Seminar on Underground Space Use

Singapore Monday 5 – Tuesday 6 November 2012

Master Planning for Underground Space Use

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Updated 28 December 2012

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Main References / Further information 1(2)

- www.geotechnics.fi ▪ CaseBank
  - HELSINKI EXPERIENCE WITH MASTER PLANNING FOR USE OF UNDERGROUND SPACE
  - GEOTECHNICAL AND GEOLOGICAL DATA MANAGEMENT IN URBAN UNDERGROUND AREAS
  - ENERGY TUNNEL NETWORK IN HELSINKI
  - TECHNICAL SERVICES AND UTILITY TUNNELS IN HELSINKI
    Reliable and optimized large-scale networks in bedrock
  - UNDERGROUND RESOURCES OF HELSINKI
  - UNDERGROUND MASTER PLAN OF HELSINKI
    A city growing inside bedrock

Main References / Further information 2(2)

Helsinki hosted World Tunnel Congress 2011

- ❖Plenty of material still on www.wtc11.org

Publications from Finland

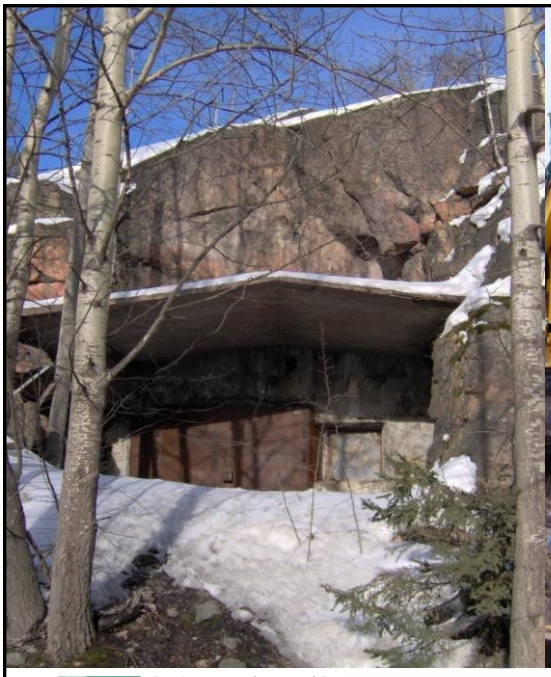
- ❖Rock -sound of countless opportunities, 2011
- ❖The Fourth Wave of Rock Construction, 1997
- ❖Orders from MTR-FTA publications:
  www.getunderground.fi/web/page.aspx?refid=192

10 minutes video for decision makers

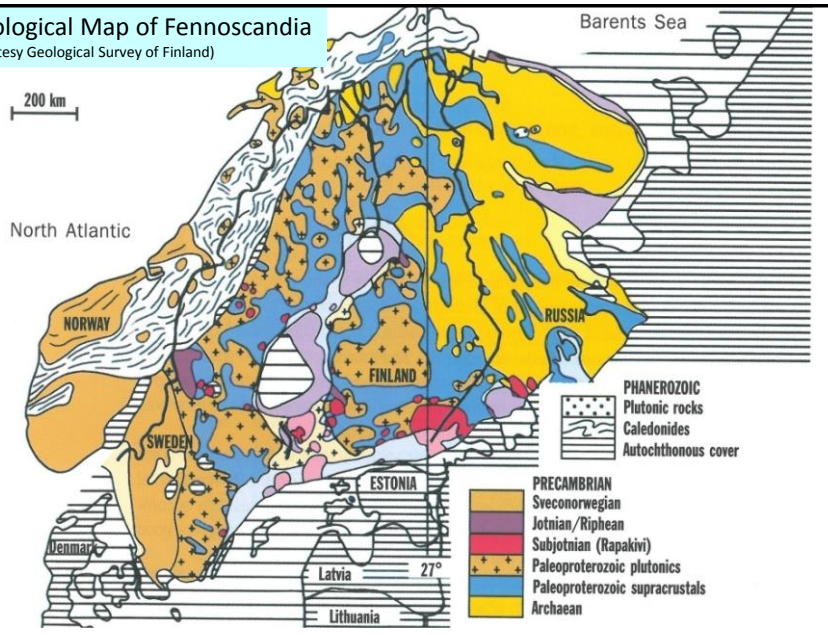
- ❖The world of underground opportunities, 2012
  www.youtube.com/watch?v=fGILwarH18s

Introduction

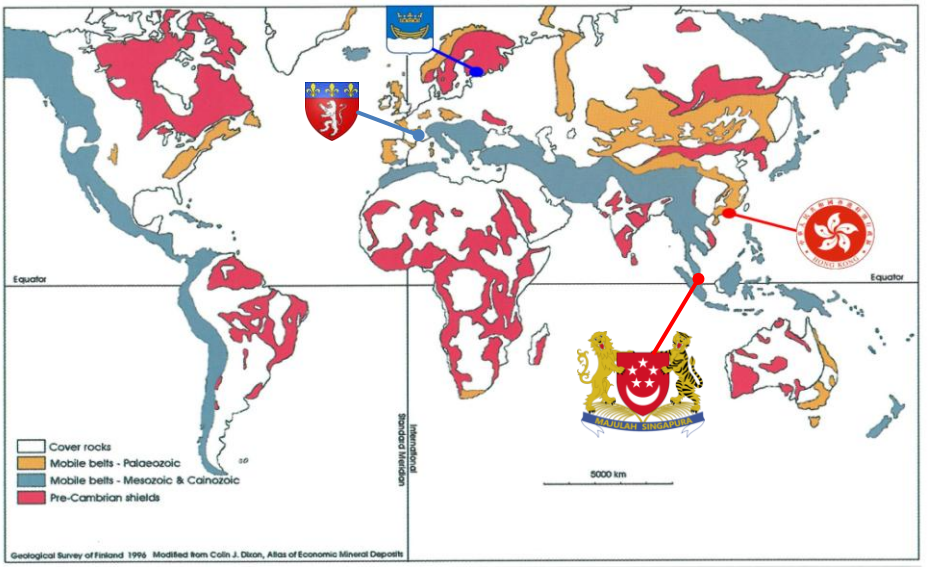
Typical Finnish landscape and a highway partly in a rock tunnel
(Photo: Rakennus Oy Lemminkäinen)



Geological Map of Fennoscandia
(Courtesy Geological Survey of Finland)



Areas of hard bedrock in the world and experiences from *Helsinki*, *Hong Kong*, *Lyon* and *Singapore*



Overview - Rocks of Singapore Island

The rocks of Singapore Island consist mainly of, in a order of geologic age from old to young, four formations:
1. Sajahat Formation of metamorphic quartz sandstone and mudstone,
2. Gombak norite,
3. Bukit Timah granite,
4. Jurong Formation of sedimentary rocks.
5. Old Alluvium (cemented soil or semi-rock)


Photo: Pertsaboy

1 Key Considerations for the Use of Underground Space


Courtesy: City of Helsinki Media Bank


VIKING LINE
Courtesy: City of Helsinki Media Bank

Statistics of Underground Helsinki

- Underground space (parking, sports, oil and coal storages, metro etc.) 10,000,000 m^3

  ~ average 1 m^2 per 100m^2 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: E. Makkonen

Courtesy Länsimetro Oy

Underground Reservation Categories

1. Community technical systems
2. Traffic and parking
3. Maintenance and storage
4. Services and administration
5. Unnamed rock resource (does not yet have a designated purpose)

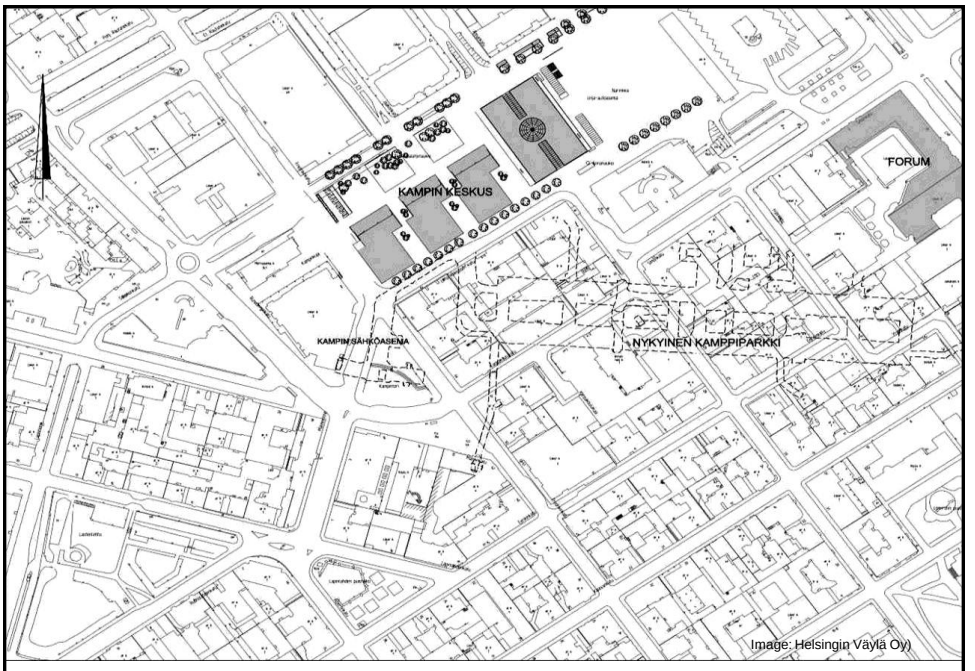


Image: Helsingin Väylä Oy)

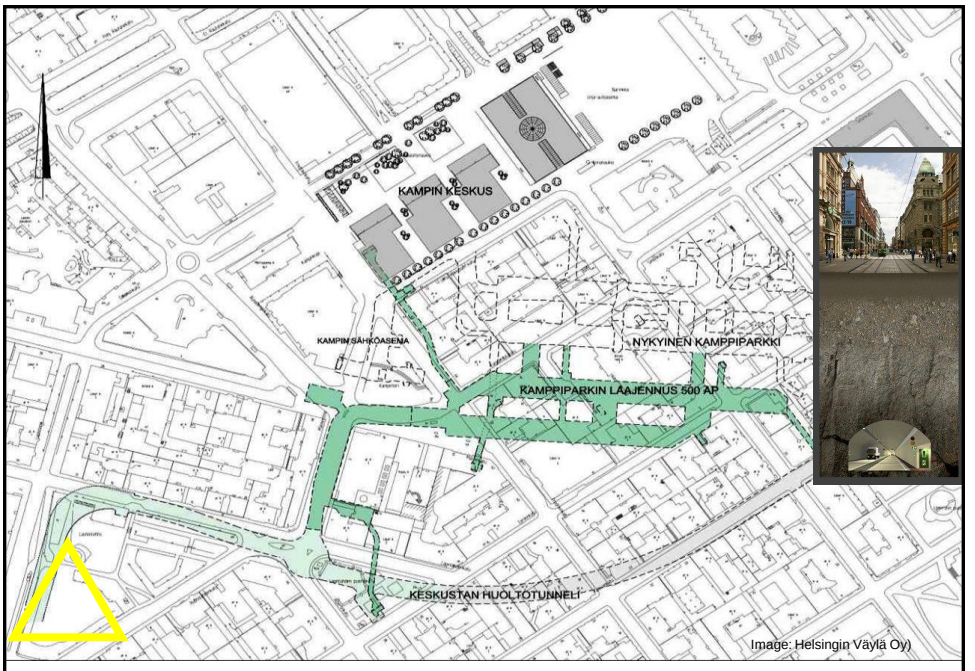
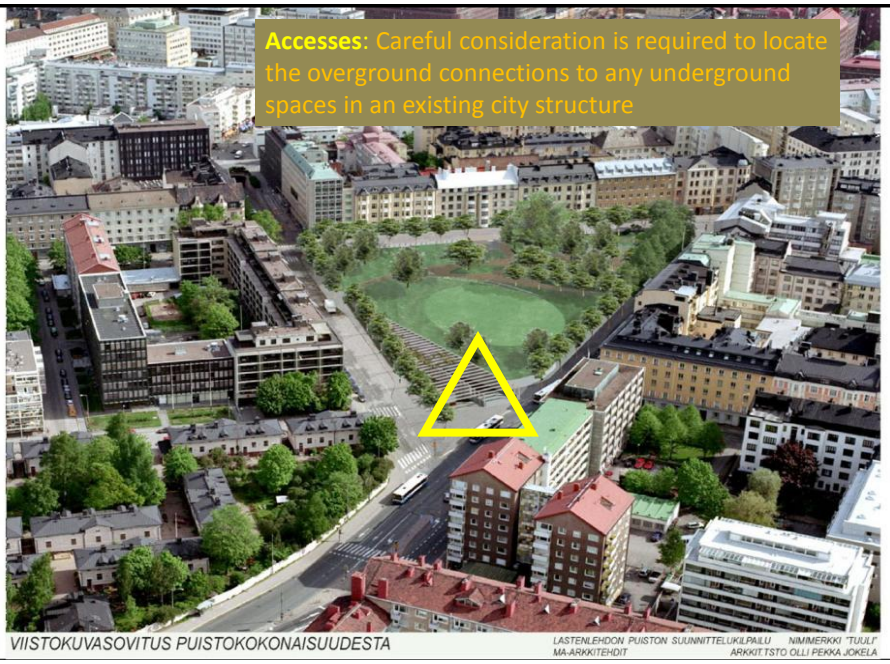
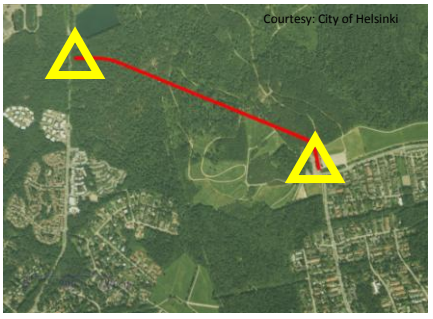


Image: Helsingin Väylä Oy)



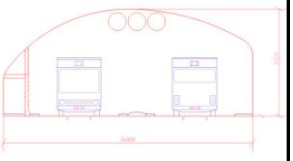
Example of Integrating Urban Structure

- Connects underground premises to each other to form coherent and interrelated complexes
- Makes sure that space reservations for public long-term projects, such as tunnels and ducts for traffic and technical maintenance, are retained for future construction



Example of Integrating Urban Structure

Courtesy: City of Helsinki



From: Open Session in World Tunnel Congress 2011, Helsinki

By: Tetsuya Hanamura, Dr. Eng.

Tunnels and UG Spaces are Strong!

=> The earthquake in Japan (March 2011) 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

Before the strike of 2011 earthquake

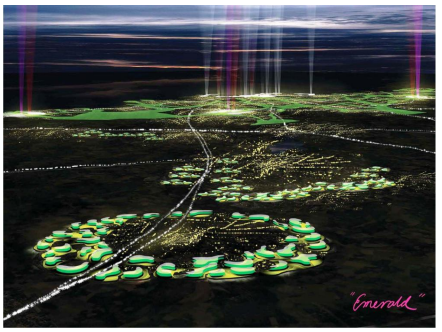
Tunnel underneath the Sendai Airport in Sendai Airport Access Line

only inundated

Tunnel entrance

In the tunnel

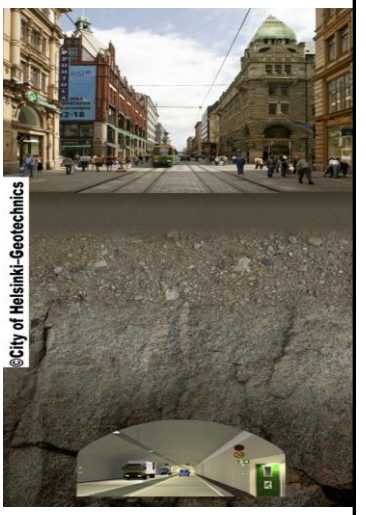
Though the tunnel was inundated by tsunami, no structural damage was observed.



2 Planning for Use of Underground Space

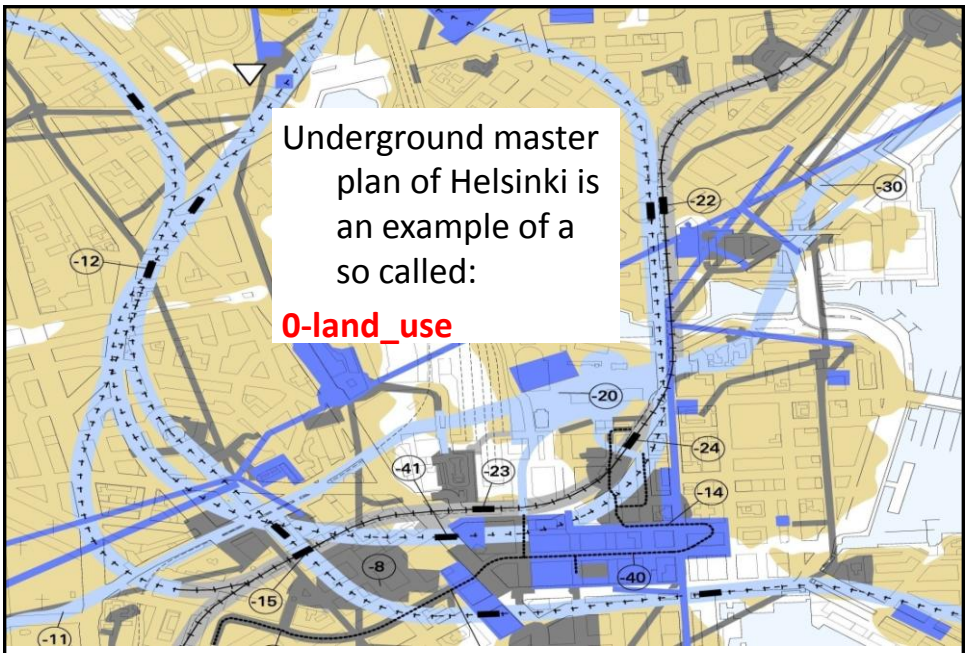
The Underground Master Plan of Helsinki

- Reserves designated space for **public utilities and private** utilities in various underground areas of bedrock over the long term
- Provides the framework for **managing and controlling** the city's underground construction work
- Allows **suitable locations** to be allocated for underground facilities



Underground Master Plan of Helsinki Includes

- More than 400 existing underground spaces and tunnels
- More than 200 new reservations in the register for long-term underground projects
- Both existing and future underground facilities and tunnels (grey indicating existing facilities and blue planned facilities)
- Space reservations on the Master Plan map are presented two-dimensionally
- In the city centre area, approximate floor elevations are indicated using circled figures
- Existing vital access links to underground technical maintenance facilities/tunnels are shown on the map with triangles



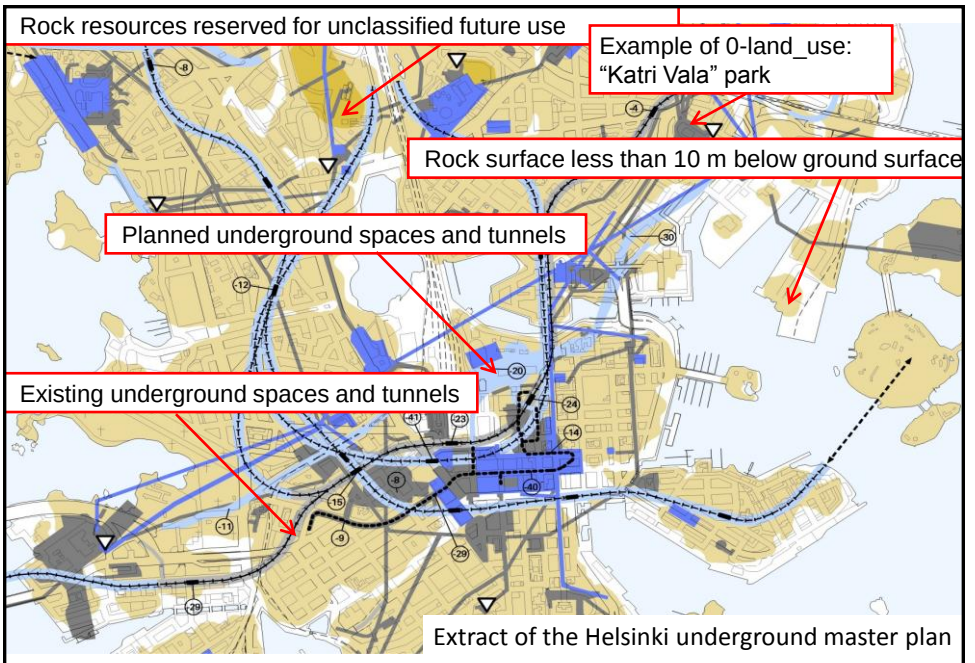
0-land_use

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

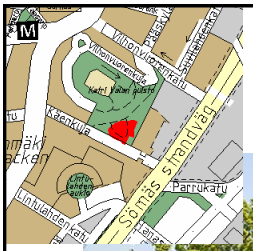
Towards 0-impact buildings and environments

A new concept was adopted by Sterling et al:

~ Preserve ground, use underground in a sustainable way

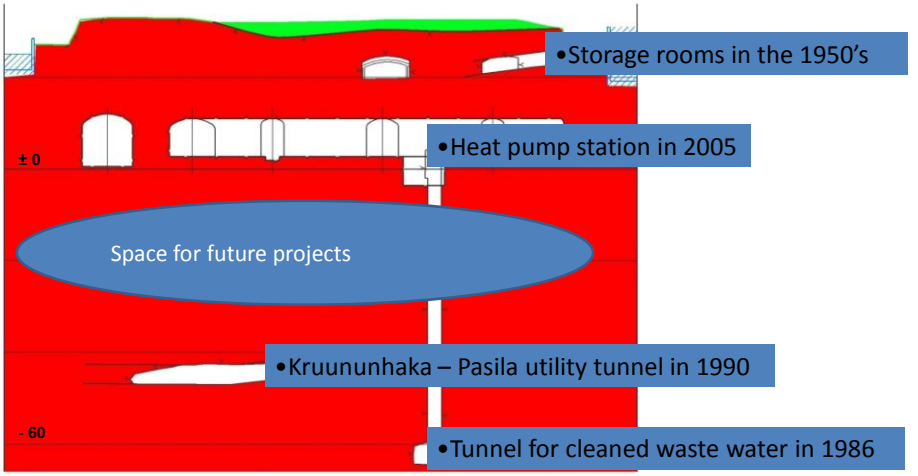


Extract of the Helsinki underground master plan



Example of 0-land_use: "Katri Vala" park

Example of 0-land_use: "Katri Vala" park



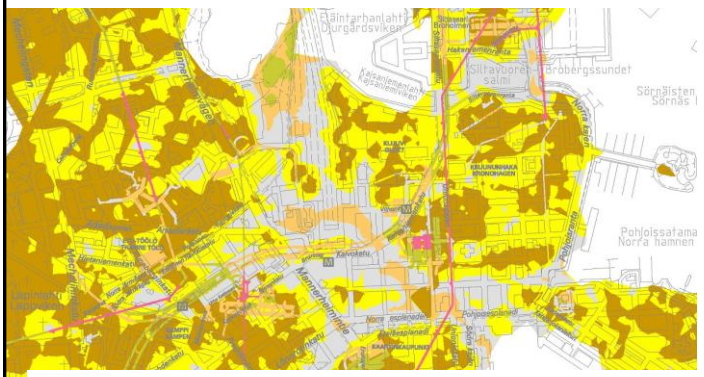
Katri Vala underground heat pump plant

- The world's largest underground heat pump plant
- The cave is 7,000 m^2 at a depth of 25 meters.
- The location is ideal:
  - outfall tunnel and utility tunnel are under the plant
  - Close to the city centre
- The production output:
  - 90 MW of district heat and 60 MW of cooling output

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 drill machine borings
- The survey also took into account local weakness zones and rock resources that have already been put to use

Rock Surface Model



Definition: Deepest public underground spaces have been taken into consideration when presenting free rock resources. Estimated rock surface is based on bedrock confirmation drilling.

An Extract of the Rrock Surface Model

Initial Survey for Unnamed Rock Resources

- Bedrock in Helsinki is in general not far below the ground surface and there are plenty of locations suitable for construction of underground facilities
- Average price of underground space is only 100 €/m^3, including excavation, rock reinforcement, grouting and underdrainage
- Outside the city centre, the survey found 55 rock areas that had a sufficient size for accommodating large underground facilities near major traffic arteries
- In many areas future underground projects can make use of entrances to existing underground facilities, which have been marked with triangles on the Master Plan map

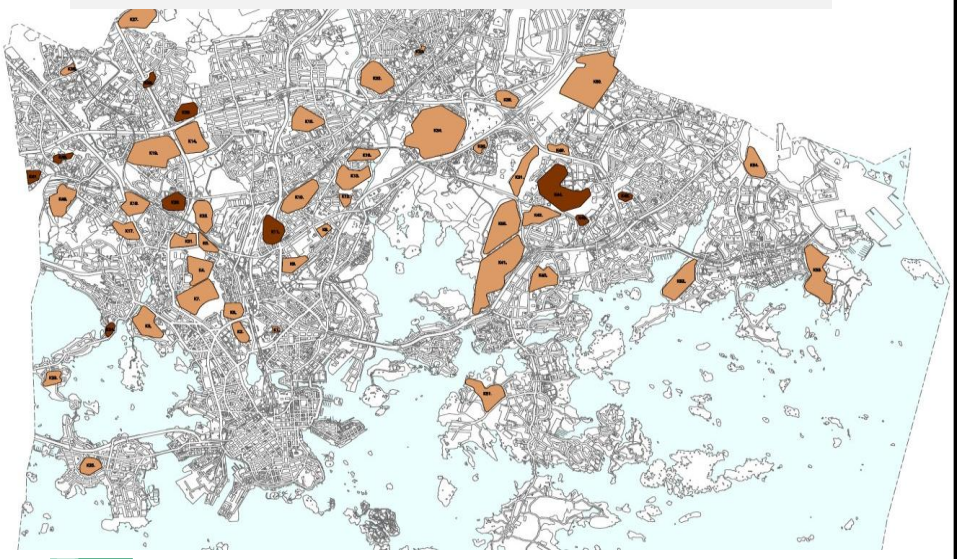
Unnamed Rock Resource Reservations

- 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

Underground Master Plan of Helsinki Includes

- About 40 unnamed rock resource reservations without a designated purpose
  - The average area of these reservations is 30 ha
  - Unnamed reservations have a total area of 1,400 ha (= 14 km^2) representing 6.4% of the land area of Helsinki

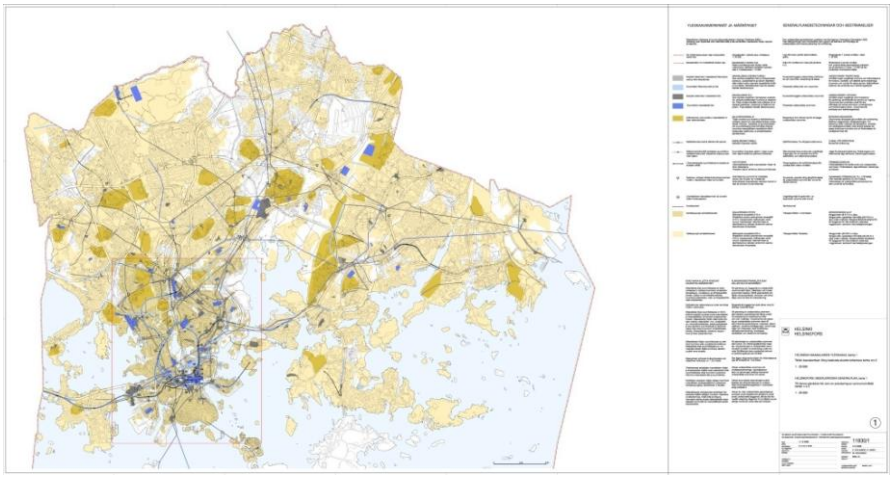
Selection of unclassified resources is purpose driven and in addition rock-resource driven



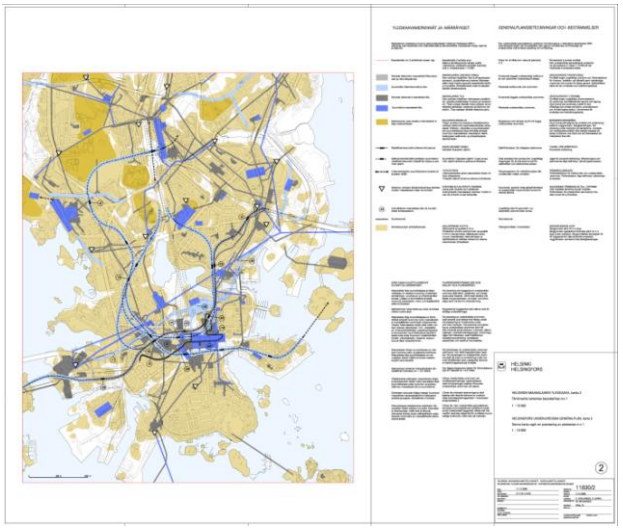
The First UG Master Plan of Helsinki

- Accepted by the City Council on 8th of December 2010
- Two competent and legally valid documents
  - 11830/1 (The whole city)
  - 11830/2 (Inner city)

11830/1 (The whole city)



11830/2 (Inner city)



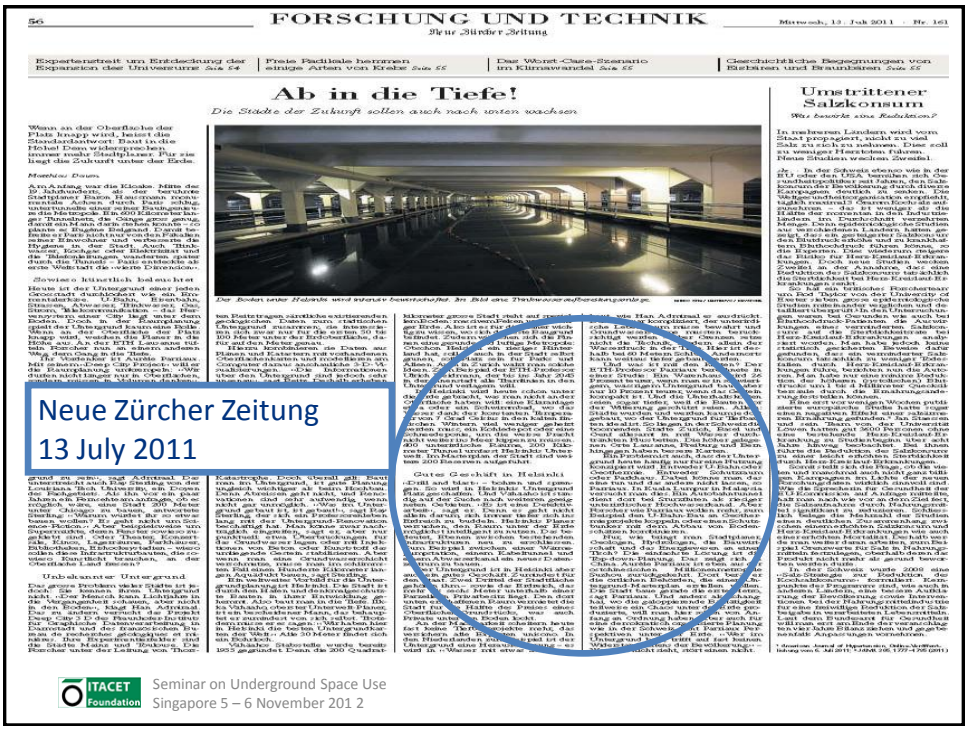
History of Underground Master Plan

- Since the 1980s the City has maintained an underground space allocation plan
- In the early 2000s there emerged a need to draw up an underground master plan for Helsinki
- On 9 December 2004, the City Planning Committee approved the planning principles
- On 4-22 April 2005, a participation and assessment plan was presented
- In 2005 an open discussion event was arranged for anyone interested, and many detailed discussions were held with different interests
- On 19 January 2006, discussions were held with the relevant public authorities based on the participation and assessment plan
- At the start of 2007 representatives were consulted from the water and energy utilities, police, defence forces and Helsinki City Rescue Department
- In May 2007, draft plan made available, aim was to submit for City Council decision by end of 2007
- 11 December 2008 decision: revised draft to be resubmitted to Committee
- On 17 December 2009, proposed plan and the statements, objections, views and responses on it were submitted for approval by City Council
- On 22 and 29 November 2010, the City Board discussed the proposed plan
- On 8 December 2010, the City Council approved the Underground Master Plan of Helsinki (except for the reservation of Pitkäkoski water treatment plant, against which an appeal was made to the Administrative Court, but was rejected on 18 November 2011)

Planning principles

9 December 2004

- Master Plan will cover the whole of the city, with city centre at scale of 1:10 000 and elsewhere 1:20 000
- Master Plan will have legal effect / no legal effect > areas to be determined later
- An underground space allocation plan will support the City's underground facilities management system and the exchange of information
- Master Plan will include space allocations for transport, civil defence, sports, various installations and establishments, water and energy supply, parking, storage, waste management and similar
- Aim to achieve joint use of facilities
- Current functions to be located underground and thus release land above ground / otherwise improve matters
- Underground spaces to be located mainly in bedrock
- Bedrock resources mainly for uses which are for the public good
- Bedrock resources below recreational areas may be used if this does not present problems
- Support arrangements for underground parking in new residential areas



56 FORSCHUNG UND TECHNIK Neue Zürcher Zeitung Mittwoch, 13. Juli 2011 Nr. 161

Expertenstreit um Entscheidung der Separation der Universume Seite 54 | Preis Packsale hermen einiges Arten von Krebse Seite 55 | Das Worst-Case-Szenario im Klimawandel Seite 55 | Geschichtliche Begegnungen von Rebhuhn und Baumfalken Seite 55

Ab in die Tiefe!

Die Städte der Zukunft sollen auch nach unten wachsen

Neue Zürcher Zeitung
13 July 2011

Umstrittener Salzkonsum

Was bewirkt eine Reduktion?

A worldwide model in underground planning is Helsinki. The city is labelled by the harbour and protected buildings. So, underground is the place to build. Mr. Ilkka Vähäaho, the leading planner of underground spaces, is a modest man. Or this is what he claims himself. However, he feels the need to say: ´Here in Helsinki we have the best soil maps in the world. There is a bore hole in every 30 metres.´

Vähäaho´s post was founded as early as in 1955. The 200 square-kilometre-city lies on special ground: massive bedrock and soft soil. It is therefore important for the planner to know the levels of solid layer for foundations. In addition, **Finns look forward to having a sound and airy metropolis: although Helsinki has gigantic backwoods, the city itself should have green areas so let there be space for parks and avenues.** Similar ideas can be found in Zurich, too. An example is served by Professor Ulrich Weidmann who wants all tramlines underground by the year 2045.

In Helsinki, **functions that are not wanted on the ground are already situated underground**: a waste water treatment plant or a swimming pool where - thanks to a steady 7-degree-temperature - heating is only needed a little in the cold Finnish winter. More examples are storages for coal and snow, which is no longer allowed to be dumped into the sea.

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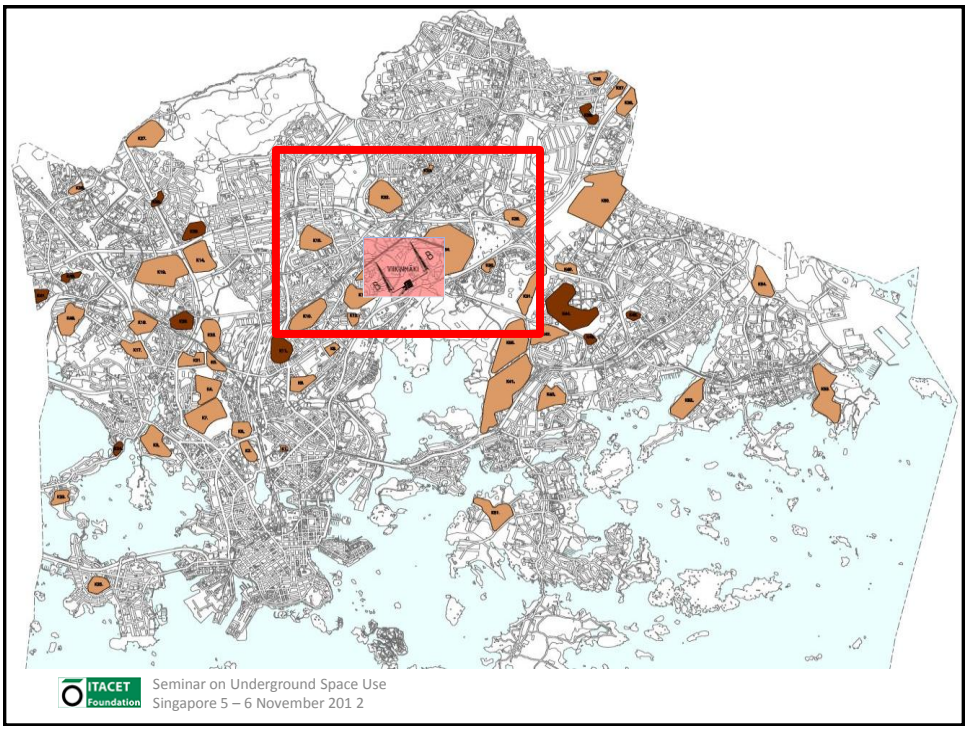

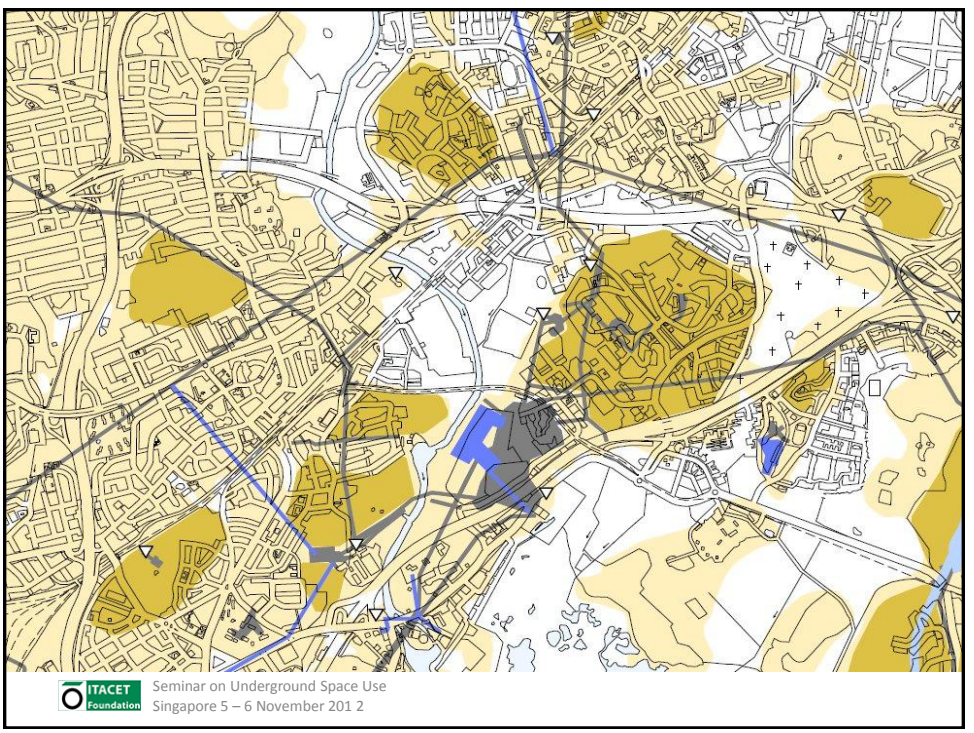


Courtesy: City of Helsinki


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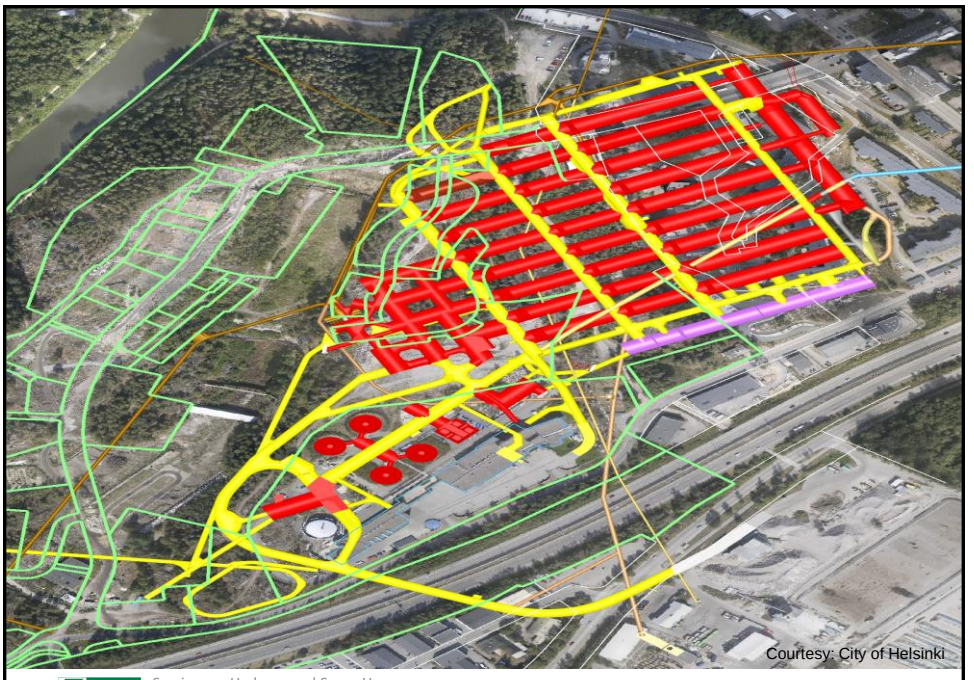


Courtesy: City of Helsinki


Billboard advertising a new residential area …
NOT Wastewater treatment plant underneath but
Kotisi taivaan katolla!
www.peab.fi
www.tuomaankallio.fi
Photo: I. Vähäaho

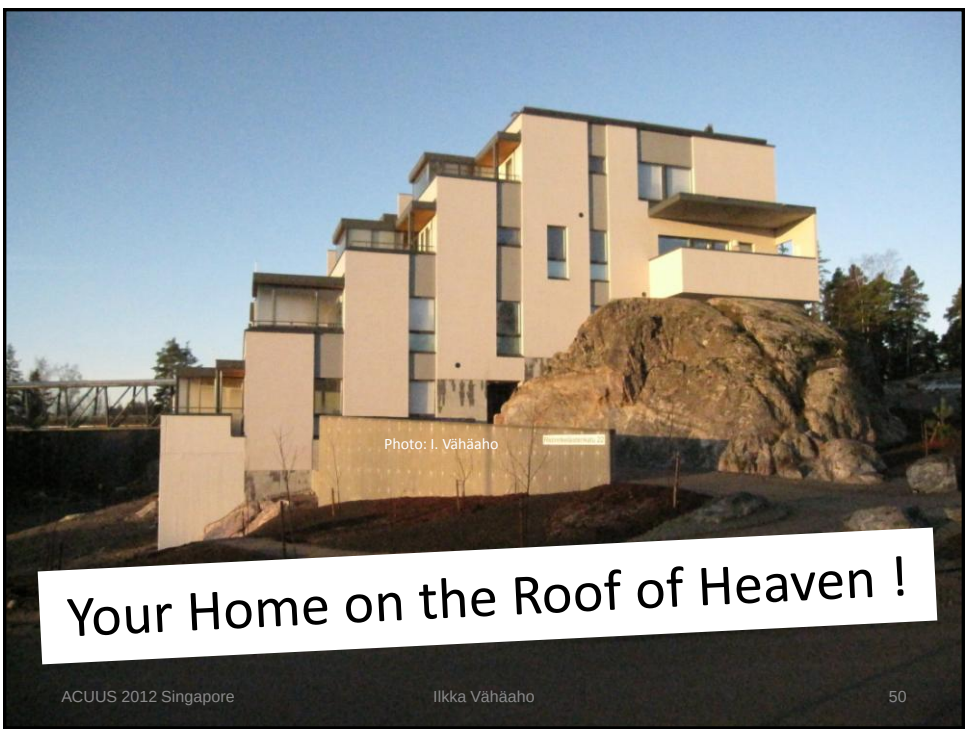


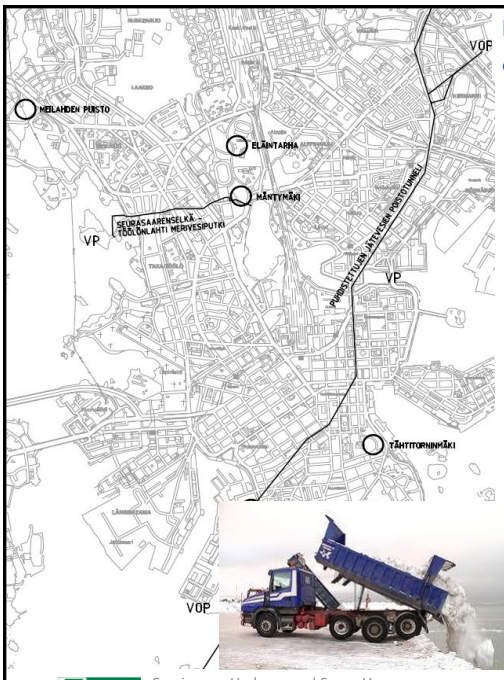
Photo: I. Vähäaho
Your Home on the Roof of Heaven !

Case: New residential area and ...

Case: New residential area and future reservation for extension of waste water treatment plant

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 m^3 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



FEASIBILITY STUDY

PRESENT WAY:
DUMPING SNOW INTO THE SEA

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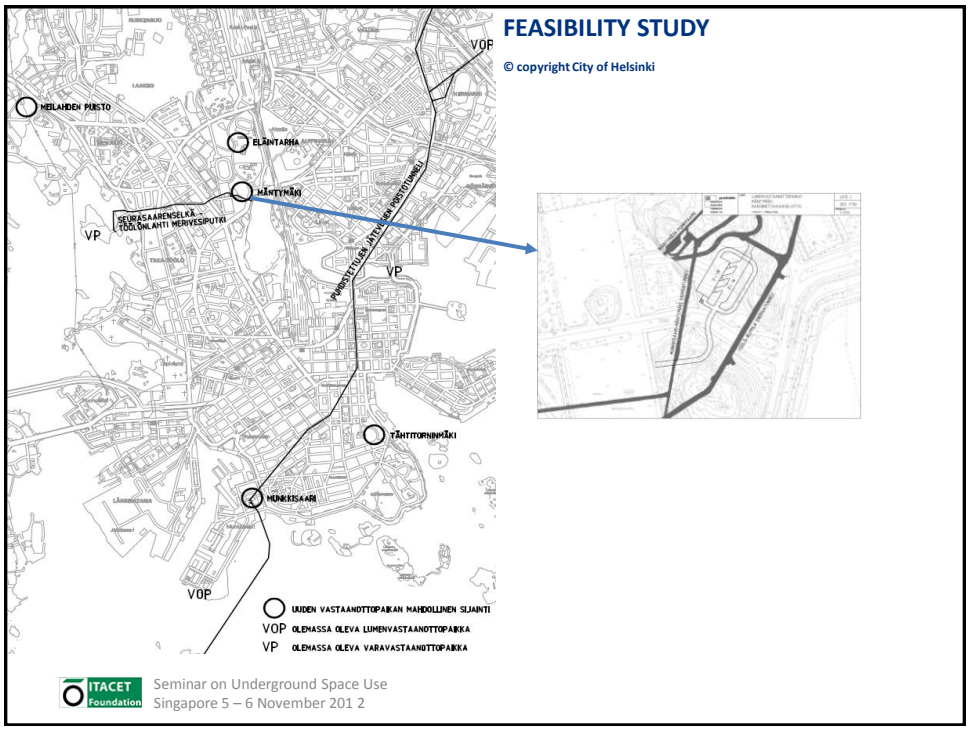
FEASIBILITY STUDY
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MELAHDEN PURSTO
ELÄINTARHA
MÄNTYMÄKI
SEURASAARENSELKÄ - TÖÖLÖNLAHTI MERIVESIPUTKI
VP
VOP
PUHDISTETTUJEN JÄTEVESIEN POISTOTUNNELI
TÄHTITORNINMÄKI
MUNKKISAARI
UUDEN VASTAANOTTOPAIKAN MAHDOLLINEN SIJAINTI
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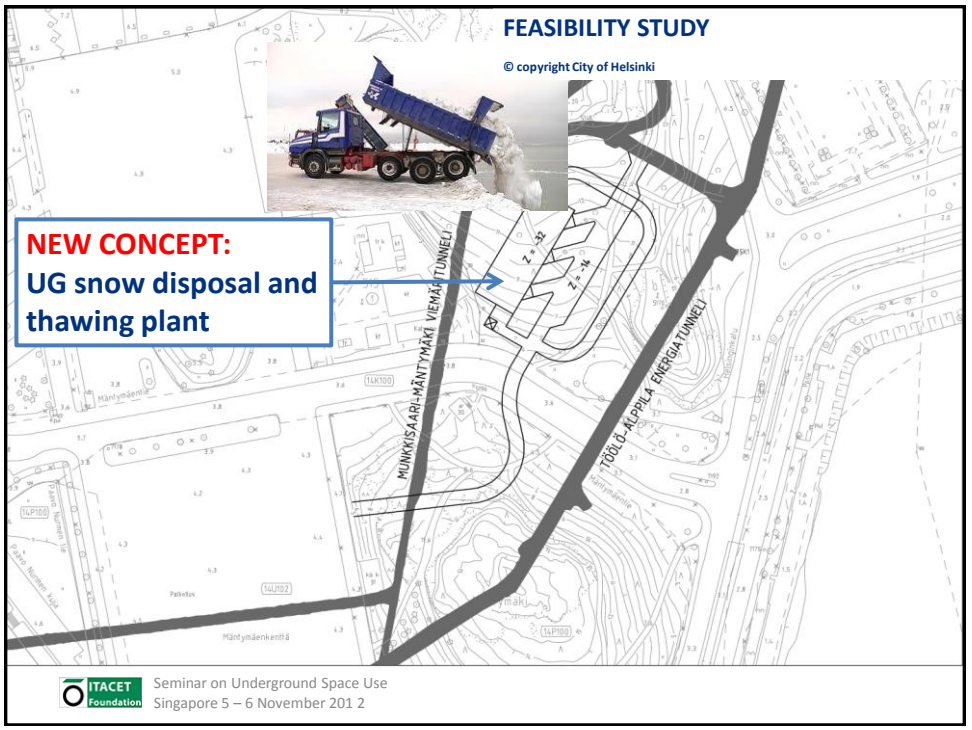
FEASIBILITY STUDY
© copyright City of Helsinki
NEW CONCEPT:
UG snow disposal and thawing plant
MUNKKISAARI-MÄNTYMÄKI VIEMÄRITUNNELI
TÖÖLÖ-ALPPILA ENERGIATUNNELI
ITACET Foundation
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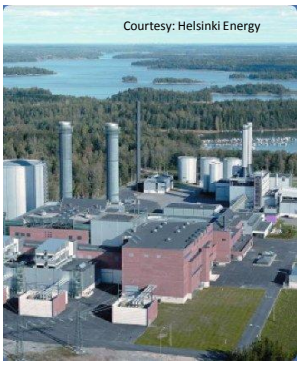
District heating

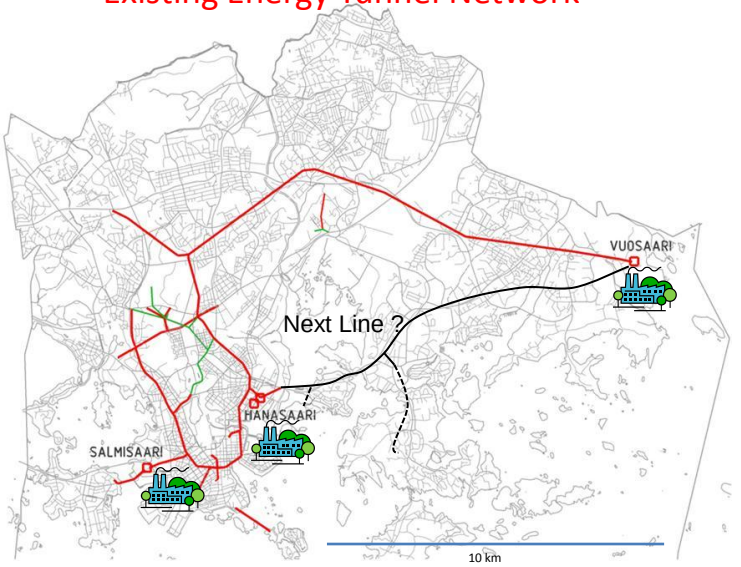
- District heating network: 1,250 km
- 7,000 GW/year to 14,000 customers
- 4 power plants, 10 heating stations
- The network has been built in loop form



District cooling

- Eco-efficient energy.
- 80 % of production based on resources which otherwise would be wasted
- Renewable energy sources such as seawater
- Length of the network 30 km
- Output 100 MW
- Clients: 170

Existing Power Plants
Existing Energy Tunnel Network



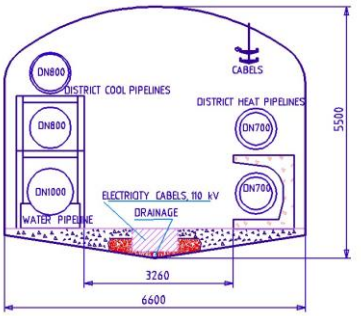
Community Technical Systems

- 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)
- Distance between shafts typically 2 km

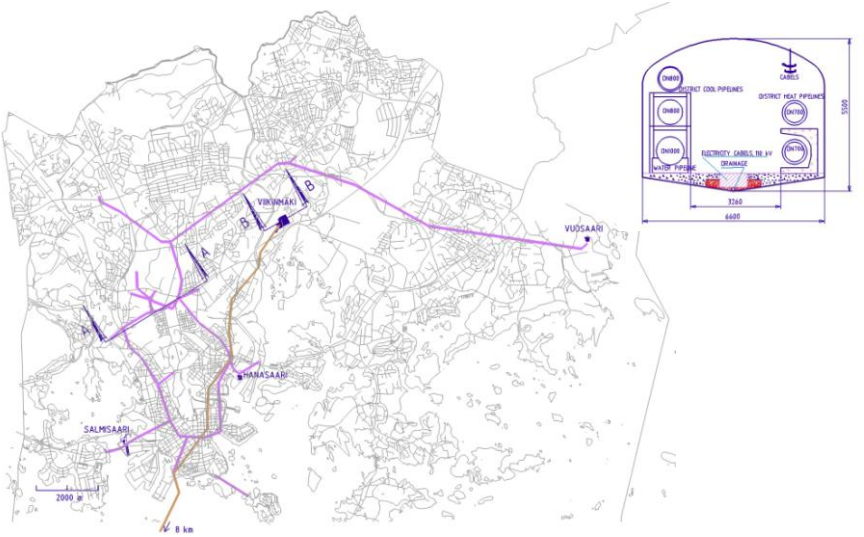

Photo: J. Vilkman

Utility tunnel

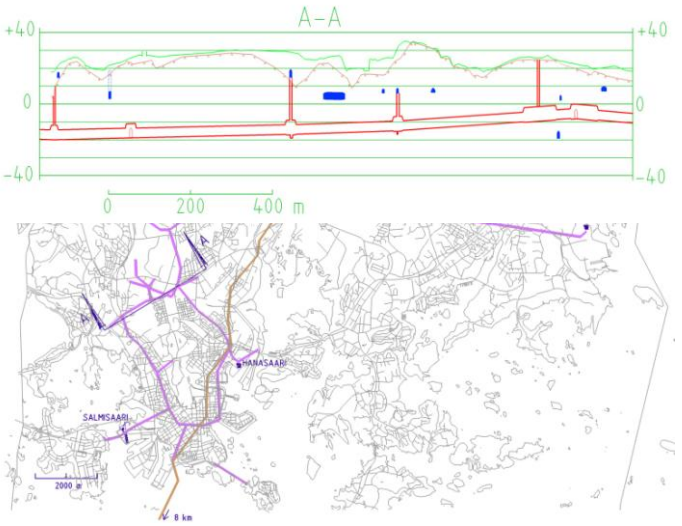
- Utility tunnel
  - district cooling,
  - district heating,
  - fresh water,
  - electricity cables and telecommunication cables
- Over 200 km of technical tunnels
- 60 km of energy tunnels used by a number of operators



Community Technical Systems



Community Technical Systems



Construction below the city area

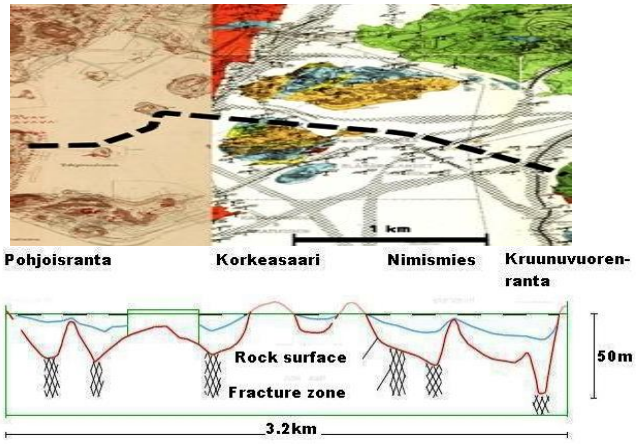
- Challenges:
  - accesses up to surfaces in built-up area (driving accesses, emergency exits, ventilation shafts, etc.),
  - drilling and blasting disturbances in city area,
  - drilling and blasting nearby existing underground spaces and
  - breakthrough to other utility tunnels


Courtesy: Helsinki Energy

Main advantages in placing different technical facilities underground

- Pipelines are straighter – savings
- Expenses are shared by several users
- Later construction on the surface not impaired
- The land released for other purposes
- Minimum interference with normal life
- Rock tunnels / spaces do not affect the environment
- Rock tunnels / spaces are safe

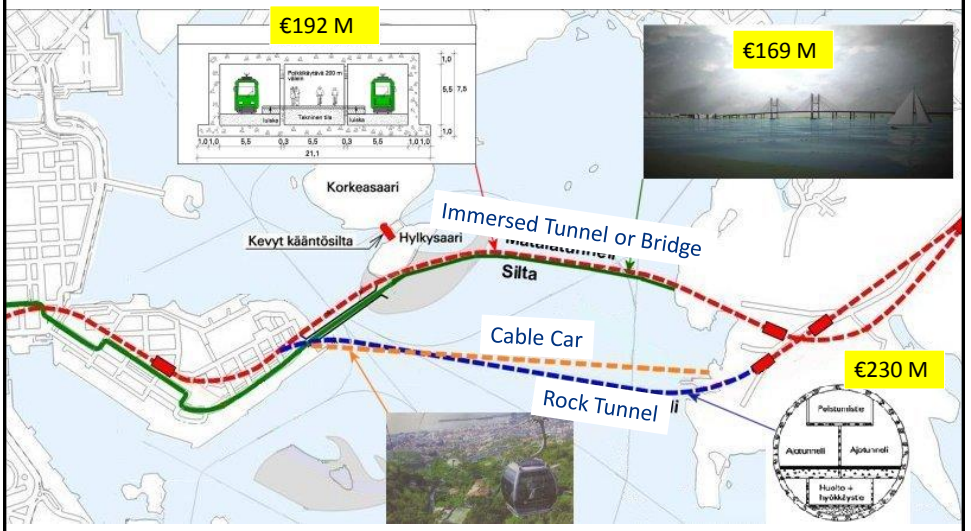
Case: Rail Link alternatives to downtown



Bedrock map (top right) and an original/historical topographic map (top left). The planned rail link has been marked using a dashed line.
Longitudinal section of soil and bedrock conditions between Pohjoisranta (city centre) and Kruunuvuorenranta (a part of an 8.4 km² island).

Rail Link alternatives

Rock Tunnel – Immersed Tunnel – Bridge – (Cable Car)



Public Transport alternatives

1.	Rock Tunnel	- Too deep and expensive
2.	Immersed Tunnel	- Expensive and uncomfortable
3.	Bridge	? Aesthetics and price
4.	Cable Car	? Cheaper but does it work
5.	Ferry	? Weather and winter

My proposal in this case is:

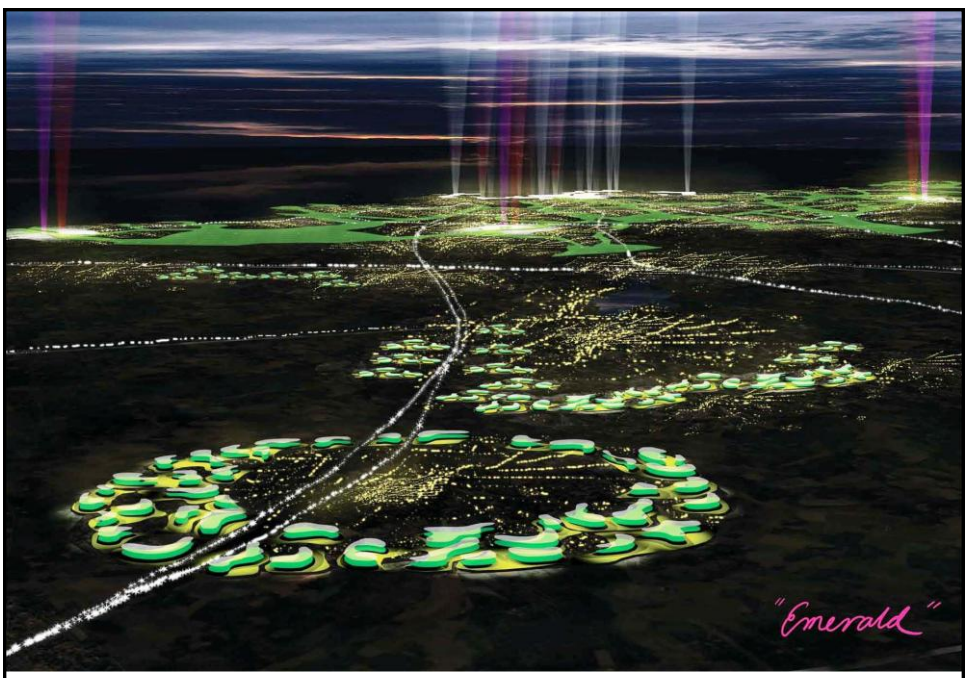
High standard and economical bridge

We are building the future

Greater Helsinki Vision 2050
– International Ideas Competition

Helsinki Conditions

- Helsinki is the capital city with 591,000 inhabitants
- Altogether 1.3 million people, approximately one in four Finns, live in the Greater Helsinki area
- Surface area of Helsinki is only 215 km^2
- Average size of municipalities in Finland is 585 km^2
- Finland has 336 independent municipalities



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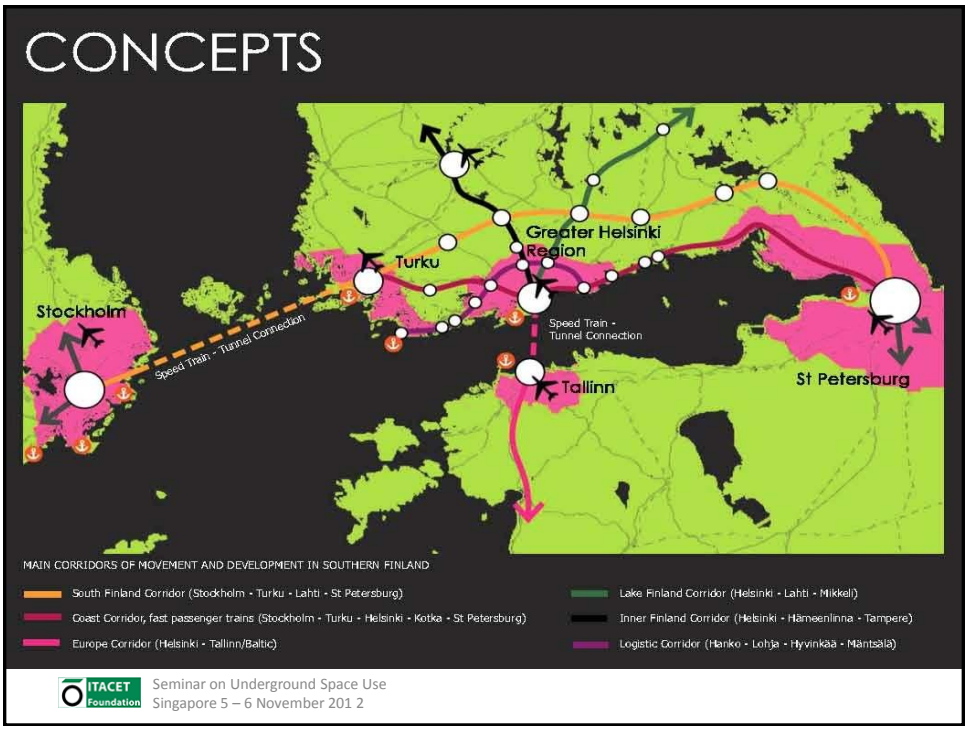


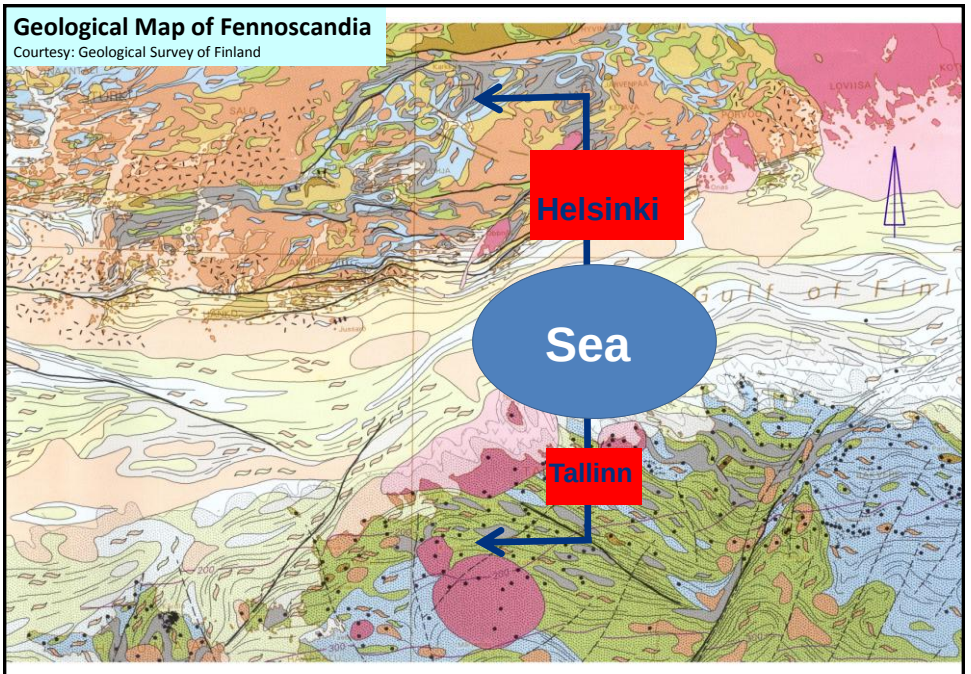
Rail Baltica 1 200 km

- The map shows the routing of a possible rail link from **Germany** (Berlin) to
- **Poland** (Warsaw), via
- **Lithuania** (Kaunas) and
- **Latvia** (Riga) to
- **Estonia** (Tallinn), and through the undersea rail tunnel to
- **Finland** (Helsinki)

Tunnel from Helsinki to Tallinn

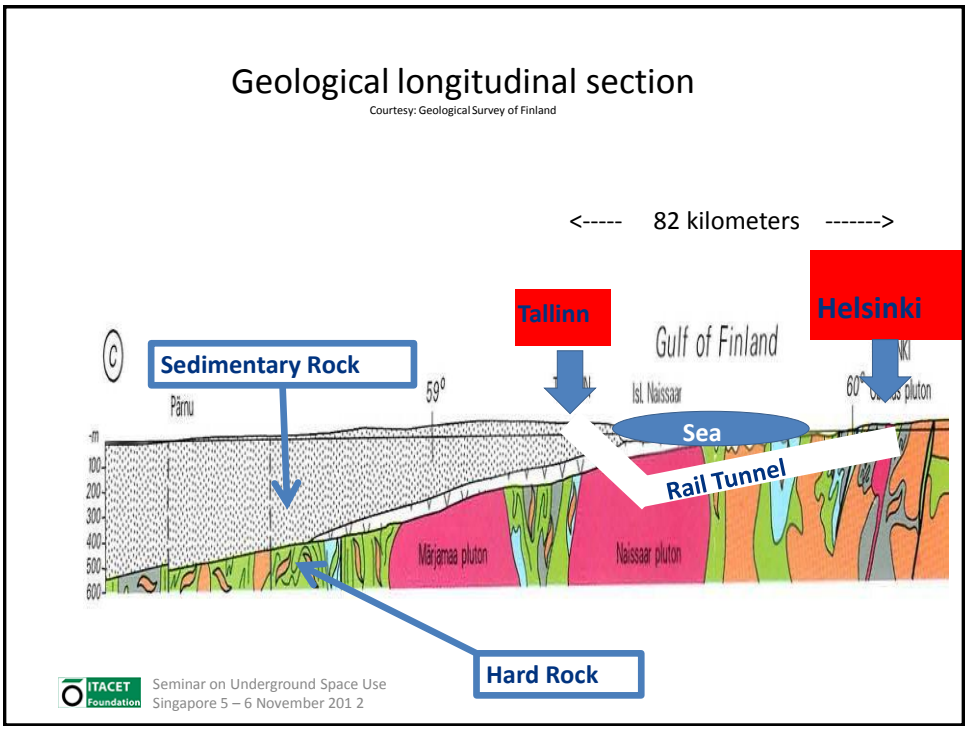
- The route of the proposed undersea tunnel from ***Helsinki (in Finland) to Tallinn (in Estonia)***
- At present fast surface vessels can cover the 82 km in about an hour and a half

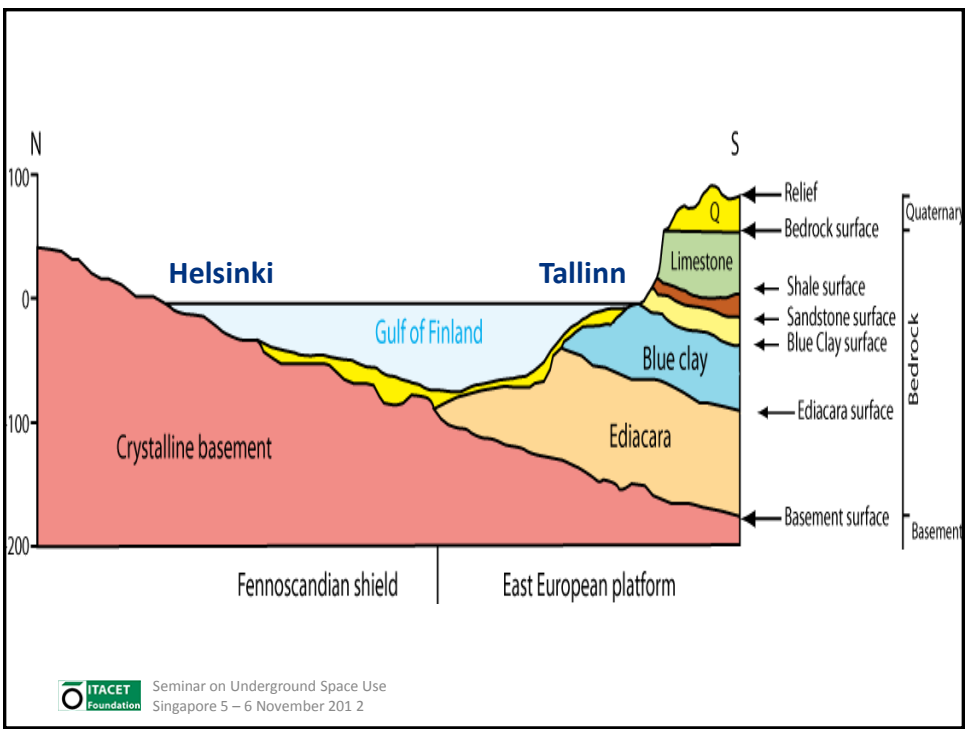
Geological Map of Fennoscandia
Courtesy: Geological Survey of Finland



Geological longitudinal section

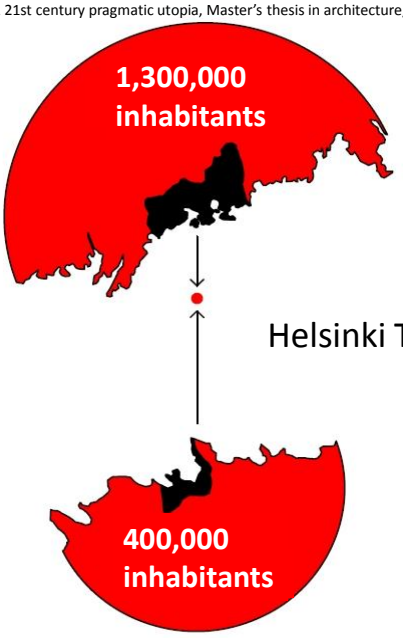
Courtesy: Geological Survey of Finland





Martti Kalliala, Talsinki island, A 21st century pragmatic utopia, Master's thesis in architecture, Helsinki university of technology, 2008

A population of 1.7 million live within an "acceptable" commuting distance.

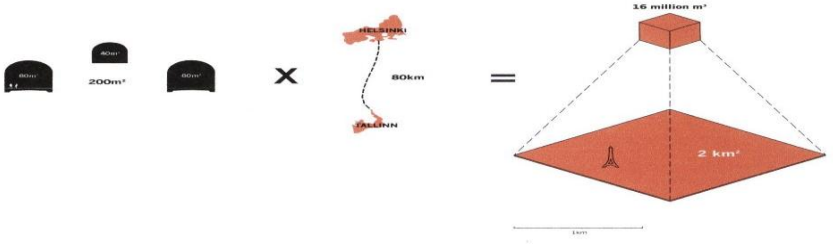


Martti Kalliala, Talsinki island, A 21st century pragmatic utopia, Master's thesis in architecture, Helsinki university of technology, 2008

From Fantasy to Vision:

Planning of Helsinki-Tallinn Twin-City

16 000 000 m³



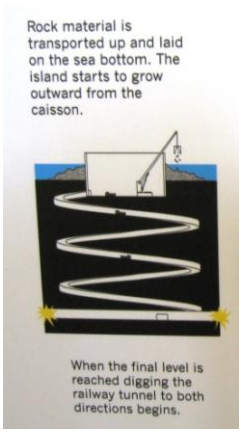
A side effect of the excavation is the production of 16 million cubic meters of blast stone. It is here where opportunity awaits.

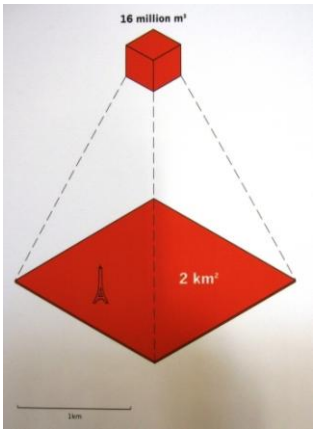
What to do with it? Two options emerge: it can be sold as raw material to Estonia, or it can be used as landfill as the value of buildable land has risen dramatically on both sides of the gulf.

Martti Kalliala, Talsinki island, A 21st century pragmatic utopia, Master's thesis in architecture, Helsinki university of technology, 2008

From Fantasy to Vision:

Planning of Helsinki-Tallinn Twin-City





Martti Kalliala, Talsinki island, A 21st century pragmatic utopia, Master's thesis in architecture, Helsinki university of technology, 2008

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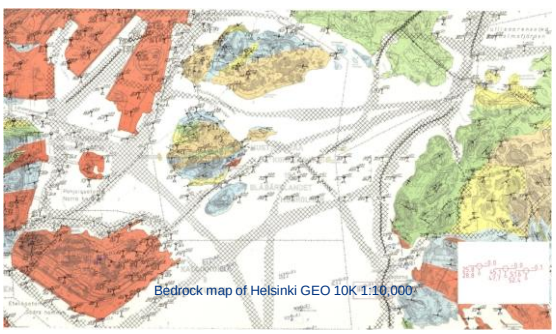
Conclusions of Key Considerations & Planning for Use of Underground Space

- It is most important to educate planners and decision makers about the usefulness of underground (UG) resources
- Cooperation of technical departments and commercial enterprises in UG construction of Helsinki is already a worldwide model
- Finnish Tunnelling Association has produced and promoted a series of books, theses and videos that visually demonstrate the potential attractiveness of the underground

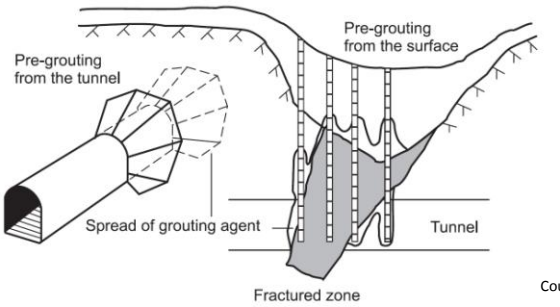


Bedrock map of Helsinki GEO 10K 1:10 000

3 Geotechnical Engineering for Underground Space

Pre-grouting is most important in Helsinki conditions

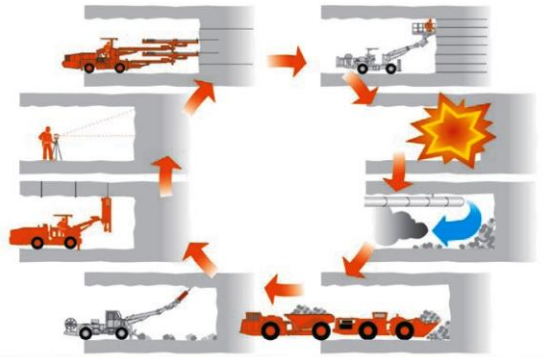
Two alternatives: From the tunnel or from the surface



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

Typical Construction Case

- Tunnel: 6.5 m x 5.5 m
- Drill & blast
- Pre-grouting
  - Allowed water leakage:
    4 l/min/100 m
- Reinforcement:
  - Bolting and
  - Sprayed concrete

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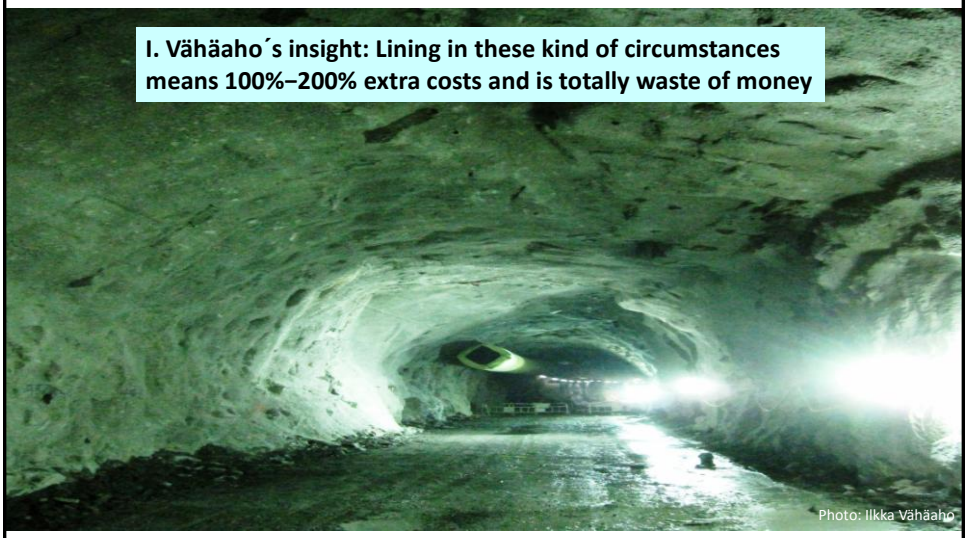
Hong Kong MTR West Island Line 25 Sep 2011



Lyon (France) Tunnel La Croix Rousse 17 Oct 2011

I. Vähäaho´s insight: Lining in these kind of circumstances means extra costs and is needed for aesthetic and cultural reasons

www.tunnelcroixrousse.fr

Singapore Mass Rapid Transit (MRT) under construction in 2004

I. Vähäaho´s question: Could the use of anchors instead of internal supports make working easier?

Photo: I. Vähäaho

Singapore Mass Rapid Transit (MRT) under construction in 2012
Downtown Stage 2 Contract 921 Little India

I. Vähäaho´s question again: Could the use of anchors instead of internal supports make working easier?

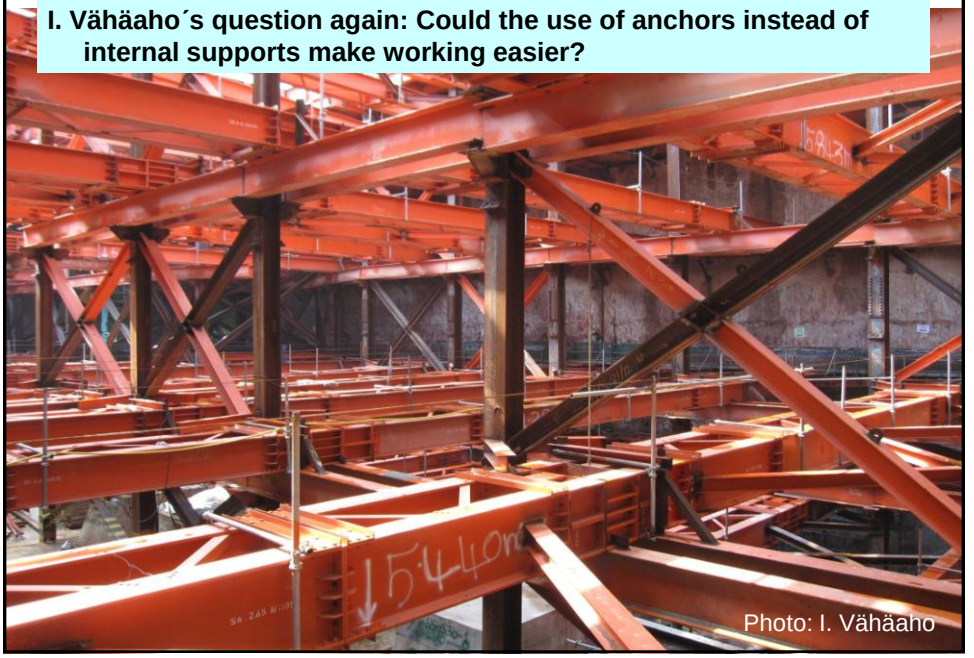
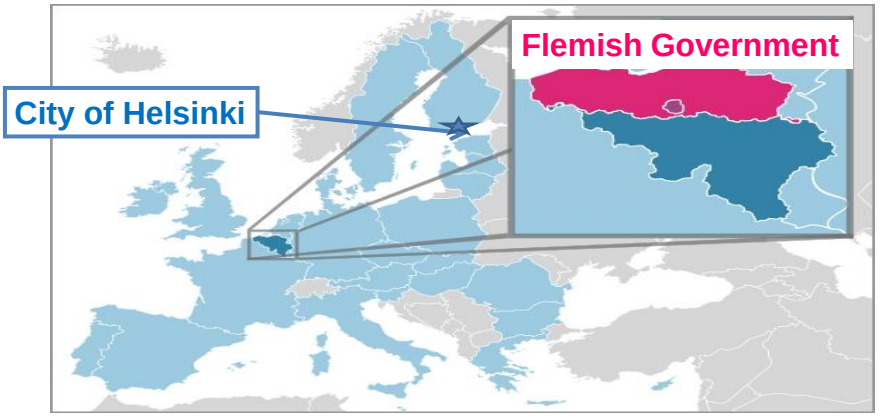


Photo: I. Vähäaho

What does a geotechnical engineer need first

?

Soil and bedrock data



The best soil and bedrock databases

Geotechnical and geological data management in urban underground (UG) areas *)

Geotechnical Division, Real Estate Department, City of Helsinki, Finland
Mr. Ilkka Vähäaho, Mr. Juha Korpi, Dr. Ilkka Satola

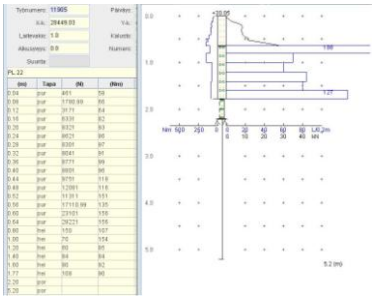
Geotechnics Division, Flemish government,
Belgium
Mr. Gauthier Van Alboom, Ms. Ilse Vergauwen

*) Paper was presented in the World Tunnel Congress 2011 and is released in the proceedings (see: www.wtc11.org)

HelsinkiSoil*i* soil and bedrock web service offers:

Can be downloaded

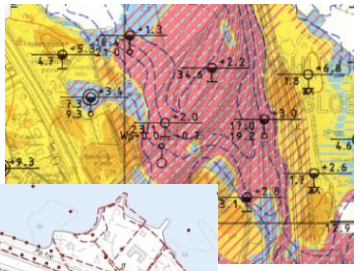
Symbols



Protocols

Profiles

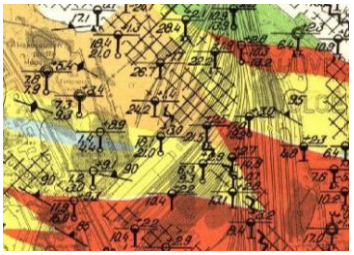
Geotechnical map



Base map

HelsinkiSoil*i* soil and bedrock web service offers:

Bedrock map



Can be viewed

Weakness zones

Timber piles

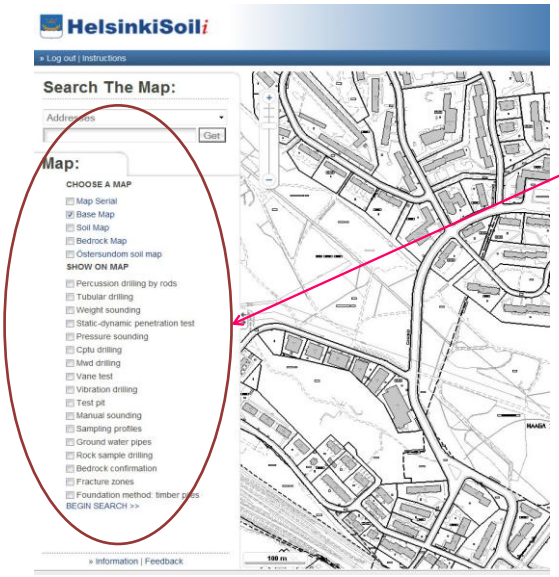
HelsinkiSoil*i* statistics

Data type	Number
Soil and bedrock investigation profiles	240,000
Sampling profiles	14,500
Groundwater measurement tubes	5,000
Internal / **external** searches per month	**50,684** / **2,224**

City surface area c. 200 km2
⇒ **Average distance between existing investigation profiles is 30m**

Average time of any existing data to be reused is
5 months / 9 years

HelsinkiSoil*i* * soil and bedrock web service graphical interface



5 different maps and 15 soil / bedrock investigation methods can be ordered

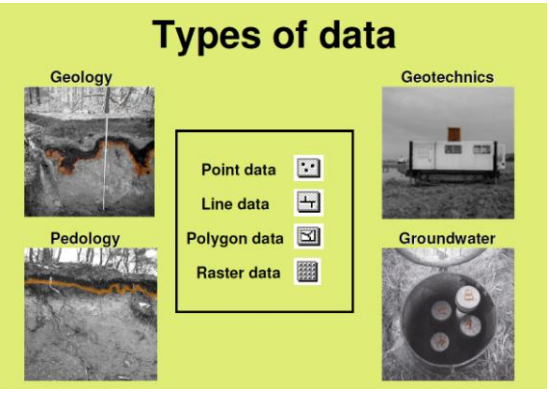
www.HelsinkiSoili.fi

Charging is based on a level that covers the maintenance costs for the system

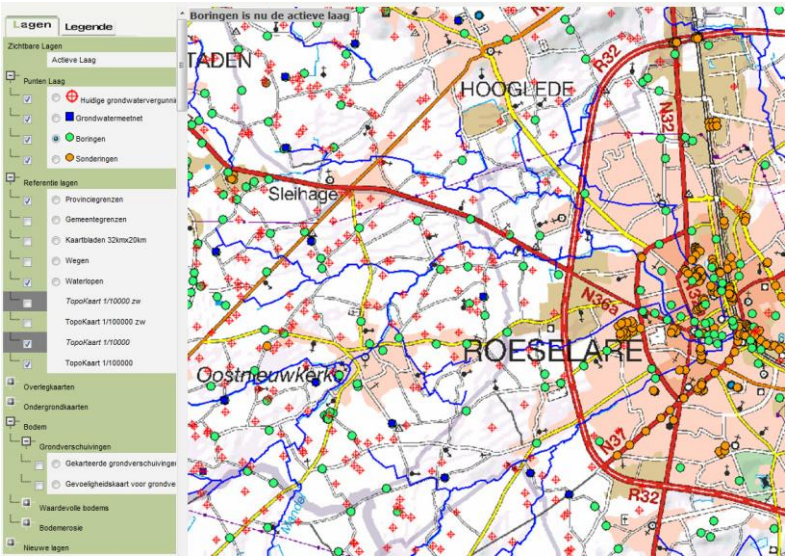
Database of the subsoil of Flanders (DOV) in Belgium since 1996

- DOV is a co-operation of three divisions of the Flemish government
- DOV is the overall database of all subsoil information of Flanders
- DOV has two types of data:
  - alphanumeric and
  - cartographic data

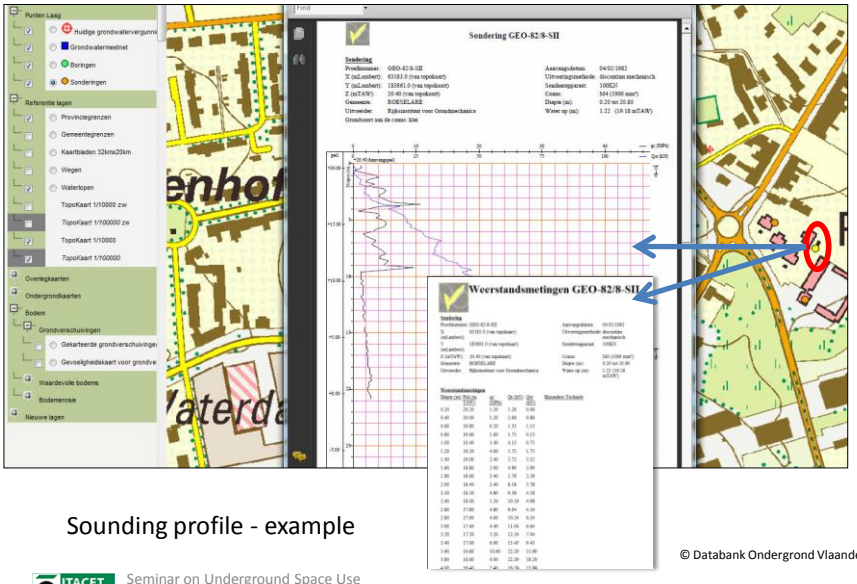
- Free for consultation on http://dov.vlaanderen.be
- Used by study bureaus, universities, divisions of the Community, private persons,...



DOV web service graphical interface - 1



DOV web service graphical interface - 2



Sounding profile - example

Successful Geotechnical Engineering needs:

- Reliable **site specific facts** on:
  - ✓ Ground, bedrock, existing UG devices and structures and future plans (= GIS Database)
- Competent and experienced **designers**
- Capable (**land)owners** and **developers**
- Reliable **authorities**
- Competitive **contractors**
- Cooperation with **neighbours**
- Good **references** from previous projects

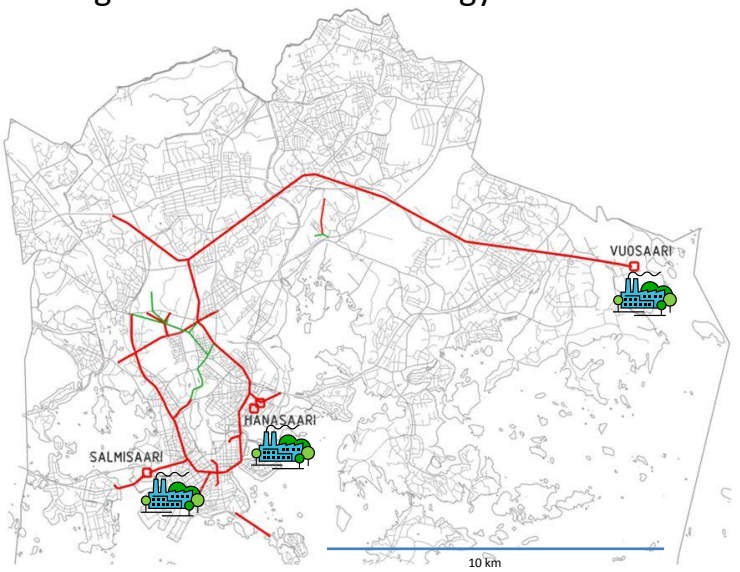
The City of Helsinki has an excellent experience in Geotechnical Data Management in urban underground areas and in placing different facilities underground!

A lot of advantages have been achieved during planning, construction and operation.

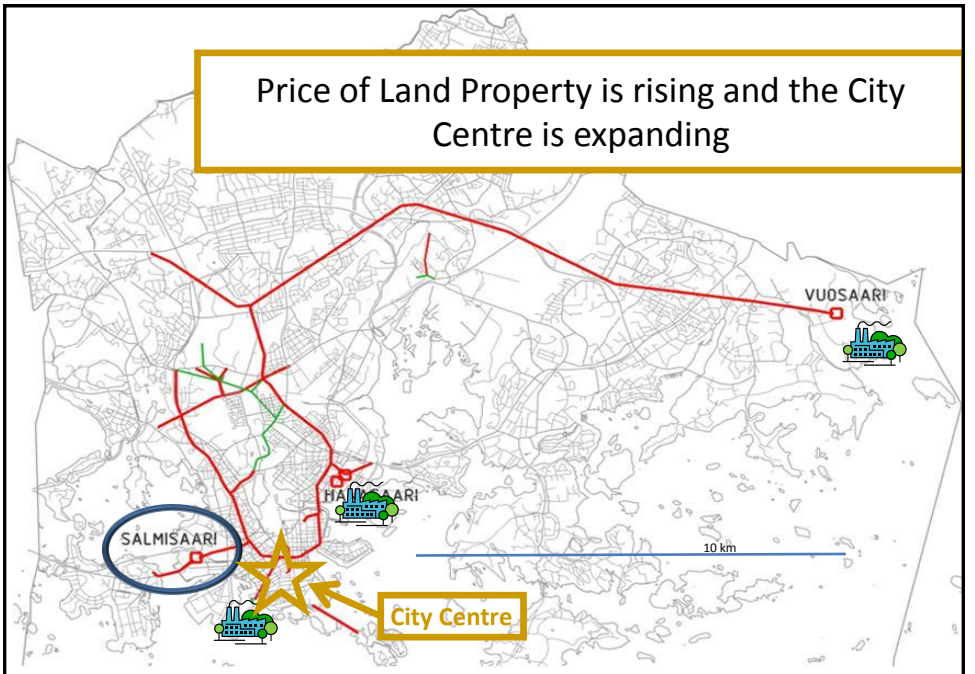
Photo: paparazzistas

4 Non-geotechnical Engineering for Underground Space Development in Helsinki

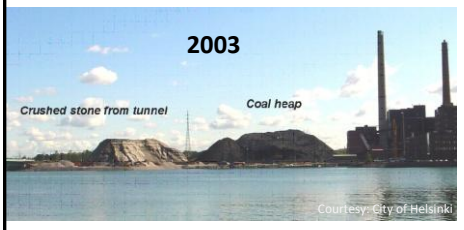
Existing Power Plants and energy tunnel network



Price of Land Property is rising and the City Centre is expanding

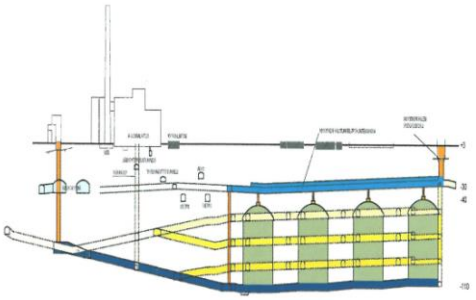


Case Salmisaari power plant's Coal heap



The new 400,000 m^3 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

Salmisaari area before and after Underground Coal Storage

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

Map of Helsinki

The green areas of land are owned by the City of Helsinki
and the white areas are owned by others

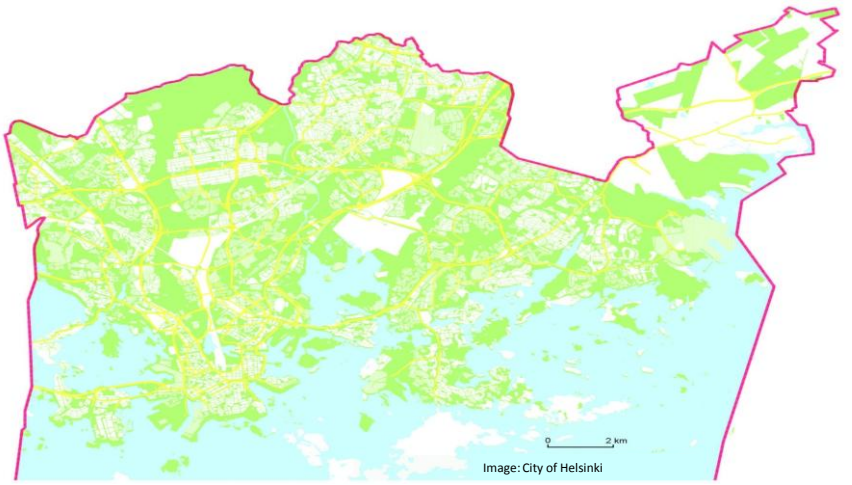


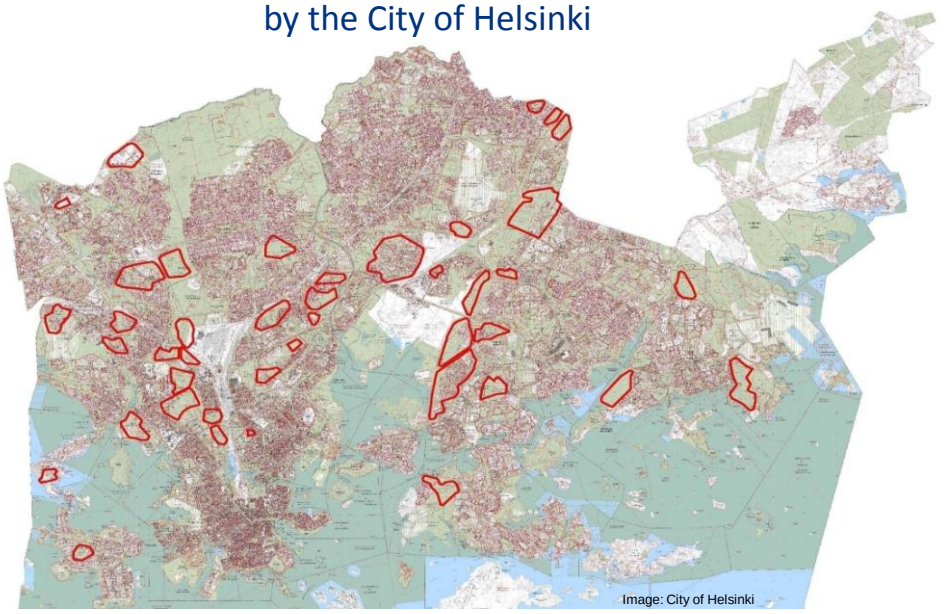
Image: City of Helsinki

- **Helsinki consists of 215 km² of land and 500 km² of sea**
- **The City of Helsinki owns 65% of Helsinki´s land area**

Land Ownership Strategy of the City of Helsinki

- The city tries to buy the needed land areas as greenfield land before zoning
- Today the city is facing more and more redevelopment of brownfields especially when developing waterfront areas
- Easier to develop underground resources under your own real estate

Future UG reservations are mainly on the land owned by the City of Helsinki



The means of getting hold of land in Helsinki 1(3)

1) **Buy the land** needed for zoning by voluntary transactions (purchases or land switches) before the zoning begins
   - The value increase of the zoning is fully usable for the carrying out of the town plan; i.e. building streets, parks, communal service properties such as schools, playgrounds etc
   - Owning the land gives the city the power to decide on the timetable of developing

The means of land acquisition in Helsinki 2(3)

2) The Finnish legislation allows the city to **"take" the land** if the voluntary negotiations fail
   - Helsinki has been reluctant to use this possibility

The means of land acquisition in Helsinki 3(3)

3) When rezoning private land, the city also negotiates **zoning agreements** with the land owners involved
   - Agreements specify how much of the public rezoning implementation costs are to be paid by the land owner
   - The payment is linked to the land value increase generated by the new town plan

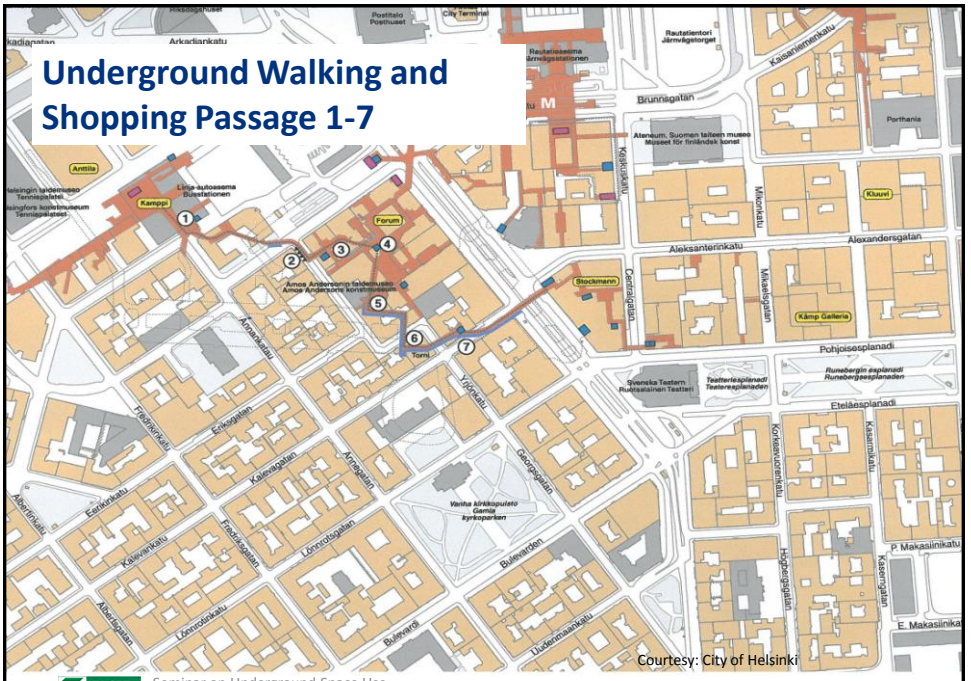
Very useful to combine UG planning with the needs of excavated rock for reclaiming purposes

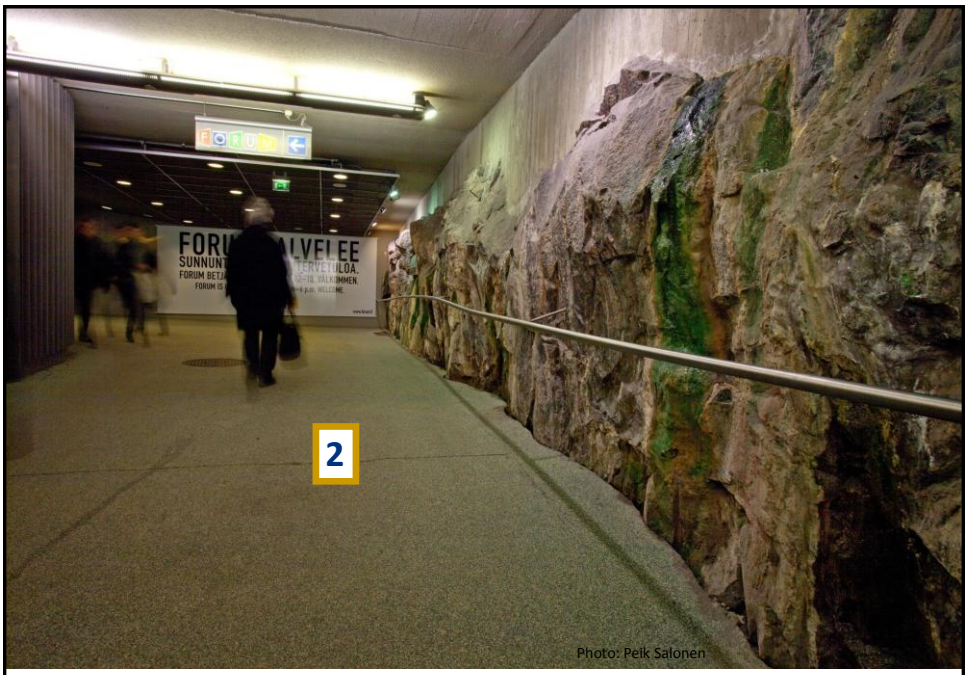
Dilemmas Facing Underground Planning

- 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 the right to use the 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

Underground Architecture & Shopping

Underground Walking and Shopping Passage 1-7




2
Photo: Peik Salonen

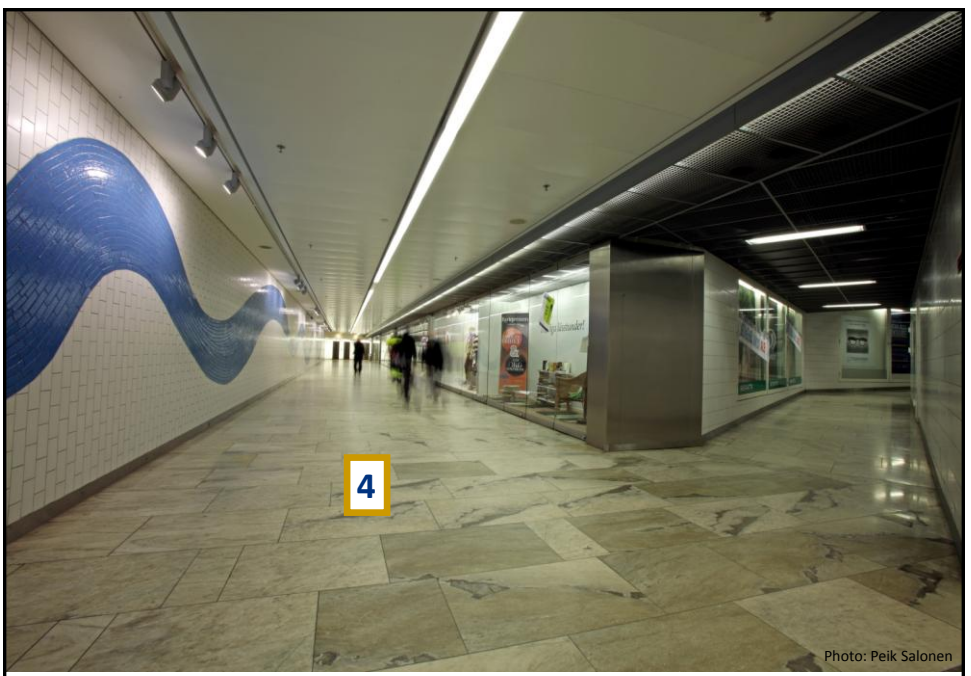

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Photo: Peik Salonen

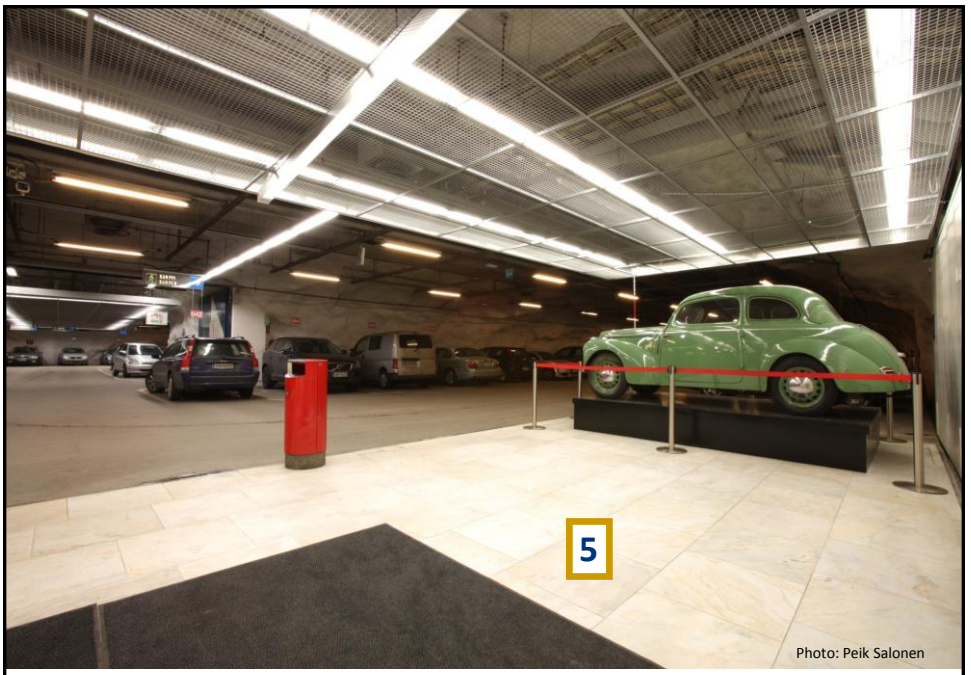

Photo: Peik Salonen

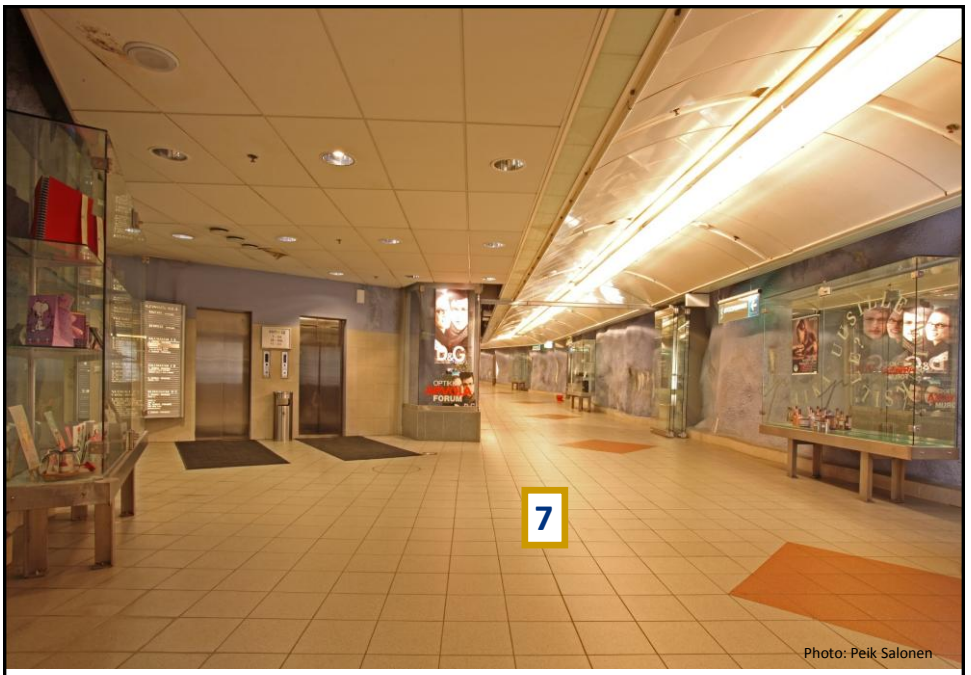

Photo: Peik Salonen

Conclusions of Geotechnical Engineering for Underground Space & Non-geotechnical Engineering for Underground Space Development

- Up-to-date soil and bedrock databases are of high value
- Placing different facilities underground is a safe and economical investment of today and even more in the future
- Owning the land donates the city the value increase of zoning and the power to decide on the timetable of development projects
- Aesthetic aspects are important and they call for skilled architects

Final 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

ITACET Foundation
Foundation for Education and Training on Tunnelling and Underground Space Use

Seminar on Underground Space Use

Singapore Monday 5 – Tuesday 6 November 2012

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