



AND **Locate25** | **G**
THE NATIONAL GEOSPATIAL CONFERENCE

Presented at the FIG Working Week 2025
6-10 April 2025 in Brisbane, Australia
FIG **Geospatial**
Council of Australia

Collaboration, Innovation and Resilience: Championing a Digital Generation

Brisbane, Australia 6-10 April



Oslo

The Fornebu Metro Line

7. April 2025

Leif Ingholm, Oslo Municipality



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PLATINUM SPONSORS



CHCNAV



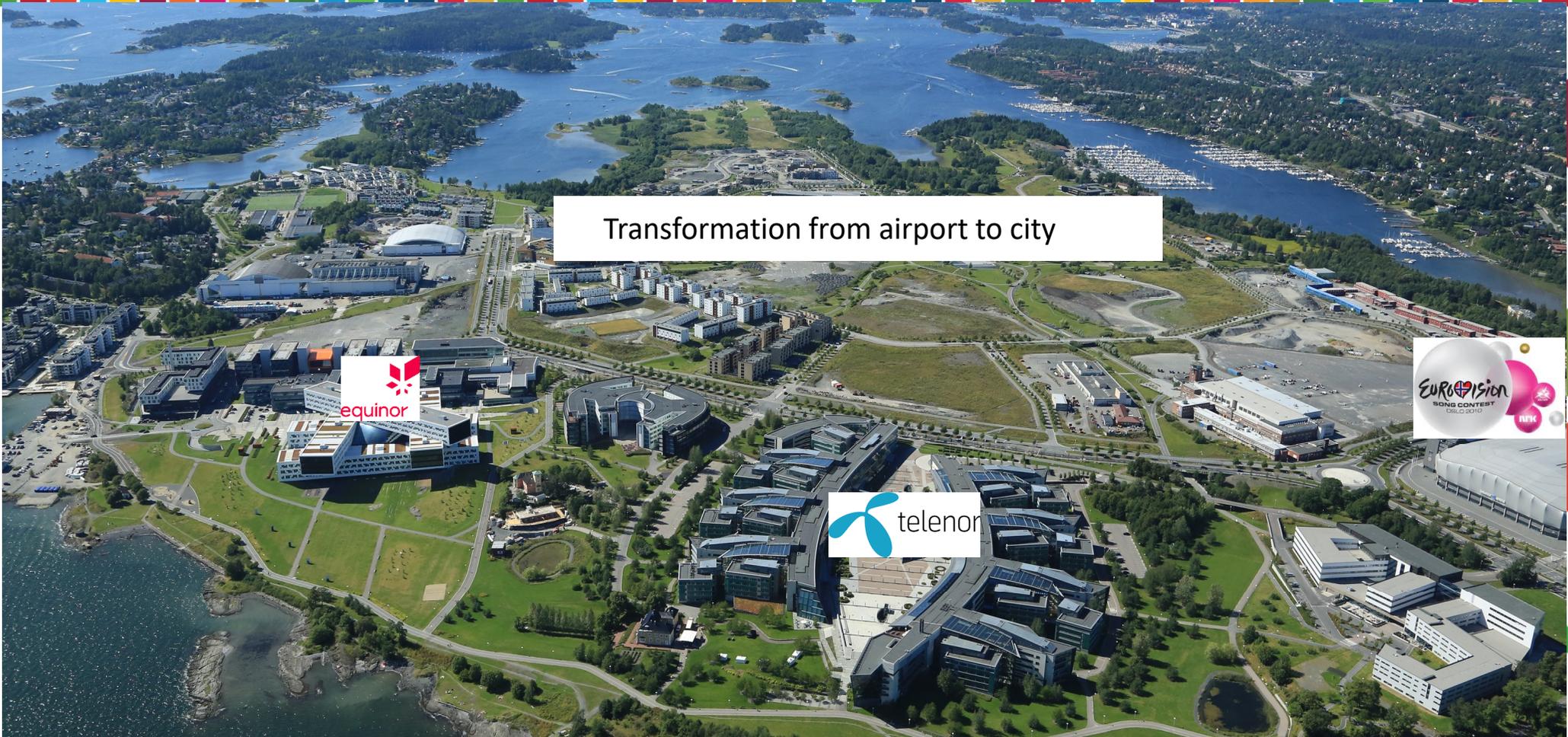
Outline

1. The Fornebu line at a glance
2. Digital 3D project – BIM
3. Electric project
4. Zoning plan
5. Who owns the underground?



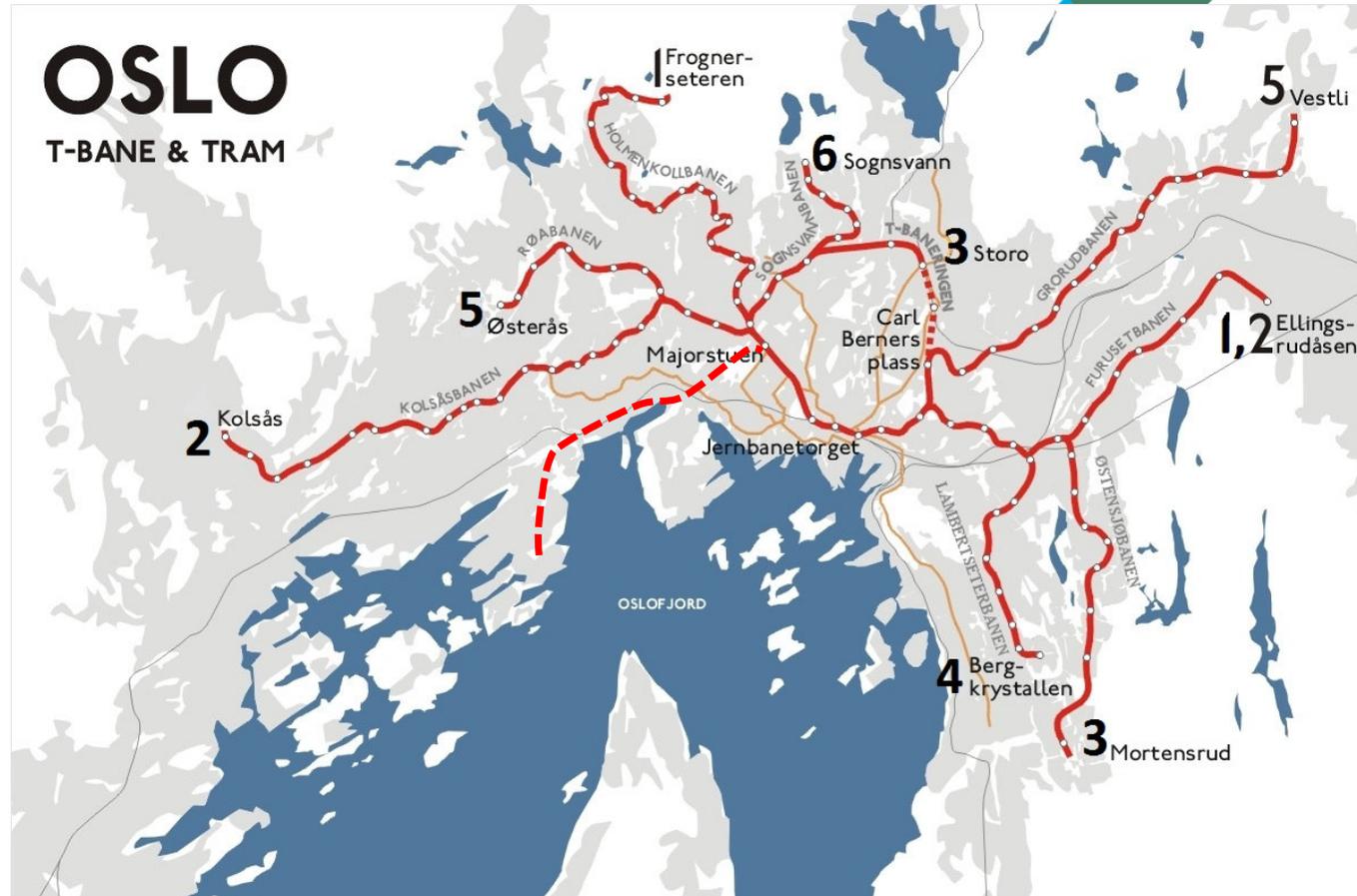
1 -The Fornebu Line at a glance





The Oslo Metro

- First line opened in 1898
- 101 stations (17 are underground)
- 100 million passengers per year JB1
- Total length 85 km
 - Large metro system compared to number of passenger journeys
- Short station spacing 0,85km
 - Global average is 1,28km
- Average speed 31km/h
 - Global average 34 km/h

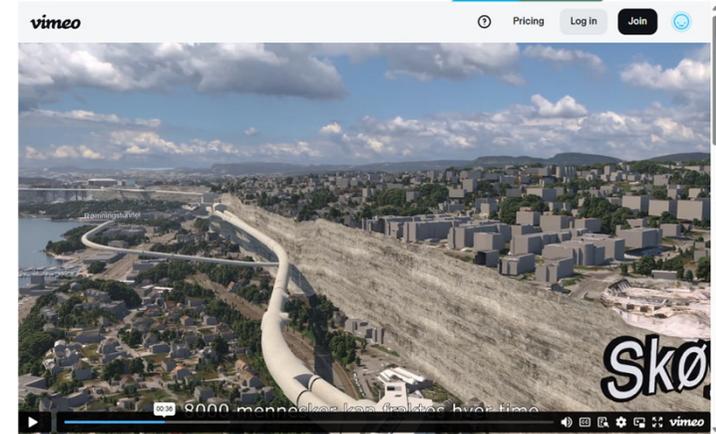


JB1 annually

Jon Magnus Lindløkken Bjørsom; 2025-04-01T12:33:07.212

2 - Fully digital 3D project – BIM (no “flat paper drawings”)

- BIM is the main information platform for the project
 - Communication with government bodies, landowners, neighbours and stakeholders
- Engineering, management, planning, cost control, contract, systematic completion, GIS



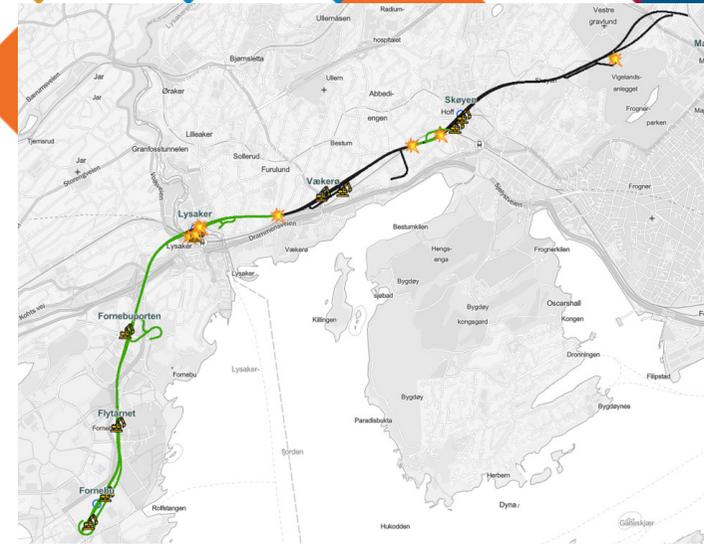
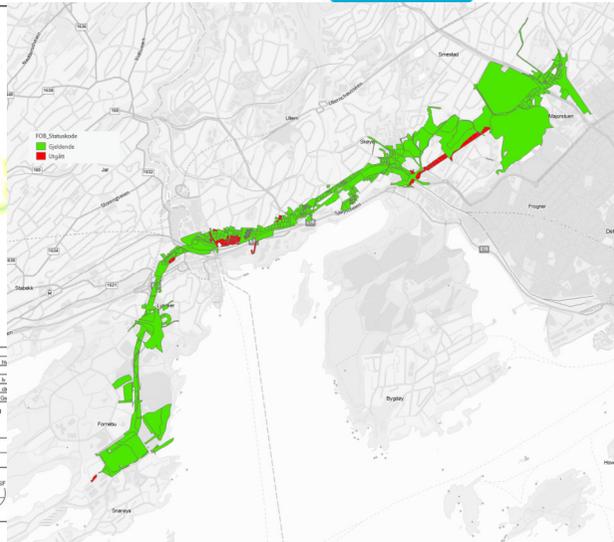
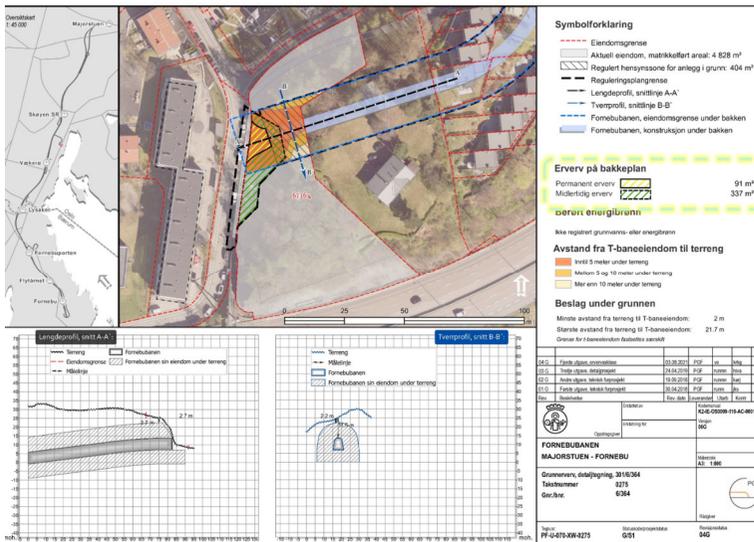


Oslo



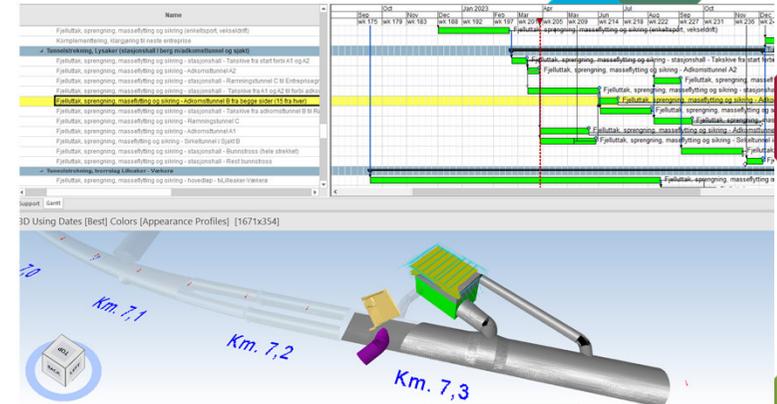
Presenter

Several GIS portals



Fornebubanen –
Publikumsmodell

- 3D engineering and coordination between disciplines
- Contractors tracking progress
- Connection to public mapping services, Cadastre data, Energy wells, External environment, Flooding Etc.



The model has entries from the description, providing a direct link between the model object and the entry in the contract.

The screenshot displays the Autodesk Revit interface with several key components:

- Model Elements Table:** A table listing model elements with columns for 'Menge' (Quantity), 'Enhet' (Unit), 'Enhetspris' (Unit Price), and 'Sum' (Total).

Element	Menge	Enhet	Enhetspris	Sum
02.3.1.001 Yttervegg Betong 830 B35	34,96	m2	2 411,03	91 131
02.3.1.002 Yttervegg Betong 400 B35	47,13	m2	2 995,06	141 345
02.3.1.003 Yttervegg Betong 500 B35	802,01	m2	2 995,06	2 405 278
02.3.1.004 Yttervegg Betong 830 B35	376,60	m2	2 995,06	1 129 443
02.3.1.005 Yttervegg Betong 800 B45	432,51	m2	2 995,06	1 297 930
02.3.1 Bærende yttervegger	1 693,15	m2		5 064 326
- Receipte Database:** A detailed table for element '003 Yttervegg Betong 600 B35', showing a breakdown of materials and their costs.

Element (02.3.1.003)	Resepthengde	Enhetspris (*)	Sum (*)
02.3.1.1... Forsikling yttervegg, en side, S...	m2	402,40	402,40
02.3.1.1... Forsikling yttervegg, en side, S...	m2	668,97	668,97
02.3.1.1... Ammering i yttervegg	kg	20,50	493 161
02.3.1.1... Betong i yttervegg, B35, lavkarbon kl...	m3	2 070,90	0
02.3.1.1... Betong i yttervegg, B30, lavkar...	m3	2 300,44	167 978
02.3.1.1... Betong i yttervegg, B45, lavkar...	m3	2 000,33	0
02.3.1.1... Forsikling yttervegg, en side, S...	m2	402,40	402,40
02.3.1.1... Forsikling yttervegg, en side, S...	m2	668,97	668,97
02.3.1.1... Etterbehandling av betongyttervegg	m2	65,94	52 888
02.3.1.1... Gummurplate XPS, t = 50 mm...	m2	288,55	288,55
02.3.1.1... Gummurplate EPS, t = 100 mm...	m2	452,78	323 932
02.3.1.1... Gummurplate EPS, t = 150 mm...	m2	572,91	0
02.3.1.1... Gummurplate EPS, t = 50 mm...	m2	215,61	0
02.3.1.1... Gummurplate EPS, t = 100 mm...	m2	317,48	0
- Viewer:** A 3D perspective view of the building model.
- Cost Sum:** A summary table showing unit prices and costs for various materials.

Enhet	Enhetspris	Skdbsh	CO2-eu/tnh
stk	36 689,54	2 031,29	1 635,28
m2	1 603,21	0,50	89,19
m2	1 895,68	59,69	98,85
m2	1 768,38	96,6	108,51
m2	1 926,87	106,46	122,99
m2	2 191,96	131,22	147,17
m2	2 455,11	129,99	174,32
m2	1 603,94	98,62	115,17
m2	1 711,99	98,47	109,68



3 - Fully electric project

Oslo Municipality requires electric or zero emission machines in all its projects

- This has led to increased demand for electric machines



(relatively) New technology

- No different in function than a regular fossil machine (according to the operators)
- Not all machines are available in electric versions
 - Mapped out in advance, so that some operations can be done with non-electric machines
 - Not permitted to use biogas under ground
- The machinery is in a development phase. The dumper trucks load 37 T
 - We have already taken in larger ones (60 T), still not “world class”, but the technology is moving.



SANY - SKT90E
Electric Off-Highway Mining Truck
Load Weight 37 T

Slide nummer 12

IM1

Her kan du vurder å si at vi ikke kan bruke biogass under jord, og derfor når vi ikke målsettingen om full utslippsfrihet i 2025. Bente har holdt presentasjon for kinesisk gruppe og har sikkert noe om dette i engelsk versjon.

Irene Synnøve Måsøval; 2025-04-01T11:52:13.125

Charging

- Charging infrastructure is important for success!
- Large construction sites =
movement between charging and attack, drains power
- Plan a sufficiently developed power grid for charging
- Requires a sufficient capacity in the local power grid





**WORKING
WEEK 2025**

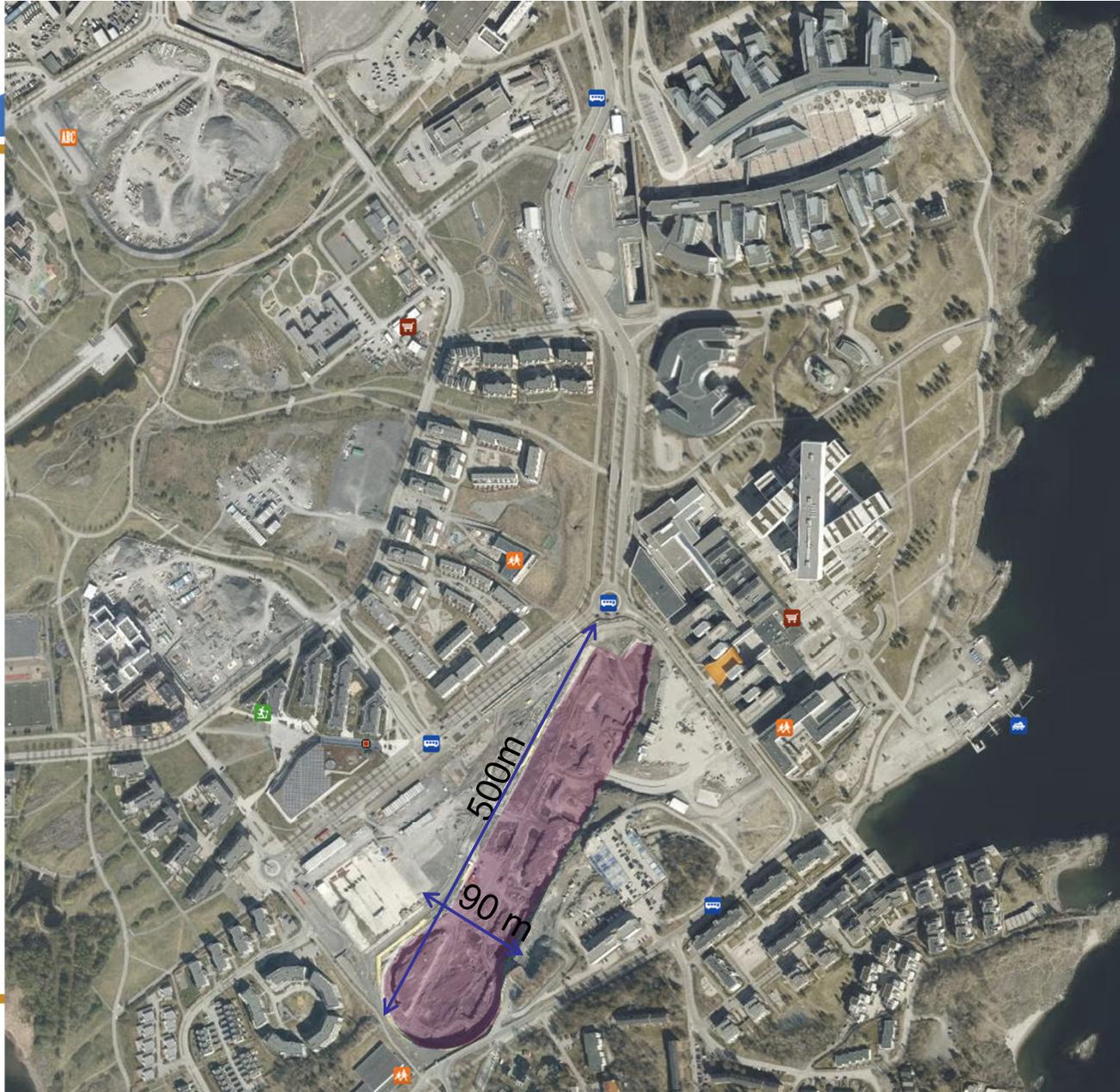


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ca **HD Meter** **Surveyors**
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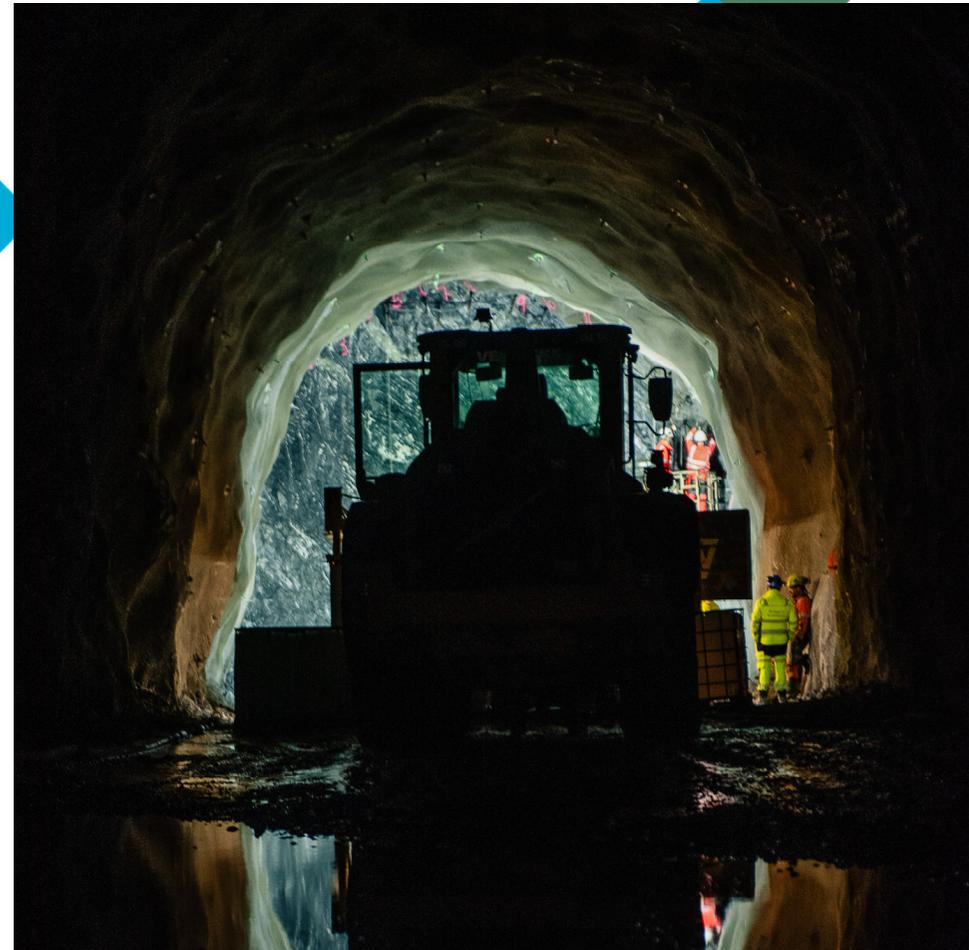


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Have a back up

- The machines have some childhood illness
- Frequent breakdowns, subsequent troubleshooting, repair and lack of spare parts, are more common for some new types of electric machinery
 - In order not to jeopardize project progress, we made predefined procedures to use non-electric machines



4 - The zoning plans

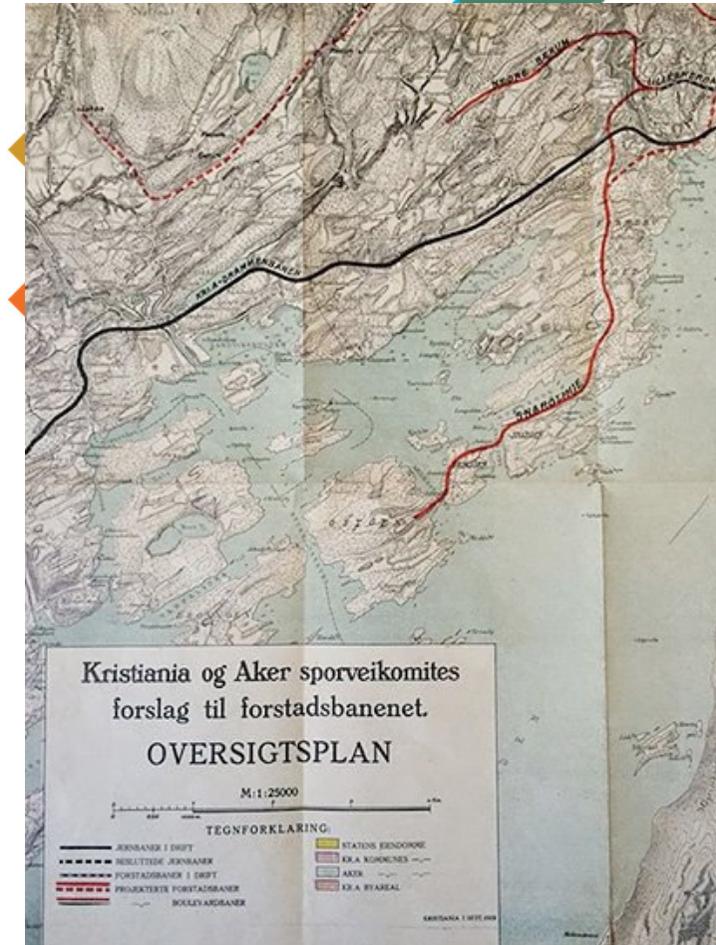
- Oslo and Bærum are two separate municipalities and therefore, two planning processes
- Greater project maturity = constantly challenged the zoning boundaries
- Always invest your energy in the early phase!
 - Early land acquisition is highly critical for progress



Zoning plan 2016-2018
Zoning plan 2020-2023

Quick historic revju

- 1919: First Suburban rail proposal
- 1939: Airport open
- 1990s: Plans for conventioal railroad.
- 2003 and 2005: Zoning plan for automatic Monorail/Sky-rail
- 2007: Plans for Sky-rail dropped – Tram proposed instedad
- 2012: Akershus County decides to built a conventional metro, connected to the existing metro system.
- 2016 and 2018: Zoning plan for metro approved
- 2020: We decide to change the layout of the metro.
- 2020-2023: Zoning and building in parallell. The plan was split in to several smaller plans.



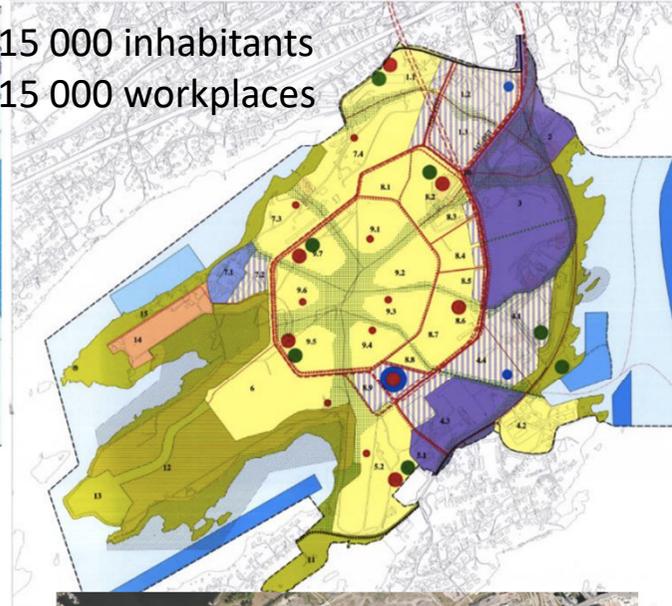
Municipal masterplan
1, 2 and 3

KDP 1 1996

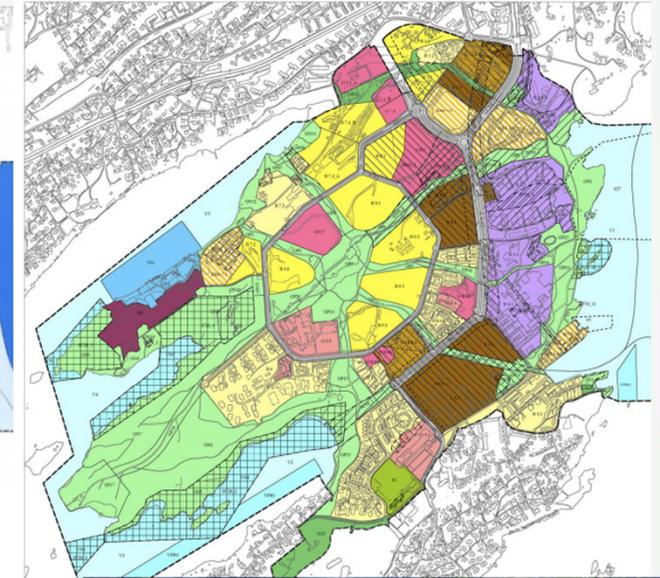


15 000 inhabitants
15 000 workplaces

KDP 2 1999

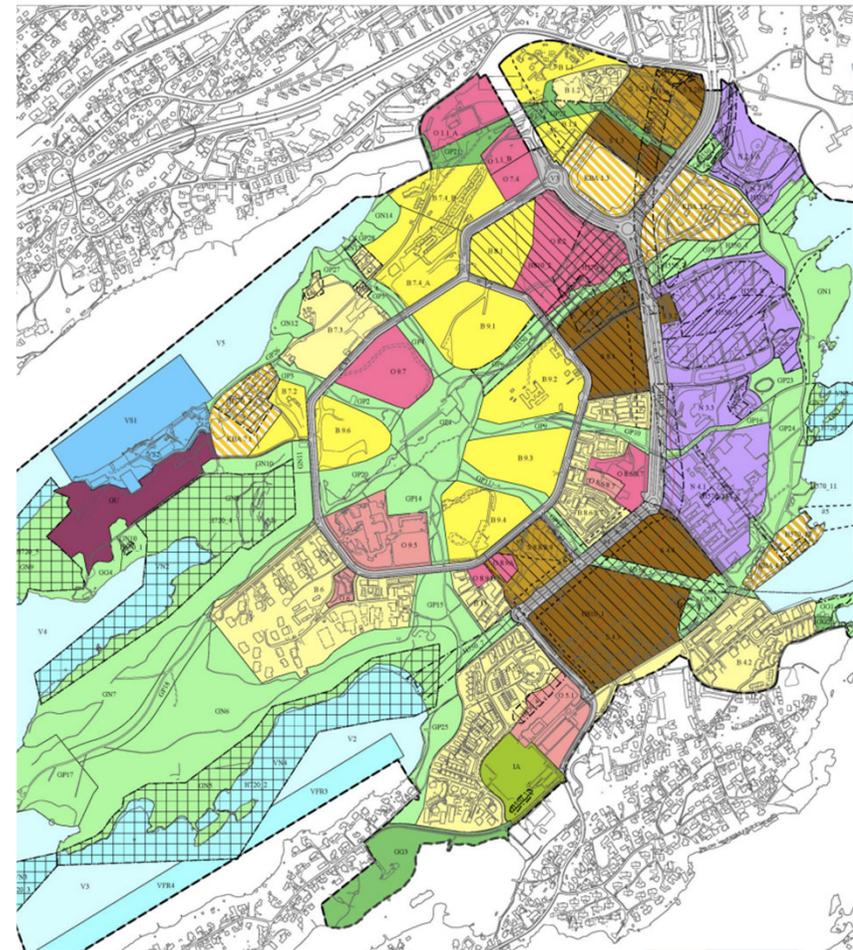
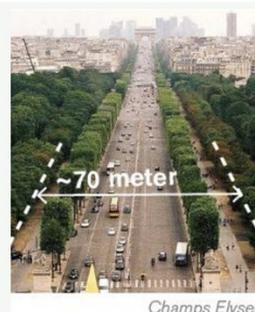


KDP 3 2019



Municipal masterplan 3

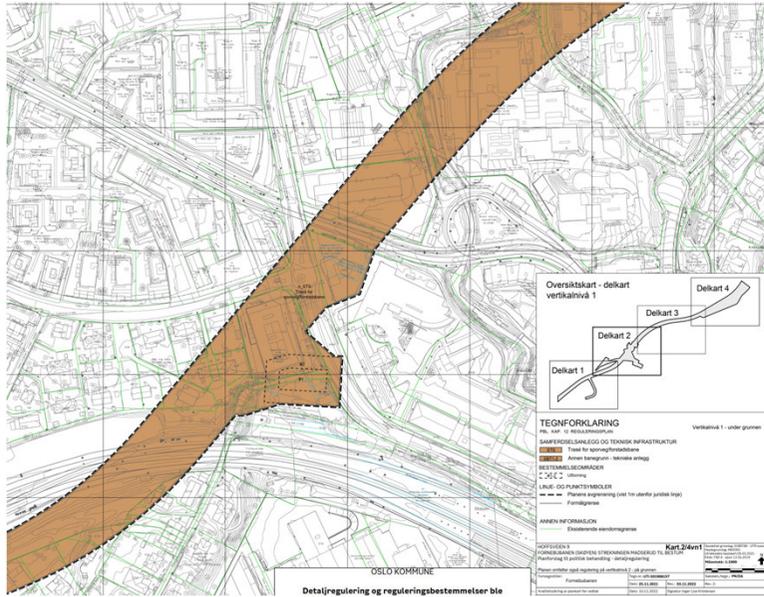
- Masterplan nr 1. and 2. from 1996 and 1999 had 15.000 inhabitants 15.000 workplaces
- In 2019 the peninsula had 7 500 inhabitants and 25 000 workplaces
- Goals for the new masterplan is to:
 - Make the metro feasible
 - Make Fornebu into a town the size of Lillehammer with 25.000 inhabitants
- Nature
- Mixed spaces
- Avenue?



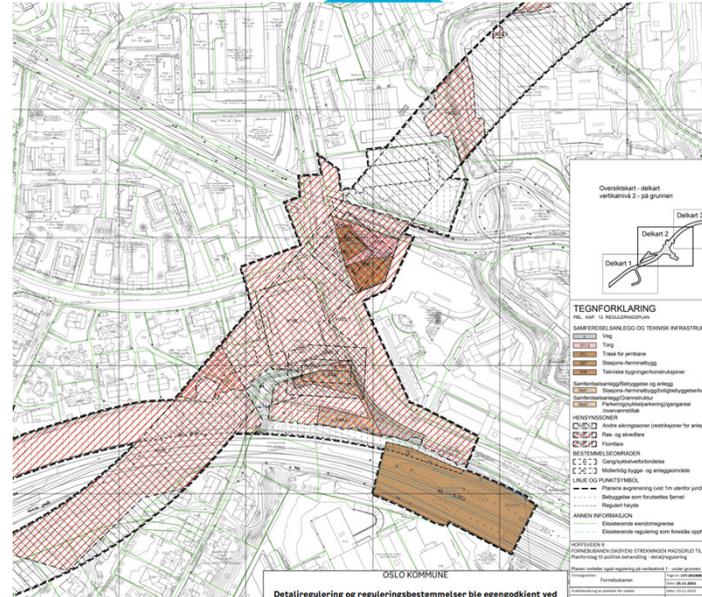
- It was a major focus on **quick clay** in Norway in 2020
- All physical planning had to have special focus on it



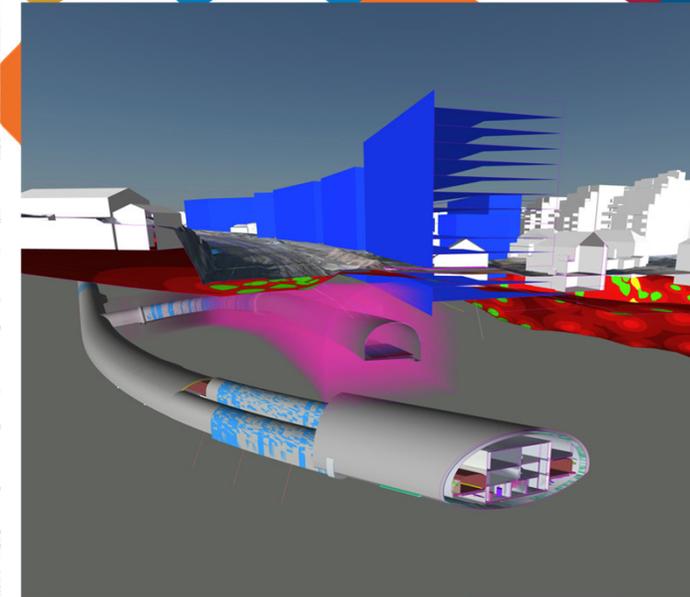
- Lack of 3D zoning plan
Property is 3D – zoning plans are 2D (levels)



■ Zoning plan level 1



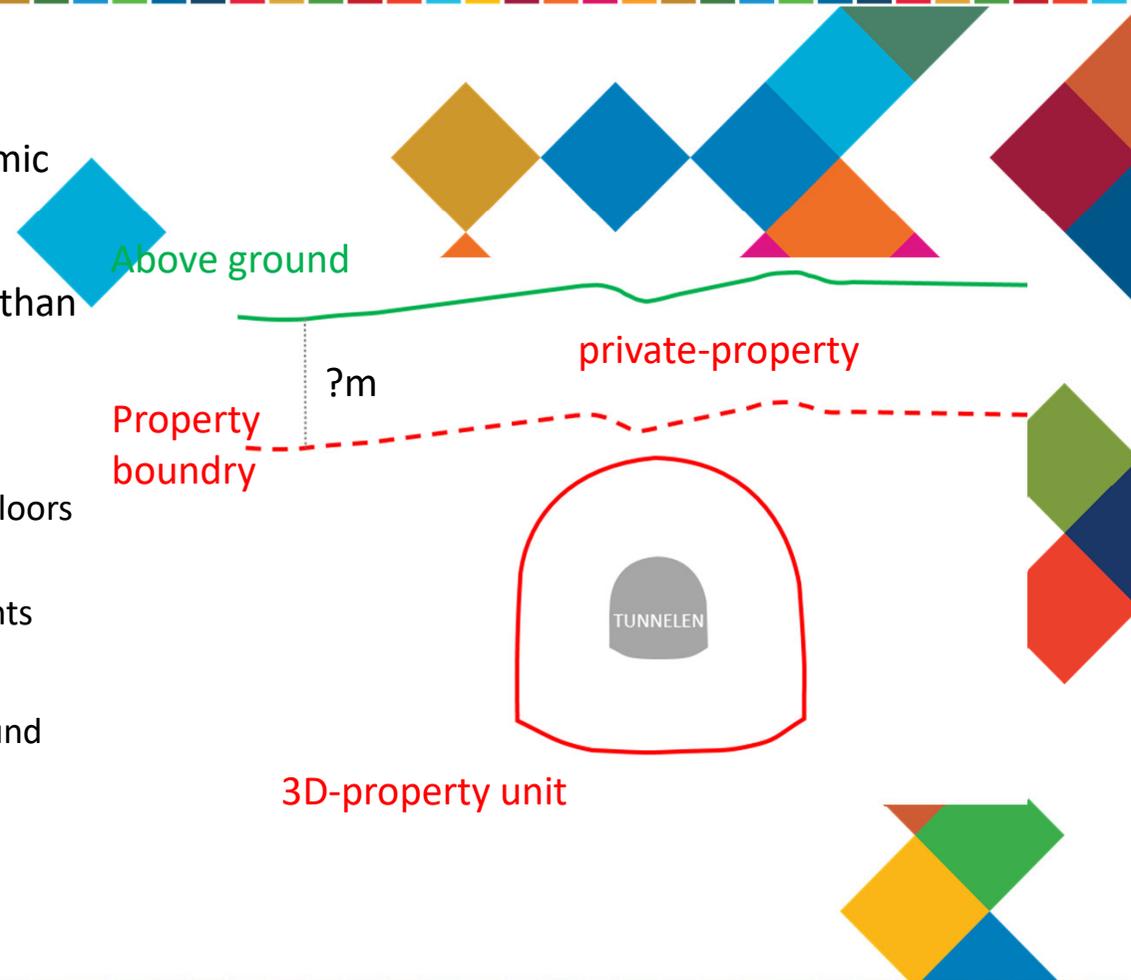
■ Zoning plan level 2



■ 3D-property-unit

5 - Who owns the underground?

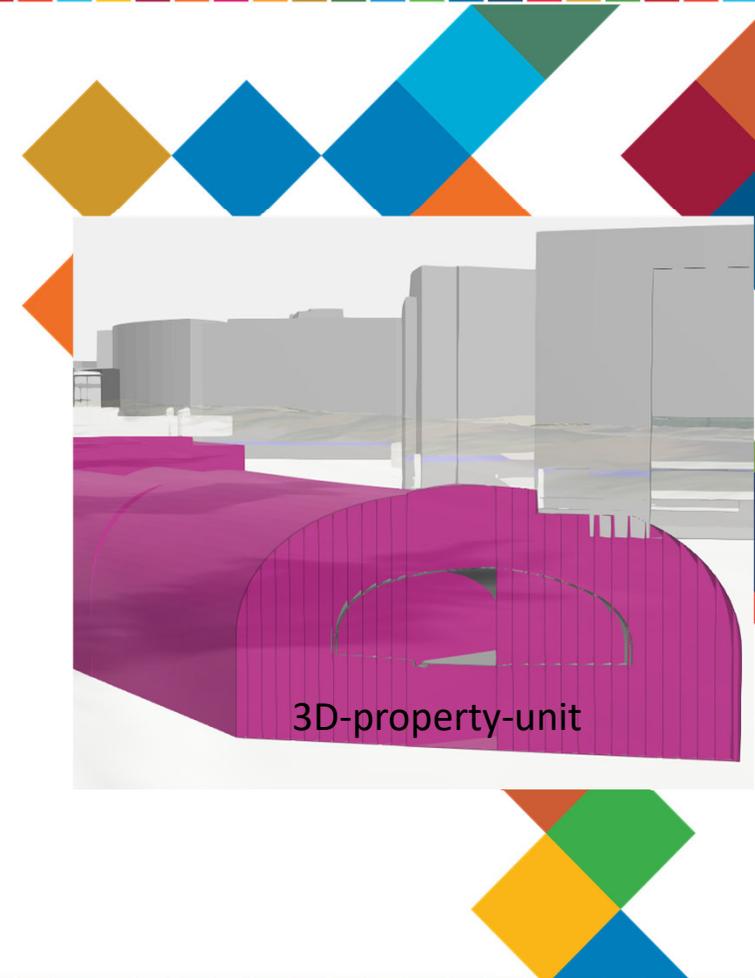
- In Norway you own as far down as you would have economic interests
- We've made assessments that property rights extend less than 10 meters down
- Reasoning:
 - 2018: Only 19 buildings in the capital region had 4 basement floors or more
 - Except the National Archives, all others were parking basements
 - Parking basements have low ceilings - 3 meters high?
 - Conclusion: ownership extends less than 10 meters underground since more than 3 basement floors are rare



95 properties in “owned underground”

Properties where our acquisition “collides” with the landowners’ property rights

- The properties are classified based on our definitions of property rights (<10 m) , as well as our definition of our own need for property (the volume of the 3D-property-unit).
- Our acceptance that a property is affected does not necessarily mean they have an economic loss and a right to receive compensation.
- We are awaiting arbitration on several properties



Land acquisition database with GIS-map

- Records
- Communication with landowners
- Communication with construction managers

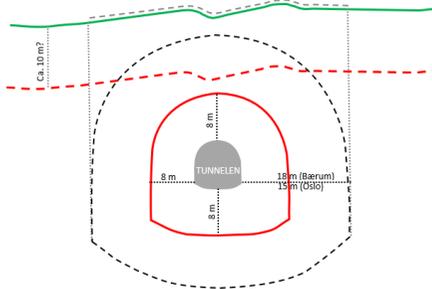
550 properties

- 140 affected above ground
- 95 affected underground
- 225 classified by us as “not owned”
- 15 have energy wells
- 40 are affected by **zones requiring special consideration** (not considered a part)
- The rest are neighbors/not affected

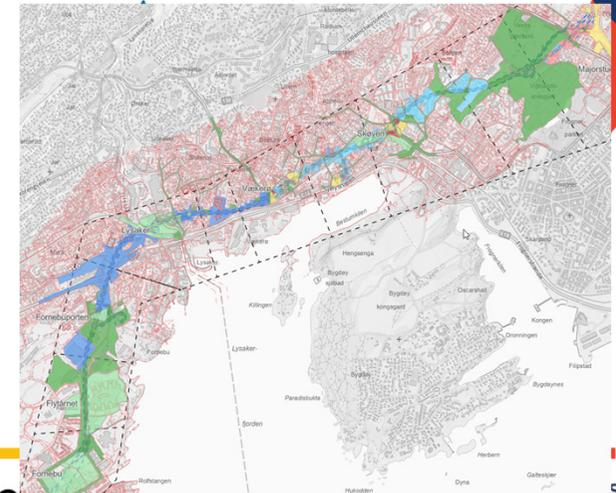
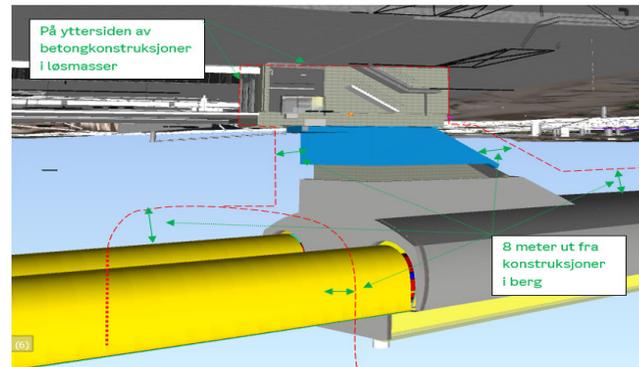
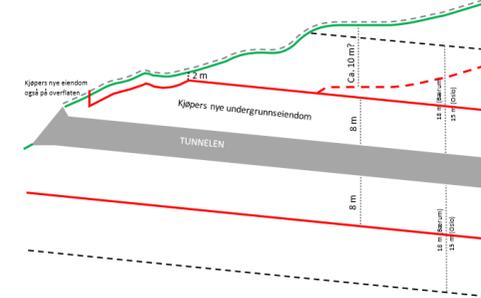
TEGNFORKLARING

- Terrengeoverflaten
- Eiendomsgrænse for anleggseiendommen
- - - Eiendomsgrænse for grunneiendommen?
- - - Hensynssoneavgrensning
- - - Hensynssonen «mittet av» på overflaten

TVERRSNITT



LENGDESNIITT



The most relevant SDGs related to the presentation and theme of this session

1st relevant SDG

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



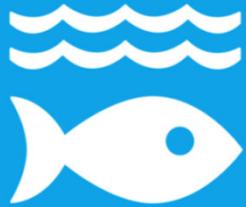
2nd relevant SDG

11 SUSTAINABLE CITIES AND COMMUNITIES



3rd relevant SDG

14 LIFE BELOW WATER



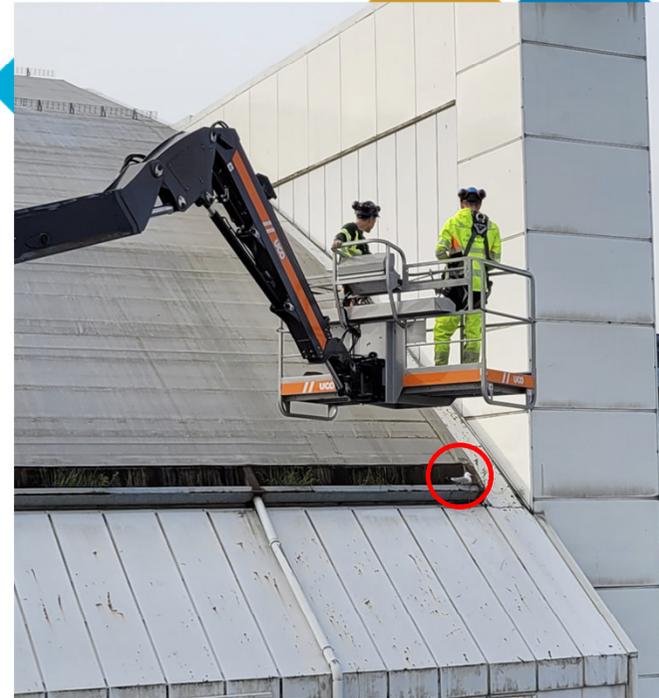
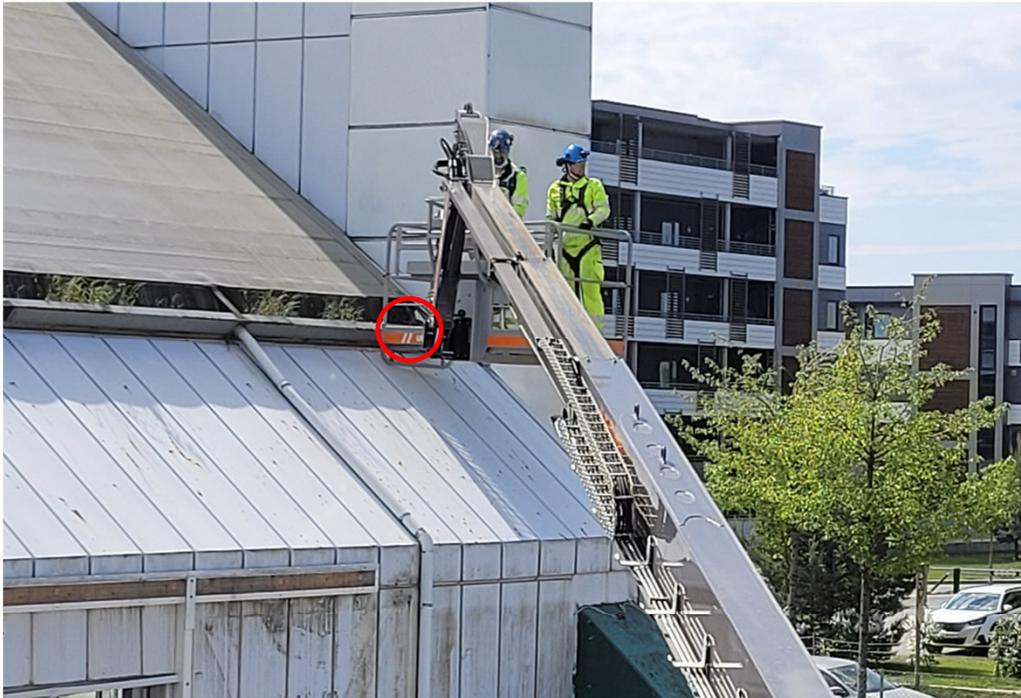
SUSTAINABLE DEVELOPMENT GOALS

International Federation of Surveyors supports the Sustainable Development Goals



Freshwater pearl mussel (*Margaritifera margaritifera*)







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Yes?



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STEP 1: SELECT HERE THE THREE MOST RELEVANT SDGs
STEP 2: COPY THE SDG INTO PREVIOUS SLIDE

1 NO POVERTY 	2 ZERO HUNGER 	3 GOOD HEALTH AND WELL-BEING 	4 QUALITY EDUCATION 	5 GENDER EQUALITY 	6 CLEAN WATER AND SANITATION 	7 AFFORDABLE AND CLEAN ENERGY 	8 DECENT WORK AND ECONOMIC GROWTH 	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES 	11 SUSTAINABLE CITIES AND COMMUNITIES 	12 RESPONSIBLE CONSUMPTION AND PRODUCTION 	13 CLIMATE ACTION 	14 LIFE BELOW WATER 	15 LIFE ON LAND 	16 PEACE, JUSTICE AND STRONG INSTITUTIONS 	17 PARTNERSHIPS FOR THE GOALS 	

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