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EXPERIENCE WITH
MASTER PLANNING FOR
USE OF UNDERGROUND
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2011, Hong Kong, pp. 1-9*

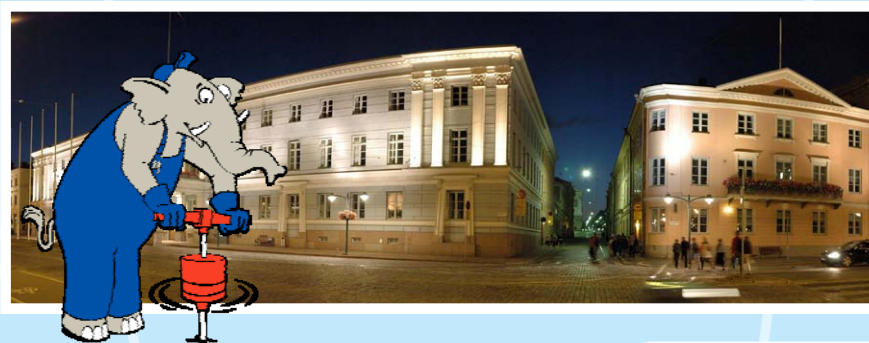
Joint HKIE-HKIP Conference on Planning and Development of Underground Space, 2011, Hong Kong

Helsinki Experience with Master Planning for Use of
Underground (UG) Space

Ilkka VÄHÄHO, Head of Geotechnical Division
Helsinki City Real Estate Department, Finland

23 September 2011

**Geotechnical Division is an Expert in
Geotechnical Data Management since 1955
and in UG Planning since 1956**



City of Helsinki



Courtesy: City of Helsinki Media Bank

Statistics of Underground Helsinki

- ❖ Underground space (parking, sports, oil and coal storages, metro etc.) 10,000,000 m³
~ average 1 m² per 100m² ground surface
- ❖ More than 400 premises
- ❖ Technical tunnels 220 km
- ❖ Raw water tunnels 24 km
- ❖ Utility tunnels “all in one” (district heating and cooling, electrical and telecommunications cables, water) 60 km

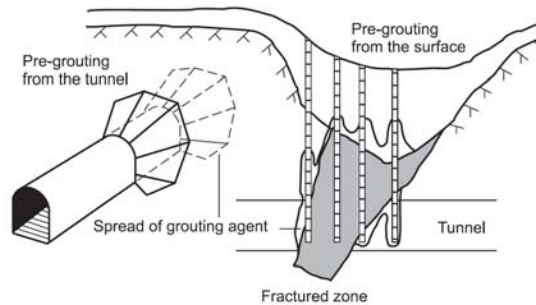


Photo: Erkki Makkonen



Courtesy Länsimetro Oy

Pre-grouting is most important in Helsinki conditions

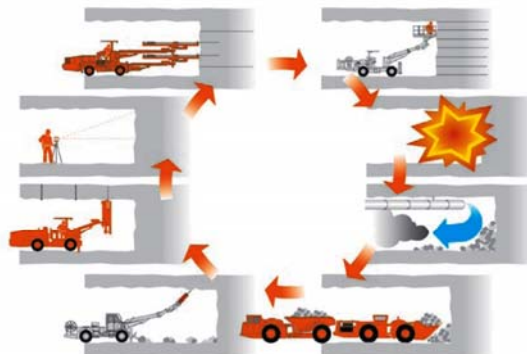


Two alternatives: From the tunnel or from the surface

Courtesy: Sandvik Mining and Construction Finland

Drill and Blast method cycle

Drilling > Charging > Blasting > Ventilation > Loading >
Scaling > Reinforcements > Measuring



Courtesy: Sandvik Mining and Construction Finland

Hong Kong MTR West Island Line 25 Sep 2011



Photo: Ilkka Vähäaho

I. Vähäaho's insight: Lining in these kind of circumstances means 100%–200% extra costs and is totally waste of money



North Harbour 1951

Courtesy: Finnish Defence Forces (Topografikunta)



From: Open Session in World Tunnel Congress 2011, Helsinki
By: Tetsuya Hanamura, Dr. Eng.

Tunnels and UG Spaces are Strong!

=> The earthquake in Japan caused little if any structural damage to the metro tunnels

=> The tsunami swept off almost everything on ground - but caused only minor damages in tunnels

Tunnel underneath the Sendai Airport in Sendai Airport Access Line

Before the strike of 2011 earthquake

only inundated

Tunnel entrance

In the tunnel

Though the tunnel was inundated by tsunami, no structural damage was observed.

Community Technical Systems

- Underground facilities for municipal and other technical services (such as energy, water supply and telecommunications) are large-scale closed networks
- Coordination is done by the Helsinki Committee on Utility Tunnels
- Utility tunnels are located at such a depth that space reservations for them do not have a significant effect on other underground facilities
(exception: deep bore holes for heating/cooling)

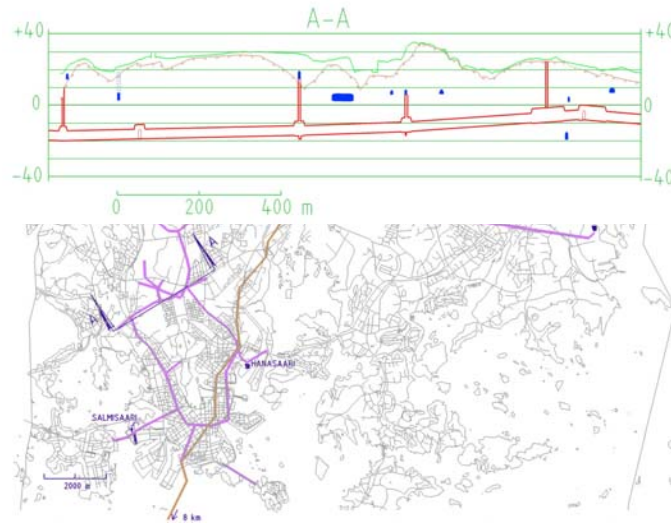


Photo: Jorma Viikman

Community Technical Systems



Community Technical Systems



 City of Helsinki

Benefits and Dilemmas of Underground Community Technical Systems

1. Reliable energy supply via a network
2. Optimisations of energy generation with major transmission networks
3. Expenses are shared by several users
4. Land is released for other construction purposes
5. The city's appearance and image are improved, as the number of overhead lines can be reduced
6. Construction work carried out on underground pipes and lines has significantly fewer disadvantages
7. Excavated rock resulting from construction of the tunnels can be utilised
8. Pipes and lines in tunnels require less maintenance, and are easier to maintain
9. Any breakages in pipes, lines and cables do not pose a great danger to the public
10. Tunnels are a safer option against vandalism

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Initial Survey for Unnamed Rock Resources (= reserved for unclassified future use)

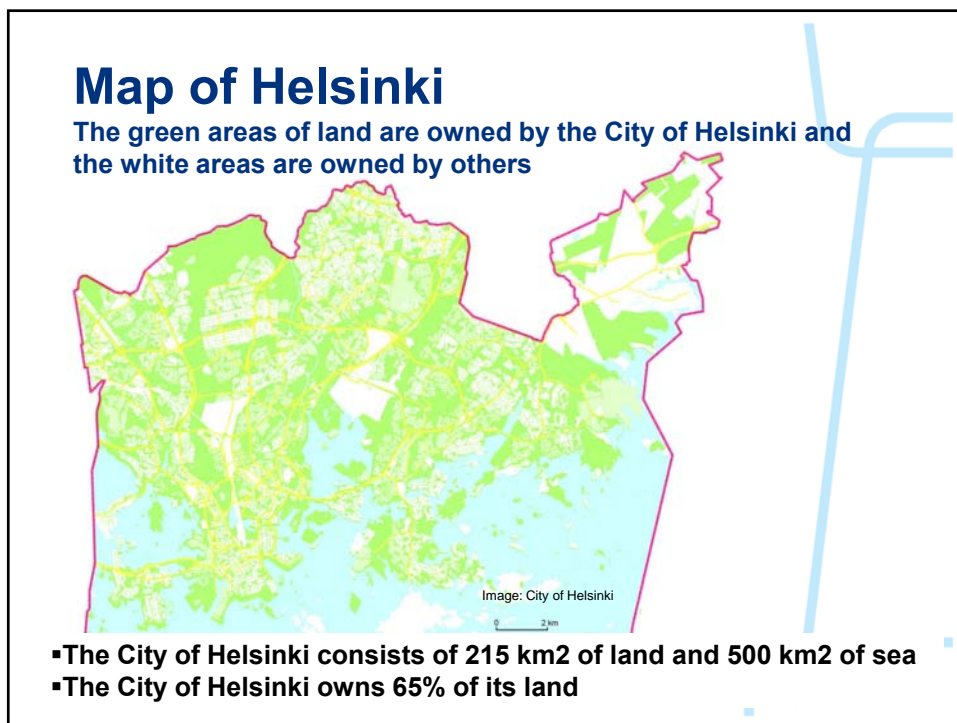
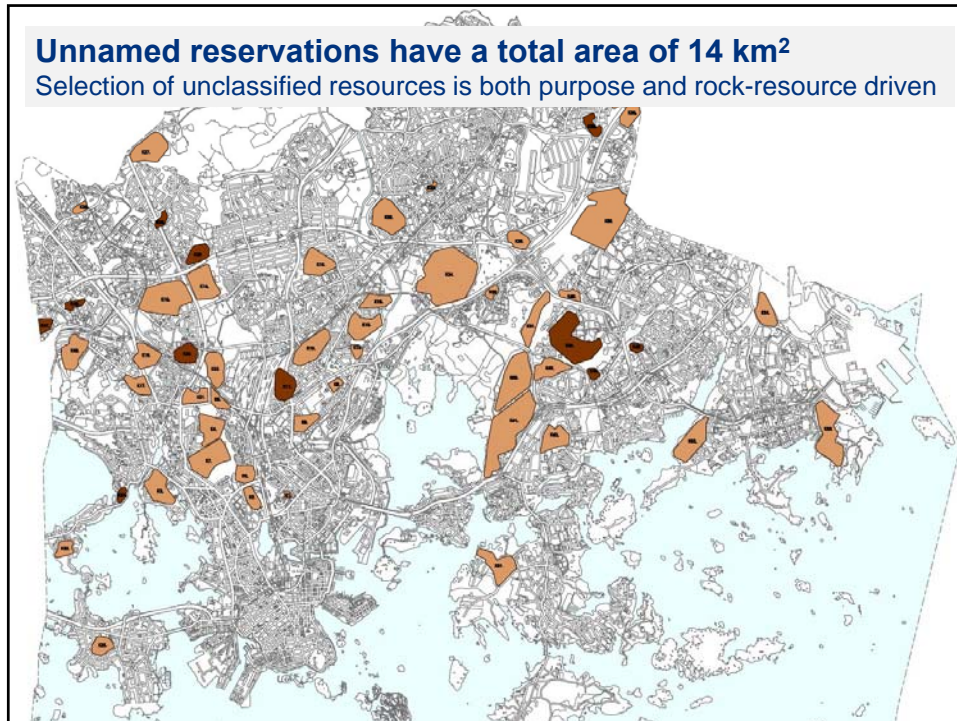
- An initial survey examined the areas and elevation levels in Helsinki which are suited for construction of large, hall-like facilities
- A model was used based on rock surface data and applying a standard-sized measurement cave (width 50 m, length 150 m, height 12 m)
- The model of the bedrock is based on base map data for exposed rock and land surface elevations and point data obtained using geotechnical drill rig borings
- The survey also took into account local weakness zones and rock resources that have already been put to use

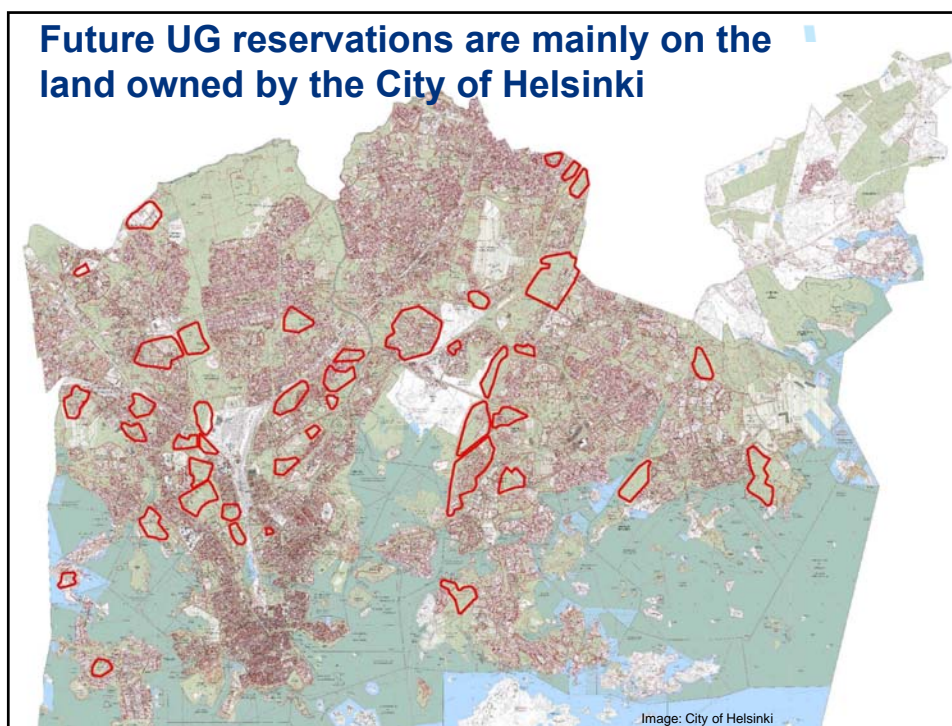


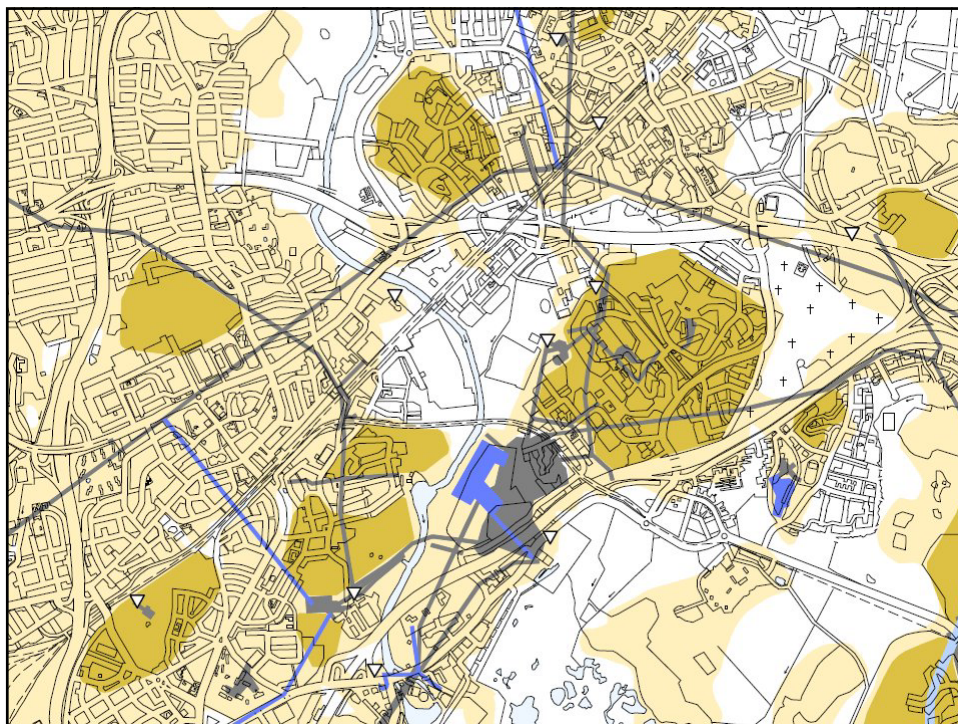
Unnamed Rock Resource Reservations

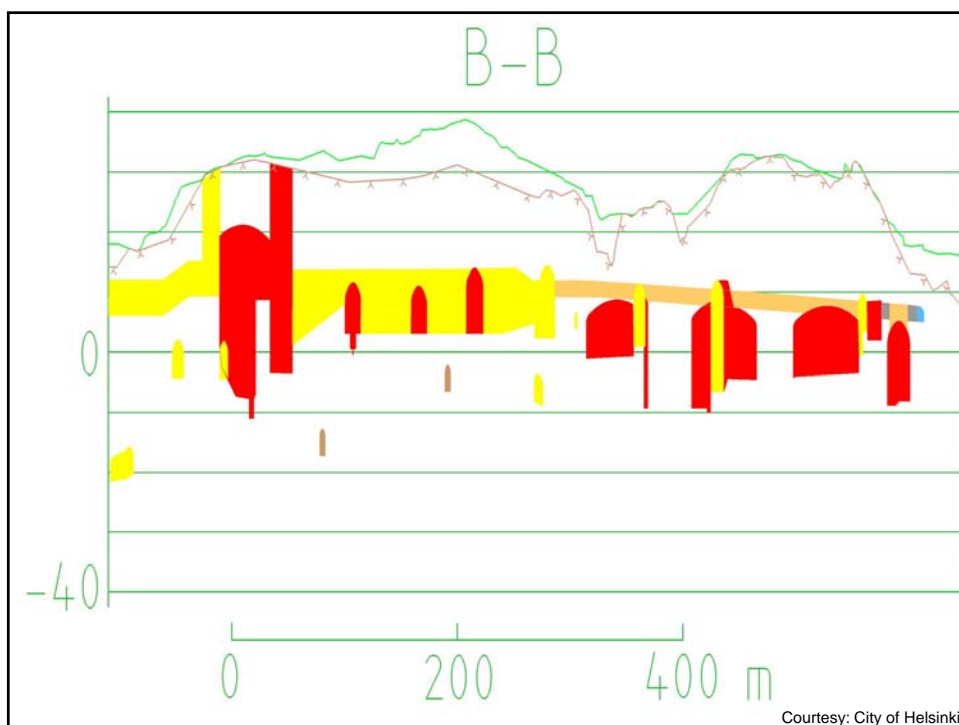
- When selecting these resources for unclassified future use the survey took into account their
 - Rock conditions
 - Accessibility from existing tunnel network
 - The present and planned ground-level uses of these areas
 - Traffic connections on ground
 - Land ownership
 - Possible recreational, landscape and environmental protection values









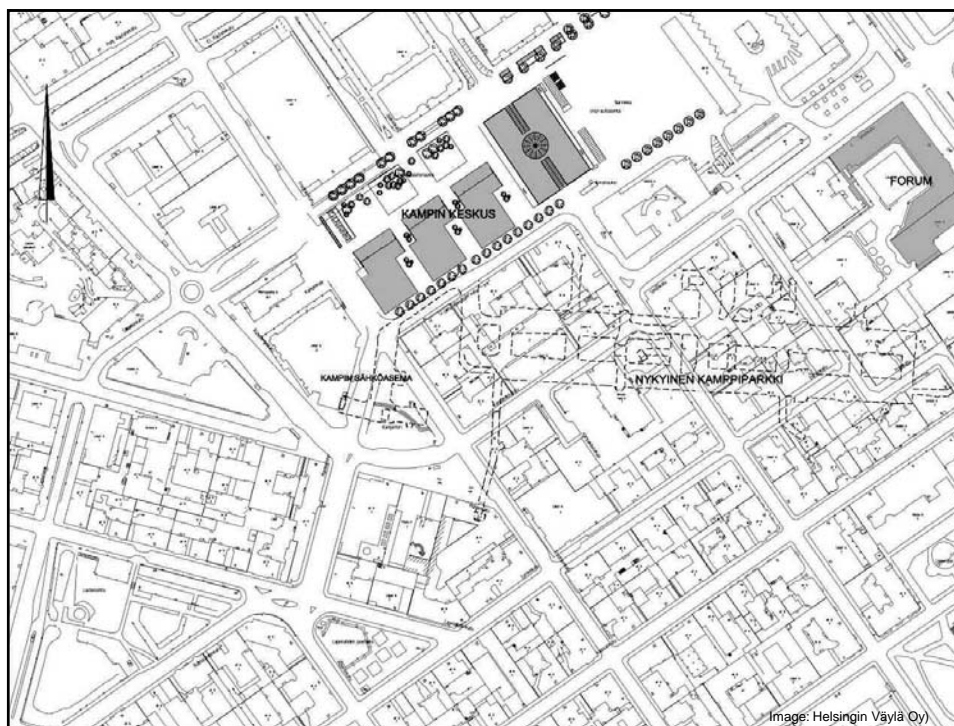


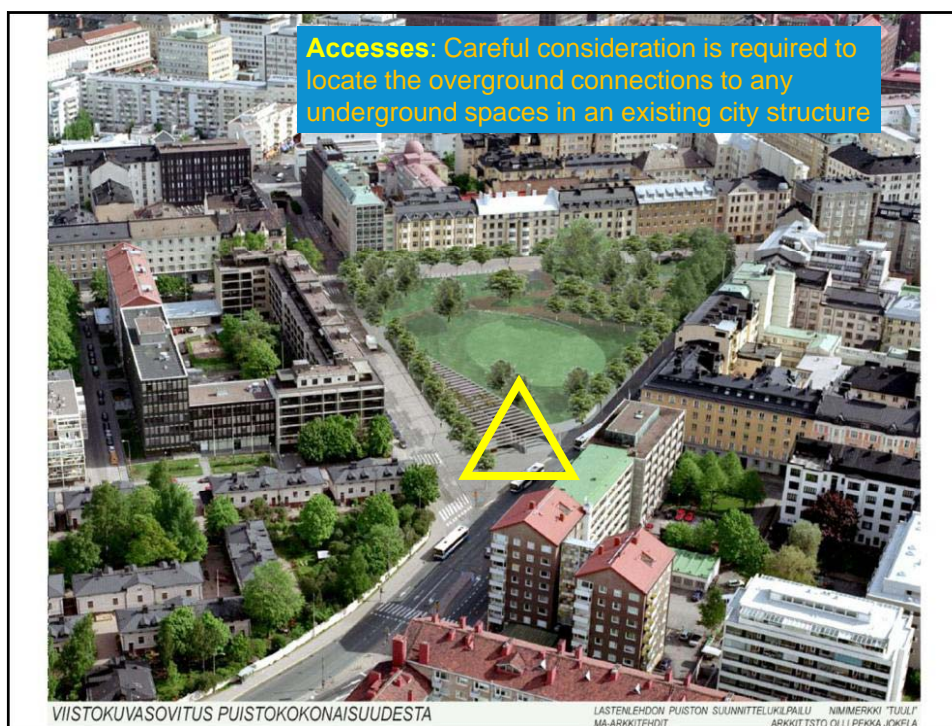




Lessons Learned from Viikinmäki Case

- Viikinmäki waste water treatment plant is the central plant for treating wastewater from six towns and cities
- It is less than 10 km from the centre of Helsinki
- The plant treats 280,000 m³ of wastewater from about 750,000 people every day
- Completed at a cost of €180 million, the treatment plant began operating in 1994
- It replaced more than 10 smaller treatment plants, all above ground, allowing these sites to be zoned for more valuable uses
- The construction of the underground wastewater treatment plant took place simultaneously with the construction of ground-level infrastructure and residential buildings





Examples of Future UG Planning

- Underground master plan of Helsinki is an example of a new **0-land_use** thinking



0-land_use

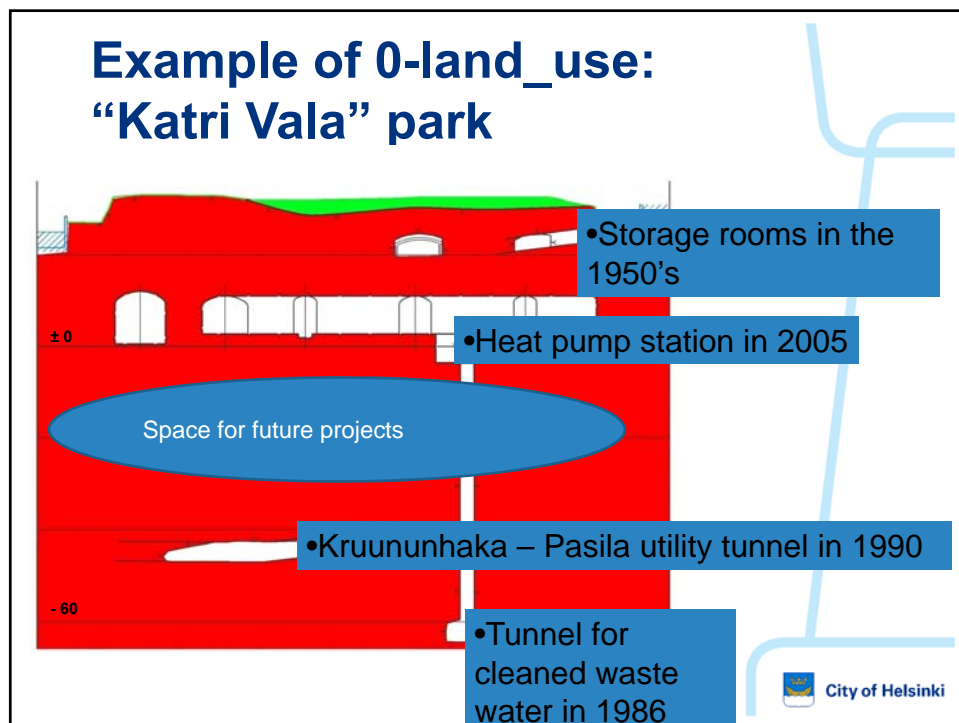
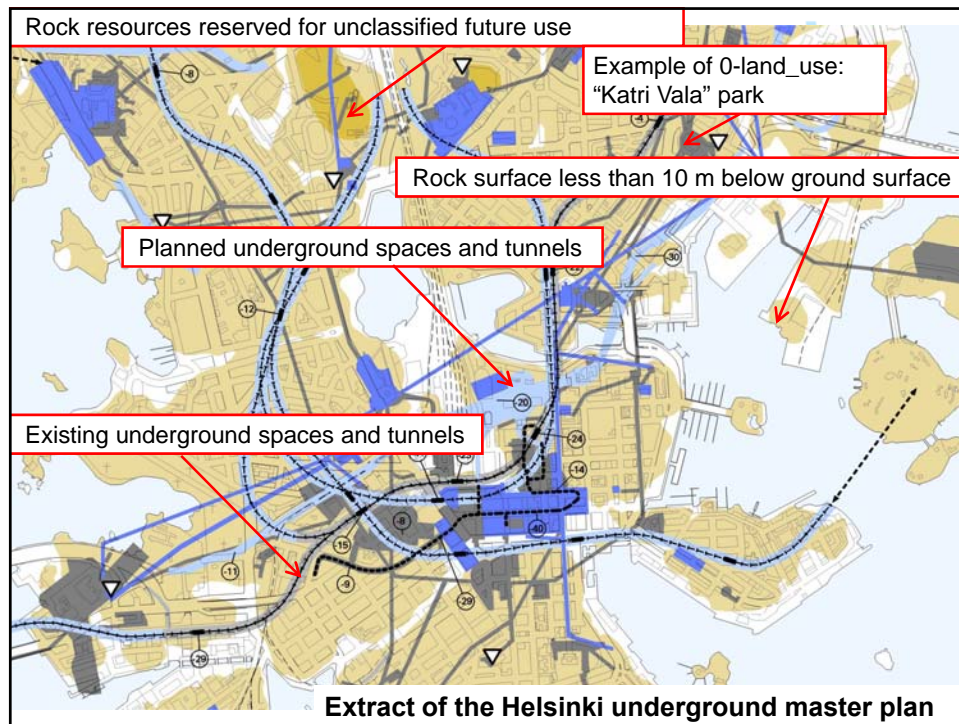
SB10 Western Europe
Maastricht, Heusden-Zolder, Aachen, Liège
11, 12 & 13 October 2010

Towards 0-impact buildings and environments

A new concept was adopted by Sterling et al:

~ Sustainable use of underground space





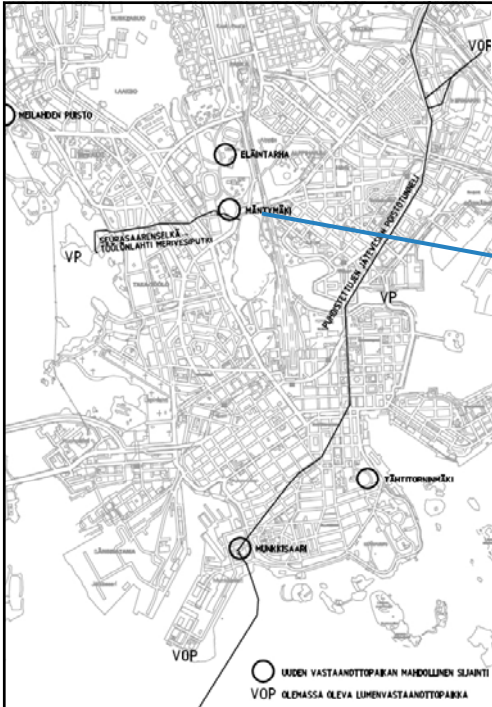


FEASIBILITY STUDY

© copyright City of Helsinki




**PRESENT WAY:
DUMPING SNOW INTO THE SEA**




FEASIBILITY STUDY

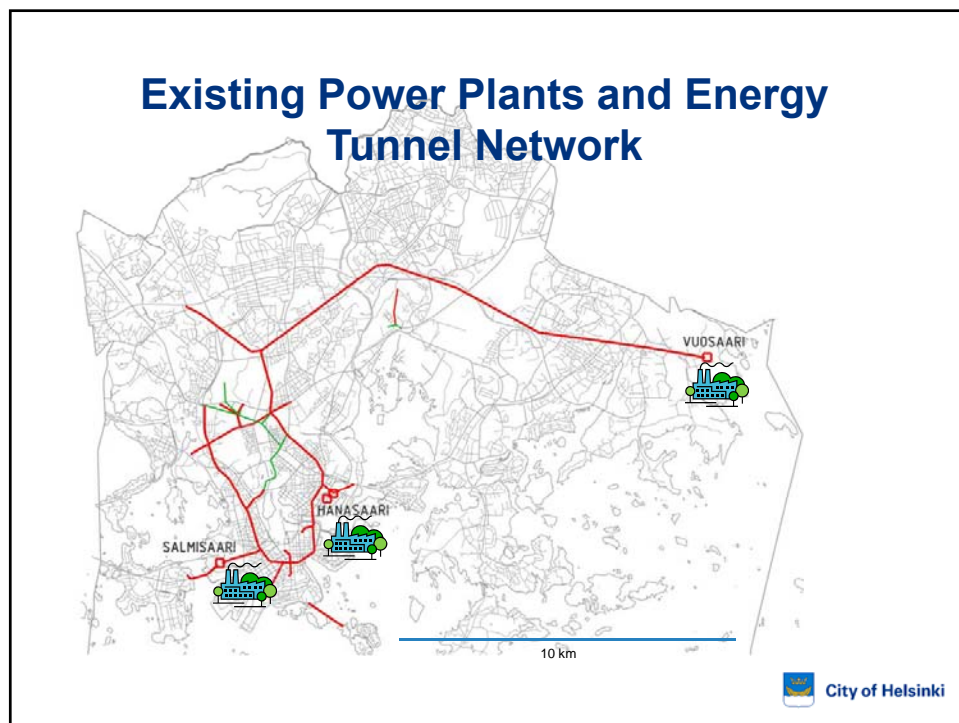
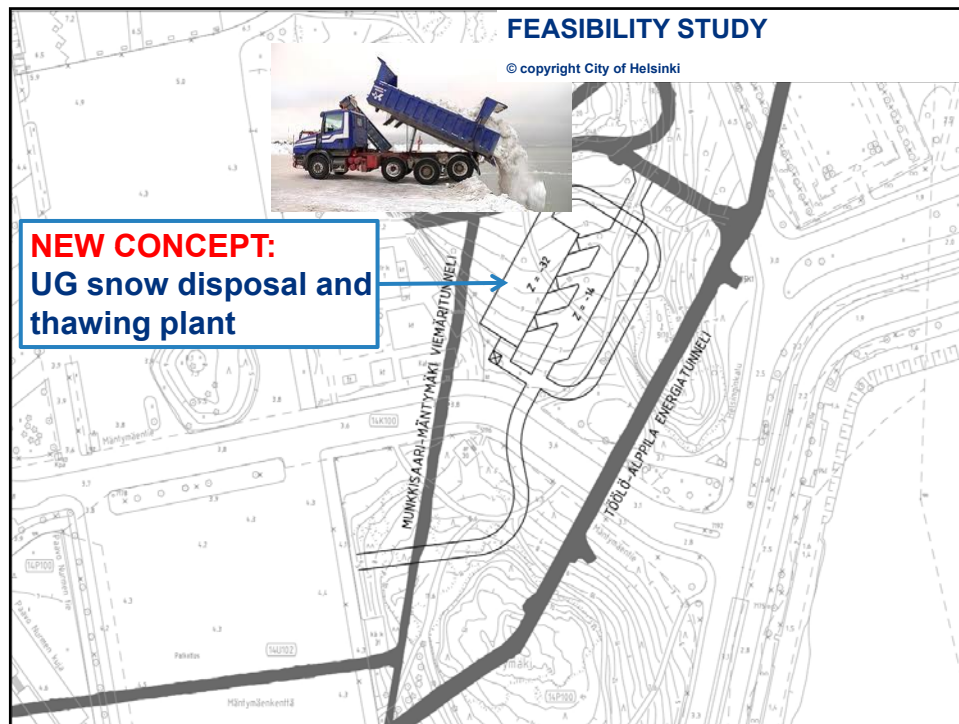
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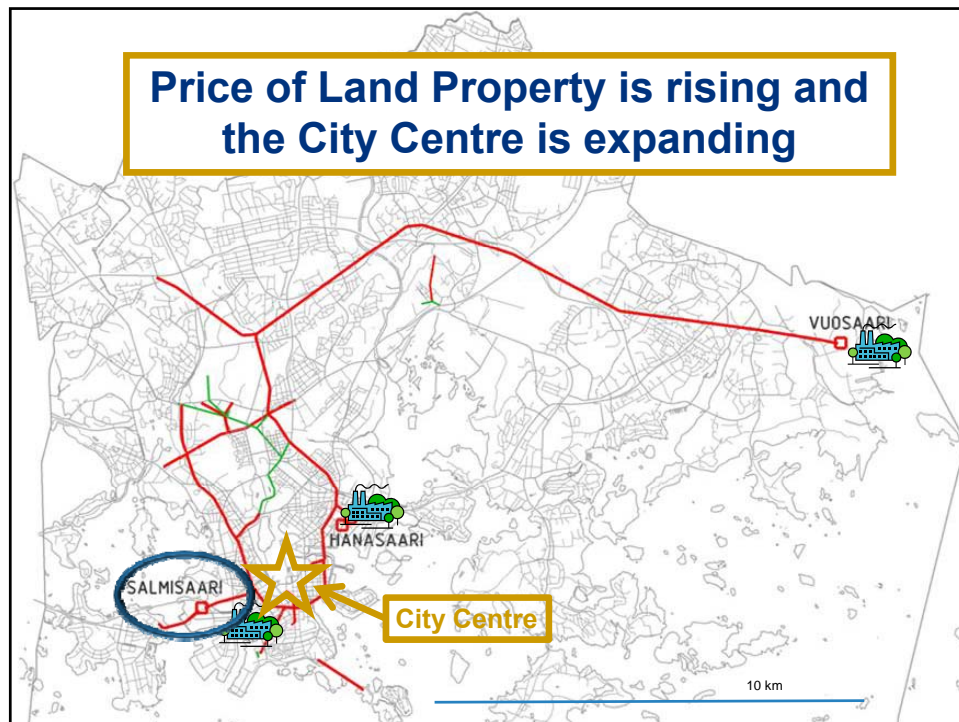


○ UUDEN VASTAANOTTOPAJAN MAHDOLLINEN SJAINTI
VOP OLEHASSA OLEVA LUMENVASTAANOTTOPAJA
VP OLEHASSA OLEVA VARAVASTAANOTTOPAJA



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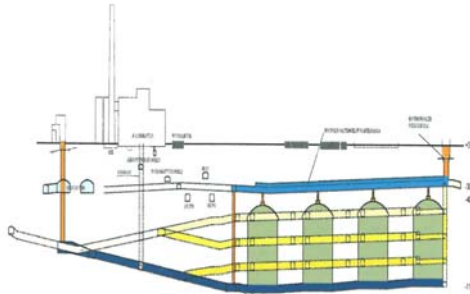
Case Salmisaari power plant's Coal heap



The new 400,000 m³ coal stock silos of the Salmisaari power plant were built (2002-2004) into the bedrock. Left hand photo (2003) with a pile of coal and a pile of quarried rock. Right hand photo (2010) the same area with a number of headquarters of some most remarkable companies in Finland.



Salmisaari Underground Coal Storage



Courtesy: Finnish Tunnelling Association



Photo: Jorma Viikman

Salmisaari area before and after Underground Coal Storage



Courtesy: City of Helsinki



Courtesy: City of Helsinki

Coal Storage Silos in bedrock were built with the price that the City of Helsinki got by selling the former Coal heap area for building ground to private companies

Dilemmas Facing Underground Planning

- According to the law (in Finland), the owner of a property has control over the underground part of the property
- The vertical extent of ownership is not specifically defined in legislation
- When interpreting the extent of ownership, **the lower boundary of a property has been limited to the depth where it can be technically utilised; in practice this means the depth of 6 m**
- **City of Helsinki charges also those companies using underground space, but the rent is only c. 50% of the corresponding ground-level rent**
- Anyone constructing facilities underground must obtain agreement on the right to use the underground construction site
- Ownership can be established through voluntary transactions, agreements or compulsory purchases based on legislation
- The precondition for obtaining a building permit is that the applicant has control over the construction site



Conclusions

- Important to educate planners and decision makers about the usefulness of UG resources
- Placing different facilities UG is a safe and economical investment
- Owning the land donates the city the value increase of zoning and helps UG Planning



Thank You!



Courtesy: City of Helsinki Media Bank, photo Markku Juntunen