ICN SUMMIT 2014

Creating Smarter Solutions

Challenge: To reduce sewage odours in the city of Barcelona

City of Barcelona, Spain
BARCELONA CICLE DE L'AIGUA

Ajuntament de Barcelona

Barcelona Cicle de l'Aigua SA

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01

Context: The city of Barcelona

01. Context: The city of Barcelona

- Placed in Northern Spain
  - Surface area of 102,2 km^2
  - 1,6 million inhabitants
  - Rain: 600 mm
- Divided into ten administrative districts, each one with its own district council, which allows a decentralized local administration, closer to the residents
- In order to improve lives of citizens, the city is working to integrate urban planning, ecology and information technology
- Barcelona was awarded the iCapital prize from the E.C. and it has initiated many smart city projects such as Zero Emissions Mobility or Open Data portal
- The city will host the 2nd EIP Water Conference (5th to 6th November 2014)

01. Context: The city of Barcelona

- **The sewage network of Barcelona**

Network magnitudes

Network length: 1.800 km

Network volume: $3*10^6$ m^3

49.500 manholes

72.000 inlets

13 subterranean + 2 opencast stormwater tanks

Stormwater tanks volume: 470.000 m^3

Volume of regulated water: $145*10^6$ m^3 /year

Regulation instruments

25 rain gauges

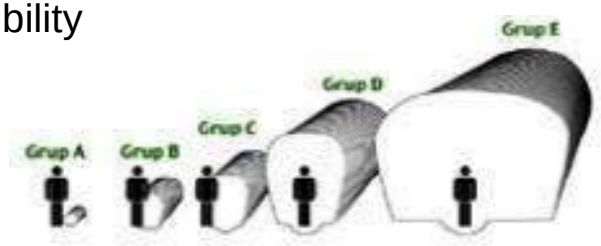
203 limnimeters

54 derivation-retention gates

Network typology

Combined sewer

Visibility



30% 15% 35% 10% 10%

02

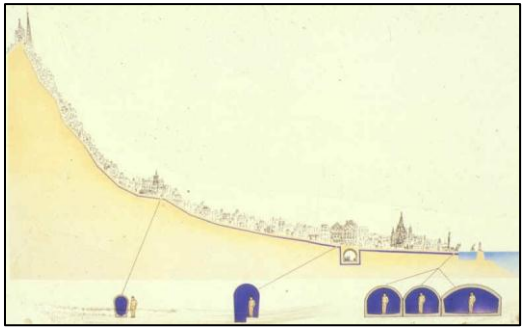
Odour problems in the city

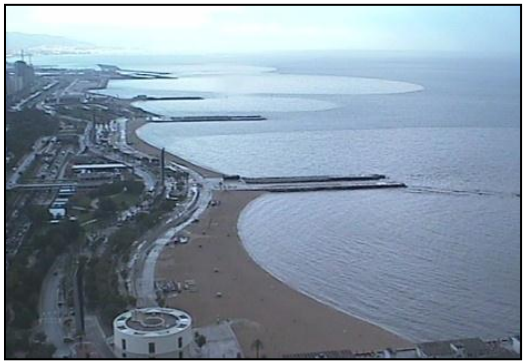
02. Odour problems in the city

→ Bad odours may have different origins: solid waste, industrial emissions, sewers, etc.

→ In the last few years citizen's sensibility to this problem has increased, especially in the case of sewer odours

- The sewerage odour presence are located in certain areas:
  - Lower areas of the city
  - Minimum slope of sewers
  - Presence of sewer facilities like stormtanks or pumping stations
  - During rainy weather: at points of discharge to the receiving environment
  - Presence of high density of restaurants discharging to sewer
  - Presence of spill industries
- Especially important in sensitive areas:
  - High population density
  - Concurred areas by citizens and tourism like beaches, ludic river basin or marina





→ All this conduct to citizen complaints

03

Processes and compounds responsible of odours in sewer

03. Processes and compounds responsible of odours in sewer

- Most common compounds in sewage:

CLASS OF COMPOUNDS	CHEMICAL COMPOUND	CHEMICAL FORMULA	ODOUR	ODOUR THRESHOLD ($mg/nm^3 air$)
SULPHURS	Hidrogen sulfide	SH_2	Rotten egg	0.0001 a 0.03
	Methylmercaptane	CH_2SH	Garlic	0.0005 a 0.08
	Ethylmercaptane	C_2H_5SH	Rotting vegetables	0.0001 a 0.03
	Dimethylsulfide	$(CH_2)_2S$	Rotting legume	0.0025 a 0.65
	Diethylsulfide	$(CH_3CH_2)_2S$	Ether	0.0045 a 0.31
	Dimethyl disulfide	$(CH_2)_2S_2$	Putrid	0.003 a 0.014
NITROGENOUS	Ammonia	NH_3	Pungent and irritating	0.5 a 37
	Methylamine	CH_2NH	Rotting fish	0.021
	Ethylamine	C_2HSHN_2	Ammonia irritating	0.05 a 0.83
	Dimethylamine	$(CH_2)_2NH$	Intense fish	0.047 a 0.16
	Cyclics comp.	C_8H_6NH	Faecal	0.0006
	Nitrogenous	C_9H6NH	Faecal	0.0008 a 0.10
	Cadaverin	$NH_2(CH_2)_5NH_2$	Rotting meat	------
Fatty acids	Acetic acid	CH_3COOH	Vinegar	0.025 a 6.5
	Butyric acid	C_3H_7COOH	Rotting butter	0.0004 a 3
	Valeric acid	C_4H_9COOH	Sweat	0.008 a 1.3
fc-Aldehyds	Formaldehyde	HCHO	Sour, suffocating	0.033 a 12
	Acetylaldehyde	CH_2CHO	Apples	0.04 a 1.8
	Butyraldehyde	C_3H_7CHO	Rancid, musty	0.013a15
	Isovaleraldehyde	$(CH_2)_2CHCH_2CHO$	Apples	0.072
Ketones	Acetone	CH_2COCH_2	Sweet fruits	1.1 a 240

03. Processes and compounds responsible of odours in sewer

- Conditions that favor the occurrence of odours (H_2S):
  - Some physicochemical and biological conditions:
    - pH < 9
    - High temperatures
    - Presence of organic matter: high concentrations of BOD, COD, TOC
    - Anaerobic conditions: low concentration of dissolved oxygen
    - High concentrations of sulfides and sulfates
    - Presence of sulphate-reducer bacteria
  - Some physical conditions:
    - Turbulence points
    - Low slope / water retention
    - Low flow velocity
    - Poor ventilation
    - Inverted siphons
    - In coastal areas: entry of seawater (sulphates)

04

Characterization study performed in the city: Poblenou neighbourhood

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Objective

Exhaustive analysis of the principal problems related to sewer odours in the Poblenou neighbourhood to propose effective actions

Methodology

Phase 1: To identify the causes

-To gather available information: network mapping, review of the citizens complaints…

-To analyse the sewer network (structural and behaviour)

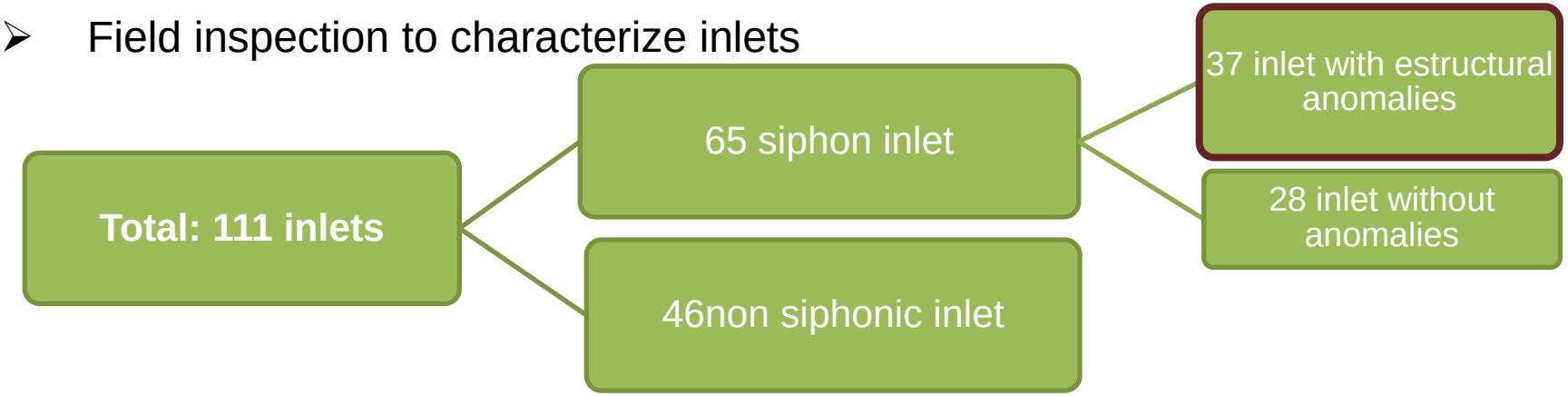
Phase 2: To determine corrective measures

Phase 3: To check the effectiveness of the applied measures

04. Characterization study performed in the city: Poblenou neighbourhood

Phase 1

- Field inspection to characterize inlets



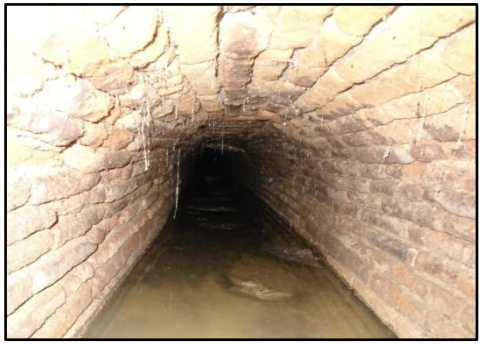
04. Characterization study performed in the city: Poblenou neighbourhood

Phase 1

➢ Field inspection in order to find sediment presence in sewers

- Significant accumulation of faecal and organic sediments (Marketplace of Poblenou)

- Water retention with some sediment presence



04. Characterization study performed in the city: Poblenou neighbourhood

Phase 1

➢ Inspections with TV camera in sewers that cannot be visited

- Water retention

- Concrete

- Other detected anomalies:
  - Tubular joints poorly executed
  - Poorly repaired sections
  - Incorrectly done gutters

04. Characterization study performed in the city: Poblenou neighbourhood

Phase 1

- Behaviour analysis of sewers: Determination of prevailing air currents inside the sewers and through inlets (anemometers analysis)

04. Characterization study performed in the city: Poblenou neighbourhood

Phase 2: Actions proposed and executed

Measure	Cost	Expected benefits	Observations
Siphon inlets reparation	Moderate	To avoid odour dispersion	Do not prevent odour generation
Elimination of concrete discharge detected in sewer	Moderate	To reduce water retention	2 options in consideration for repairing: to do a trench or to use a milling robot
To check over the organic wastes from the market	Low	To reduce the odour generation	Coordination with Barcelona Marketplaces
Removal of sewer low points	High	To improve the sewer functionality	Disturb the neighbours during the construction

Phase 3: Effectiveness of the applied measures is currently being reviewed

05

Example of some preventive and corrective measures conducted in the city

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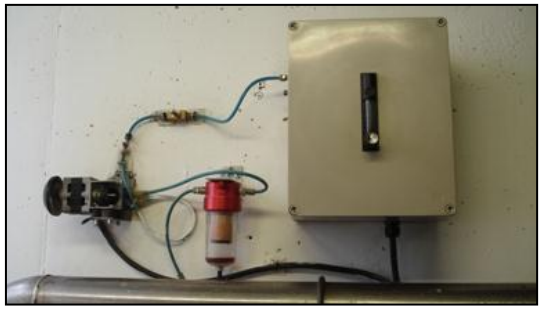
05. Example of some preventive and corrective measures conducted in the city

- **Pumping station (vacuum station):**

• Active carbon filters:
- Vacuum tank air outlet flow
- Underground chamber air outlet flow

• On-line and in real time H_2S measurement:
-Vacuum tank air outlet flow
-Chimney flow



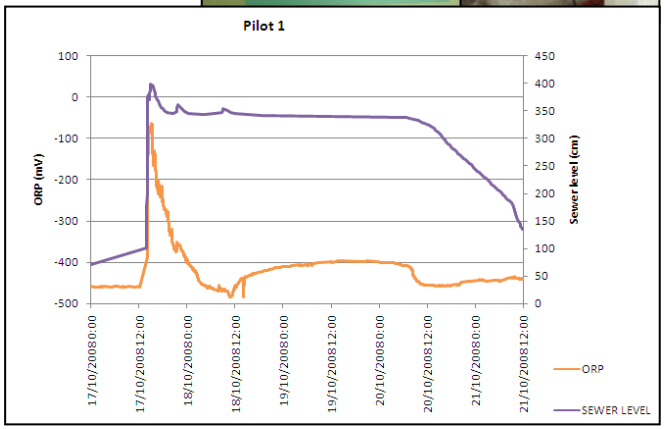
• Ventilation

05. Example of some preventive and corrective measures conducted in the city

- **Anti-CSO stormtank:**

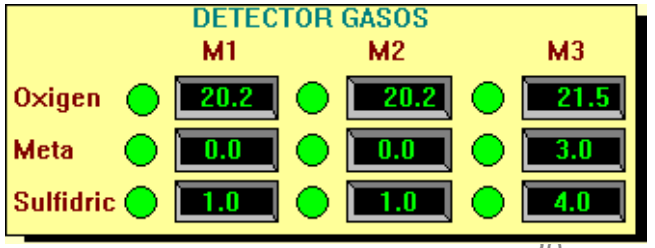
• Ventilation

• Online and real time ORP measurement



• Active carbon filters:

• Online and real time gas measurement (risk prevention)



05. Example of some preventive and corrective measures conducted in the city

- Anti-odour curtains:

- Anti-odours flap in inlets:

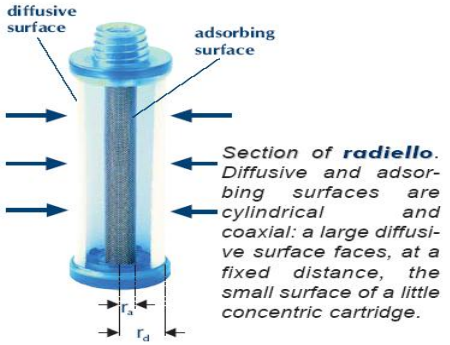
05. Example of some preventive and corrective measures conducted in the city

- Masking products:

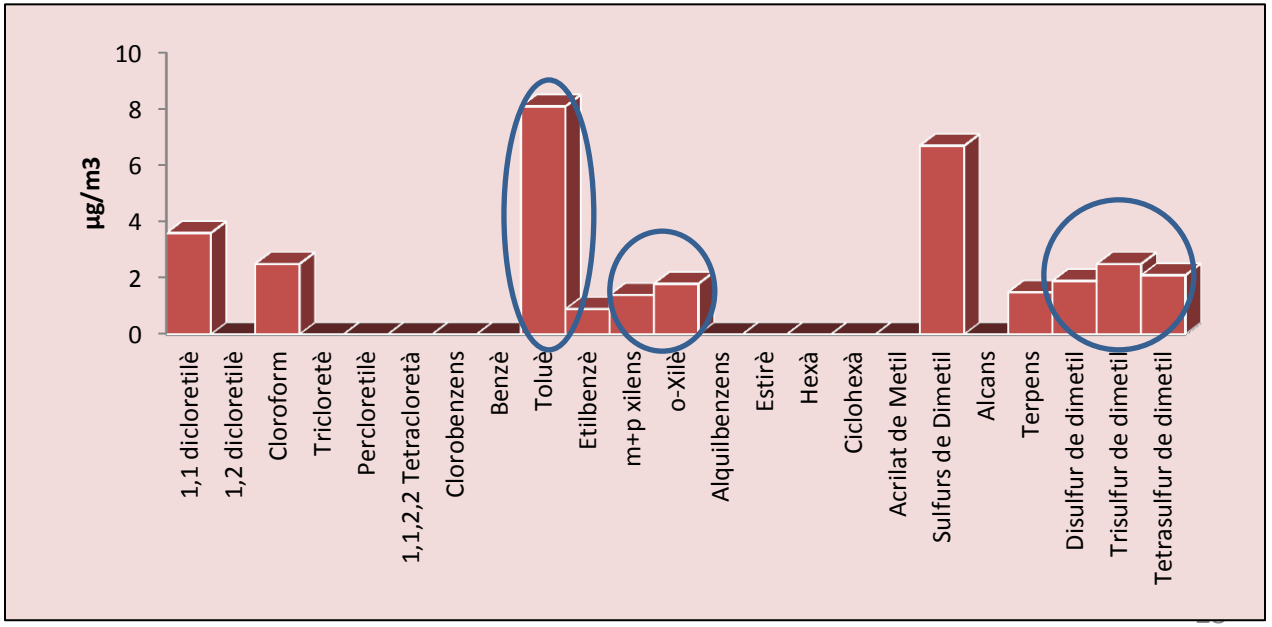
- Potassium permanganate:

05. Example of some preventive and corrective measures conducted in the city

- Air sampling campaigns:
- Industrial areas
- Sensible areas



Example of results in a pumping station in a concurred area:



06

Present and future challenges to achieve

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Awareness → good practice into sewage discharging

- Citizens
- Activities that could cause odours (industry, restaurants, etc…)

→ To promote citizens environmental awareness campaigns
→ Increase inspections of industrial activities

Measures

- Further enhance the establishment of **preventive measures** at the origin and,
- if necessary, **corrective measures** on the focus of detection of odours, particularly important in sensitive areas.

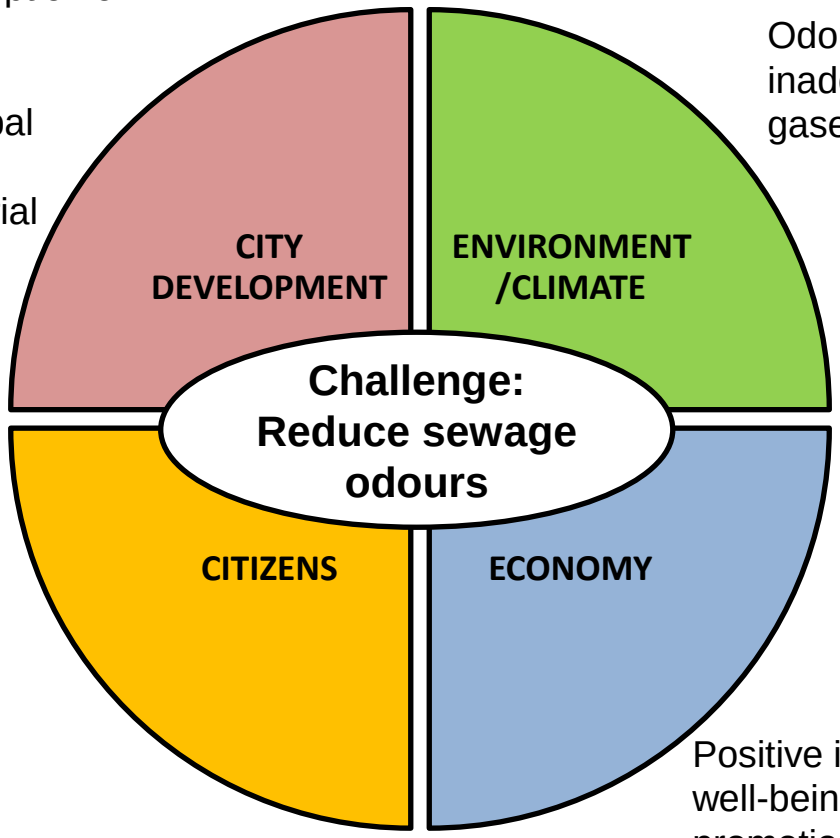
→ Encourage studies to detect and define the origin of odours
→ Structural measures: Improving network configuration with best available techniques during network renovation. Example: slope network amelioration, install siphonic inlets…
→ Conduct research of sensor technologies to prevent the odour occurrence
→ New trends: Advance sewer network cleaning (using a GIS application integrating historical data, complaints, structural problems, etc.)

Final goal → To have tools to act on the prevention and correction of appearance of odours to improve the citizens welfare and quality of life in the city of Barcelona

06. Present and future challenges to achieve

Less odours → better perception of the city

It will help to improve a global problem that implies citizen awarness, decrease industrial and domestic discharges, sewer remodelation



Odours often in relation to inadequate discharges (liquid, gaseous, solid)

Long term feasible and in continuous monitoring

Possible funding: take advantatge on remodeling works on sewers...

Must be accompanied by a change in attitude: good practice in the origin

May improve the citizens welfare and quality of life in the city

Positive impact on the perception of well-being in town (positive for tourism, promotion of outdoor activities ...)

Thank you for your attention

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