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GIS based analysis of heat demand and subsurface potential of abandoned mine infrastructure in the Ruhr region

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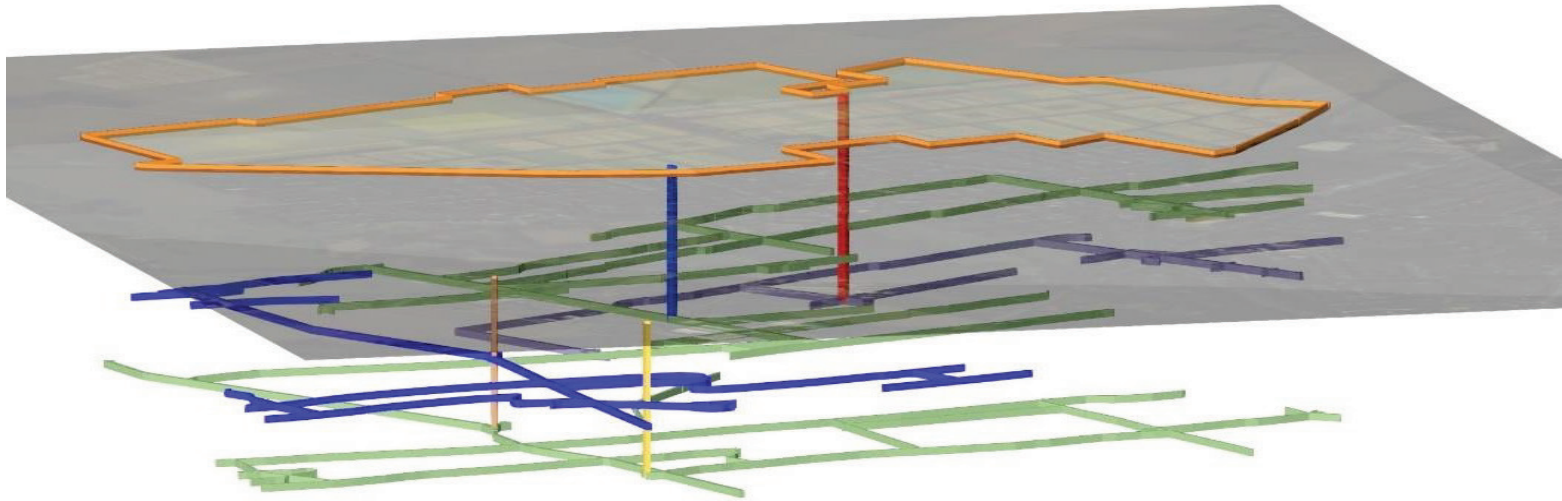
Structure

GIS based analysis of heat demand and subsurface potential of abandoned mine infrastructure in the Ruhr region

1. Introduction
2. Old mining situation & underground potential
3. Digitization of mine infrastructure
4. Analysis of heat demand
5. Combination of demand and potential
6. Outlook & conclusion



Chapter 01

Introduction & motivation

Motivation behind this approach
Introduction

- Climate change, global situation
- Calling for green energy and more independent energy supply
- A part of the solution to this problem can be provided by the mine water e.g. as heat storage and heat source

- Long mining history in the Ruhr-area
- Different research projects, such as:
  - HeatStore, Dannenbaum (D2Grids), PUSH-IT
- Projects could prove the concept and the functionality of our ideas
  - Time to roll out the concepts in to the real world

- **GIS is used to visualize the demands and potentials for better accessibility**

Chapter 02

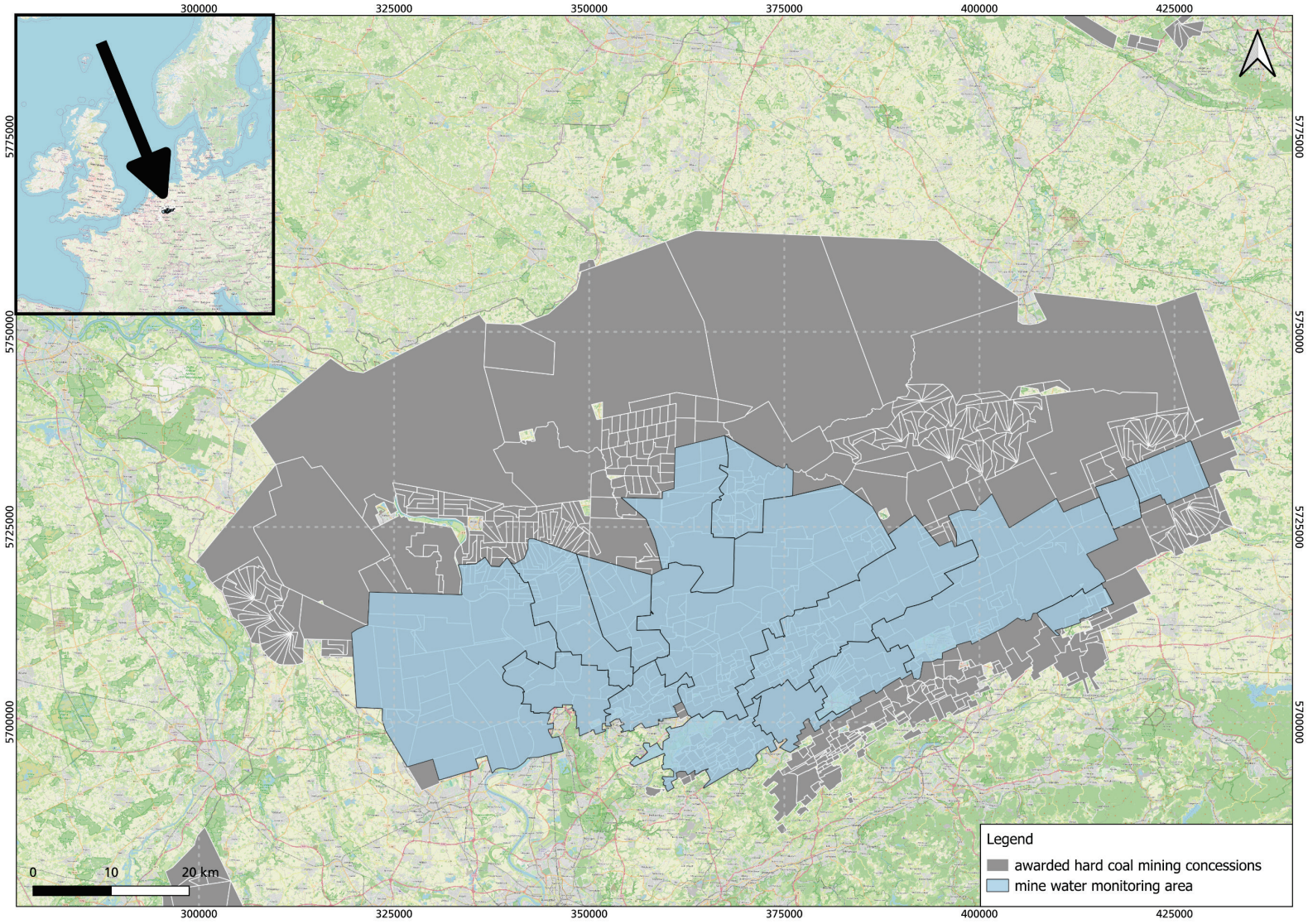
Old mining situation & geothermal potential

Mining history in the Ruhr-Area
Old mining situation & geothermal potential

- Due to good geological circumstances hard coal was found at the surface in the Ruhr -Area
- 700 years of mining history in the Ruhr Area
- Roughly 1300 Collieries
- 9.9 Billion tons hard coal extracted
- depths of up to 1635 m
- resulting in various mine levels with different geothermal potential and use cases

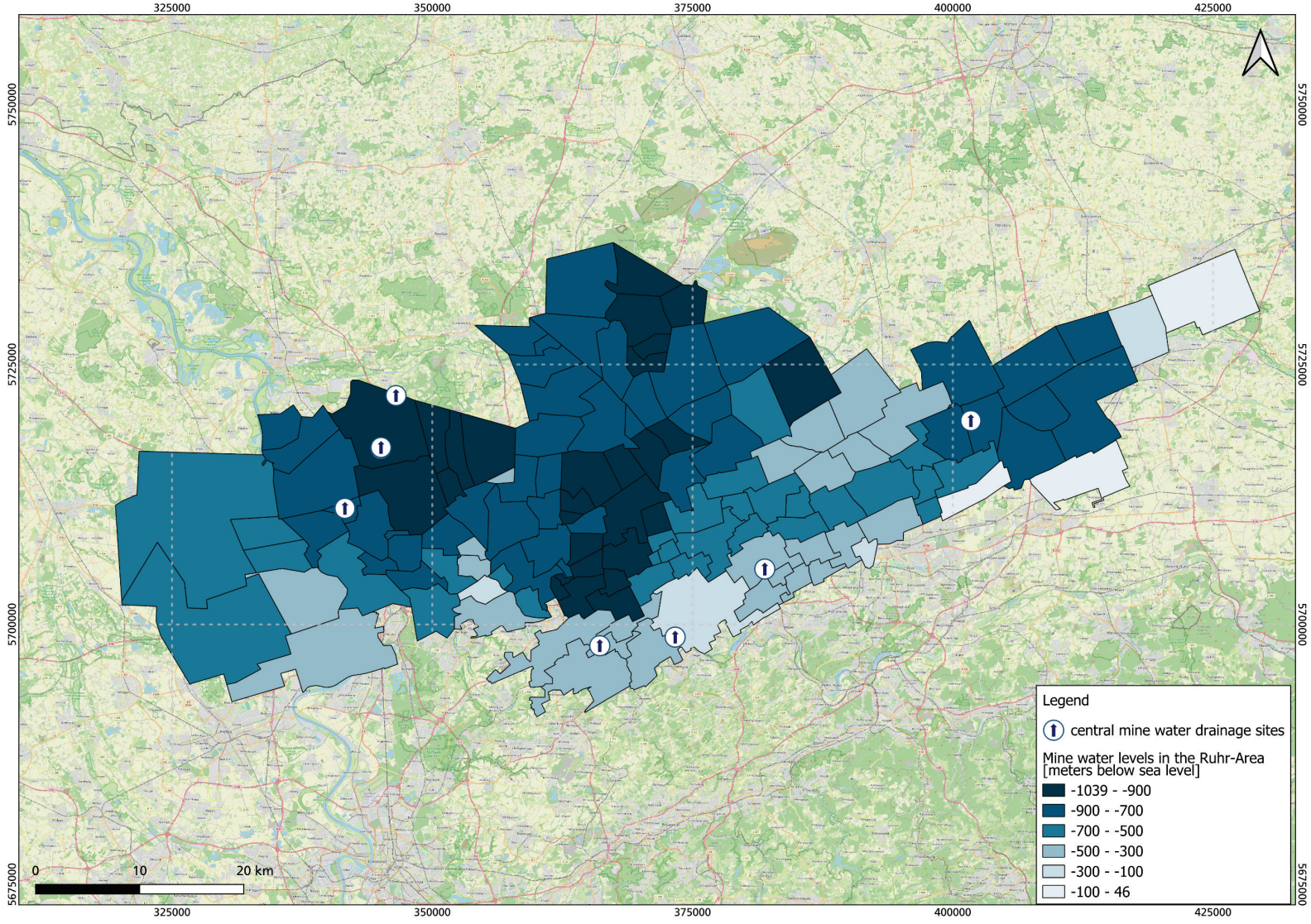
Fraunhofer IEG

Hard coal mining concessions & mine water monitoring area



Mine water levels in the Ruhr area

- The mine water level (MWL) is influenced by the water management locations
- MWL provide an indication of the economic viability of the development
- MWL also gives an indication on possible use cases
- Current status, may change in the future
- Making new areas economic viable



Geothermal potential

Old mining situation & geothermal potential

- Geothermal potential varies a lot depending on the amount of water being producible at what temperature -> correlation with depth
- Deeper mine levels provide higher geothermal potential but need higher CAPEX
- Higher mine water levels result in lower pumping costs and therefore lower OPEX

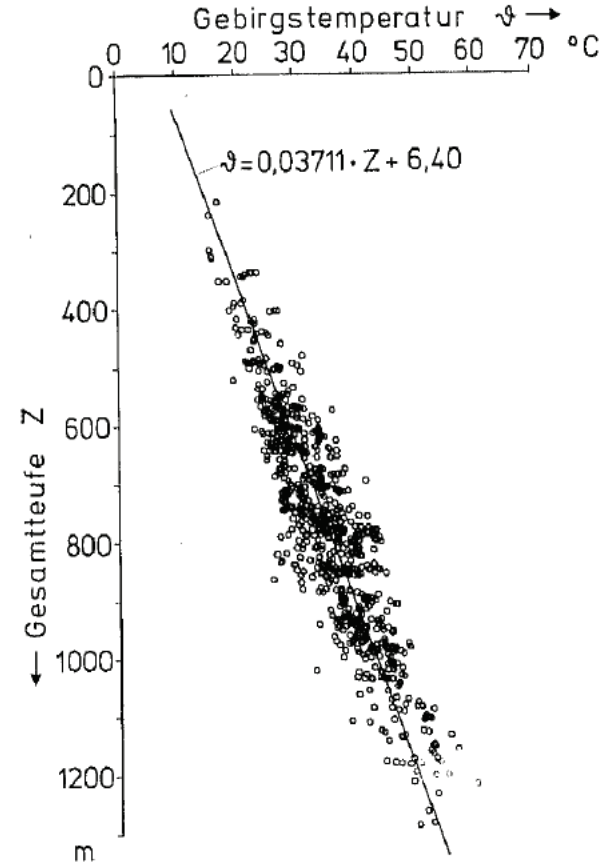


Bild 3. Gebirgstemperaturen und Teufen im niederrheinisch-westfälischen Steinkohlengebiet (817 Messungen).

Chapter 03

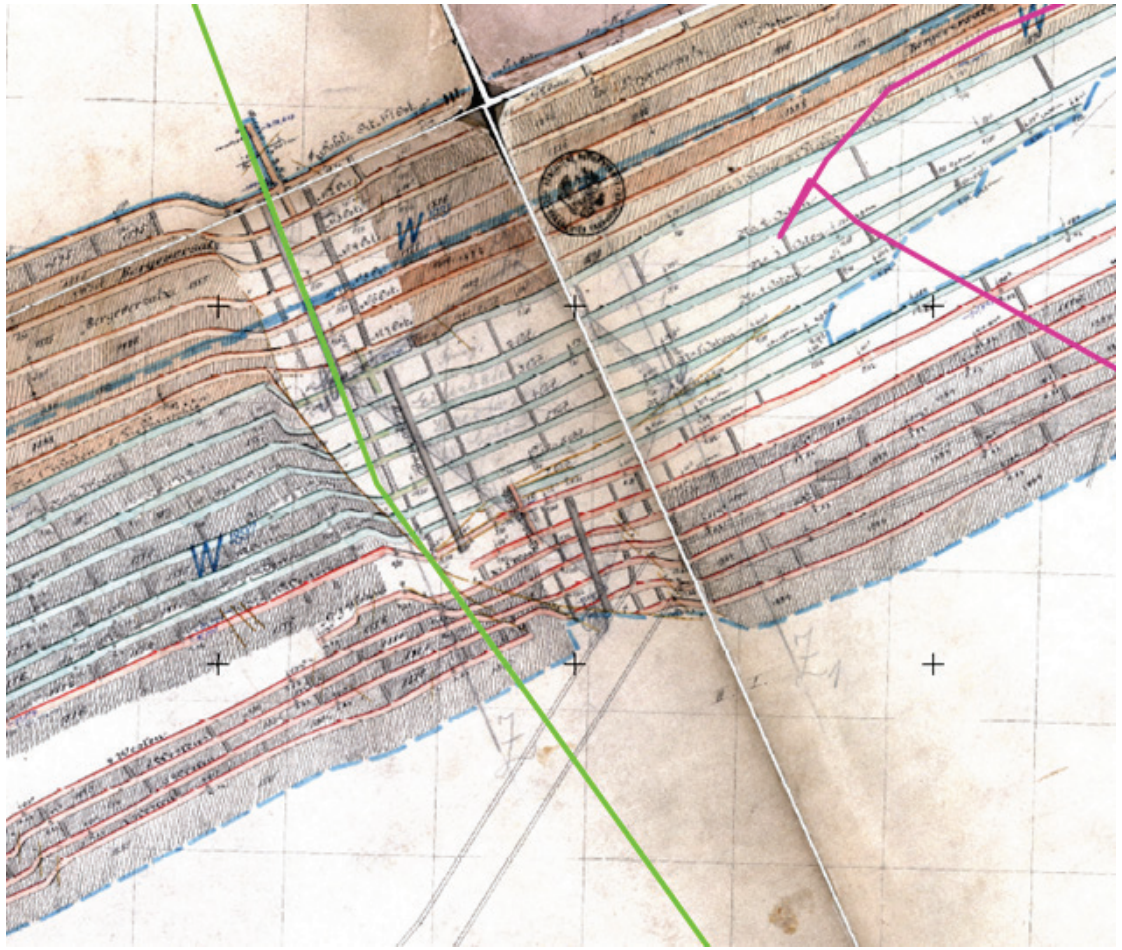
Digitalization of mining infrastructure

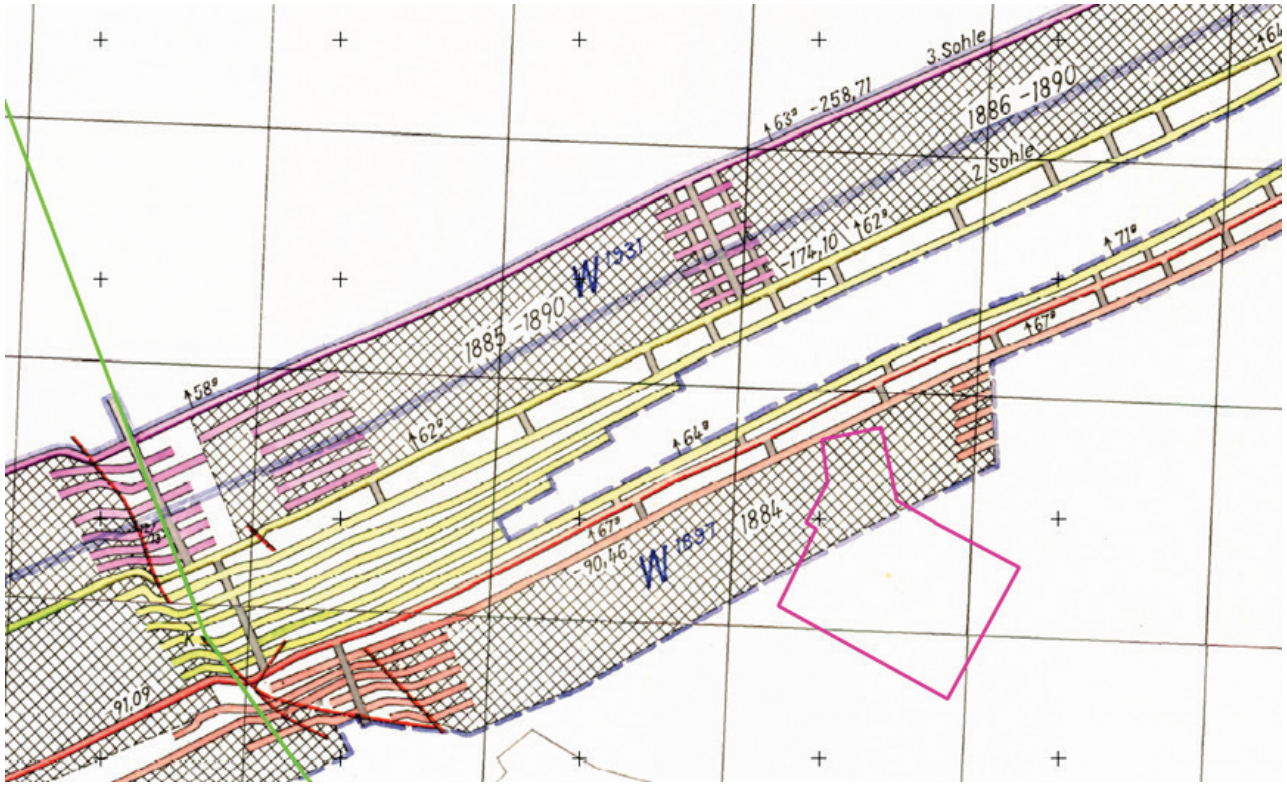
Data availability
Digitalization of mining infrastructure

- The mine surveyors drew up detailed plans of the underground workings during operation
- Those plans were duplicated
- One plan was given to the mining authority as part of the documentation of the operation
- The second plan was kept by the mine operator (and often contains even more details)
- The quality of those plans varied vastly depending on the age and owner of the mine, as well as the responsible mine surveyors
- Data missing: Temperatures, water levels, shape of the cross sectional area of the drafts, hydraulic connections

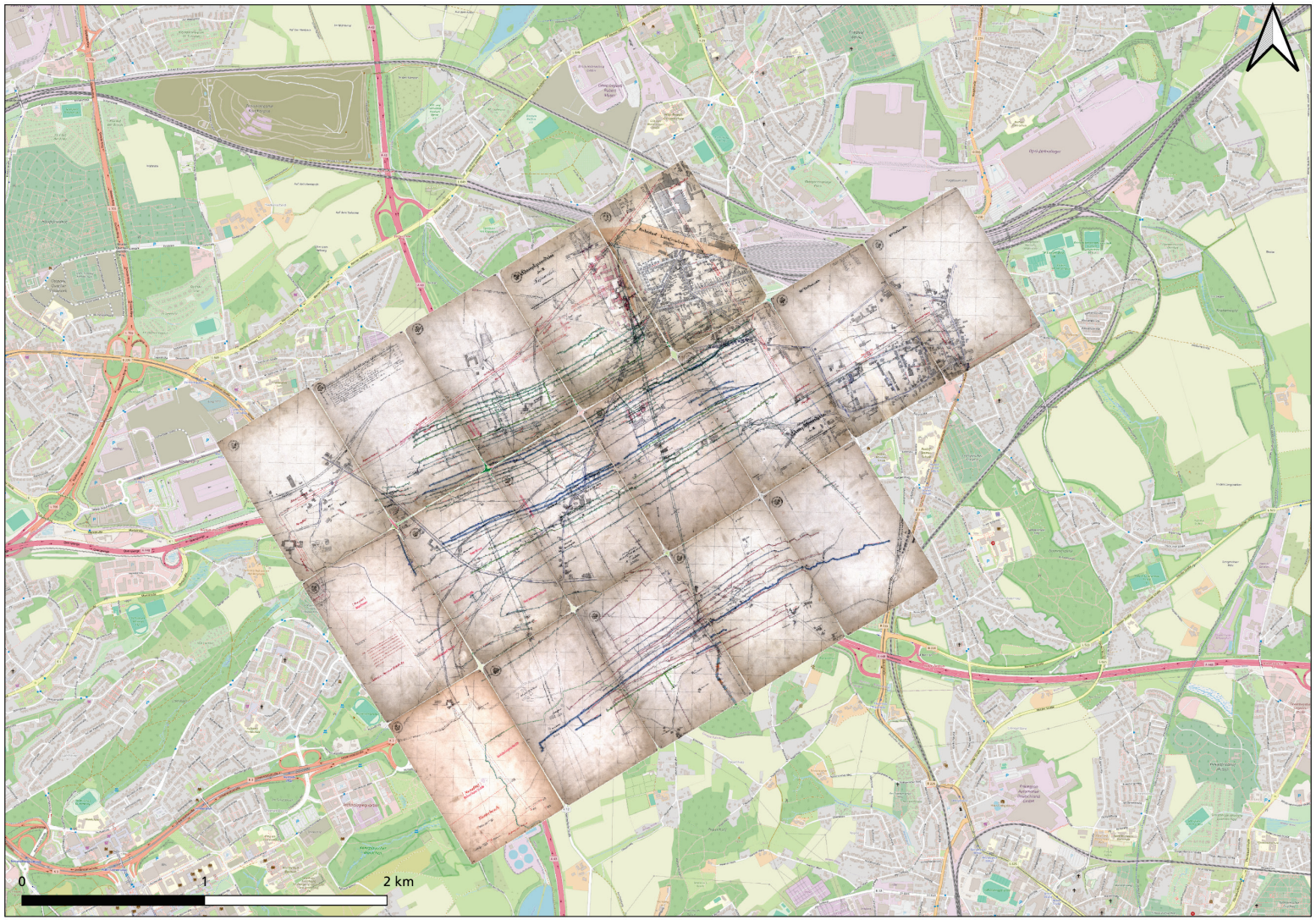
Comparison between different quality's of mine layouts

Digitalization of mining infrastructure

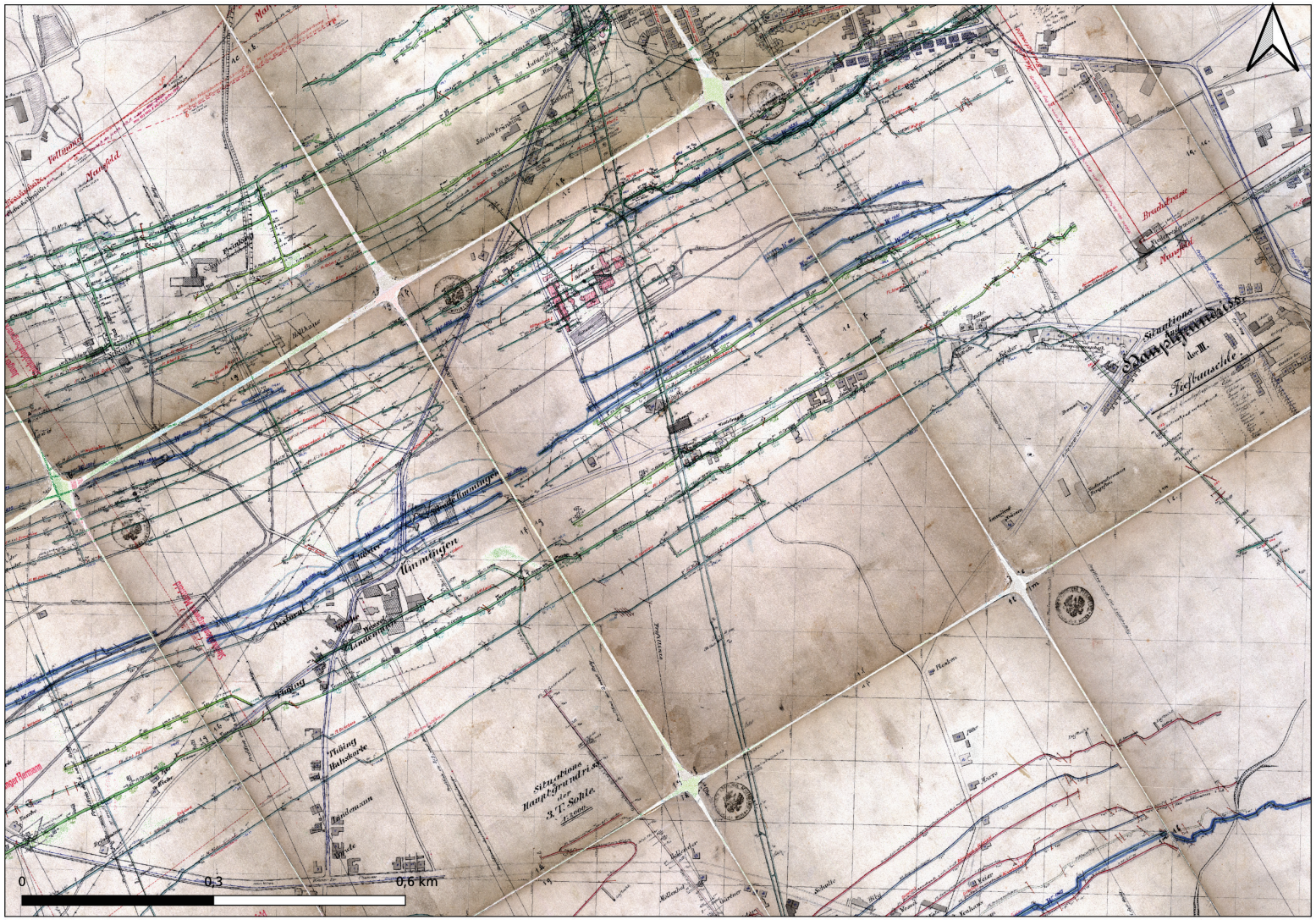




Mine layout imported into GIS

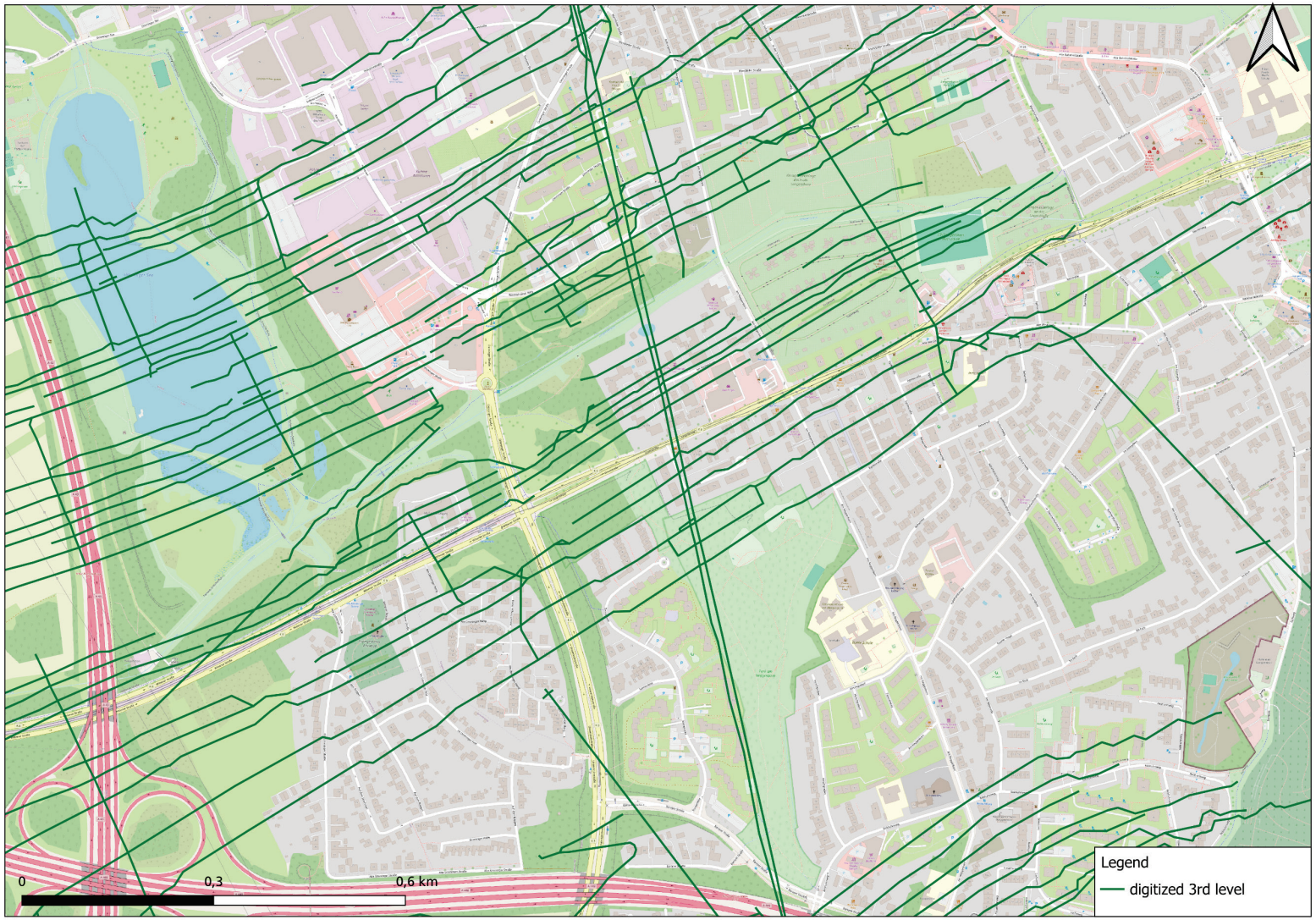


Zoomed into the mine layout

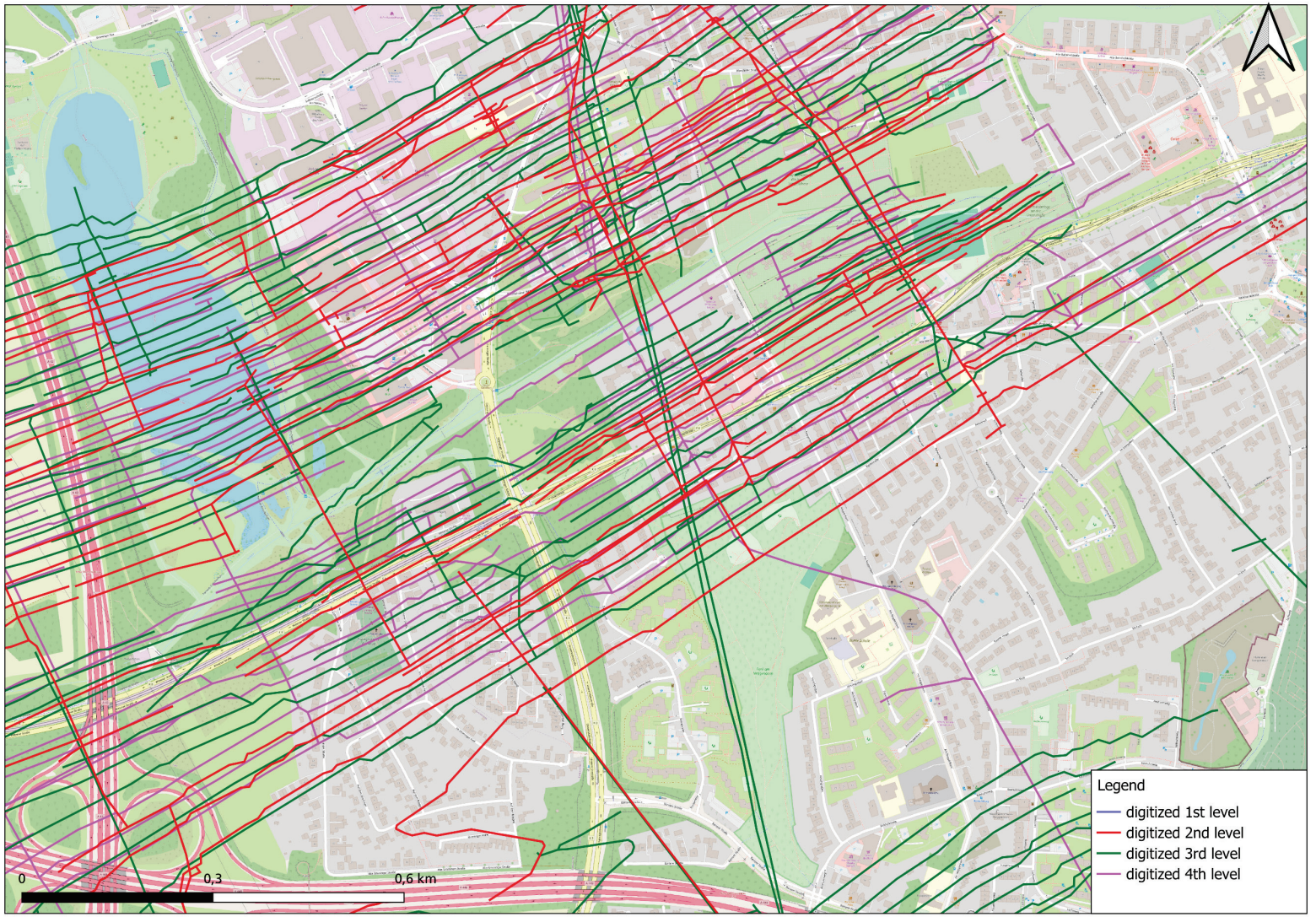


Mine layout with digitized 3rd mine level

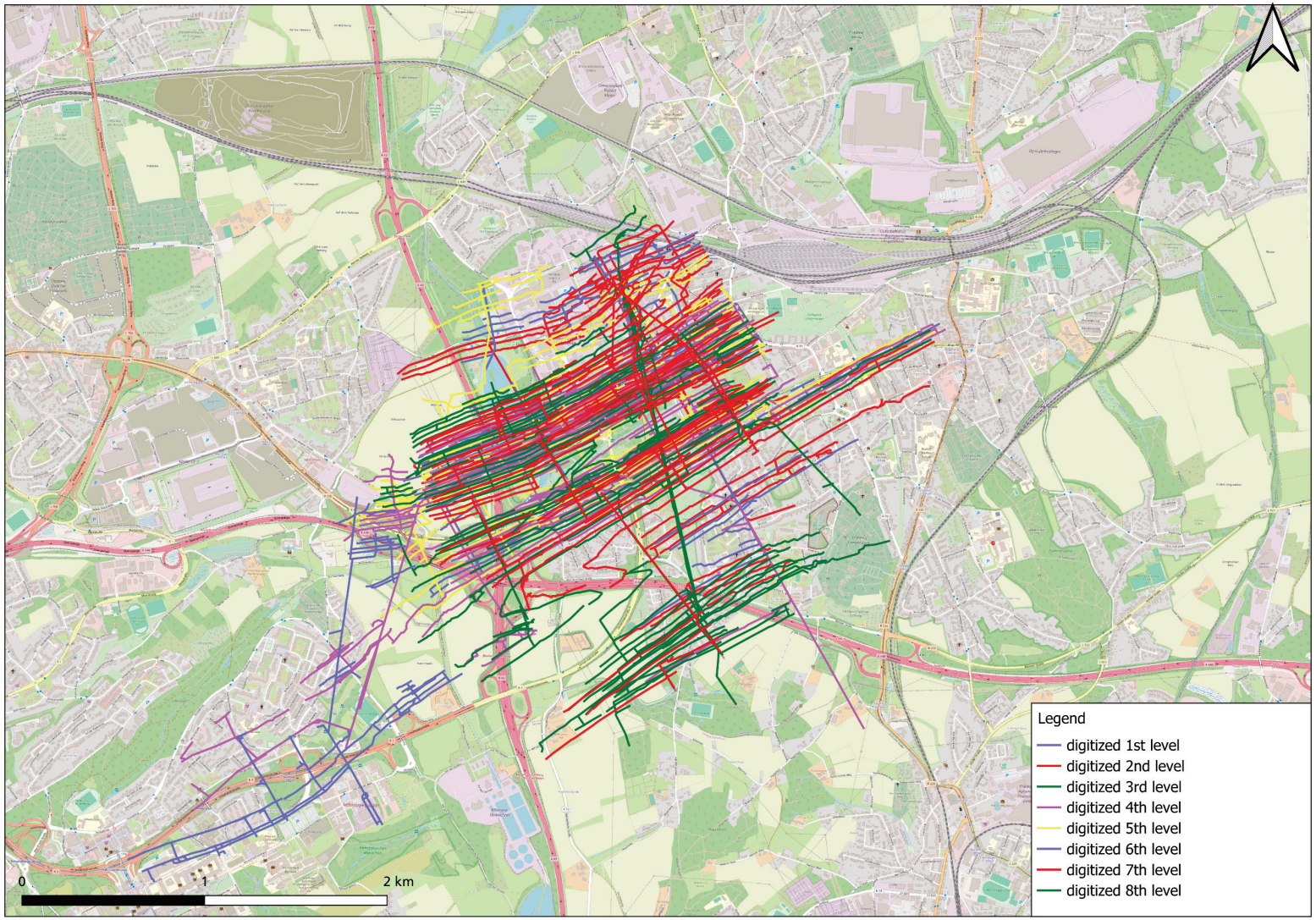
Digitized 3rd mine level on real world map



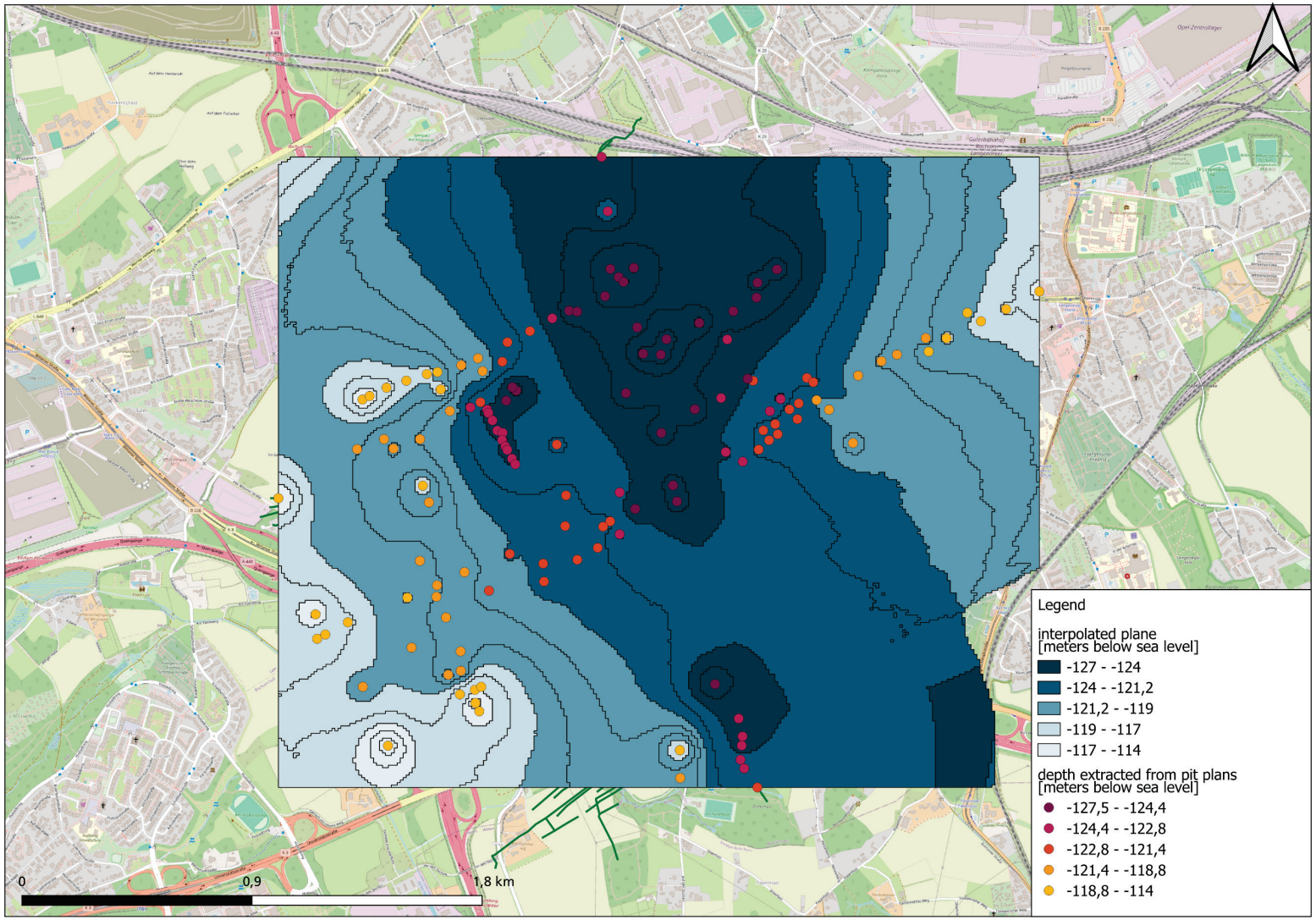
Digitized first four mine levels on real world map



Whole digitized mine layout



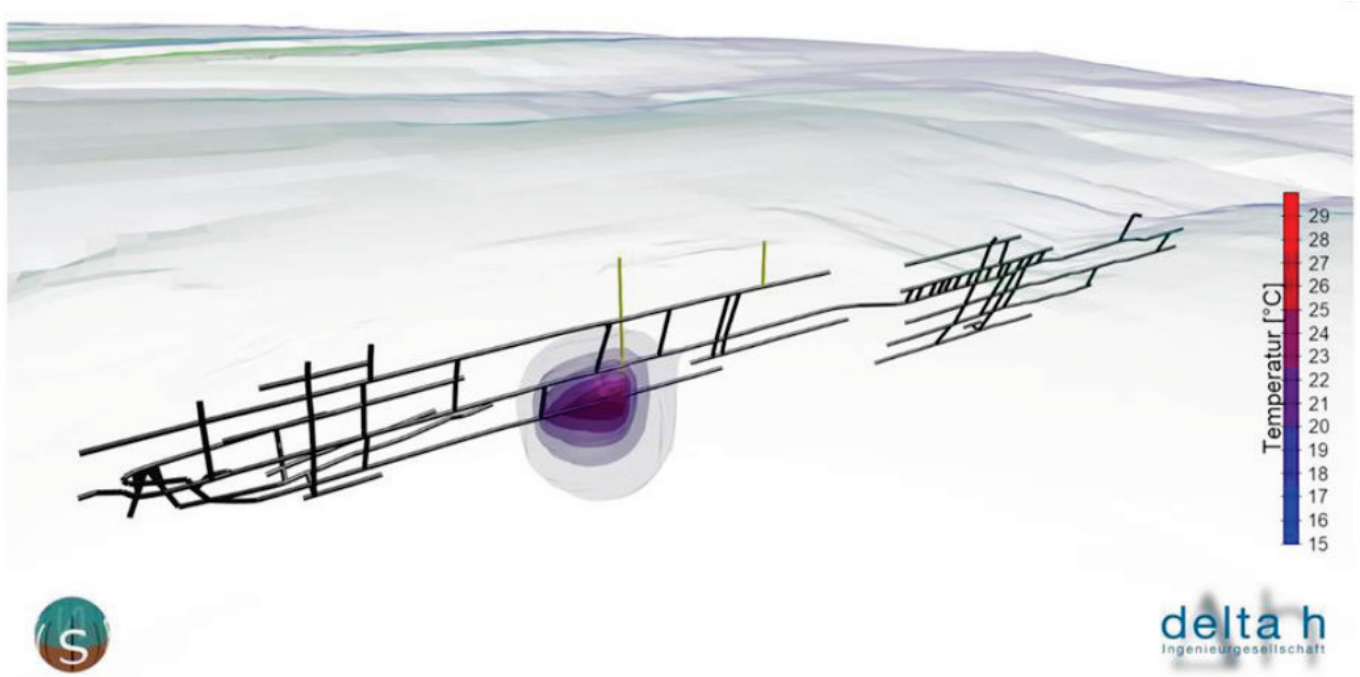
Extracted depth points of the mine layer & interpolated plane



Further use of digitized data

Digitalization of mining infrastructure

- Plotting a 3 D model for better understanding and visualization
- E.g. Python, QGIS or other software
- Shapefiles can be used in simulation software like SPRING
- Combination with underground model, hydraulic information, geological model,
- Thermo -hydraulic modelling / simulation
- 3D well path planning



Chapter 04

Analysis of heat demand

Available data basis
Analysis of heat demand

- Two type of main data sources:
- Available gas consumption data
- Heat demand model
- Gas consumption has to be provided by the local supplier
- Heat demand model is available for everyone
- Also provides estimates for the future including the influence of renovation of buildings

WW_spez_m_	WW_m_2025	RW_WW_sp_1	RW_WW_m_20	RW_spez_m1	RW_m_2030	WW_spez_m1	WW_m_2030	RW_WW_sp_2	RW_WW_m_21	RW_spez__1	RW_m_2035
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12,20000000000	50,97990575570	626,115176880...	2616,33546800...	613,915176880...	2565,35556224...	12,20000000000	50,97990575570	626,115176880...	2616,33546800...	265,000969031...	1107,35446118...
12,20000000000	356,481782646...	241,941325049...	7069,48154500...	229,741325049...	6712,99976236...	12,20000000000	356,481782646...	241,941325049...	7069,48154500...	107,888671317...	3152,48736707...
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12,20000000000	839,285204500...	143,542163634...	9874,82083279...	131,342163634...	9035,53562829...	12,20000000000	839,285204500...	143,542163634...	9874,82083279...	70,83951714340	4873,32447806...
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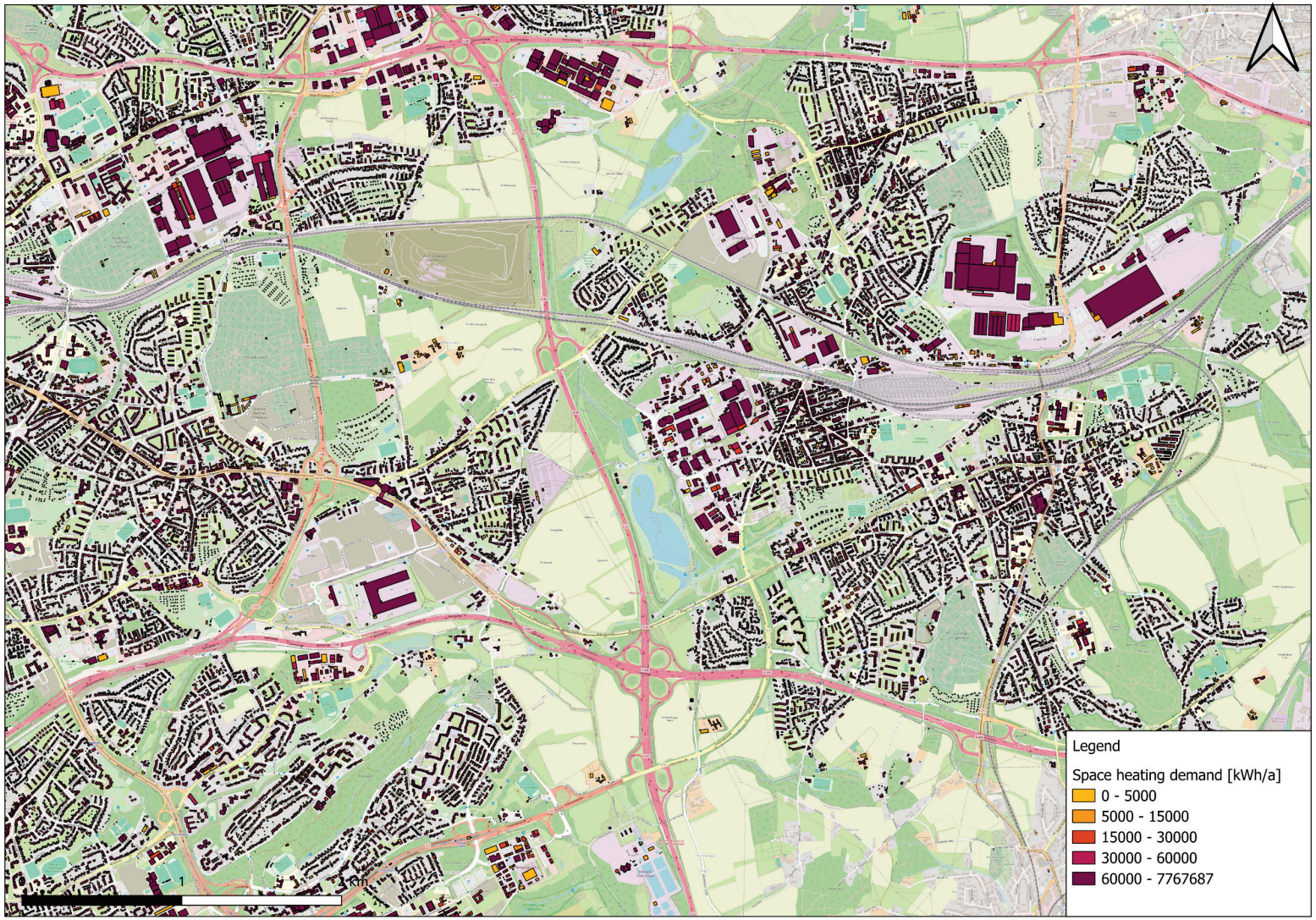
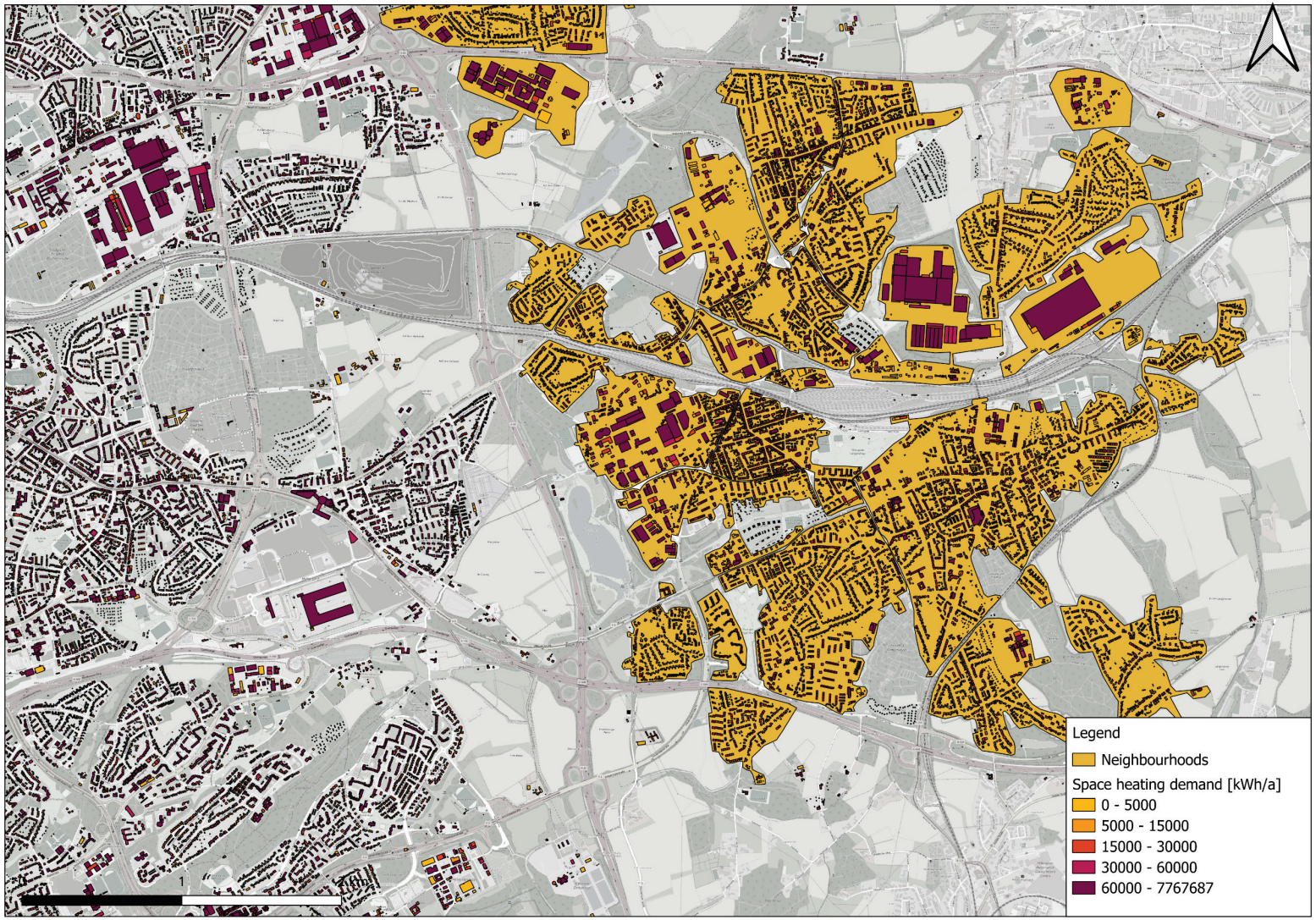
Heat demand model in GIS

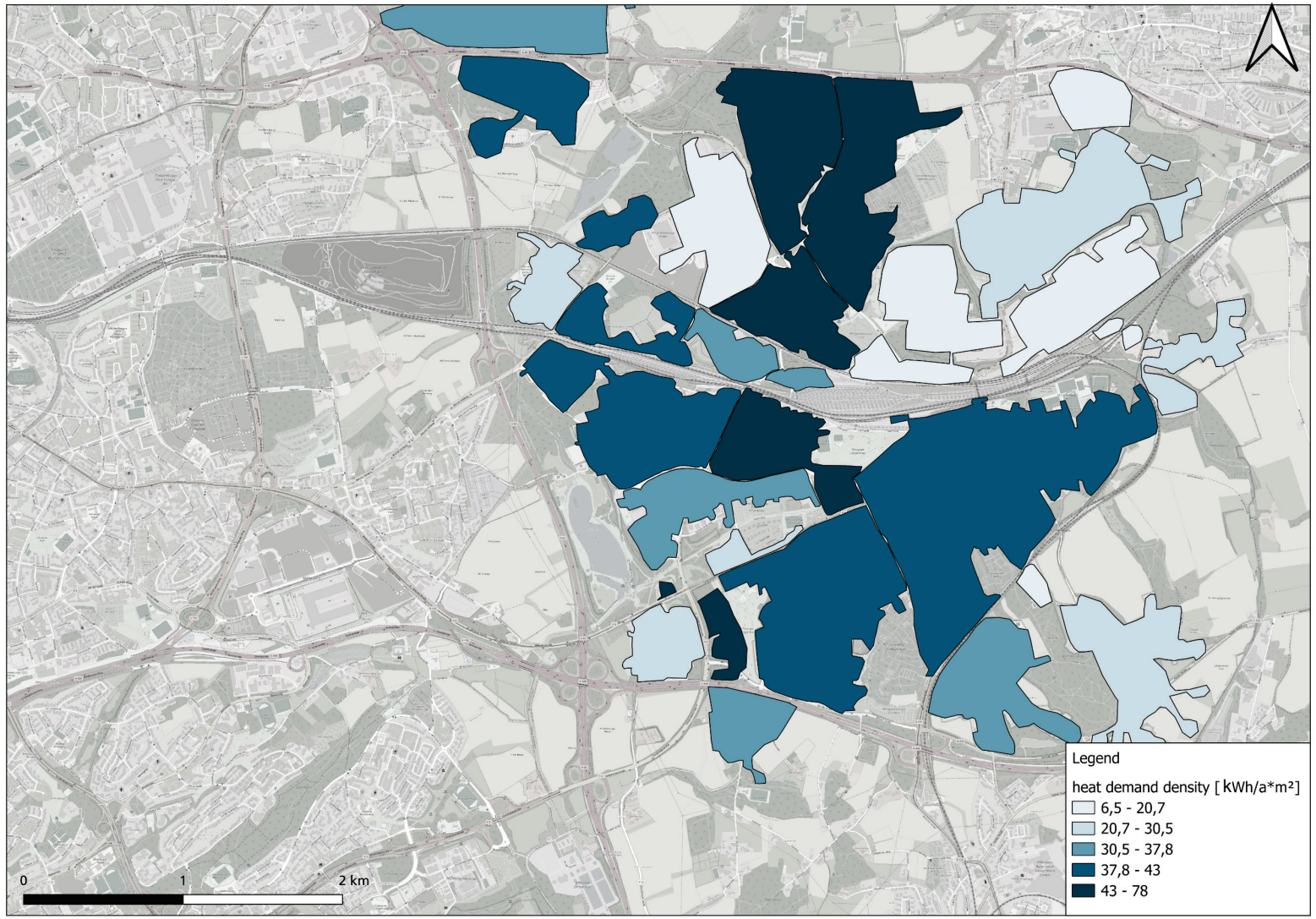


Chosen districts in corporation with the local supplier



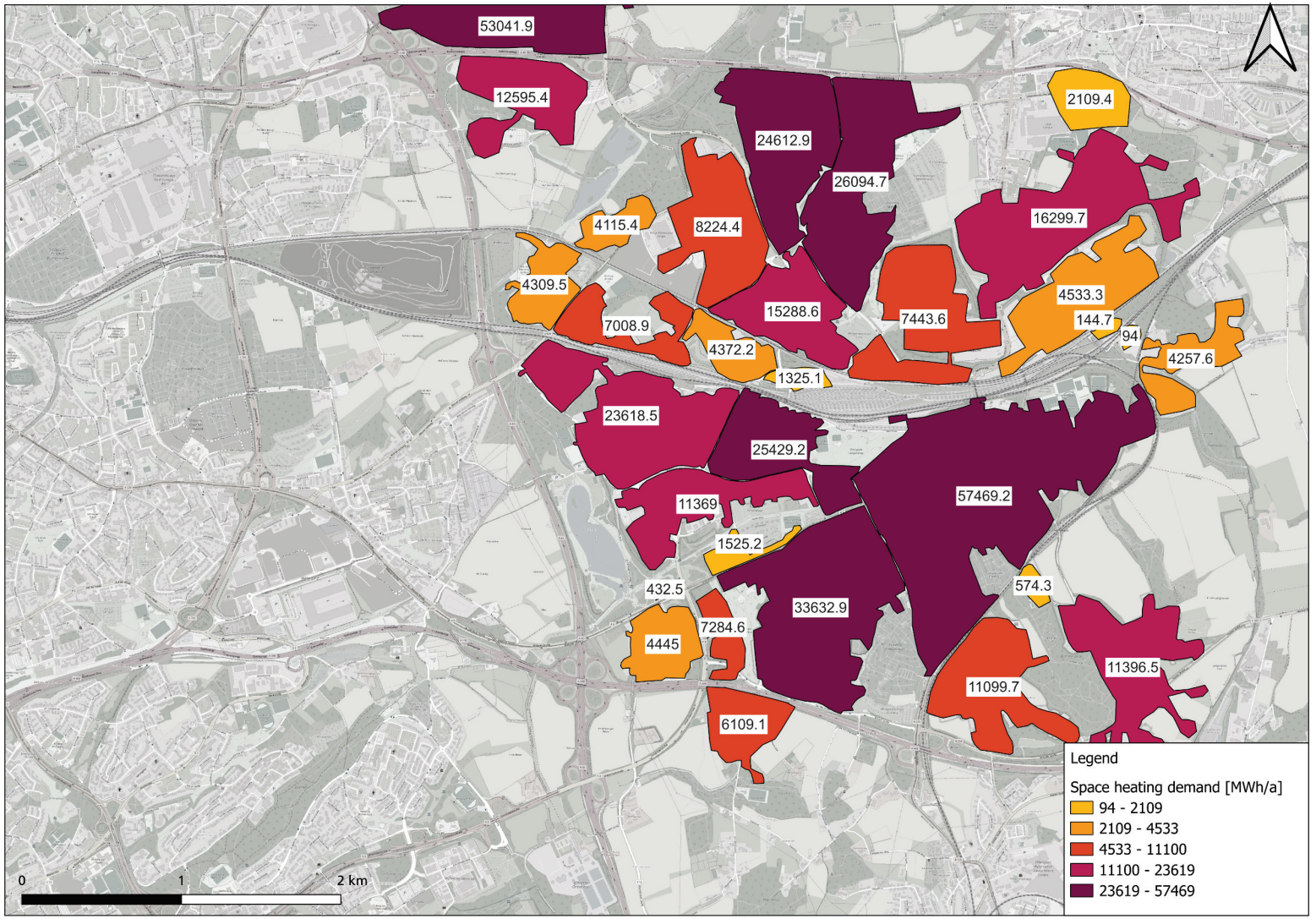
Heat demand density

- Heat demand density indicates areas with high economical relevance for setting up new DHN
- Values above 30 kWh/a*m² are preferred
- Values can change depending on the loc circumstances



Total heat demand for each district

- Gives an indication on how much energy needs to be provided by the mine water
- Creates the base for concept creation
- Makes it possible to create iterative expansion stages for possible DHN



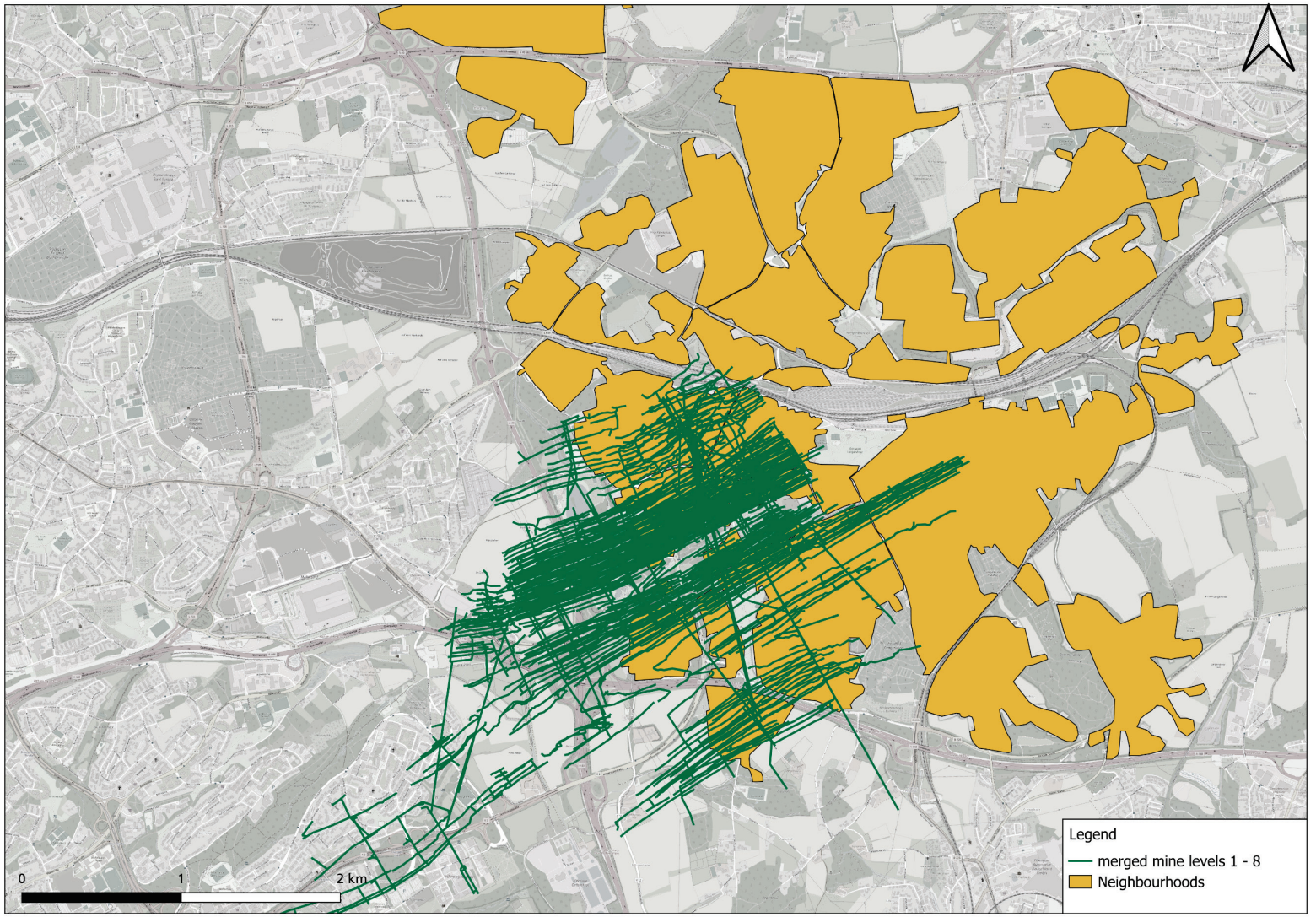
Chapter 05

Combination of subsurface data and heat demand data

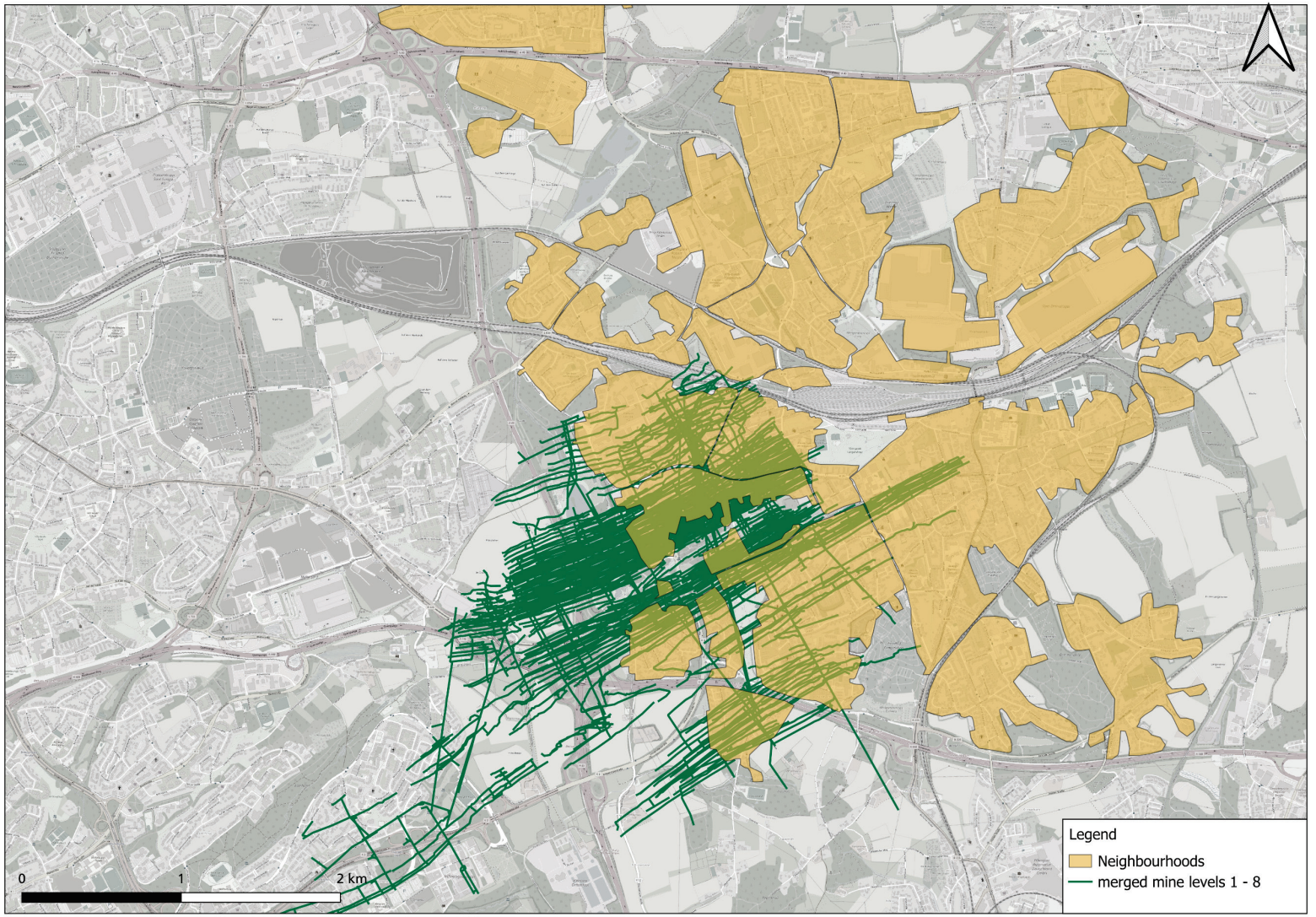
Approach
Combination of subsurface data and heat demand data

- Plotting both the mining infrastructure and the demand on the same maps allows us to start developing concepts
- Prioritizing areas that have a higher heat demand density
- Finding potential drilling locations suiting both the position in the DHN as well as a drilling target inside of the mine
- Visualization of overlapping areas that are interesting for potential use

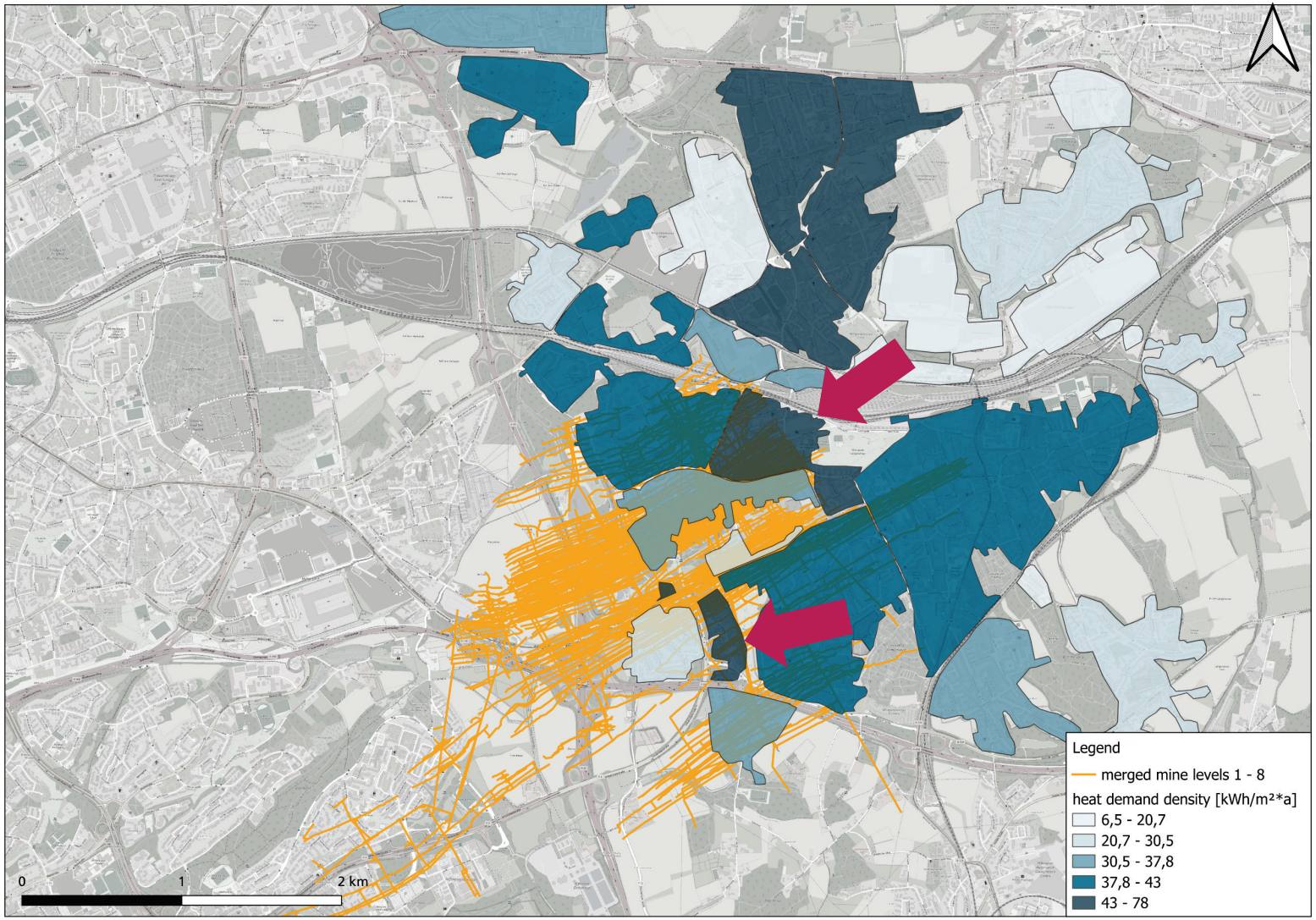
Mine layout combined with the districts



Mine layout combined with the districts



Mine layout combined with the district heat demand density



Reasoning

Combination of subsurface data and heat demand data

- After locating interesting looking areas new concepts can be developed
- Those concepts can than be evaluated and analyzed further with for example numeric modelling or LCOH calculation

- This approach needs a GIS software as a base to blend all the different data sources and input layers with each other!
- Especially for the local suppliers as our customers, creating those maps and showing them the complex concepts in a reasonable & understandable manor is essential!

Chapter 05

Conclusion & Outlook

Conclusion & Outlook

- A holistic approach is needed for an optimal blending of potentials and demands
- It is necessary to provide local energy suppliers with the best and most comprehensible results, since they are no experts in this field

- It is our goal to create guidelines for mine water projects, to streamline the process of developing those and provide a part of the solution to reduce CO2 emission
- Knowledge transfer to other mining applications and sites outside of the Ruhr Area
- Bring more sites in operation
- Show that the concepts work and improve our own methods

Thank you very much for your attention