

# Toolkit Snow Transport

How to efficiently transport snow

Deliverable 4.5

31<sup>st</sup> May 2025

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- (1) Snow Transport – Challenging sustainable snow management
- (2) Snow Transport – Strategy and challenges
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- (4) Snow Transport – Examples of good practices

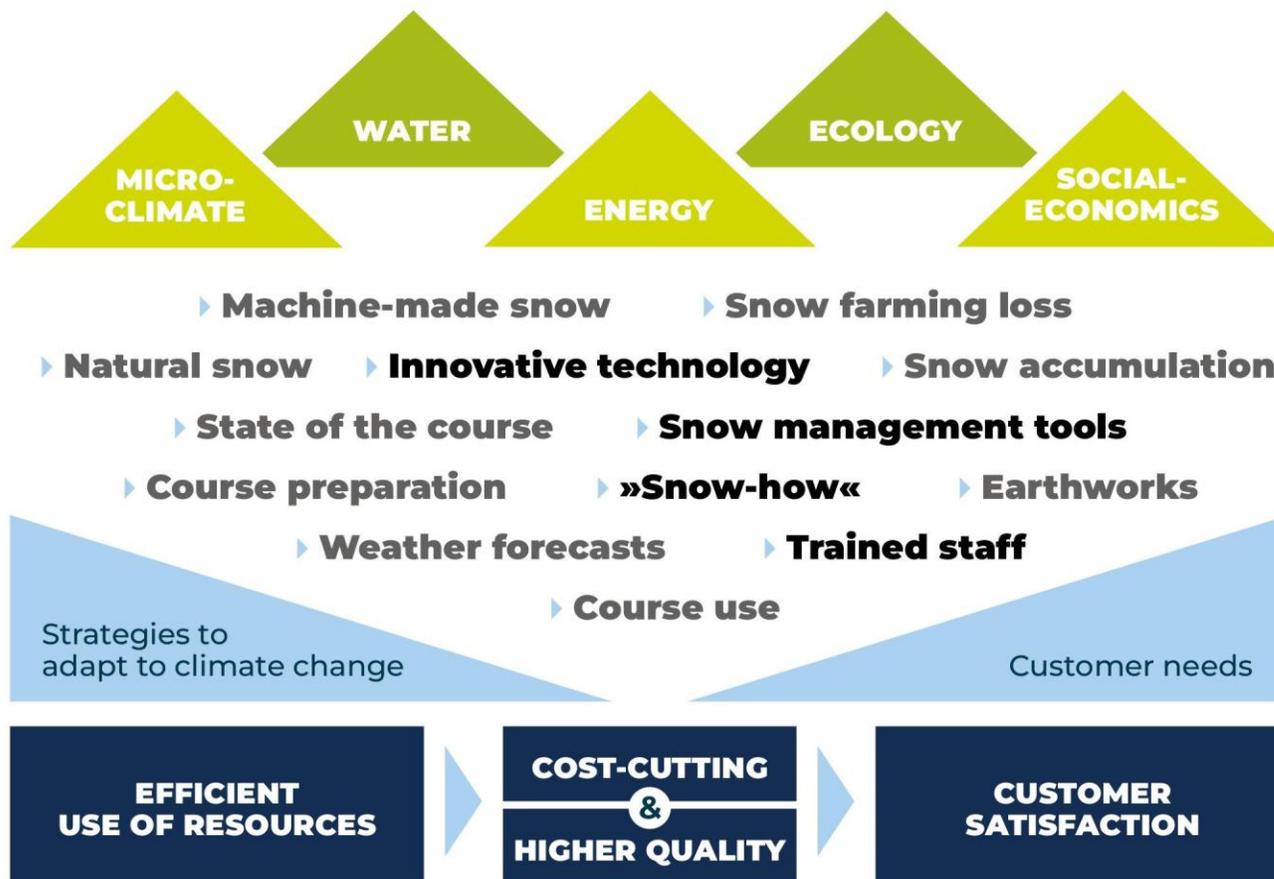
# (1) Snow Transport

Challenging sustainable snow management



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# (1) Sustainable snow management



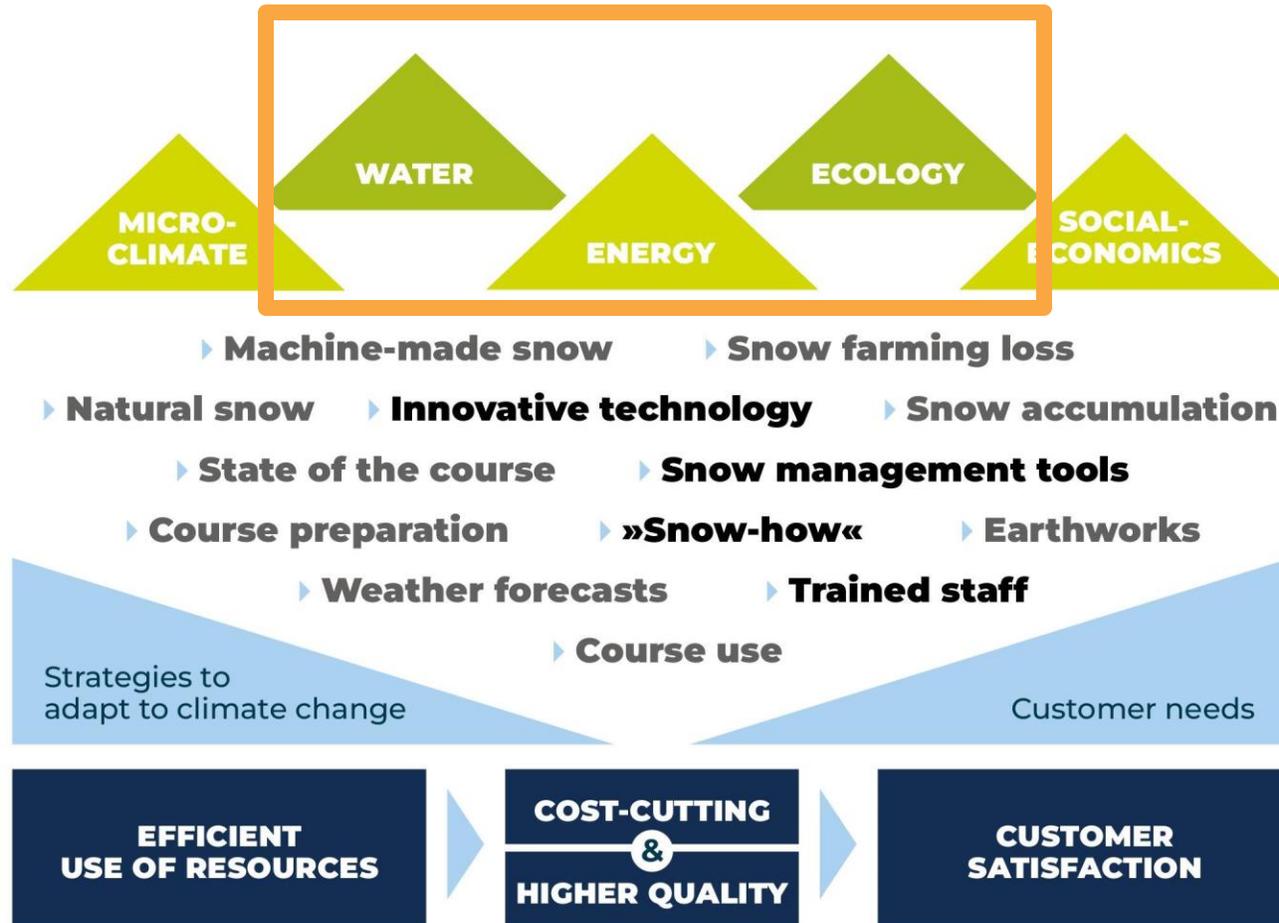
...to **reliably provide snow**...

...within a given set of climatological, hydrological, ecological, and social-economical constraints...

...to run snow sport infrastructures in an **ecologically and economically sustainable** manner.

...to reduce **costs** while improving the **quality of snow** sports facilities.

# (1) Sustainable snow management - Snow Transport



SNOW...

Snow Transport  
the resource intense  
consequence of snow  
production & storage

# (2) Snow Transport

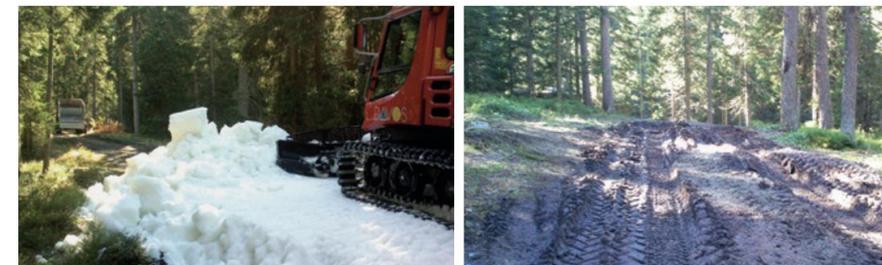
## Strategy and Challenges



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## (2) Different Snow transportation strategy

- Producing right on track with full track coverage
  - Pros:
    - Minimal snow transport
    - Low work moving snow production equipment
  - Cons:
    - Large investment cost requires snow production infrastructure along ski track.
    - No snow guarantee
  
- Producing snow depot/s along track and push the snow out
  - Pros:
    - Less investment cost
  - Cons:
    - High work moving snow production equipment
    - No snow guarantee
  
- Producing on a storage (over summer)
  - Pros:
    - Snow guarantee
  - Cons:
    - large cost for transportation
    - Need hard surface to use large machines



## (2) Snow transportation challenges

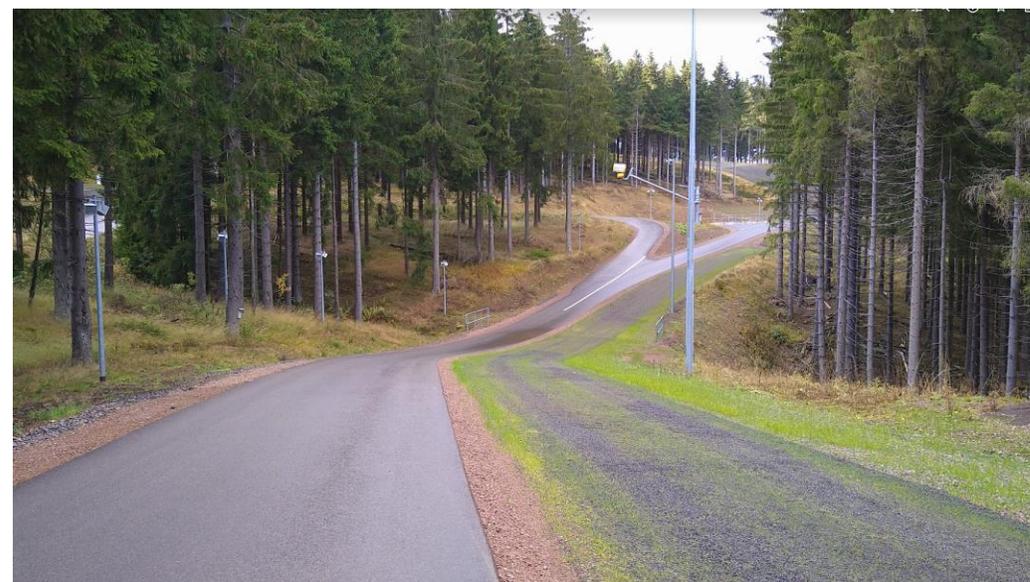
### Easy to access with transportation vehicles if:

- hard paths
- frozen ground
- rollerski loop



### Difficult access with transportation vehicles if:

- soft farm fields
- wet ground
- woods no access
- steep uphill / downhill
- Snowy weather



# (3) Environmental impact & costs



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### (3) Environmental impact & costs

#### Cost from different parts of snow storage

| Venue       | Storage      |          |             |                |        | Total |
|-------------|--------------|----------|-------------|----------------|--------|-------|
|             | Pile shaping | Covering | De-covering | Distribution   | Others |       |
| Lenzerheide | 0,39         | 1,51     |             | no data so far |        |       |
| Pokljuka    | 0,15         | 0,24     | 0,21        | 1,29           | 0,04   | 1,93  |
| Martell     | 0,31         | 0,82     |             | no data so far |        |       |
| Notschrei   |              |          |             | no data so far |        |       |
| Jakucyce    |              |          |             | no storage     |        |       |
| NMNM        | 0,32         | 0,23     | 0,57        | 1,62           |        | 2,74  |
| Östersund   |              |          | 1,01        | 2,4            | 0,43   |       |
| Vålådalen   |              |          | 0,62        | 2,85           | 0,12   |       |
| Kontiolahti |              |          |             |                |        | 3,69  |
| Otepää      | 0,40         |          |             |                |        |       |

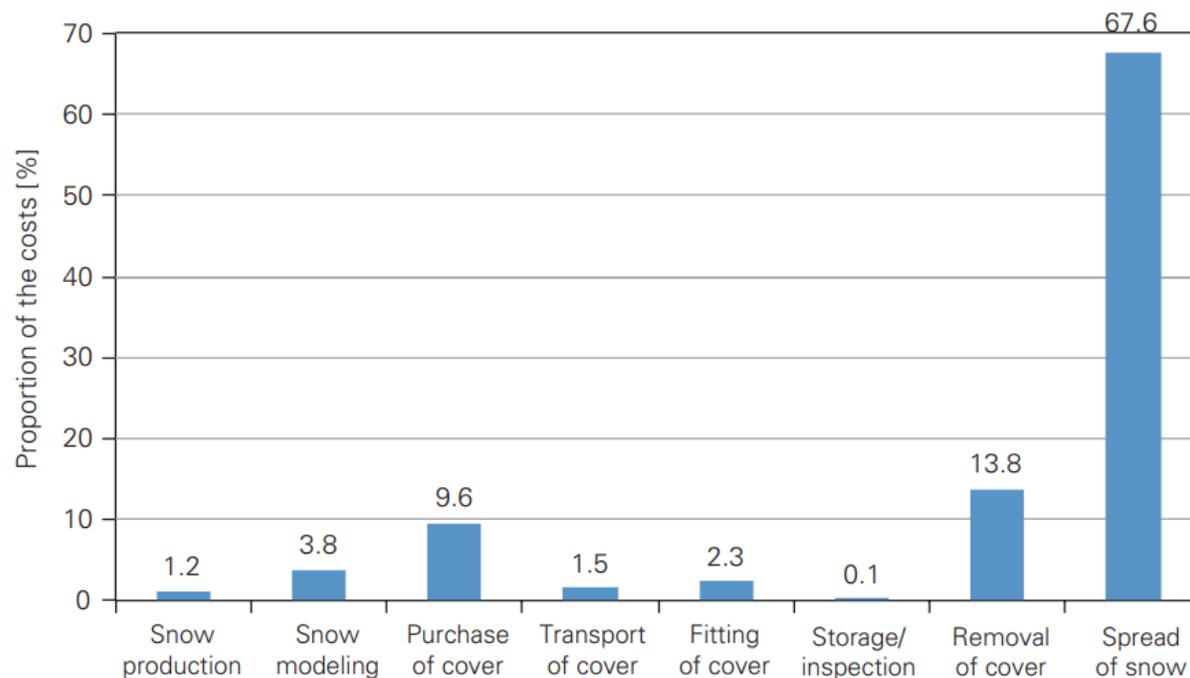
SIEPPUR venues 2023:  
 ESR(storage)\* = 1.9...3.7 kWh/m<sup>3</sup>  
 ESR (distribution) 1.29 - 2.85 kWh/m<sup>3</sup>  
 \*includes distribution

Annecy Le Grand Bornand

**4,29**

### (3) Environmental impact & costs

Cost from different parts of snow storage – Davos 2016



Snow transportation drives costs and energy consumption

# (4) Examples of good practices



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# Create supporting ski trails for snow transport

**Challenge:** Soft ground makes transportation challenging with heavy trucks

**Solution:** Make ground work, Adding isolating plates underneath the ground under the ski course both prevent heat transfer from geothermal fluxes as well as it is providing a supporting layer for heavy trucks with less ground work needed.

**Location:** Multiple ski areas in southern Finland



# Making the snow more homogenous before transport

**Good practices:** Shaving snow with an excavator shovel, two piles for shorter transportation distance

**Good practices:** Crushing snow with a forked excavator shovel



# Avoid dirt and rock during transportation of snow

**Challenge:** Snow dirtied during transport

**Solution:** Cleaning snow transport equipment from dirt/rock before work on snow. Get rid of enough of the sawdust from the pile and avoid going too deep into the ground or on the side of the storage if it is next to a hill.

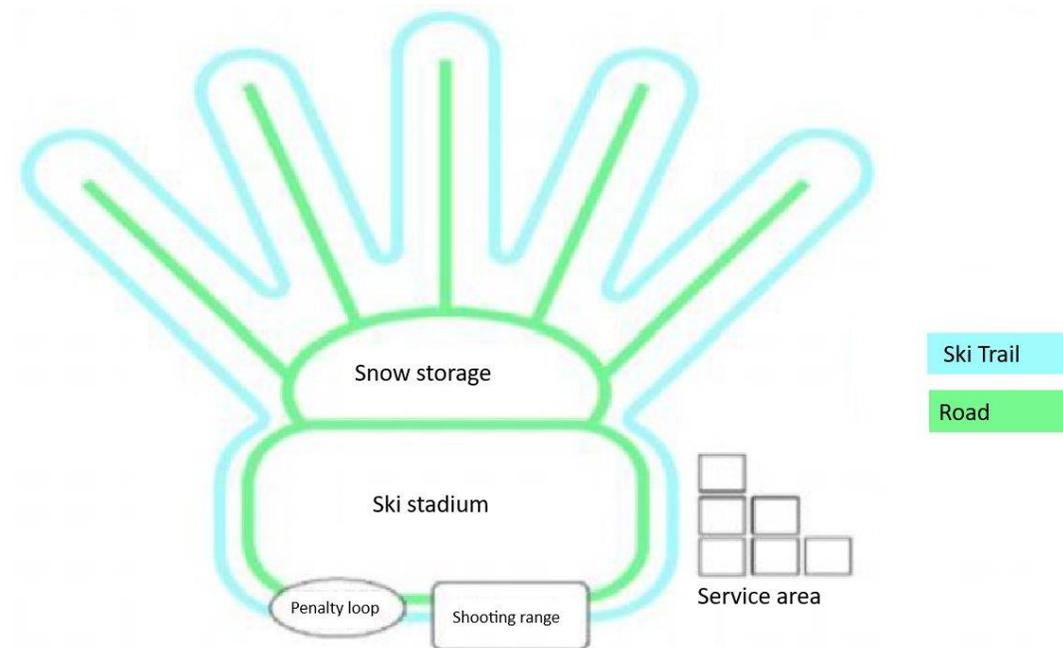


# Minimise transport distance with choice of storage location/multiple smaller storages

**Challenge:** To reduce impact of snow transportation which costs most money and consumes most energy

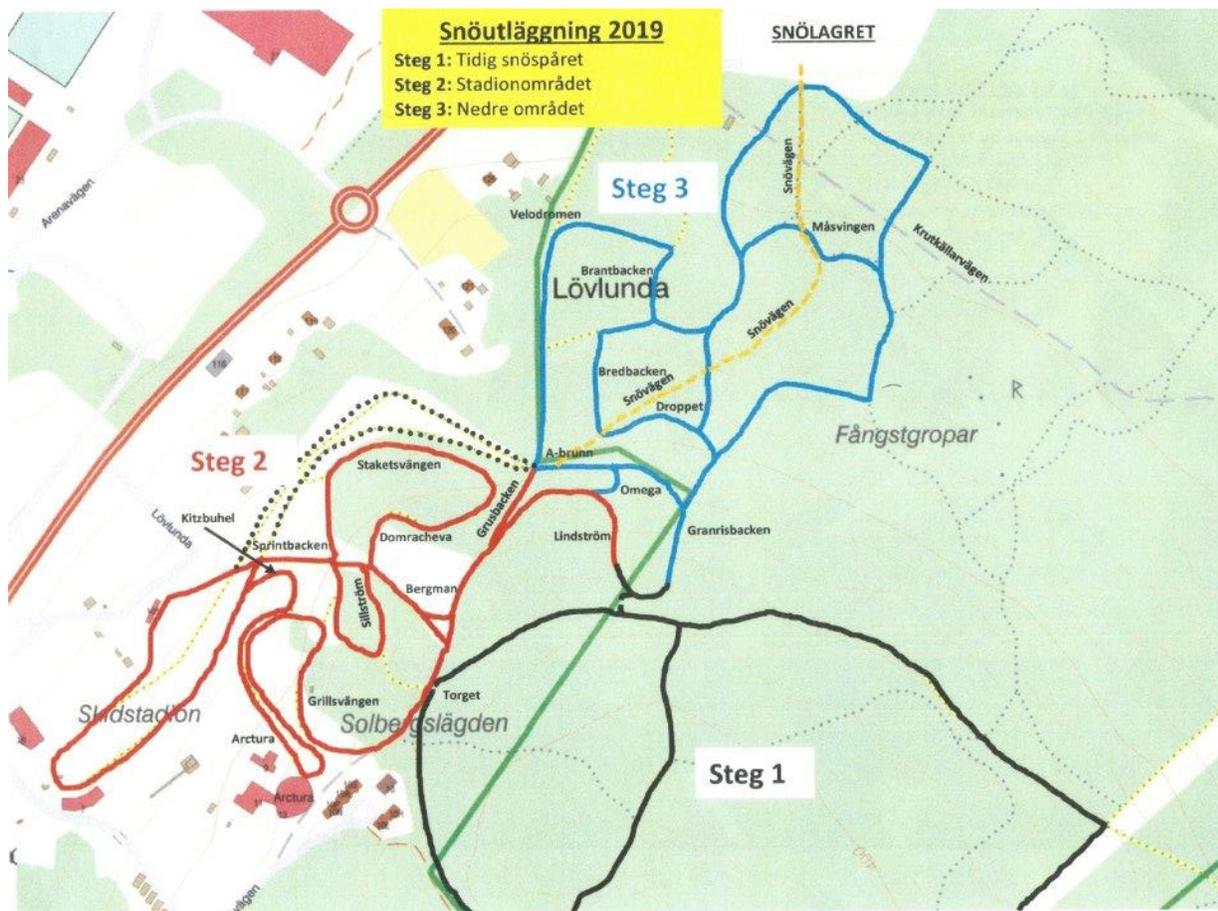
**Solutions:** Optimising storage placement to ensure a reduction in the transport distance from the storage to course; consider using more than one storage to reduce transportation distance.

**Design of an optimal ski area -**  
Imaginary skia area to minimize snow transport distance in a ski area



SOURCE: Auganæs, SB., Melin Söderström, E. (2020). Veileder for snølagring (PDF)

# Snow distribution plan



## Östersund

- 60 000 m<sup>3</sup> snow transport
- Optimize snow distribution and shorten time for snow distribution.
- Dividing into large section which section to start with.
- Divide into smaller section and decide starting points.

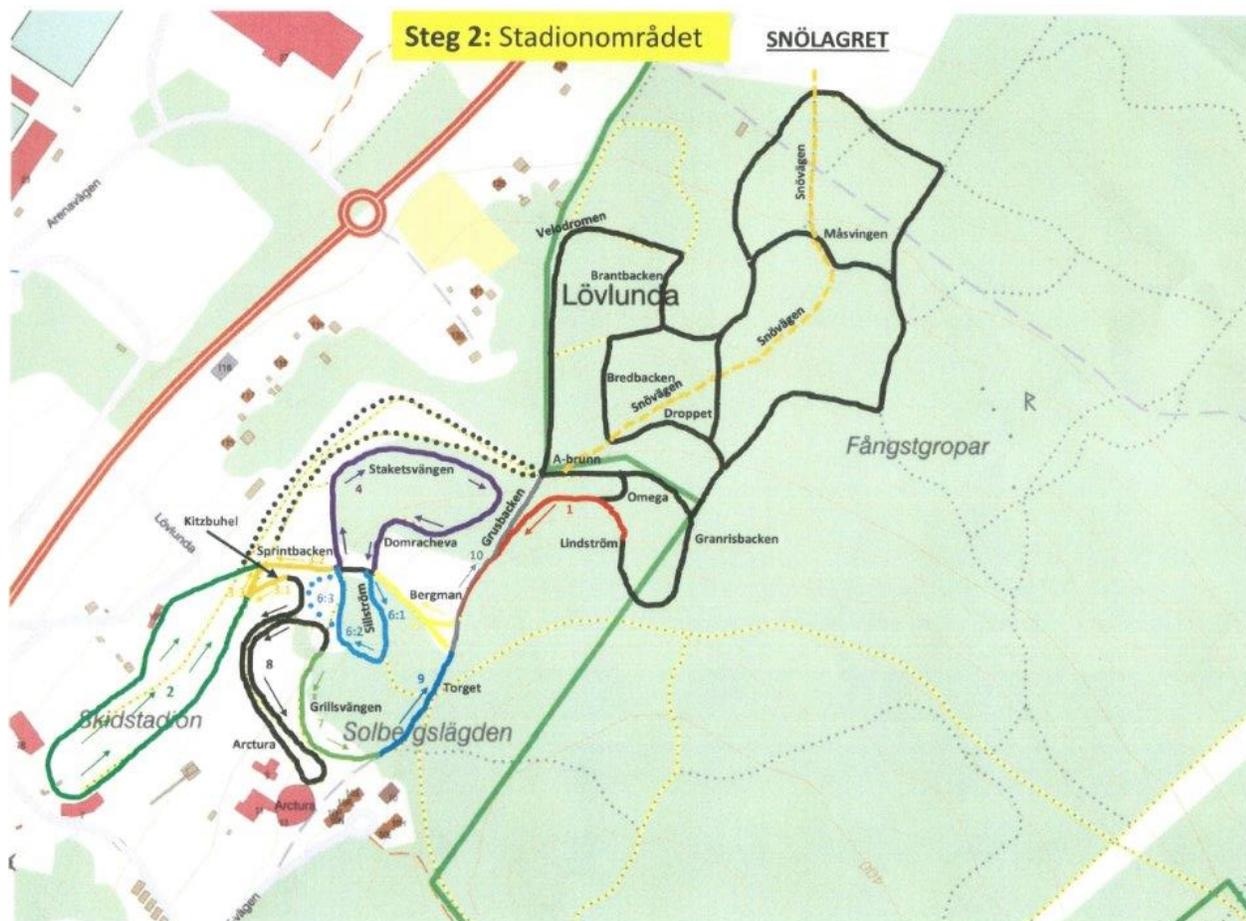
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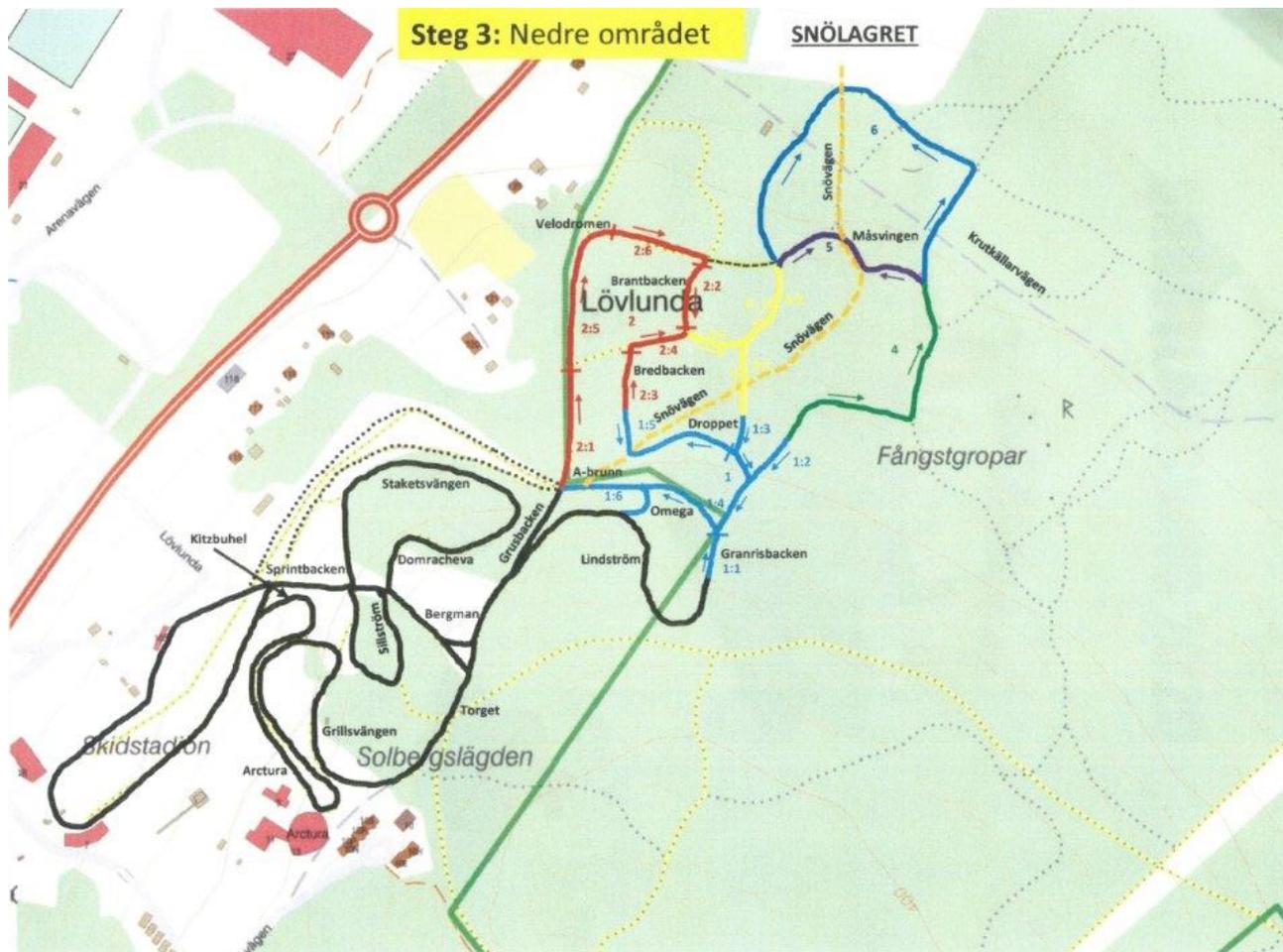
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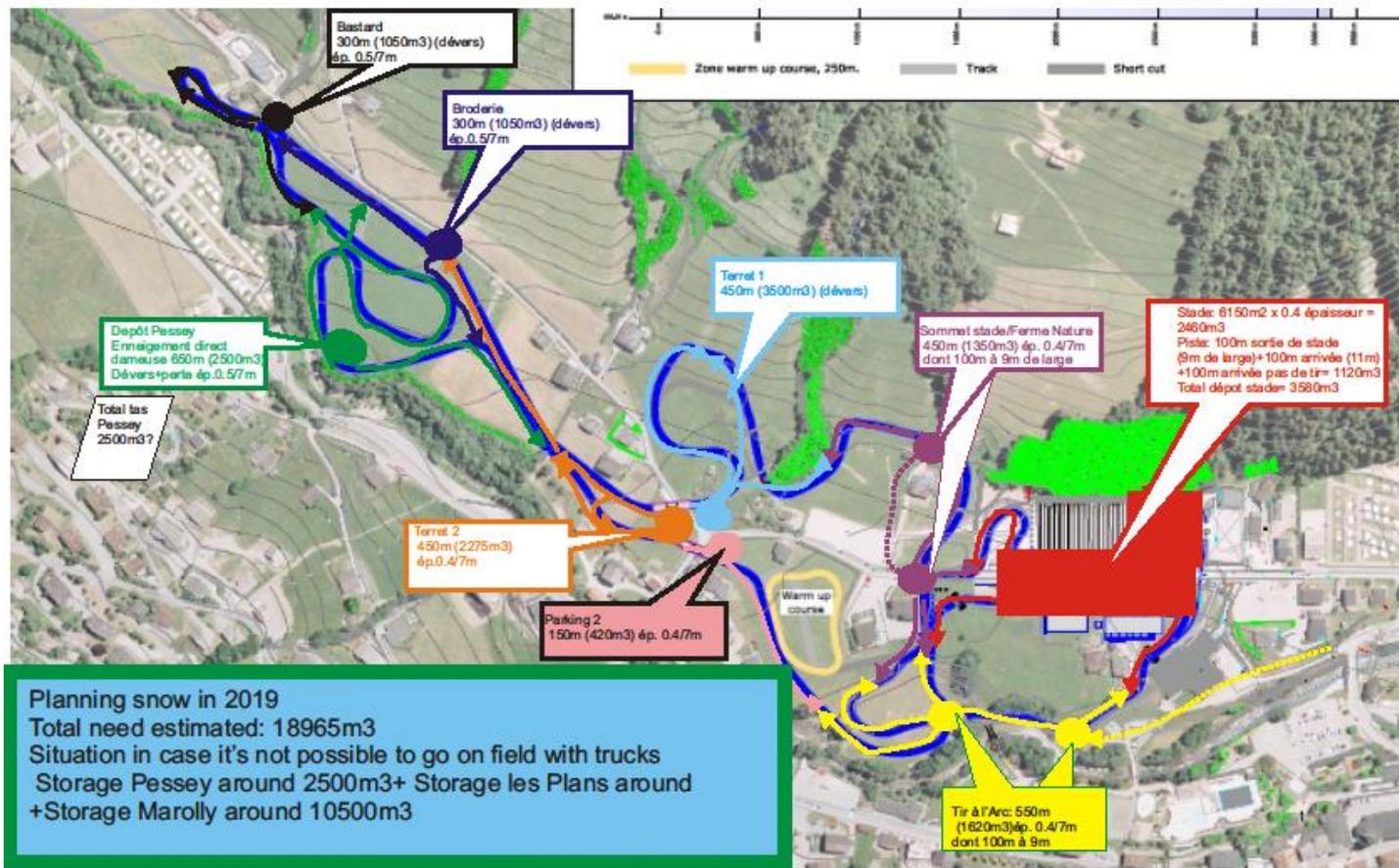
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# Anney Le Grand-Bornand



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**Trucks deposit point lower section**



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**Trucks deposit point higher section**



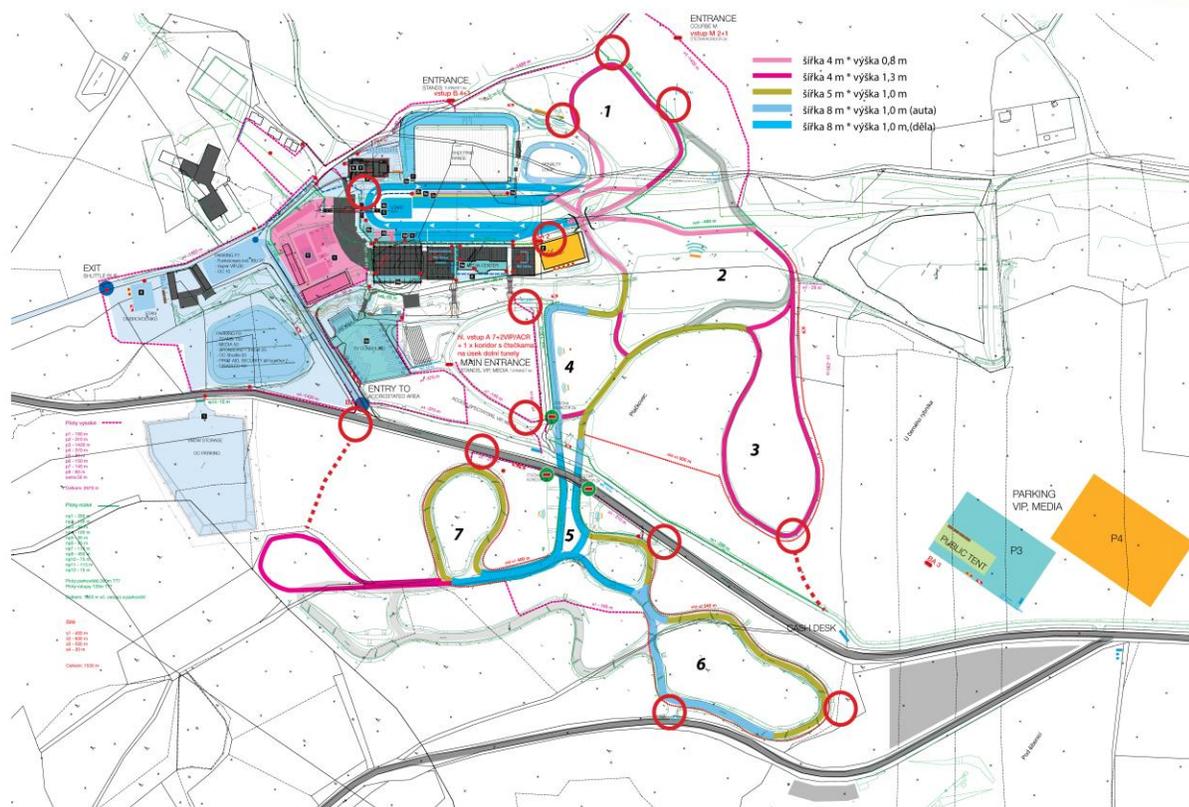
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# Nove Mesto Na Morave

## PROXIMITY TO COURSES



NOVÉ MĚSTO NA MORAVĚ CZECH REPUBLIC - SNOW STORAGE PRESENTATION

5



# Using tractors with trailers or small agricultural vehicles

**Challenge:** To minimize cost or possible to transport snow on soft ground

**Solution:** Using tractors with trailers, dumpers or wheel loaders to reduce costs if these vehicles are available at the ski area. These types of vehicles have less weight per surface area making them suitable for driving on soft ground where heavy machines sink.



# Tarpet snow slide

**Place:** Kontiolahti, Finland

**Challenge:** To ensure efficient and safe transport of snow.

**Solution:** Sliding snow on steep hills using a tarp. Tip the snow onto a tarp then slide the snow down to the bottom, and then upwards.

**Tips:** Remove the tarp little by little during the process; slide the snow on the tarp during wet snow/rain conditions. Benefits are faster and safer (risk of sliding trucks) snow transport.



# Excavator use for compressing snow

**Challenge:** Stored snow usually consists of chunks of snow and requires removal of air pockets in the snow to ensure course becomes even and strong.

**Solution:** Using an excavator to drive over the snow once distributed from snow storage rather than a snow groomer. An excavator has more weight distributed on less area compared to a groomer and will therefore compact the snow better.



# Snow transport in pipe



- 15 m<sup>3</sup> snow/hour (20kw)
- Possible upgrade to about 40 m<sup>3</sup>/h with larger pipes

# CONTACT US

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