SWIM and Horizon 2020 Support Mechanism

Working for a Sustainable Mediterranean, Caring for our Future

Design of Long Term Solutions for Solid Waste Management

Sanitary landfills

Presented by:

Mr. Faouzi BEN AMOR, Environmental of Expert - MeHSIP

SWIM and Horizon 2020 SM Title of Meeting

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Landfill design - General information

Landfill design means:

- Dimensioning the landfill (waste quantity, example for 20 yrs.)
- Design of **the whole infrastructure** (like access road, buildings, electric power supply, drinking water supply, all internal roads, weighbridge, workshop etc.)
- To decide which **bottom liner** system is the best under the given circumstances / conditions
- Dimensioning of **leachate collection** system and storage pond
- Dimensioning of **leachate treatment**
- Dimensioning of **landfill gas collection** system and flare (and probably landfill gas utilization)
- Dimensioning **surface water drains** and retention ponds
- **Stability analyses**, settlement calculations...

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Landfill design

General information

- Good design of a landfill will **prevent**, or **reduce** as far as possible, **negative effects on the environment**, as well as the **risks to human health** arising from the landfilling of waste.
- The design process should be consistent with the need to **protect the environment and human health**.
- Landfill design is an interactive process incorporating the **conceptual design** proposals, the findings of the **site investigation** and the **environmental** and **risk assessment**.
- Typical landfill consists of **several cells** in which the waste is systematically placed.
- Landfill base usually consists of a **liner** (clay or synthetic) that **minimizes the leakage** of liquid waste materials and leachate into **groundwater system**.

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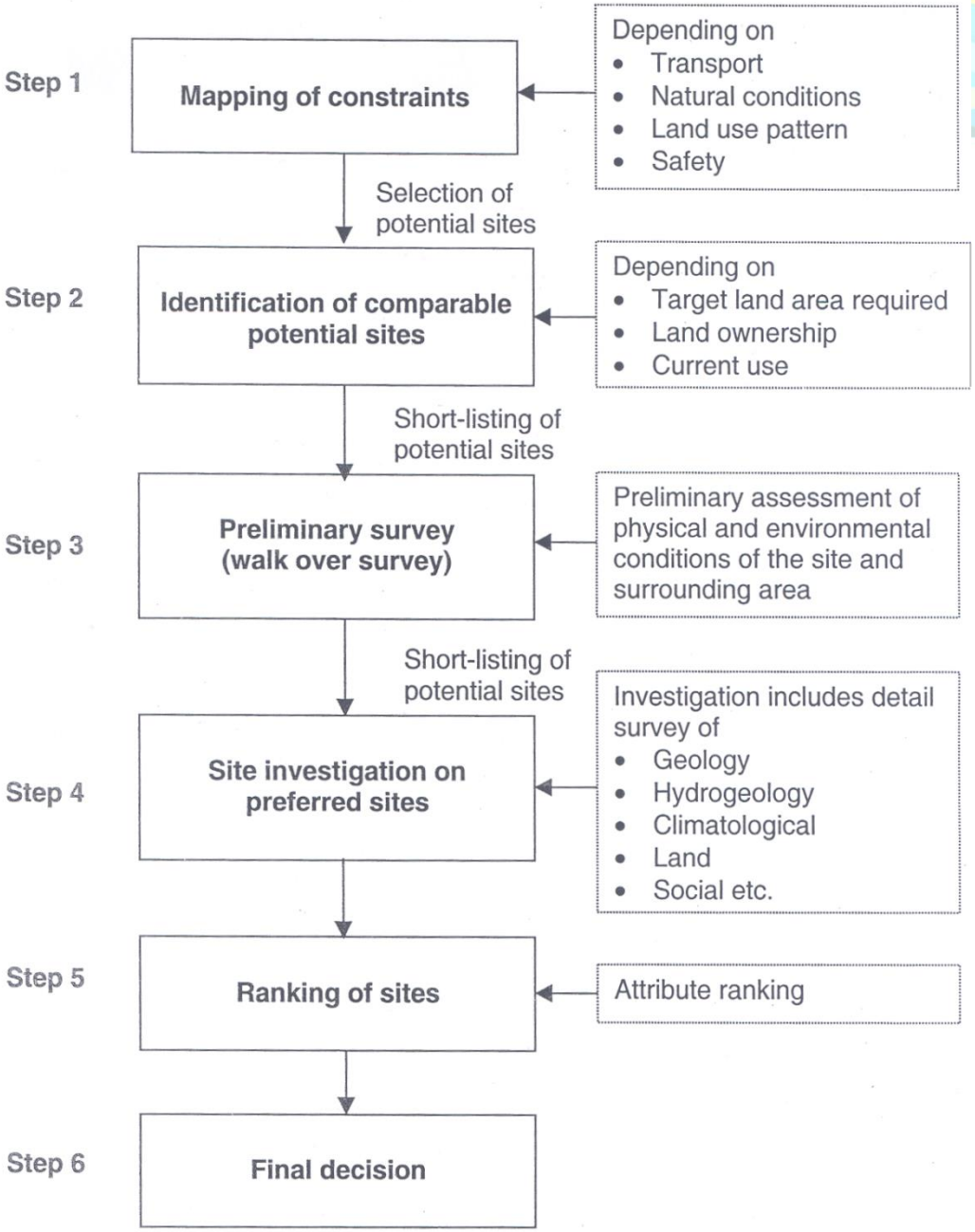
Landfill design

Presentation content

- Landfill siting
- Site investigation
- Volume / capacity of landfill
- Design principles – conceptual
- Surface water drainage system
- Leachate collection and treatment system
- Lining systems (Bottom liners)
- Landfill gas collection system
- Landfill infrastructures

Landfill design

Siting



Landfill design - Siting

Common Problems

- Can take lengthy periods of time and is politically challenging
- There is a strong likelihood of receiving some opposition to the proposed landfill
- In some cases this opposition can paralyze progress for many years
- Opposition is likely to be greatest for ISWM facilities involving landfill and incineration
- Or when one municipality is receiving another municipality's waste. Or waste from a city is being sent to a satellite area.

Landfill design – **Siting exclusion criteria**

- Drinking water protection and catchment areas
- High flood areas
- Areas with highly permeable soils
- Areas with unstable ground like swamps, moors and/or marshes.
- Areas with extreme topography/morphology
- Areas endangered by swallow holes, collapse sites, deep digging
- Areas in close proximity to populated areas (or centres of settlement)
- Areas beyond a reasonable distance from centres of waste generation
- Areas nearer than 2 km to airports
- National parks, nature protection areas
- Historical, religious or other important cultural sites or heritage

Landfill design

Siting inclusion criteria

- The size of the site should be larger than the minimum area requirement for the construction of the landfill (should satisfy least 15-20 years capacity)
- The site should have some possibility for land acquisition
- The site should have some possibility for engineering design and environmental protection
- The site should have some possibility of being acceptable to neighboring public/communities
- The location of the site should have a good chance to have compatibility with wider development priorities, and specific regional development and land use plans

Landfill design

Site investigation

- **Site topographic survey**: must be done at good scale to be used as the baseline for earth work quantities precisely (to extend beyond site limits and to be attached to national geodesic system);
- **Sub Soil Investigation:** type of soil, depth of GWT and bedrock, permeability of various strata, strength parameters for stability, extent of availability of liner materials (borehole drillings, soil sampling, stratigraphy logging, in-situ testing) ;
- **Hydrogeological Investigation**: Depth of GWT, GW flow direction, Baseline GW quality parameters;
- **Hydrological Investigation**: To estimate the quantities of runoff for appropriate design of drainage facilities (limits of watershed, IDF curves, etc.)
- **Geological and seismic Investigation**: to delineate the bedrock profile beneath the landfill base

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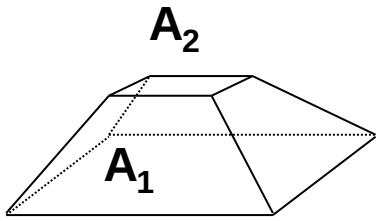
Landfill design - Capacity for 15 years

Year of operation	Year	Pop. Growth	Population	MSW prod. Rate	Waste Quantity	Average waste density	Average waste volume	Cover material	Landfill volume	Total Landfill volume
		%	hab.	kg/hab/day	t/year	t/m^3	m^3/year	%	m^3/year	m^3
1	2011	2,5%	113 972	0,89	37 024	0,9	41 138	15%	47 308	47 308
2	2012	2,5%	116 821	0,89	37 949	0,9	42 166	15%	48 491	95 799
…	…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…	…
11	2021	2,5%	145 894	0,94	50 056	0,9	55 618	15%	63 961	603 460
12	2022	2,5%	149 541	0,94	51 308	0,9	57 008	15%	65 560	669 020
13	2023	2,5%	153 280	0,94	52 590	0,9	58 434	15%	67 199	736 219
14	2024	2,5%	157 112	0,97	55 625	0,9	61 806	15%	71 077	807 295
15	2025	2,5%	161 040	0,97	57 016	0,9	63 351	15%	72 854	880 149

The needed area of the landfill can be estimated as follows (as a first rough estimation)

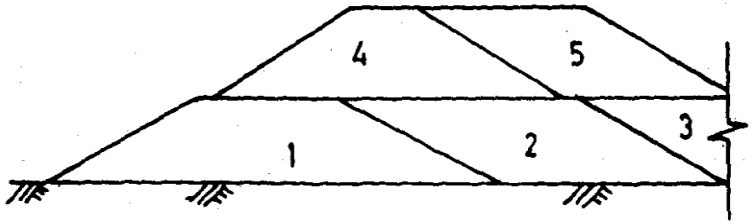
$$V = \frac{(A_1 + A_2 + \sqrt{A_1 \cdot A_2}) \cdot h}{3}$$



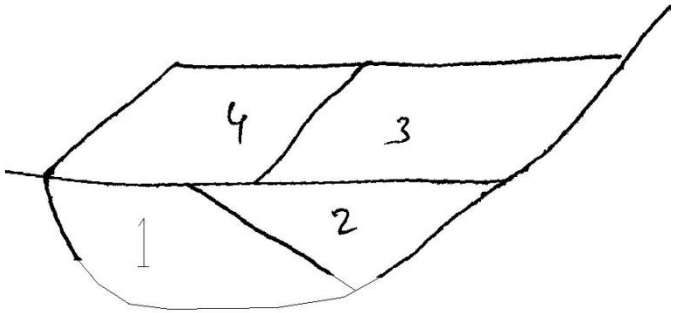
The average height of a landfill should be minimum 15, better 20 m.

Landfill design – **Design principles**

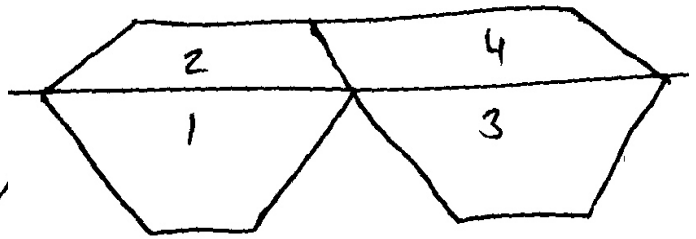
Whether the landfilling is to be above or below the ground surface or a combination of both depends on the **topography** of the site and the **depth of ground water table**. There are many possible sections and the landfill may take the following forms



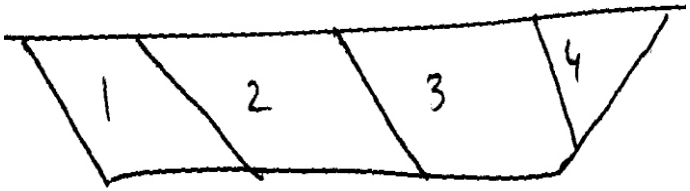
Above ground landfill



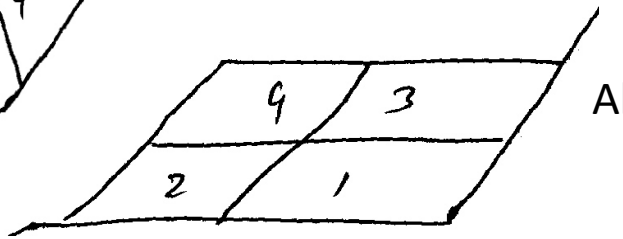
Valley landfill



Above and below ground landfill

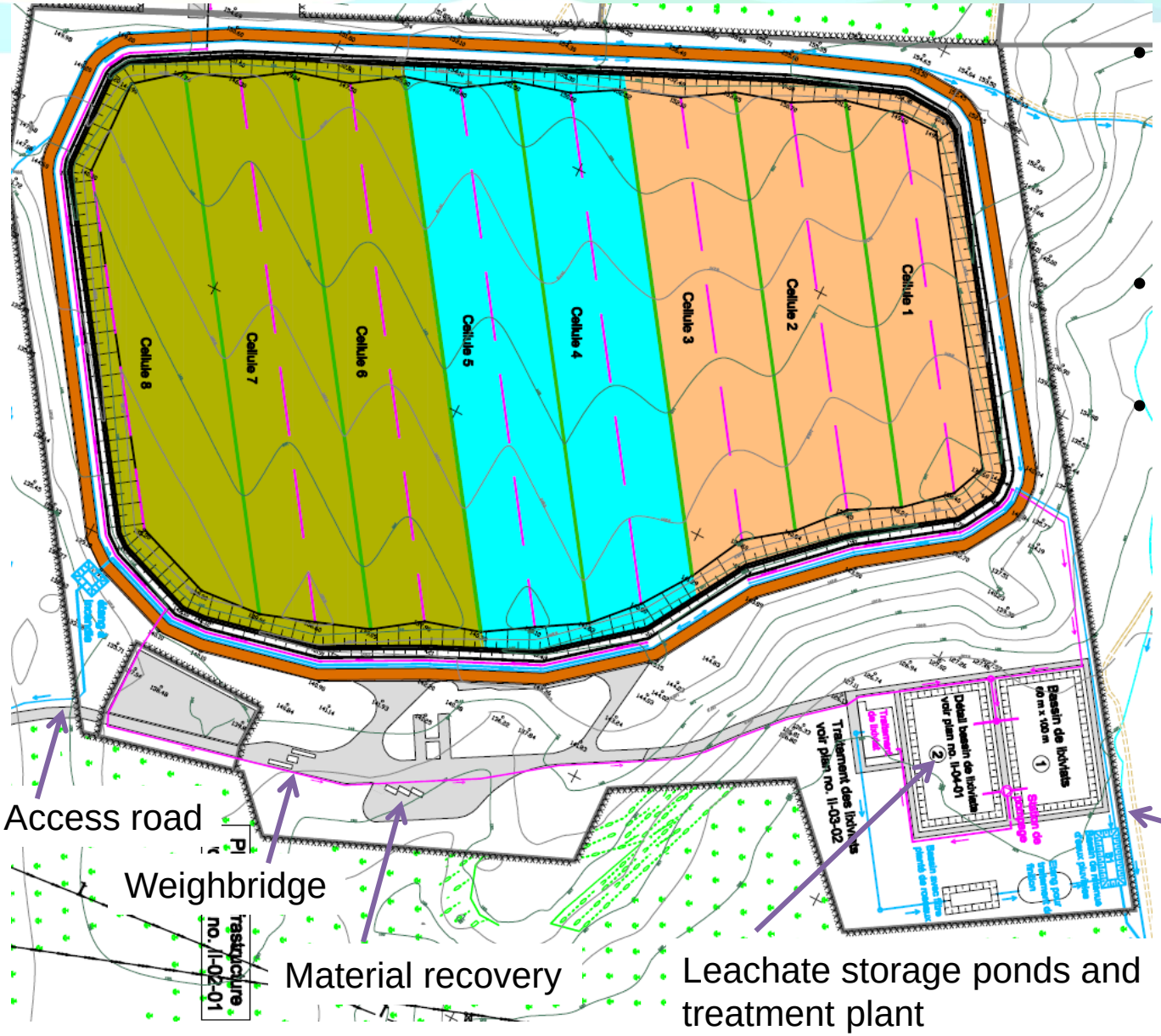


Below ground landfill



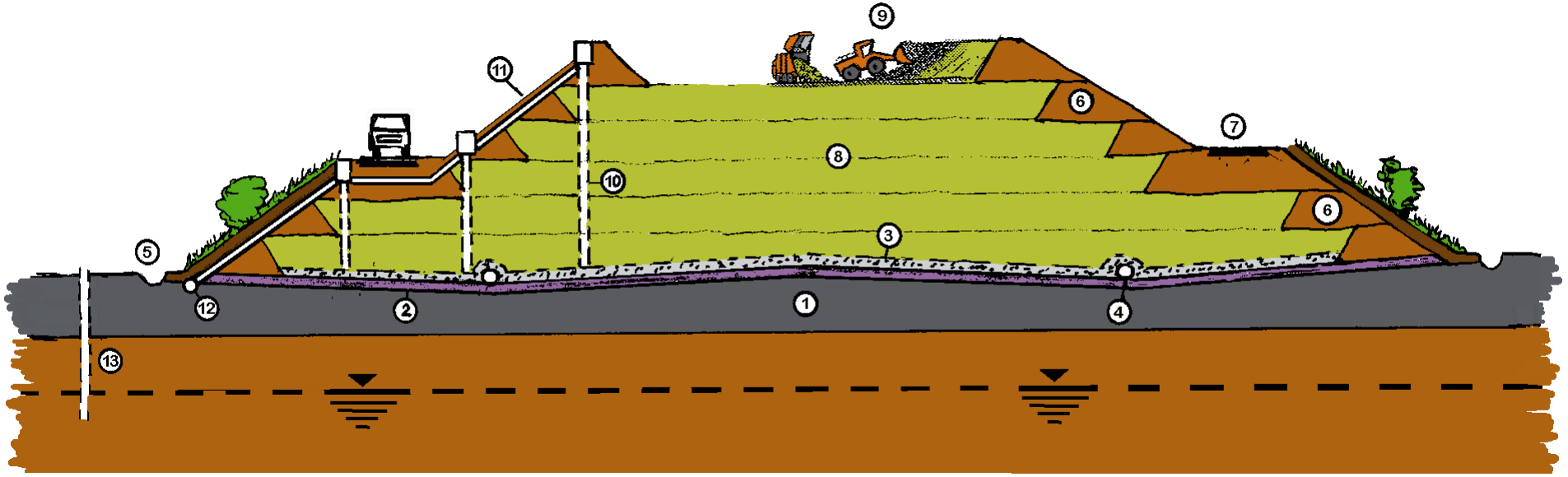
Slope landfill

Landfill design - **Site layout plan**



- Layout of Kabouti landfill - 2nd sanitary landfill of Greater Tunis
- Serving about 1 million inhabitants
- Currently under construction

Landfill design – Cross section through landfill



(1)	Geological barrier
(2)	Bottom liner
(3)	Drainage system
(4)	Leachate collection / discharge
(5)	Surface water drainage
(6)	Embankment dams
(7)	Access road to landfill

(8)	Waste body
(9)	Waste installation
(10)	Landfill gas collection system
(11)	Capping system
(12)	Landfill gas collection pipe
(13)	Groundwater monitoring
(14)	Plants (so-called recultivation)

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