Horizon 2020 Initiative to de-pollute the Mediterranean by the year 2020

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in collaboration with UNEP/MAP

Training on mercury management and remediation of contaminated sites

"Key Points in a Contaminated Site Investigation"

Almadén, Spain, 18th-19th November 2015

Joan Bartoll
Management Department of Contaminated Soils
Waste Agency of Catalonia

ABOUT THIS PRESENTATION

To explain the key aspects to be considered in an investigation of a mercury contaminated site. Why?

Before accepting the results of a potentially contaminated site investigation we must assess the investigation itself.

The site investigation has been done properly?
Is the characterization enough?
Do I understand the uncertainties associated with the collection and analysis of soil samples?
Does the conceptual model make sense?
Are the data coherent with the conceptual model?

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POTENTIALLY CONTAMINATED SITE INVESTIGATION

Site investigation is a very **important part of Environmental Sound Management (ESM) of mercury contaminated sites**.

In fact site investigation is the critical work to define the management actions.

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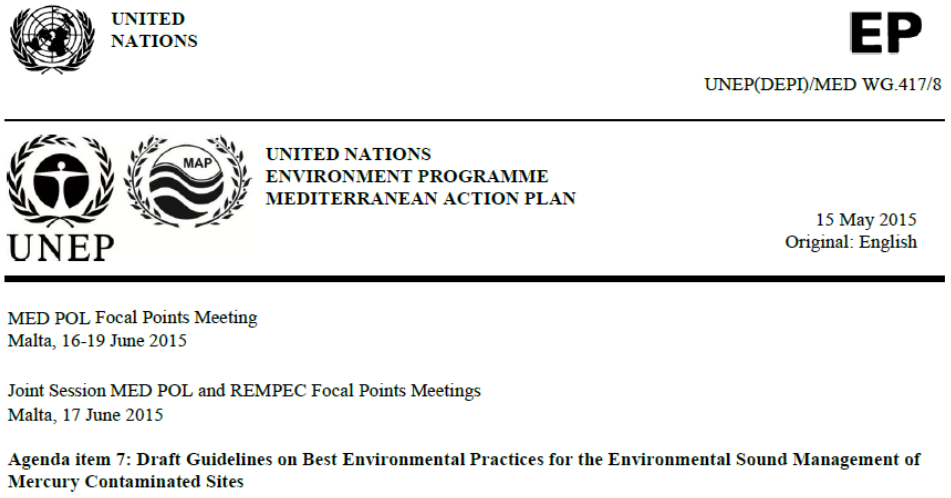
POTENTIALLY CONTAMINATED SITE INVESTIGATION

This presentation is related to some points of the **"Draft Guidelines on Best Environmental Practices for the Environmental Sound Management of Mercury Contaminated Sites".**

Identification of mercury-contaminated sites
Identification of environmental impacts
Environmental characterization of mercury-contaminated sites
Sample preparation and analytical procedures
Risk assessment



UNITED NATIONS

EP

UNEP(DEPI)/MED WG.417/8

UNITED NATIONS
ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

UNEP

15 May 2015
Original: English

MED POL Focal Points Meeting
Malta, 16-19 June 2015

Joint Session MED POL and REMPEC Focal Points Meetings
Malta, 17 June 2015

Agenda item 7: Draft Guidelines on Best Environmental Practices for the Environmental Sound Management of Mercury Contaminated Sites

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POTENTIALLY CONTAMINATED SITE INVESTIGATION

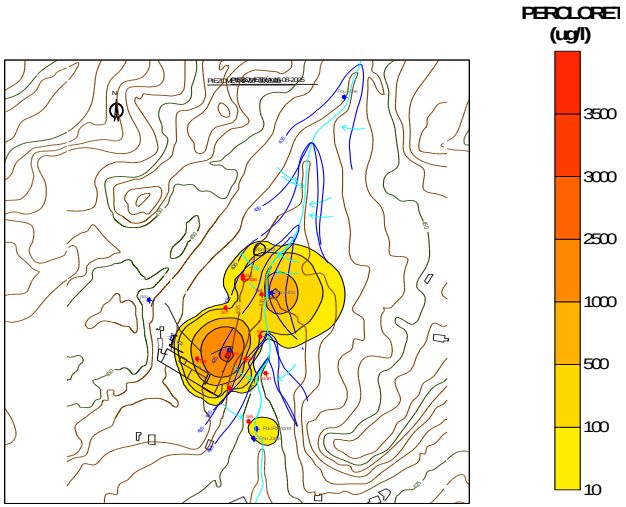
I'm not sure about begin by groundwater sampling...

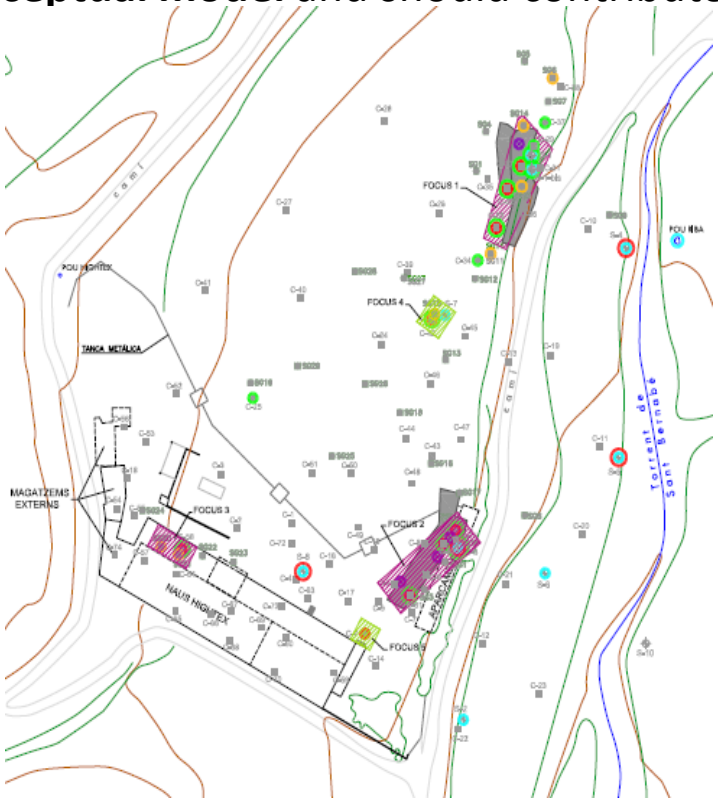
soil sampling first?

POTENTIALLY CONTAMINATED SITE INVESTIGATION

A site investigation is a **phased approach** to determining the **type and extent of any contamination** and determining if significant **risk** exists from the toxic or hazardous substances. It involves characterizing a site to get a **conceptual model** which is going to be updated as the investigation phases are carried out.

A site investigation should be based on **a conceptual model** and should contribute to develop and improve it.





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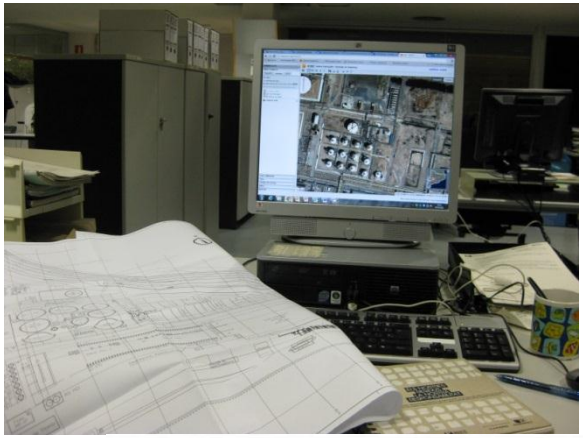
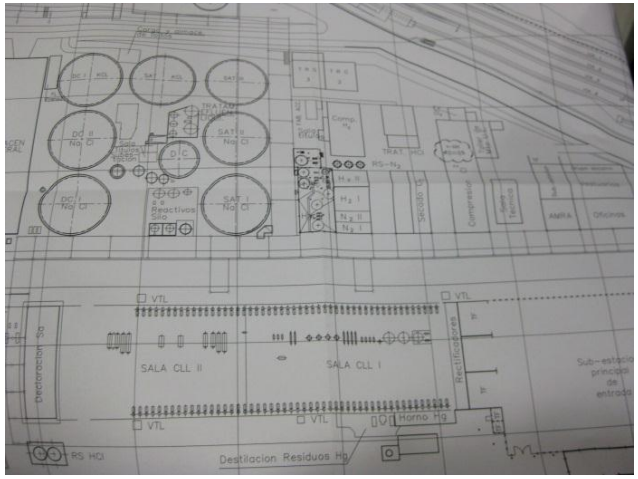
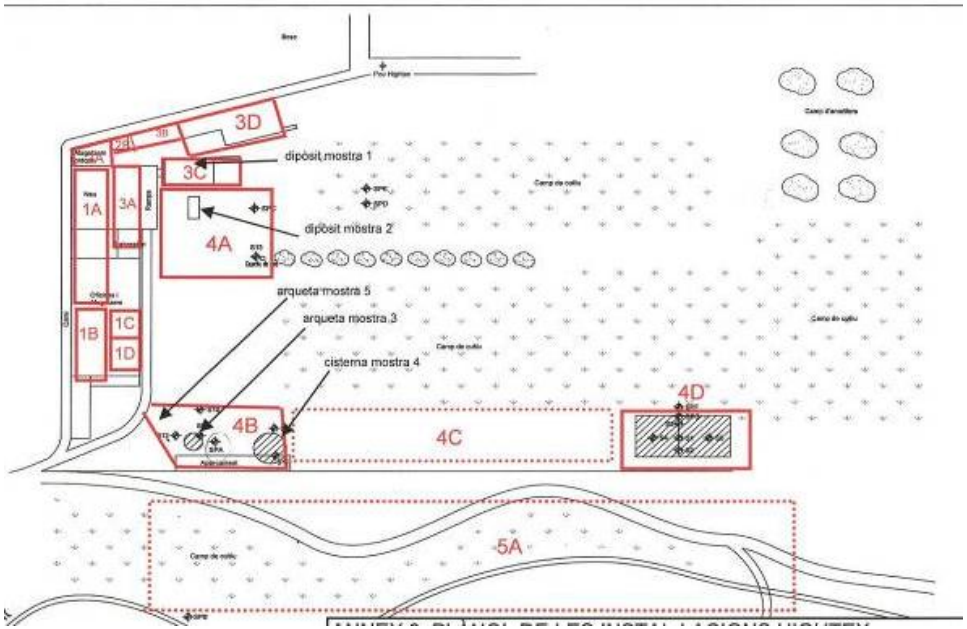
POTENTIALLY CONTAMINATED SITE INVESTIGATION







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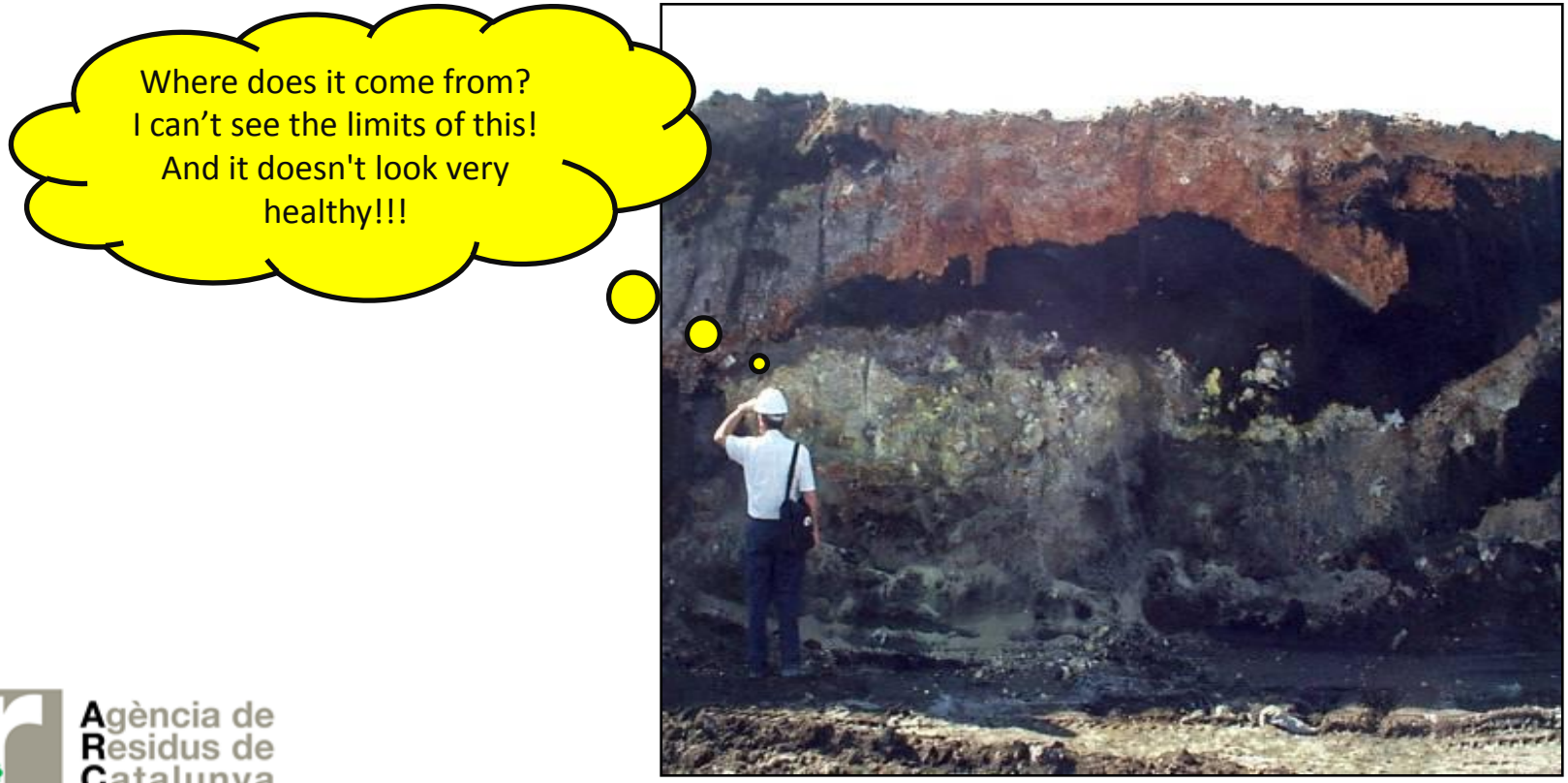
POTENTIALLY CONTAMINATED SITE INVESTIGATION

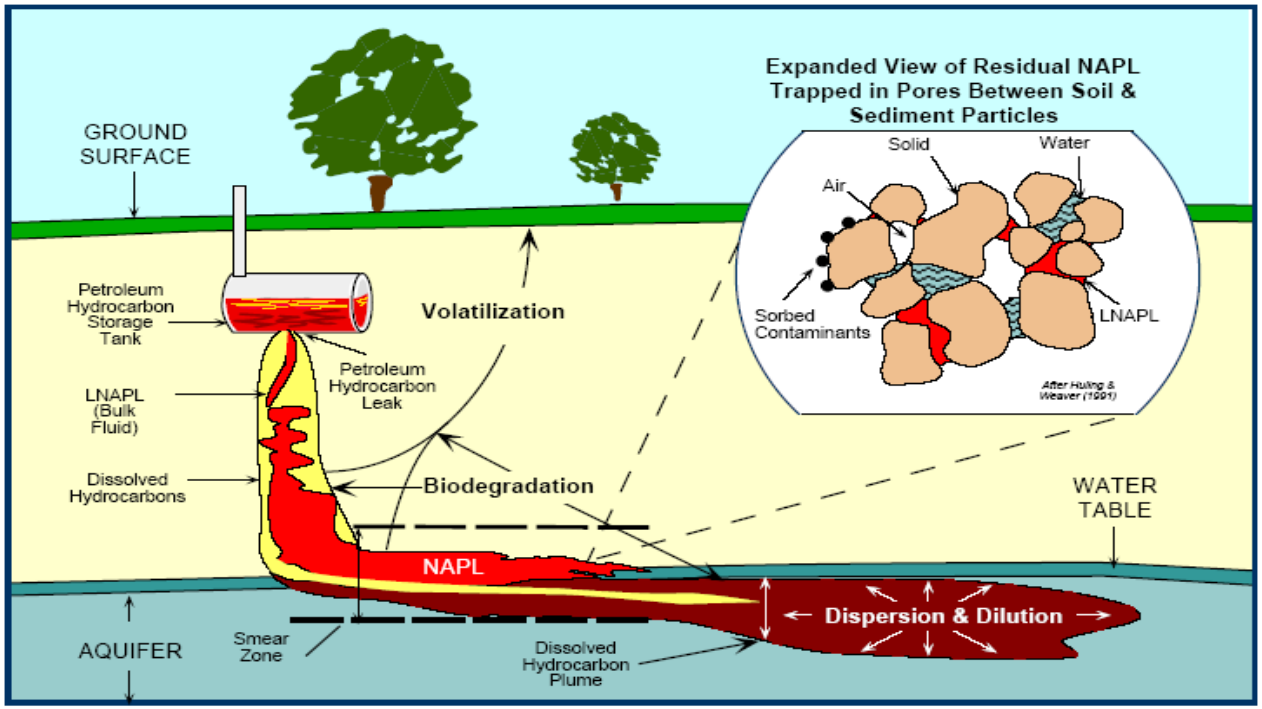
To characterize a contaminated site it should be established:

- The original sources of contamination
- The distribution of contamination
- If significant risk exists to human health or to the environment



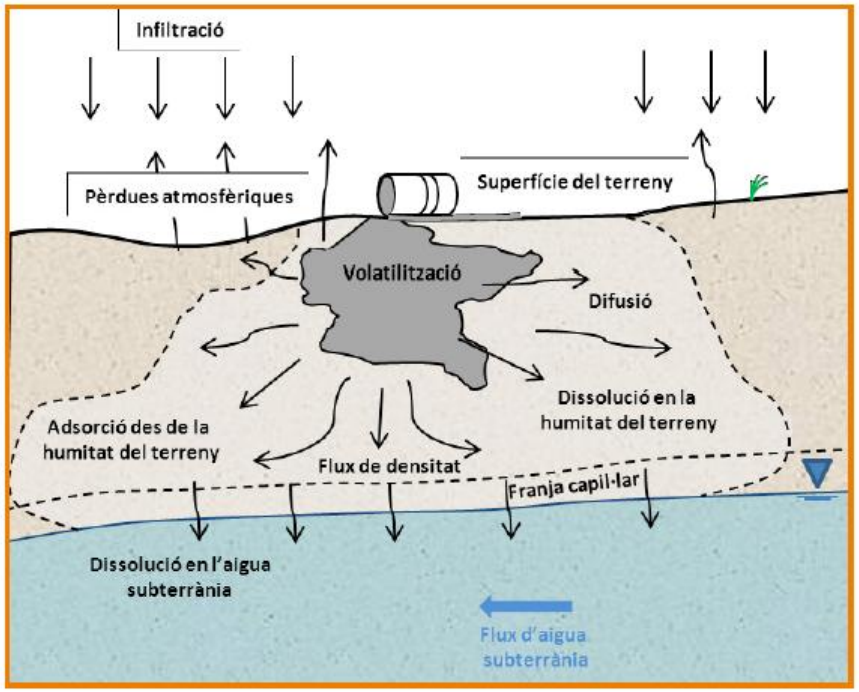
CONCEPTUAL MODEL

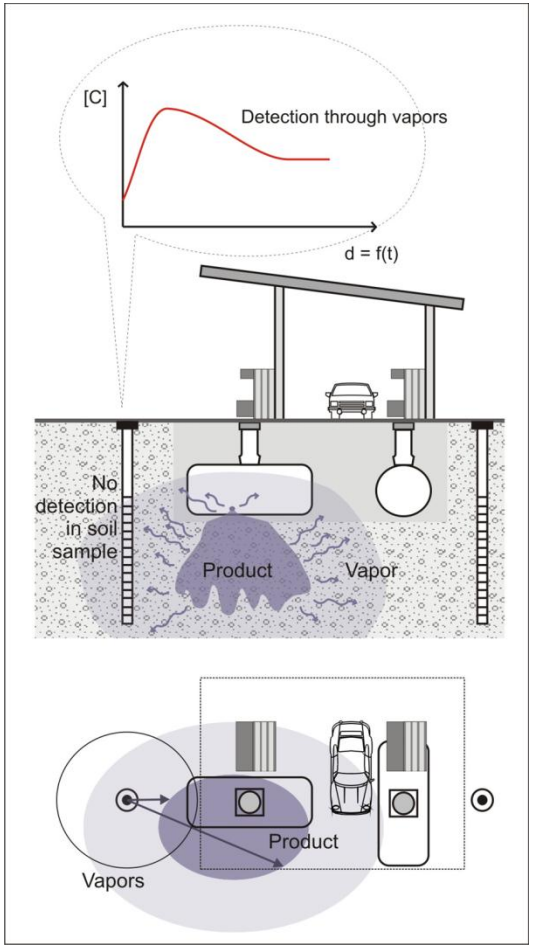
A conceptual model is a simplified description of the environmental conditions and its purpose is to identify potential sources of contamination, distribution of contaminants in the environment compartments, receptors which may be affected by contamination and pathways which may link both.



CONCEPTUAL MODEL

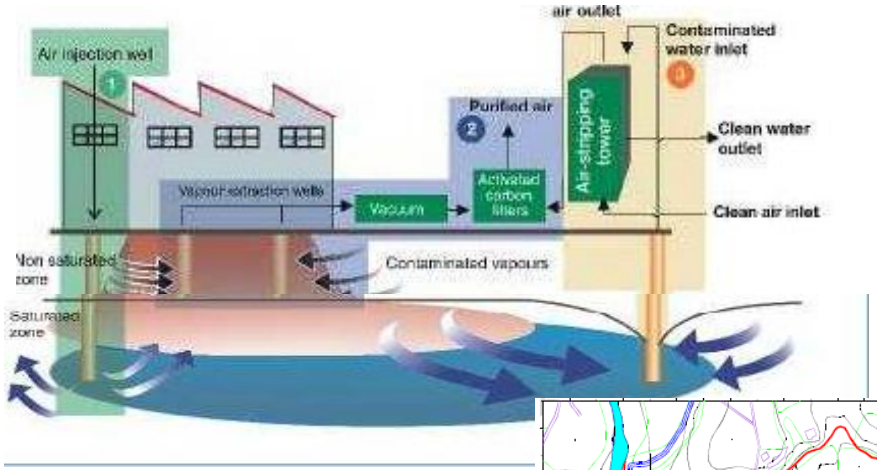
A conceptual model is usually represented by a mixture of pictures, diagrams and text and it is used to provide a vision of the site.

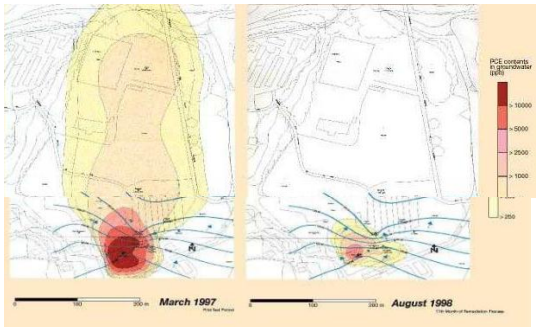


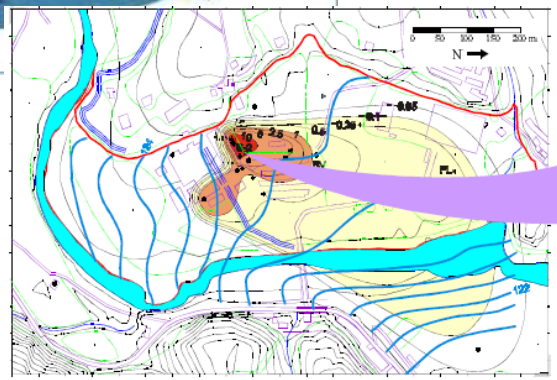


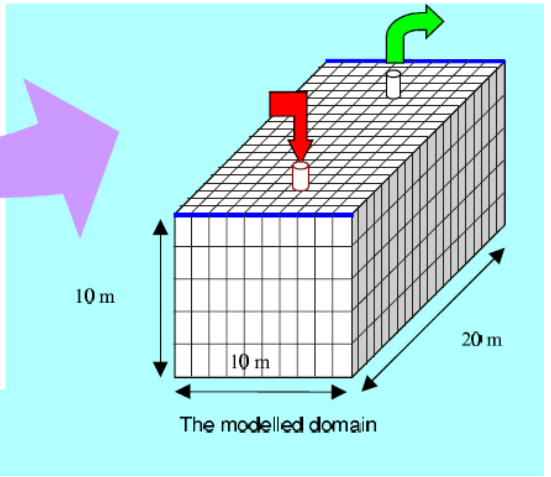
CONCEPTUAL MODEL

The conceptual site model should be developed before undertaking a detailed site investigation and it should be proved and updated regularly during the successive phases of the site investigation.









Modelling procedure

The experiment was modelled with PHAST (Parkhurst et al., 2000) in a step by step approach. First the geochemical conceptual model was built as described in Yan and Schwartz (1999) and tested with PHREEQC (Parkhurst, 1995) under batch

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INVESTIGATION PHASES

The investigation of a site potentially contaminated should be undertaken in phases.

Every site will not necessarily require each phase to be carried out.

The main investigation phases		
This presentation		Other common alternative descriptor
Phase 1	**Preliminary site investigation**	Preliminary Phase, Preliminary site study, stage 1; Phase 1 desk top study; Phase 1 background information study; Phase 1 contaminated site audit; Phase 1 environmental site assessment (ESA); Preliminary recognition
	Includes preliminary site inspection	Site walkover survey; Phase 1 site inspection
Phase 2	**Detailed site investigation**	Stage 2; Phase 2 field investigation; Phase 2 ESA; environmental benchmarking, sampling and analysis phase; Intrusive investigation, Preliminary evaluation
	Could include: an exploratory investigation before a main investigation Includes environmental risk assessment (ERA)	
	Supplementary site investigation or additional investigation	Additional phase 2 ESA; Phase 3 ESA, Detailed evaluation
after remediation	**Site validation investigation or control of the pollution remaining**	Remediation validation investigation; soil benchmarking, control of the expected results

PRELIMINARY SITE INVESTIGATION

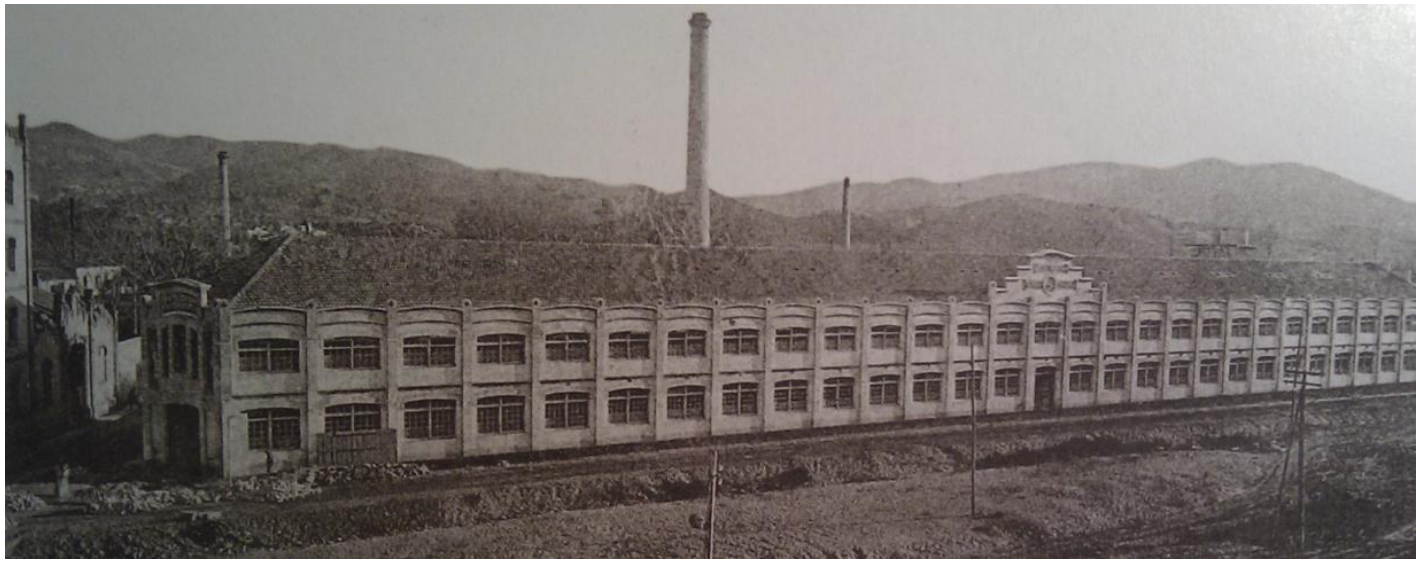
The main objective of the preliminary site investigation is to provide background information relevant to a potential contamination. The present and past uses of the site should be included in order to identify the nature of potential contaminants.

- It involves compiling information about the site to design the initial conceptual site model.
- It is often combined with a preliminary site inspection.
- It should always be carried out before any sampling or analysis is undertaken

SITE HISTORY

A chronological history of the site and previous site uses should be traced from the present day back to the initial use.

The previous activities and processes on the site, and the chemicals and products used, stored or disposed of at the site, should be identified.



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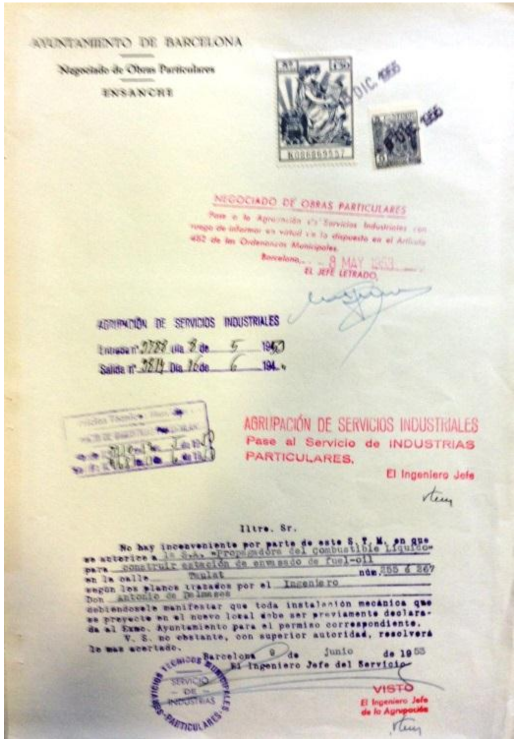
review of discharge permits, consents or licences



AYUNTAMIENTO DE BARCELONA
Negociado de Obras Particulares
ENSANCHE

NEGOCIADO DE OBRAS PARTICULARES
Pase a la Agrupación de Servicios Industriales con ruego de informar en virtud de lo dispuesto en el Artículo 452 de las Ordenanzas Municipales.
Barcelona, 8 MAY 1953
EL JEFE LETRADO,

AGRUPACIÓN DE SERVICIOS INDUSTRIALES
Entrada nº 3788 día 8 de 5 1953
Salida nº 3814 Día 16 de 6 194..

AGRUPACIÓN DE SERVICIOS INDUSTRIALES
Pase al Servicio de INDUSTRIAS PARTICULARES.
El Ingeniero Jefe

Iltre. Sr.

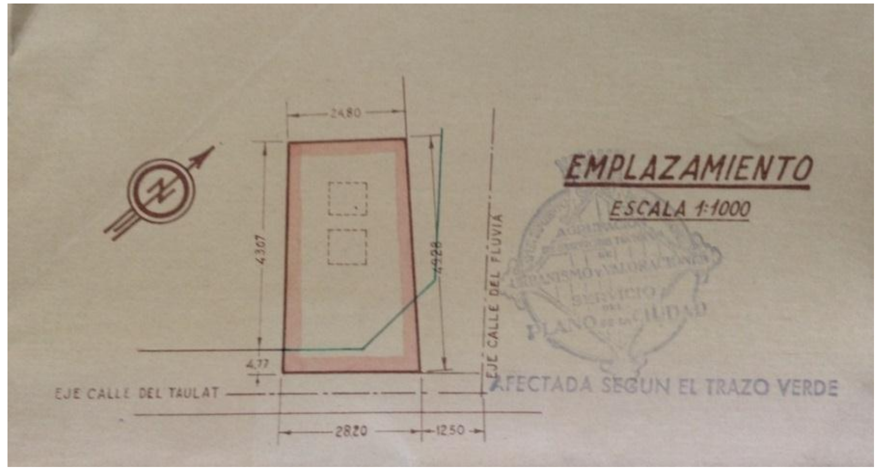
No hay inconveniente por parte de este S. T. M. en que se autorice a la S.A. "Propagadora del Combustible Líquido" para construir estación de envasado de fuel-oil en la calle Taulat núm. 255 á 267 según los planos trazados por el Ingeniero Don Antonio de Dalmases debiéndosele manifestar que toda instalación mecánica que se proyecte en el nuevo local debe ser previamente declarada al Excmo. Ayuntamiento para el permiso correspondiente.

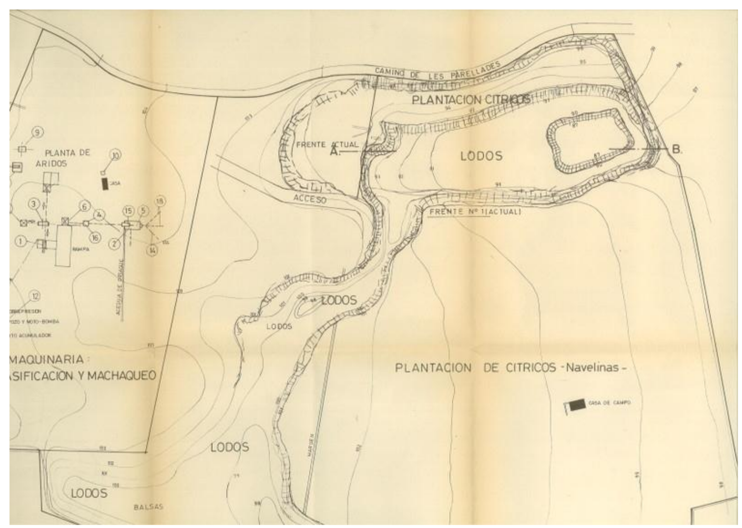
V. S. no obstante, con superior autoridad, resolverá lo más acertado.

Barcelona 9 de junio de 1953
El Ingeniero Jefe del Servicio

SERVICIOS TECNICOS MUNICIPALES – SERVICIO DE INDUSTRIAS – PARTICULARES

VISTO
El Ingeniero Jefe de la Agrupación





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SITE HISTORY

aerial photos.

SITE HISTORY

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POTENTIALLY SOIL CONTAMINATING ACTIVITIES

Are (or were) the industrial activities in a site "potentially soil contaminant activities"?

There are lists of activities and industries that are considered to have a higher potential for soil contamination because they use of hazardous substances.

Soil Potential Contaminating Activities List, stablished and published by RD9/2005.
http://www.magrama.gob.es/es/calidad-y-evaluacion-ambiental/temas/suelos-contaminados/09047122800b7aff_tcm7-3206.pdf

ANNEX I

Potentially soil-contaminating activities

CNAE93-Rev1	Description
11.10	Extraction of crude petroleum and natural gas
11.20	Service activities incidental to oil and gas extraction, excluding surveying
13.20	Mining of non-ferrous metal ores, except uranium and thorium ores
15.40	Manufacture of vegetable and animal oils and fats
17.30	Finishing of textiles
17.542	Manufacture of textiles impregnated, hardened or covered with plastic materials
18.301	Dressing, tanning and dyeing of furs
19.10	Dressing, tanning and finishing of leather
20.10	Sawmilling and planing of wood; industrial preparation of wood
20.20	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards
21.1	Manufacture of pulp, paper and paperboard
21.24	Manufacture of wallpaper
22.2	Printing and service activities related to printing (1)
23.10	Manufacture of coke oven products

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PRELIMINARY INSPECTION

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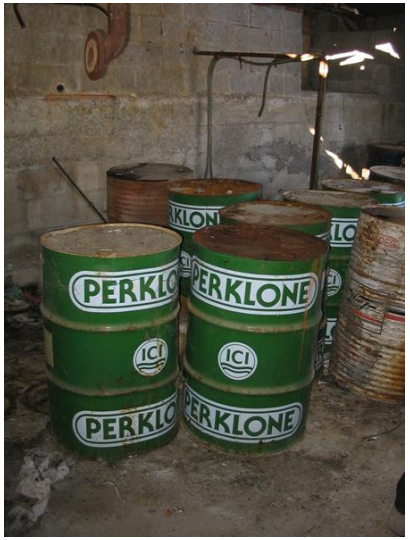
PRELIMINARY INSPECTION



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PRELIMINARY INSPECTION

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DETAILED SITE INVESTIGATION

A detailed site investigation may be required to confirm or qualify the findings of the preliminary site investigation.

Soil samples should be analyzed for contaminants identified on the basis of the preliminary site study.

Sampling of groundwater is required in a site investigation unless it can be demonstrated that there is no water table or there's limited potential for groundwater being contaminated.

The results from the detailed site investigation should be assessed and the conceptual site model updated.

If a contamination is identified, a risk assessment should be carried out to determine its impact on human health or the environment.

SOIL SAMPLING

The soil-sampling strategy should be based on the objectives and on the preliminary investigation results.

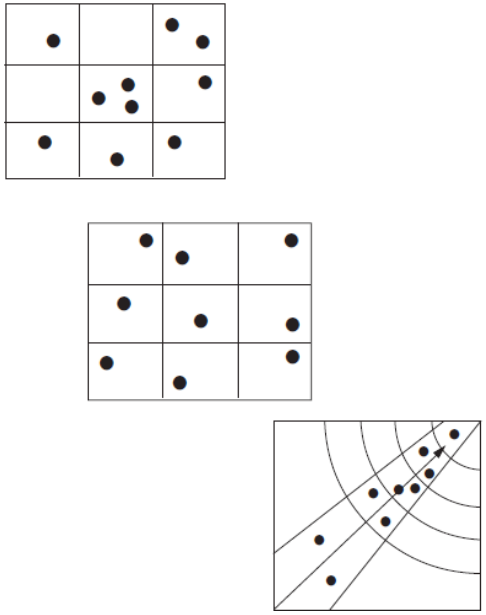
Common sampling objectives could be:

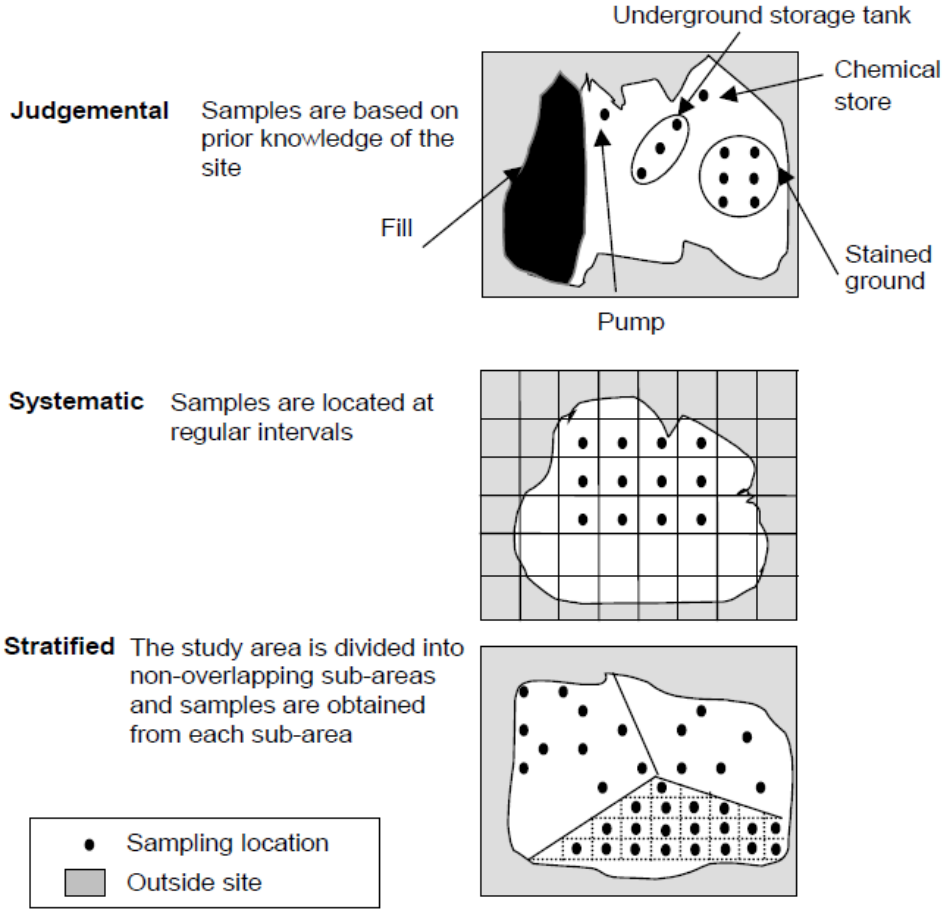
- to establish the type and location of sources of contamination
- to establish the nature, degree and extent of contaminant distribution
- to verify following a clean-up that the contamination on site has been reduced
- waste characterization purposes

SOIL SAMPLING

There are different types of sampling patterns commonly used:

- judgemental or selective
- systematic
- random
- stratified.





SOIL SAMPLING TECHNIQUES

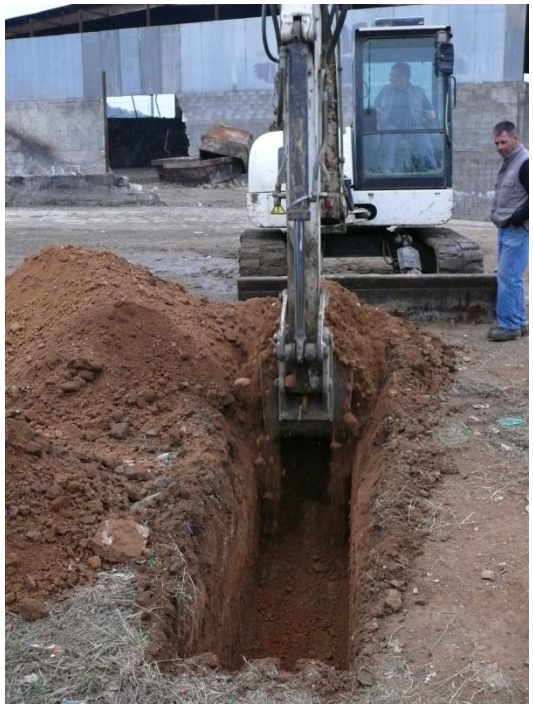
	Advantages	Disadvantages
Grab sampling (push tubes, shovel)	Low cost Quick No access restrictions Minimal soil disturbance	Depth limit: surface – 0.3 m Impractical in difficult soil conditions Care is required to ensure the quality of sample recovered

SOIL SAMPLING TECHNIQUES

	Advantages	Disadvantages
Hand auger	Low cost Quick No access restrictions Minimal soil disturbance	Depth limit: 2–3 m (with ease) Impractical in difficult soil conditions Limited ability to observe the nature of the material Labour intensive

SOIL SAMPLING TECHNIQUES

	Advantages	Disadvantages
Test pits (machine dug)	Lower cost than boreholes Relatively quick Ability to make detailed observations of the strata Ability to recover samples	Extent of soil disturbance, occupational exposure, compaction Depth limit is 3–5 m depending on excavator Impractical in unstable soil conditions and hard rock Not suitable for installing monitoring bores due to disturbance



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SOIL SAMPLING TECHNIQUES

	Advantages	Disadvantages
Boreholes (different types of drilling rings and drilling systems)	Minor disturbance of soils Limited occupational exposure Accurate recovery of samples Ability to sample at depth Suitable for most ground conditions Can be used for installing groundwater and gas monitoring wells	More expensive than other techniques Limited ability to observe materials Air rotary rigs not suitable for volatiles Can cause preferential pathways for contaminant migration, if not appropriately constructed

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GROUNDWATER SAMPLING

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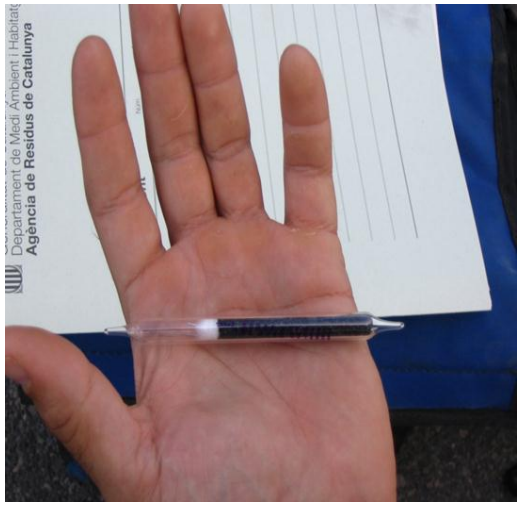
SOIL GAS SAMPLING



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REFERENCE LEVELS

Reference levels are guideline concentrations to indicate that a concentration of a contaminant substance in the soil or in other environment compartment could result in risk for the human health or the ecosystems.

If a concentration surpasses the reference levels it's necessary to develop a risk assessment.

substances	Reference levels in mg/Kg	Soil samples concentration							
	urban uses	1	2	3	4	5	6	7	8
Mercury	**3**	< 1	< 1	< 1	< 1	< 1	< 1	< 0,05	< 0,05
Arsenic	**30**	15	7	< 5	14	< 5	11	7,9	5,2
Bari	**880**	590	290	170	120	100	8300	110	51
Cadmium	**5,5**	3	4	14	< 3	14	4	0,31	0,38
Cupper	**310**	10000	3100	3300	18	14000	5600	29	9,2
Chromium	**1000**	260	83	63	45	120	160	21	23
Molybdenum	**7**	8	11	< 5	13	8	< 5	< 1	< 1
Nickel	**470**	930	170	200	24	350	320	16	14
Lead	**60**	450	530	570	25	330	990	27	5,3
Zinc	**650**	1900	2900	1900	62	7700	1800	53	35

REFERENCE LEVELS

Soils reference levels (NGR) for metals and metalloids applicable in Catalonia

ELEMENT	INDUSTRIAL USE mg/kg ds	URBAN USE mg/kg ds	OTHER USES mg/kg ds
Antimony	30 *	6 **	6 **
Arsenic	30 **	30 **	30 **
Barium	1.000 ***	880	500
Beryllium	90	40	10
Cadmium	55 *	5.5	2.5
Cobalt	90	45	25 **
Copper	1.000 ***	310	90
Chromium (III)	1.000 ***	1.000 ***	400
Chromium (VI)	25	10	1
Tin	1.000 ***	1.000 ***	50
Mercury	30 *	3	2 **
Molybdenum	70 *	7 *	3,5 **
Nickel	1.000 ***	470 *	45 **
Lead	550 *	60 **	60 **
Selenium	70 *	7 *	0,7
Thallium	45 *	4,5 *	1,5 **
Vanadium	1.000 ***	190	135 **
Zinc	1.000 ***	650 *	170 **

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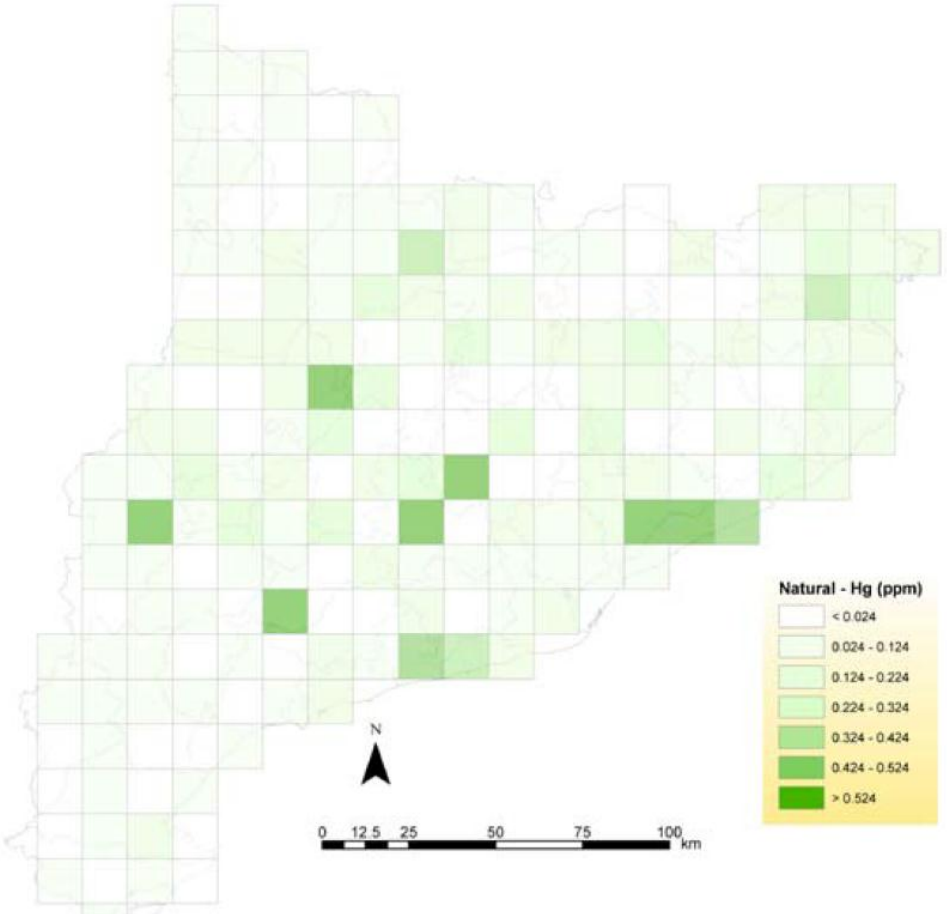
Waste Agency of Catalonia (ARC)
http://residus.gencat.cat/en/ambits_dactuacio/sols_contaminats/nivells_generics_de_referencia_ngr/valors_dels_ngr_per_metalls_i_metal_loides_i_proteccio_salut/

REFERENCE LEVELS

Natural background levels of mercury in Catalonia

From: 270 samples
of soil:
203 in natural land
30 in urban zones
37 in industrial zones



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http://residus.gencat.cat/web/.content/home/lagencia/publicacions/sols_contaminats/sols_nivelldefons.pdf

REFERENCE LEVELS

Groundwater reference levels for metals on sites contaminated by isolated point sources in Catalonia.

	No Risk Values (VGNR) ug/l	Remediation Values (VGI) ug/l
Substances GRUP 1		
Mercury	1	1,5
Arsenic	15	40
Cadmium	15	70
Antimony	20	60
Chromium(VI)	100	450

Catalan Water Agency (ACA)
http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P23400229712616538740000&profileLocale=en

RISK ASSESSMENT

Does the site represent a real or potential risk to the human population and/or to the environment?
What is the magnitude of the risk?
Should the site be restored to reduce the risk?

The environmental risk assessment (ERA) is a process that assigns magnitudes and probabilities to the adverse effects of contamination. It is an instrument that can help to define whether or not environmental measures should be implemented at a contaminated site.

The ideal decontamination objective would be to restore the site with concentrations to the levels found in the environment prior to contamination. However, this may be economically unfeasible and a decontamination based on risk target levels should be considered.

RISK ASSESSMENT

RBCA Tool Kit for Chemical Releases, Versión 2.52e

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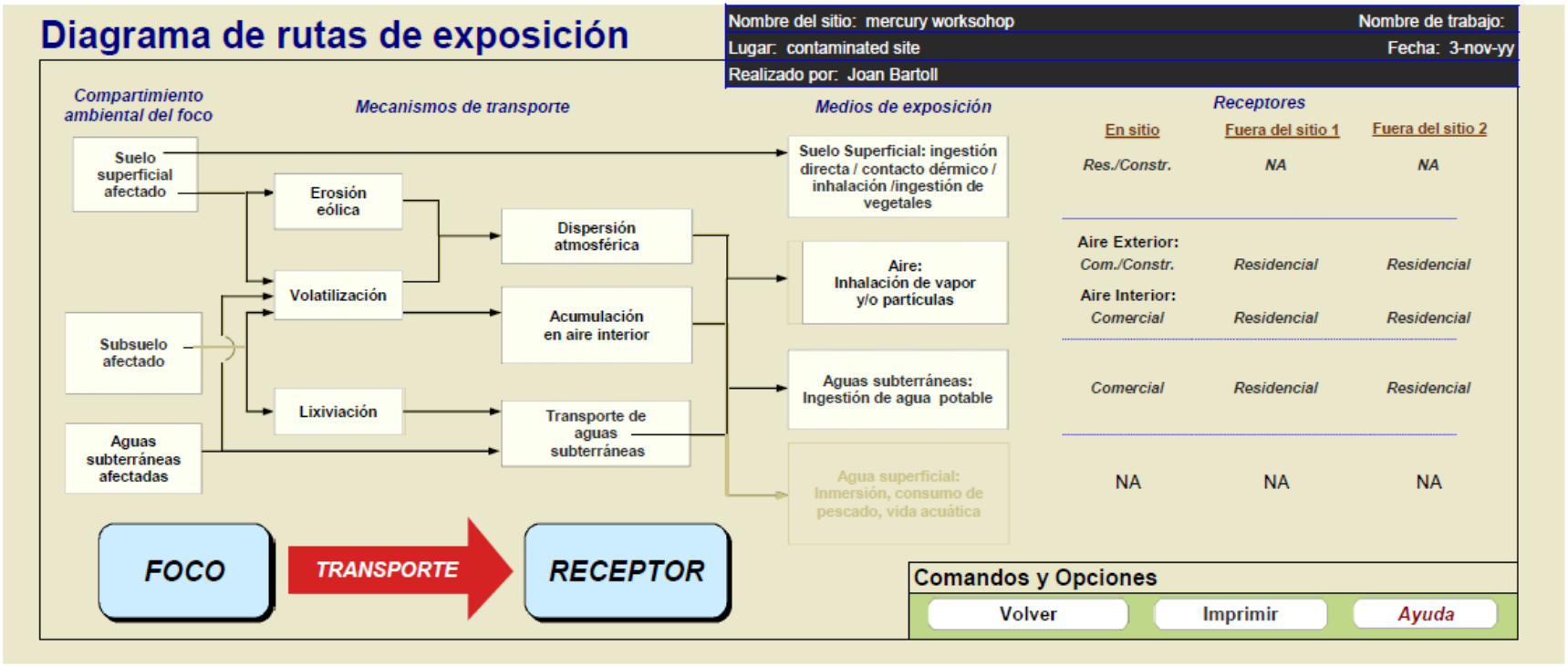
RBCA Tool Kit for Chemical Releases, Versión 2.52e



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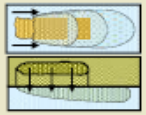
RISK ASSESSMENT

Identificación de las rutas de exposición

1. Exposición al agua subterránea



Ingestión de agua subterránea/ impacto al agua superficial

Receptor:	Com.	Res.	Res.
	En sitio	Fuera del sitio 1	Fuera del sitio 2
Distancia:	0	100	500 (m)

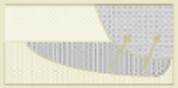
Compartimiento ambiental del foco:

- [x] Aguas subterráneas afectadas
- [x] Suelos afectados lixiviando a aguas subterráneas

Opción:

- [x] Aplicar el valor MCL como LEBR para ingestión (sólo cálculo inverso)

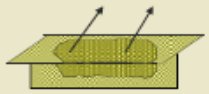
Exposición por descarga de aguas subterráneas y contacto con agua superficial



- [ ] Natación
- [ ] Consumo de pescado
- [ ] Criterios de calidad de agua especificados

Ingresar Criterios

2. Exposición al suelo superficial



Exposición combinada

Rutas Aplicadas

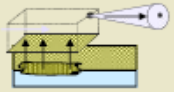
Receptor:	Res.
	En sitio
Obrero de Construcción	[x]

- [x] Ingestión directa
- [x] Contacto dérmico
- [x] Inhalación (volatilización + partículas)
- [x] Ingestión de vegetales

Opciones para vegetales

Nombre del sitio: mercury worksohop
Lugar: contaminated site
Realizado por: Joan Bartoll
Nombre de trabajo: Fecha: 3-nov-

3. Exposición al aire



Volatilización y partículas - inhalación de aire ambiental

Receptor:	Com.	Res.	Res.
	En sitio	Fuera del sitio1	Fuera del sitio 2
Distancia:	0	100	500 (m)

Compartimiento ambiental del foco: Obrero de Construcción [x]

- [x] Suelos afectados: volatilización a aire ambiental
- [x] Aguas subterráneas afectadas: volatilización a aire ambiental
- [x] Suelos superficiales afectados: partículas al aire ambiental

Volatilización - inhalación en aire interior

Receptor:	Com.	Res.	Res.
	En sitio	Fuera del sitio 1	Fuera del sitio 2
Distancia:	0	100	500 (m)

Compartimiento ambiental del foco:

- [x] Suelos afectados: volatilización a aire interior
- [x] Suelos afectados lixiviando a aguas subterráneas: volatilización a aire interior
- [x] Aguas subterráneas afectadas: volatilización a aire interior

Opciones para edificio

4. Comandos y opciones

Pantalla | Imprimir página | Cambiar unidades | *Ayuda*

Factores de exposición y riesgo aceptable | Diagrama de flujo de exposición

SUPPLEMENTARY SITE INVESTIGATION

A review of the detailed investigation may still identify aspects where there is a deficiency of information, then a supplementary investigation will be required.

- data on areas of concern not investigated during the detailed site investigation
- a clearer delineation or definition of a particular area or depth of contamination
- information to confirm the applicability of a particular remedial option
- long term monitoring of groundwater and ground gas wells

And finally…, the key points are:

- Get a proved conceptual model
- Carry out the investigation by phases:

✓ the preliminary site investigation should be emphasized, especially the site history investigation

✓ the detailed site investigation should be designed based on the results of the preliminary site investigation

GUIDELINES ABOUT CONTAMINATED SOIL INVESTIGATION AND SAMPLING DESIGN

ARC, Waste Agency of Catalonia, (2012) "Methodological guide to carry out vacuum assays in vapor devices at gas stations"(in Spanish):
http://residus.gencat.cat/web/.content/home/lagencia/publicacions/sols_contaminats/guia_meto_cast.pdf

Department of Environmental and Conservation, Government of Western Australia (2001): "Development of Sampling and Analysis Programs (Guideline for the Assessment of Sites Incorporating Underground Storage Tanks and Contaminated Site Assessment Guidelines for the Development of Sampling and Analysis Programs as amended)"
www.environ.wa.gov.au

Department of Environment and Conservation, Government of Western Australia (2010): "Assessment Levels for Soil, Sediment and Water".
http://www.esdat.net/Environmental%20Standards/Australia/WA/Assessment%20Levels%20-%202010.pdf

Ministry for the Environment of New Zealand (2004): "Contaminated Land Management Guidelines No. 5.Site Investigation and Analysis of Soils (Revised 2011)"
http://www.mfe.govt.nz/publications/land-hazards/contaminated-land-management-guidelines-no-5-site-investigation-and

US EPA (2002): "Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan, EPA QA/G-5S"
http://www.water.ca.gov/environmentalservices/docs/qaqc/choosing_a_sampling_design_for_environmental_data_collection.pdf

The Centre for Research into the Built Environment (1994): "UK Contaminated Land Research Report CLR 4, Sampling strategies for contaminated land".
http://www.eugris.info/envdocs/CLR04_00.pdf

Horizon 2020
TO DE-POLLUTE THE MEDITERRANEAN BY THE YEAR 2020

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MERCURY CONTAMINATED SITE INVESTIGATION

To characterize a mercury contaminated site it should be established:

- Which are the original sources of contamination
- The distribution of contaminants in the site and in the environmental compartments
- The zones of the site with different contamination characteristics, if in the soil are likely to be on the surface or at depth, distributed over an entire area or in localized 'hot spots'
- What are the forms of mercury present: metallic mercury, inorganic mercury, methyl mercury, and the total amount of mercury
- What are the environmental compartments impacted; water (surface, groundwater); biota (fish, plants,..); soil, soil gas and sediments and air
- What is the extent of the contaminated area
- The behavior of mercury in environmental compartments
- What are the consequences of the pollution, both in and out of the site
- If significant risk exists to human health or to the environment

SITE HISTORY

The sources of information for the site history may include:

- Interviews with site personnel and neighbours, covering questions relating to site history, any known incidents or complaints, management practices, waste disposal, and any chemical storage areas
- A review of permits and licenses under environmental legislation; discharge permits; consents to discharge to air, water or ground; trade waste consents; and dangerous goods, hazardous substances, licences
- A review of available environmental reports, environmental incident investigation reports, tank removal records, process descriptions, waste disposal and chemical inventories, material safety data sheets and newspaper articles
- Local authority record reviews, including regional council databases
- A review of historical society records, and any relevant literature relating to the site, purchase transactions - sale of sites, due diligences
- The layout of current and historical facilities, and site drainage plans
- Photographic records, including aerial photos. Inventory of sites and potentially soil polluting activities done by different administrations.
- Enforcement by existing legislation related to potentially soil polluting activities

MERCURY

In its elemental form, mercury (CAS No. 7439-97-6) is a dense, silvery white metal, which is a volatile liquid at room temperature. Mercury readily forms amalgams with a variety of other metals including sodium and zinc, although not with the lighter transition metals such as iron.

Inorganic mercury can be transformed by bacteria into methylmercury in sediments and soils, at a rate depending of the physic-chemical characteristics of the soil. Methylmercury (CH_3Hg^+) is a highly toxic bioavailable form of organic mercury and cumulative throughout the food chain

The three major forms (speciation) that can be found in the environment are:

- Metallic mercury (Hg^0), in liquid and gas equilibrium depending of the temperature.
- Inorganic mercury (Hg^{2+}, HgO, $HgCl_2$, HgCl…)
- Organic mercury (CH_3-Hg-CH_3, CH_3-Hg-NH_2, CH_3-Hg-SH…)

Chemical data for mercury from the UK Environmental Agency "Soil Guideline Values for mercury in soil Science Report SC050021 / Mercury SGV ";
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/313877/scho0309bpqg-e-e.pdf

Table 6
Recommended chemical data for elemental mercury, inorganic mercury and methylmercury (at 10°C unless stated)

Chemical property	Elemental Hg		Inorganic Hg^{2+}		Methyl Hg^{+}	
Air-water partition coefficient, dimensionless	0.117	Estimated by Clapeyron relationship from the Henry's Law constant at 25°C	NA		‡ 9.00×10^{-6}	Recommended literature value
Dermal absorption fraction, dimensionless	NR		0	Environment Agency (2009b)	0.1	Environment Agency (2009b)
Diffusion coefficient in air, $m^2 s^{-1}$	6.34×10^{-6}	Estimated by Heinsohn and Cimbala method (2003)	NA		8.61×10^{-6}	Estimated by FSG method
Diffusion coefficient in water, $m^2 s^{-1}$	2.00×10^{-9}	Estimated by Hayduk and Laudie method (1974)	NA		8.61×10^{-10}	Estimated by Hayduk and Laudie method
Octanol–water partition coefficient (log), dimensionless	0.62	Recommended literature value	NA		1.7	Recommended literature value
Organic carbon–water partition coefficient (log), $cm^3 g^{-1}$	4.16 #	Estimated from soil–water partition coefficient	NA		1.9	Calculated using non-hydrophobic relationship with the octanol–water partition coefficient
Relative molecular mass, $g mol^{-1}$	200.59	Recommended literature value	NA		251.1	Recommended literature value
Soil–water partition coefficient, $cm^3 g^{-1}$	NA		500	Recommended literature value	NA	
Vapour pressure, Pa	0.07028	Recommended literature value	NA		1.13 (25°C)	Recommended literature value
Water solubility, $mg L^{-1}$	0.056 (25°C)	Recommended literature value	74,000 (20°C)	Recommended literature value	100 (21°C)	Recommended literature value
Soil-to-dust transport factor, dimensionless	0.5	Environment Agency (2009b)	0.5	Environment Agency (2009b)	0.5	Environment Agency (2009b)
Sub-surface soil to indoor air correction factor	1	Environment Agency (2009b)	1	Environment Agency (2009b)	1	Environment Agency (2009b)
Soil-to-plant concentration factor, mg kg^{-1} FW plant per mg kg^{-1} soil						
Green vegetable produce	NR		3.8×10^{-3}	Recommended literature value	† 3.8×10^{-3}	Recommended literature value
Root vegetable produce	NR		6.9×10^{-3}	Recommended literature value	† 6.9×10^{-3}	Recommended literature value
Tuber vegetable produce	NR		4.3×10^{-3}	Recommended literature value	† 4.3×10^{-3}	Recommended literature value
Herbaceous fruit produce	NR		1.0×10^{-3}	Recommended literature value	† 1.0×10^{-3}	Recommended literature value
Shrub fruit produce	NR		1.1×10^{-3}	Recommended literature value	† 1.1×10^{-3}	Recommended literature value
Tree fruit produce	NR		1.0×10^{-3}	Extrapolated from other produce categories	† 1.0×10^{-3}	Extrapolated from other produce categories

Notes: # Value estimated from soil–water partition coefficient for inorganic compounds of mercury at a fraction of organic carbon of 0.0348 (equivalent to 6% SOM).
‡ K_{aw} experimental value at Cl- ionic strength of 0.2×10^{-3} mol.
† Insufficient data to derive separate plant uptake factors for methylmercury compounds from soil solution and therefore data for inorganic compounds have been adopted.
FW = fresh weight
NA = not applicable because the CLEA model does not require these values in the derivation of assessment criteria for inorganic / organic chemicals.
NR = not relevant as oral pathways are not considered

POTENTIALLY SOIL CONTAMINATING ACTIVITIES BY MERCURY

Mercury was used primarily in the recovery of gold and silver from ores and in the manufacture of fulminate (explosive salt) and vermillion (red pigment).It was also used in agriculture, alkaline batteries, chloralkali plants, dental fillings, paints, pharmaceuticals, thermometers, and in electrical apparatus. Many of these applications have now been phased out in western countries.

The main sources of contamination have been mining and smelting, burning of fossil fuels, industrial production of sodium hydroxide and chloride, and waste incineration although mercury also occurs in trace amounts in the production of chemical substances, chemical fertilizers, pharmaceutical products and catalyzers; batteries and fluorescent lights.

At the “Basel Convention Technical guidelines for the environmentally sound management of wastes consisting of elemental mercury and wastes containing or contaminated with mercury” you can find lists of activities source of mercury waste (table 2 of the guide).
http://www.basel.int/Implementation/Publications/TechnicalGuidelines/tabid/2362/Default.aspx

REFERENCE VALUES FOR MERCURY IN SOIL

Table of reference values for mercury from the UK Environmental Agency "Soil Guideline Values for mercury in soil Science Report SC050021 / Mercury SGV ";
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/313877/scho0309bpqg-e-e.pdf

Table 2
The Soil Guideline Values for mercury presented in this table should only be used in conjunction with the information contained in this technical note and with an understanding of the exposure and toxicological assumptions contained in *Updated technical background to the CLEA model* (Environment Agency, 2009b), *Human health toxicological assessment of contaminants in soil* (Environment Agency, 2009c) and *Contaminants in soil: updated collation of toxicological data and intake values for humans. Mercury* (Environment Agency, 2009d).

Land use	Soil Guideline Value (mg kg^{-1} DW) [1,2]		
	Elemental Hg [4]	Inorganic Hg^{2+}	Methyl Hg^{+} [4]
Residential	1.0	170	11
Allotment	26 [3]	80	8
Commercial	26 [3]	3,600	410

[1] Based on a sandy loam soil (Environment Agency, 2009b) and 6% SOM.
[2] Figures are rounded to one or two significant figures.
[3] SGV is based on the vapour saturation limit.
[4] For the purposes of modelling the vapour inhalation pathway, elemental mercury and methylmercury are treated as organic.

ANALYSIS OF MERCURY IN WATER SAMPLES

Speciation in water is an important topic for the understanding of mercury behavior in the environment and for the treatability of water contaminated with mercury. Various forms of Hg arising from various means of treatment of the water sample have to be distinguished (e.g. filtration of sample and treatment with BrCl yields information on HgD = Hg°+ HgR + HgC; however acid digestion followed by analysis yields information on HgT = HgP+HgD):

- HgT = total
- HgP = particulate
- HgD = dissolved Hg
- HgR= reactive
- Hgo = gaseous
- HgC = colloidal / residual

Analysis of water samples for methyl-Hg may be accomplished with the use of isotopic tracers and GC-ICP-MS analysis.

Mercury levels in aquifers can only be compared with reference values (for example, those of the US-EPA) when the analyzed samples have not been filtered.