



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

www.h2020.net

in collaboration with UNEP/MAP

Training on mercury management and remediation of contaminated sites

"Reconditioning of the "Cerco de San Teodoro" slag heap. Minas de Almadén (Ciudad Real, Spain)" Almadén, Spain, 18-19 November 2015

Javier CARRASCO Minas de Almadén y Arrayanes S.A. Industrial Activities Manager jcarrasco@ctndm.es





UMP MINE ALMADEN

This waste heap contains deposits of waste from the mining operations as well as slag from the metallurgical processes accumulated through the centuries.

The volume of the waste heap is at present close to 3,5 million tons, covering 10 hectares









DUMP GEOMETRIC CHARACTERISTIC

OCCUPIED AREA (ha)	9.1
TOP AREA (ha)	4,9
SLOPE AREA (ha)	4,2
WASTE AMOUNT (t)	3,500,000
MAXIMUM HEIGHT (m)	58,7
MEDIUM SLOPE ANGLE	36º
PERIMETER (m)	865





5

ENVIRONMENTAL IMPACT ASSESSMENT

• HYDROGEOLOGIC CONTAMINATION



ALMADEN DUMP



ENVIRONMENTAL IMPACT ASSESSMENT

• HYDROGEOLOGIC CONTAMINATION

• ATMOSPHERIC CONTAMINATION Resuspension of dust downwind and mercury evaporation from the dump surface



ALMADEN DUMP



7

ENVIRONMENTAL IMPACT ASSESSMENT

- HYDROGEOLOGIC CONTAMINATION
- ATMOSPHERIC CONTAMINATION
- GROUND OCCUPATION
- Environmental effect irreversible
- **Contamination** of nearby **lands** by dust dispersion



ALMADEN DUMP



ENVIRONMENTAL IMPACT ASSESSMENT

- HYDROGEOLOGIC CONTAMINATION
- ATMOSPHERIC CONTAMINATION
- GROUND OCCUPATION
- **GEOTECHNICAL RISKS** High risk of **landslide** and **rock falls**



ALMADEN DUMP



ENVIRONMENTAL IMPACT ASSESSMENT

- HYDROGEOLOGIC CONTAMINATION
- ATMOSPHERIC CONTAMINATION
- GROUND OCCUPATION
- GEOTECHNICAL RISKS

• **MORPHOLOGY AND LANDSCAPE** Modification of visual and chromatic landscape



ALMADEN DUMP





© Centro Tecnológico Nacional de Descontaminación del Mercurio

HELP

Desarrollado por el Instituto de Desarrollo Regional - UCLM.















CHARACTERIZATION OF SURFACE WATER ALMADEN DUMP FUENTE VIEJA STREAM Parque Minero de Almadén **River network:** little flow and low slope. AZOGADO STREAM Conditioned by climate In summer, intermittent flow VALDEAZOGUES RIVER

www.h2020.net

14

٠



CHARACTERIZATION OF SURFACE WATER



HELP



CHARACTERIZATION OF SURFACE WATER



C Centro Tecnológico Nacional de Descontaminación del Mercurio

HELP

Desarrollado por el Instituto de Desarrollo Regional - UCLM.







© Centro Tecnológico Nacional de Descontaminación del Mercurio

HELP

Desarrollado por el Instituto de Desarrollo Regional - UCLM.



N = North

NE = Nor

E = Este

S = Su

SO = Sur



CHARACTERIZATION OF SOILS DEEP SOIL SAMPLES



Centro Tecnológico Nacional de Descontaminación del Mercurio

HELP

Desarrollado por el Instituto de Desarrollo Regiona www.h2020.net

18

N = North

NE = Nor

E = Este

SE = Surest

S = Su

SO = Suro

O = Onste



To define the **acceptable concentration** limit for mercury in soil:

- Samples need to be taken at points in the environment at which it can be guaranteed that there is no contamination.
- These sampling points must have **geological substrates** with **similar** characteristics to those in the contaminated site.
- Under these conditions:



*According **Royal Decree 9/2005** of 14 January, which set the relationship of activities potentially contaminating soil and criteria and standards for the declaration of contaminated soils.











CHARACTERIZATION OF AIR

Reference concentration of mercury in air:

1000 ng/m³ annual average (WHO Air Quality Guideline for Europe)

300 ng/m³ reference concentration in residential areas (United States Environmental Protection Agency (EPA))







MAIN WORKS: **ENCAPSULATION OF THE DUMP** AIMS:

- STABILITY AND LANDSCAPE INTEGRATION WITH THE DUMP AND THE SURROUNDINGS
- SECURING WATERPROOFING, AND ISOLATION FROM ITS SURFACE.



PHASES 1. DUMP FORMING

• Remodel the slopes and the capping plate of the dump

Stabilizing their conditions

Earth filling of 493,582 m3 of material







2. DUMP SEALING:
Functions:
To prevent the entrance of water in the dump, avoiding the generation of leachate and the material dispersion.

Insulation, avoiding mercury evaporation in the dump ace













LOW INCLINATION SLOPE





SEALING SURFACE SCHEME HIGH INCLINATION SLOPE













PHASES 3.INSTALLATION OF A COLLECTION, CIRCULATION AND EVACUATION WATER SYSTEM

Aim: To avoid the erosive effects which can affect the dump stability



PHASES
4. RESTORATION OF THE VEGETAL LAYER.
AIM:
To recover vegetation in the restored surface
The landscape integration of the dump and the

surroundings.

ACTIONS: Contribution of 50 cm of topsoil all over the surface, about 170.000 m3 Hydroharvest in 16 ha



ENVIRONMENTAL MONITORING

GIS AZOGUE

(GEOGRAPHIC INFORMATION SYSTEM ABOUT ALMADEN DUMP)

- System designed to store, manipulate, analyze, manage, and present the environmental data about the monitoring of Almaden dump.
- Incorporate topography and orthophotos, and analytical controls of the environmental characterization
- On a GIS web platform (so that information can be consulte over the **Internet**).
- It is a **public information** for everybody

Enter: http://www.ctndm.es/proyectos/1-in.php Press: Epter SIG





RESTORATION OF THE WASTE HEAP IN THE SAN TEODORO ENCLOSURE The first results: Emission to the atmosphere



Source: Dr Pablo Higueras (UCEM)













WATER MONITORING SURFACE WATER: RIVER







The restoration works are reducing:

- The material dispersion and mercury evaporation
- The lixiviate production which had as final destination the surrounding streams
- The underground flow below the dump





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

www.h2020.net

THANK YOU!



Javier Carrasco: jcarrasco@ctndm.es