

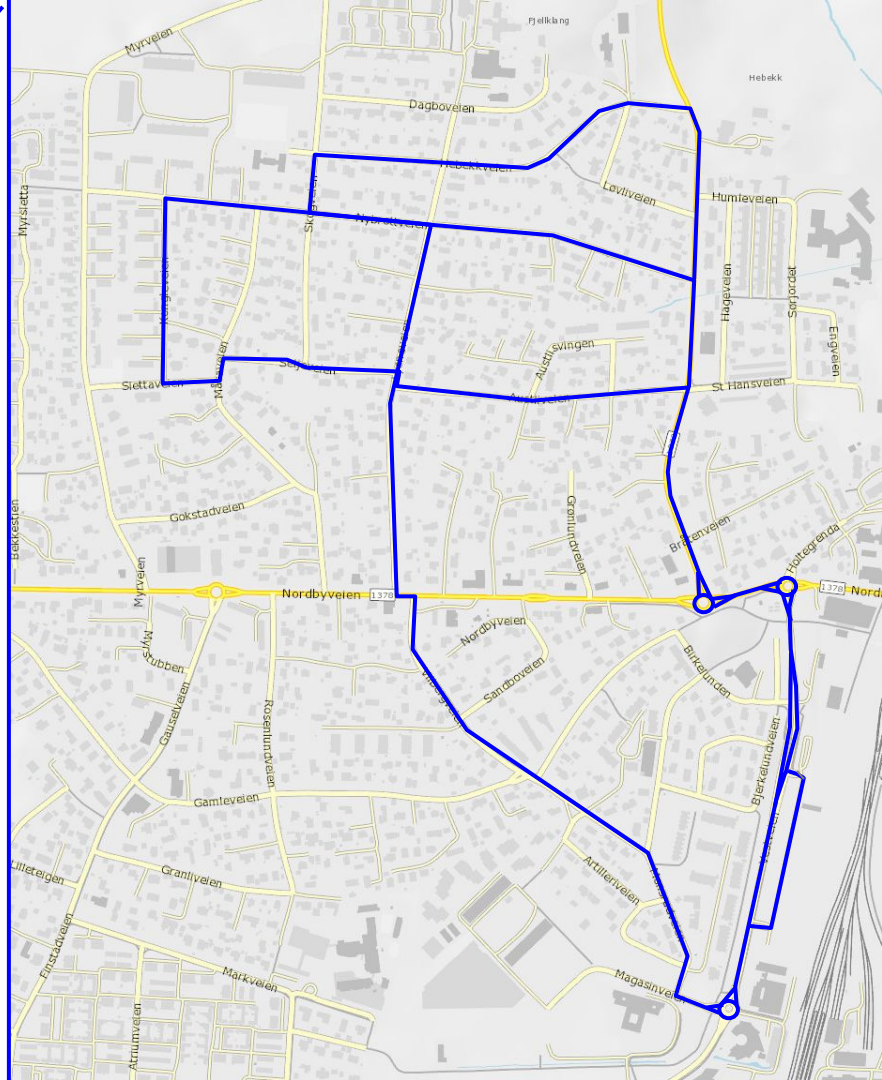
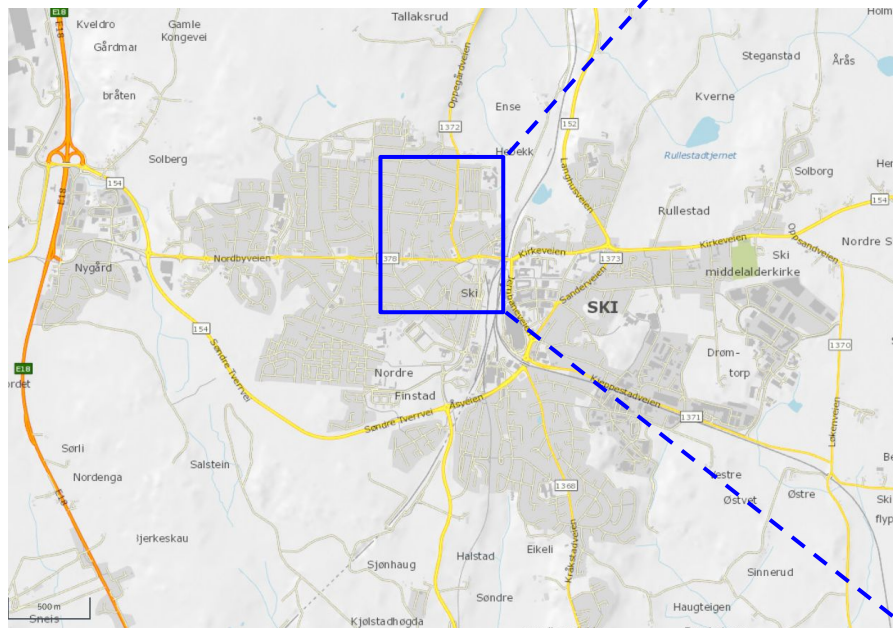
# NEW METHOD FOR RISK ANALYSIS



## Initial Ski test area

Initial test area is focused on the neighbourhood of Hebekk.

Route already active with Sensible 4 / Toyota vehicles



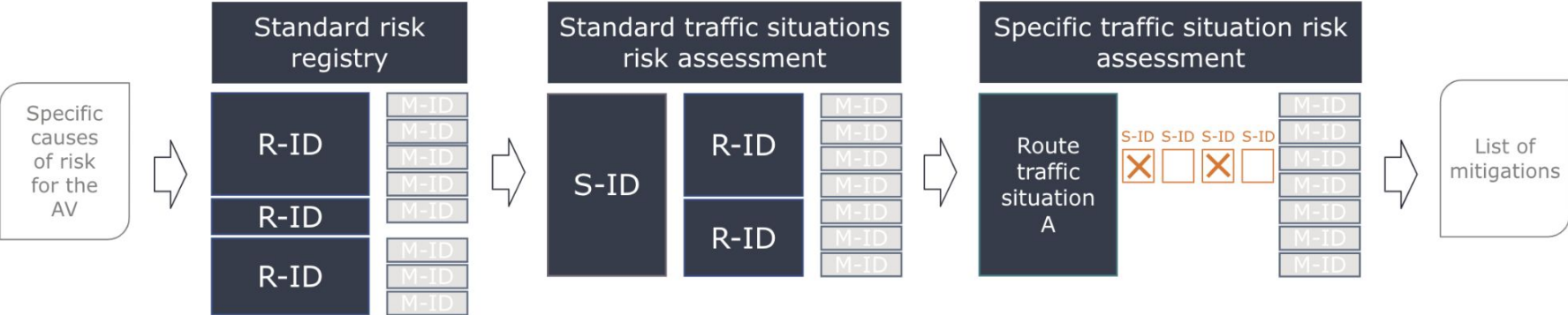
## Test area 2.0?

As soon as technology makes it possible, the area should be expanded to cover all of Ski.

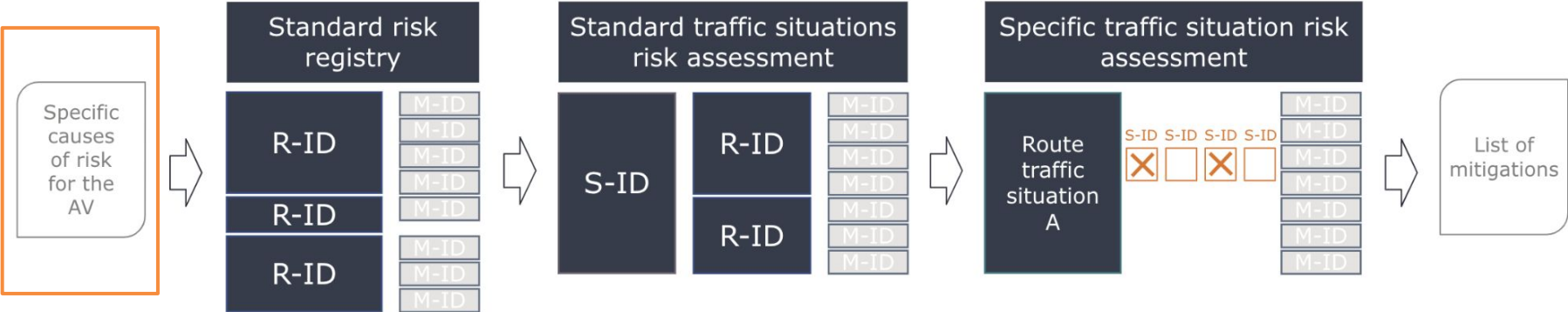
How can we scale up risk assessment?



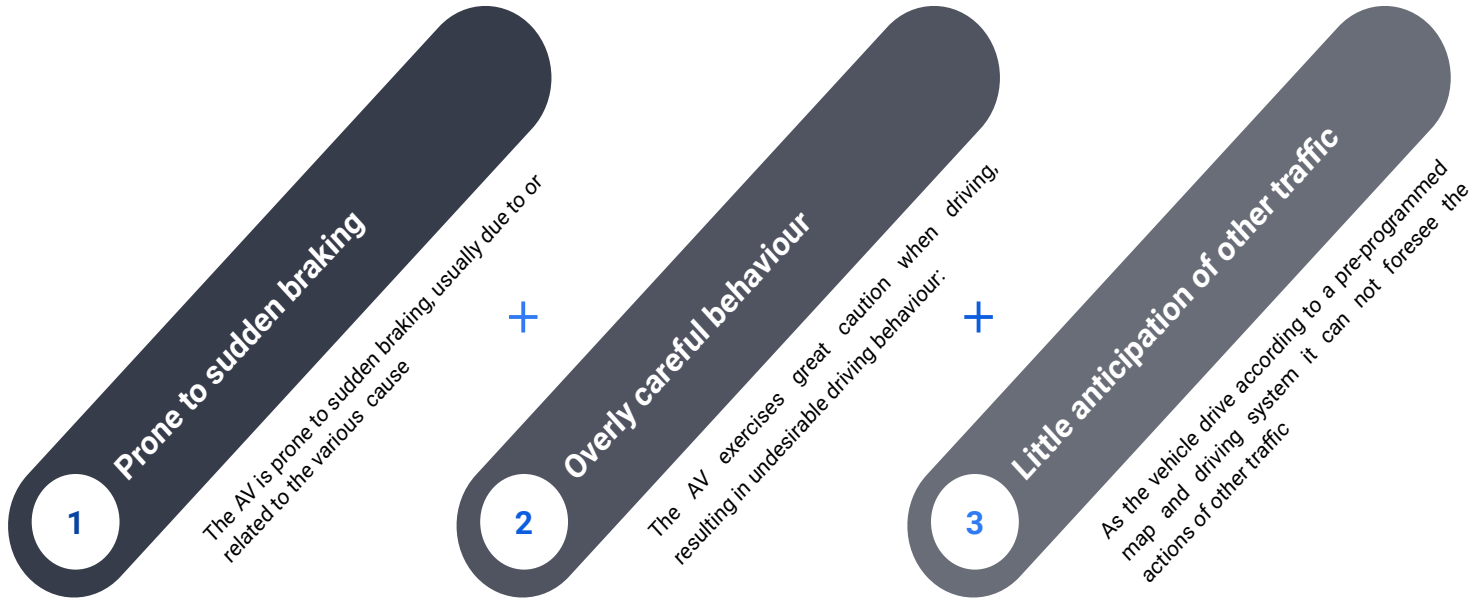
# Methodology for risk assessment



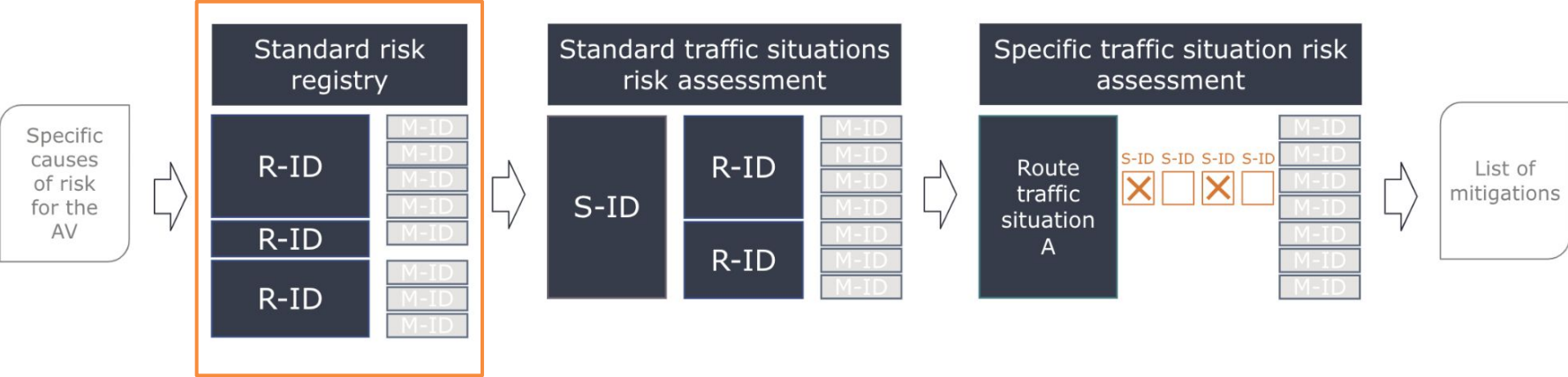
# Methodology for risk assessment



# Specific causes of risk for the AV



# Methodology for risk assessment



# Standard Risk Registry

Standard risks are derived from the specific causes of risk

Risk (R-ID)			Causes			Unwanted scenarios			Standard traffic scenario (S-ID)											
Title	Description	Risk score	Causes	Cause mitigations		Consequences	Consequence mitigations		1	2	3	4	5	6	7	8	9	10		
Sudden breaking on road	Sudden detection of objects causes the bus to break. [...]	3B	Ghost detection	M-ID 1	Adding signs in the area informing other road users of the AVs operating.	Back-end collisions due to sudden breaking	M-ID 1	Adding signs in the area informing other road users of the AVs operating.												
			Sudden loss of localisation	M-ID 2	Signs on the back of AV urging other road users not to overtake the AV	Dangerous overtakings due to impatience	M-ID 3	Sign in the back end of the autonomous vehicle to warn vehicles of sudden stops												
			[...]	[...]	[...]	[...]	[...]	[...]	[...]	x			x				x		x	



# Standard Risk Registry

Causes of risks are derived as well as potential mitigations

Risk (R-ID)			Causes			Unwanted scenarios			Standard traffic scenario (S-ID)											
Title	Description	Risk score	Causes	Cause mitigations		Consequences	Consequence mitigations		1	2	3	4	5	6	7	8	9	10		
Sudden breaking on road	Sudden detection of objects causes the bus to break. [...]	3B	Ghost detection	M-ID 1	Adding signs in the area informing other road users of the AVs operating.	Back-end collisions due to sudden breaking	M-ID 1	Adding signs in the area informing other road users of the AVs operating.												
			Sudden loss of localisation	M-ID 2	Signs on the back of AV urging other road users not to overtake the AV	Dangerous overtakings due to impatience	M-ID 3	Sign in the back end of the autonomous vehicle to warn vehicles of sudden stops												
			[...]	[...]	[...]	[...]	[...]	[...]	[...]	x			x				x		x	

# Standard Risk Registry

As well as risk related consequences and associated mitigations

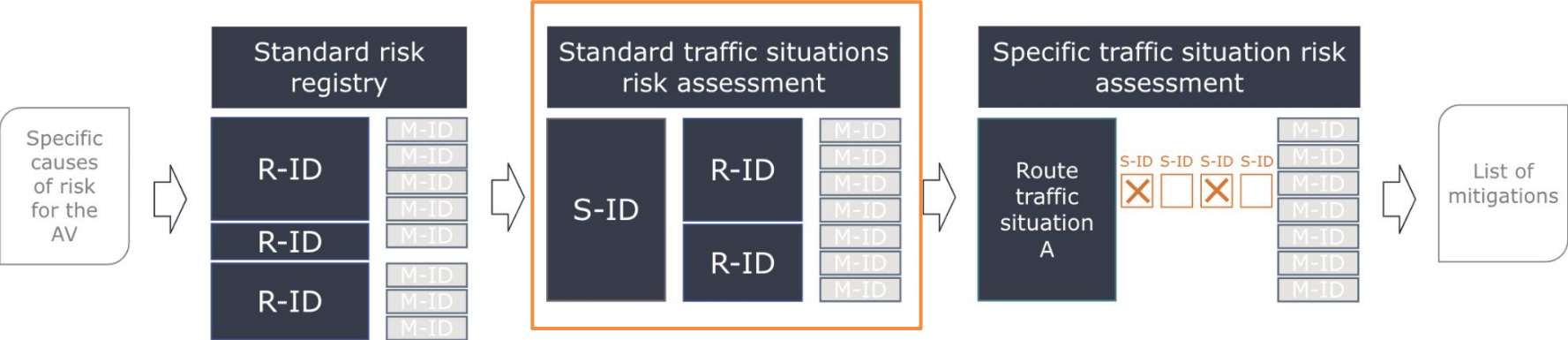
Risk (R-ID)			Causes			Unwanted scenarios			Standard traffic scenario (S-ID)											
Title	Description	Risk score	Causes	Cause mitigations		Consequences	Consequence mitigations		1	2	3	4	5	6	7	8	9	10		
Sudden breaking on road	Sudden detection of objects causes the bus to break. [...]	3B	Ghost detection	M-ID 1	Adding signs in the area informing other road users of the AVs operating.	Back-end collisions due to sudden breaking	M-ID 1	Adding signs in the area informing other road users of the AVs operating.												
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			[...]	[...]	[...]	[...]	[...]	[...]	[...]	x			x				x		x	

# Standard Risk Registry

For each standard risk it is identified which standard traffic situations it might be relevant for.

Risk (R-ID)			Causes			Unwanted scenarios			Standard traffic scenario (S-ID)											
Title	Description	Risk score	Causes	Cause mitigations		Consequences	Consequence mitigations		1	2	3	4	5	6	7	8	9	10		
Sudden breaking on road	Sudden detection of objects causes the bus to break. [...]	3B	Ghost detection	M-ID 1	Adding signs in the area informing other road users of the AVs operating.	Back-end collisions due to sudden breaking	M-ID 1	Adding signs in the area informing other road users of the AVs operating.												
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			[...]	[...]	[...]	[...]	[...]	[...]	[...]	X			X			X		X		

# Methodology for risk assessment



# Standard traffic situations risk assessment

Transposing the risk registry to obtain risks per standard scenarios

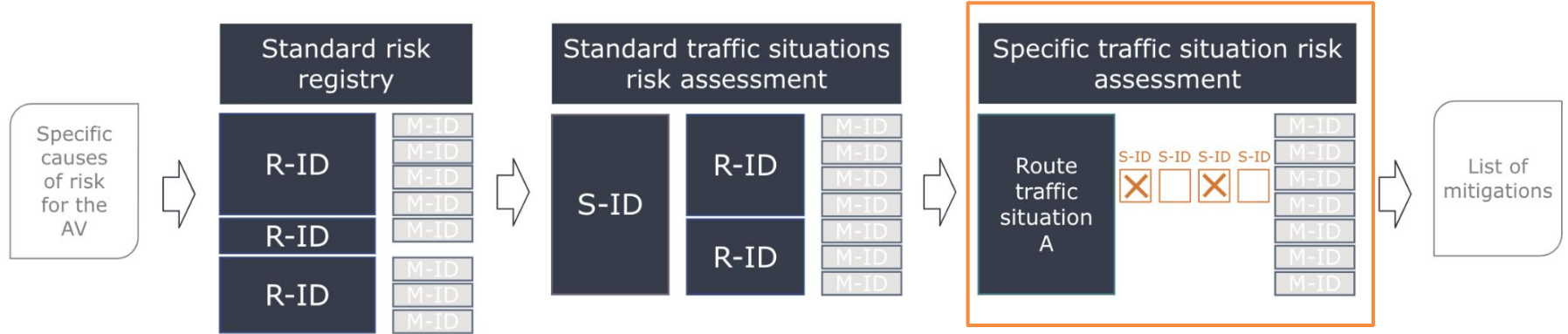
Standard scenario ID (S-ID)	Standard situation	Risk ID (R-ID)	Risk description	Risk Matrix score	Mitigation ID (M-ID)	Risk Mitigations
S-ID 1	Straight through intersection	R-ID 1	Sudden breaking on road	3B	M-ID 1	Adding signs in the area informing other road users of the AVs operating.
					M-ID 2	Signs on the back of AV urging other road users not to overtake the AV
					M-ID 3	Sign in the back end of the autonomous vehicle to warn vehicles of sudden stops
					M-ID 5	Trim vegetation limiting blind spots
					M-ID 8	Establish yield for crossing vehicles
					M-ID 9	Establish unconditional yield in intersection
					M-ID 10	Adding line markings prohibiting overtakings
		R-ID 4	Slow to start after POI or trajectory is clear	2C	M-ID 1	Adding signs in the area informing other road users of the AVs operating.
		M-ID 2	Signs on the back of AV urging other road users not to overtake the AV			
		M-ID 3	Sign in the back end of the autonomous vehicle to warn vehicles of sudden stops			

# Standard traffic situations risk assessment

Transposing the risk registry to obtain risks per standard scenarios

Standard scenario ID (S-ID)	Standard situation	Risk ID (R-ID)	Risk description	Risk Matrix score	Mitigation ID (M-ID)	Risk Mitigations
S-ID 1	Straight through intersection	R-ID 1	Sudden breaking on road	3B	M-ID 1	Adding signs in the area informing other road users of the AVs operating.
					M-ID 2	Signs on the back of AV urging other road users not to overtake the AV
					M-ID 3	Sign in the back end of the autonomous vehicle to warn vehicles of sudden stops
					M-ID 5	Trim vegetation limiting blind spots
					M-ID 8	Establish yield for crossing vehicles
					M-ID 9	Establish unconditional yield in intersection
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					M-ID 2	Signs on the back of AV urging other road users not to overtake the AV
					M-ID 3	Sign in the back end of the autonomous vehicle to warn vehicles of sudden stops

# Methodology for risk assessment



## Specific traffic situations risk assessment

Categorising all traffic situations on the route by predefined standards.

Automatically generating list of associated possible mitigations.

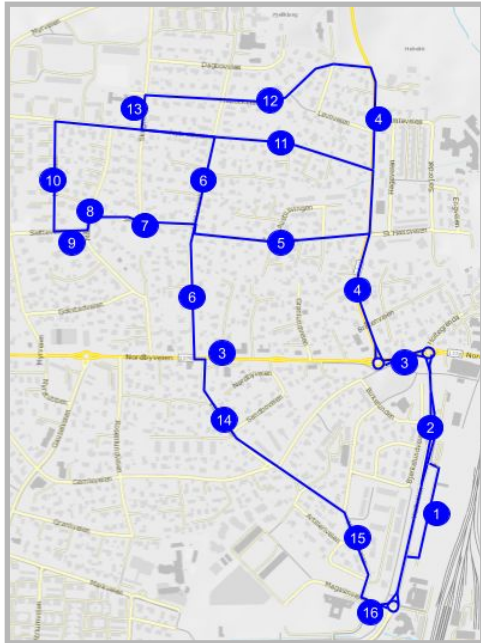
Risk score is re-assessed after activation of potential mitigations.

Specific traffic situation	Type of standard situation	S-ID	S-ID	S-ID	S-ID	S-ID	S-ID	Risk score before mitigations	Mitigation list		Active/ inactive	Risk score after mitigations
		1	2	3	4	5	6					
Roundabout at Norbyveien and Vestveien	Roundabout							3B	M-ID 1	Adding signs in the area informing other road users of the AVs operating.	x	2B
					X				M-ID 2	Signs on the back of AV urging other road users not to overtake the AV	x	
									[...]	[...]		

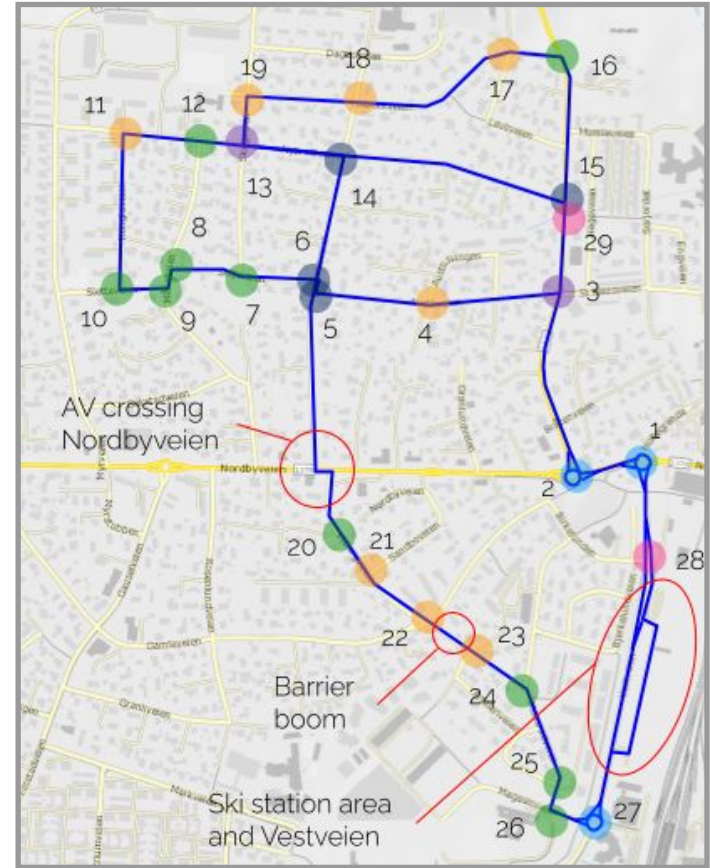


# Specific traffic situations risk assessment

Specific situations can be POIs or road sections

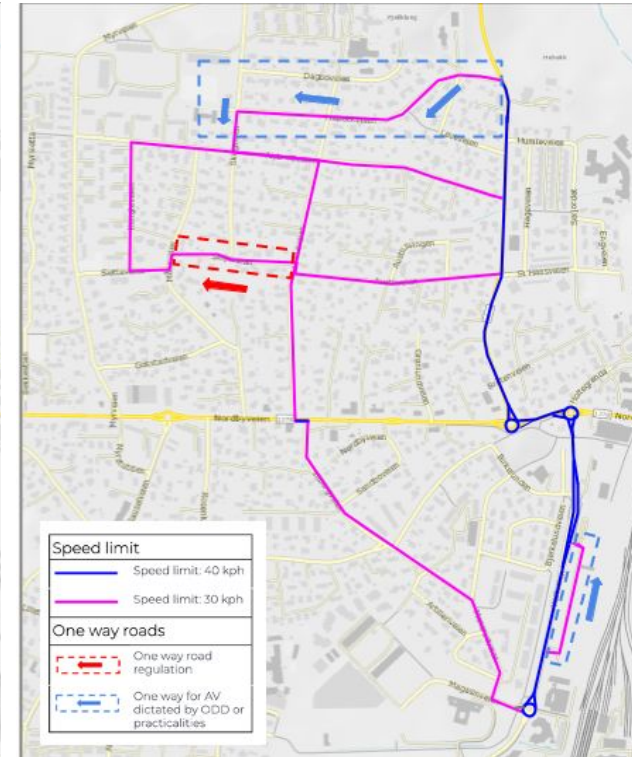
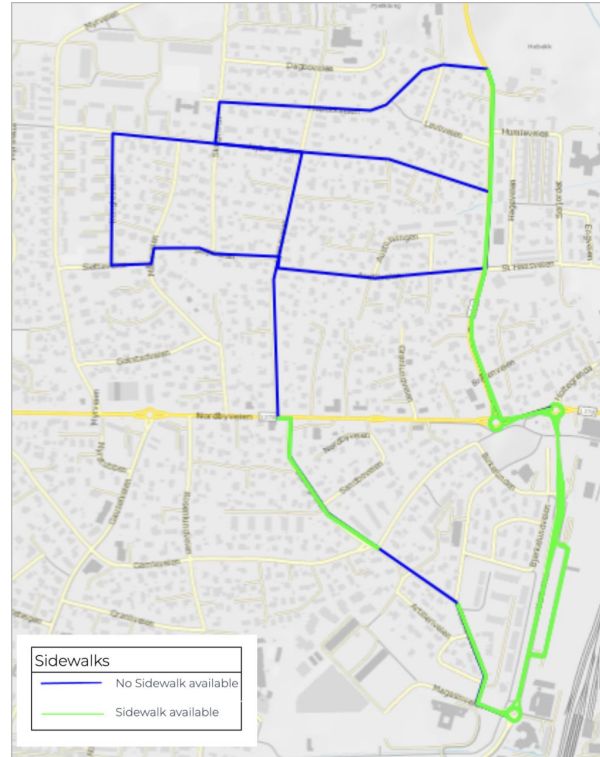
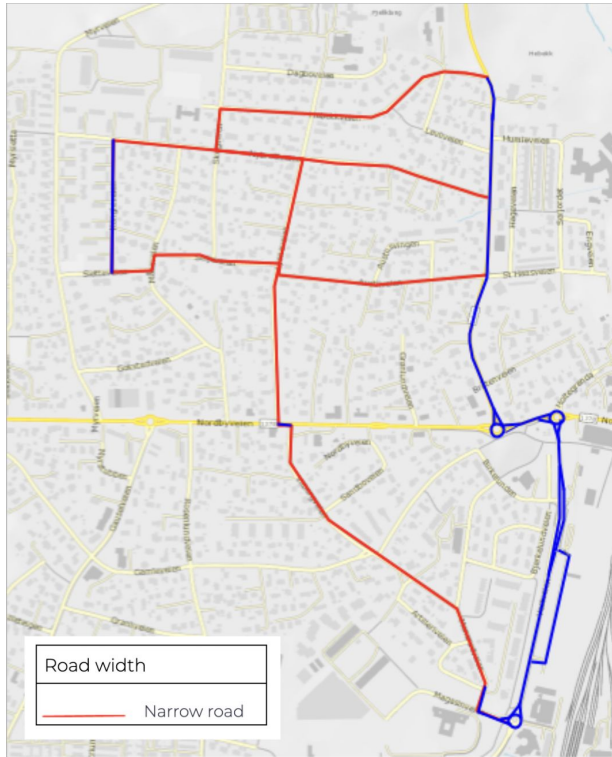


Points of Interest	
<b>Neutral points of interest</b>	
	T-intersection with 1 course of action
	T-intersection with several courses of action
	4-legged intersection with one course of action
	4-legged intersection with several courses of action
	Roundabout
	Stand alone pedestrian crossings
<b>Extra awareness points of Interest</b>	
	Point of interest with special circumstances that require special risk analysis



# Specific traffic situations risk assessment

Som identified by data extracted from vegkart.no

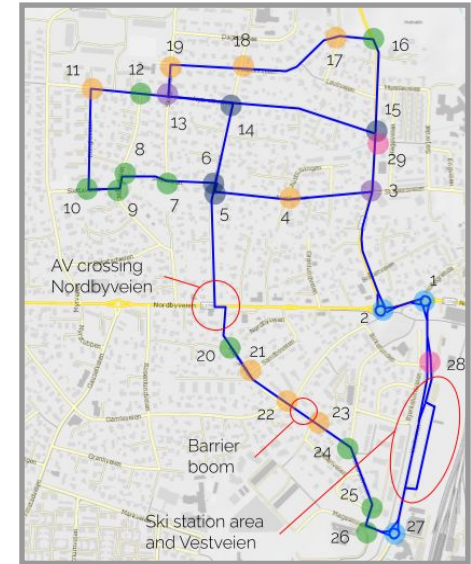


# Specific traffic situations risk assessment

Combining all specific traffic situations, their related risks and mitigations, a list of all unique mitigations is compiled.

Traffic situations:POIs			Standard POI scenario									
ID	Description	Type of standard situation	S-ID 1 Straight through intersection	S-ID 2 Right turn in intersection	S-ID 3 Left turn in intersection	S-ID 4 Roundabout	S-ID 5 Pedestrian crossing	S-ID 6 Reduced visibility	Risk score before mitigations	Mitigation list	Active/ inactive	Risk score after mitigations
1	Roundabout at Norbyveien and Vestveien	Roundabout				x			3B	M-ID 1 Adding signs in the area informing other road users of the AVs operating. M-ID 2 Sign indicating vehicle is self driving M-ID 3 Sign in the back end of the autonomous vehicle to warn vehicles of sudden stops M-ID 4 Sign on the back of AV indicating its road speed M-ID 5 Trim vegetation limiting blind spots M-ID 6 Raised pedestrian crossing M-ID 8 Establish yield for crossing vehicles M-ID 9 Establish unconditional yield in intersection M-ID 10 Adding line markings prohibiting overtakings M-ID 13 Reduced speed on the road the shuttle comes from.	Active Active Not active Active Not active Active before project N/A Active before project Not active Active	2B

Points of Interest
<b>Neutral points of interest</b>
● T-Intersection with 1 course of action
● T-Intersection with several courses of action
● 4-legged intersection with one course of action
● 4-legged intersection with several courses action
● Roundabout
● Stand alone pedestrian crossings
<b>Extra awareness points of interest</b>
○ Point of interest with special circumstances that require special risk analysis



# Methodology for risk assessment

