3D geological and groundwater modelling for the public water supply management – A case study from Karhinkangas aquifer, west Finland

Shallow groundwater is an important source for public water supply in Finland. However, geological complexity of glaciofluvial and ice-marginal deposits could cause the greatest challenges for aquifer body identification and groundwater resource estimation. During the past 20 years, the Geological Survey of Finland (GTK), in collaboration with the municipalities, waterworks and local ELY-centres, has carried out 3D geological mapping of the aquifers for groundwater resource assessment with the integration of various geological and geophysical techniques including site investigation with gravimetric survey for identification of the bedrock surface, GPR survey for the internal structures of sediments with confirmation of the drilled borehole data. 3D geological model provides not only geological framework for groundwater flow model, but also useful data for the vulnerability and risk assessments for water supply management of the groundwater area. The applications and visualization of 3D geological and groundwater flow modelling have facilitated the authority and non-geologist user understanding of geological structures and flow paths of aquifer which could establish information sharing and more reliable on groundwater resource estimation.

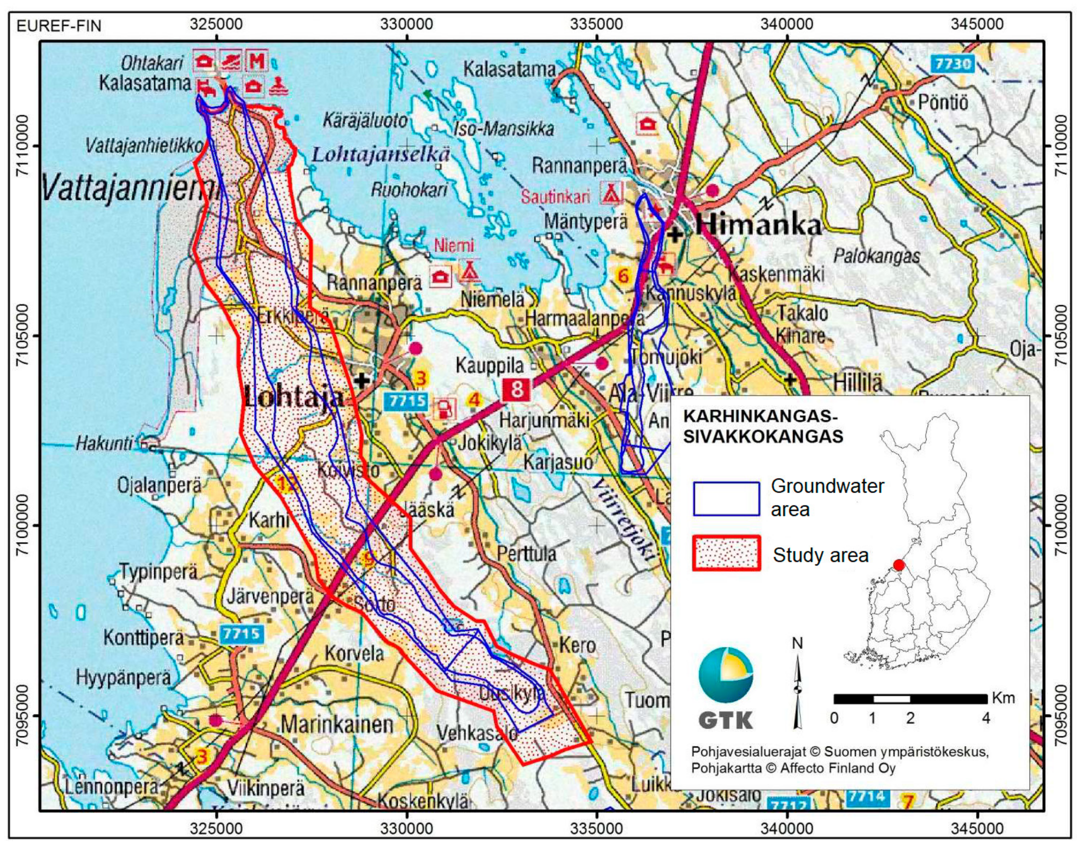

Fig. 1 Location map of the study area.

This study presents the applications of 3D geological and groundwater flow models from a case study in Karhinkangas groundwater area that locates in the low-lying terrain in the west-coast of Finland. 3D geological model revealed the main superficial units: glacial till, sand and coarse gravel of esker sediments, glaciomarine fine sediment, littoral deposit and peat, and outlined the location of aquifer body and groundwater divides. New water intake wells were planned in the optimized locations and depths, while groundwater flow model estimated water budgets, flow paths and travel times to the intake wells based on the pumping scenarios of the expected increase in demand of groundwater supply in the future.

Acknowledgements

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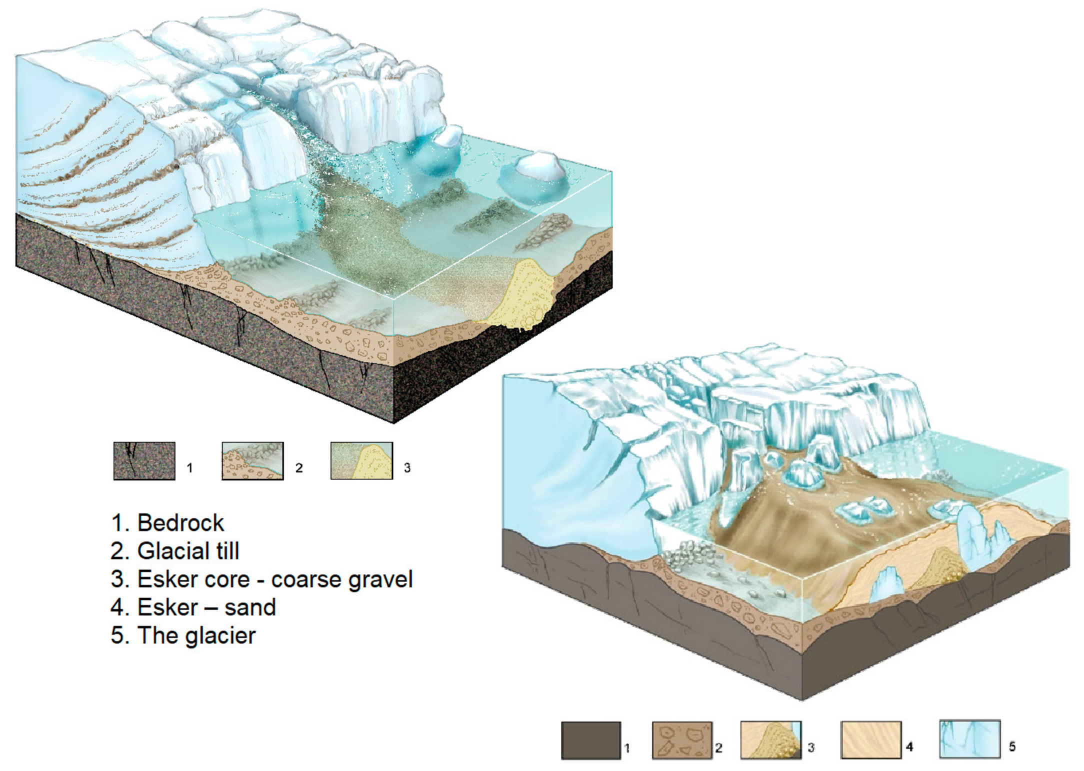

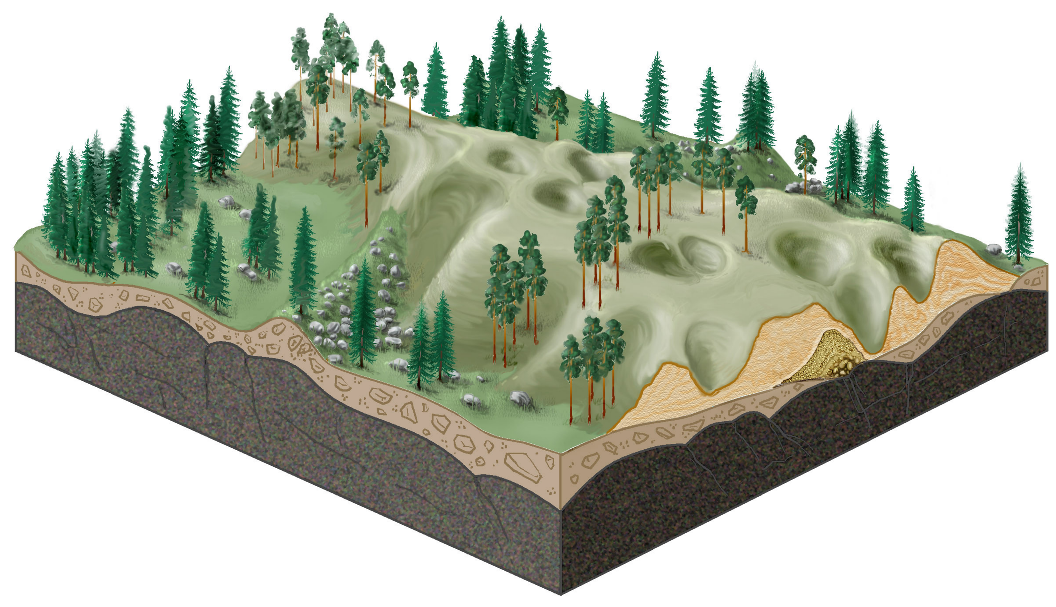

Fig. 2 Conceptual models of the glaciofluvial complex with the esker and kettle holes. Esker was deposited at the melting stage of the glacier. Figure: GTK/Harri Kutvonen.

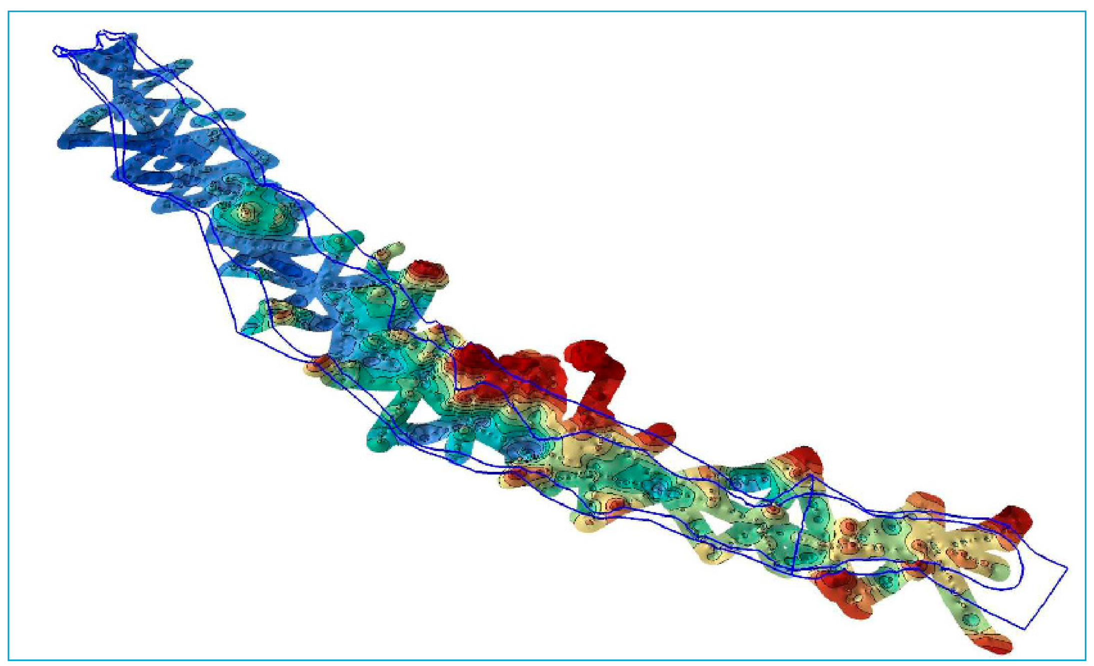

Fig. 3 Interpolated bedrock surface elevation based on the gravimetric survey and drilled borehole data.

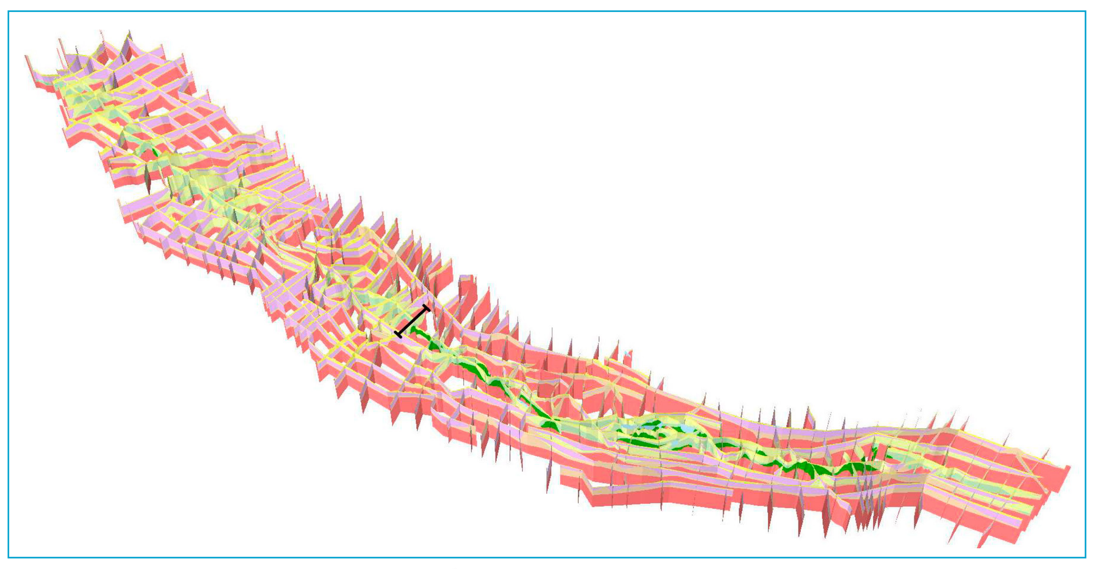

Fig. 4 Fence diagrams of the main geological units in the study area.

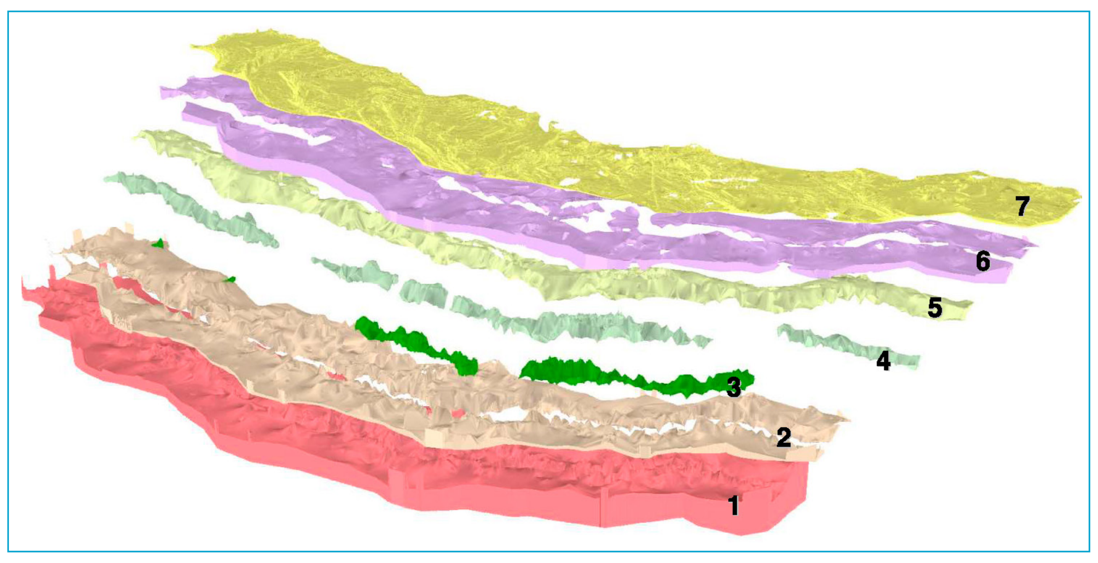

Fig. 5 Solid model of the main geological units in the study area: 1) bedrock; 2) glacial till; 3) esker core - coarse gravel; 4) esker –sand and coarse sand; 5) esker - fine sand; 6) glaciomarine fine sediment (silt and clay); 7) littoral deposit (sand). The solid model was constructed by using GSI3D program from the BGS. The bulk-volume of each unit can also be estimated.

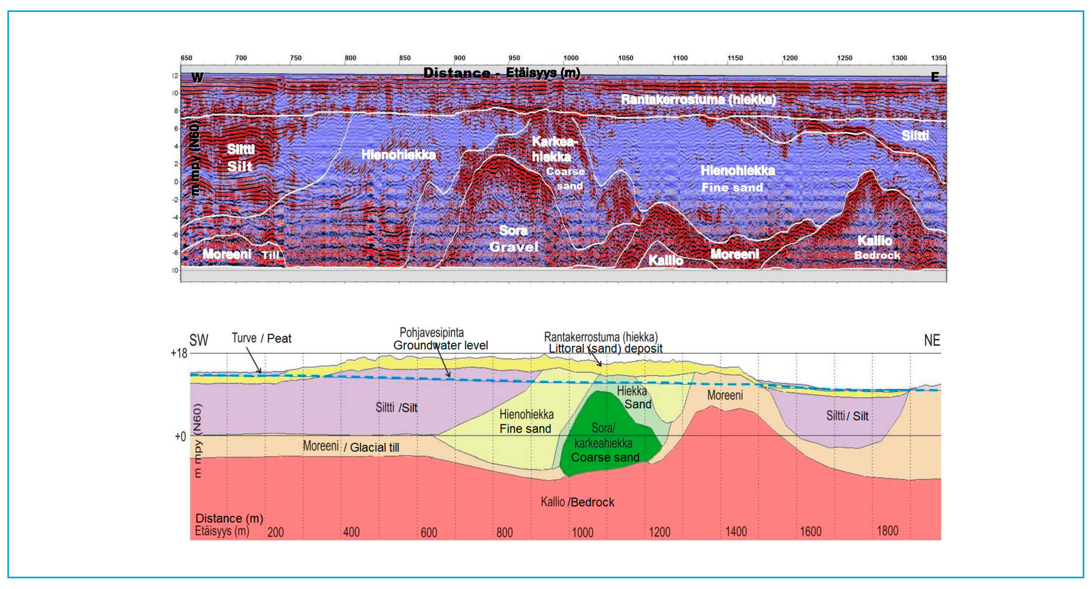

Fig. 6 GPR-profile (top) and the interpreted geological units (bottom) based on the GPR- reflection profile calibrated with the sediments from drilled borehole.

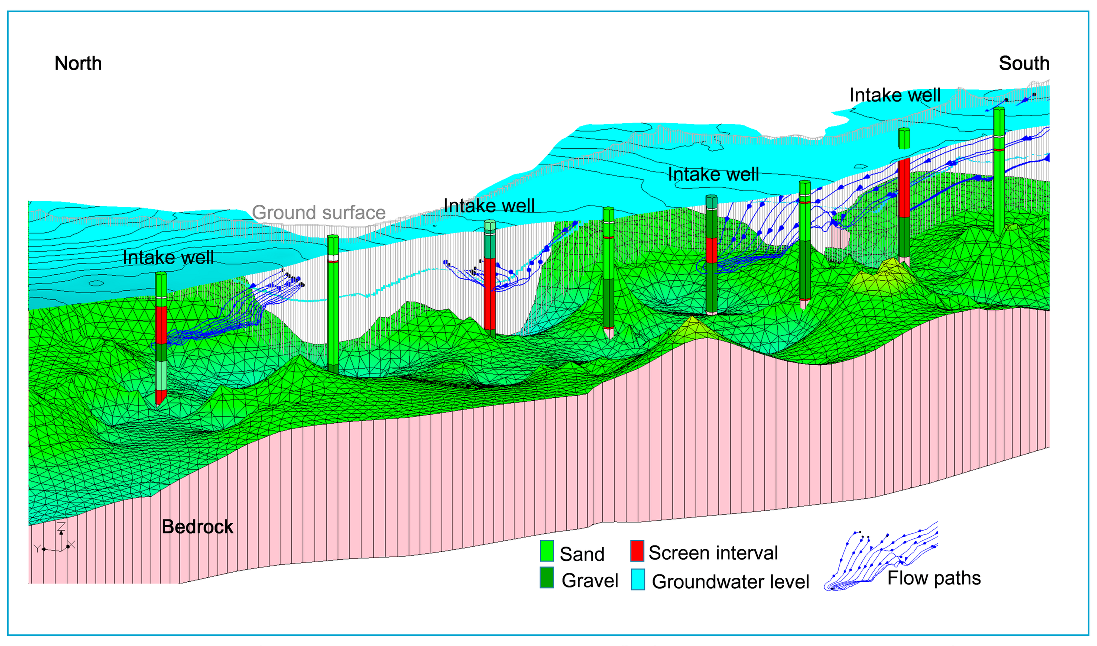

Fig. 7 3D Geologic cross-section of the new proposed water intake wells with information of sediments and screen intervals at the well locations. The groundwater flow path, direction and travel time toward the intake wells can be calculated by using the particle tracking in the saturated zone flow MODFLOW/MODPATH codes.

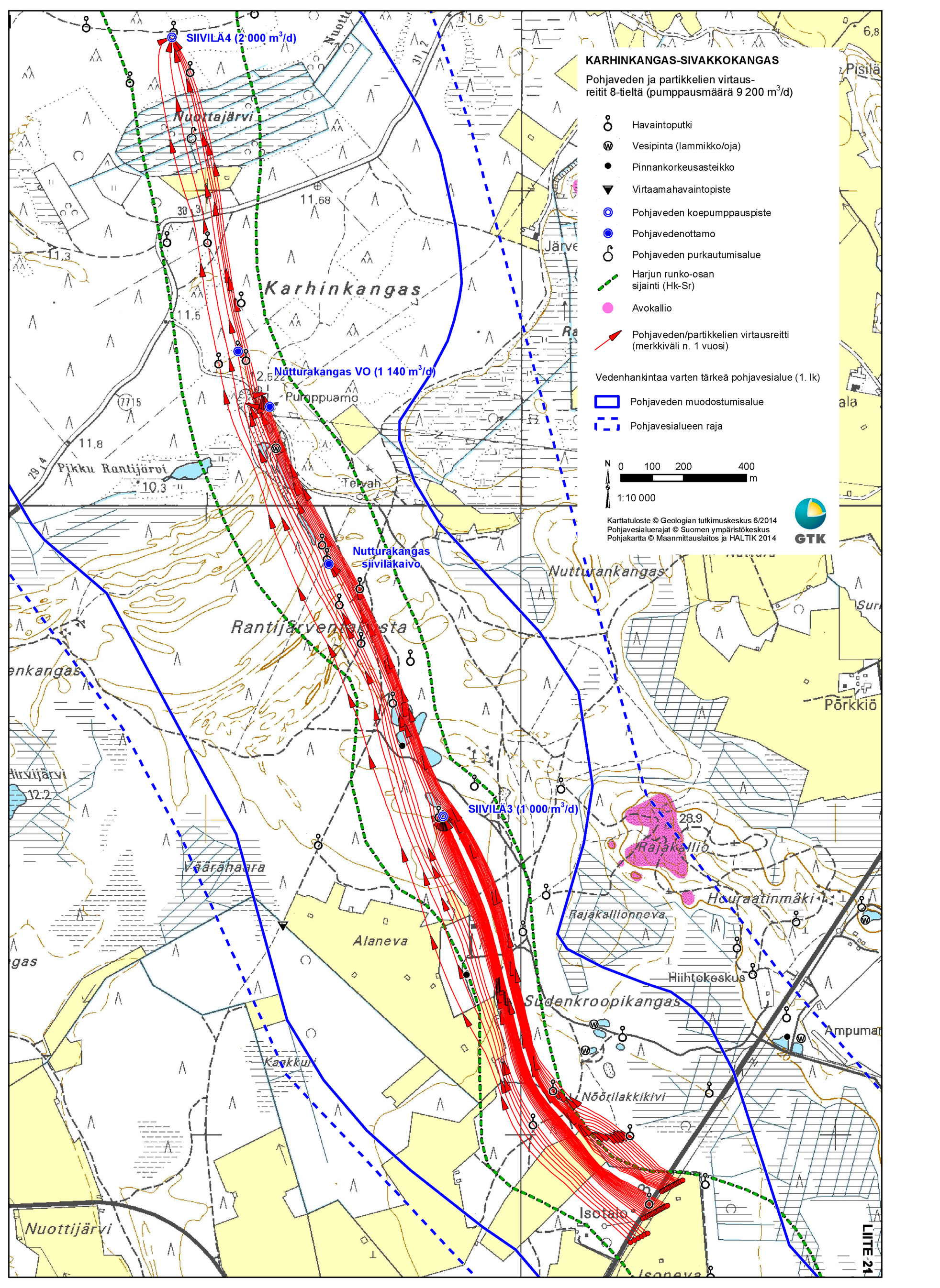

Fig. 8 2D map presenting the groundwater flow path and direction from point sources toward the intake wells.

References

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Lähde – GTK's groundwater service: http://lahde.gtk.fi

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