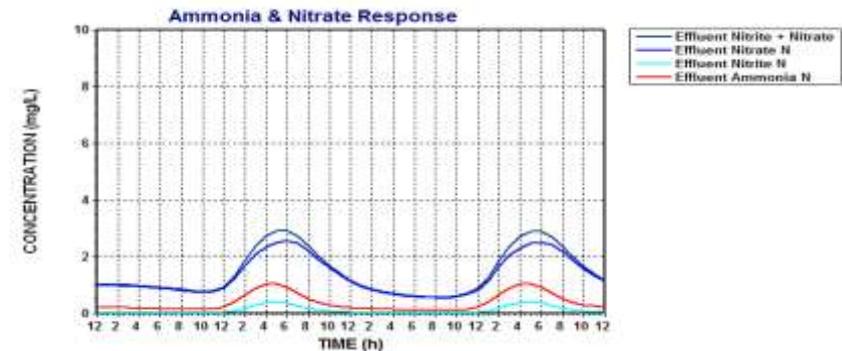
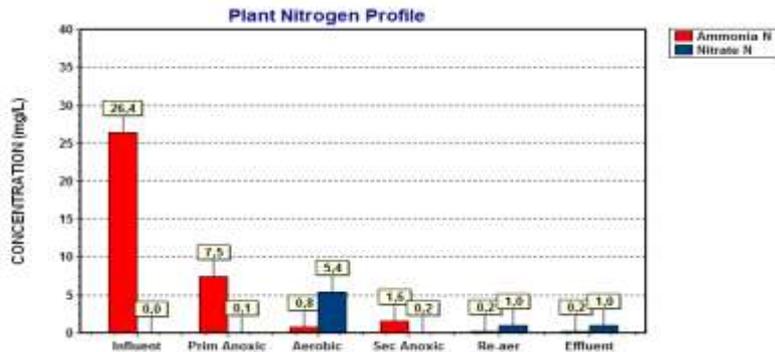
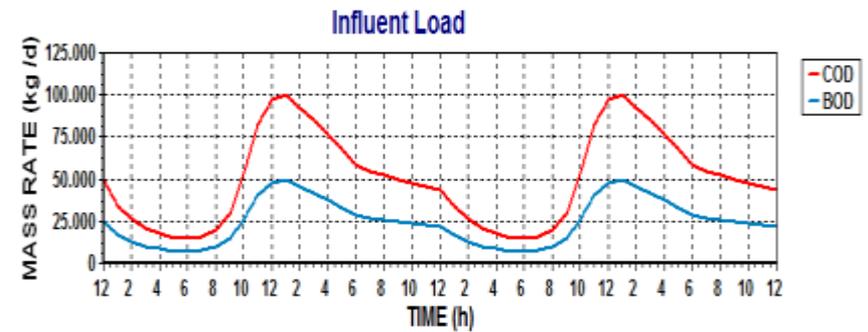
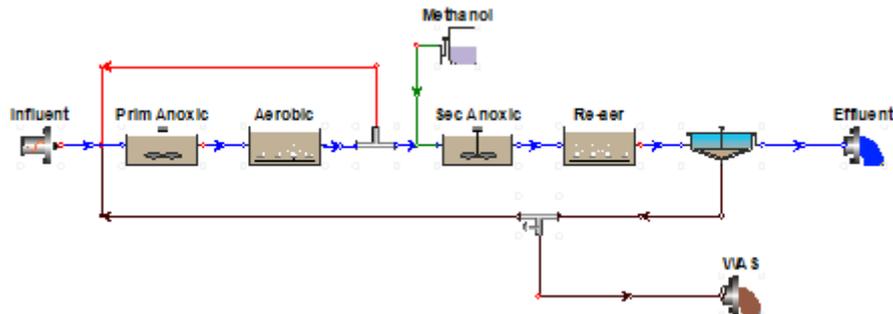
- Management of the great amount of information generated:
  - Analytical data, flow rates, maintenance data, historical data, etc.
  - Most of the data is incorporated into a data base (SQL server)
- Paperwork:
  - Visits reports
  - Maintenance reports
  - Monthly reports including data of all the facilities: treated volume, analytical data, sludge production data, energy consumption ratios (Kw.h/m<sup>3</sup>) ,etc.

# Control of WWTPs Operation: experimental work

## □ Process modeling (Biowin)

- Optimization and expansion of an existent WWTP
- Compliance with discharge limits
- Reduction of operational costs
- Development of control strategies
- Design of treatment plants

# Control of WWTPs Operation: experimental work

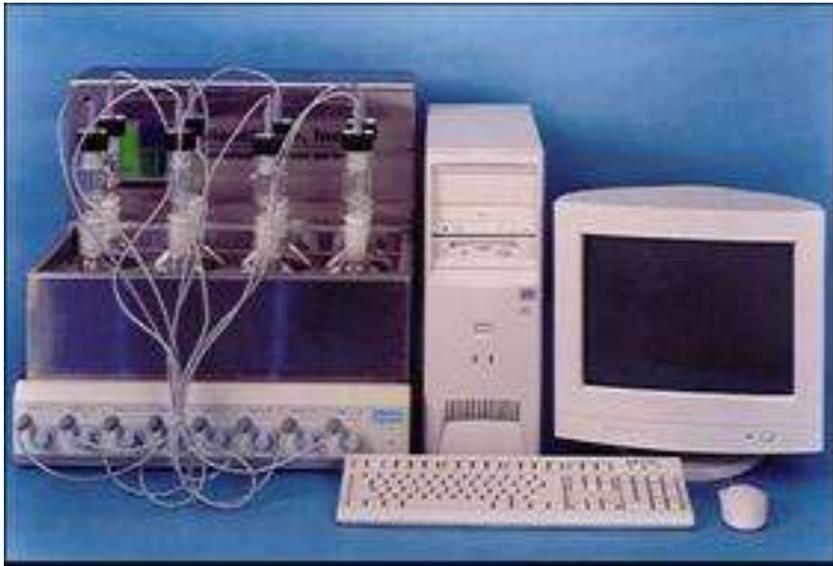


Process Modeling of WWTPs

# Control of WWTPs Operation: experimental work

- **Respirometry and batch tests**
  - Assess the process to detect operational problems.
  - Evaluation of the toxic or inhibitory effect of some substances on the biological process.
  - Characterization of wastewater and determination of kinetic parameters for modeling.

# Control of WWTPs Operation: experimental work



Respirometer and batch test set up

# Control of WWTPs Operation: experimental work

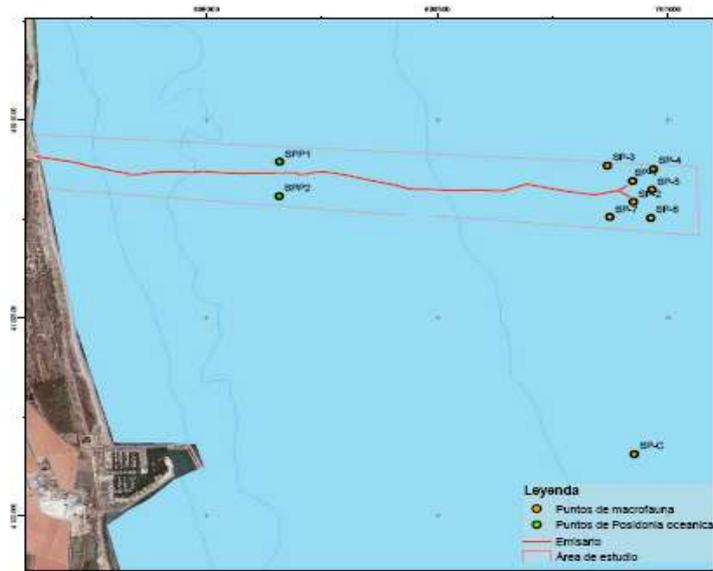


Orange color due to an illegal discharge to a WWTP

# Control of WWTPs Operation: supervision and control of submarine outfalls

- ❑ Structural supervision:
  - Annual film recording of all length of the pipe
  - Photographs of the possible structural damages.
  - Detailed report on the state of the outfall.
- ❑ Environmental supervision.
  - Effluent and receiving water analysis: Annual analysis including physical–chemical and microbiological analysis.
  - Sediments and organisms control:
    - The effect (if any) of the discharge on the receiving waters and sediments will be determined.

# Control of WWTPs Operation: supervision and control of submarine outfalls



Drawing of the submarine outfall of San Pedro (Murcia) and photograph with broken ballasts

# Control of WWTPs Operation: supervision and control of submarine outfalls



*Leptocheirus pectinatus*



*Apseudes talpa*



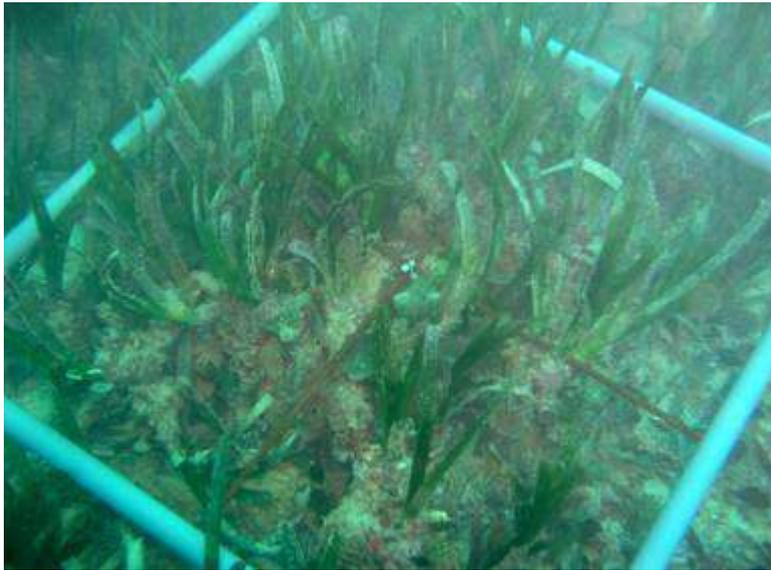
*Sternaspis scutata*



*Ebalia tumefacta*

Organisms from one of the sampling points

# Control of WWTPs Operation: supervision and control of submarine outfalls



Measuring density of *Posidonia Oceanica*

# Control of WWTPs Operation: Conclusions

## □ Conclusions

- **The Regional Agency for Wastewater Treatment and Sanitation (ESAMUR)** is a public regional company that:
  - Collects and manages the **Sanitation Tax**, applying it to the operation , maintenance and control of all the public WWTPs and sanitation facilities.
  - **ESAMUR** does not operate neither control directly the facilities, awarding this tasks to private companies by public bidding.
  - Payment of WWTPs operation is done by ESAMUR through the analysis and flows data gathered by the controller.

# Control of WWTPs Operation: Conclusions

- The close Control of Maintenance and operation of WWTPs allows:
  - Optimization of their performance
  - Compliance with discharge limits
  - Keeping an adequate electromechanical working condition

مع خالص شكري  
وامتناني

Thank you  
for your attention

Merci pour  
votre attention



*For additional information please contact:  
Sustainable Water Integrated Management – Support Mechanism: [info@swim-sm.eu](mailto:info@swim-sm.eu)*

*Website: [www.swim-sm.eu](http://www.swim-sm.eu)*