Trunk Road Vt 12, Southern Ring Road of Lahti, Project Part 1B

Project plan for the development phase and Value for Money report 29 May 2018

Specification sheet

VALTARI is an alliance and a joint organisation set up by the Finnish Transport Agency, City of Lahti, Municipality of Hollola, Skanska Infra Oy and Pöyry Finland Oy to plan and execute Project Part 1B of the Vt 12, Southern Ring Road of Lahti Overall Project. The parties above will collaborate closely in the alliance contract, sharing the risks and benefits and following open book principles.

The **Overall Project** Vt 12, Southern Ring Road of Lahti, consists of two Project Parts. Project Part 1, Vt 12, Southern Ring Road of Lahti, comprises the construction of Trunk Road Vt 12 between Soramäki–Kujala/Joutjärvi Trunk Road Vt 4 (Project Parts 1A and 1B) as well as the improvement of highway 167, the southern radial road to Lahti, between Renkomäki–Laune (Project Part 2).

Project Part 1B is the contract for the eastern end of the Southern Ring Road of Lahti, starting from the western side of the Nikula interchange and ending at the Joutjärvi interchange, which is at the border of the project area.

The alliance's accounting will be based on the **open book method**. Accordingly, all financial information and payment traffic associated with the execution of the alliance will be transparent for all members of the alliance.

The **owner partner** in the alliance is the financier of Project Part 1B and the representative of the end users. In this case, there are three owner partners: The Finnish Transport Agency, City of Lahti and Municipality of Hollola. Pursuant to the implementation agreement, the Finnish Transport Agency represents all owner partners.

The alliance's **service provider** is the company that provides services and contracts within the alliance. In this case, the service-providing parties are Skanska Infra Oy and Pöyry Finland Oy.

The **Project Supervisor** is the alliance party that has been appointed as the Project Supervisor in the alliance contract and that is responsible for managing the worksite and acting in compliance with the statutory duties of a Project Supervisor. The Project Supervisor in VALTARI is Skanska Infra Oy.

The **Alliance Steering Committee (ASC)** is the supreme decision-making body responsible for the management of the alliance. The ASC includes representatives of each party to the alliance.

The **Alliance Project Group (APG)** is responsible for the operative management of Project Part 1B.

There are a total of six **technology groups** in the alliance organisation. They are Routes, Bridges and Retaining Walls, Tunnel, Technical Systems, Geotechnology and Landscape. The organisation also includes other expert groups that are not associated with a specific technology. Examples of these are the Environment, Communications and Risk Management group.

The **Project Plan** is the execution plan of the alliance contract. Among other things, it includes the organisation of the alliance, the target outcome cost, overall schedule, key objectives and related indicators, and a description of the management system.

The **Value for Money** concept describes the benefits obtained in relation to the costs and risks. In alliance projects, the Value for Money Report describes the value generated by the alliance in relation to the inputs invested in the project. In this report, the Value for Money Report of the procurement and development phase is presented in Chapter 6.

Key objectives are part of the incentives scheme of the alliance. They are agreed upon between the parties to the alliance and steer the alliance organisation towards high performance and the desired outcome.

The **bonus and sanctions scheme** is the incentives scheme used in the alliance, under which the parties either earn bonuses or are subjected to sanctions, based on the score of the key objectives.

The **development phase** is the planning phase of the alliance contract, during which the technical and financial goals of the alliance contract are specified and an execution

plan is created for the project (known as the Project Plan). The **implementation phase** is the actual construction phase of the contract. It is performed as specified in the Project Plan.

Ex-post accountability is included in the implementation phase and lasts for two to six years, depending on the part in question. The ex-post accountability period starts when a work object is completed and received by the owner.

The **division into blocks** is both geographical and technical. The construction of Project Part 1B is divided into five blocks: A) Nikula interchange area, B) Concrete tunnel at Patomäki, C) Laune interchange area, D) Rock and concrete tunnel at Liipola, as well as E) Kujala interchange area.

Civil engineering assessment is a method for assessing the safety of a civil engineering worksite.

Frequency of accidents is calculated by dividing the number of occupational accidents in a given period by the number of working hours performed. The figure indicates the number of occupational accidents that have led to an absence per one million working hours.

Target outcome cost is the binding budget for the implementation phase set by the alliance during the development phase.

Safety coordinator is the person appointed by the constructor pursuant to the Government Decree on the Safety of Construction Work, who is responsible for the occupational safety obligations of the constructor.

Management system of the Alliance describes the management, working culture, operating methods and procedures of the Alliance in the execution of the project.

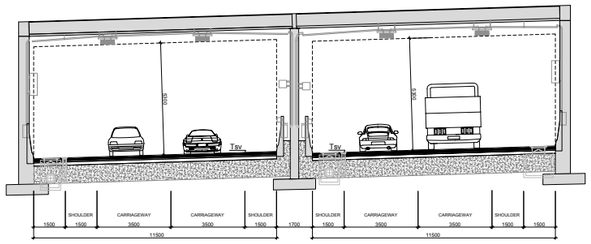
Summary

Project

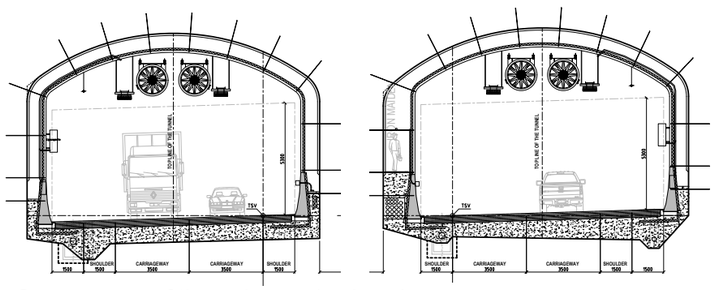
Project Part 1B of the Trunk Road Vt 12, Southern Ring Road of Lahti, consists of the construction of 4.5 kilometres of trunk road from the western side of the Nikula interchange to Trunk Road 4. The new alignment will bypass the centre of the City of Lahti from the southern side.

Tunnels to be constructed

Two motorway tunnels will be constructed for the stretch of the Project Part. Both tunnels will have a separate tunnel tube for each driving direction, a 80 km/h speed limit, a ban on overtaking heavy traffic, and a ban on pedestrian access and cycling. The concrete tunnel at Patomäki will be approximately 400 metres long and the combined rock and concrete tunnel at Liipola approximately 1,000 metres long. If an accident occurs, the emergency exit doors and corridors between the vehicle tunnels will serve as exit routes that lead into the other, clean and safe tunnel tube.



Cross-section of the concrete tunnel at Patomäki



Cross-section of the rock tunnel at Liipola

Objectives

Project Part 1B is a part of the larger Overall Project of Vt 12, Southern Ring Road of Lahti. The objectives of the Overall Project are:

- A clear and functional traffic system that directs both regional urban traffic and long-distance traffic smoothly and safely to the correct routes.
- Improvement in the predictability of logistics, including cost savings.
- Functional and efficient access to the industrial and logistics areas of Kujala and Lotila.
- Promoting the development of the Nostava logistics area.
- Promoting the development of the areas around the Lahti railway station, as well as in Asko, Sopenkorpi and centre of Hollola.
- Improving residential comfort in the areas surrounding the current Trunk Road Vt 12 in central areas, as pass-through traffic is eliminated and traffic noise, emissions and congestion are reduced.
- Reduction of the risk of groundwater contamination in Laune and Salpakangas, which are important water supply areas.

The key objectives for the performance of the alliance are derived from the general objectives of the overall project and are presented in the description of the incentives scheme.

Organisation

The VALTARI alliance, formed jointly by the owner partners and service providers, is responsible for the execution of Project Part 1B (development, execution and ex-post accountability phases). The parties to the alliance are the Finnish Transport Agency, City of Lahti, Municipality of Hollola, Skanska Infra Oy and Pöyry Finland Oy. The organisation is presented in the chart on the next page and in more detail on page 9 of the Project Plan.

Target outcome cost

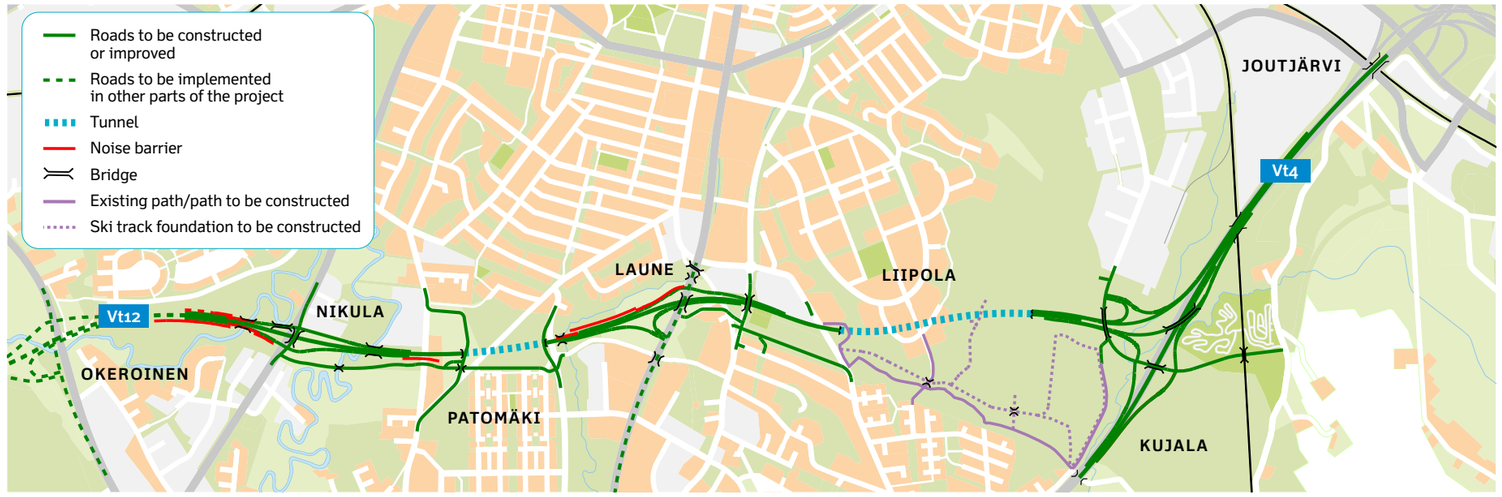
The target outcome cost was specified during the development phase, based on initial data and plans that gradually became more specific. The planning of the development phase is based on an approved final engineering plan pursuant to the Highways Act. A cost expert, external to the owner partner's organisation, participated in the target outcome cost process throughout the entire development phase. The final target outcome cost is EUR 172,358,650. The target outcome cost is fixed and not bound to any index.

Risks and opportunities

The alliance manages risks by systematically identifying risks and analysing the effects of their potential realisation. The investigations and planning conducted in the development phase have significantly reduced the risks involved in the implementation phase. Moreover, several ideas were generated in the development phase which were recorded in the risk register as opportunities. Some of the opportunities became part of the design solutions and thereby affected the target outcome cost. The target outcome cost includes a risk provision.

Ideas rejected or frozen during the development phase may be reconsidered during the implementation phase. During the implementation phase, the innovation potential of the alliance will increase thanks to the worksite organisation, so we will obtain more new ideas on work methods and techniques in addition to ideas on design solutions. The tight collaboration between owner partners, designers and constructors and the risk management process under the management system will also generate new opportunities throughout the implementation phase.

TECHNICAL SCOPE OF THE ALLIANCE CONTRACT



Vt 12, 2+2 lanes	4,5 km
Interchanges	3 pcs
Ramps	5,2 km
Vt 4, additional lanes for the stretch Kujala–Joutjärvi	2,5 km
Other roads	0,5 km

Streets	4,0 km
Pedestrian ways and cycle paths	2,7 km
Ground water protection at Laune	apx. 200 m
Concrete tunnel at Patomäki	0,4 km
Rock and concrete tunnel at Liipola	1,0 km
Noise barriers	1,7 km

New bridges	12 pcs
Widening and repair of the current bridges	2 pcs
Demolition of the current bridge	1 pcs
Hiking routes at Liipola	apx. 2,5 km

Incentives scheme

The incentives scheme of the alliance consists of the following parts:

- The bonus pool from which any bonuses are paid is 1.1 MEUR, which is approximately 0.65% of the target outcome cost, but the pool may grow if the costs are lower than the target outcome cost.
- Performance of the alliance associated with the key objectives (KO): The key objectives are measured during the entire duration of the project. If the performance of a service provider exceeds the key objectives, the bonus paid to the service provider will increase. Conversely, if the performance of a service provider fails to meet the key objectives, the sanctions the provider must pay to the owner partner will increase.
- Positive and negative incentives of lower significance than the key objectives.
- A major negative modifier that might, at worst, halve the bonus pool or empty it completely.
- A cost incentive associated with the target outcome cost, whose magnitude and distribution among the alliance parties depends on how well the target outcome cost is met.

The key objectives and their weights in the implementation phase of the alliance contract are:

1. Schedule and phasing, weight 49%
2. Safety, weight 41%
3. The level of problem-free operation of the road during the ex-post accountability period, weight 10%

VT 12 VALTARI – ORGANISATION FOR THE IMPLEMENTATION PHASE

ALLIANCE STEERING COMMITTEE (ASC)
- Convenes monthly
- Decisions associated with the technical or financial scope
  - Representation of the parties to the alliance
  - The core group has the right to speak

CORE GROUP
- Reporting of the project status and preparing the matters that need a decision from the ASC

ALLIANCE PROJECT GROUP (APG)
- Convenes weekly
- The people in charge participate according to the progress of the project
- Decisions on operative actions
- Representatives from all parties

CONSTRUCTION
- Route, bridge, geotechnology, concrete and rock tunnel, technical systems
  - Labour management and persons in charge of specific regions
  - Subcontractors
- The Production Steering Team convenes weekly

PLANNING AND DESIGN
- The Steering Team for Planning and Design convenes weekly

INTEGRATION OF PLANNING, DESIGN AND CONSTRUCTION
- Planning, design and construction in the technology groups is matched to the goals of the project
- The groups convene regularly
- Route, bridge, geotechnology, concrete and rock tunnel, technical systems and landscape group

SUPPORT FUNCTIONS
- The groups convene regularly
- Safety, finance, quality, communications, environment, risks, traffic control

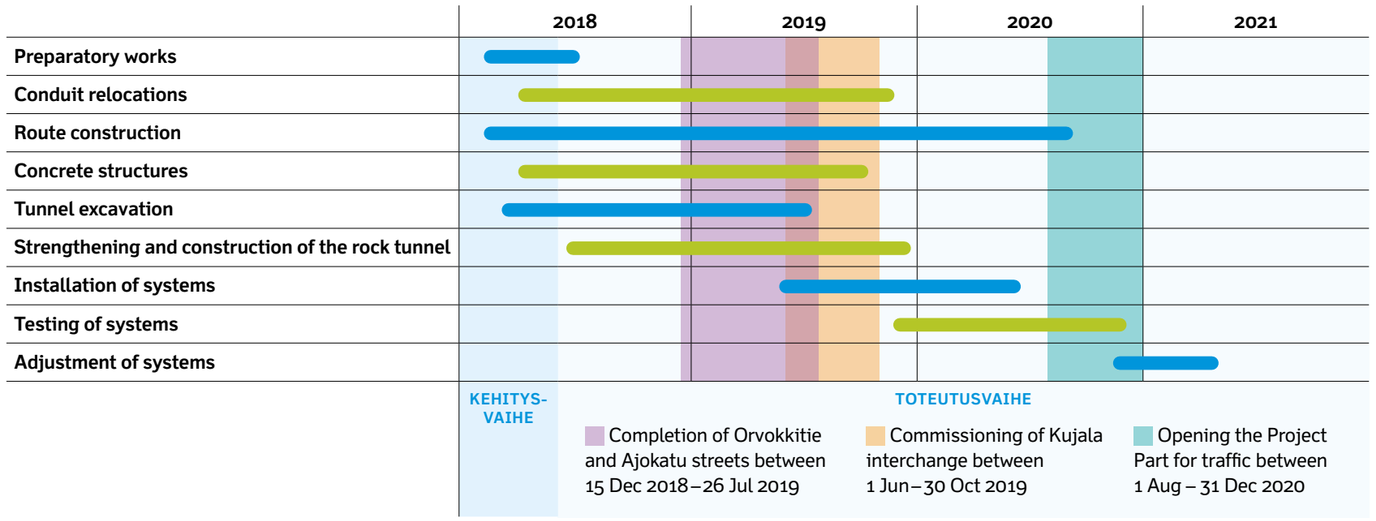
Planning project

The design of the structures belonging to the route engineering, geotechnical and bridge engineering plans was partly begun during the development phase. In all engineering disciplines, the technical solutions were specified and agreed upon in order to form the basis for the structural plan. During the implementation phase, the construction plans are supplemented with measurement data to facilitate construction. The design and construction utilise model-based planning, where implementation models are created from the design models.

Schedule

The implementation phase starts in June 2018 and lasts a total of three years and three months. The road will be opened to traffic almost a year before, i.e. in November 2020, and any remaining finishing work will be completed by September 2021.

OVERALL SCHEDULE OF VALTARI



DECISION-MAKING LEVELS

ASC	• Changes in scope • Procurements exceeding 10 MEUR • The most significant risks
Core group	• Urgent decisions • Participating ASC and APG members
APG	• Decisions that steer the project • Approving the procurement plan
Construction groups	• Decisions that steer planning, design and execution

Levels of decision-making and flow of information between the groups

Management system of the alliance

The management system includes a description of the operating methods and procedures of the alliance for executing Project Part 1B. The central themes include procurements, schedule and cost management, safety, quality and risk management, financing and invoicing practices, data and HR management and steering of planning, design and construction.

The foundation of the performance of the alliance is timely decision-making based on factual information, as well as a good flow of information. They ensure that the planning, design and construction proceeds efficiently and that mistakes and shortages are prevented in advance while avoiding loss. The authority levels in decision-making are described in the table below.

Table of Contents

1 Objectives of the project

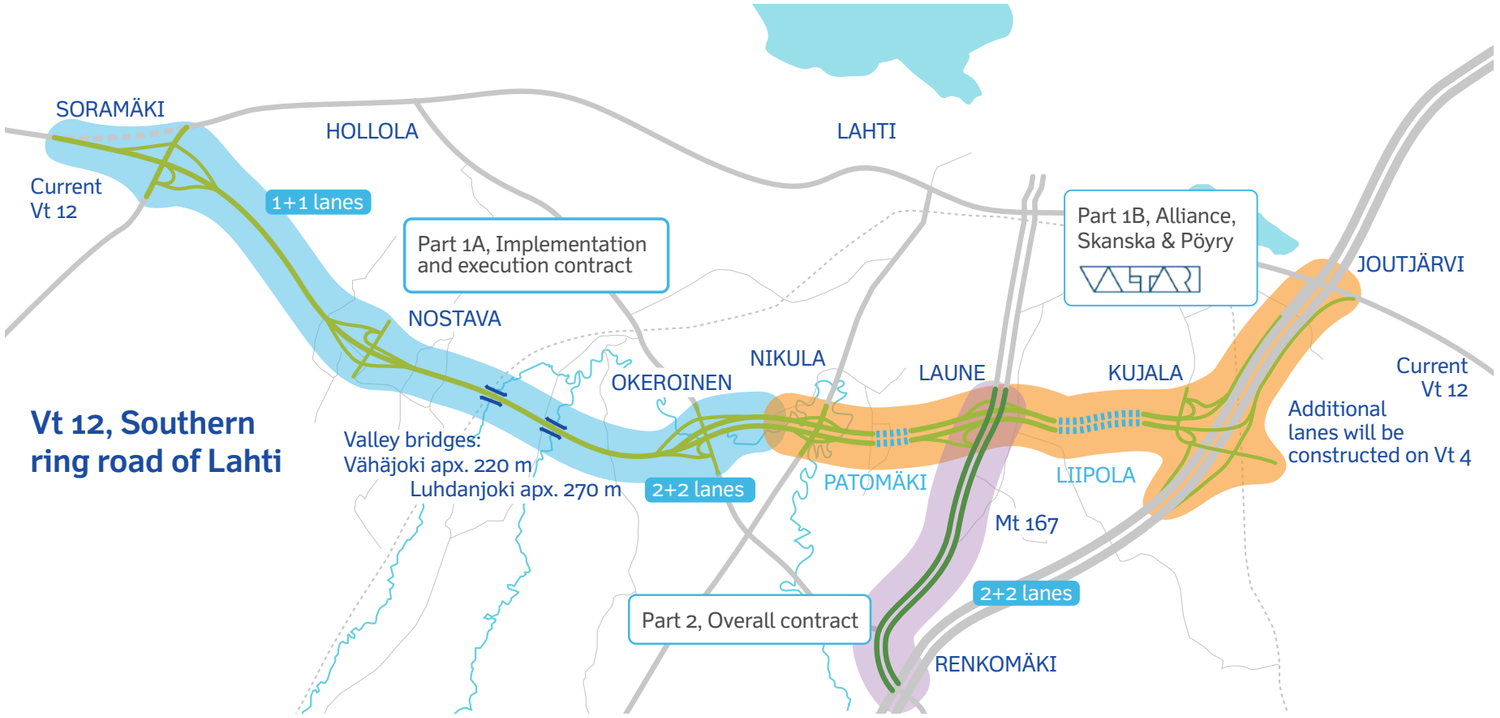
1.1 Introduction

Trunk Road Vt 12 will be built into a new terrain corridor as two separate contracts with a total length of approximately 13 kilometres. The road will be a one-carriageway semi-motorway on the Soramäki–Okeroinen stretch, and a two-carriageway, four-lane motorway between Okeroinen and Kujala. The road will divert from the existing semi-motorway on the western side of Soramäki and will run via the Okeroinen, Laune and Liipola areas to Kujala, where it will join Trunk Road 4.

Project Part 2 will be executed as a separate contract.

The contracts in the Overall Project are:

- Project Part 1A: at the Hollola end of the Southern Ring Road of Lahti, Trunk Road Vt 12 will be constructed as a two-lane semi-motorway in a new terrain corridor between Soramäki and Okeroinen. This Project Part will be executed as a plan-and-implement contract.
- Project Part 1B: the contract for the eastern end of the Southern Ring Road of Lahti, starting from the western side of the Nikula interchange and ending at the border of the project area at the Joutjärvi interchange. This Project Part is technically challenging as it involves the construction of several interchanges and two tunnels, among other things. This is an alliance contract.



- Project Part 2 consists of the improvement of highway 167, which is the southern radial road to Lahti. Uudenmaankatu road will be widened to have four lanes between Renkomäki and Laune. Some pedestrian underpasses and bridges in the area will also be refurbished. This is an all-in contract.

The alliance contract of Project Part 1B will implement the technical systems for the Overall Project.

Each contract has its own special characteristics, which have been taken into account in the detailed objectives. In the alliance contract, some objectives are defined as key objectives. The performance of the alliance parties in attaining these key objectives will deter-

mine the amount of bonus received by the parties via the bonus mechanism.

The performance of the alliance contract in meeting its objectives will be reviewed and monitored throughout the construction and ex-post accountability period. The reviews will be carried out regularly, which enables the planning and implementation of corrective actions if the review results indicate that the objectives of the contract will not be met, or if the performance of the alliance does not meet the requirements.

1.2 Common objectives of the Overall Project

At present, Trunk Road Vt 12 runs through the centre of Lahti and the densely constructed urban area of the Municipality of Hollola, and no alternative routes exist. This situation is poor in view of environmental health, residential comfort, development of land use, as well as traffic flow and safety. The objectives of the Overall Project are:

- A clear and functional traffic system that directs both regional urban traffic and long-distance traffic smoothly and safely to the correct routes.
- Improvement in the predictability of logistics, including cost savings.
- Functional and efficient access to the industrial and logistics areas of Kujala and Lotila.
- Promoting the development of the Nostava logistics area.
- Promoting the development of the areas around the Lahti railway station, as well as in Asko, Sopenkorpi and centre of Hollola.
- Improving residential comfort in the areas surrounding the current Trunk Road Vt 12 in centreal areas, as pass-through traffic is eliminated and traffic noise, emissions and congestion are reduced.
- Reduction of the risk of groundwater contamination in Laune and Salpakangas, which are important water supply areas.

The key objectives for the alliance are derived from the general objectives of the Overall Project and are presented in the description of the incentives scheme in Chapter 5.

A session at VALTARI's Big Room

2 Organisation for the implementation phase

The Alliance Steering Committee is the supreme decision-making body in the organisation. The chairperson of the Committee is a representative of the Finnish Transport Agency. The Steering Committee makes decisions on the technical scope, target outcome cost or agreements of the alliance contract. All parties to the alliance have a representative with decision-making power in the Steering Committee. In addition, a four-member core group and a representative from the Transport and Infrastructure Department of the Uusimaa Centre for Economic Development, Transport and the Environment will also participate in the work of the Steering Committee, but with right of discussion only. The Steering Committee convenes approximately once a month.

The Alliance Project Group is in charge of the operative management of the Project Part and prepares matters for introduction to the Steering Committee. The chairperson of the Group is the Project Manager of the alliance, who also presents the matters prepared by the Project Group to the Steering Committee. The Project Group consists of representatives of the owner partners and persons in charge of construction and planning. Experts from the construction, planning or support functions are invited to participate in the Project Group as necessary (Extended Project Group). The Project Group convenes weekly.

The steering of construction takes place within the Production Steering Team, while planning and design is steered in the Technology Groups; both groups convene weekly. The construction, planning and technology types are integrated in integration meetings. Support functions have their own, regularly convening groups. Integration between the alliance and the Implementation and Execution Contract of Project Part 1A will take place in separate integration meetings, where the chairperson is the Project Manager of the Overall Project.

All decisions in the alliance contract will be made unanimously. The regularly convening technology groups and other groups belonging to the alliance organisation are presented in the organisational chart on the next page. The composition of the groups is presented in the tables on the next page.

VT 12 VALTARI – ORGANISATION FOR THE IMPLEMENTATION PHASE

ALLIANCE STEERING COMMITTEE (ASC)

- Convenes monthly
- Decisions associated with the technical or financial scope
  - Representation of the parties to the alliance
  - The core group has the right to speak

CORE GROUP

- Reporting of the project status and preparing the matters that need a decision from the ASC

ALLIANCE PROJECT GROUP (APG)

- Convenes weekly
- The people in charge participate according to the progress of the project
- Decisions on operative actions
- Representatives from all parties

CONSTRUCTION

- Route, bridge, geotechnology, concrete and rock tunnel, technical systems
  - Labour management and persons in charge of specific regions
  - Subcontractors
- The Production Steering Team convenes weekly

PLANNING AND DESIGN

- The Steering Team for Planning and Design convenes weekly

INTEGRATION OF PLANNING, DESIGN AND CONSTRUCTION

- Planning, design and construction in the technology groups is matched to the goals of the project
- The groups convene regularly
- Route, bridge, geotechnology, concrete and rock tunnel, technical systems and landscape group

SUPPORT FUNCTIONS

- The groups convene regularly
- Safety, finance, quality, communications, environment, risks, traffic control

ASC (ALLIANCE STEERING COMMITTEE)

Representation	Person
Finnish Transport Agency, Chairperson	Pekka Petäjäniemi
City of Lahti	Jorma Vaskelainen
Municipality of Hollola	Heli Randell
Skanska	Markus Lipsanen
Skanska	Pekka Räsänen
Pöyry	Kaarle Korhonen
Skanska, Alliance Project Manager	Janne Tikkamäki, right of discussion, core group
Finnish Transport Agency	Janne Wikström, right of discussion, core group
City of Lahti	Antti Ojanen, right of discussion, core group
Pöyry	Klaus Einsalo, right of discussion, core group
Uusimaa Centre for Economic Development, Transport and the Environment	Tuovi Päiviö, right of discussion
Rakennuttajatoimisto HTJ Oy	Tuomo Takkinen, Secretary

APG (ALLIANCE PROJECT GROUP)

Representation	Person
Management of the Alliance, core group	Janne Tikkamäki, Project Manager
Representation from the Finnish Transport Agency, core group	Janne Wikström, Project Director/Overall Project
Representation from the City of Lahti, core group	Antti Ojanen
Steering of planning and design, core group	Klaus Einsalo
Chief Designer	Ilkka Puustinen
Foreman in charge	Timo Takala
Management of subcontracts, steering of schedule	Mikko Korhonen
Bridge construction, innovation activities of the alliance	Jukka Jääskeläinen
Technical system, quality management	Jari Volanen
Concrete tunnels	Pekka Koponen
Rock tunnels	Tuomas Laamanen
Integration of planning, design and construction	Tapani Toivanen
Development of operations	Antti Leskinen
Steering of target outcome cost	Mikko Puttonen
Steering of procurements	Jarno Arkko
Daily communications	Tarja Kojo
Steering of safety	Mari Korpela

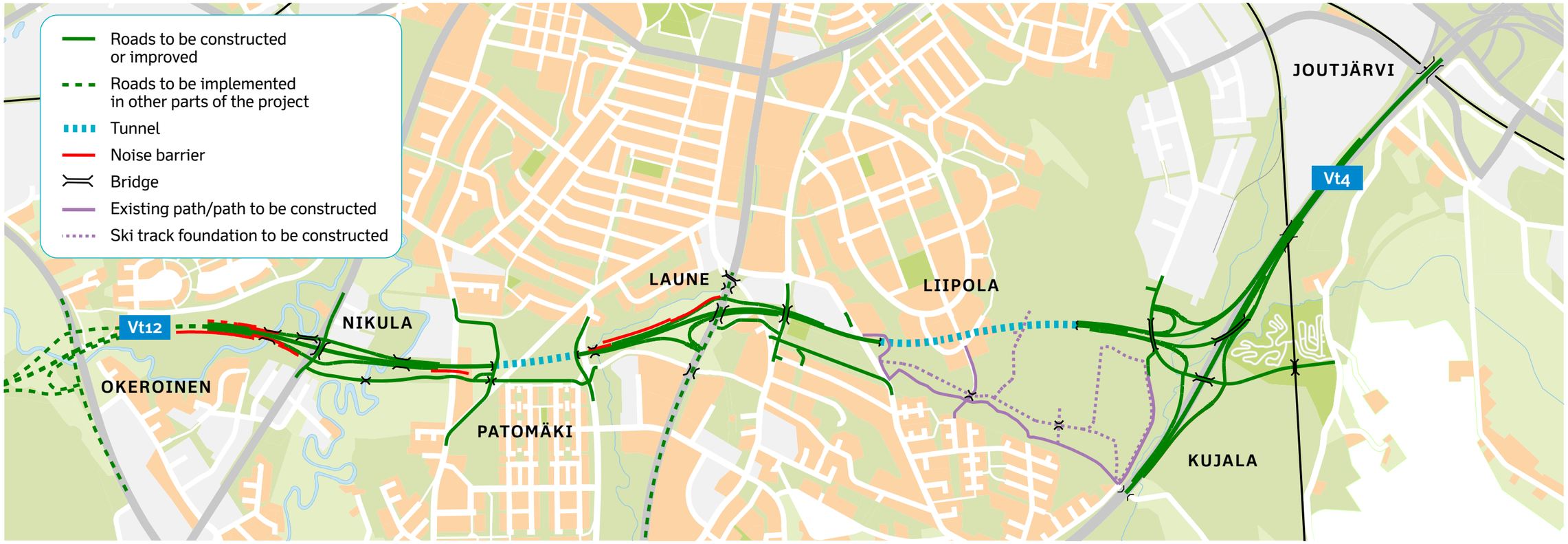
The composition of the Alliance Project Group, including the core group, the persons in charge of each block and other experts that are part of the standard composition. The composition of the Project Group will change during the implementation phase.

In addition, the Extended Project Group (XPG) consists of the following members:

Bridges	Jari Mannala
Concrete tunnel	Juha Sarkkinen
Interior fittings of tunnels	Lauri Harri
Excavation	Janne Lehtinen
Routes	Hanna Kuusisto
Geotechnology	Jaana Vinter
Bridges and Retaining Walls	Kirsti Helminen
Concrete structures	Olli Salo
Technical systems	Jaakko Vuopio
Geotechnical support	Niko Asikainen

3 Technical scope of the project

COMPOSITION OF PROJECTS IN THE VALTARI ALLIANCE CONTRACT



Vt 12, 2+2 lanes	4.5 km
Interchanges	3 pcs
Ramps	5.2 km
Vt 4, additional lanes for the stretch Kujala–Joutjärvi	2.5 km
Other roads	0.5 km

Streets	4.0 km
Pedestrian ways and cycle paths	2.7 km
Ground water protection at Laune	apx. 200 m
Concrete tunnel at Patomäki	0.4 km
Rock and concrete tunnel at Liipola	1.0 km
Noise barriers	1.7 km

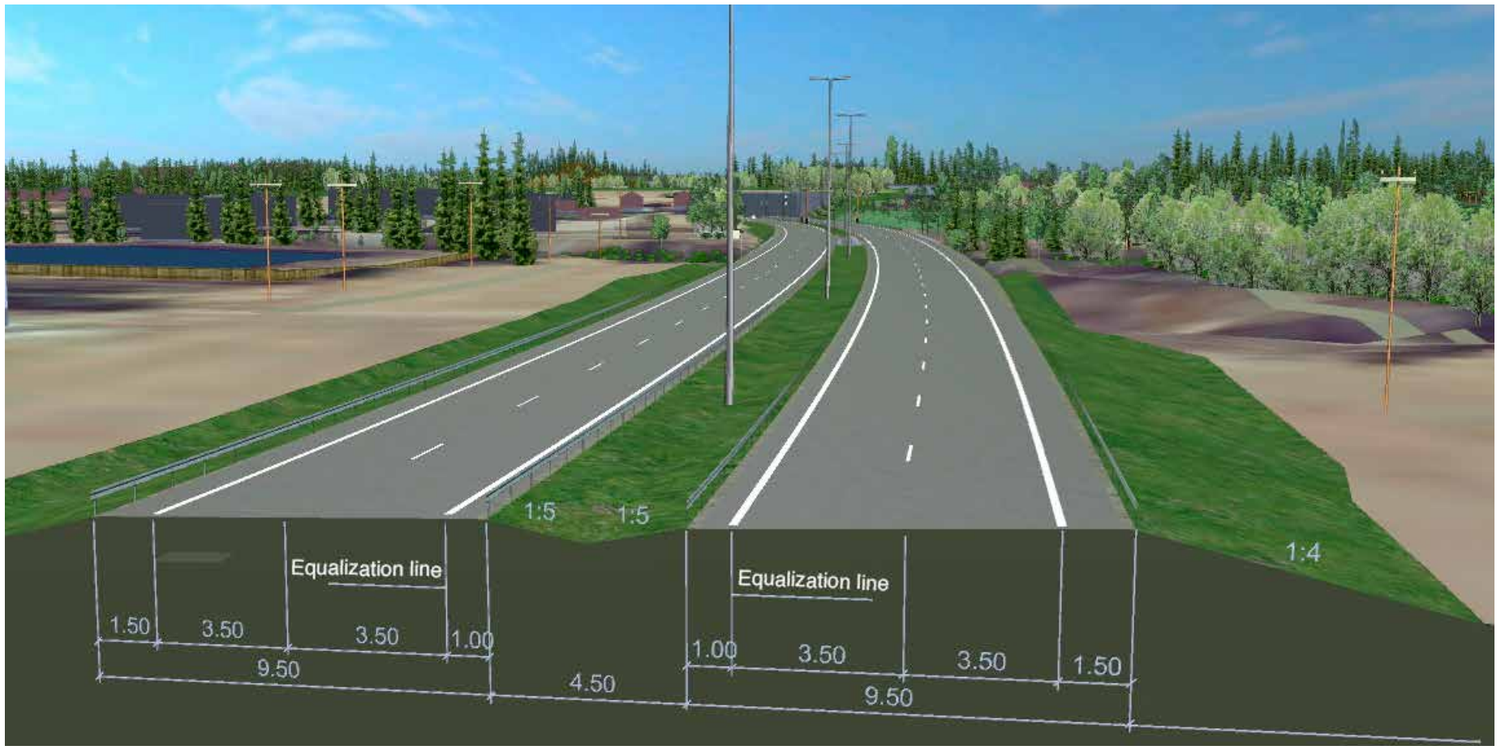
New bridges	12 pcs
Widening and repair of the current bridges	2 pcs
Demolition of the current bridge	1 pcs
Hiking routes at Liipola	apx. 2.5 km

3.1 General

Project Part 1B comprises the construction of 4.5 kilometres of Trunk Road Vt 12 from the eastern side of the Okeroinen interchange to Trunk Road 4. The new alignment will bypass the centre of the City of Lahti from the southern side.

The starting points for the execution of the project and its specific technical solutions are:

- The general plan of the southern bypass road of Lahti and its environmental impact assessment completed in 1996. The Finnish Transport Agency approved the general plan on 24 May 2011.
- A final engineering plan, completed in 29 May 2015 and approved on 3 June 2016, pursuant to the Highways Act. The final engineering plan became legally valid on 14 May 2018 by a decision of the Supreme Administrative Court.
  - Change D to the final engineering plan, Nikula interchange. Approved by the Finnish Transport Agency on 22 March 2018
  - Change E to the final engineering plan, detailed solutions for soil dumping areas. In administrative processing pursuant to the Highways Act in spring 2018.
- The horizontal alignment of the Trunk Road pursuant to the approved final engineering plan is presented in the land use plans of the City of Lahti, Municipality of Hollola and in the regional plan of Päijät-Häme, which was approved by the Ministry of the Environment on 11 March, 2008.
- Decisions on environmental permits pursuant to the Water Act
- Design principles created during the development and construction planning phase of the Alliance



Typical cross section of a Trunk Road

3.2 Routes

The Trunk Road to be constructed under Project Part 1B will be implemented as a 2+2-lane motorway. The junctions between the Trunk Road and the street network will be implemented as interchanges. At Liipola, the Trunk Road cuts the current Apilakatu street, so a replacement street, Orvokkitie, will be constructed. In the stretch covered by the alliance contract, a total of three interchanges will be built on Trunk Road Vt 12:

- Nikula interchange E4, which will serve as a connection from Helsingitie road (highway 140) to the Ring Road.
- Laune interchange E5, which will serve as a connection from Uudenmaankatu road (highway 167) to the Ring Road.
- Kujala interchange E6, which will serve a connection between the Ring Road and Trunk Road 4 while also serving connections related to land use.

On all trunk roads and ramps, the final edge markings will be implemented as sinusoidal cuts (all the way to the asphalt course when the road is opened for traffic). The marking between lanes will be implemented as paste embedded in the final SMA course; on the asphalt course, the markings will be implemented as surface paste markings. On pedestrian and cycle paths, the pedestrian crossing markings and markings separating modes of transport will be 7 mm thick with embedded paste. Other markings on pedestrian and cycle paths will be 3 mm thick with surface paste.

3.3 Tunnels

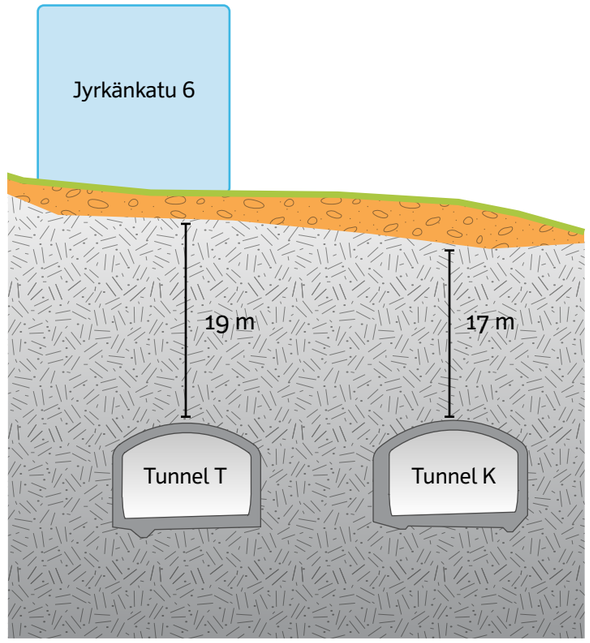
Two motorway tunnels will be built on the section of the Project Part. Both tunnels will have a separate tunnel tube for each driving direction. The tunnels will have a 80 km/h speed limit, a ban on overtaking heavy traffic and a ban on pedestrian access and cycling. The length of the Patomäki tunnel will be approximately 400 metres, and the Liipola tunnel approximately 1,000 metres. If an accident occurs, the emergency exit doors and corridors between the vehicle tunnels will serve as exit routes that lead into the other, clean and safe tunnel tube.

Patomäki tunnel

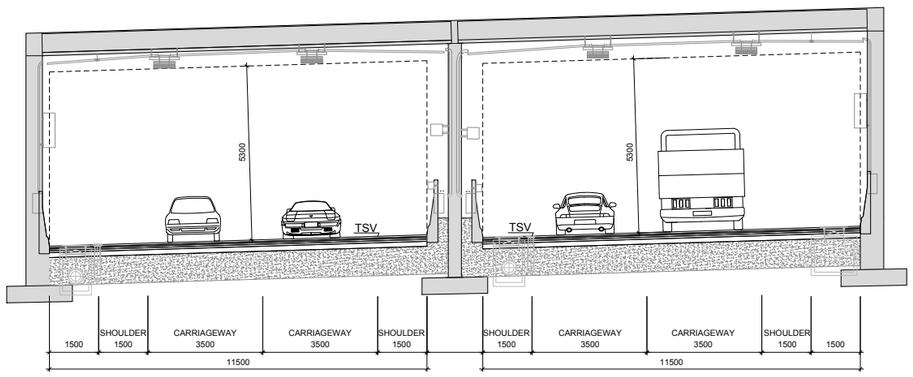
- Concrete tunnel
- The vehicle tunnels are separated by a 0.4 m thick concrete wall
- The vehicle tunnels will have emergency exit doors at 100 m intervals
- Natural ventilation

Liipola tunnel

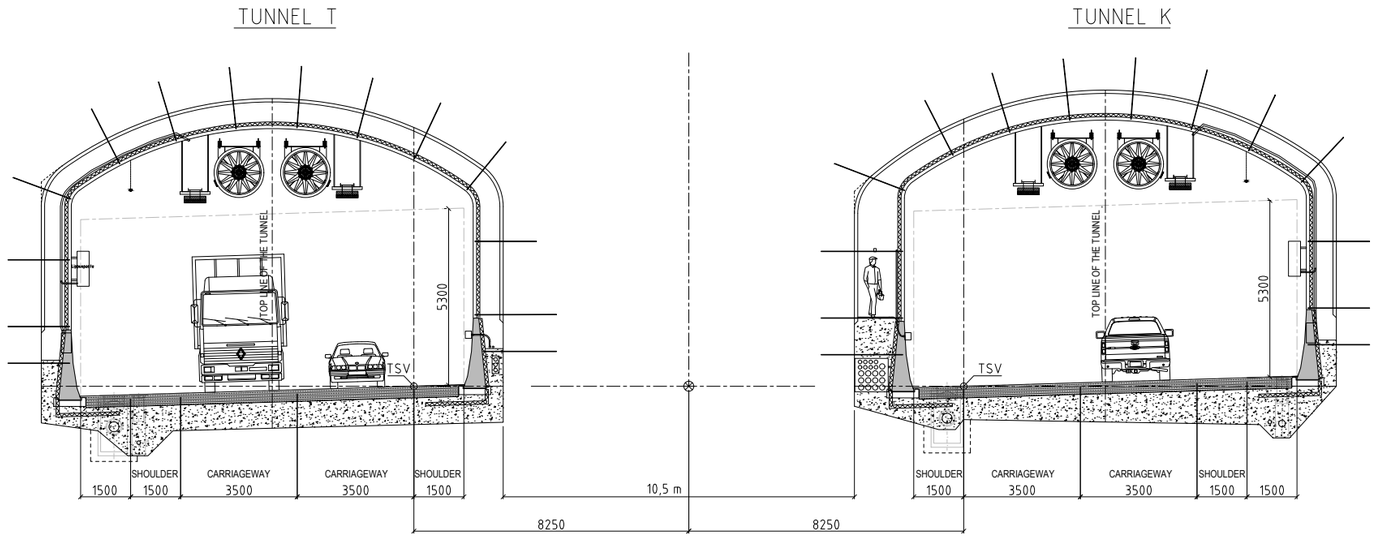
- Two rock tunnel sections and one concrete tunnel section between them
- Concrete mouth structures, approximately 70 m at the western end.
- The distance between the vehicle tunnels is 10.5 m
- A separate 1.2 m wide corridor for technology and maintenance will be constructed near the intermediate pillar of the southern vehicle tunnel.
- Five corridors between the vehicle tunnels at 126–215 metre intervals
- The corridors serve as fire and smoke compartmented emergency exits between the vehicle tunnels.
- The technical device premises, the maintenance and technology corridor and the emergency exits will be pressurised with clean air. The technical premises do not have a connection to the tunnel.
- Longitudinal ventilation system that also acts as a smoke extraction system in exceptional circumstances



Thickness of the rock overlay at Liipola.
T=Tampere direction, K=Kouvola direction



Cross-section of the concrete tunnel at Patomäki



Cross-section of the rock and concrete tunnel at Liipola

3.4 Technical systems of road tunnels

3.4.1 Introduction

The engineering of the technical systems of the road tunnels is based on Directive 2004/54/EC of the European Parliament and of the Council, the Finnish Transport Agency's instructions and regulations on road tunnels, and the safety concept of the Patomäki and Liipola tunnels created during the final engineering plan phase and approved by the adminstrative authority of tunnels on 13 February 2018.

3.4.2 Control system

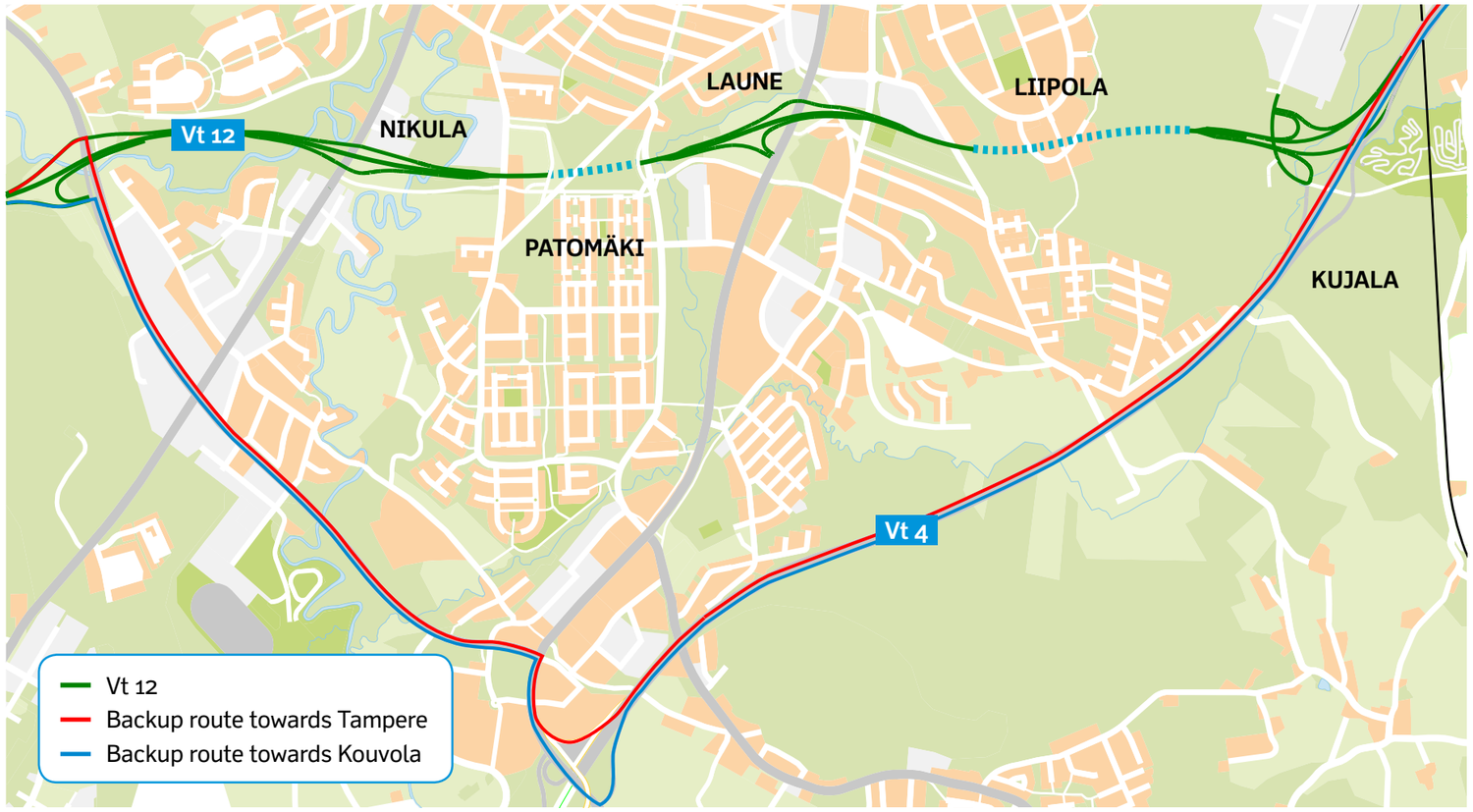
The control system controls the traffic in tunnels and on the road and street network connecting to the tunnels in both normal and exceptional circumstances. In the case of an accident, the control system also controls the operation of the safety systems. The technical systems connected to the control system consist of systems for traffic management, electricity, telecommunications, safety, HVAC and tunnel lighting. The control system and the associated technical systems will be connected to the Finnish Transport Agency's roadside technology network.

3.4.3 Traffic management system

The traffic management system that is a part of the control system enables the Road Traffic Centre to monitor the traffic situation around the clock. The devices and other technical systems connected to the traffic management system generate alerts and alarms based on which the Road Traffic Centre controls traffic during disruptions and maintenance. Lane guides enable traffic to be directed to a single lane, so that the closure of the entire tunnel can be avoided. In the case of a disruption or hazard, traffic can be warned and speed limits can be lowered. The tunnels can be closed and traffic can be directed to a backup route (see picture below).

The traffic management system contains the following parts:

- Variable speed limit signs
- Variable speed limit signs with warning signs
- Informative signs
- Lane guide signs
- Backup route signs on the corresponding sections on Trunk Road 4 and highway 296
- Traffic lights and boom barriers required for stopping traffic
- Road barriers at the mouths of tunnels, preventing the traffic from crossing the middle section of the road
- Automatic traffic measurement points
- Roadside weather station
- Traffic cameras
- In the Liipola tunnel, a disruption detection system that enables the following problems to be identified:
  - A stopped vehicle, measuring at least 1.5 x 1.5 x 3 metres
  - A vehicle driving in the wrong direction
  - A slow vehicle



In prolonged exceptional situations, the traffic will be directed to the backup route.

The HVAC part of the control system will be connected to other technical systems and devices that can generate alerts, and some of which can be controlled from the Road Traffic Centre during exceptional situations. The most important of such systems are the power and safety systems, the ventilation and smoke extraction system and tunnel lighting.

3.4.4 Power and safety systems

Both tunnels will have a power connection. Uninterrupted supply of power will be ensured by UPS devices. In addition, a standby generator will be installed in the Liipola tunnel.

Both tunnels will have a fire alarm system that covers the traffic tunnels, connecting corridors, technical premises and device premises. The traffic tunnels will be equipped with fibre optic cables for fire detection, and other premises with heat/smoke detectors. The fire alarm will be sent both to the emergency response centre and the control system, which will automatically start smoke extraction in the Liipola tunnel in receiving an alarm from the fibre optic cables. Other safety systems are:

- Announcement system (Liipola tunnel only)
- Emergency phone system
- VIRVE network (a telecommunications network for the authorities)
- Radio coverage in the tunnel, at least one specified frequency
- Crime alarm system
- Door control
- Camera surveillance of technical premises

3.4.5 Ventilation and smoke extraction system

The Patomäki tunnel will have natural ventilation and smoke extraction. Thanks to natural ventilation, no space provisions are needed for fans. The Liipola tunnel will be equipped with a longitudinal ventilation and smoke extraction system. The jet fans located in the vehicle tunnels will be used for both ventilation and smoke extraction. The fans are equipped with variable frequency drives and are controlled by the traffic management system, either automatically or manually.

In case of a fire, the exit routes at the connecting corridors of the Liipola tunnel will be brought to positive pressure. Positive pressure prevents smoke from spreading into the connecting corridors in case of fire in the vehicle tunnel. In normal conditions, the device premises of the connecting corridors are kept at a slight positive pressure to prevent dust from the traffic tunnel from entering the premises.

3.4.6 Lighting

The Trunk Road and the connecting ramps, roads, streets and tunnels are illuminated to the extent presented in the final engineering plan. The road and tunnel lighting will be implemented with LED technology.

The lighting of the tunnels will be controlled automatically by the HVAC part of the traffic system, based on the input from luminance meters. Both tunnels will be equipped with a safety lighting system.

3.4.7 Other technical systems

Other technical systems to be implemented in both tunnels are:

- A fire water system
  - A fire water station outside the tunnel, connected to the municipal water distribution system
  - Dry riser pipes with input and outlet connectors
  - Dry feeder pipes between the tunnel tubes
- Drainage and waste water sewers

3.5 Road technology solutions

3.5.1 Route for special transports

The east-west route for special transports runs on Trunk Road Vt 4 from the Renkomäki interchange to highway 296, and transfers to the new route of Trunk Road Vt 12 at the Okeroinen interchange. The northbound special transport along Trunk Road Vt 4 runs along ramp R6, R7 and R9 of the Kujala interchange and joins ramp R1. Southbound special transports use ramps R3 and R8 at Kujala, Vanharadankatu street K6 and ramp R5.

3.5.2 Drainage

Storm water drainage will be constructed for Trunk Road Vt 12. The storm waters will be discharged to existing bodies of water. In the case of an accident, run-off waters will be discharged via expanded ditches and wells equipped with stop valves. A separate drainage system will be constructed for groundwater management at the Laune groundwater pan.

Surface water retention basins will be constructed at the soil dumping areas for the duration of construction. The basins slow down the flow of water coming from the area and reduce the clouding of bodies of water downstream.

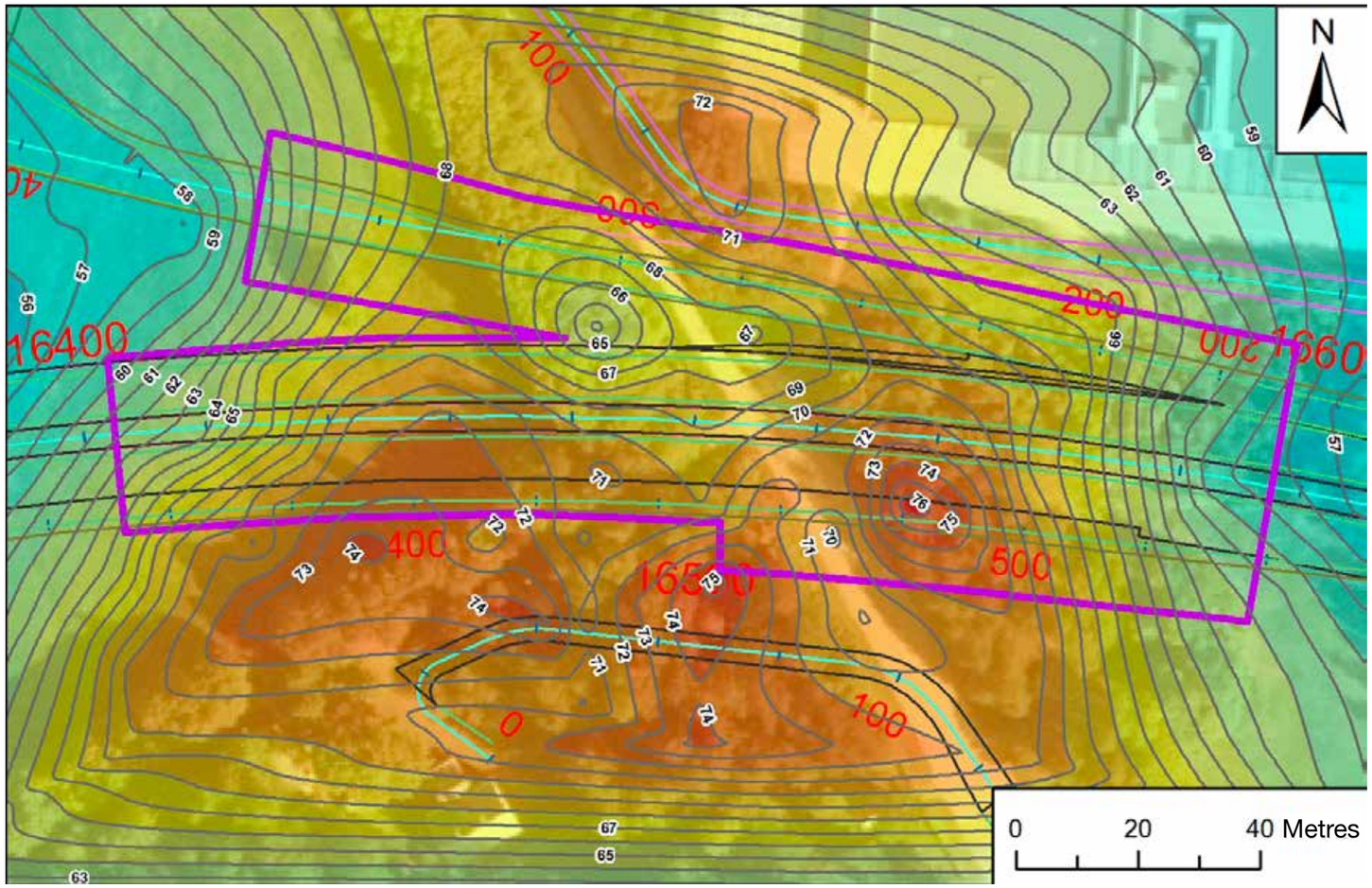
A separate drainage and collecting system for wash and fire water will be constructed in the tunnels. The system collects the waters and leads them to closed containment pools. The waters collected in the pools will be pumped into a tank truck and transported to a water treatment plant. The system will also be useful in the case of chemical spills, for example.

3.5.3 Groundwater management and protection

At the Patomäki concrete tunnel, Laune and Liipola concrete tunnel, Trunk Road Vt 12 will be built at a level lower than the current groundwater table.

The concrete tunnel at Patomäki will be an almost waterproof structure that will be kept dry with subsurface drains. Drainage waters will be discharged into existing bodies of water. The waterproofing structures will be implemented by using foil and/or bentonite. On the western side of the tunnel, the road will continue in a cut where waterproofing is implemented by foil and/or bentonite. Groundwater seeping into the excavation during construction will be drained into existing bodies of water.

At Laune, Trunk Road Vt 12 runs through a groundwater area. In this area, a watertight concrete structure will be constructed and roadside slopes will be equipped with challenging chloride barriers. The surface soil in the area is clay, under which there is a layer of gravel and sand which is highly pervious to water. The concrete ground water pan will be located in the area where the clay layer is the thinnest or will be penetrated during the construction or the road. In other locations, the groundwater protection will be constructed using foil and bentonite.



The picture shows the elevation of the underside of clay/silt (contours), alignment of the Trunk Road and a solid violet border around the area in which groundwater protection measures will be implemented.

During construction, the groundwater table will be lowered to at least elevation +74.5. The lowering will be achieved by means of sieve tube wells. The pumped waters will be directed along a discharge line to Paskurinoja creek. The Regional State Administrative Agency of Southern Finland has granted an environmental permit pursuant to the Water Act for the lowering of the ground water table and discharging of the water. The permit specifies the maximum allowed pumped volume, in relation to which a change is being applied for, in order to perform the planned constructing work as dry work. At the same time, we are applying for a change of scope of the concrete structure in order to match the soil conditions better, now that they are known in more detail. The effects to groundwater in the area will be monitored during construction. The monitoring will use methods approved by the Häme Centre for Economic Development, Transport and the Environment.

When construction is complete, the groundwater table at Laune will be controlled by subsurface drains. If the groundwater table in the area rises to an elevation of +76, groundwater flows to the subsurface drains of the pan and from there along the discharge line to Paskurinoja creek.

The rocky part of the Liipola tunnel will be made watertight by grout injection. On the western rock tunnel section at Liipola, the water conveyance of the rock mass

will be investigated by systematic sounding drillings during construction. Areas found to be conveying water will be pre-injected with mainly cement-based injection materials. Major individual leaks will be plugged with post hoc injections.

Drilling waters and groundwater seeping into the tunnel will be collected in a settling basin and oil separation devices, after which they will be directed via the research tunnels and openings into the sewer network of Lahti Aqua Oy. Groundwater seeping into the excavation of the concrete tunnel will be drained into existing bodies of water.

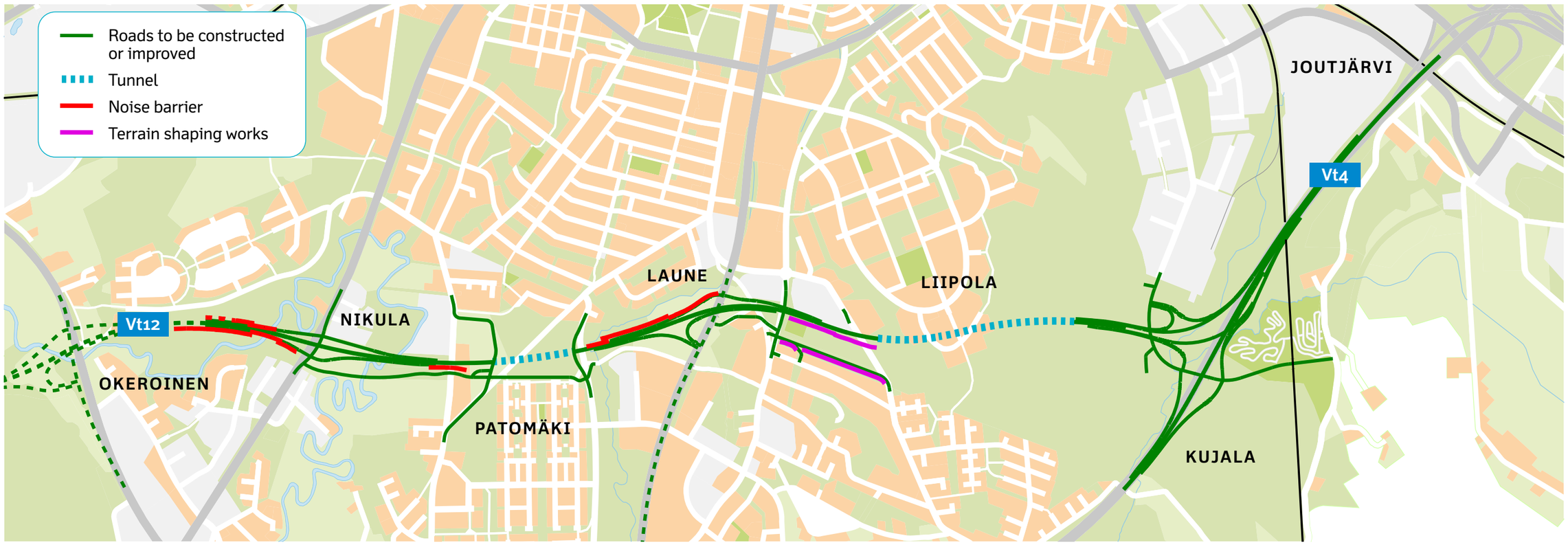
The small amount of leakage water seeping into the completed rock tunnel will be collected by the drainage system, which will lead the waters through the western entrance of the tunnel into the storm water network. In the concrete tunnel section, the subsurface drain system will keep the concrete structure dry. The subsurface drains will lead water into a drainage system inside the tunnel.

The Liipola area contains a pristine spring, which the project will alter under a permit granted pursuant to the Waters Act. The surface of the spring will be monitored during construction by methods approved by the Häme Centre for Economic Development, Transport and the Environment.

3.5.4 Noise abatement

A total of 1.7 km of noise abatement structures will be constructed at residential areas near the Nikula and Laune interchanges. At the western end of the Liipola tunnel, noise abatement will be improved from the level specified in the final engineering plan by relocating soil materials. The existing settlements will be protected

NOISE BARRIERS



against noise to at least the level specified in the final engineering plan.

The noise barrier 14 at Sokeritopanmäki presented in the final engineering plan will not be implemented, since the area is no longer in residential use due to a change in the town plan. Noise abatement rail 16 and walls 17 and 15 will not be implemented at Kujala, since in the next few years, the buildings at Lakkilantie will cease to be residential buildings and their ownership has already been transferred to the City of Lahti. Project Part 2 will implement the noise abatement measures for highway 167 at Laune interchange.

3.5.5 Soil stabilisation

The new routes will mainly be located on weak soil consisting of clay and silt of varying thickness. The weak soils are at their deepest near River Porvoonjoki at the western end of the Project Part. The clay is mostly overconsolidated and its dry crust is stiff.

During the development phase, the entire project area was subjected to a very comprehensive array of additional site surveys (approximately 1,000 in total). Static-dynamic penetration tests, vane tests, CPTU tests and percussion drillings were conducted in the terrain. In addition, a large number of soil samples were collected and subjected to basic assays, consolidometer tests and triaxial compression tests. Corrosion studies were performed at the bridge, tunnel and pile slab sites to determine the aggressive qualities of the soil and groundwater. Test pumpings were carried out at Patomäki, Liipola and Laune to determine the water conveyance of the soil in view of water management during construction and the permanent effects the structures will have on groundwater.

The routes at Kujala interchange will mainly be constructed on embankments. Therefore, two test embankments were constructed during the development phase on the Vanhanradankatu street (K6), which will be part of the Kujala interchange, in order to determine the settlement properties of the natural ground in the area. The embankments were constructed in November 2017, so by the end of the development phase, we will have been able to monitor any shifts and settlement in them for approximately six months. The monitoring results of test embankments, soil samples and calculations were processed in collaboration with Aalto University. The results obtained from the test embankments have served as input for the design of soil stabilisation solutions for the Kujala area. In addition, the settlement measurement data has been used in the design of Ajokatu (K5) at Laune.

Thanks to the results of the investigations and the monitoring of settlement in test embankments during the development phase, the soil stabilisation solutions of routes could be made lighter than the pile slab presented in the final engineering plan, for example by means of preloading and other lightening measures. Many of the previously conducted vane tests were disturbed, which means that, in places, the strength of the natural ground is higher than estimated and allows for higher ground-supported embankments. Laboratory tests and soundings have confirmed that the clay beds are very overconsolidated in places, which is supported by the observed settlement behaviour of the test embankments. As a result, the settlement characteristics of natural ground allow for higher ground-supported embankments to be constructed, since based on calculations, the overall settlement will be relatively minor. During construction, several routes will be prestressed in some parts with surcharge loading, in order to avoid troublesome settlement during use. On some streets as well as bicycle and pedestrian lanes, the bottom structures have been rated to allow settlement in use. Any settlement will be fixed by replacing the pavement, for example. Routes like these are listed separately in the design principles in the project.

The most challenging geotechnical sites are:

- The groundwater pan at Laune
- The large and challenging excavation of the Patomäki tunnel
- The structures around the openings of Liipola tunnel and the excavation of the intermediate concrete tunnel
- The streambed of River Porvoonjoki at the Nikula interchange
- The noise abatement wall (Me12) at Laune
- Widening of the current western overpass (S31) at Lepola

3.6 Required conduit and device relocations

Conduit and device relocations will be carried out in collaboration with their respective owners. The most significant and challenging relocations as far as the scheduling is concerned will be performed on the Ajokatu and Luhdantaustankatu streets. Moreover, the relocation of the Hartwall water main requires careful scheduling and integration of work to avoid a prolonged downtime in production.

The most significant conduit and device relocations are:

- Sewers and water mains of Lahti Aqua at the Nikula interchange area, sewer at the Liipola concrete tunnel.
- Changes to Lahti Energia's power grid, relocation of 110 kV and 20 kV powerlines at Ajokatu street and Patomäki sports field.
- For the telecommunications companies DNA, Elisa and Telia, the most extensive relocations will take place on Helsingintie road and Luhdantaustankatu street.
- Lahti Energia's district heating pipes must be relocated at Nikula, Laune interchange and Ajokatu street.
- Lahti Energia's natural gas pipes must be relocated at Patomäki and Laune interchange.

Some conduit relocations were made before the implementation phase of the alliance began. This ensures that the entire project will stay on schedule.

3.7 Routes, bridges and other structures to be constructed

3.7.1 List of routes, bridges and noise barriers

LIST OF ROUTES

Route	Cross section interval/ length m	Administrative classification/ Functional classification	Technical cross section	Design speed km/h	Loading class	Require-ments class
Vt 12						
	13850–14000/150	Motorway	2x13.0/10.5 median 4.5	80	25.0 asphalt (AB)	V1
	14000–15020/1020	Motorway	2x9.50/7.0 median 4.5	80	25.0 asphalt (AB)	V1
	15020-15040/20	Motorway	2x9.50/7.0 median 4.5	80	25.0 asphalt (AB)	V1
	15040–15223/183	Motorway	Area of change, median 4.5 to 2.7	80	25.0 asphalt (AB)	V1
	15223–15630/407	Tunnel	2x11.50/7.0 median 1.7	80	25.0 asphalt (AB)	V1
	15630–15680/50	Motorway	Area of change, median 2.7 to 4.5	80	25.0 asphalt (AB)	V1
	15680–15815/135	Motorway	Area of change, median 2.7 to 4.5	80	25.0 asphalt (AB)	V1
	15815–16805/930	Motorway	2x9.50/7.0 median 4.5	80	25.0 asphalt (AB)	V1
	16805–17120/315	Motorway	Area of change, median 4.5 to 13.5	80	25.0 asphalt (AB)	V1
	17120–18050/930	Tunnel	2x11.50/7.0 median 13.5	80	25.0 asphalt (AB)	V1
	18050–18200/150	Motorway	Area of change, median 13.5 to 10.5	80	25.0 asphalt (AB)	V1
	18200–18245/45	Motorway	Area of change, median 13.5 to 10.5	80	25.0 asphalt (AB)	V1
	18245–18305/60	Motorway	2x9.50/7.0 median 13.5	80	25.0 asphalt (AB)	V1
E4 Nikula interchange						
E4R1	329–517/188	Highway	6.5/4.5	80	6.0 asphalt (AB)	V2
E4R2	7–256/249	Highway	6.5/4.5	80	6.0 asphalt (AB)	V2
E4R3	240–556/316	Highway	6.5/4.5	80	6.0 asphalt (AB)	V2
E4R4	10–219/209	Highway	6.5/4.5	80	6.0 asphalt (AB)	V2

Route	Cross section interval/ length m	Administrative classification/ Functional classification	Technical cross section	Design speed km/h	Loading class	Require-ments class
E5 Laune interchange						
E5R1	241-484/243	Highway	6.5/4.5	80	10.0 asphalt (AB)	V2
E5R2	42-220/178	Highway	6.5/4.5	50	10.0 asphalt (AB)	V2
E5R3	241-449/208	Highway	6.5/4.5	80	6.0 asphalt (AB)	V2
E5R4	45-280/235	Highway	6.5/4.5	80	6.0 asphalt (AB)	V2
E6 Kujala interchange						
E6R1	139-735/596	Highway	9.0/7.0	80	25.0 asphalt (AB)	V1
E6R1	735-780/45	Highway	Area of change	80	25.0 asphalt (AB)	V1
E6R1	780-1046/266	Highway	6.5/4.5	80	25.0 asphalt (AB)	V1
E6R2	343-538/195	Highway	6.5/4.5	50	6.0 asphalt (AB)	V2
E6R3	857-1276/419	Highway	6.5/4.5	80	25.0 asphalt (AB)	V1
E6R3	1276-1321/45	Highway	Area of change	80	25.0 asphalt (AB)	V1
E6R3	1321-1540/219	Highway	9.0/7.0	80	25.0 asphalt (AB)	V1
E6R4	4-253/249	Highway	6.5/4.5	50	6.0 asphalt (AB)	V2
E6R5	20-269/249	Highway	6.5/4.5	80	6.0 asphalt (AB)	V2
E6R6	240-576/336	Highway	6.5/4.5	80	6.0 asphalt (AB)	V2
E6R7	20-218/198	Highway	6.5/4.5	80	6.0 asphalt (AB)	V2
E6R8	628-974/346	Highway	6.5/4.5	50	6.0 asphalt (AB)	V2
E6R9	100–307/207	Special tran-sports	6.5/4.5		6.0 asphalt (AB)	V2

Route	Cross section interval/ length m	Administrative classification/ Functional classification	Technical cross section	Design speed km/h	Loading class	Require-ments class
Highways						
M2, high-way 140	200-670/ 470	Regional road	8/7+ped & cycle 5.0/4.5 outer separator 1–6	60	6.0 asphalt (AB)	R2
M4, Vt4	95200–95800/600	Trunk Road	additional lanes 3.5/5.0	120	25.0 asphalt (AB)	V1
M4, Vt4	95800–97760/1960	Trunk Road	additional lanes 3.5/5.0	100	25.0 asphalt (AB)	V1
Pedestrian and bicycle traffic routes						
Y11J	0–697/697	ped. & cycle	3.5		Ped. & cycle road, gravel	K1
Y11J	930–1090/ 160	ped. & cycle	3.5		Ped. & cycle road, gravel	K1
Y11J	1090–1110/ 20	ped. & cycle	Area of change		Ped. & cycle road, asphalt	K1
Y11J	1110–1313/ 202	ped. & cycle	4.5/4.0		Ped. & cycle road, asphalt	K1
Y32J	0–43/43	ped. & cycle	4.0		Ped. & cycle road, gravel	
Streets						
K2 Porvoon-joentie road	0–930/930	Feeder road	5.5 + ped. & cycle 3.5/3.0 verge 0.5–3	40	2.0 asphalt (AB)	R2
K3 Luhdan-taustan-katu road	0–430/430	Feeder road	6.5 + ped. & cycle 3.5/3.0 verge 4.0	40	2.0 asphalt (AB)	R2
K4 Orvokkitie road	0–620/620	Feeder road	6.0 + ped. & cycle 3.5/3.0 verge 0.5	40	2.0 asphalt (AB)	R2
K5 Ajokatu road	20–400/ 380	Feeder road	ped. & cycle 3.5/3.0 verge 0.5 + 6.5 + ped. & cycle 4.0/3.5 verge 0.5	50	2.0 asphalt (AB)	R2
K6 Vanhan-radankatu street	40–1320/ 1280	Arterial	7.0 + ped. & cycle 3.5/3.0 verge 1–3	50	6.0 asphalt (AB)	R2
K7 Mäkelän-katu street	/10	Intersection		30	2.0 asphalt (AB)	R2
K8 Apilakatu street	0–80/80		Turning bay	40	2.0 asphalt (AB)	R2
K9 Sokeri-topankatu street	0–18/18		curr.			
K10	/25	Intersection	curr.			
K11	0–220/220		narrowing the existing street			
K11J	697–930/ 233	ped. & cycle	3.5		Ped. & cycle road, gravel	K1
K11J	1312–1325/ 13	ped. & cycle	4.5/4.0		Ped. & cycle road, asphalt	K1
K11J	1325–1460/ 135	ped. & cycle	3.5/3.0		Ped. & cycle road, asphalt	K1
K19J	0–324/324	ped. & cycle	5.0/4.5		Ped. & cycle road, asphalt	K1
K26J	0–98/98	ped. & cycle	3.5		Ped. & cycle road, gravel	
K28J	0–130/130	ped. & cycle	3.5		Ped. & cycle road, gravel	
K29J	0–40/40	ped. & cycle	3.5		Ped. & cycle road, gravel	
K30J	0–90/90	ped. & cycle	3.5/3.0		Ped. & cycle road, asphalt	
K60J	0–47/47	ped. & cycle	4.0		Ped. & cycle road, gravel	
K61J	50–130/80	ped. & cycle	4.0		Ped. & cycle road, gravel	
T102	0–180/180		narrowing the existing street			
T103	/10	Intersection				
T104	0–145/145					
T105	0–20/20					
T106	/20	Intersection				
T201		Intersection				
T202		Intersection				
Hiking routes at Liipola	/approx. 2500		3–8		Ped. & cycle road, gravel	

LIST OF BRIDGES

ID and name of bridge	Location	Type	Horizontal clearance, m	Vertical clearance, m
S18 Kukonkoski bridge	Vt 12/pedestrian and bicycle way, River Porvoonjoki	Continuous cantilever slab bridge made of reinforced concrete	14.9…18.05+ 15…18.2	3.2 m
S101 ramp bridge E4R4	E4R4/River Porvoonjoki	Continuous beam bridge made of prestressed concrete	7	
S20 Nikula intersection bridge	M2/Vt 12	Continuous cantilever beam bridge made of prestressed concrete	19.75…24.8	5.2
S22 Ali-Juhakkala bridge	Trunk Road Vt 12/ pedestrian and bicycle way, River Porvoonjoki	Continuous cantilever slab bridge made of reinforced concrete	16.4…14.5+ 13.5	3.2
S201	Y11J/River Porvoonjoki	Wooden glued beam bridge	4.5	
S23 Underpass of Porvoonjoentie road	K2/J11	Slab frame bridge II made of reinforced concrete	12	3.2
S38 Bridge at Paskurinoja creek	Vt 12/River Porvoonjoki	Cantilever slab bridge made of reinforced concrete	10+10	HW+1.0
S25 Intersection bridge at Ajokatu street	K5, K20J, K21J/Vt 12, E5R2, E5R3	Continuous cantilever beam bridge made of prestressed concrete	15.5	5.2
S35 Huovilanmäki intersection bridge	K6/E6R1…E6R4	Continuous beam bridge made of prestressed concrete	12.5	5.2
S28 Kujala intersection bridge	E6R1/VT4, E6R7	Continuous beam bridge made of prestressed concrete	9.5	5.2
S29 Lotila intersection bridge	K6/Vt4	Continuous cantilever beam bridge made of prestressed concrete	12.5	5.2
S31 Lepola overpass	Vt4, E6R3/ Lahti–Loviisa track	Continuous slab bridge made of reinforced concrete	new 18.35 (current one 13)	4.8/5.6
S30 Pippo underpass	Lahti–Loviisa track/ K6	Continuous cantilever beam bridge made of prestressed concrete	7.2	5.2
S37 Kujala intersection and overpass bridge	Vt4/Kasaajankatu street, Lahti–Kouvola track	Continuous hollow core slab bridge made of reinforced concrete	new 14.05 (current one 13.25)	7.56
104 Pippo pedestrian underpass (to be demolished)	Vt4/pedestrian and bicycle way	Slab frame bridge made of reinforced concrete	16+13	3.4
S32 Metsäpekkala underpass (no actions)	Vt4/pedestrian and bicycle way	Slab frame bridge made of reinforced concrete	13+12.25	3.2

LIST OF NOISE BARRIERS

Barrier number	Location			Type	Length, m	Elevation from the grade line/ road surface
	Route	Cross section interval	Left/right			
Me7	Vt 12	13700–14090	right	Earth berm	390	Grade line + 3.0
Me8	Vt 12	14064–14180	right	Concrete rail	116	Road surface +1.4
Me8	E4R1	327–375	right	Concrete rail	48	Road surface +1.4
Me45	E4R1	349–459	right	Earth berm	110	Grade line + 3.0
Me9	Vt 12	14050–14190	left	Concrete rail	140	Road surface +1.4
Me10	Vt 12	14920–15060	right	Earth berm	140	Grade line + 3.0
Me11	Vt 12	15685–15797	left	Concrete rail	112	Road surface +1.4
Me12	Vt 12	15755–16110	left	Earth berm	355	Grade line +6.0
Me13	E5R4	20–285	right	Fence	265	Grade line +4.5

3.7.2 Technology premises and devices

The technology premises at the Liipola tunnel will be implemented as a space excavated in rock (cross section 17680) which will function as a research tunnel for the conduction of vibration and properties of the rock mass during construction. The technology premises will contain:

- A transformer station
- A room for the standby generator
- An oil tank
- Premises for distribution boards
- A telecommunications room for chassis switches and logic devices
- A room for ventilation equipment
- Premises for mobile operators
- A control room and storage

The room for the standby generator will be equipped with an oil trap and surface level alarm. The oil trap will be installed in a location where it can be easily accessed and maintained. Stormwater entering the premises will be directed into the drainage system of the tunnel. The stormwater drains will be equipped with stormwater wells with sand traps. The door opening will be equipped with a well with a grille and heat tracing.

In addition, all connecting corridors of the Liipola tunnel will have compartmented technology premises. The device premises of the Patomäki tunnel will be located at the tunnel entrances on the ground surface.

3.7.3 Structures to be demolished

Two residential buildings have been demolished on the western side of the Patomäki tunnel in the area of Project Part 1B. Two (2) industrial buildings and one warehouse will be redeemed and demolished at the Laune area. In addition, three residential buildings at Mäkelänkatu are now owned by the City of Lahti and, due to a change in the town plan, they are no longer used as residential buildings.

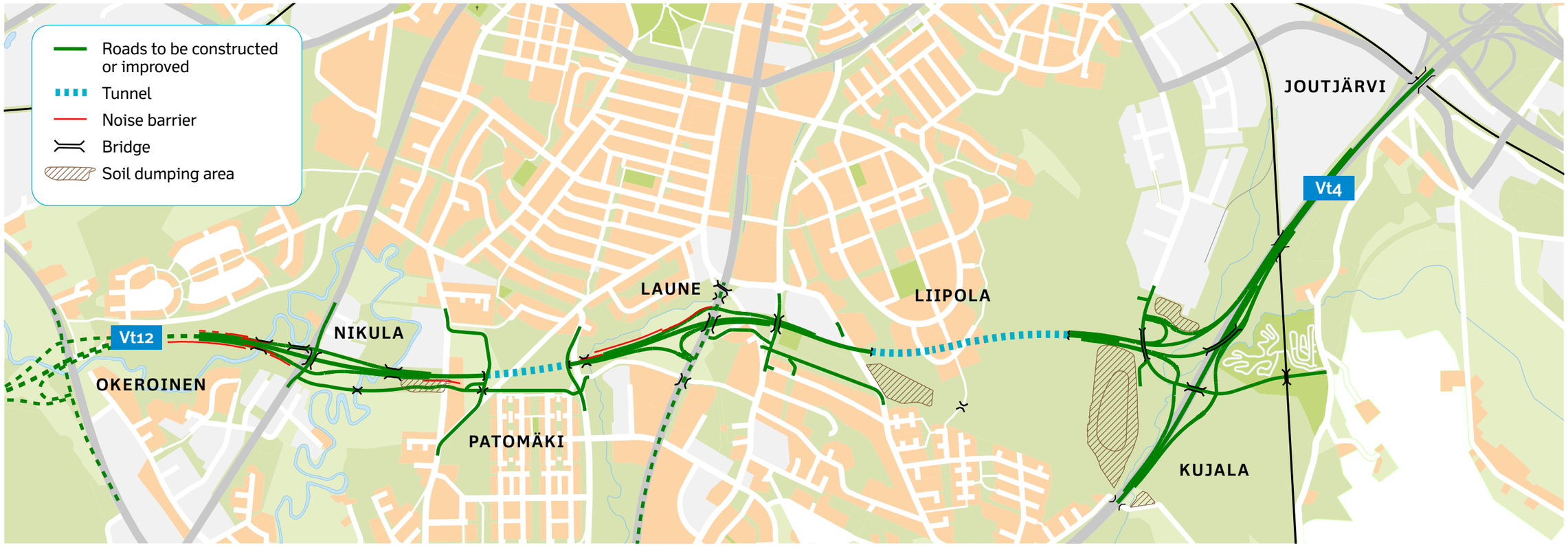
3.7.4 Soil dumping areas

Of the soil dumping areas presented in the final engineering plan, three areas have been reserved for the alliance project:

- Area 7 on the western side of the Patomäki tunnel
- Area 8 on the southern side of Trunk Road Vt 12 at Kujala
- Area 9 southern end of Vanharadankatu industrial area
- In addition, contouring the terrain at Patomäki sports field

Change E to the final engineering plan proposes that soil dumping area 8 be expanded and a new area (area 20) be allocated at the western end of the Liipola tunnel next to the Nikkilä residential area. This change is currently in administrative processing.

SOIL DUMPING AREAS ON CONTRACT PART 1B



3.7.5 Further specifications to the final engineering plan

During the development phase, the solutions in the final engineering plan were made more specific. The further specifications are based on more detailed initial data and more detailed planning and design. All changes implement the effects presented in the final engineering plan.

ROUTES

- The grade of Trunk Road Vt 12 was made more detailed at the Patomäki tunnel. This change transfers the lowest point of the Trunk Road to the western side of the tunnel, enabling slope drainage of the tunnel.
- The grade of the Trunk Road was lowered at the Liipola tunnel, which shortens the concrete intermediate tunnel.
- The cross section of Porvoonjoentie road (K2) was narrowed by 0.5 metres. The road will be implemented as a 5.5 m road, which conforms to the current stretches on the northern and southern side.
- The pedestrian and cycling connections from Uudenmaankatu to Ajokatu (K19J) was transferred from between the Laune ramp (E5R3) and Gigantti plot to the southern side or Trunk Road Vt 12 at the edge of Sokeritoppa. This change results in a more pleasant connection, since the corridor between Gigantti and Laune ramp was quite narrow. The connection forms a clear route directly to the yard of a school and community centre.
- The route K24J with its bridges, presented in the final engineering plan, will not be implemented. The hiking route will be connected to the pedestrian and cycling path of Vanharadankatu street on both sides of the Ring Road, enabling people to cross the Ring Road across the Huovilanmäki junction overpass.
- The location of the change of the streambed of River Porvoonjoki was moved eastwards. This change improves the flow of the river, shortens the Ali-Juhakkala bridge (S22) and minimises the impact on Lahti Aqua's settling basin.
- The storm water pumping station presented in the final engineering plan of Laune interchange will not be needed, since storm water drainage can be implemented as slope drainage.

BRIDGES

- The underpass at Pippo (S30) was changed from a three-span cantilever beam bridge to a one-span cantilever beam bridge and the vertical clearance was increased from 4.8 m to 5.2 m.
- The cross section of the Kujala intersection bridge (S28) was changed from a box girder bridge to a T-beam bridge.
- The underpass at Porvoonjoentie road (S23) was changed from a straight-walled rigid frame structure (clear span 8.0 m) to an oblique-walled rigid frame structure (clear span 6.0 m). As a result, the underpass conforms better to the new underpasses that will be constructed during the improvement of highway 167, Uudenmaankatu
- The park bridge across River Porvoonjoki (S201) and route Y11J will be implemented in their entirety, and a corresponding plan will be created for the administrative processing at the City of Lahti. An environmental permit pursuant to the Water Act will be applied for the bridge.

LIGHTING

- The road and tunnel lighting will be implemented with LED technology. Compared to other solutions, this ensures the best availability of spare parts during their lifecycle and better adjustability of illumination.

TUNNELS

- Based on the review, the Patomäki tunnel will be implemented as an approximately 400 m tunnel instead of the previously planned 500 m tunnel. The length of the tunnel will be shortened from the western end. As far as noise emissions are concerned, the shorter tunnel will also correspond to the level presented in the final engineering plan, but this necessitates extensions to noise barriers, among other things. The sports field area will remain between the streets in the scope presented earlier. The structure of the Patomäki tunnel is not rated for constructing buildings above the tunnel.
- The length of the concrete tunnel at the western entrance of the Liipola tunnel was revised to match the natural ground in the area. The concrete tunnel will be shortened by 25–30 metres so that the entire concrete tunnel can be constructed ground-supported. The noise calculation presented in the final engineering plan was made without the concrete tunnel section, so the shortening of the tunnel has no effect on the noise level. The required administrative permit for the change will be applied for.
- A maintenance corridor was added between the connecting corridors in the southern tube of the Liipola tunnel. The maintenance corridor increases the availability of the tunnels, since some maintenance tasks can now be performed without closing the tunnel tube or a lane.

- Unlike specified in the earlier plans, the technical device premises at Liipola tunnel will be constructed in the middle of the tunnel instead of the previously planned location at the western end. These premises will also serve as a connection to the maintenance corridor.
- At the Patomäki tunnel, the technical premises were moved from the middle of the tunnel to the entrances of the tunnel in order to keep the Patomäki recreational areas as intact as possible, and to eliminate the need to use the walking and pedestrian paths (K11J) as the maintenance accessway.
- The lower section of the tunnel wall up to a height of two meters will be have a lighter colour than usual. Lighter surfaces reduce the need for illumination power and any exceptional situations can be detected better.

GEOTECHNOLOGY SOLUTIONS

- The soil stabilisation solutions at Nikula, Patomäki, Laune and Kujala have been made more specific based on new site surveys and rating calculations
- Structures that prevent the groundwater table from falling too low will be constructed in the deep cut on the western side of the Patomäki tunnel
- At Laune, the elevation of the concrete pan that protects groundwater has been increased and its scope has been revised based on new site surveys

TECHNICAL SYSTEMS

- The longitudinal ventilation of Liipola tunnel and smoke extraction in exceptional situations will be implemented with seven pairs of fans in each vehicle tunnel instead of the five pairs presented in the final engineering plan. This change is the result of the revision of the heat release rating from 30 MW to 100 MW.
- The Patomäki tunnel will be implemented as an approximately 400-metre tunnel. Under the Tunnel Directive, a 400-metre tunnel is considered a short tunnel and can thus be implemented with lighter technical systems.
- The Liipola and Patomäki tunnels will be equipped with a fire water system.

TRAFFIC MANAGEMENT

- The final engineering plan presents the operating class of the tunnels as TY2 (high-speed main traffic arteries). Due to the Nikula interchange, the operating class was revised to TY1 (heavily trafficked main traffic arteries in an urban setting). As a result of this change, traffic cameras will be located also inside the Patomäki tunnel.
- If the tunnels are closed, the backup route will be highway 296, Ala-Okeroistentie road – Uudenmaankatu road – Renkomäki interchange – Trunk Road Vt 4 (see figure on page 13). The current alignment of Trunk Road Vt 12 will cease to exist as a highway when this project is completed, and from the perspective of land use, there will be no reason to guide traffic through a street network under development. Traffic cameras will be placed along the backup route at Renkomäki interchange, intersection of highway 167 and highway 296 and intersection of highway 296 and highway 140.
- A weather camera and traffic camera were added to the interchange at Soramäki
- Lane guidance signs will be implemented in the tunnels. Lane guidance improves the usability of the tunnel, since the tunnel can still be used even if one lane is closed.
- No measurement points for regulating access to the tunnel will be implemented, since regular queuing of traffic is not expected.
- The ramps at the entrances of the tunnels will be shaped in ways that significantly mitigate the risk of driving in the wrong direction. Therefore, no loop for detecting vehicles driving in the wrong direction will be implemented on the ramp.

3.7.6 Items not included in the technical scope

The following items are not included in the target outcome cost, and their potential procurement will be decided upon later:

- The top pavement layer of the Trunk Road Vt 12 line section (SMA course) that will be implemented around 2023 will be procured separately by the owner partner. The Trunk Road section will be opened for traffic with the 3rd pavement layer (asphalt).
  - However, the target outcome cost includes a 4th pavement layer (SMA slab) on the stretch of Trunk Road Vt4 that will be widened.
  - The target outcome cost includes the management of post-completion settlement by means of levelling mix or other method, with a schedule that enables the last pavement layer to be constructed as an SMA slab with uniform thickness.
- Construction of the Laakso-Nikkilä noise barrier on Vt4 outside the project area.
  - The target outcome cost does not include additional transport of soils from dumping area 8 or the construction of the noise barrier. The decision on the construction of noise protection structures that do not belong to the scope of this project will be made separately once the plans are complete and administratively approved.

- Increasing the quality of Y11J by widening the cross section and adding an asphalt pavement
- Hiking route connection that runs under the Ali-Juhakkala bridges.
- Development of the junction area of Ajokatu street and Orvokkitie road
- Spare parts inventory to be handed over to the party that maintains the technical systems
- Costs of connecting to Finnish Transport Agency's systems
  - Connecting the traffic camera system
  - Connecting telecommunications to the trunk network
  - Centralised management of alarms, calculation of recommendations, processing of metadata
  - Licences to the Finnish Transport Agency's systems

3.8 Ex-post accountability phase

The ex-post accountability phase will start when the Project Part is completed and opens for traffic, minor deficiencies notwithstanding. The ex-post accountability phase will last for five years, except the following:

- Tunnel structures, six years
- Asphalt pavements, three years (excluding any needs to repair settlement after completion; for such repairs, the period will be five years)
- Plantings and urban landscaping, three years
- Paste markings, two years
- Technical systems
  - After the tunnels have been opened for traffic, a period of functional verification and adjustments will start and last for at least six months. The duration of the functional verification and adjustment period will be extended for any subsystems that contain significant defects that have not yet been successfully eliminated.
  - When the functional verification and adjustment period ends, a two-year ex-post accountability will start. Any defects in an individual subsystem shall only affect the start of the ex-post accountability phase for that particular system.

3.9 Care and maintenance

When completed, the Southern Ring Road of Lahti will be part of the road network, and will be cared for and maintained by the Uusimaa Centre for Economic Development, Transport and the Environment. The streets constructed in the project will be transferred to the custody of City of Lahti. Operating and maintenance instructions will be created for the as-built scope.

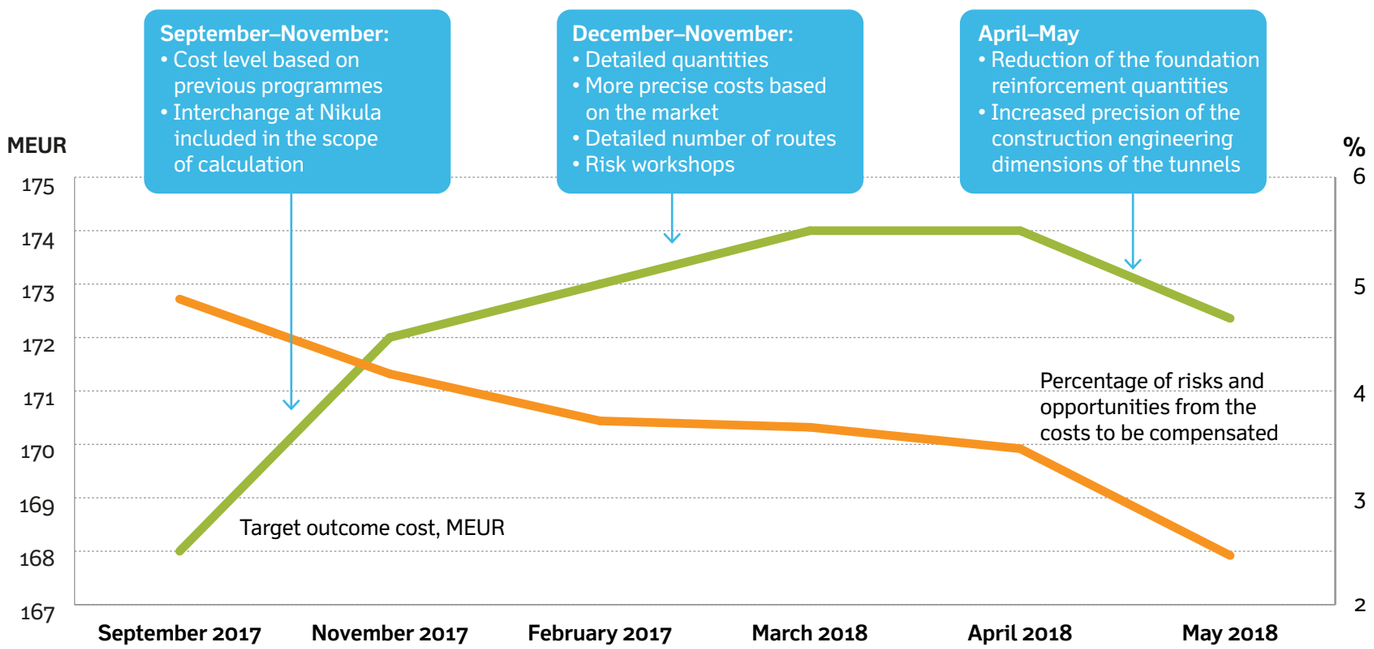
The care and maintenance of subparts will be transferred to the party that will assume responsibility for them based on joint terrain renews.

4 Target outcome cost

The target outcome cost was specified during the development phase, based on initial data and plans that gradually became more specific. The target outcome cost went through several calculation rounds, and during each round, the masses and quantities were verified based on the model. A cost expert, external to the owner partner's organisation, participated in the target outcome cost process throughout the entire development phase. The final target outcome cost is EUR 172,358,650. For a detailed breakdown, see the table on the right. The target outcome cost target of the owner partner was approximately EUR 170 million. The fact that the final target outcome cost is slightly higher results from the extension of the scope of the Project Part to include the construction of an interchange in Nikula (approx EUR 6 million), and an increased understanding of the general cost level. In the Request for Tender, the owner partner's estimate of the costs to be compensated was EUR 140 million. In view of the scope of the final target outcome cost, the costs to be compensated amount to approximately EUR 157.9 million. The commission has been changed to correspond to the increase. The target outcome cost is fixed and not bound to any index.

The target outcome cost process, including the development of the cost estimate and risk provision during the development phase alliance contract is presented in the image below. The target outcome cost and its accuracy are assessed in more detail in chapter 6 of this report.

INCREASE IN THE PRECISION OF TARGET OUTCOME COST AND RISK PROVISION



TARGET OUTCOME COST

	EUR
Work-specific construction costs (including operating costs and joint costs)	**139,518,059.24**
Routes: Structures, conduit relocations	33,315,913.00
Groundwater protection structures: Concrete structures, earthworks including supports	965,231.00
Pile slabs: Earthworks, slabs and piling	9,400,986.00
Noise barriers	2,024,803.00
Bridges	17,194,505.00
Patomäki tunnel: Earthworks, concrete structures	17,468,328.00
Liipola tunnel: Western concrete tunnel, concrete intermediate tunnel, eastern concrete tunnel, rock tunnels (including the technical premises and connecting tunnels), earthworks at the Liipola tunnels and rocks in the open section	36,377,549.57
Technical systems	22,770,743.67
Design costs: Development phase alliance contract (DPAC) and implementation phase alliance contract (IPAC) phases	**9,184,780.00**
Development phase alliance contract (Skanska)	**2,392,511.43**
TOTAL	**151,095,350.67**
Risks and opportunities	**3,879,001.00**
Risk provision	5,014,001.00
Opportunities	-1,135,000.00
Provision for cost increases	**2,397,633.00**
Provision for the ex-post accountability period	**500,000.00**
Costs to be reimbursed	**157,871,984.67**
Fees	**14,486,665.33**
Skanska, fixed sum, as stated in the tender on 26 June 2017	10,000,000.00
Skanska, change of the commission to conform to the change in costs to be compensated. Principles of the commercial model, item 3.2	1,276,570.33
Pöyry	3,210,095.00
TARGET OUTCOME COST	**172,358,650.00**

5 Commercial model

5.1 Compensation and commissions paid for service providers and the incentives scheme

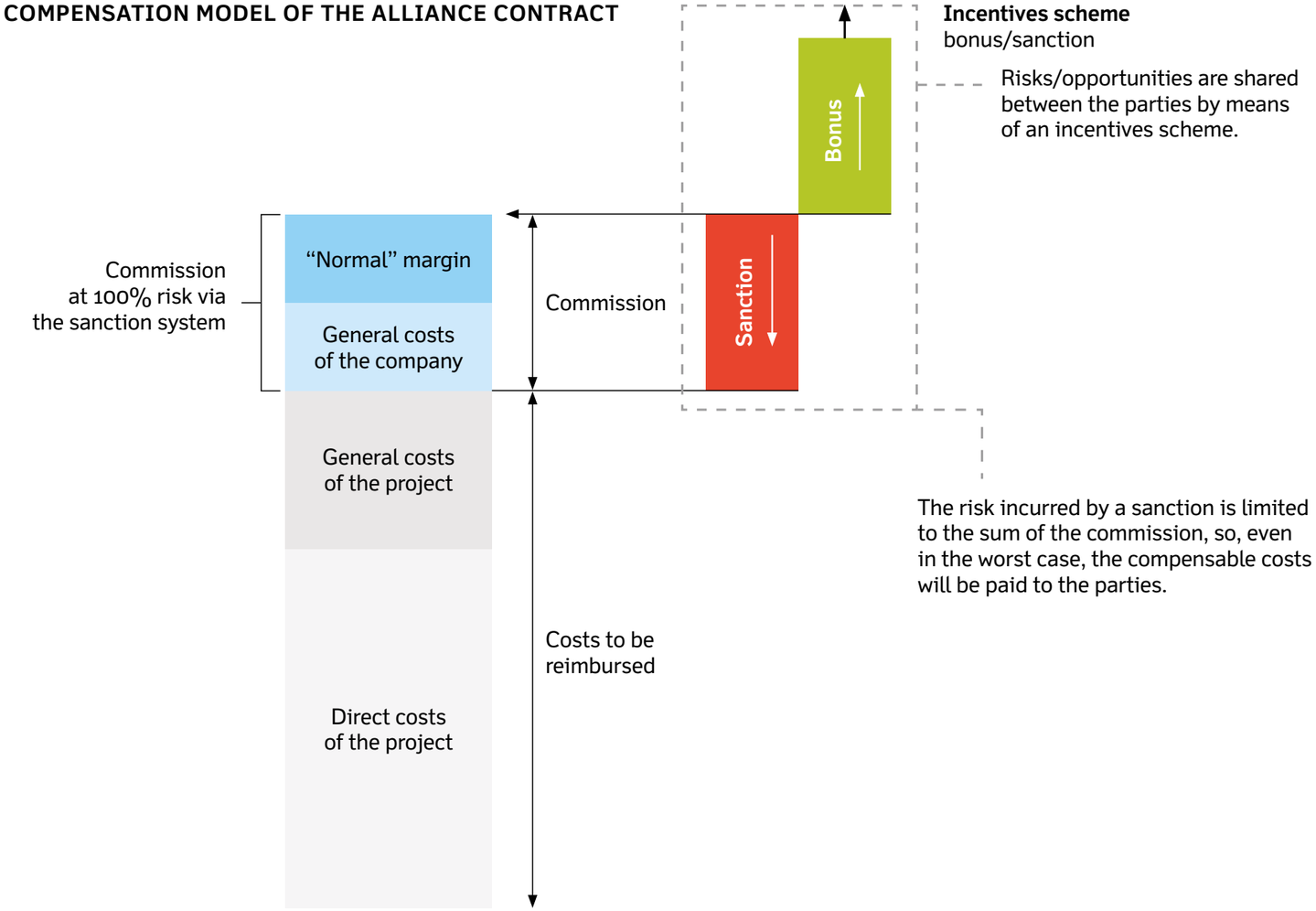
The service providers are paid a commission as follows:

- The commission paid to Pöyry Finland Oy, the company in charge of the planning, is a percentage of the compensable costs generated via the company.
- Skanska Infra Oy, the Project Supervisor, will be paid a fixed commission in EUR.

In all cases, the direct costs of the project and any project-specific general costs will be paid to the service providers. The commission paid on top of these will be based on the performance of the alliance in the different subareas of the incentives scheme. The alliance incentives scheme is presented in the picture on the following page. The incentives scheme of the alliance consists of the following parts:

- The bonus pool from which any bonuses are paid is 1.1 MEUR, which is approximately 0.65% of the target outcome cost, but the pool may grow if the costs are lower than the target outcome cost.

COMPENSATION MODEL OF THE ALLIANCE CONTRACT



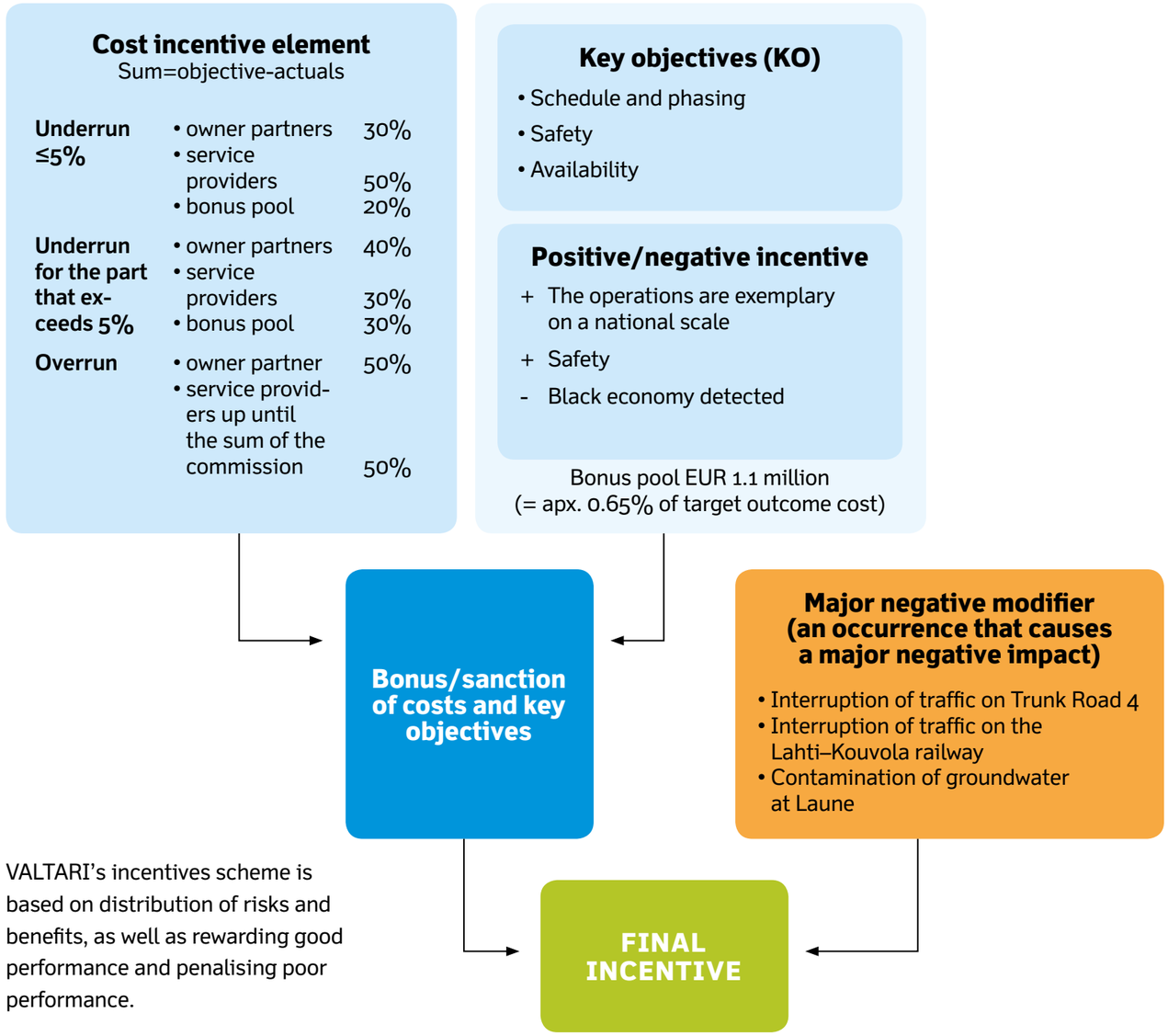
- Performance of the alliance associated with the key objectives (KO):
  - The key objectives are measured during the duration of the project
  - If the performance of a service provider exceeds the key objectives, the bonus paid to the service provider will increase. Conversely, if the performance of a service provider fails to meet the key objectives, the sanctions the provider must pay to the owner partner will increase
- Positive and negative incentives of lower significance than the key objectives
- A major negative modifier that might, at worst, halve the bonus pool or empty it completely
- A cost incentive associated with the target outcome cost, whose magnitude and distribution among the alliance parties depends on how well the target outcome cost is met

If the target outcome cost is underrun by less than 5%, the benefits are distributed to the alliance parties as follows:

- The owner partners get 30% of the difference
- The service providers get 50% of the difference
- 20% of the difference is transferred to the bonus pool

If the target outcome cost is underrun by 5% or more, the difference is divided as follows:

- The owner partners get 40% of the part exceeding 5%
- The service providers get 30% of the part exceeding 5%
- 30% of the part exceeding 5% will be transferred to the bonus pool



VALTARI's incentives scheme is based on distribution of risks and benefits, as well as rewarding good performance and penalising poor performance.

If the target outcome cost is exceeded, the responsibilities are divided among the alliance parties as follows:

- Owner partners' liability for the overrun: 50%
- Service providers' liability for the overrun: 50%

The sanctions resulting from the incentives scheme cannot exceed the total sum of the commission of the service providers.

5.2 Key objectives and performance indicators, including justifications

Derived from the general objectives of the Overall Project, the key objectives of the alliance emphasise taking the special characteristics of the contract area into account. In the City of Lahti, it is essential that the disruptions caused to Laune School and Trunk Road traffic (Trunk Road Vt 4 and Trunk Road Vt 12) by the works be minimised, that the traffic connections to the Kujala industrial area be completed rapidly, and that the completed Trunk Road operate without disruptions after it has been opened to traffic. Worksite safety is another key objective.

The indicator scale for the key objectives is -100 – +100. Maximum performance gives +100 points and a complete failure -100 points. The minimum requirement is 0 points, and to attain this, the performance must exceed the average performance in the industry. A result of 0 points does not trigger bonuses nor sanctions.

VERBAL DESCRIPTIONS OF THE PERFORMANCE LEVELS

Performance level	Properties
Breakthrough 70–100 points	• An objective not previously achieved in Finland. • Cannot be achieved with previously used methods – requires new ways of thinking. • The alliance does not know how it will reach the outcome it has set, but believes this to be possible and is 100% committed to reaching it.
Flexibility 10–70 points	• Has been achieved previously, but only in rare instances. • The alliance knows how to do this and can utilise previously used methods, but flexibility of resources/staff is nevertheless needed to achieve the outcome.
Minimum requirement 0–10 points	• Significantly better than the sustained performance of individual parties in other projects. • Performance level reached as a result of collaboration between the best players in the industry.
Failure -50–0 points	• A performance level that does not meet the owner partner's minimum requirement.
Complete failure -100–50 points	• Extremely poor performance.

5.3 Positive and negative incentives

The purpose of the key objectives is to promote excellent performance in important areas. The positive and negative incentives that affect the commission of the parties strive to achieve the same result. The negative incentive penalises occurrences of black economy. The positive incentive rewards excellent operations which might be associated, for example, with the high quality of the completed product, new innovations or other performances better than the regular performance in the infrastructure sector.

5.4 Calculation of the performance level score

The bonuses and sanctions for the performance of the alliance are calculated as follows:

1) For each key performance area, the score of the actual performance is recorded and multiplied with the weight of the key performance area. Finally, the resulting individual scores are added together. The effect of positive/negative incentives is added/subtracted from this score using the formula preciously stated.
2) This operation results in a total score between -100 … 0 … +100. The score is converted to EUR using the formula: total score/100 x maximum bonus.

5.5 Major negative modifiers

The alliance contract area overlaps with the Laune ground water area, which is an important water supply. Protecting this area and preventing its contamination is one of the most important objectives which must be taken into account both in construction and the as-built solutions. However, this objective has not been included among the key objectives, since contamination of groundwater due to the worksite is defined as a major negative modifier in the incentives scheme. A major negative modifier is one that can halve the bonus pool or empty it completely. Other major negative modifiers are cases where traffic has to be interrupted on the Lahti-Kouvola railway or Trunk Road 4 for at least 24 hours due to the construction site of the Alliance.

KEY OBJECTIVES OF THE PROJECT

	Weight	Key objective	Indicator	Method of measurement	-100, complete failure	0, minimum requirement	100, breakthrough	Observations
Schedule and phasing	24%	**Commissioning of the Kujala interchange -K6, R5, R6, R7, R8, R9 and Trunk Road Vt 4 width increases, bridge repairs included. Disruption on Trunk Road Vt 4 caused by the construction of S28 has ended.**	Commissioning for traffic by the deadline date	Date	31 Dec 2020	31 Oct 2019–15 Nov 2019	1 June 2019	Marketing of the Kujala industrial area can be started at an early stage and the disruption caused to Vt4 is minimised.
	15%	**Completion of Orvokkitie (K4), Ajokatu (K5) and K19J.**	Commissioning for traffic by the deadline date	Date	15 Dec 2019	26 Jul 2019–9 Aug 2019	15 Dec 2018	Rapid completion of the section near the school. 'Completion' here means complete except for some minor finishing works. Stone works and urban landscaping may still be unfinished. All routes (including pedestrian and cycling connections and bus stops) must be paved and their final illumination must be operational. Any defects will be remedied during school vacations.
	10%	**Opening the project for traffic within the agreed time window**	The target window for commissioning for traffic is 8–10/2020	Yes / No	Opening for traffic after 1 Jan 2021	Opening for traffic between 1 Nov 2020 - 31 Dec 2020	Opening for traffic between 1 Aug 2020 - 30 Oct 2020, or before 1 Aug 2020, if integrated with ST	
Lack of disruptions on the completed road	10%	**Lack of traffic disruptions on Trunk Road Vt 4 and Trunk Road Vt 12 during the ex-post accountability phase**	Availability of Trunk Road Vt 4 and Vt 12 during peak hours. 6:00 am – 9:00 pm	% of total time (6 am – 9 pm), calculated from each beginning 2 hour period. Tunnel closure hours are calculated as double. Percentage is calculated to an accuracy of 2 decimals. The smallest defect to be calculated is the closure of a lane/ramp. The closure of an entire tunnel tube is calculated as double hours.	**70.00%**	**98.50%**	**100.00%**	Will be tied 100% to ex-post accountability phase.
Safety	15%	**No accidents occur in the project.**	Frequency of accidents during the EPAC phase. An absence of at least 1 day due to an accident, number of accidents/ million working hours.	Frequency expressed as a percentage. Precision: one decimal	**40**	**7…10**	**0**	Including subcontractors
	10%		Severity of incidents. Number of absence days resulting from the accident.	Number of absence days resulting from the accident. Year 2018.	**100**	**25**	**0**	Including subcontractors. Will be reviewed on a year-by-year basis.
				Number of absence days resulting from the accident. Year 2019.	**240**	**60**	**0**	
				Number of absence days resulting from the accident. Year 2020.	**140**	**35**	**0**	
	Weight	**Key objective**	**Indicator**	**Method of measurement**	**-100**	**-50**	**0**	**50**	**100**	**Observations**
	7%	**Continuous improvement**	Reoccurrence of shortcomings detected during safety assessment rounds. Minor and serious shortcomings are listed separately.	The ASC will make the decision at the end of the EPAC phase. The situation will be monitored in the ASC meetings throughout the EPAC period.	Shortcomings **occur repeatedly at the worksite during execution, no lessons are learned and the operations do not improve.**	Shortcomings occur repeatedly at the worksite during execution, **some lessons are learned and the operations improve slightly.**	Shortcomings **are not repeated at the worksite to a significant extent during construction and no serious shortcomings are repeated.** Lessons are learned from mistakes and operationsimprove.	No repeated shortcomings (minor or serious) are found **at the worksite during execution.** Lessons are learned from mistakes and operations improve.	No repeated shortcomings (minor or serious) are **found at the worksite during execution.** Lessons are learned **from mistakes and operations improve continuously.**	Safety rounds, Monday afternoon/ week. HTJ & a representative from VALTARI.

POSITIVE/NEGATIVE INCENTIVE

	Weight	Key objective	Indicator	Method of measurement	Effect on score			
Efficient methods of working		**The operations are exemplary on a national scale**	The Project Part earns a national award by 31 December 2021.	Yes/No ASC will make the decision	**+2**			The result obtained in this section is added to the result of the previous sections; however, the maximum final score cannot be higher than 100.
					0	3.5	7	
Safety	7%	**Improving the participation of all employees**	Engaging all employees in the improvement of the safety culture.	ASC will make the decision at the end of the EPAC phase	Observations on safety are made as in a regular contract.	Regular safety observations with a clearly larger scope than in a regular contract, with most of the observations made at the labour management level	Regular safety observations with a clearly larger scope than in a regular contract, with the observations made at foreman and employee level (including subcontractors).	All people who will be familiarised
					-3		+3	
	2%	**No accidents occur in the project**	During the ex-post accountability phase, no accidents occur that would lead to an absence of one day or more	pieces	**2 or more accidents**		**0**	Including subcontractors, will be tied 100% to the ex-post accountability phase.
No black economy		**No black economy**	An external or internal audit detects black economy activity, which manifests itself as shortcomings in the registration, pension insurance, tax payments, terms and conditions of employment or arrangement of occupational health care in a subcontractor company of the alliance, which, according to the ASC's interpretation, should have been noticed.	Yes/No ASC will make the decision.	**-2 per observation**			The result of this item is subtracted from the result of the previous items

Exemplary operation and continuous improvement of safety are defined as a positive incentives and an observation of black economy activity as a negative incentive.
The table includes the indicators and measurement methods of the incentives and their effect on the performance score.

MAJOR NEGATIVE MODIFIERS

	Indicator	Method of measurement	Effect
• Interruption of traffic on Trunk Road Vt 4	Total interruption of 24/48 hours	Yes/No	A 24-hour interruption empties the bonus pool by 50% and a 48-hour break empties it completely.
Interruption of traffic on the Lahti–Kouvola railway	Total interruption of 24/48 hours	Yes/No	A 24-hour interruption empties the bonus pool by 50% and a 48-hour break empties it completely.
Contamination of groundwater at Laune	Serious contamination of groundwater caused by the Alliance. ASC makes the decision.	Yes/No	Empties the bonus pool

Major negative modifiers included in the incentives scheme.

6 Value for Money during the procurement and development phase

6.1 Value for Money

The ultimate objective of the alliance model is to generate optimum value for the financers and key stakeholders of the project. This does not simply refer to lowest price, but the achievement of or exceeding the set goals – quality, scope, availability, environment, etc. depending on the project – while keeping to the target outcome cost or underrunning it. This combination does not require an exceptional performance from the implementing organisation, if the target outcome cost is not stringent. However, a stringent target outcome cost is a starting point in the alliance contract. Furthermore, the creation of value and the performance of the alliance behind it should be transparently demonstrable from the start of the development phase until the end of the ex-post accountability phase.

In Finnish alliance contracts so far, the generation of value pursuant to the 'Value for Money' concept has been reported separately, not in the Project Plan. However, VALTARI decided to combine both into a single document, since both documents partly deal with the same things. Among other things, the Project Plan presents the incentives scheme created jointly in the development phase, key objectives of the implementation phase and the target outcome cost created in collaboration with the alliance parties. The Value for Money report, which in this case is a chapter in the Project Plan, assesses the ambitiousness and impact of these items; the target outcome cost is assessed by its stringency. We also assess how well the goals set for the development phase are met.

The next chapters assess how well VALTARI has created value for money during the development phase and what kind of capacity VALTARI has for creating value for money in the implementation phase.

6.2 Procurement phase of the alliance contract

6.2.1 Why is Project Part 1B implemented as an alliance contract?

When the procurement model of Trunk Road Vt 12, Southern Ring Road of Lahti, was decided upon, the goal was to have as wide a range of tenderers and best experts on the field as possible competing for the project. To facilitate decision-making, a presentation and discussion event on the project was held on 4 August 2016. During the event, feedback was collected using various methods from organisations operating in the infrastructure sector, including a separate online survey.

A workshop during the procurement phase

The conclusion was that the best way to meet the objectives is to procure the construction of Trunk Road Vt 12, Southern Ring Road of Lahti, in two parts as follows:

- Part 1A that begins from the border of the project area at Soramäki and extends to the eastern side of Okeroinen interchange will be procured as an implementation and execution contract. In an implementation and execution contract, the contractor is responsible for both the creation of the construction plan and the actual construction. At the tendering phase, the owner partner set product-specific requirements for the project. In this way, the owner partner can find the most cost-effective design solution and construction can start rapidly.
- Part 1B that starts on the western side of the Okeroinen interchange, and ends at the border of the project area at Kujala, is technically the most challenging part of the project. The selected procurement model was an alliance, which is well-suited for executing a complex project that contains many financial and other risks.

6.2.2 Procurement process

The procurement process started by the publication of the procurement notice on 20 February 2017. Four consortiums sent a participation application by the deadline, which was 27 March 2017:

- LATU: Lemminkäinen Infra Oy and WSP Finland Oy
- VALTARI: Skanska Infra Oy and Pöyry Finland Oy
- LEKA-12: Destia Oy, A-Insinöörit Suunnittelu Oy and Saanio & Riekkola Oy
- VT 12 LATU: YIT Rakennus Oy, Sito Oy and Ramboll Finland Oy

SCORING OF THE PRELIMINARY QUALITY OFFERS

Tendering consortium	Total score
LATU: Lemminkäinen, WSP	89
VALTARI: Skanska, Pöyry	87
LEKA-12: Destia, A-Insinöörit, Saanio&Riekkola	61
VT 12 LATU YIT, Sito, Ramboll	65

The consortiums that submitted a participation application met the eligibility requirements, and the invitation to submit a tender was sent to the consortiums on 3 April 2017. All four consortiums also submitted a preliminary quality tender by the deadline of 5 May 2017. The tenders received conformed to the detailed Request for Tender dated 30 March 2017. The following parts of the preliminary quality tender were evaluated:

- The suitability of the tenderer's organisation for the project and recognised references
- The experience and suitability of the tenderer's key personnel for the project (appointment of best employees for the project) and the engagement and roles of the key personnel in the project
- The tenderer's expertise in phasing the work, creating schedules and reacting to changes

The owner partner's experts in the workshops of the first phase
Janne Wikström/Finnish Transport Agency, Project Manager
Juha-Pekka Hämäläinen/Finnish Transport Agency, Project Engineer
Esa Sirkiä/Finnish Transport Agency, Deputy Director, Project Implementation Department
Antti Ojanen/City of Lahti, Construction Contracting
Jukka Lindfors/City of Lahti, Chief of Transport Planning
Mauri Mäkiaho/Finnish Transport Agency, Alliance Expert
Heidi Hillner/Finnish Transport Agency, Alliance Expert
Veijo Wallin/Rakennuttajatoimisto HTJ Oy, Construction Contracting
Tuomo Takkinen/Rakennuttajatoimisto HTJ Oy, Construction Contracting
Pekka Nurminen/Finnish Transport Agency, Expert in technical systems
Raine Sallinen/Finnish Transport Agency, Expert in technical systems

Experts who participated in the arranging of the event
Ilmari Sikander/Rakennuttajatoimisto HTJ Oy, facilitator of the event
Petri Roivas/Infrap, neutral observer
Matti Sivunen/Boost Brothers, alliance competence

- The tenderer's ability to innovate and encourage the creation of new solutions, as well as the ability to identify opportunities and risks in the project
- Criticism directed at the cost estimate of the final engineering plan: The tenderer's ability to use the cost estimate in the final engineering plan to identify and analyse factors that affect costs
- The tenderer's expertise in identifying the key objectives that are significant for the project

The tenders were scored on the basis of the evaluation criteria above. The scores are presented in the table above. The assessment group convened on 8 and 23 May 2017 and 29 May 2017. The group consisted of the following persons:

- Janne Wikström, Finnish Transport Agency
- Juha-Pekka Hämäläinen, Finnish Transport Agency
- Mauri Mäkiaho, Finnish Transport Agency
- Heidi Hillner, Finnish Transport Agency
- Esa Sirkiä, Finnish Transport Agency
- Antti Ojanen, City of Lahti
- Tuomo Takkinen, Rakennuttajatoimisto HTJ Oy

Independent observer Petri Roivas was also present at all evaluation meetings.

The first phase workshops were held in Lahti in May 2017. The maximum allowed number of participants for each tenderer was ten (10) key persons of the implementation phase, with at least the key persons stated in the tender participating. The participants from the owner partner's side were representatives of the project group and any necessary experts (table on the preceding page).

The workshops were open discussion events without a formal presentation of the tenders. The workshops included assignments that were carried out in small groups and the participants were given assignments associated with the tender. The material produced during the day was evaluated from the perspective of its usability in the project. The actual alliance capability was not evaluated at this stage.

The decision on which two consortiums shall be allowed to continue in the tendering process was made

	A3 1 Phasing			A3 2 Ideas and opportunities			A3 3 Criticism directed at the cost estimate of the final engineering plan			A4 2 Workshop presentation/ demonstration			A5 Alliance competence			B Price, commission percentage			
	Weighting 15%			Weighting 10%			Weighting 10%			Weighting 20%			Weighting 20%			Weighting 25%			
	Scaled score	**15%**	Score	Scaled score	**10%**	Score	Scaled score	**10%**	Score	Scaled score	**20%**	Score	Scaled score	**20%**	Score	Scaled score	**25%**	Commission, %	**Total score**
LATU Lemminkäinen, WSP	100.00	**15.00**	92.5	89.47	**8.95**	85	58.33	**5.83**	52.5	81.14	**16.23**	71.67	88.17	**17.63**	74.5	100.00	**25.00**	9.75%	**88.64**
VALTARI Skanska, Pöyry	89.19	**13.38**	82.5	100.00	**10.00**	95	100.00	**10.00**	90	100.00	**20.00**	88.33	100.00	**20.00**	84.5	99.59	**24.90**	9.79%	**98.28**

	Quality score	Price score	Total score	Commission for construction, EUR	Commission of planning and design	Comparison percentage
LATU Lemminkäinen, WSP	63.64	25.00	88.64	10,500,000.00	45.0	9.75
VALTARI Skanska, Pöyry	73.38	24.90	98.28	10,000,000.00	52.9	9.79

on 2 June 2017. The two best consortiums, VALTARI and LATU, were admitted to the tender workshops. The two-day workshops were held on 12–13 June 2017 (LATU) and 15–16 June 2017 (VALTARI). The workshops evaluated the tenderers' capability to operate in an alliance, the materials created in the development workshop and the content and execution of the preliminary assignment presented in the invitation. The topics of evaluation were:

- Ability to operate in an alliance, project management ability and collaboration ability
- Ability to integrate with the owner partner and other experts and operate as if they already were parties to the alliance
- Ability to make decisions and generate excellent material

After the workshops, both consortiums submitted a quote by the deadline 27 June 2017. The quote was given as a fixed fee for construction and as a percentage commission for the consulting service. The cost estimate given by the owner partner for the compensated costs of procurement package 1B was approximately EUR 140 million.

The quotes were scored by awarding 100 price points for the lowest bidder. The score of the second lowest bidder was calculated with the formula
100 – [100 x (difference)/(lowest price)], where
Difference = The difference between the commission percentages of the second lowest and lowest quote.
Lowest price = The commission percentage of the lowest quote

To enable comparison of the quotes, the commission quoted by each contractor was converted into a commission percentage by using the ratio of the quoted commission to the contractor's share of the target outcome cost stated by the owner partner in the Request for Tender.

The winner of the tendering was VALTARI consortium set up by Skanska Infra Oy and Pöyry Finland Oy. The final quality score, quote, price score and total score of VALTARI and LATU consortiums are presented in the table on the preceding page.

After the conclusion of the first and second phase, the owner partner arranged a feedback discussion session for all tenderers.

6.2.3 Assessment of the independent observer on the tendering process

The independent observer participated full-time in all workshops of the tendering phase. In the second stage workshops, he paid special attention to the fact that the discussions between the LATU consortium and the owner partner would not benefit the VALTARI consortium in the subsequent workshops. The independent observer's assessment was that in all workshops, the owner partner's actions fulfilled the requirements of equality and non-discrimination extremely well. He had no negative comments on the workshops.

The tenders were evaluated qualitatively in a session held on 19 June 2017 and the quotes were compared in a session on 27 June 2017. An independent observer participated in both sessions. The observer was of the opinion that the evaluated items and matters stated in the summary of justifications on the comparison and scoring of the quality tenders conformed to the Request for Tender and the awarded scores corresponded to the verbal description and were calculated correctly. The independent observer did not take a stand on the actual content of the evaluation. The independent observer also ensured that the procurement documents sent to the tenderers by email were the same as the ones created as a result of the evaluation sessions.

The final statement of the independent observer on the tendering process was as follows:

"I have participated in the tasks, discussions and meetings described above as an independent observer. The process was executed thoroughly and professionally and was open, impartial, equal and non-discriminatory. All phases of the procurement were carried out in the manner stated in advance in the Request for Tender documents. Arrangements, schedules and conditions were equal to all tenderers. The owner partners and tenderers demonstrated good alliance spirit during the process. As an independent observer and as stated above, I have no complaints about the procurement procedure and procurement decision."

6.3 Operation of the alliance during the development phase

6.3.1 Objectives, tasks, schedule and costs of the DPAC phase

The primary task of the development phase is to create a plan on the execution of the project, i.e. a Project Plan. The Project Plan describes how the structures and systems belonging to the technical scope of the contract are planned, designed, constructed, handed over to the owner partner and commissioned, and at what price (target outcome cost) and schedule this will take place. The budget of the development phase was EUR 6 million, which was increased by EUR 1.4 million as the number of tasks increased.

The completion of the Project Plan and its approval in the alliance Steering Committee requires that the development phase can reliably and transparently produce the information required by the plan. Milestones were set in the development phase schedule for the most important items that need to be investigated and decided upon. The milestones of the development phase are described in more detail in the table on the right.

6.3.2 Organisation and decision-making in the DPAC phase

The organisation of the development phase is presented in a chart on the next page. The highest decision-making power lies in the Alliance Steering Committee (ASC). The operative management of the project is the task of the Alliance Project Group (APG) that is led by a Project Manager. Inside the Project Group there is a smaller Core Group that includes representatives from all parties to the alliance. The Core Group will also make decisions

MILESTONES OF THE DPAC PHASE	Date
September 2017	
1. Level 1 of target outcome cost: Details added on quantities and missing cost items in the final engineering plan	Wed, 13 Sep 2017
October 2017	
2. Schedule for 2018 jointly agreed in order to steer construction planning	Wed, 11 Oct 2017
3. Key objectives and their measurement method jointly agreed upon	Tue, 24 Oct 2017
November 2017	
4. Level 2 of target outcome cost: Quantities of the final engineering plan revised • Contains the 1st estimate on technical systems • Includes the additions: Nikula interchange, bridge Y11j, 2 culverts for Trunk Road Vt 4 and field structures at Patomäki	Wed, 15 Nov 2017
5. The design and execution principles of tunnels and technical systems are jointly agreed upon	Wed, 15 Nov 2017
December 2017	
6. Level 3 of target outcome cost: The key alternatives have been investigated	Wed 13 Dec 2017
7. Presentation of the execution and resourcing of construction planning	Wed 13 Dec 2017
January 2018	
8. Level 4 of target outcome cost: The calculation of quantities and costs of the selected technical solution is complete. Risks and opportunities have been defined and costs have been calculated.	Wed, 24 Jan 2018
9. The final key objectives, indicators and their strictness have been jointly agreed upon	Wed, 24 Jan 2018
February 2018	
10. Decision to start construction planning	Wed, 7 Feb 2018
11. Schedule of the EPAC phase has been set	Wed, 7 Feb 2018
March 2018	
12. The subcontracting incentives scheme has been jointly agreed upon	Wed, 28 Mar 2018
April 2018	
13. Level 5 of target outcome cost: Cost estimate completed at each technology group	Wed, 25 April 2018
May 2018	
14. Level 6 of target outcome cost: Final proposition of the APG on the construction costs	Wed, 2 May 2018
15. Start of EPAC phase	Wed, 30 May 2018

between meetings when necessary. Other experts from different technology groups will visit the Project Group as necessary (extended Project Group).

The technology groups will make independent decisions on the matters associated with their respective technology. Only matters that affect the scope, target cost, schedule or risks of the project will be escalated to the APG for decision-making. The integration of technology types within VALTARI took place in the extended Project Group where the technology groups presented the progress of the planning, and design and integration. A scheduling wall was used weekly to integrate the technology groups' schedules. A separate Steering Team for Planning and Design (not shown in the organisation chart below) started in April 2018. The integration of the alliance and the Implementation and Execution Contract takes place in separate integration meetings, where the chairperson is the Project Manager of the Overall Project.

The communication tasks of the Alliance were coordinated in the joint communications team of the Overall Project, with the alliance having a representative in the team.

A list of all matters needing a decision was kept in the project data repository in SharePoint. Whenever a need for a decision was identified, a person in charge of a technology type or another employee of the alliance would record the item on the list with appropriate identi-

ORGANISATION FOR THE DPAC PHASE

<table>
<tr><td>DECISION-MAKING LEVELS</td><td colspan="5"></td></tr>
<tr><td>ASC</td><td colspan="5">Pekka Petäjäniemi (Chair) Jorma Vaskelainen Heli Randell Markus Lipsanen Pekka Räsänen Kaarle Korhonen
Right of discussion only: Janne Wikström Janne Tikkamäki Klaus Einsalo Tuovi Päiviö Tuomo Takkinen (Secretary)</td></tr>
<tr><td>APG</td><td colspan="5">Janne Tikkamäki (Chair) Janne Wikström Antti Ojanen Klaus Einsalo Jukka Jääskeläinen Tuomas Laamanen
Timo Takala Mikko Puttonen Antti Leskinen Juha-Pekka Hämäläinen Ilkka Puustinen Tuomo Takkinen (Secretary)</td></tr>
<tr><td rowspan="2">TECHNOLOGY GROUPS</td><td>Route group
Hanna Kuusisto (Chairperson)
Marialina Norring (Secretary)
Timo Takala
Janne Wikström
Ilkka Puustinen</td><td>Geo group
Jaana Vinter (Chairperson)
Pauli Ahonen (Secretary)
Niko Asikainen
Veli-Matti Uotinen
Riku Hakoniemi
Risto Ketonen</td><td>Skills group
Kirsti Helminen (Chairperson)
Teemu Järveläinen (Secretary)
Jukka Jääskeläinen
Antti Rytkönen</td><td>Tunnel group
Klaus Einsalo/Olli Salo (Chairperson)
Riiko Schamarin (Secretary)
Tuomas Laamanen
Jukka Jääskeläinen
Antti Rytkönen</td><td rowspan="2">Tunnel technology
Jari Oinas (Chairperson)
Jaakko Vuopio (Secretary)
Jari Volanen
Raine Sallinen
Pekka Nurminen
Matti Poutanen
Jussi Borgenström
Tapani Toivanen
Pekka Uutela</td></tr>
<tr><td>Conduit relocations
Jari Volanen (Chairperson)
Kyösti Kanerva (Secretary)
Ilkka Puustinen
Juha-Pekka Hämäläinen</td><td>Landscape design
Matti Ventola (Chairperson)
Hanna Ylitalo (Secretary)
Timo Takala
Arto Kärkkäinen</td><td>Traffic control
Tarja Kojo (Chairperson)
Joel Peiponen (Secretary)
Timo Takala
Marko Kelkka</td><td>Environmental effects
Noora Guzman Monet</td></tr>
<tr><td colspan="6">STEERING OF PLANNING Direction of planning: Klaus Einsalo Chief Designer: Ilkka Puustinen Steering of schedule & information management: Kyösti Kanerva</td></tr>
<tr><td colspan="2">MANAGEMENT SYSTEM Antti Leskinen</td><td colspan="2">TARGET OUTCOME COST Mikko Puttonen Seppo Kaikkonen</td><td colspan="2">IDEA GENERATION PROCESS Kyösti Kanerva</td></tr>
<tr><td colspan="2">SAFETY Ari Seppänen
Safety coordinator: Eija Luoma (HTJ)
Traffic arrangements during construction: Jari Ristiniemi (HTJ)</td><td colspan="2">COMMUNICATIONS/COLLABORATION WITH STAKEHOLDERS Tarja Kojo</td><td colspan="2">PROCUREMENTS Jarno Arkko Kasper Åhman</td></tr>
</table>

The people in bold form the core group of APG: The Extended Alliance Project Group consists of the persons and tasks shown with the same background colour as the core group.

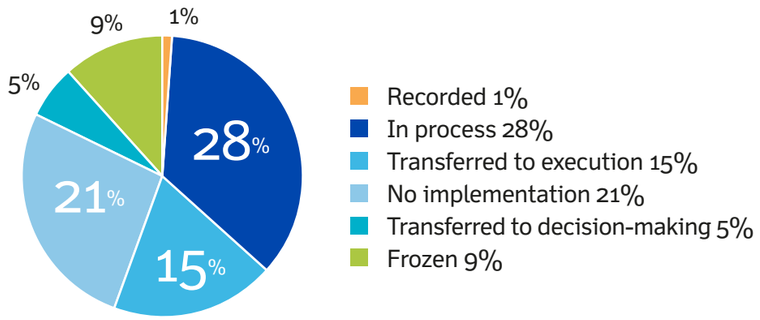
fiers and appendices, and assign it to the correct group for decision-making. The decisions made on the matter were recorded on the list either in the APG or the associated technology group. The matters on the list could be viewed by technology type. The person in charge of the administration of the decision list was Antti Leskinen.

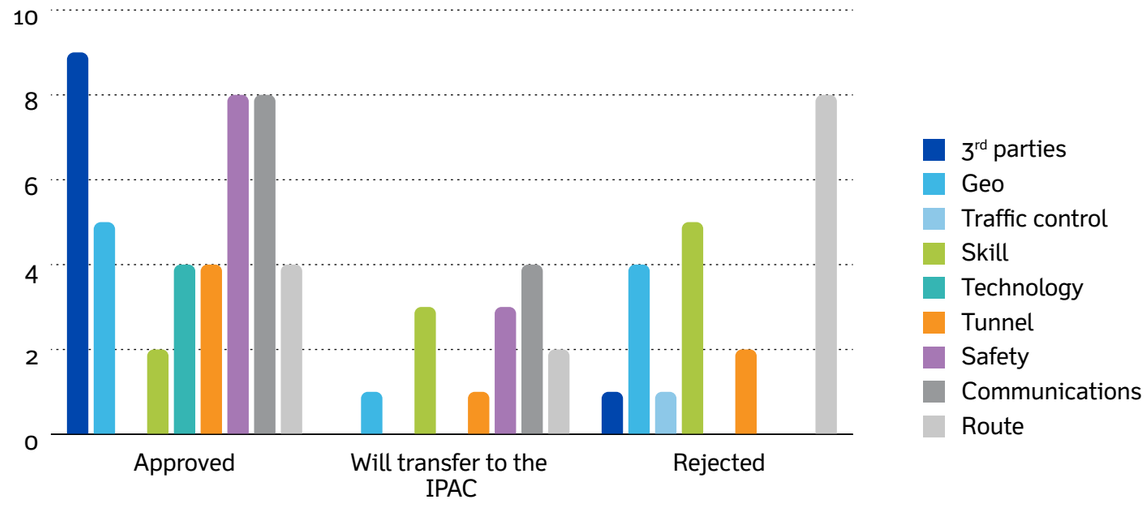
6.3.3 Operating models of the DPAC phase

The **schedule management** tool for the DPAC phase was Last Planner that was maintained in Big Room. Every Monday starting at 12 o'clock, Last Planner was used to verify the actualisation of the agreed tasks and to check and agree upon the tasks for the upcoming weeks. Whenever the schedule was reviewed, the persons in charge of each technology type (or their deputies) presented the matters and the other staff were in the listener role. The tool was used until March 2018 mostly to verify the situation of the schedule, not so much for detecting and preventing potential risks for the schedule. From late March onwards until the end of the DPAC phase, new instructions were issued on the use of the Last Planner, which shifted the emphasis to the detection and prevention of schedule risks. The focus was on the control of the schedule of deliverables that were a precondition for the transfer to the implementation phase and the creation of a phase schedule for the first four months.

Identification of risks took place in technology-type-specific and block-specific risk workshops. The persons in charge of technology identified risks that were assigned a probability and severity as in a regular risk assessment. The identified risks were processed in separate workshops that were a part of the impact assessment of risks and opportunities.

The **alliance managed risks** by systematically identifying risks and analysing the effects of their potential realisation. The risk register was managed by the same person who was in charge of the calculation of target outcome cost.





Status of ideas recorded on the idea list by 28.3.2018 (left) and the distribution of ideas across engineering disciplines and themes (below).

An open **list of ideas** was created in the SharePoint data repository to supports the idea generation process. Every person who participates in the project can list their suggestions for improvement, comment on others' ideas and develop them further. At the end of March 2018, a total of 81 ideas were recorded on the list. These were associated with both of the technical implementation solutions in the project, as well as its operating methods such as safety, Big Room operations, well-being at work, and internal and external communications. The idea list has a person in charge who will appoint a person in charge for the further processing and feasibility assessment of the idea, and will monitor the status of the further processing of the idea. In addition, any ideas that affect the target outcome cost are added to the risk register as opportunities, so that they are taken into account in the process for setting the target cost.

Not all ideas generated in the project have been recorded in the list of ideas, but they have nevertheless been taken into account in the planning and implementation solutions without a special process. This is due to the fact that some alternative design and implementation solutions are not considered ideas, but a part of the normal design and construction process. For example, significant entities missing from the list of ideas are ideas on the shortening of tunnels that were presented during the tendering phase of the project and immediately at the beginning of the development phase. These and other important alternatives were documented separately and their development was monitored in the weekly design meetings held on the first half of the development phase, and in the joint scheduling meeting and the APG, if necessary.

The core of the operation of the alliance consists of the **Big Room operations and weekly schedule**. All persons working in the alliance were familiarised with the project. The key persons of the alliance worked in the Big Room at Alavudenkatu road, Lahti, every week for at least 1–3 days. From the start of the DPAC phase to the end of March 2018, all important meetings and events that required the presence of key persons were scheduled to take place between Monday and Wednesday in the weekly calendar. After this, the alliance adopted a new weekly schedule that reflected the routines of the upcoming EPAC phase, where the active Big Room days are Tuesday, Wednesday and Thursday.

The IT infrastructure of the Big Room covers all conference rooms and workplaces. Conference rooms are equipped with video projectors, projection screens and Clickshare technology that enables a display to be shared quickly and in parallel. In addition, the Big Room has two freely mobile 70" touchscreen TVs that are used as extra displays in meetings and workshops. Two smaller workrooms/meeting rooms are equipped with smaller TVs. At the beginning of the development phase, the premises were equipped with a DNA 100/100 Mb fibre optic cable that was connected to the Elisa MPLS network used by Pöyry. This gave the Big Room access to Pöyry's in-house network and also made WiFi available. Later, fixed network connections were extended to all conference rooms. Furthermore, Big Room has multifunction printers connected to the Skanska and Pöyry network, and a plotter connected to the Pöyry network.

During the development phase of the alliance, certain overarching themes emerged concerning **target value design (TVD)**:

1. The owner partners want to have the route open for traffic by the end of 2020. This was taken into account in resourcing and scheduling. To manage the schedule risks associated with the deployment of technology, an alliance contract was made with Caverion for the duration of the DPAC phase (with an option for a contract for the EPAC phase).
2. A decision was made to deviate from the original scope definition and to include the Nikula interchange in the scope of the Project Part. The City of Lahti emphasised that the interchange should be completed simultaneously with the Ring Road. The scope change presented challenges to the target outcome cost. Construction of the Nikula interchange costs about EUR 6 million, the sum of which had to be met by innovation and strict cost control in the other solutions of the Project Part.
3. For the owner partners and key stakeholders, significant milestones in the schedule are the execution of works near the Laune School during pupils' summer holiday(s) and the partial commissioning of the Kujala interchange in 2019. These milestones were included in the overall schedule of the implementation phase.
4. The uninterrupted flow of traffic on Trunk Road Vt 4 is critically important for the owner partners as well as businesses and residents of the Lahti region, which is why it was selected as the primary factor guiding the planning of works in the implementation phase.
5. The magnitude of the target outcome cost is approximately EUR 170 million.

6.3.4 Setting of the target outcome cost and ensuring its strictness

The target outcome cost was determined on the basis of initial data and plans that became more accurate step by step. The first target outcome cost was calculated at the beginning of the development phase in autumn 2017, on the basis of the final engineering plan. At that point, masses and quantities were verified by means of models. This was repeated during every cost calculation round. A total of six calculation rounds were carried out during the development phase. The last target outcome cost was calculated in May 2018, yielding a final amount of EUR 172,358,650.

Between the calculation rounds, the input data and plans were made more detailed based on observed uncertainties and risks. At the same time, new design solutions were brainstormed on the basis of the final engineering plan in order to drive costs down. Brainstorming took place in the technology groups, in the Big Room among the designers, and in separate idea workshops.

A characteristic feature in the calculation process of the target outcome cost was that, during each round, risks could be eliminated by redesigning and new savings could

be achieved by brainstorming and the assessment of alternatives, which resulted in significant cost reductions. However, previously undetected cost items were also discovered during the process. As a result, the target outcome cost did not always fall between the rounds, in spite of the identified cost saving opportunities.

An external cost expert, Heikki Koski of TamRap Oy, was available for the alliance during the entire development phase. He monitored the target outcome cost process in meetings chaired by the person in charge of the steering of the target outcome cost. The calculations concerning bridges and retaining walls were inspected by B. Eng (Civil Engineering), Mikko Östring.

The external cost expert reviewed the cost estimates and concentrated on labour costs, joint procurement costs, project costs, subcontracting and risks and opportunities.

Calculation and revision of costs progressed simultaneously with the creation of plans and bills of quantities. The cost expert mainly verified the calculation independently, based on the materials supplied by the head accountant. According to the account of the external cost expert, the service provider clearly and openly described the calculation principles in the follow-up meetings.

6.4 Results of the Value for Money principle during the development phase

6.4.1 Achieving of the objectives set by the owner partner

The development phase began in early August 2017. The milestones of the development phase schedule were met – not completely on schedule, but nevertheless early enough to enable decision-making and staying on schedule in the development phase. The decision to switch to the implementation phase was taken in the alliance steering committee on 25 May 2018.

Other objectives of the owner partner were:

- Inclusion of the Nikula interchange within the technical scope of the project
- Completion of Project Part 1B by the end of 2020
- Target outcome cost approximately EUR 170 million
- Highest possible availability during work and after completion of the project
- The duration of the development phase is approximately one year

The overall schedule, worksite logistics and target outcome cost of the Project Part have been created to meet all of the owner partner's objectives listed above. The owner partner's objective for the duration of the development phase was met, since the development phase lasted only nine months. The duration was kept so short, because we wanted to take full advantage of the summer season in the construction works of the first implementation phase. All mass transfers within the worksite will take place via the worksite roads, which will improve the usability of roads and streets that are kept open for traffic during construction.

6.4.2 Budget of the DPAC phase

The budget of the DPAC phase was EUR 6 million. The actuals exceeded the budget by approximately EUR 1.4 million. The overrun was caused, among other things, by the increase in scope of the Project Part, the excavation of investigation tunnels already during the DPAC phase, a wider range of site surveys and groundwater test pumpings than those specified in the

Drilling equipment being calibrated at Liipola in April 2018.

original plan, and the start of construction planning in early February 2018.

The construction of Nikula interchange was not included in the original scope of the Project Part, but its significance as part of a functional traffic system was emphasised in the Request for Tender. For the City of Lahti, it is important that the interchange be completed at the same time as the Ring Road, which is why a decision was made to include the interchange in the scope of the Project Part.

Construction planning was carried out to a larger extent in the DPAC phase than originally intended. The reason was the compression of the schedule of the implementation phase and the desire to efficiently utilise the first construction season that began in June 2018.

The decision to start the excavation of research tunnels during the development phase was based on the Value for Money principle. As a result, the estimated duration of the implementation phase could be shortened by approximately two months, and information on the characteristics of the rock and the vibration effects caused by the excavation was obtained. As a result, the characteristics of the rock are known better, the excavation process works routinely from the start of the EPAC phase, excavation has progressed close to the actual tunnel alignment, and the excavation of the traffic tunnel could begin immediately.

In the Laune area, the groundwater table must be lowered for the duration of the works. Small-scale test pumpings were conducted at Laune after the start of the DPAC phase in autumn 2017. The pumpings were used to test how the groundwater table reacts to pumping. However, the results did not provide certainty that the pumping volumes granted under the water permit are sufficient to achieve the desired lowering of the groundwater table. After the turn of the year, we decided to carry out more test pumpings on a wider scale than originally planned, in order to verify the situation and eliminate the associated risks included in the target outcome cost.

6.4.3 Analysis of the target outcome cost and demonstrating its stringency

This chapter analyses the target outcome cost process and the labour costs included in the target outcome cost, provisions made for an increase in cost level, the schedule of the implementation phase, the handling of risks and opportunities, procurements, project costs and joint costs, and the planning of the development phase. The analysis is based on a report written by Heikki Koski, an external cost expert.

LABOUR COSTS

The external cost expert verified the work methods, material costs, efficiency of work, material consumption coefficients and overlaps between the technology types used in the labour cost calculations. Subcontracting was reviewed in greater detail in the calculation meetings for each technology type. The service provider stated that the subcontracting inquiries were comprehensive. The proportion of subcontracting among labour costs is large.

To estimate the efficiency of work, reference information from previous worksites was used for both own works and those works for which no subcontractor offers exist.

The material consumption coefficients used where not theoretical, but based on the service provider's experiences.

Construction of a sieve tube well related to test pumping of groundwater and lowering of the groundwater table during the development phase.

PROVISIONS MADE FOR AN INCREASE IN COST LEVEL

An increase in cost level has been hedged against by binding procurements and subcontracting contracts. For procurements to be made later, hedging has been achieved by including a cost increase provision in the target outcome cost. Each year in the EPAC phase has a separate estimate of a cost level increase. It is difficult to estimate the increase in cost level. The increase must only take account of those areas that cannot be hedged against by procurements of subcontracting agreements.

SCHEDULE

The construction schedule is tight. A tight schedule is positive from the cost perspective. The short turnaround time of the contract will reduce the cost. On the other hand, an excessively tight schedule poses a risk. The project costs and joint costs will increase from the cal-

culated value, if the construction time increases. The service provider has expressed their concerns on several occasions about the tightness of the schedule, particularly concerning the start of the works.

RISKS AND OPPORTUNITIES
Risks have been priced at a reasonable level considering the size of the project. The highest individual cost risk is the quantity risk at EUR 1.4 million. As the degree of completion of planning is low, the basic assumption is that the calculated quantities are on the low side. Incomplete structural solutions are partly also quantity risks, which generates a slight overlap in risks. It is possible that quantities have been calculated with a safety margin, due to the incompleteness of the plans.

SUBCONTRACTING AND MATERIAL PROCUREMENTS
Approximately 55% of subcontracting and material purchases were agreed during the DPAC phase. A high proportion of subcontracting gives protection against increases in costs and transfers the risk of work efficiency to the subcontractors. The downside is that we also lose the opportunity to achieve cost savings in the EPAC phase. According to the cost expert, it is better that most of the procurements are already determined during the DPAC phase.

PROJECT COSTS AND JOINT COSTS
The service provider has allocated a sufficient number of persons to the project, but not unreasonably many. The table of costs presented by the head accountant of the service provider was realistic and did not contain extra cost items. The calculations were detailed and well-planned.

PLANNING AND DESIGN
The service providers' planners and designers had strong competence and know-how, enabling them to perform planning in the DPAC phase. However, the resources allocated for planning were not wholly sufficient in all areas. On the other hand, the service provider says that some of the total number of hours reserved for planning were left over. The degree of completeness of the planning is a cause of uncertainties in the bills of quantities.

SUMMARY
The calculation of the cost estimate demonstrated the alliance spirit. Collaboration between the planners, designers, constructors and representatives of the owner partner was good. The alliance succeeded in generating efficiencies and cost savings during the development phase. Based on the materials and cost calculations received, the external cost expert suggests that the cost assessment dated 25 May 2018 be approved as the target outcome cost.

6.4.4 Risks of the project and their distribution

The calculated target cost outcome includes the execution of work, provided that the administrative decisions listed above enable the execution.

- Change E to the final engineering plan, approval given in 2018 (soil dumping areas)
- Potentially change F to the final engineering plan, approval given in early 2019 (details of the Patomäki tunnel area)
- Change to the environmental permit pursuant to the Water Act in early 2019
- A provision is needed for a separate bonus to be awarded to the subcontractor of technical systems if they reach their key objectives; the provision made by the owner partners will be EUR 360,000. The VALTARI alliance will be responsible for any incentive effects resulting from an underrun in the target outcome cost of technical systems.

6.4.5 Analysis of the indicator values of the incentives scheme

The core of the alliance's incentives scheme consists of key objectives (KO) and the strictness of their value indicators. The key objectives are presented in chapter 5.2 Key objectives and performance indicators. VALTARI's key objectives and weights are:

1. Schedule and phasing 49%
2. Safety (KO 32%, positive incentive 9%) 41%
3. Lack of disruptions on the completed road 10%

The performance level scale (for example -100…0…+100) of the indicators will be set as follows

- The minimum requirement level (0) is better than the level usually attained in the infrastructure sector
- The bonus paid in EUR for performance exceeding the minimum level corresponds to the benefit generated for society/owner partner.
- The sanction levied for performance poorer than the minimum level corresponds to the lost benefit
- For each indicator, a score of +100 requires a breakthrough
- For each indicator, a score of -100 indicates a complete failure.

The indicators for the key objective **'Schedule and phasing'** are associated with the time of completion of the

Kujala interchange (24%), the streets and pedestrian and cycle paths K4, K5 and K19J in the vicinity of Laune School (15%), and the time of completion of the entire Project Part (10%). Two of the indicators, Kujala and the entire Project Part, emphasise the early realisation of land use benefits resulting from completion. In the Laune School area, the primary focus is on the health and safety of the pupils of the school. This key objective has the highest weight, 49%.

The indicator values associated with the schedule are strict. For example, top-level performance at the Laune School area requires that the works reach completion during the first six months. This means that the works start at full pace immediately at the beginning of the EPAC phase, and full advantage is taken of the school holiday period. At the Kujala interchange, top-level performance means that Vanhanradankatu, ramps 5–9, the intersection bridge and the widening of Trunk Road 4 can be constructed in a year without unreasonable interference to the traffic on the Trunk Road.

The key objective has a major steering effect on the operations and performance of the alliance due to its large weight. The largest sums of money are associated with the Kujala interchange and the streets near the Laune School.

The total weight of **safety**-related key objectives and positive change agents is 39%. The indicators of this objective relate directly to the safety of the worksite in the implementation phase (22%), safety of the ex-post accountability phase (2%), participation of employees in safety activities (7%) and continuous improvement of safety (7%). The only reasonable goal for employee safety is zero occupational accidents. Safety is important at all worksites and also authorities supervise it.

Safety at infrastructure worksites is also important from the perspective of the attractiveness of the infrastructure sector and availability of workforce.

VALTARI's contract contains high-risk works, such as tunnel excavation. Hundreds of people from dozens of different companies will work at the worksite. A challenge for the alliance is to make all employees, from the smallest subcontractor to the Project Supervisor of the alliance, aware of and committed to a joint safety culture and its continuous improvement. This is further complicated by the tightness of the schedule.

The indicator values for the safety objective are set so that level 0 can be achieved with a good safety culture. Top-level performance is probably almost impossible to reach based on any of the indicators. The indicators are very strict, considering the nature of the worksite – a large, long-term worksite that includes employees from a range of different working cultures and high-risk works. The key objective therefore has a strong steering effect on the safety-related activities of the worksite.

The key objective **Lack of disruptions on the completed road** has a weight of 12%. This objective is completely

related to the ex-post accountability phase and daytime traffic on Trunk Roads 12 and 4. This objective encourages the alliance to plan and implement all solutions in a way that completely eliminates unforeseen repair works after the road has been commissioned for traffic, or, if this is not possible, such repairs can be done during the hours with the lowest traffic volumes. This objective applies to the tunnels in particular, since any unforeseen repairs in tunnels may, at worst, result in the closing of the tunnel, causing a major disruption to traffic. During the development and implementation phase, the attainment of the objective can be facilitated by selecting tried and true methods and solutions and delivering the highest possible quality.

A top-level performance requires that no unforeseen repairs are needed between 6 am – 9 pm, during the ex-post accountability phase. The indicator for this objective could not be any stricter. However, it is completely possible to attain this objective. A complete failure would mean that one third of peak traffic hours (6 am – 9 pm) would be disrupted to some extent.

The weight of the key objective is reasonable, considering the way in which top-level performance can be achieved. The maximum bonus is therefore moderate. Likewise, the sanction is also moderate. Both sums, however, are large enough to encourage the alliance to strive towards sustainable, high-quality solutions.

In conclusion, it can be said that the key objectives selected among all objectives of the Overall Project emphasise the early realisation of land use benefits for the Lahti region as a result of the completion of the road, worksite safety and minimisation of disturbance caused by construction for local residents. The performance level scale of the key objective indicators is strict and the bonuses and sanctions are in line with the benefits gained by society/owner partners as a result of good performance, or lost due to poor performance.

Two central themes are missing from the key objectives: the prevention of the contamination of a groundwater area important to water supply and the minimisation of traffic disruptions (duration 24 hrs or more) caused by the construction work. However, both of these themes are included in the incentives scheme. A total interruption of traffic on Trunk Road 4 is defined as a major negative modifier, and so are a total interruption of train traffic on the Lahti–Kouvola track and the contamination of groundwater at Laune. Furthermore, the minimisation of time-to-completion at the Laune School and works on Trunk Road 4 will also facilitate the minimisation of disruptions during construction.

Together, the key objectives and major negative modifiers will create an incentives scheme that has a strong steering effect towards the objectives associated with the improvement of everyday life and the urban habitat of the Lahti region and its residents.

6.5 Assessment of the success of the procurement and development phase

According to the independent expert who supervised the procurement phase, the arrangements, schedules and conditions of the procurement phase were equal for all tenderers and the entire procurement process was completed openly and professionally. A sufficient number of tenders were received, four in total. Final bids were received from the two consortiums that made it into the last phase. The bids were of around the same magnitude. The procurement phase can be considered a success.

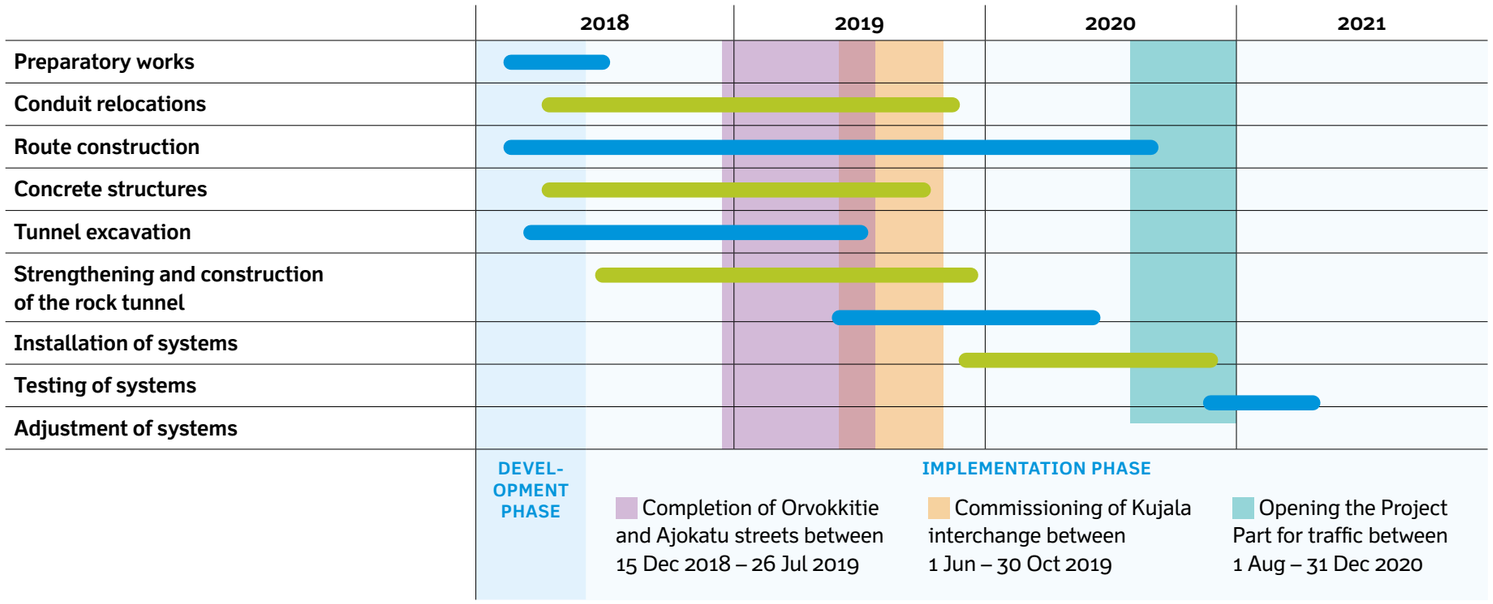
The development phase can also be considered a success, even though its budget was exceeded by EUR 1.4 million. The overrun was caused by a decision to invest more on analyses that enable risks to be designed out, construction planning that enables the EPAC phase to be started quickly, and the excavation of research tunnels. According to the independent expert, the outcome of the development phase was an appropriately stringent target outcome cost and an incentives scheme that encourages the attainment of the correct objectives for financiers and key stakeholders. The grading scale of the key objective indicators is strict, and earning maximum bonuses is not easy on the basis of any of the indicators – in fact, in the case of some indicators it is almost impossible.

7 Implementation of the project

7.1 Overall schedule

According to the overall schedule approved in the Project Plan, the implementation phase lasts for three years and three months. However, the road will opened to traffic almost a year before, i.e. in November 2020, and any remaining finishing work will be completed by September 2021. The total duration of the project is mainly affected by the construction of rock and concrete tunnels and the installation and deployment of technical systems. The construction of routes and interchanges is scheduled so that they are complete no later than the commissioning of the tunnels. The milestones of the alliance contract and its critical path are presented in the table on the right.

OVERALL SCHEDULE OF VALTARI



MILESTONES OF PROJECT PART 1B

	Milestone	Completed
1	Permission for the 20 kV line to go under the track	1 Jun 2018
2	Conduit relocations at Ajokatu completed	1 Jun 2018
3	Start of the excavation of the Liipola traffic tunnel on the western part	15 Jun 2018
4	Relocating the natural gas pipeline at Patomäki	31 Jul 2018
5	Beginning of pile driving at Patomäki tunnel	22 Aug 2018
6	Construction of concrete structures of the Patomäki tunnel begins	24 Sep 2018
7	Start of the excavation of the Liipola traffic tunnel on the eastern part	30 Sep 2018
8	Construction of the concrete structures of the intermediate tunnel at Liipola	4 Dec 2018
9	Groundwater is lowered to the planned level at the Laune pan	31 Dec 2018
10	Blasted rock structures at ramp E6R7 completed	29 Apr 2019
11	Laune pan completed	15 May 2019
12	Western entrance of the Liipola tunnel completed	29 May 2019
13	Eastern entrance of the Liipola tunnel completed	29 May 2019
14	Orvokkitie road and Ajokatu street completed (S25 can be commissioned for traffic)	26 Jul 2019
15	Concrete structures and waterproofing of Patomäki tunnel completed	12 Aug 2019
16	Installation of technical systems at Liipola begins	1 Sep 2019
17	Construction of technical premises at Liipola completed	10 Sep 2019
18	Filling of the surroundings of the western end of Patomäki tunnel, at the location of the technical premises, completed	15 Sep 2019
19	Construction of the western technical premises Patomäki completed	19 Oct 2019
20	Kujala interchange commissioned for traffic (KO)	31 Oct 2019
21	Telecommunications connection to Kouvola completed	1 Dec 2019
22	I/O testing of telematics in the Design and Implement contract area completed	30 Mar 2020
23	Functional testing of systems begins	4 May 2020
24	Asphalt paving completed	31 May 2020
25	Road safety audit completed	15 Sep 2020
26	Commissioning permit received	28 Oct 2020
27	Trunk Road Vt 12 commissioned for traffic	1 Nov 2020
28	Project completed	30 Sep 2021

7.2 Planning and design

7.2.1 General

Planning consists of supplementing and creating construction plans for routes and structures belonging to the technical scope of the project. During the development phase, the plans are created down to a level of detail that allows the target outcome cost to be determined reliably enough. During the implementation phase, the plans will be further refined into construction plans, in collaboration with the constructor. The construction plan will use the GK27-ETRS coordinate system and the N2000 height system.

7.2.2 Initial data

LAND SURVEYING

During the development phase, the terrain data from the final engineering plan was supplemented with land surveying throughout the project area, until the precision of the data was sufficient for creating a construction plan. The most important objectives were surveying for the terrain model for Trunk Road Vt 4, determination of pavement thicknesses, and surveying the location and elevation of underground conduits.

During the implementation phase, supplementary surveying will be carried out at individual sites, for planning if necessary.

SOIL SURVEYS

A significant number of site surveys and laboratory test were performed during the development phase, to determine the soil conditions down to the precision required by the construction plan. To investigate the settlement characteristics of the soil in the Kujala area, two test embankments were constructed during the development phase and their settlement was monitored for six months. In addition, the groundwater conditions of the Patonäki, Laune and Liipola area were investigated by means of groundwater tubes and test pumpings. The locations of bridges and conduits will be examined in more detail during the implementation phase to assist in the construction of the types of foundation.

OTHER INITIAL DATA

During the development phase, the technology types supplemented and updated the initial data they needed. The initial data was collected into an initial data model. The analysis of the initial data paid particular attention to the verification of the coordinate and height system of the received data. If necessary, the coordinate and height data was converted to conform to the system used in the project.

Any deficiencies in the initial data detected during the implementation phase will be supplemented at that stage.

7.2.3 Design principles

The construction plan is based on preliminary construction plans and further specifications to the final engineering plan created during the development phase.

Design principles created during the development phase guide the planning and determine the technical

Illustration of the Kujala interchange viewed from the east.

level of the plans. The design principles were made more detailed during the development phase and include jointly agreed technical solutions. The design principles will be supplemented as necessary during the entire implementation phase and will act as specifications for the work descriptions and quality requirements of the individual works required in the project.

7.2.4 Steering and management of the planning process

The Steering Team that was in charge of the management and steering of planning in the development phase will continue operating during the implementation phase. The Steering Team of Planning and Design consists of the Planning Project Manager, Chief Designer, the people in charge of the technology types and other experts as necessary. The task of the Steering Team is to monitor that planning proceeds on schedule and that sufficient resources are available. The Steering Team is in charge of integrating the plans of the different technology types. Another important task of the Steering Committee is to pass information between the various technology types, and to integrate planning and construction. Plans for solutions are created in technology group meetings and workshops. Selection of a solution among the options also takes place in technology workshops.

The planning and inspection process is described in the picture below. The planning solutions are selected jointly already during the planning phase, which eliminates the need to adjust the planning principles during self-inspection. The role and participation of representatives from the Finnish Transport Agency and a Centre for Economic Development, Transport and the Environment will be agreed upon separately for each technology type. The inspection process will be documented in the self-inspection library in SharePoint.

PHASES OF THE PLANNING PROCESS

Joint selection of design solutions	Designer's review	Internal review at the design bureau	Self-inspection	Status review every Wednesday (core team)	Potential external review
• Planners of each technology type together • Designer/constructor/owner partner together • Labour management participates in the selection of solutions • Primary material suppliers and subcontractors • External reviewed participates already at an early phase		• Planners and people in charge of technology types (for example common route/geo, bridge/geo) • Planning assistant TO BE AGREED BY TECHNOLOGY TYPE	• Planners and people in charge of technology types • Chief Designer • Person(s) in charge of construction technology • Person in charge from the Finnish Transport Agency TO BE AGREED BY TECHNOLOGY TYPE		
1. Integrated design solutions that are optimised for the entire Project Part 2. Early agreements upon solutions that have a significant effect on the target outcome cost and principles that affect the planning of the entire project 3. Taking key objectives into account		1. Design solutions are functional and correct 2. The required matters are presented 3. The content of the design documents is uniform (maps, cuts, lists, model data) 4. Verification of integration	1. Matters requiring special attention during construction 2. High-risk targets 3. Construction schedule	1. Plans and models up-to-date 2. Version management of the design and model materials 3. Recordings, observations and justifications for solution selections in SharePoint	
Grounds for selecting a design solution, comparison of and decisions on design solutions recorded in SharePoint		Recording of observations and items to correct in the internal review		Review and completion of records	
Draft plans in SharePoint		Supplementation or correction of plans based on the review			

7.2.4 Model-based planning

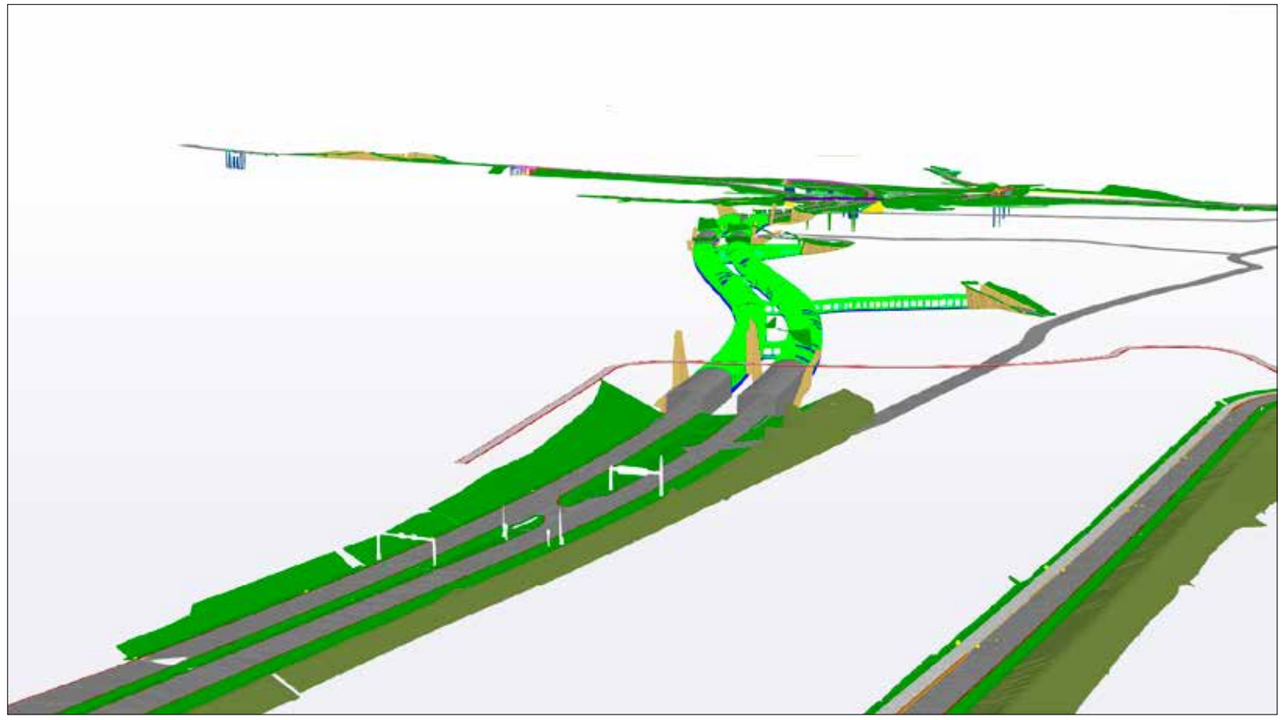
The design and construction of Project Part 1B utilise model-based planning where implementation models are created from the design models.

INITIAL DATA MODEL

The initial data model contains data obtained or measured from different sources pursuant to the Guideline on General Requirements for an Infrastructure Model (YIV 2015). The initial data model will be supplemented as necessary during the implementation phase.

COMBINATION MODEL

A combination model was created during the development phase in the Trimble Connect cloud service. The combination model brought together the design models of the different technology types and some selected initial data. The combination model is used for transmitting planning information between technology types and ensuring that the plans are integrated. The combination model also enables us to visualise solutions and helps in the planning of construction works. The combination model will be updated regularly with any changes to the design models, and will be kept up-to-date throughout the implementation phase.



A view of the combination model towards east (Trimble Connect)

PRESENTATION MODEL

A visual presentation of the completed Project Part. A video will be created from the presentation model.

DESIGN MODEL

Planning will take place by modelling the structures, equipment and devices into a design model. The design models will become more detailed as planning proceeds, and they ultimately serve as input for creating survey data for construction. The modelling and utilisation of models in construction will take place at a different level of precision, based on the technology type.

MACHINE CONTROL MODEL

Based on the survey data, the route structures will be converted into machine control models. Machine control brings benefits in construction quality, quality assurance, collection of as-built data and monitoring the progress of work.

AS-BUILT MODEL

Finally, the collected as-built data and plans will be used to create an as-built model for the maintenance organisation of the road, to be utilised in maintenance tasks.

7.2.5 Construction plan

The designs of technology types vary in the level of completion reached during the development phase. The design of the structures belonging to the route engineering, geotechnical and bridge engineering plans was partly started already during the development phase. In all engineering disciplines, the technical solutions were specified and agreed upon in order to form the basis for the structural plan. During the implementation phase, the construction plans are supplemented with measurement data to facilitate construction.

The table below shows the content of the construction plan and its subcomponents in the order of the Table of Contents.

7.3 Construction

The worksite is divided into five blocks A–E. Blocks A, C and E are mostly route blocks, and B and D are tunnel blocks. The implementation phase will begin in June 2018, and construction will start at full swing in Kujala, around Laune School and Patomäki. The construction of the Liipola rock tunnel was begun during the development phase, through the excavation of research tunnels.

At the start of the implementation phase, works will start in all blocks with varying intensity.

Plan part	Content and special features
R1 Basic data	• Table of contents of the construction plan • Reports of the safety audits of the plan
R2 Common documents	• Description of road construction works, the work descriptions for each technology type will be located in each part of the plan • Design principles and associated lists of structural parts • Typical structural cross sections of roads and streets
R3 Main road, R4 Other highways, R5 Private roads, R6 Streets	• R3 contains the plan maps and Trunk Road Vt 12 plans • R4 contains the plans for other highways (M2 Helsingintie and Trunk Road 4) and the plans for the interchange ramps • R5 contains plans for private roads • R6 contains the plans needed for the changes and supplements of the streets of the City of Lahti
R7 Tracks	• Changes caused by the new underpass to the Lahti–Loviisa track
R8 Measurements	• Measurement and model data for machine control models, etc.
R9 Foundation engineering	• Plans for preloading and lightening of routes • Relocating the streambed of River Porvoonjoki • Excavations of the Patomäki and Liipola concrete tunnels

Plan part	Content and special features
R10 Management of waters	• Draining plan maps, longitudinal sections of the required stormwater drains • Longitudinal sections of Vartio-oja creek and drawings of the large culverts of Vartio-oja • Separate system for regulating the groundwater table at the groundwater pan at Laune • Groundwater protection at Laune
R11 Conduits and devices	• Necessary plans for relocations of conduits of Lahti Energia and Lahti Aqua
R12 Road environment	• Landscaping the tunnel exits and entrances • Treating of the environment of River Porvoonjoki • Treating the landscape types to preserve their characteristics
R13 Masses and quantities	• Pile-specific mass tables for each route serve as input for examinations in Dynaroad
R14 Traffic arrangements during construction	• General traffic arrangements in collaboration with the constructor
R15 Bridges	• Four bridges across bodies of water: S18, S22 and S201 across River Porvoonjoki and S38 across Paskurinoja creek • Two bridges (S31 and S37) to be widened and repaired on Trunk Road 4, and an underpass to be demolished
R16 Other bridges and retaining walls	• Plans for pile slabs, noise barriers and the abutment of Nikula • Plans for the groundwater pan at Laune

Plan part	Content and special features
R17 Lighting	• Special illumination of bridges S28 and S35
R18 Fixed traffic control	• Changes caused by the Kujala interchange to the signs on Trunk Road 4 • Backup route signs in case of tunnel closure
R19 Traffic light control	• Traffic light control of the ramp connections of the Nikula and Laune interchanges
R20 Telematics	• Devices required for tunnel closure, lane-specific signs
R21 Tunnels	• Plans for Patomäki and Liipola tunnels
R22 HVAC systems and fire safety of the tunnels	
R23 Electrical, telecommunications and safety systems of the tunnels	

7.3.1 Key phases of work by block

Works will start in each block at the start of the implementation phase. The tasks on the critical path are mainly associated with the implementation of tunnels and technical systems. The following is a list of the most important phases of work by block.

BLOCK A, NIKULA

- Conduit relocations and construction of worksite roads during 2018
- Relocating the streambed of River Porvoo and filling up the old streambed during 2018
- Pile driving and construction of S22 will begin in October 2018. The other bridges (S201, S20, S18 and S101) will be constructed in spring and summer 2019
- Pile driving in the area west of Trunk Road 140 will be completed by February 2019
- Construction of interchange ramps E4R1, E4R2, E4R3, E4R4 will start in summer 2019
- The construction of routes for Trunk Road Vt 12 and M2 will begin in 2019. M2 will be paved late 2019 and Trunk Road Vt 12 in the summer of 2020.

BLOCK B, PATOMÄKI

- Conduit relocations and construction of worksite roads during 2018
- Soil cuts, pile driving and construction of the bottom slab at the Patomäki concrete tunnel will begin in summer 2018. The construction of the Patomäki concrete tunnel will continue until the end of 2019. The tunnel will be paved in August 2019.
- K2, K3, K11J B will be built in 2019, the remaining K26J and K28J in 2020
- The Patomäki field area will be finished in 2021, and technology will be installed in the tunnel in 2020

BLOCK MAP

BLOCK C, LAUNE

- Conduit relocations and construction of worksite roads during 2018
- Route construction will be started on Trunk Road Vt 12, K4 at the Laune School Area, K5, K7, K8 and K19J in summer 2018 and they will be completed mostly by the end of 2019
- The construction of interchange E5R4 will begin in 2018
- S25 will be constructed in 2018. Bridge S38 over Paskurinoja creek will be constructed in 2019
- The construction of the concrete pan that protects the groundwater at Laune will begin in 2019
- The construction of interchange ramps E5R1, E5R2 and E5R3 will start in spring 2019
- The interchange will be paved in 2019, and Trunk Road Vt 12 will be paved in August 2019
- Installation of technology in 2019

BLOCK D, LIIPOLA

- Worksite roads and conduit relocations will be completed in 2018
- The excavation of research tunnels will begin in spring 2018 and the excavation works will continue as a normal tunnel excavation until summer 2019
- The construction of the concrete parts of the concrete intermediate tunnel at Liipola is planned for December 2018 to October 2019
- The construction of route structures and installation of technology in the tunnel will occur in phases in 2019 and 2020

BLOCK E, KUJALA

- Worksite roads will be constructed and conduits will be relocated in the spring and summer of 2018
- The excavations required by the widening of Trunk Road 4 will start in July 2018 and will be completed by spring 2019, after which the construction will proceed to road structures
- Crushing will begin at the eastern end of the Liipola tunnel in autumn of 2018
- Pile driving will start in June 2018 and will be completed in February 2019
- The construction of S35 and S29 will start in summer 2018; S28 and the other carriageway of S37 on the second half of 2018; S30 and the Pippo railway bridge in early 2019 and S31 and the other carriageway of S37 in spring 2019
- Paving will start in May-June 2019
- K6, E6R5, E6R6, E6R7 and E6R8 will be commissioned for traffic first in autumn 2019; E6R1, E6R2, E6R3, E6R4 and E6R9 will be commissioned for traffic later

7.3.2 Traffic arrangements during construction

The planning of traffic arrangements during construction will follow the guidelines of the Finnish Transport Agency, guidelines of the City of Lahti on traffic arrangements on the street network and safety regulations and other regulations created for Project Part 1B. The traffic arrangements will be planned by the alliance. The arrangements affecting highways will be inspected by an expert consultant of the Finnish Transport Agency and arrangements affecting the street network will be arranged by the City of Lahti.

Plans will be created of the construction-time traffic arrangements and the plans will be processed and approved in a traffic arrangement workgroup that holds meetings regularly. The parties that will be invited to participate in the workgroup are an expert consultant of the Finnish Transport Agency, representatives of the City of Lahti and a representative from the traffic unit of the Centre for Economic Development, Transport and the Environment.

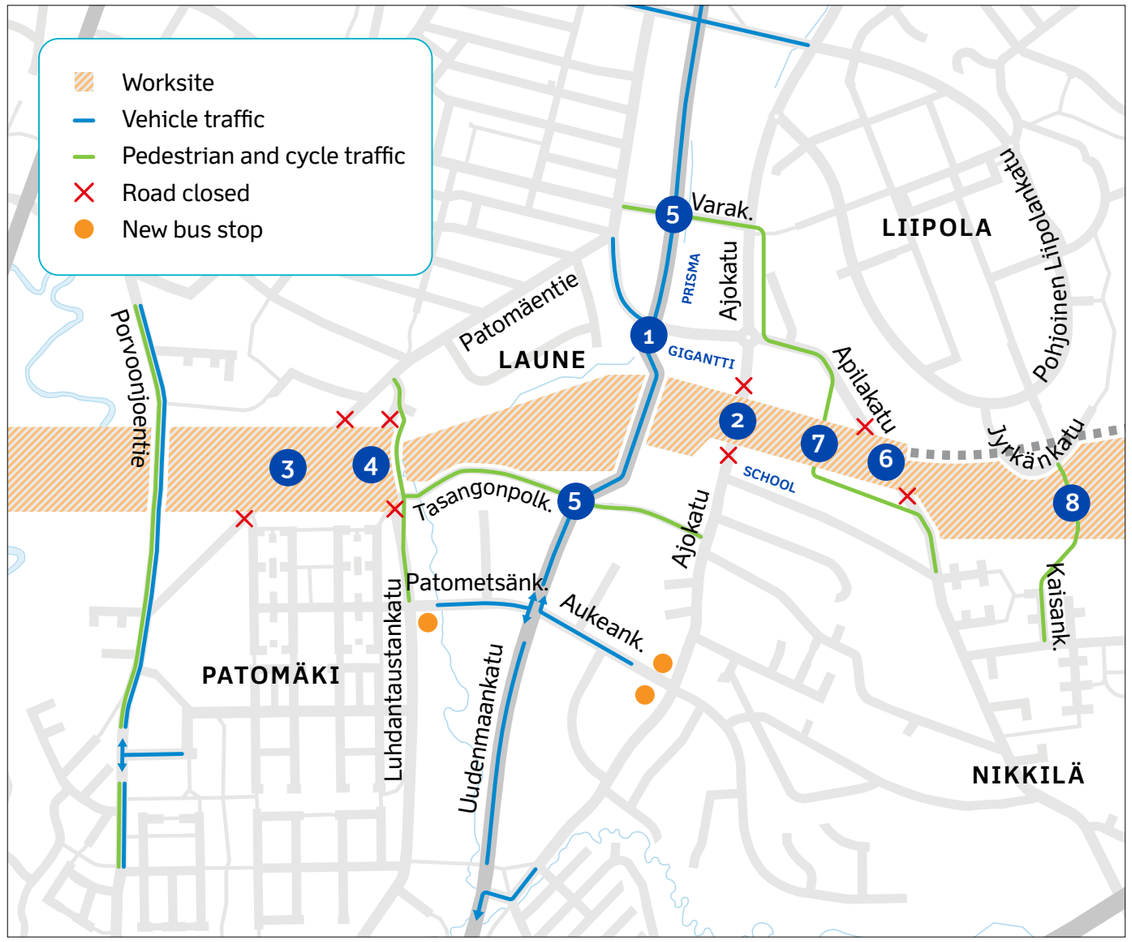
The plans on the agenda will be completed and made available for the experts at least two weeks before the traffic arrangements are implemented. Circumstances that need urgent processing can be processed on a tighter schedule over electronic messaging channels.

An up-to-date list will be kept on approved and available traffic arrangements.

The construction-time traffic arrangements will be reviewed in the field before they are commissioned and documented in the worksite journal. On the field, special attention will be paid to the functionality of the arrangements and their compliance with the plan. Any changes will also be updated to the plans and, if necessary, approved separately in the traffic arrangements workgroup. The condition of long-term traffic arrangements will be reviewed at least once a week, and even more frequently before any foreseen traffic peaks.

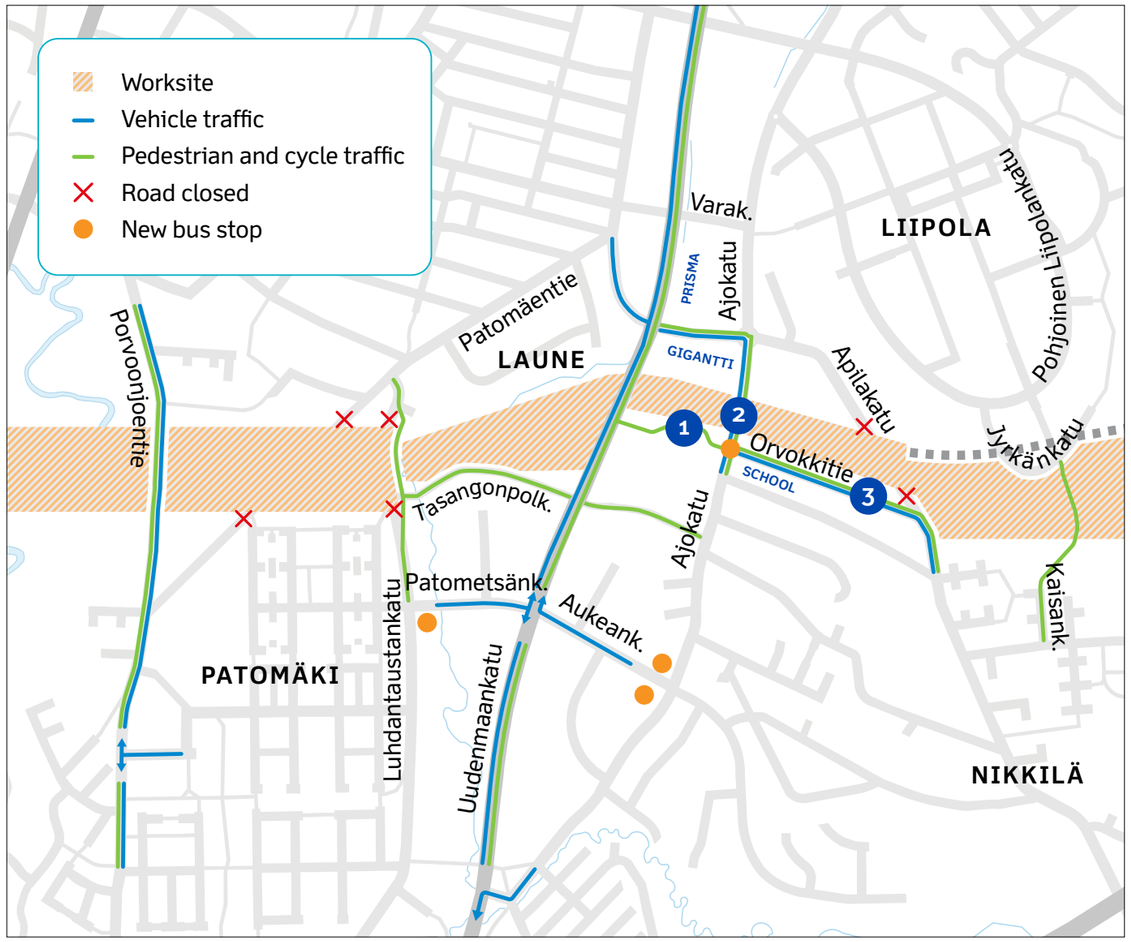
On the highway network, the most significant traffic arrangements will be made on Trunk Road Vt 4 and highway 140 during 2018–2019. During construction, the speed limit on Trunk Road Vt 4 will be 60 km/h for approximately one year on a 3 km long stretch. This will prolong journeys by approximately 2–6 minutes, more so during peak hours. On the street network, the largest arrangements affect Ajokatu street, Luhdantaustankatu street and Porvoonjoenkatu road. The traffic arrangements on the street network will be carried out in four phases during 2018–2020. In summer and autumn 2018, the traffic arrangements will have a significant effect on the traffic connections from Nikkilä towards Laune. The construction-time traffic arrangements will inevitably prolong travel times.

PHASE 1: JUNE 2018



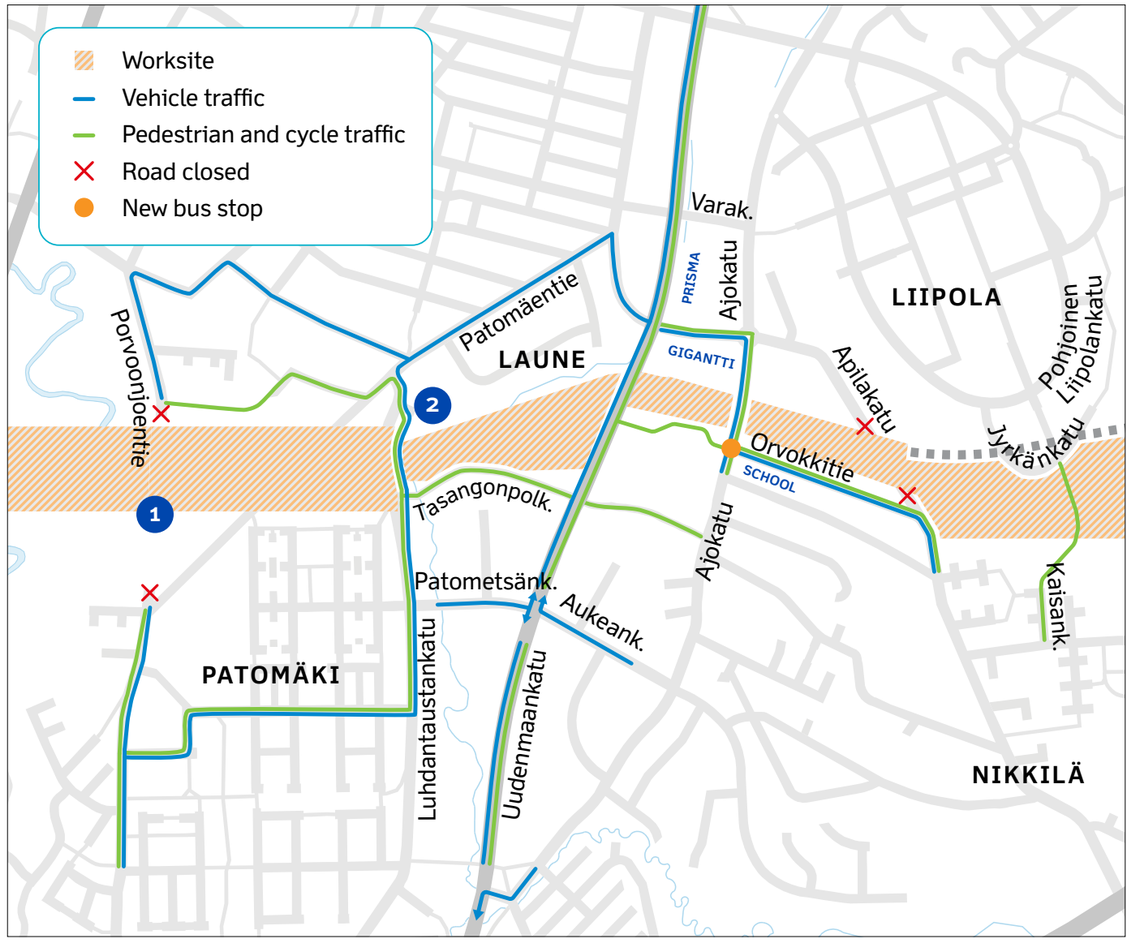
1 The Laune overpass will be demolished between 5 and 6 June 2018. The closest pedestrian and cycling underpasses are at Tasangonpolku and Varakatu street.
2 Traffic on Ajokatu street will stop on 6 June 2018.
3 Patomäki field will not be available and Patomäentie road will be closed on 6 June 2018.
4 Vehicle traffic on Luhdantaustankatu will stop in June; a replacement pedestrian and cycling connection exists.
5 Current pedestrian and cycling underpass.
6 Traffic on Apilakatu street will end in June-July 2018.
7 The pedestrian and cycling underpass that replaces Apilakatu street will be available when Apilakatu is closed.
8 Pedestrian and cycling underpass.

PHASE 2: NO LATER THAN AT THE START OF THE SCHOOL YEAR IN 2019



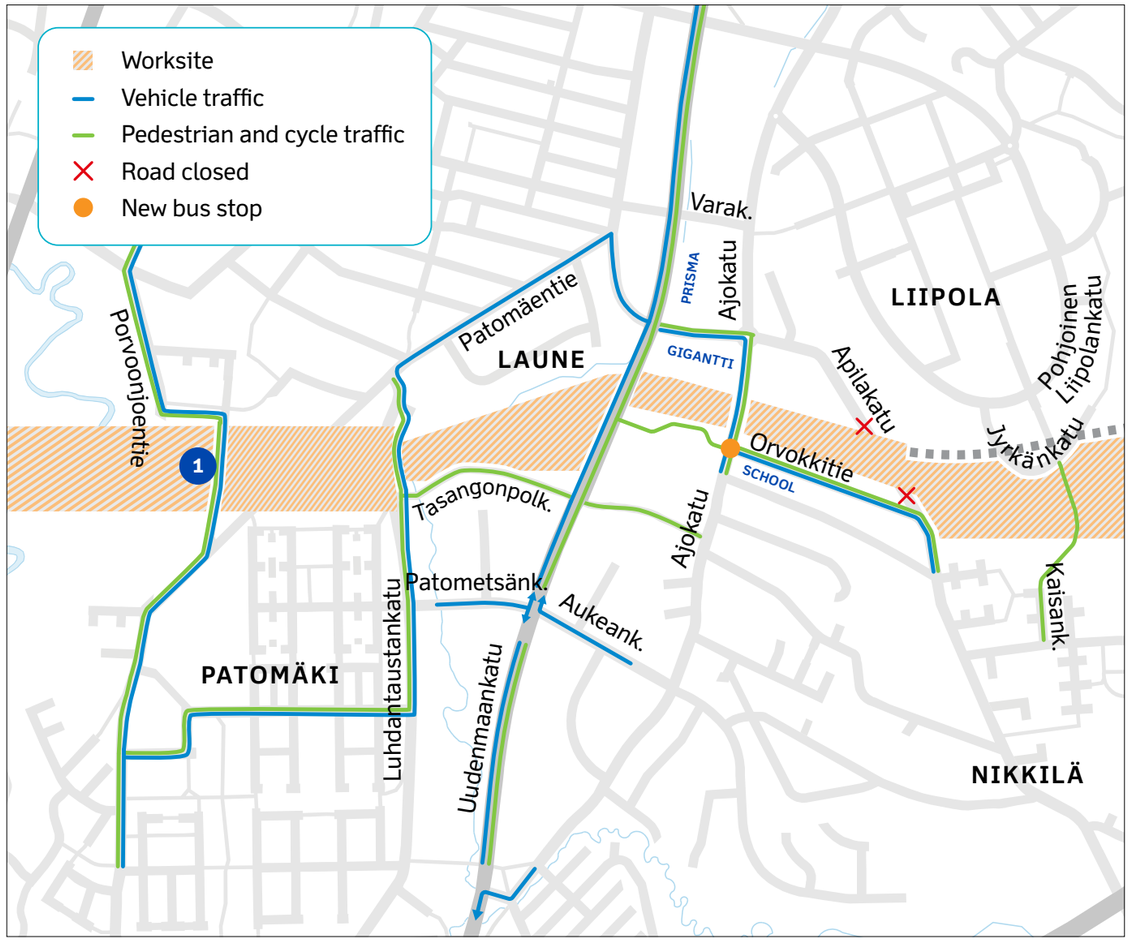
1 Pedestrian and cycle connection K19J completed.
2 Traffic that would run on Ajokatu street now runs on the bridge across the Ring Road.
3 Orvokkitie road completed.

PHASE 3: AUTUMN 2019



1 Porvoonjoentie road will be cut off.
2 Luhdantaustankatu street will be opened for traffic.

PHASE 4: 30 JUNE 2020



1 Porvoonjoentie road will be opened for traffic in its new location.

7.3.3 Laune School as a special item

Laune School is located between the Laune interchange and the western entrance of the Liipola tunnel that will be constructed during the alliance contract. The construction affects the school's traffic connections significantly. Noise and dust from the worksite will disturb the school.

One of the key objectives of the alliance is the safety of the school's students and the mitigation of the disturbance caused by the worksite to the school. The alliance started communicating with the Laune School and other schools and day care centres in the affected area well in advance of the implementation phase. The communication will be intensive also during the implementation phase. The communication will focus on providing information well in advance on upcoming phases of work and changes to traffic arrangements. If requested, the alliance will participate in teaching activities and events held at the school. Interesting topics that could be integrated in the teaching of various school subjects could be, for example, data model-based design, machine control, tunnel excavation and the machines and technology used at the worksite.

Some examples of the measures taken to mitigate the disruption to Laune School:

- Minimisation of the duration of work in the vicinity of the school
- Taking full advantage of school holiday seasons
- Close collaboration with the staff, pupils and parents
- Engaging the school staff in making safety observations
- By improving noise abatement and dust containment measures if the results of environmental monitoring and feedback from the school give rise to such a need

7.3.4 Construction of tunnels

CONCRETE TUNNEL AT PATOMÄKI

The pad foundation, walls and cover of the Patomäki concrete tunnel will be cast in-situ at approximately 16.5 m blocks. The mould used will be a system mould. The cover will be constructed by using a TT slab element as a mould. The construction phases of the pad foundation and walls of the Patomäki tunnel are surveying, boarding, reinforcement and casting. The phases of the in-situ casting of the cover are the installation of TT slabs, reinforcement, boarding and casting. The waterproofing method will be selected based on the conditions observed during work.

CONCRETE INTERMEDIATE TUNNEL, MOUTH STRUCTURES AND INTERNAL STRUCTURES OF THE LIIPOLA TUNNEL

The mouths and intermediate tunnels at Liipola will be cast in-situ at approximately 15-metre blocks. The mould will be a system mould. The construction phases of the Liipola tunnel will be surveying, boarding, reinforcement and casting. The walls of the connecting tunnels and technical premises will be cast in-situ and constructed as masonry. The road tunnels will be lined with an insulating structure made of shotcrete. The lower part of the wall will be constructed of concrete elements. The waterproofing method will be selected based on the conditions observed during work. The spiral staircase

and gangway of the maintenance corridor will be built from steel.

LIIPOLA ROCK TUNNEL

Construction of the Liipola tunnel will consist of excavation and civil engineering works. The phases of tunnel excavation are surveying, probe drilling, pre-grouting, drilling and charging, blasting and scaling, loading of blasted rock, installation of rock bolts and shotcreting, i.e. rock reinforcement. The construction technology works consist of drillings for the support bolts of the insulating structure, soldering the bolts, installing the insulating material, shotcreting of the insulating structure to make it fireproof, construction of technical premises and installing the necessary equipment therein, installing the elements of the lower part of the wall, constructing and paving the road, constructing the connecting corridors (emergency exists) between the traffic tunnels and installing the necessary equipment therein, as well as lighting, instrumentation and signs.

These work phases partly overlap in the schedule. Different phases of work will be carried out simultaneously in different parts of the tunnel. The excavation of the Liipola rock tunnel will take place between April 2018 – September 2019. The reinforcement and insulation structures will be constructed between August 2018 – October 2019.

The tunnel excavation will be performed by three drill jumbos. The working hours will follow the decision issued as a result of the noise notification. Excavation, pile driving, support works, open excavation and tunnel excavation will be performed from Monday to Friday from 7 am to 10 pm, on Saturdays from 8 am to 8 pm and on Sundays from 10 am to 6 pm. However, any works that cause noise and vibration will mainly be performed on Monday to Friday between 7 am and 9 pm. Any works performed on weekends will be reported separately. Blasted rock will be loaded and transported also at night, taking into account the distance of the unloading site from the nearest sites that will be disturbed.

A three-boom rock tunnel drill, also known as a tunnel jumbo.

7.3.4 Technical systems

The installation of technical systems will start with telecommunication connections along the Riihimäki–Kouvola track, and with the installation of a trunk router at Kerava and Kouvola. The installation of telecommunications devices and other telematics on Project Part

1A will take place in summer 2019, as soon as progress with construction work on the Project Part A1 makes this possible. These actions serve as preparations for connecting the project's telecommunications devices to the Finnish Transport Agency's network.

The installation of systems in the Patomäki tunnel will start in August 2019, when the construction of the concrete tunnel is fully complete. The overground device premises and cable routes will be constructed when the fillings surrounding the tunnel are complete. Technical devices will then be installed on the device premises and cables will be run from the device premises into the tunnel.

The Liipola tunnel is divided into work blocks for performing construction work and installing technical systems. Each work block spans the distance between the connecting corridors. The works at each block are scheduled so that installation of technical devices starts immediately after the lining and shotcreting work at the block is completed.

The installation of technical devices will start in the eastbound tunnel tube (K) at Liipola, in the block interval YK4-YK3 in early autumn 2019. The construction of the technical premises will start at the same time. The installations will then proceed to the other work blocks of the eastbound tunnel tube. The installations will move over to the blocks of the westbound tunnel tube (T) as the lining and shotcreting works proceed. The installation of technical devices will be completed in spring 2020, so that system tests can be started in early May 2020. The testing and deployment of technical systems is described in chapter 7.4 Commissioning plan.

7.3.5 Mass use plan

The cut masses generated by the Project Part will mainly consist of soil unfit for construction. Rock obtained from the excavation of the Liipola tunnel could be used, for example, in the structural courses of the road, blasted rock structures and embankments, in soil exchange fillings and as crushed rock needed on the worksite. The excavation works in rock cuts have been expanded from the original plans, but remain within the limits of the road area.

The excavated masses and the rock obtained from rock cuts will be utilised as efficiently as possible within the Project Part. However, in the beginning of the implementation phase, crushed rock will be purchased from third parties before the worksite starts to generate crushed rock for itself. Rock materials will also be bound initially for a certain time by surcharge loading, which is the foundation engineering method selected for prestressing the natural ground.

The soil cuts in the Project Part are mostly clay and silt. They will be used as possible in noise barriers and also below the Patomäki field. They are difficult to use in other applications. The remaining masses will be dumped in soil dumping areas, of which there are three in the Project Part area. Changes to the Project Part's soil dumping solutions were presented through Change E of the final engineering plan, which is currently (spring 2018) in administrative processing pursuant to the Highways Act. The outlook in spring 2018 is that, due to financial and technical reasons, actual recycled materials will be not used on the Project Part, but if an opportunity to do so presents itself, it will not be rejected. However, the use of recycled materials is not recommended at the Laune groundwater formation.

BLASTED ROCK	m³ theoretical solid volume	m³ theoretical structural volume
Cuts	454,106	
Embankments		149,209
Structures (blasted rock)		243,671
Crushing		390,583
Deficit/Surplus	**-105,511**	

SOILS	m³ theoretical solid volume	m³ theoretical structural volume
Cuts	996,633	
Noise barrier		31,989
Slopes		88,995
Revetments		19,441
Soil dumping areas		608,300
Loading berm		8,800
Landscaping fillings		205,791
Fillings above tunnels		106,746
Deficit/Surplus	**66,145**	

m³ theoretical solid volume = bank measure at the site of the cut
m³ theoretical structural volume = structural measure at the target site

An attempt will be made to find a target site within the project area for surplus filling soil.

Excavated rock will be crushed in Kujala, in the vicinity of the eastern entrance of the Liipola tunnel. The rock will be transported along worksite roads with efficient dumpers. No routes used by general traffic will be used for transporting soils or rock within the worksite, unless otherwise agreed. By concentrating mass transports on the worksite roads, we can minimise the disruption to general traffic and improve traffic safety.

7.4 Commissioning plan

7.4.1 General

The tunnels will be commissioned in full capacity simultaneously. A key objective of the project is to have as few disruptions to traffic as possible after the tunnels have been commissioned.

7.4.2 Testing of technical systems

Trunk Road Vt 12, Southern Ring Road of Lahti, will have a single traffic management system that controls all traffic management devices and subsystems located on the stretch between Okeroinen and Kujala interchange. The traffic management system will be implemented by the VALTARI alliance.

In this document, 'technical systems' refers to the traffic management system and its control system and all other technical subsystems that communicate (status information, commands, etc.) with the traffic control system or some other technical subsystem.

The term 'control system' means all software, telecommunications hardware and other devices and components that belong to the control system. In addition to control systems, technical systems also comprise all control devices and devices on the field.

Technical systems will be tested in four phases. Each phase must be self-inspected and inspected by the alliance before moving on to the next phase. The phases are as follows:

- Testing at the factory
- Device testing (IO testing)
- Functional testing
- Trial run of all systems together

The phasing of the system seeks to improve the functionality and reliability of the traffic management systems. Testing at an early phase reduces the disruptions caused to traffic and helps in the final deployment on the field. The alliance will create detailed testing plans during the implementation phase.

The management system will be connected to T-LOIK, which is an integrated user interface for traffic control. In its final state, the system will be controlled via the T-LOIK interface. The native user interface of the control system will function as a spare user interface. The alliance will perform FAT tests and integration tests for the T-LOIK connection during the testing of the management system. After the trial run of all systems together, the T-LOIK connection will be SAT tested. The Finnish Transport Agency's T-LOIK project will perform the SAT testing with help from the alliance.

Trunk Road Vt 12, Southern Ring Road of Lahti, can be commissioned for traffic at the end of 2020 using the system's own user interface, if the SAT testing of the T-LOIK user interface is not complete and T-LOIK cannot yet be used as a result. T-LOIK tests will be completed after commissioning for traffic, during the adjustment period.

7.4.3 Operational training

Operational training for officials on duty in the Road Traffic Centre will be provided after the traffic management system is complete. The instructions for managing accidents and disruptions will be created in collaboration with the Road Traffic Centre and the rescue depart-

ment well in advance of the commissioning of the tunnels for traffic. The training project for officials on duty in the Road Traffic Centre will include a section on the actions to be taken in exceptional situations. Operational training for the system will be provided before the rescue rehearsal. Refresher training will be provided for the officials on duty 1–2 months after the road has been commissioned for traffic.

Orientation and training for the rescue authorities will be planned in collaboration with the rescue authorities during the EPAC phase. The alliance will provide maintenance training for the staff in charge of the use and maintenance of the road. The training will focus on matters in the maintenance manual and on the technical service manuals of the technical systems.

During the EPAC phase, a decision will be made on whether training should also be provided to other key groups (bus drivers, taxi drivers, etc.).

7.4.4 Rescue rehearsals

Rescue rehearsals directed by the rescue department will be held in the tunnel section before it is commissioned for traffic. The alliance will participate in the planning of the rescue rehearsals together with the rescue department and Road Traffic Centre. The number and content of the rescue rehearsals will be made more specific in the EPAC phase.

7.4.5 Tunnel maintenance manual

Before the tunnels are commissioned for traffic, the alliance will create a tunnel maintenance manual that provides the operational and maintenance staff with a general overview of the tunnels, their structures, technical systems and instructions on the operation and maintenance of the tunnels. The maintenance manual will be written in collaboration with the party administering the tunnel.

7.4.6 Commissioning inspection of technical systems

Before the commissioning inspection, the alliance will collect all measurement, testing and calibration protocols of all devices and cables of the system in one place. This will be done in collaboration with the system and device suppliers. During the commissioning inspection of technical systems, the alliance will inspect the functionality of all subsystems and their devices in collaboration with the system and device suppliers and will ensure that the delivered overall system completely fulfils all technical and functional requirements. Furthermore, the inspectors will verify that the control system of traffic management is connected to the Finnish Transport Agency's centralised disruption management system.

The administrative authority in charge of road tunnels will appoint an inspection unit of the Finnish Transport Agency to inspect the commissioning documentation collected by the alliance. In addition, the inspection unit will conduct spot tests of devices and their installations, and will create inspection reports of them.

The documentation on the commissioning inspection forms the largest part of the self-inspection of the alliance's technical systems.

A condition for commissioning the traffic management system is an appropriately executed commissioning inspection of the traffic management system.

7.4.7 Reception inspection

Before the stretch of road is commissioned for traffic, a reception inspection will be performed on the alliance contract.

7.4.8 Communicating the commissioning

A communications campaign aimed at road users will be launched prior to opening the tunnel for traffic. The campaign will describe how to act when approaching the tunnel and how to drive in it. Particular attention is paid to the actions to take in case of a vehicle malfunction, engine stall, traffic jam, accident and fire.

7.4.9 Commissioning permit for a tunnel

The commissioning of a tunnel for general traffic requires a commissioning permit granted by the administrative authority in charge of tunnels. The permit procedure is described in the Finnish Transport Agency guideline 33/2016 on the regulations and guidelines on the management and safety of road tunnels.

To the administrative authority the tunnel administrator will submit a tunnel commissioning proposal, safety documents of the tunnel and the following statements and documents on the approval of the tunnel and its opening for traffic:

- A statement by the party in charge of having the tunnel constructed
- Training plan
- A statement by the rescue department
- A fire inspection record by the rescue department
- Statement by the Centre for Economic Development, Transport and the Environment
- Statement by the TTJ unit of the Finnish Transport Agency
- Statement by the body in charge of road tunnel safety
- General inspection report of the tunnel structures
- Statement by the Road Traffic Centre

The body in charge of the safety of the tunnel will issue a statement on the safety document of the tunnel to be commissioned. If necessary, the administrator of the tunnel will create a response to that statement. The safety documents of the tunnel to be commissioned will be sent for approval to the tunnel administrator well in advance of the proposal for commissioning the tunnel.

The alliance will ensure that sufficient resources are available for creating the tunnel safety documentation and will help other parties to create the related documents they are in charge of.

7.4.10 Adjustment period

After the tunnels have been commissioned to traffic, a six-month adjustment period will begin, during which the operation of the technical systems in the tunnel will be monitored and adjusted. The operation of the ventilation and disruption management system (DMS) at the Liipola tunnel will be monitored and adjusted in a systematic manner. The operation of other technical systems will be adjusted as necessary, mainly based on feedback received from the Road Traffic Centre and road users. Furthermore, the SAT testing of the T-LOIK connection will be performed during this adjustment period, if it was not completed before the tunnel was opened for traffic.

The DMS cannot be adjusted to a final operating condition until there is vehicle traffic in the tunnel. The observation of the DMS will pay particular attention to false alarms given by the system. The adjustments seek to minimise false alarms that, according to experience, are often triggered by wet conditions. Towards the end of the adjustment testing period, the DMS system will undergo a final test to ensure that the adjustments have not impaired the system's ability to detect actual disruptions (vehicles that are stopped or driving in the wrong direction).

The operation of ventilation at Liipola tunnel must be observed when the tunnel is opened to traffic and the ventilation settings must be adjusted based on the results of the observation. Particular attention must be paid to the impairment of visibility in the tunnel resulting from dust kicked up by traffic. The observation will be carried out in collaboration with the Road Traffic Management Centre. Any necessary adjustments will be decided upon in collaboration with the designer of the ventilation system.

8 Environmental and social responsibility

8.1 Management of environmental matters

The Project Group will steer the monitoring of the change to the environment and is responsible for reporting to the authorities in compliance with the regulations. Practical coordination will take place in the communications and environment workgroup. The residents' concerts and contacts are often associated with environmental impact or disturbance caused by construction, such as noise, dust, vibration or change of traffic connections.

The disruption caused by construction will be prevented and mitigated by the following means, among others:

- Environmental matters will be taken into account in the risk tables of the technology types (analysis and agreements on actions).
- The procedures of environmental matters are described in the execution plan of each work phase, which are reviewed with the employees before the work phase starts.
- Environmental matters at the worksite are reviewed at the kick-off meetings of the contract and also during familiarisation training and in weekly worksite meetings.
- Block-specific environmental instructions are created for each block.
- Whenever possible, the selected construction methods and machinery will be ones that cause as little disruption as possible to the surrounding residential areas.
- The worksite will follow the working hours stated in the decision based on the noise notification, the regulations in the decision on the environmental permit of the crushing plant, and the regulations and monitoring obligations in the water permits.
- The environmental documents will be stored in the shared data repository that everyone can access when needed.
- Information on the work phases will be disseminated effectively. For example, people will be able to subscribe to a service that will send them an SMS whenever blasting is about to occur in the Liipola tunnel.

The generation of waste at the worksite will be minimised by careful planning of procurements and work phases:

- Precise quantities of materials in procurements to avoid loss
- Careful protection, storage and handling of materials at the worksite
- Recyclability of mould materials, etc.

Construction waste will be collected separately, sorted (wood, concrete, metal, cardboard, hazardous waste and mixed waste) and delivered to an appropriate waste collection site to ensure a maximum amount of recycling. Likewise, waste generated in the worksite office and personnel rooms will also be sorted (for example paper, glass, metal, organic waste and mixed waste). Hazardous waste will be collected separately and disposed of appropriately.

Chemicals, solvents, oils and other hazardous waste generated during construction will be managed according to the applicable authoritative regulations. Hazardous substances will be stored according to regulations. Workers will be instructed in the handling of chemicals. The MSDSs of the substances will be kept easily accessible for everyone at the worksite.

If oils or other hazardous materials spill to ground, the contaminated soil will be processed in a manner approved by the environmental authority.

The contamination of groundwater will be prevented as follows:

- Any larger amount of chemicals will be stored outside the groundwater area (on a watertight foundation and within a spill containment structure).
- During familiarisation sessions, all employees are

informed about the special precautions required when working on a groundwater area.

- Commissioning inspections and regular service of machines.
- Ensuring that the worksite has enough absorbent for accidental spills.
- Waterproof parking and maintenance spaces, equipped with oil and sand trap wells, will be constructed for the machines.

The industrial waters from tunnel excavation will be directed to sedimentation basins and from there on to the sewer system. Storm waters will be directed to the terrain. If necessary, storm waters can be directed to surface waters via a balancing reservoir, filtering dam or other such structure.

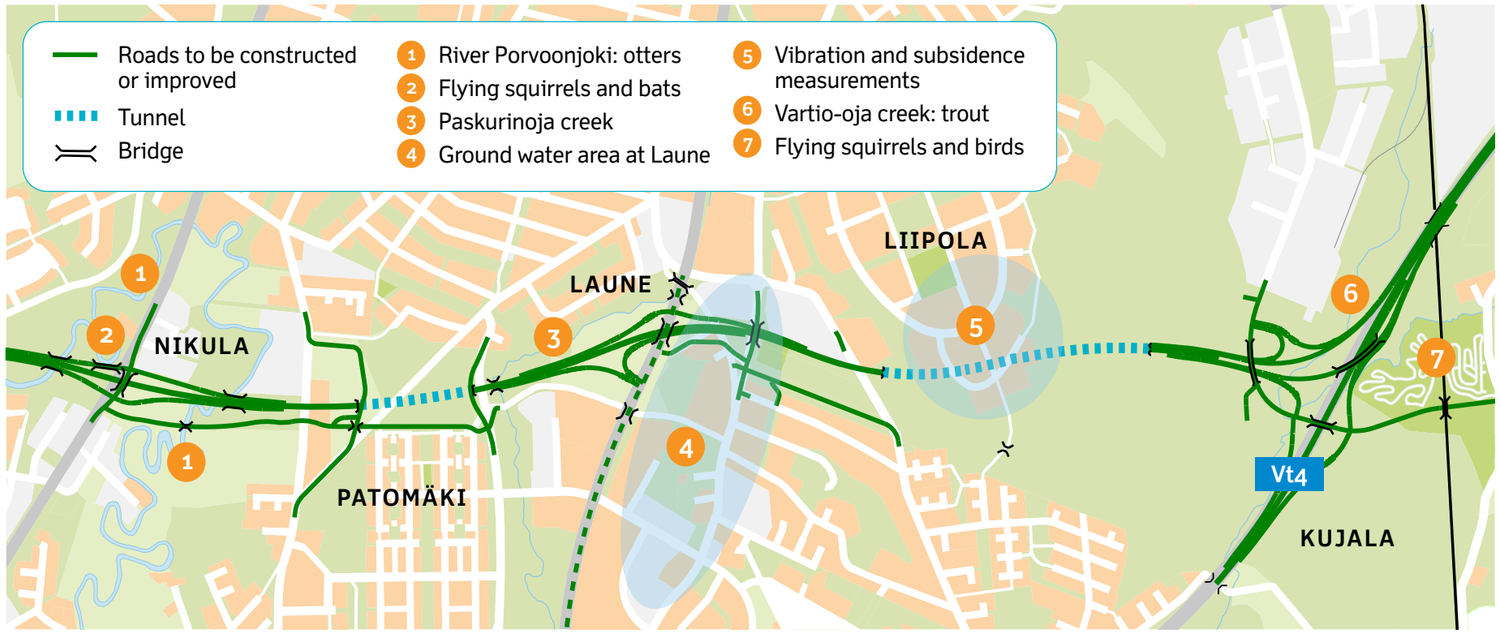
8.2 Environmental certificate

A CEEQUAL (Civil Engineering Environmental Quality Assessment and Award Scheme) environmental certificate will be sought for the project. CEEQUAL is an evidence-based environmental classification and evaluation system that is managed by BRE Global Ltd. The goal of CEEQUAL is to guide infrastructure construction and the entire construction business towards more environmentally efficient and environmentally conscious construction. The certificate will be applied for the entire Project Part 1B, which means that the performance of all parties to the project will be scored and evaluated.

8.3 Environmental monitoring

Several environmental monitoring projects have been created for the project. The monitoring of surface water and groundwater and the potential settlement of buildings are based on the terms and conditions of already granted water permits. The surface water monitoring

ENVIRONMENTAL MONITORING RELATED TO VALTARI



ENVIRONMENTAL MONITORING IN PROJECT PART 1B

Monitoring	Carried out by	Reporting
Groundwater at Laune: volume to be pumped, quality of groundwater, level of groundwater table	Water quantity & level: Alliance/Pöyry. Quality: Eurofins	Häme Centre for Economic Development, Transport and the Environment, City of Lahti
Surface waters, bridge locations, designated ditches: quality, quantity to an extent	Eurofins	Häme Centre for Economic Development, Transport and the Environment, City of Lahti
Nature, flying squirrels, otters and bats	Alliance/Pöyry	Häme Centre for Economic Development, Transport and the Environment, City of Lahti
Fish in Vartio-oja creek	Eurofins	Fisheries Management Authority of the North Savo Centre for Economic Development, Transport and the Environment
Noise and vibration from excavation	Suomen Louhintakonsultit Oy	City of Lahti
Other noise from the worksite, e.g. at Laune School	Alliance/Pöyry	City of Lahti
Settlement of buildings at Liipola and Laune	Pirkanmaan Mittauspalvelu Oy	Häme Centre for Economic Development, Transport and the Environment, City of Lahti
Dust, residential areas in the vicinity of the worksite	Alliance/Skanska	City of Lahti

project will also take into account bodies of water that might be affected by the construction, but whose monitoring is not prescribed in the water permits.

In addition, the presence of species mentioned in the appendices of the Nature Directive (bats, otters, flying squirrel) will be monitored in the Project Part. The monitoring of flying squirrels will take place in known habitats at Pippo and Kukonkoski. The monitoring of bats will take place on the location of waterway bridges of the project. The presence of otters will be monitored on the location of bridges that cross River Porvoonjoki.

Construction noise levels will be monitored at Laune School. Noise measurements will be carried out as necessary elsewhere in the area of the project. Vibration measurements and monitoring of the potential settlement of buildings will be carried out in the area affected by excavation.

An event for residents at Nikkilä in May 2018.

8.4 Communications and stakeholders

The alliance contract is a part of the Overall Project that consists of three different contracts. This setup results in a very simple and clear division of works and responsibilities between the contracts and different organisations. The communications plan created for the project presents overall principles that apply to all parties and deal with matters such as key persons, stakeholders, target media, objectives and organisation of communications, primary messages and crisis communications. The crisis communications guidelines will be updated for the implementation phase.

Communications is a part of the operative management of the project and is tightly integrated with the core operations of the alliance, such as work in the Big Room and Project Group. The significance of communications and stakeholder collaboration is particularly important since the project has several participants, and construction will take place in residential areas and affect residents in a multitude of ways for a long time.

Communications is not only directed outwards. In an alliance contract, the success of internal communications will have a significant effect on the performance of the organisation in the key objectives. Internal communication helps to improve communication and collaboration between operators, unify operating methods and ensure that all participants are working towards the same goal and communicate similar messages in their external communications.

8.4.1 Key messages and objectives of communications

The objective and task of communications is to support the success of the project by engaging in open and two-way communication, which ensures that all important target groups receive the correct, sufficient, proactive and up-to-date information about the project, its effects and progress. Openness simply means that both internal and external communications say everything that can be said without jeopardising trade secrets, including any mistakes and failures.

Communication will use channels and means that serve the target groups best. Communications also serves to construct a positive attitude towards the pro-

ject by emphasising the benefits it brings (key messages) and enabling the necessary interaction between the target groups and the project. The key messages of the project are:

- Smoother and safer traffic
- Improving the potential to develop business life and land use
- A more pleasant residential environment
- Protection of groundwater

8.4.2 Communication channels and responsibilities

Communications will take place in multiple channels and all parties to the alliance have tasks associated with communications: The Finnish Transport Agency, City of Lahti, Municipality of Hollola and VALTARI. Communications of the Overall Project is coordinated by a communications consultant (Valve Group Oy).

The Project Part will use the following communications channels and methods:

- Events for residents:
  - Events about to the Overall Project
  - Targeted events for the residents of a given area
- Media releases
- Weekly bulletin of the Overall Project
- Website, Facebook, Twitter
- Lahti map service, Mapgets
- Notifications for residents
- SMS news for residents near the worksite
- VALTARI's feedback phone (tel: +358 50 308 4770)
- A map-based service that displays the construction-time traffic arrangements will be launched in early summer 2018. The service will also display the progress of the works.

8.4.3 Communications during disruptions

The crisis communications plan of the Overall Project includes principles underlying communications during disruptions and actual crisis communication instructions; written separately for headquarters and worksites, if necessary. Communications during disruptions involve enhanced communications that are necessary in the following situations:

- Major accidents, other events that severely impair the usability of the road or track network.
- (Individual) occurrences on the traffic network which gain a lot of attention from the media, but which do not significantly impair the usability of the road or track network.
- Other situations that could negatively affect the reputation of the overall project or its parties constructing Trunk Road Vt 12, the Southern Ring Road of Lahti.

8.4.4 Internal communications within the alliance

At peak times, hundreds of people will work in the alliance. Their background is in different companies and public organisations, all of which have a different operating culture. However, the alliance needs uniform operating models throughout the organisation in order to work in the best possible way. This applies to at least the core processes, such as safety, quality assurance, schedule management, innovation system, communications and collaboration.

The core of internal communications lies in Big Room work, meeting and workshop practices, SharePoint that acts as a data repository, and the induction of employees. Other channels and practices of internal communications include:

- Weekly VALTARI published on Thursdays
- Weekly bulletin of the Overall Project
- Familiarisation and the worksite guide provided to the employees
- Website of the project and Facebook
- Information display at the Big Room cafeteria
- Training sessions, recreation events and kick off events

8.5 Permits and notifications

Most of the permits required by the project were applied for in the previous planning phases of the project. The permits required for implementing the project have been analysed and recorded in the list of permits. The monitoring duties prescribed in the permits will be carried out by the alliance.

If the plans change significantly as they become more detailed, new permits or changes to existing permits may have to be sought. The exact need for a permit will be agreed upon in detail with the corresponding authority. Each permit will be appointed a person in charge who is responsible for a correctly-timed application for a permit, submitting the necessary notices and carrying out the required actions before starting the works, monitoring the works and promoting the progress of the case.

Before the works commence (a minimum of 30 days prior), a noise notification will be submitted and the residents, medical care institutions, educational institutions and other sites that may be disturbed by the operations will be notified.

9 Management system

9.1 Procurement plan

Procurements will be based on a procurement plan created during the development phase. All procurement tasks and the persons in charge of them will be recorded in the plan. Other items recorded in the plan will be the costs and scheduling based on the planning schedule and overall schedule. Matters associated with procurements will be processed in the procurement group. The group will consist of the Procurement Manager, Procurement Engineer, Area Engineer of each technology type, Project Manager of the alliance, Project Manager of planning and a representative of the Finnish Transport Agency.

Based on the proposition of the procurement group, the alliance Project Manager will make decisions on procurements up to a value of EUR 10 million. The Project Group will be informed about the decisions. The Steering Committee will make decisions on procurements exceeding EUR 10 million and procurements to be made from a party that provides services for the alliance (or a subcontractor of such party). If necessary, the procurement group and the steering committee of the alliance can make urgent decisions by giving their approval by email. The decision on the procurement format to be used will be done on a case-by-case basis. It is also pos-

PHASES OF THE PROCUREMENT PROCESS

1	2	3	4	5	6	7
a. Preliminary preparation of the procurement, based on the procurement plan b. Developing the plan and having it approved in collaboration with Pöyry c. Determining quantities; Area Engineers and designers	a. Preparing the Request for Tender b. Looking for tenderers and contacting them c. Verifying the preselection of tenderers d. Sending Request for Tenders, answering questions	a. Reception and comparison of the tenders b. Comparison of tenders, phase 1 negotiations c. Comparison of tenders, phase 2 negotiations d. Selection of suppliers e. Adding a supplier to be monitored by the Reliable Partner service	a. Preliminary approval for the contract in a procurement meeting	a. Final approval of the contract APG/ASC **b. Making the contract**	Delivery starts	a. Collecting the documentation associated with the material/work performance b. Management of complaints/notifications c. Reporting the procurement to the stakeholders of the alliance d. Evaluation of the supplier in collaboration with the Area Engineers/labour management e. Final financial report
Steering of planning and design	**Procurement process, 8 weeks**				**Delivery period**	**Procurement steering and control**

sible to form sub-alliances. The operating methods and principles of the alliance will be applied to a maximum extent in the subcontracting chain.

The special requirements and key objectives of the alliance contract will be presented to the subcontractors already in the Request for Tender phase, and will also be recorded as objectives for work or delivery in the agreements. The Requests for Tender will encourage subcontractors to innovate by giving the subcontractors an opportunity to submit alternative tenders with regards to work methods and materials.

Contractors may not transfer their contracted job to a third party without a written approval from the alliance. However, the alliance may approve the use of such a subcontractor for special reasons. The contractor must present the subcontractor in due time before the work begins. Chaining the subcontractors beyond one subcontractor is prohibited.

Procurements of the implementation phase for which the schedule is clear or which are critical may be subjected to tendering already in the development phase. If the content and price of the tenders are optimum (Value for Money), conditional agreements may be made for the most significant procurements during the development phase.

Tenders received for each procurement entity will be subjected to a comparison of tenders with the purpose of assessing the unit prices, agreement terms and conditions and other provisions associated with the procurement (such as contractual bonuses, provisions for extra work). The tenders, tender appendices, documents on agreement negotiations and the justifications for selecting a supplier will be documented in SharePoint, which serves as a data repository for the alliance, and also in the owner partner's procurement systems.

For small procurements, such as procurements from ironmongers, we can utilise Skanska's annual or periodical volume agreements that have been subjected to competitive tendering and that fulfil the owner partner's requirements for the supplier. In such cases, the procurement group must give its approval for the procurements and the procurements must stay within the limits set by the procurement group. Any post-hoc reimbursements or bonus practices will be deleted from the annual agreements to ensure transparency.

9.2 Subcontractor management

The most important phases of subcontractor management and control are:

- Kick-off meeting: preconditions for starting the work and an agreement review
- Weekly production management meeting: integration of works, schedule and communications
- Daily integration of works: meeting of goals and communicating and processing any exceptions
- Follow-up meetings and worksite meetings: contractual control of subcontractors
- Self-inspection and reception inspection: verification of the actualisation of the scope and quality of the subcontracted work
- Final financial report: review of the financial success of subcontracting

Subcontracted works will be inspected according to RYHT 2000 and YSE 98 terms and conditions, including any further specifications laid down by the owner partner (reception inspection, final financial report and warranty inspection). The RYHT and YSE terms and conditions will always be attached to the Request for Tender and agreement as appendices.

Companies acting as subcontractors for the VALTARI alliance are expected to fully comply with the obligations laid down in the Act on the Contractor's Obligations and Liability when Work is Contracted Out. This must be demonstrated before the subcontracting agreement is made by providing the owner partner with certificates on compliance with obligations or a company report printed out from the tilaajavastuu.fi service. Subcontractors are obliged to keep certificates and company reports up-to-date via the service. Data on the company obtained from the service may be no older than three months. If the company's situation has changed, the company must submit new certificates. A contractor must also present the same certificates for its chained subcontractors. The contractors and their subcontractors must have liability insurance in force for the sum of EUR 1,000,000.

9.3 Schedule management

9.3.1 Overall schedule

The overall schedule of the implementation phase was created in the development phase workshops, whose participants included the persons in charge of each technology type. Updated versions of the schedule were displayed on the Big Room wall and were open to comments. The planning and procurement schedules were created based on the overall schedule. A reverse phase schedule event was held at the end of the DPAC phase, to verify that the parties have a mutual understanding of the overall schedule and that the overall schedule can be started.

Keeping to the general schedule is always the primary goal. If there is a danger that the schedule will not be met, or the works are lagging behind the schedule, corrective actions will be planned. Any changes to the over-

all schedule will always be communicated to the alliance Steering Committee.

9.3.2 Milestones

The milestones of the overall schedule form the critical path of the project and the key tasks of the Project Part. Meeting the milestones will ensure that the overall schedule is met. Determining the critical path is an essential part of the project's schedule management.

9.3.3 Phase schedule

The overall schedule guides the creation and execution of the phase schedule. A reverse phase schedule workshop will be held approximately every three months, with the participants being all key persons and primary subcontractors of the alliance. The workshop will plan and integrate the works for the next three months. The overall schedule may only be changed for compelling reasons. The key persons in charge of construction and planning monitor adherence to the phase schedule on a weekly basis, and will determine the actions necessary to keeping to the phase schedule. Any obstacles to meeting the phase schedule will be recorded in an obstacle log reviewed weekly in the Project Group. Any changes that affect the overall schedule will always be communicated to the alliance Steering Committee.

9.3.4 Weekly schedules (3–6 weeks)

The phase schedule will steer the actualisation of the weekly schedule. A weekly meeting and schedule meeting will be held every Thursday morning. The foremen must submit their planned schedule for the upcoming weeks to this meeting in advance. The meeting will process all tasks in the phase schedule that will be carried out during the next six weeks, and an associated, more detailed plan for the next three weeks. The meeting will also process matters related to quality, safety, the environment and communications. The phase schedule may only be changed for compelling reasons. Any obstacles to meeting the weekly schedule will be recorded in an obstacle log reviewed by the Project Group in every case. Minutes of the meeting and the obstacle log will be distributed to the key persons and primary subcontractors of the alliance.

9.3.5 Schedule objectives

In addition to the milestones, the alliance has key objectives associated with keeping to schedule:

- Opening the Project Part for traffic within the agreed time window
- Completion of Orvokkitie (K4), Ajokatu (K5) and K19J in the time window agreed upon
- Completion of the Kujala interchange in the agreed time window (including K6, R5, R6, R7, R8, R9 and widening of Trunk Road 4 with bridge repairs. Disruption on Trunk Road 4 caused by the construction of S28 has ended)

The performance indicators for the key objectives are described in more detail in section 5 Commercial model.

9.3.6 Reporting of the schedule situation

The schedule situation of the project will be reported regularly to the Project Group, which will make decisions on corrective actions, if necessary.

Furthermore, the Dynaroad schedule created for the project will be updated weekly with the actuals of the schedule for the primary tasks. By reviewing the schedule in the road time chart, the adherence of individual

tasks to the schedule can be seen transparently, while also seeing their effect on the whole schedule.

9.4 Innovation system

The purpose of innovation activities is to discover operating models that improve the performance of the alliance and ideas that reduce construction costs. The ideas that are best from the 'Value for Money' perspective will be implemented. The primary procedures for managing innovations are:

- An encouraging atmosphere
- Ease of presenting ideas
- Efficient processing and execution of ideas
- Communicating about ideas and the rewarding of ideas

9.4.1 Ease of presenting ideas

The SharePoint data repository has had a list of ideas since the start of the development phase of the project. Training on the use of the idea list is provided for all employees of the alliance. Ideas can also be presented orally or by email to the superiors or the maintainer of the idea list. Furthermore, ideas can be brought up in weekly meetings and other meetings at the worksite. During the implementation phase, the alliance's potential for innovation will increase significantly, as the worksite organisation starts its work.

9.4.2 Efficient processing and execution of ideas

A person has been appointed to take charge of innovations. The task of this person is to appoint a technology group or expert for each recorded idea, so that they can develop it further. Every month, the person in charge will report any new ideas and their processing status to the Project Group.

The ideas will be classified as follows: recorded, in process, transferred to decision-making, transferred to implementation, will not be implemented and frozen. The person in charge is responsible for classifying the ideas.

APG steers the implementation of ideas in the weekly meeting. It is assumed that the number of ideas generated in a week is reasonable enough to be processed by the Project Group. Innovation workshops will be held a few times a year to process and refine existing ideas.

9.4.3 Communicating about ideas and the rewarding of ideas

The ideas generated during the implementation phase and the status of implemented ideas will be reviewed monthly in the joint weekly meeting of the Project Part. The best ideas and the status of all ideas will also be communicated in the internal weekly bulletin of the alliance.

Efficient and visible processing of ideas is a critical component in the creation of an atmosphere that encourages innovation. The principles and methods for issuing awards to ideas will be decided on in the alliance Project Group at the beginning of the implementation phase.

9.5 Financing

Pursuant to the contract, no financing costs will be caused to the service providers in the DPAC or EPAC phase, unless otherwise agreed. Based on the cash flow forecasts, the sum that will be paid as advance payment will correspond to the average cost of the upcoming months. The actual cash flow will be examined each quarter, and the result serves as input on the decision whether to change the sums of the advance payment items.

The term of payment for approved invoices between the owner partner and the service provider is 21 days. As a rule, the term of payment between the service provider and subcontractor is 30 days. The term of payment will be negotiated in the subcontract agreement negotiations. The term of payment may be shortened, if this brings financial benefits.

The risk of increase in material prices will be controlled by monitoring the development of prices and, if necessary, by procuring and paying for the materials in advance in light of the progress of the construction work. This applies in particular to structures that contain a lot of metal (reinforcing steel, cables, piles, portals, lighting columns).

9.6 Cost management

The objective of cost management during execution is to:

- Create an up-to-date and realistic forecast of the actualisation of the target outcome cost.
- Create an efficient system for monitoring and steering the project costs according to an agreed transcription system.
- Ensure that the contract tenders are competitive and do not exceed the target outcome cost.
- Use cost forecasts to ensure that problems can be dealt with early so that the target outcome cost will not be exceeded.
- Generate an appropriate and informative monthly report for the various levels of the organisation, or more often, if necessary, for targets under special monitoring.
- Store all cost control data in a format that is easy to utilise.

The costs incurred to the parties of the alliance will be compensated according to the actual costs determined from transparent accounting. An independent financial

expert will audit the accounting regularly throughout the project.

The cost forecasts reported by the alliance parties will be collected and reported monthly in the alliance Steering Committee. The cash flow forecast will also be updated at the same time.

The actualisation of the target outcome cost will be forecasted and reported in real time during the implementation phase. The cost forecast will be revised based on the actuals at one-month intervals. Transcription instructions will be created based on the cost monitoring requirements. The transcription instructions will be handed out to every person who inspects purchase invoices of a worksite.

9.7 Invoicing practices

The City of Lahti and Municipality of Hollola have authorised the Finnish Transport Agency to act as the owner partner in the project. The service provider will first submit all invoices in PDF format to be reviewed by a representative of the construction consultant (Rakennuttajatoimisto HTJ Oy), who will verify the correctness of the invoices and approve them for payment. The invoices must itemise the commission and the costs to be compensated.

For purchases of construction services, the City of Lahti is under a reverse VAT obligation. The City of Lahti's share of the invoicing on construction services is under a reverse VAT obligation (reverse VAT 0%). The invoices for purchases other than construction services shall contain VAT for all parties (Finnish Transport Agency, City of Lahti and Municipality of Hollola).

A detailed description of the information that must appear on an invoice can be found in the invoicing instructions for Trunk Road Vt 12, Southern Ring Road of Lahti.

Payer	Proportion, %	VAT practice:
Finnish Transport Agency	72.00	VAT rate in force
City of Lahti	25.20	• Construction services: reverse VAT • Others: VAT rate in force
Municipality of Hollola	2.80	VAT rate in force

9.8 Quality management

9.8.1 General

The alliance aims to produce a faultless deliverable. The minimum quality level of the deliverable is defined in the planning documents, InfraRYL requirements and other application guidelines. Each employee of the alliance has a role in the production of quality. Quality assurance is based on the demonstration of the deliverable at the correct time.

Materials to be handed over by the alliance will be collected in the project data model. Eventually, the materials will be exported into the shared model of Trunk Road Vt 12, the Southern Ring Road of Lahti. The content and structure of the transferred materials will be similar to those of Project Part 1A of Trunk Road Vt 12.

9.8.2 Total Quality Management

Quality assurance of the alliance is part of the management system, and responsibility for quality is clearly expressed on all levels of the organisation, from management to production.

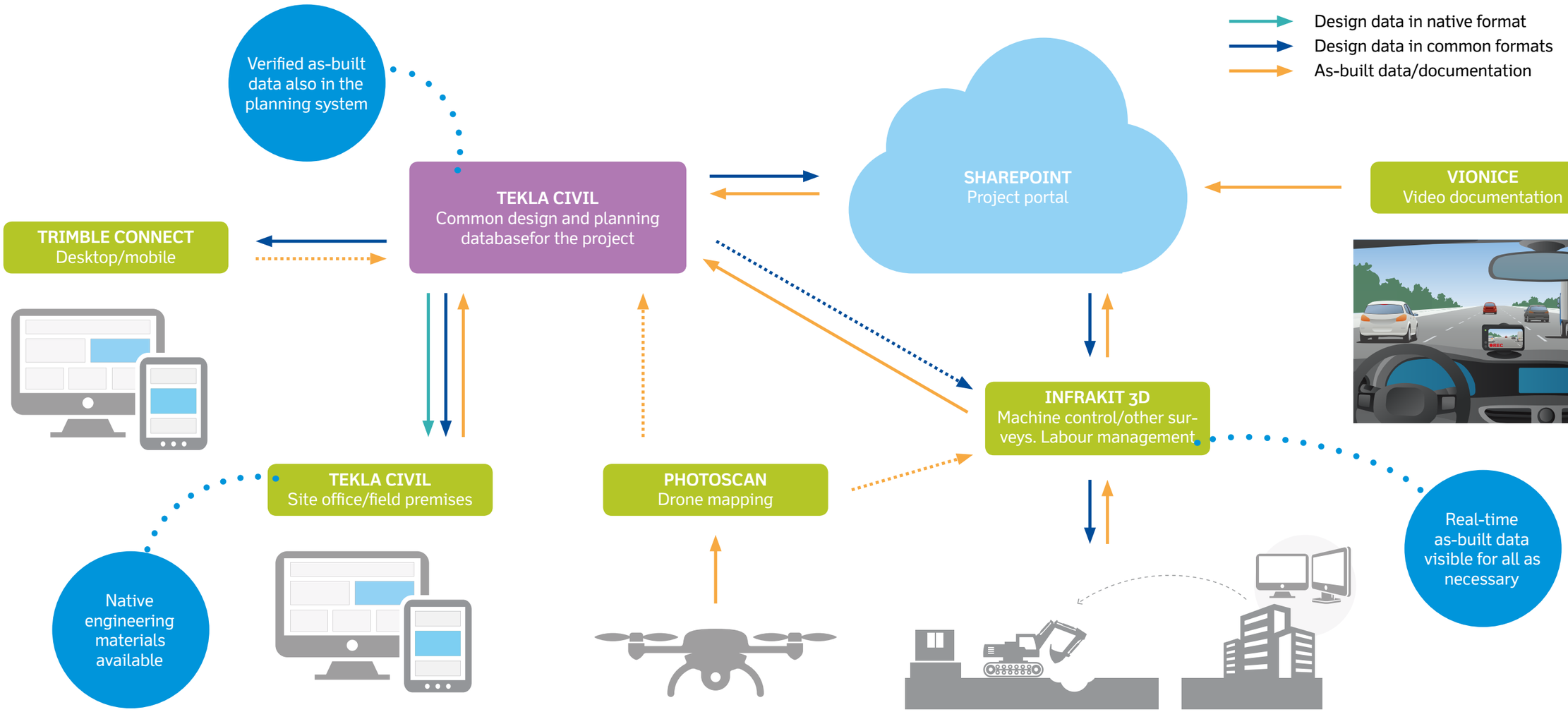
- Meetings of technology groups will review the status of quality monitoring within the group, the actualisation of technical quality and executed quality assurance actions, and this information will be reported to meetings of the Production Steering Team.
- The Production Steering Team will review the situation within the construction groups and steer their operations. The Production Steering Committee will also process matters arising from other quality assurance sources and draw together the matters to be reported and decided upon in the alliance Project Group.
- The Project Group will monitor the situation, make decisions and approve the required changes.
- The Quality Manager will verify that the process works, make necessary spot inspections to ensure that the functional and technical quality requirements are met, and report directly to the Project Group as necessary.

Quality assurance in the alliance will also include internal and external audits. The Quality Manager of the alliance will perform targeted internal audits. External audits will be carried out through the organisations of the alliance's service provider parties. Reports will be created of the audits. The reports will include an evaluation of the specified process, matters that work well, and matters that require improvement. Any exceptions detected in the audits will be corrected and analysed in order to improve operations.

9.8.3 Technical quality assurance

An assurance plan will be created for the alliance. The plan will describe the quality assurance actions for each phase of work, building element and project parts, including, but not limited to:

MANAGEMENT OF SURVEY DATA ON THE WORKSITE



- Work plan
- Quality Plan
- Detailed engineering plans
- Survey plan
- Self-inspection and quality report of a phase of work

At a minimum, a work and quality plan, self-inspection and quality report will be created for each phase of work.

The alliance will be responsible for all surveying performed on the project in collaboration with the necessary subcontractors and operators. Verification surveys will be performed as described in the quality plan and InfraRYL requirements. Results of the verification survey will be collected in the Infrakit cloud service, in which the soil structures' compliance with requirements will be determined. Any results that exceed tolerances and any significant changes during construction will be recorded in the SharePoint data repository of the alliance or directly into the Tekla Civil database, so that the designer can update the implementation model into an as-built model. The as-built model will be stored in Trimble Connect.

Follow-up measurements will also be carried out during the contract, in order to detect any settlement and or movement. The surveys will be carried out through precision levelling and/or as tacheometer surveys.

9.8.4 Processing of exceptions

An exception report will be created of any quality exceptions and functional exceptions. The exception report will describe the exception, its causes, suggested corrective actions and actions to prevent its reoccurrence. The corrective actions required by the exception will be planned in the relevant technology group and will also be approved there, up to a certain level. Exceptions will also be processed in construction groups, Production Steering Team and in the project group, if necessary. Exceptions that affect final quality will be processed in the alliance Steering Committee. They will be collected in the handover materials and the required quality reports.

9.8.5 Continuous improvement

The alliance's ability to produce quality is continuously improved. The people in charge of directing the continuous quality improvement are the Quality Manager and the required experts. Any exceptions and repeated quality observations will be collected and their root causes determined. If necessary, process and operating method will be changed, instructions made more specific and personnel trained.

9.9 Steering of planning and design

The planning, design and execution solutions of the project will be completed in technology groups. The groups work in a collaborative manner and their participants include designers, constructors, representatives of the owner partners and any required experts. The groups will convene as necessary throughout the EPAC phase.

Personal responsibilities for planning and design tasks will be specified down to daily level in weekly meetings held for each technology type. The planning and design situation of each technology type will be reviewed in the weekly Project Group meetings, and in a more detailed manner in the situation report submitted to the Project Group by the persons in charge of each technology type.

In addition to the weekly schedule meeting, planning and design is steered in weekly sessions of the Planning and Design Steering Team led by the Project Manager in charge of planning. Other participants include the Chief Designer, the people in charge of the technology disciplines, and the data model coordinator.

9.10 Control of production

9.10.1 Decision-making

The foundation of the performance of the alliance is timely decision-making based on factual information, as well as a good flow of information. They ensure that the planning, design and construction proceeds efficiently and that mistakes and shortages are prevented in advance while avoiding loss.

The authority levels in decision-making are described in the table below. The flow of information within the alliance is based on the data repository, Big Room operations and the meetings and workshops held according to the weekly schedule. They are described in the following chapter.

DECISION-MAKING LEVELS

ASC	• Changes in scope • Procurements exceeding 10 MEUR • The most significant risks
Core group	• Urgent decisions • Participating ASC and APG members
APG	• Decisions that steer the project • Approving the procurement plan
Construction groups	• Decisions that steer planning, design and execution

Levels of decision-making and flow of information between the groups

9.10.2 Meeting procedures and the operation of groups

The meeting procedures of the alliance strive towards efficient use of time, results and distribution of information. The meetings will be prepared well and have clear objectives. The minutes of the meeting will be an easy way to see the matters processed in the meeting and the results achieved. Invitations to the meetings will be sent well in advance, and the participants of the meeting will be the correct persons with sufficient authority. If necessary, the project staff will be trained in how to hold efficient meetings. The weekly schedule of the alliance is presented in the picture below. The most important meeting and their tasks are presented in a table on the next page.

The integration of construction and planning schedules will take place in weekly production meetings. Generation of ideas for planning and design together with the constructors will be facilitated in the technology groups and in the Steering Team of Planning and Design to be convened once a week. The situation of integration and any corrective actions will be decided on a weekly basis within the Project Group.

Most of the meetings and daily interaction with operators will take place in the Big Room of the alliance at Lahti. The staffing of the Big Room will vary as the project progresses, but representatives of all parties of the alliance will nevertheless be present in the Big Room at all times. The Big Room will challenge participants to meet, discuss, generate ideas and inspire each other.

WEEKLY SCHEDULE OF VALTARI

Time of day	Monday	Tuesday	Wednesday	Thursday	Friday
7:00 am	**Familiarisation** 7:30–8:30 am		**Familiarisation** 7:30–8:30 am		
8:00 am		**Supervisor meeting** 8:00–10:00 am Persons in charge of specific regions, foremen			
9:00 am			**Procurement** 9:00–10:30 am	**Production control** 9:00–11:00 am Based on the schedule: Schedule, Quality, Safety, Environment, Communications. Foremen of subcontractors participate in this meeting.	
10:00 am		**Jointweekly meeting** 10:00–11:00 am			
11:00 am	**Lunch break** 30 min	**Lunch break** 30 min	**Lunch break** 30 min	**Lunch break** 30 min	**Lunch break** 30 min
Noon	**Skanska's monthly meeting-** noon – 12:30 pm (1st Monday of each month)				
1:00 pm		**Finance** 1:00–3:00 pm (once a month per group)	**Alliance Project Group (APG)** 12:30–4:00 pm	**Guests**	
2:00 pm		**Steering of planning and design** 2:00–4:00 pm			
3:00					

Meeting participants: Joint, including foremen of subcontractors; Production; Planning; Agreed upon separately

9.11 Safety

The objective of the project is zero occupational accidents and the maintenance of employees' health.

Continuous and systematic work on safety is needed to achieve this goal. All planning and execution of work will be based on the "safety first" principle. Safety is one of the key objectives of the alliance.

Occupational safety in the alliance is guided by the owner partner's safety documents, which present the hazards caused by the properties, conditions and characteristics of the construction project and information on occupational safety and health associated with the implementation of the project.

The alliance will draw up written safety rules for construction, which will state the safety management objectives and procedures. The rules will also include instructions on safety monitoring and inspections, collaboration and worksite meetings, use of an ID badge and access pass, and the processing of safety plans that require the approval of the parties.

A safety plan, to be updated as the work progresses, will be created for the worksite. The plan will describe the actions taken to control the occupational risks identified. The safety plan will be reviewed at the kick-off meeting of the worksite and with all employees during the familiarisation sessions. Furthermore, safety risks and actions will be included in the execution plan of each work phase and the plans will be reviewed alongside the employees participating in the work phase prior to starting the works. In addition, an organising plan (regional plan) and a fire and rescue plan will be created on the worksite.

All employees (including subcontractors) must have a valid occupational safety card and Road Safety 1 card. People in charge of traffic arrangements or working in a supervisory position within them must have a valid Road Safety 2 card. Anyone performing hot work or granting hot work permits must have a valid hot work card. All persons moving about on the worksite must have a photo ID card and wear personal protective equipment (high-visibility clothing, helmet with a chin strap, protective glasses, safety shoes, suitable gloves). Access passes are granted only to people who have undergone worksite familiarisation training and have the required competencies. Each employee's tax number and the validity of their occupational safety card and Road Safety 1 card will be verified during the familiarisation training. When work is being performed on a block of the worksite, the block must have at least one person trained to give first aid.

VALTARI CORE MEETINGS

Meeting	Persons in charge	Tasks	Frequency, IPAC
Alliance Steering Committee (ASC)	Committee chairperson	Key decisions on scope, quality, risks, overall schedule, target outcome cost and resourcing	1 a month
Alliance Project Group (APG)	Project Group chairperson	Key decisions on target outcome cost, planning and design, schedule, procurement, quality, safety	1 a week
Steering Team of Planning and Design	Project Manager of Planning and Design	Key decisions on planning and design	1 a week
Construction groups	Persons in charge of each construction area	Alignment of planning and design with production, steering towards production goals	1 a week
Production Steering	Persons in charge of each technology type	Safety, quality, the environment, communications and procurement tracking and tasking	1 a week
Procurement meeting	Procurement manager	Procurement decisions, presentations for APG/ASC	1–2 a month
Schedule meeting	The person in charge of scheduling	Updating the schedule	1 a week
Finance meeting	The person in charge of finances	Updating the target outcome cost forecasts by technology type	1 a week
Communications	The person in charge of communications	Communicating the project situation to the parties in the alliance	1 a week

A civil engineering assessment will be carried out weekly at the worksite. The results and other occupational safety matters will be processed in the weekly meeting. Safety observations at the worksite will be submitted via an electronic system. Instructions on how to use the system will be provided during the familiarisation sessions. The submitted safety observations will be recorded and corrective actions will be agreed upon. This policy seeks to reduce the number of accidents.

The safety plan and documents associated with safety will be stored in a separate safety folder. Other documents to be stored in addition to the safety plan include, but are not limited to, familiarisation forms, access pass lists, hot work plans, execution plans for a work phase, civil engineering assessment results, accident reports, close call notifications, traffic accident notifications, safety observations, documents on machine reception inspections, lists of chemicals, material safety data sheets and a list of persons with first aid training.

9.12 Risk management

During the development phase, risks in Project Part 1B were identified in risk management workshops. Based in these risks, a technology type specific risk register was created and stored in SharePoint. The risk register of the development phase will be supplemented and maintained throughout the implementation phase. The risk register will contain identified risks and the actions taken to manage them. The management of occupational safety risks is described in the previous chapter. The alliance Steering Committee will decide upon the insurance strategy and practice at the beginning of the EPAC phase.

9.13 HR management

The key areas of HR management in the project:

- Clear roles and clear organisation
- Familiarisation and training
- Job rotation and taking the need for deputies into account
- Culture that is open and promotes well-being at work
- Taking the special characteristics of posting work into account
- Collaboration

The goal is to enable employees to enjoy their job and be motivated to reach the key objectives of the alliance.

9.13.1 Clear roles and clear organisation

The staffing needs of the implementation phase are based on the organisation plan created in the DPAC phase. The plan states the resources and roles needed in each phase of the alliance contract. The staffing of the implementation phase is based on the roles, performance reviews held with the key persons and the principle of 'what is best for the project'.

The staffing needs of the alliance change during the different phases of construction due to the length of the implementation phase and the technical content of each Project Part. Roles will change and new resources will be obtained as necessary. Staffing needs and changes will be communicated to both the Project Group and the Management Group.

9.13.2 Familiarisation

All persons working in the alliance will be familiarised with their work before they start working. For employees, this means familiarisation with the alliance contract format and the special characteristics of the Project Part in addition to the normal familiarisation and guidance at the worksite. For white-collar employees, the familiarisation is based on how to work in the alliance environment and what systems are used in the work.

9.13.3 Job rotation and taking the need for deputies into account

Resourcing of the alliance takes into account holidays, illnesses and employee turnover. All key persons have a deputy. The deputies are mostly people who hold the same role. The duration of the alliance contract also enables systematic job rotation, which means that people working in the alliance can learn and develop their skills in new tasks.

9.13.4 Culture that is open and promotes well-being at work

The white-collar employees of the alliance work in Big Room which enables easy sharing of information and assistance. The headcount of white-collar employees will be approximately 50 persons throughout the implementation phase. As a result, special attention has been paid to the functionality and comfort of the working premises since the beginning of the DPAC phase. Conference rooms are easy to reserve and silent spaces are also available. Office desks are electric and enable working while standing. The functionality of the work premises has been improved, and further improvements will be made based on feedback from users.

The weekly calendar and meeting practices of the alliance are clear, but can also flexibly accommodate changing situations. Unnecessary meetings will be avoided. The persons in charge will prepare the meetings and ensure that the deliverables and tasks agreed in the meetings are distributed accordingly. Internal communication in the alliance plays an important role in creating a community spirit and transparent work culture.

During the implementation phase, workshops will be held to survey the employees' well-being at work and their commitment to the key objectives of the alliance. Based on the results obtained in these workshops, corrective actions will be taken as necessary. The actions will be processed in the Project Group, who will also appoint people to be in charge of the actions.

9.13.5 Taking the special characteristics of posting work in to account

Many white-collar and blue-collar employees work as posted employees on the Project Part. Flexible working hours will be arranged whenever possible especially for people who have a long commute. Otherwise, the accommodation and movement of posted employees will be adjusted as necessary to create as good working conditions as possible.

9.13.6 Collaboration

The following joint events will be arranged for the project staff:

- Themed VALTARI afternoons once a year.
- Recreational events held in summer and in winter. These events are agreed upon on a case-by-case basis in the Project Group.
- Other events that are invented in the project organisation to promote team spirit. The decision on whether to arrange these events will be made by the Project Group.

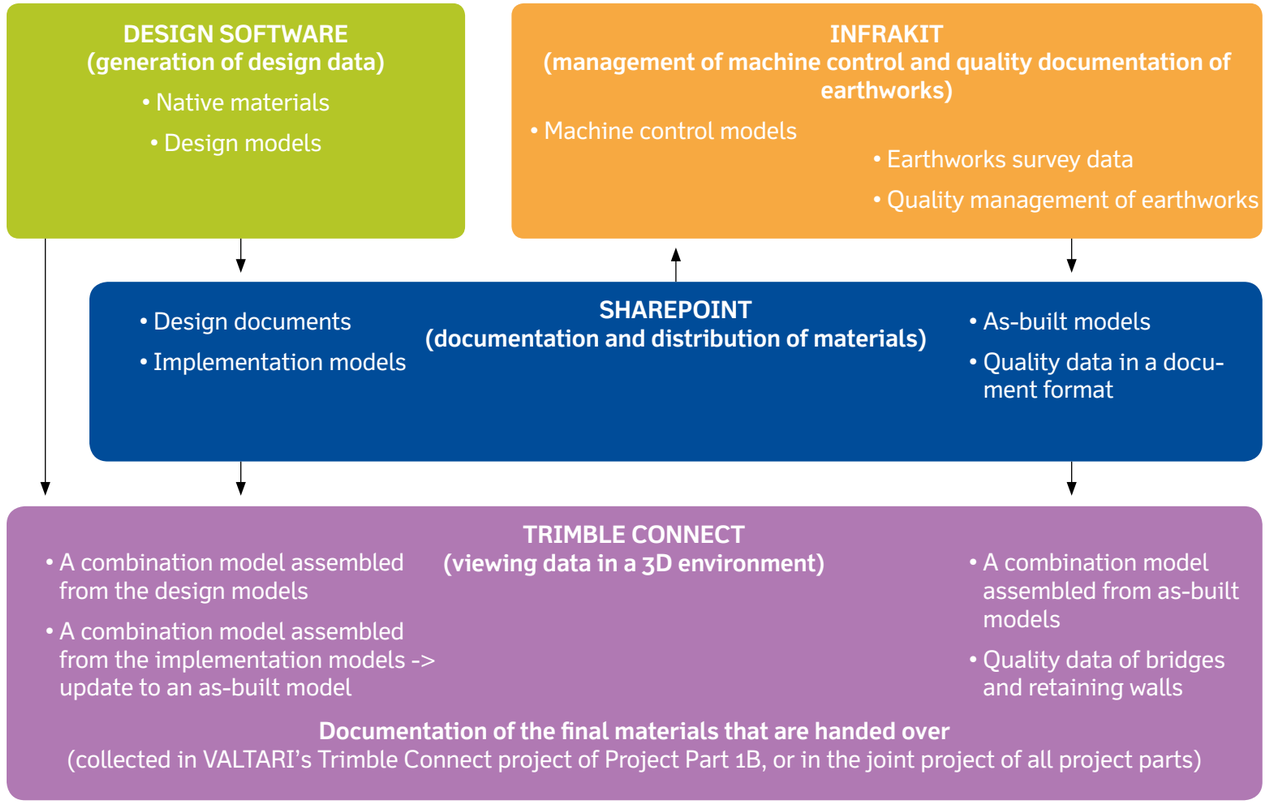
The alliance will also support exercise opportunities of people working on the project, especially posted employees. The costs associated with this will be decided upon by the Project Group.

9.14 Information management

Information management in the project is based on the SharePoint data repository and Trimble Connect cloud service.

SharePoint enables the data repository to be accessed as a network drive, which means that materials can be edited directly without the need to save it on the organisation's own network drive. This enables transparent information management, where all participants of the project can see the documents created and updated by other people. In addition to files, SharePoint will con-

SOFTWARE AND DATA MANAGEMENT IN THE ALLIANCE



tain a list of decisions, a list of ideas, a risk register and the documentation from self-inspection of plans. All of these documents utilise data in SharePoint. The plan and design documents of the project will be stored in a dedicated section in SharePoint, and rest of the documents in another section.

A combination model that was assembled from different plan and design models was maintained in Trimble Connect during the development phase. In addition, Trimble Connect was used to transfer up-to-date reference materials between the network drives of the planning and design organisations. During the implementation phase, the implementation models of the project will be stored in SharePoint. The final handover materials of the project will also be collected in SharePoint. The models in SharePoint will be synchronised regularly with Trimble Connect by using the Trimble Connect Sync function.

9.15 Reporting

The people in charge of planning, production and support functions will report the situation of their respective area weekly to the Project Group. The persons in charge will record the situation in the minutes of the meeting of the Project Group. Matters needing a decision will be recorded in the project decisions list before the meeting takes place. In the meeting, the persons in charge will report the situation on their respective area. Decisions made in the Project Group will be recorded in the list of decisions. Up-to-date meeting materials can be seen in the project portal.

The core group will create a situation report on the Project Part for the monthly Steering Committee meeting. The report will be sent to the Steering Committee three working days prior to the meeting. Themes discussed in the report will be the status of construction and planning, safety, finance, quality, schedule, personnel, the environment and procurements. The details of this report and the methods used to measure performance in each theme will be agreed upon during the EPAC phase.

9.16 Internal audits

The functionality and development of the management system will be ensured by means of regular internal audits:

- An external auditor will evaluate the success of the alliance format during the project. The auditing will be based on interviews by the auditor and the self-reflection of the project group. The auditor will give feedback and suggestions for improvement for the project group.
- The performance of project management will be audited by Skanska's internal steering committee for large projects. The auditing will be based on evaluation of the generated materials. Summaries of the audit will be processed in dedicated steering committee meetings. The steering committee will give feedback and suggestions for improvement for the project.
- An internal auditor of Skanska will audit the performance of construction operations during the project. The audits ensure that construction is managed as defined in the processes.
- Furthermore, the progress of the project will be audited by Skanska's internal extended follow-up meetings which ensure that the correct actions are taken in the steering of the project.

9.17 Training plan

The performance of the alliance will be ensured by correctly timed, targeted training. The following training will be provided during the project:

- The necessary systems training
- Safety training
- Qualification training
- Training associated with alliance competences

All people working in the Project Part will participate in safety training workshops. This will also ensure that information is disseminated. The workshops will be held at least twice a month during the implementation phase.

People working in the Big Room will be provided with annual training on alliance competences. The training sessions will reflect on tasks already completed and will also seek to ensure that operations are continuously improved and people understand what working in an alliance entails. System and qualification trainings will be provided as necessary for selected persons working on the project. The need for training will be verified regularly as part of predictive work planning. Training-related matters will be processed once a month in the project group. The table below presents the key areas of the alliance's training plan.

KEY AREAS OF VALTARI'S TRAINING PLAN

Topic of training	Participants	Trainer
Alliance competence and collaboration	All white-collar workers	External facilitator, internal training
Objectives and operating methods of the project	Everyone	Kick off event at the beginning of the project, internal training during the project
Shared IT systems and software (such as SharePoint and Trimble Connect)	All white-collar workers	Internal training, will be arranged as necessary
Special IT systems and software	To be determined case-by-case	External and internal trainers
Qualifications required by production, design and planning	To be determined case-by-case	General educational programmes of the sector
Other necessary training	To be determined case-by-case	To be determined case-by-case