Key Aspects of Long Railroad Tunnels

(e.g. Semmering Base Tunnel alignment selection process)

Johannes Kleberger
May 28th 2012 Ankara

Key Aspects of Long Railroad Tunnels

- Appropriate Alignment selection process
- Geological investigation and ground modelling
- Definition of maximum longitidinal gradient
- Definition of minimum horizontal radius
- Design speed selection/aerodynamic design
- Tunnel system selection (passenger trains only or mixed traffic, maintenance concept for railroad line)
- Tunnel Safety Infrastructure according to Internat. Standards
- Tunnel construction method(s) selection
- Construction contract selection/ fair risk share
- Construction budget availability
- Realistic construction time scenario

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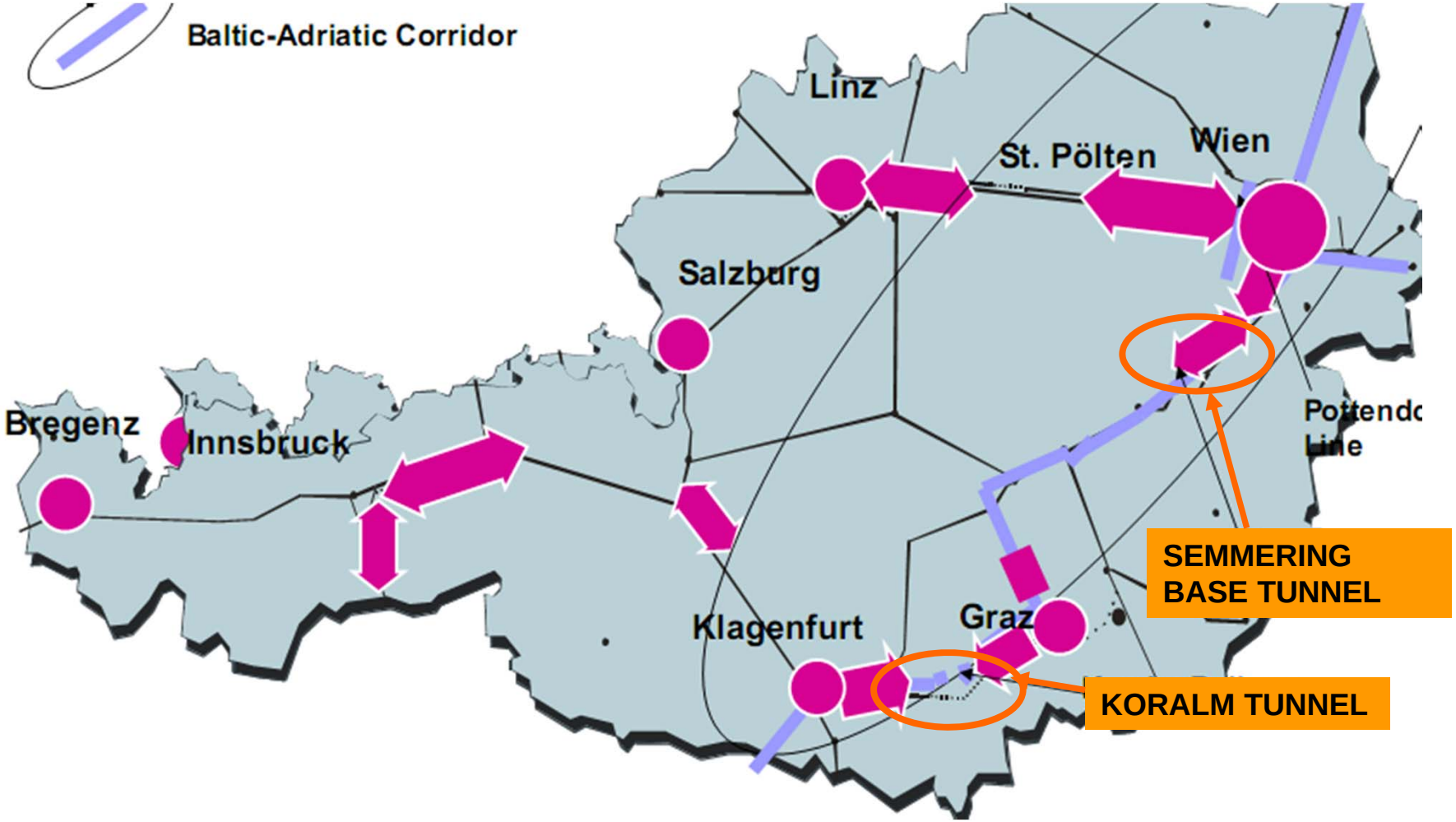
OVERVIEW



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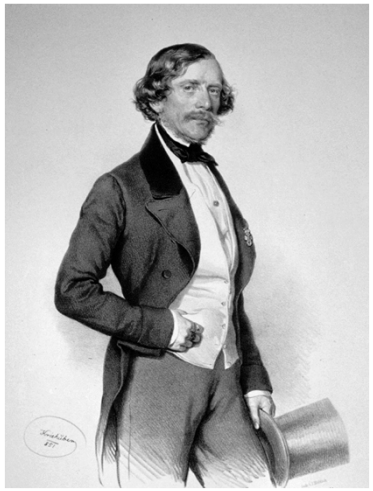
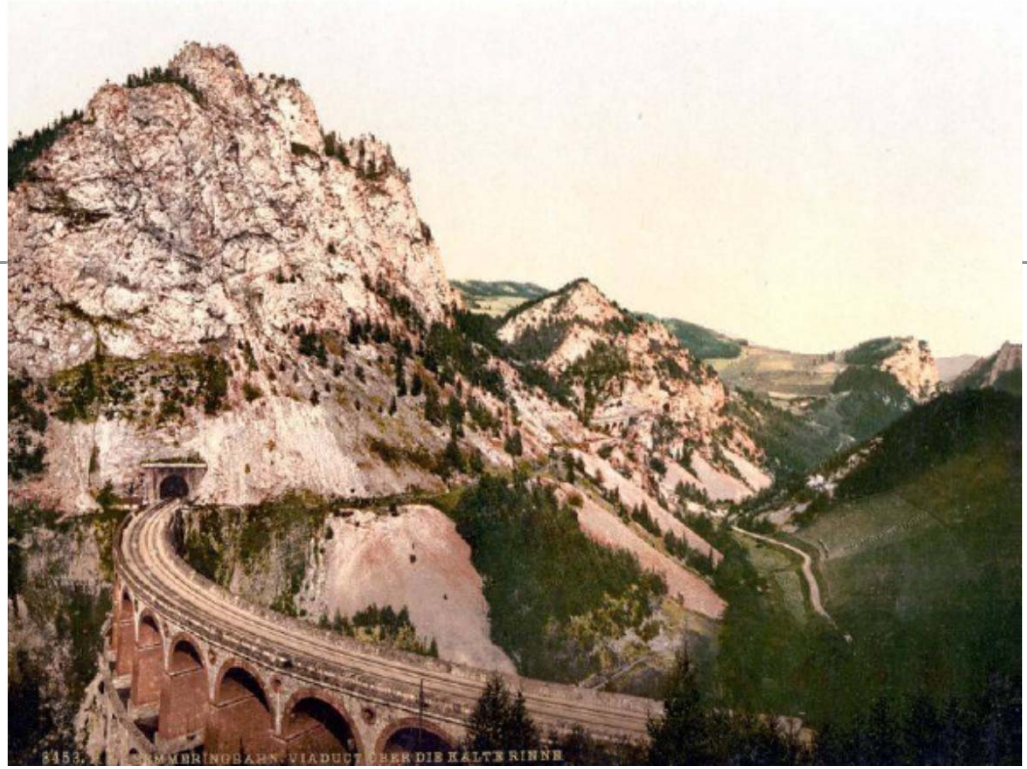
GHEGA-LINE





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GHEGA-LINE (UNESCO WORLD HERITAGE)

- built from 1848 - 1854 by Carl Ritter von Ghega
- 41.8 km length from Gloggnitz to Mürzzuschlag (linear distance: 21 km)
- more than 20.000 workers
- 15 tunnels (total length 5.420 m) and 16 viaducts
- max. gradient 28 ‰ (25 km >20 ‰)
- original speed 6 km/h, today max. speed 70 km/h
- 2 lokomotives for heavy cargo trains

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DESIGN PARAMETER FOR BASE TUNNEL new

- maximum gradient 0,85 %
- minimum horizontal radius 3.000 m
- design speed 230 km/h
- 2 parallel single-track tubes
- emergency stop in the middle of the tunnel
- minimum inner clearance of 41 m2
- cross passages every 500 m
- „short construction time“ and „high flexibility in construction“
  → intermediate construction accesses, use of TBM

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PLANNING PROCESS

1st Step: Development of Corridors

- Development of alignment alternatives
- Consideration of recommendations from „outside groups“

2nd Step: Alignment Selection

- **Definition of criteria and weighting**
- **Evaluation of alignment alternatives**
- **Selection of recommended alignment**

3rd Step: Preliminary Design for Selected Alignment

- **Design of tunnel, shafts, adits, cross passages, portals and auxiliary structures**
- **Environmental impact assessment**
- **Application of statutory approval**

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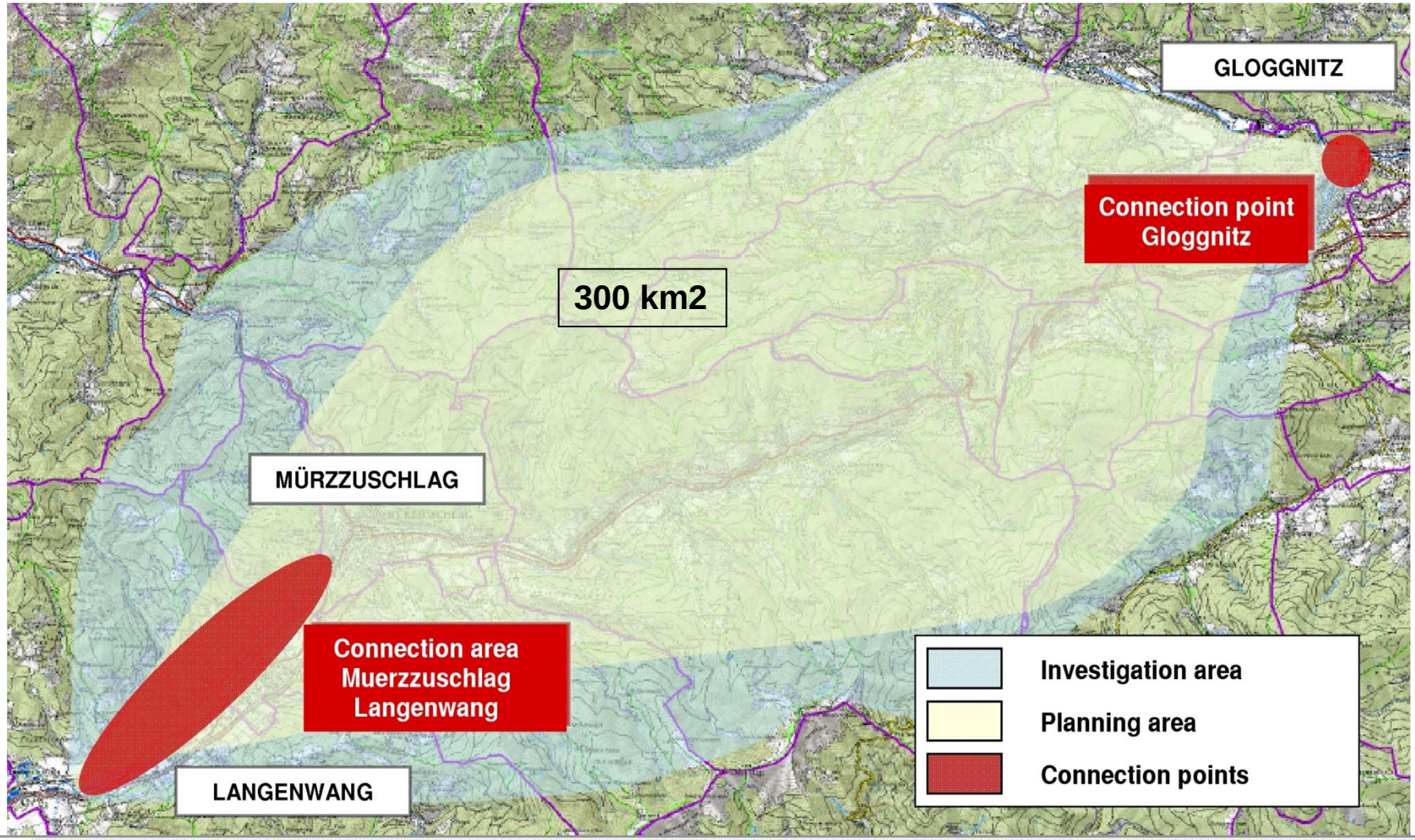
PLANNING AREA



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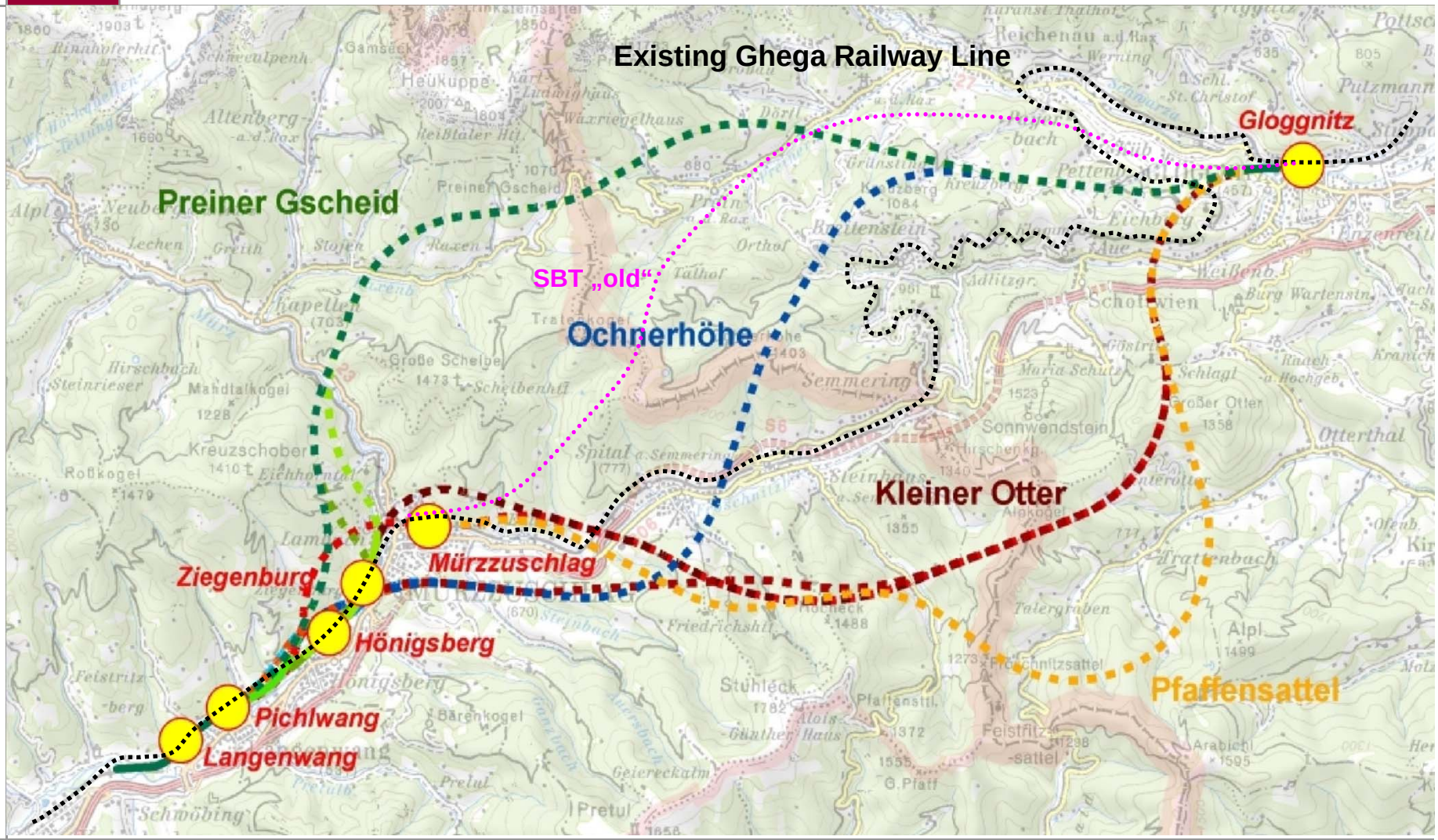
STUDIED CORRIDORS FOR SBTnew



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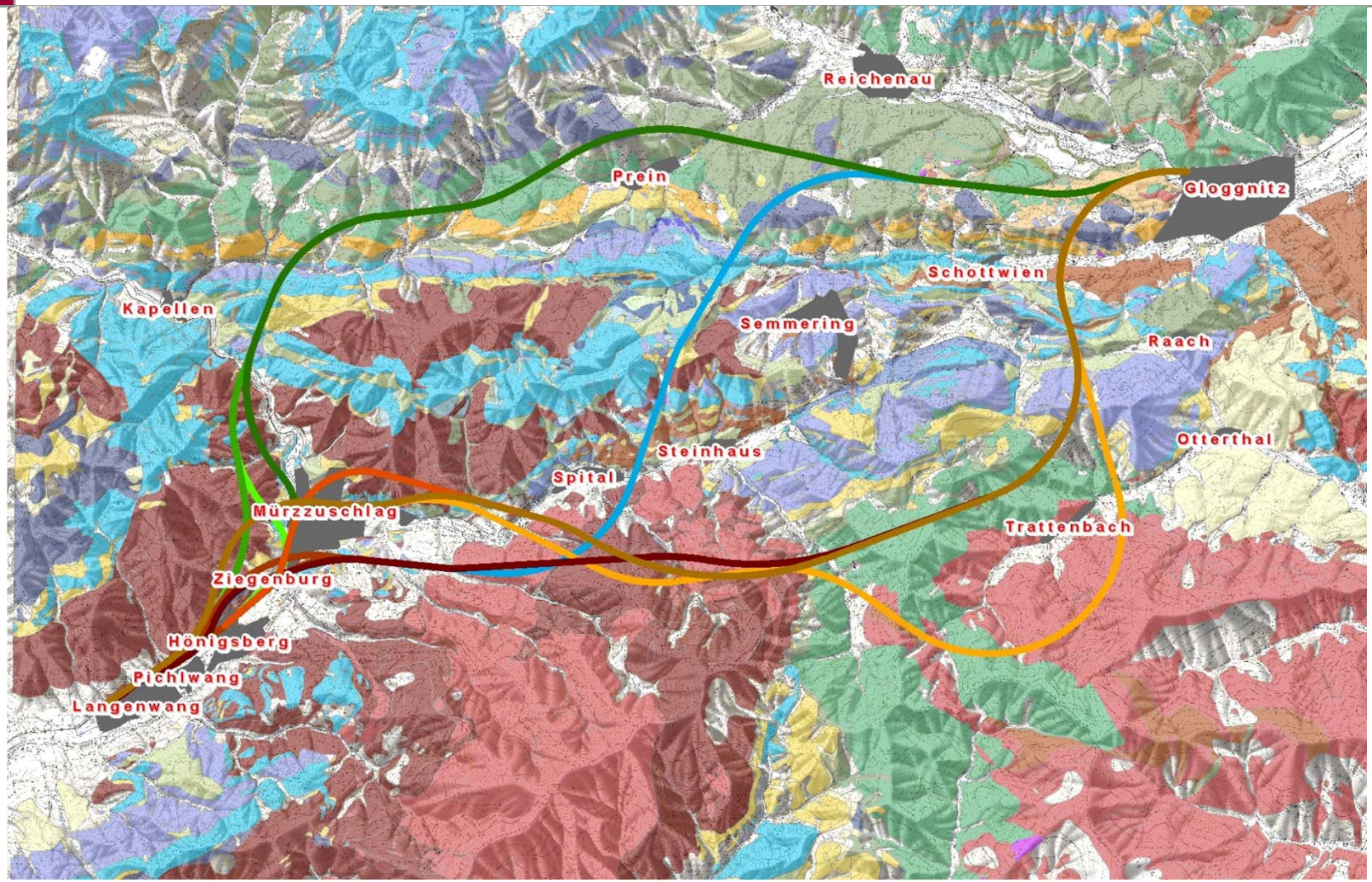
SURFACE GEOLOGICAL MAP



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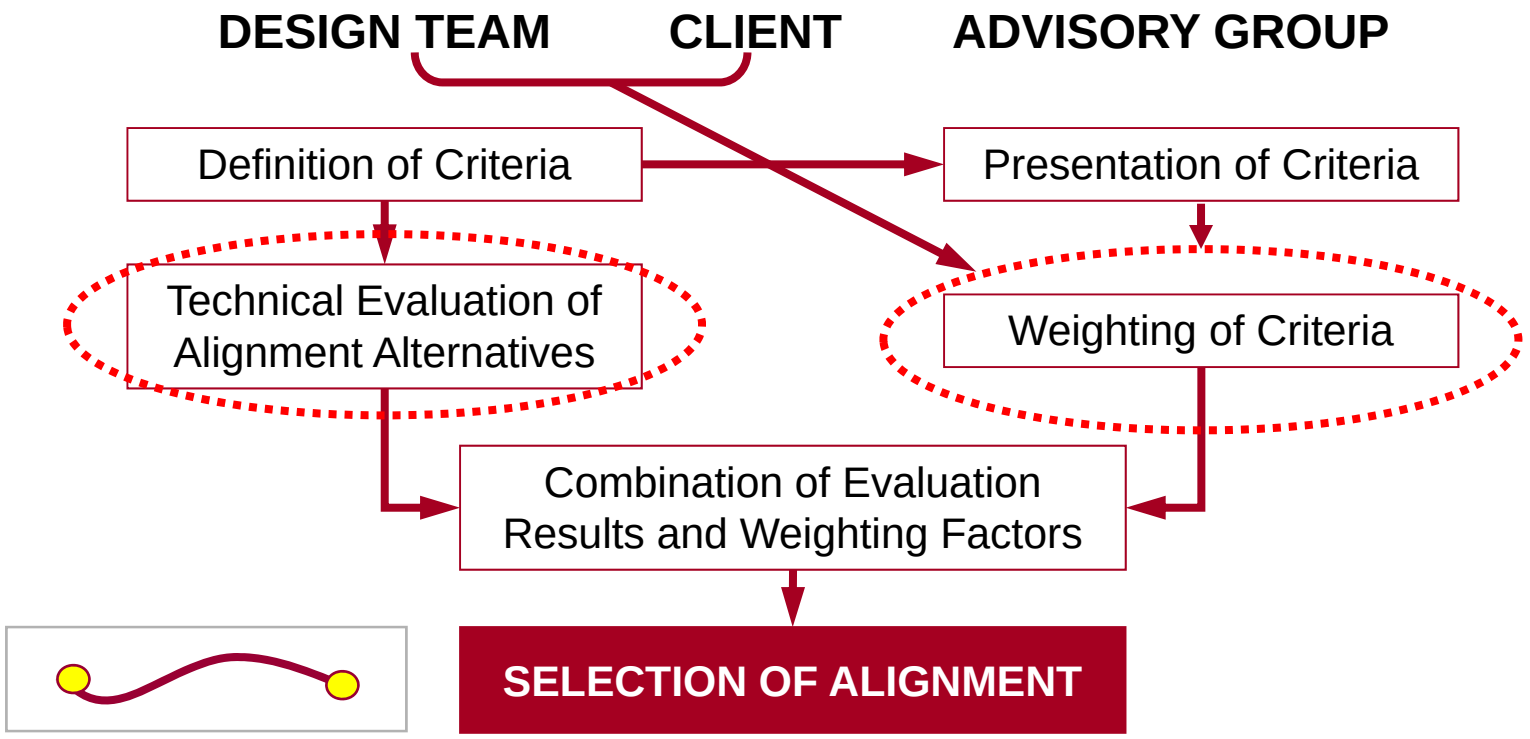
PLANNING PROCESS

2nd Step: Alignment Selection



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CATALOGUE OF CRITERIA

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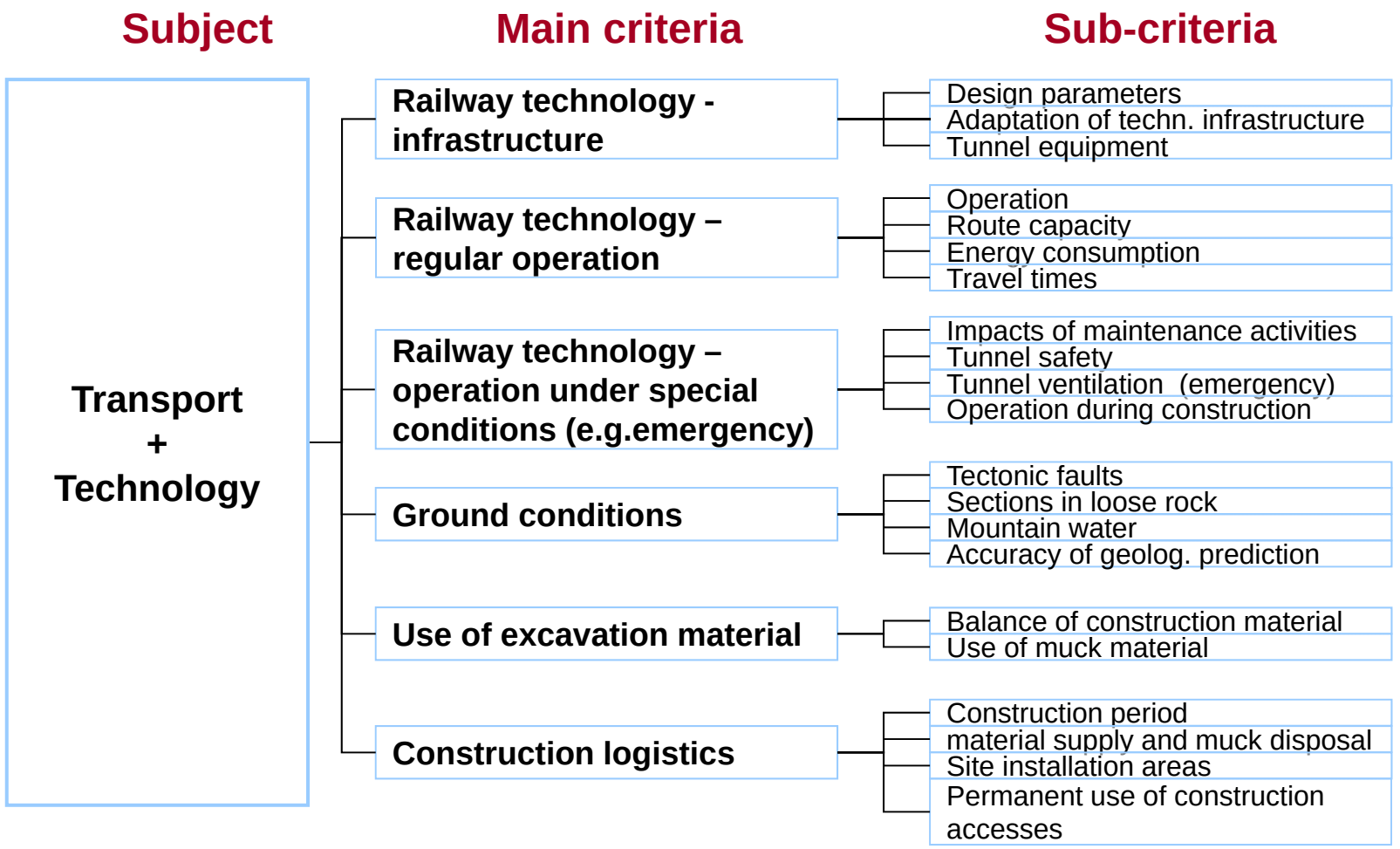

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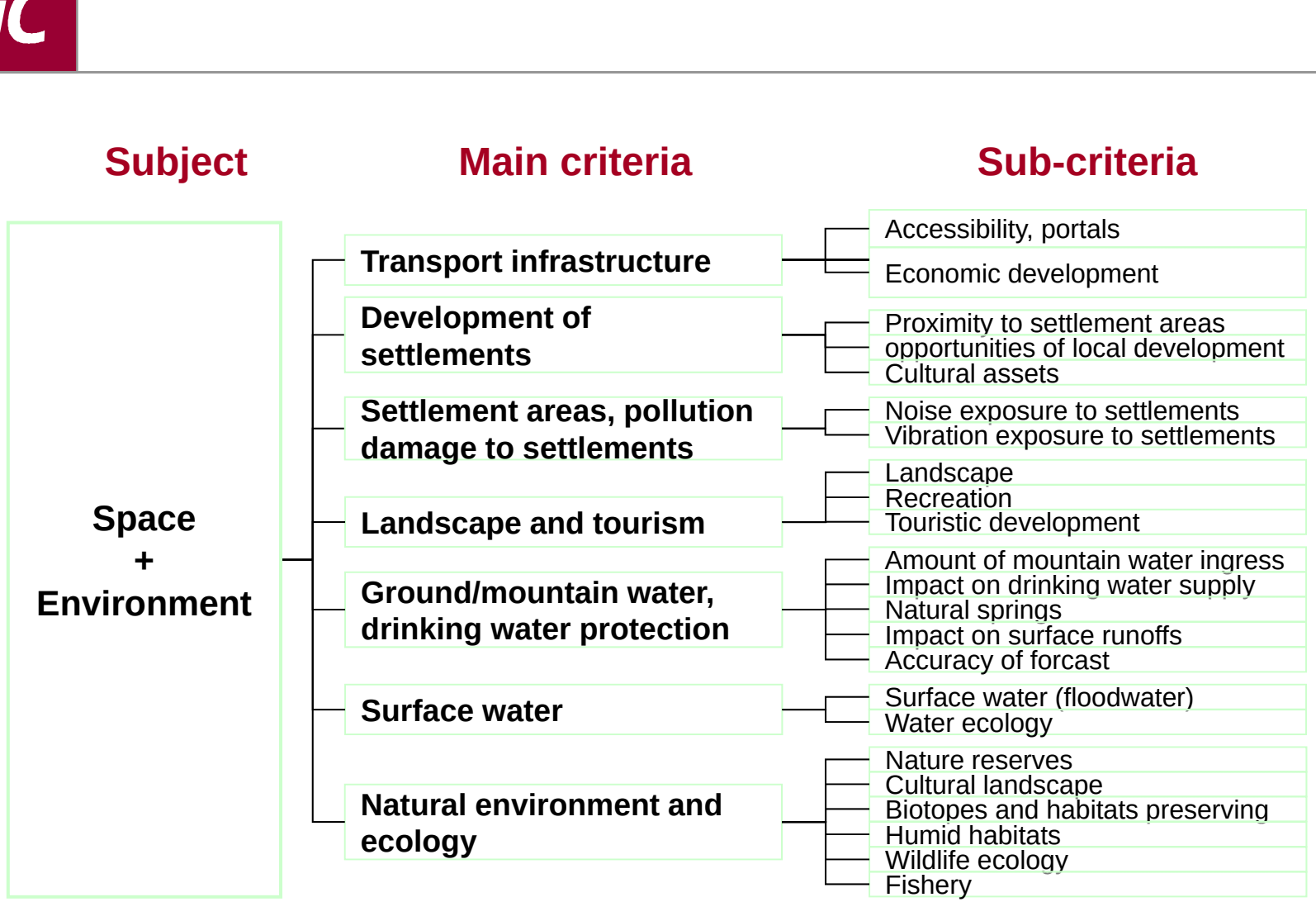

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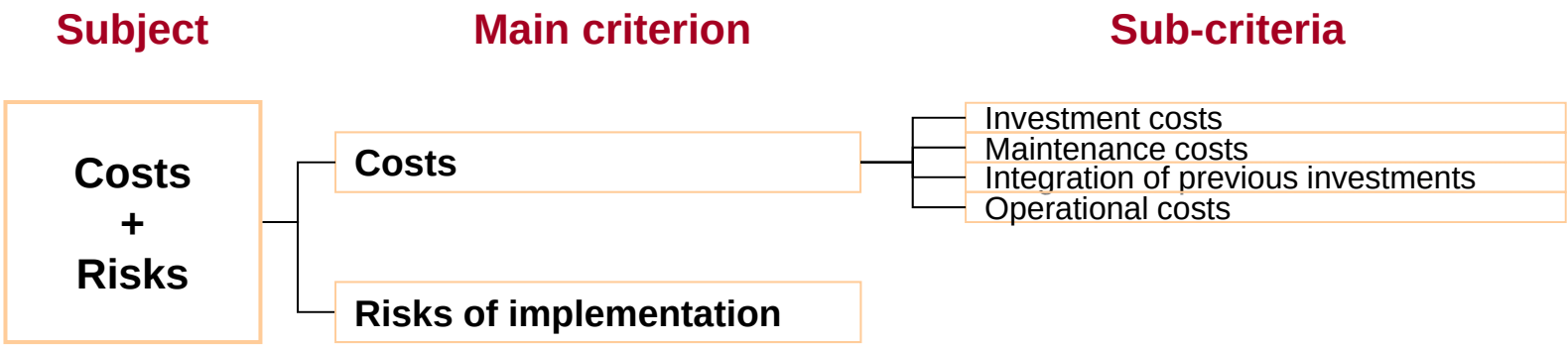

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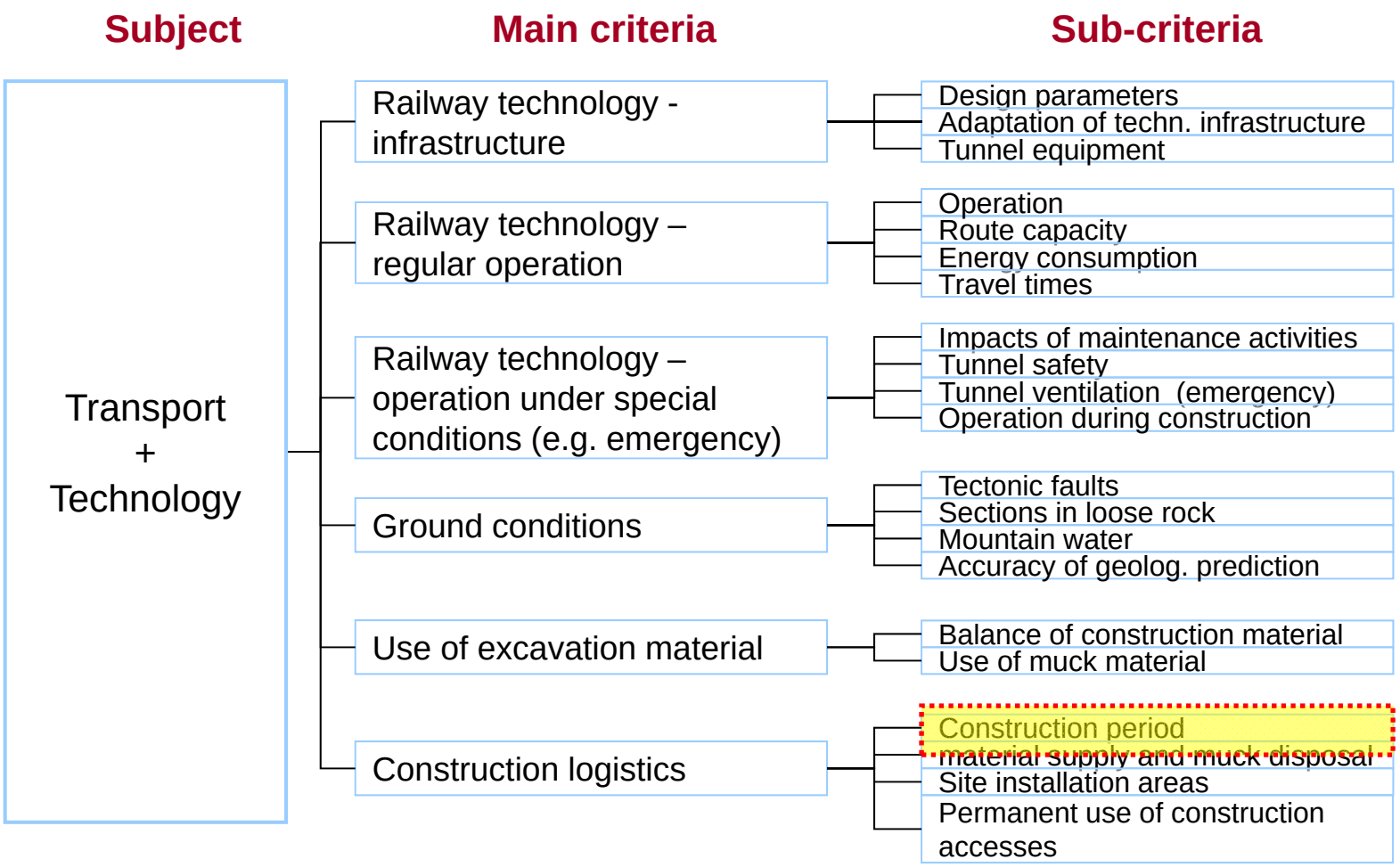

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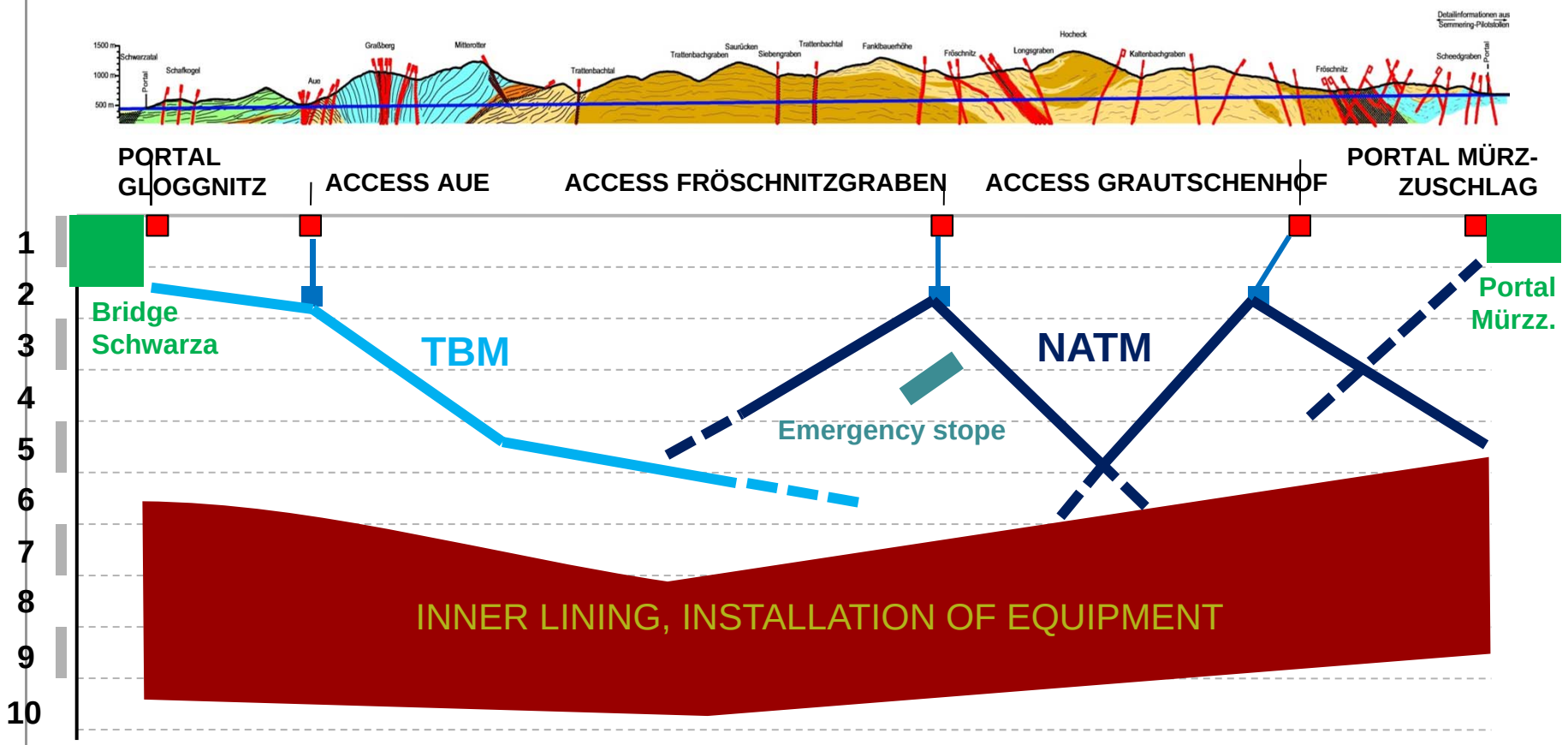

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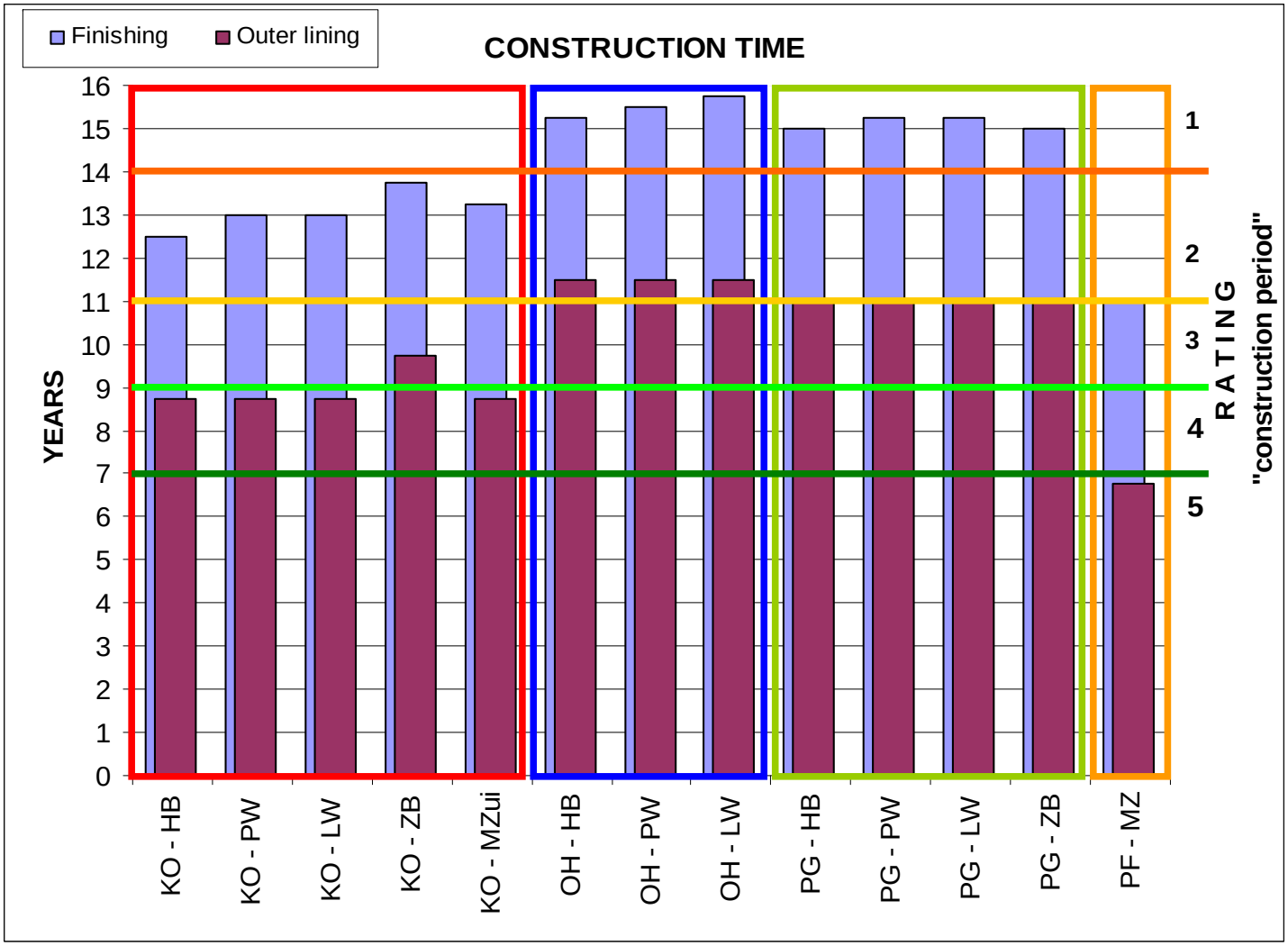
SUB-CRITERIA: CONSTRUCTION PERIOD

MAIN PARAMETER:

- **CONSTRUCTION TIME**



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RESULT OF CONSTRUCTION LOGISTICS

	KO-Hb	KO-Pw	KO-Lw	KO-Zb	KO-Mz	OH-Hb	OH-Pw	OH-Lw	PG-Hb	PG-Pw	PG-Lw	PG-Zb	PF-Mz
1.6 Construction logistics	3	3	2	3	3	2	2	2	1	1	1	1	3
1.6.1 Construction period	2	2	2	2	2	1	1	1	1	1	1	1	3
1.6.2 Material supply and muck disposal	3	3	3	3	3	3	3	3	1	1	1	1	3
1.6.2 Permanent use of construction accesses	4	3	2	4	3	4	4	4	4	3	2	3	4

5	**EXCELENT**	**Corresponds completely to the project-goals**
4	**GOOD**	**Corresponds to the project-goals in a high degree**
3	**AVERAGE**	**Corresponds in the essential points to the project-goals**
2	**BELOW AVERAGE**	**Fulfills substantial project-goals only insufficiently**
1	**BAD**	**Does not fulfil substantial project goals**
!	**RISKS IN IMPLEMENTATION**	

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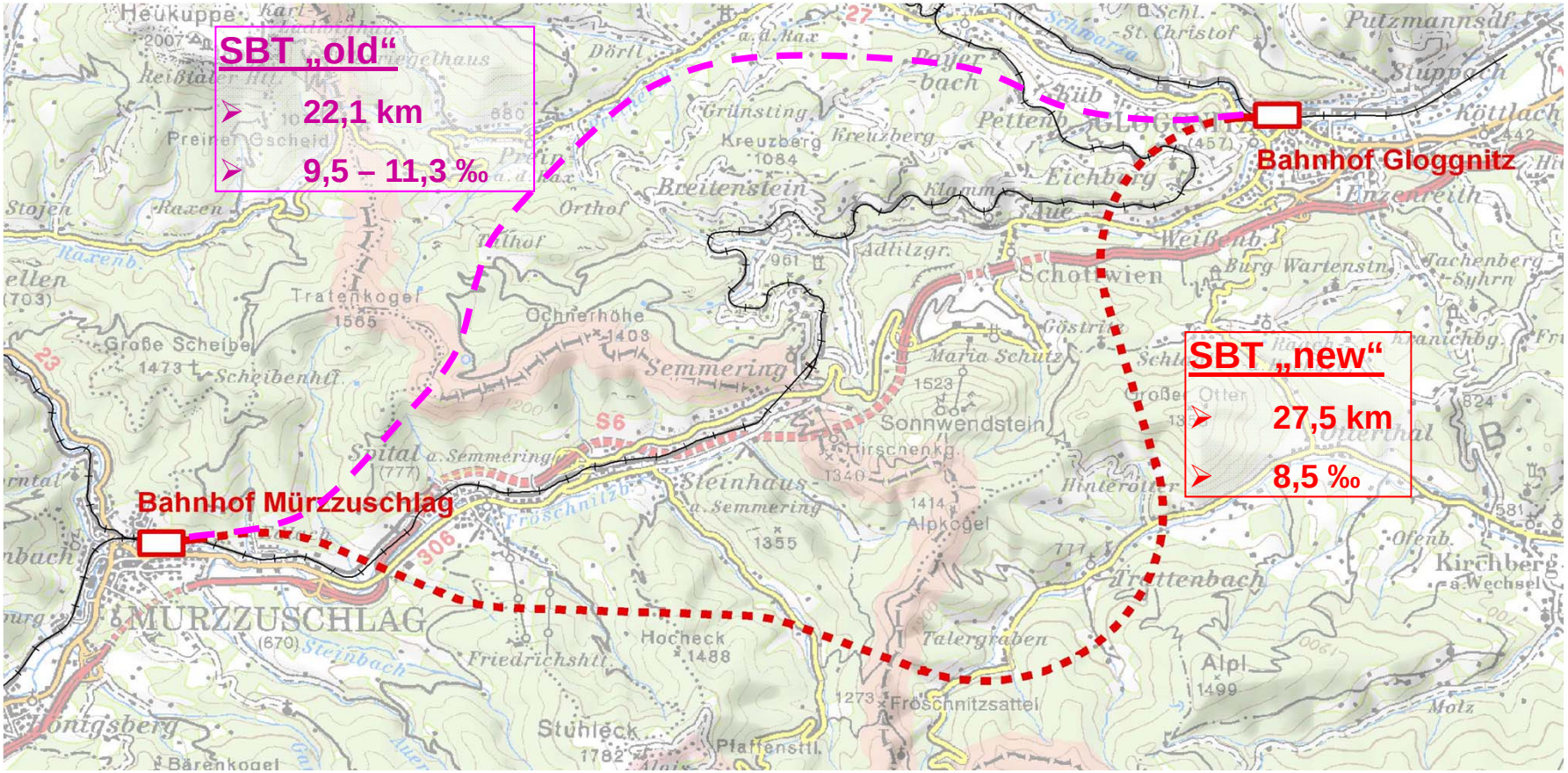
SELECTED ROUTE „PFAFFENSATTEL“



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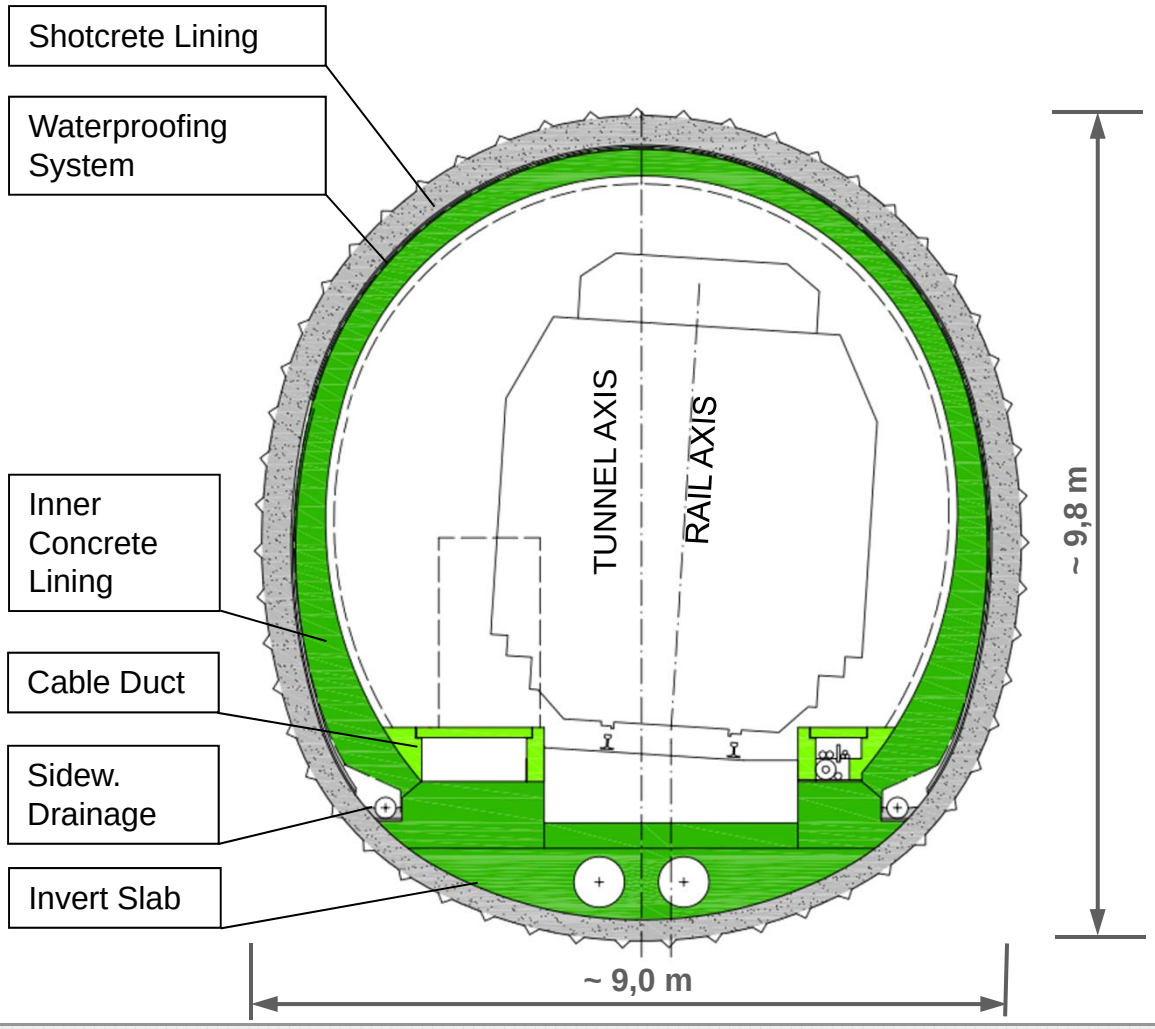
CONSTRUCTION DETAIL NATM



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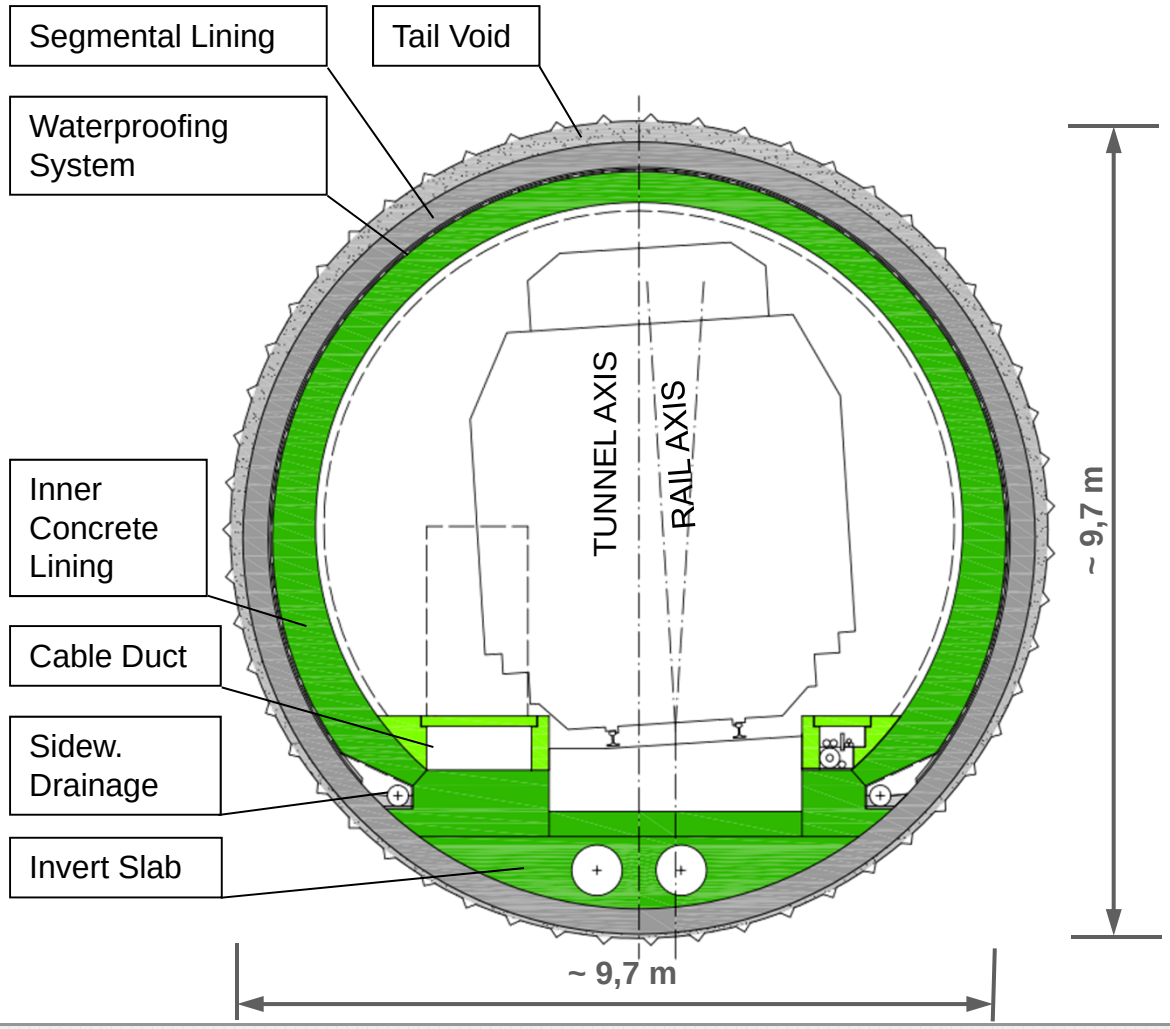
CONSTRUCTION DETAIL TBM



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SITE INVESTIGATION

(1) GROUND INVESTIGATION FOR 4 PROPOSED CORRIDORS

- 75 core drillings (total length 10.900 m), max. depth of 350 m
- Documentation and monitoring of 3.700 springs, wells, creeks

(2) GROUND INVESTIGATION FOR SELECTED ALIGNMENT

- Additional 55 core drillings (total length 17.500 m), max. depth of 720 m
- Geophysical and geoelectrical investigation (totally 15 profiles)
- In-situ (borehole) testing (acoustic scan, sonic lock, vertical seismic profiling, insitu stress measurements by hydro frac)
- Laboratory testing

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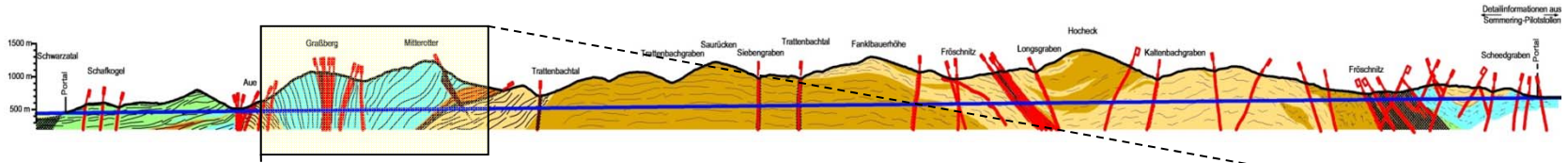
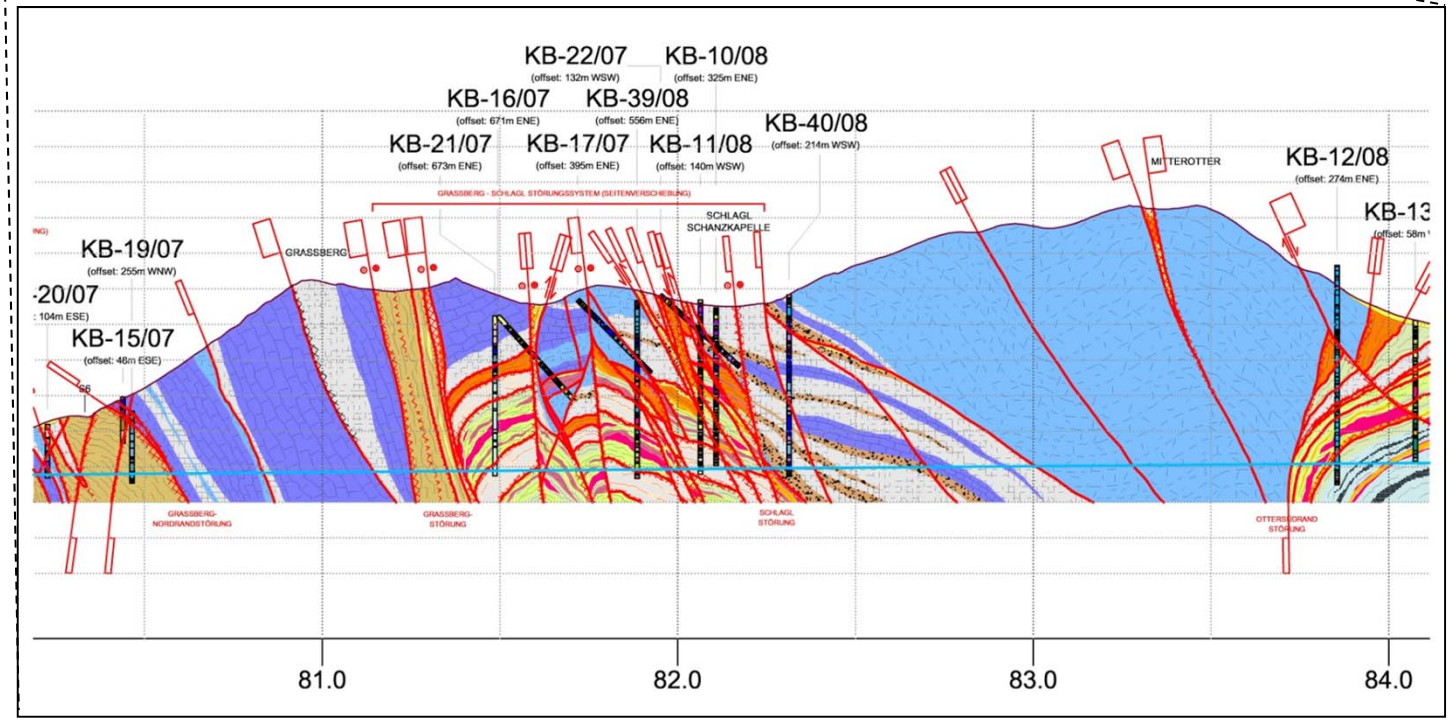
“SCHLAGL FAULT ZONE”





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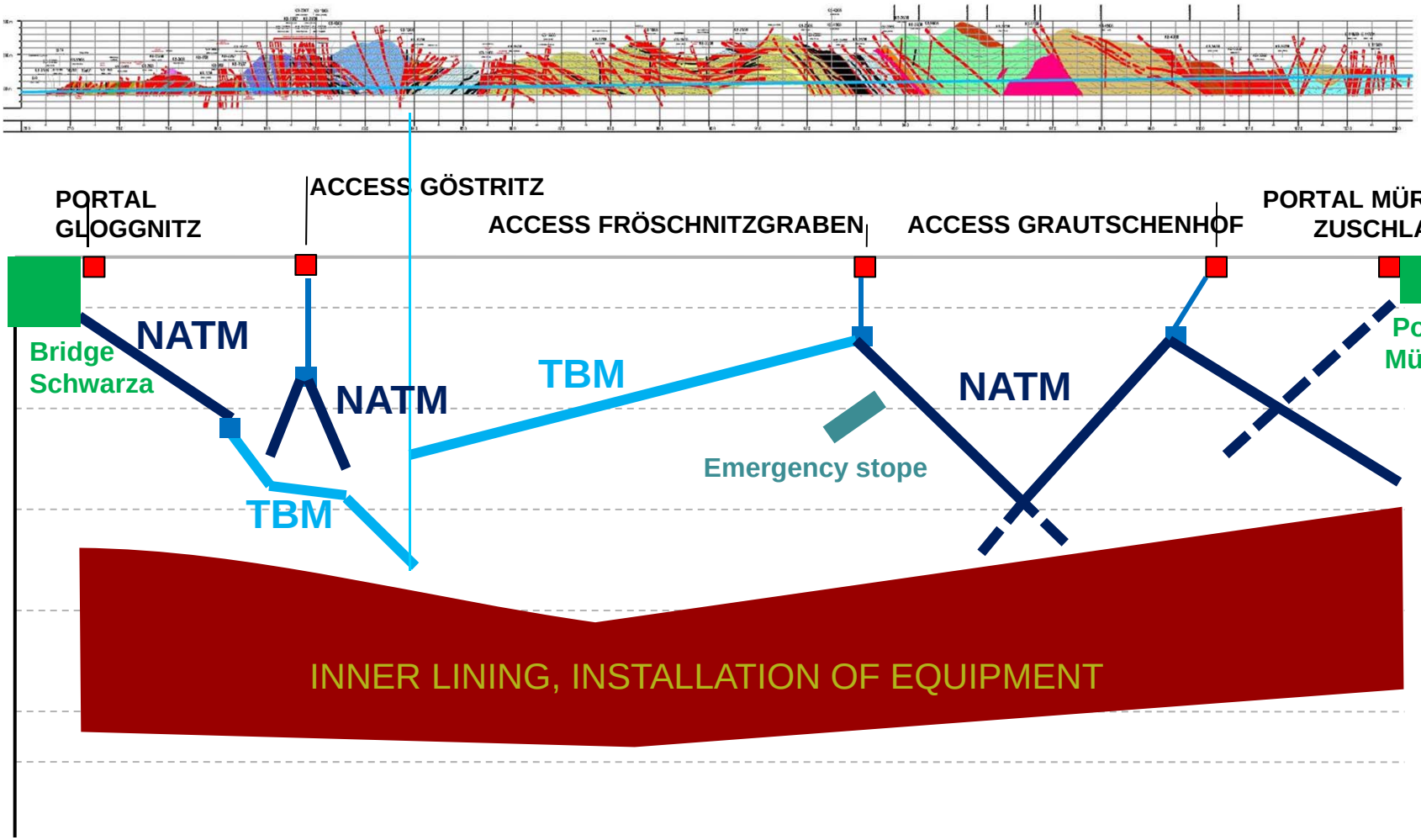
CONSTRUCTION CONCEPT



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Key Aspects of Long Railroad Tunnels, *what typically can go wrong with long railroad tunnels*

- Construction cost estimates are much too optimistic (maybe for political reasons) bringing the project in jeopardy
- Geological investigation and ground modelling are insufficinet, too little time and budget (yielding troubles with ground conditions during construction andusually creates great time and cost overruns) Reasons maybe selection process for site investigation company (think about how you select your medical doctor or your lawyer)
- Unsuitable construction methods were chosen as to insufficient ground model, tunnel may be stopped to excavation difficulties
- Construction contract selection not optimal
- Construction budget tot available in time
- Unrealistic construction time assessments

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Johannes Kleberger
March 28th, 2012

COMPANY PRESENTATION

I N T E R N A T I O N A L

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I N T U R K E Y

More than 25 design and/or consultancy contracts since the year 2000

Melen Istanbul Water Supply Project • BC1 Marmaray Project • Bahce Nurdagi Tunnel • Gerede System Isikli Tunnel • Kargi Dam and HEP • Metro Market Istanbul Solar Cooling • Avali Dam • Bursa Metro • Dogancay HEP • Bandirma Gas Power Plant • Pembelik HEP • Yenikapi Turnback Tunnel • Polatli Tunnel • Ankara Metro Ulus Keciören • Ermenek HEP • Bursa Opel Environmental Audit • Konaktepe HEP and Dam • Esen II HEP • Cine RCC Dam • Bogazkoy GT Power Station • Bolu Tunnel after Düsce Quake • Niksar and Akinci HEPS • Erdemir Power Station • Obruk Baraj • Karacasu Dam • Mursal HEP

Floreasca City Centre Bucharest, Romania

Praterstern Railway Station Vienna, Austria

Vienna Airport – East and West Pier, Austria

Europlex Warsaw, Poland

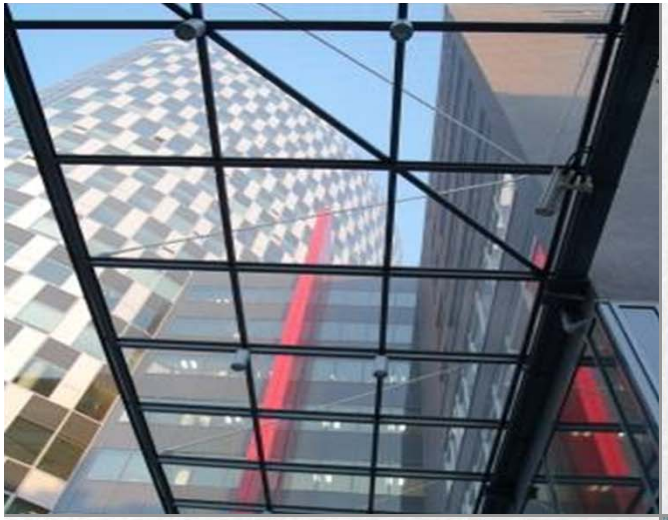
Europeum Business Centre Bratislava, Slovakia

Extension of the Regional Railway Line S2, Austria

E N G I N E E R I N G

& E C O N O M I C S

Project management, project control, project organisation and controlling, construction contracts and award of contracts, cost management and scheduling, ”Turn Key Engineering” and ”Total Project Management”, BOT (Build-Operate-Transfer) and PPP (Public-Private-Partnership), Due Diligence, feasibility studies, services as experts and consultants and construction logistics



Office Building Zagreb Tower, Croatia

Building Physics Design Europlaza – Construction Phase 4, Austria

Raiffeisen Centrum Prague, Czech Republic

Iride Business Park, Romania

New IMBA-GMI Science Laboratory Building, Vienna, Austria

Millennium Tower III, Slovakia

Serious Crimes Court, General Contractor, Tirana, Albania

B U I L D I N G S

& S T R U C T U R E S

Design of buildings and industrial structures, site supervision, structural design of buildings and supporting structures, concrete buildings, steel constructions, composite constructions and timber constructions, building physics, general contractor and construction management, expert statements in the fields of building construction, Due Diligence

Design (preliminary design, concept, tender design, detailed design), site supervision, building services engineering, including heating, air-conditioning, ventilation, sanitary equipment, electrical engineering (low voltage and high voltage current), special facilities (safety engineering, measuring and control technology, data line), building construction and industrial construction, transport facilities, municipal utilities

M E C H A N I C A L & E L E C T R I C A L E N G I N E E R I N G

Palais Mollard, Rehabilitation, Vienna 1, Austria

Europe Business Centre, Belgrade, Serbia, Montenegro

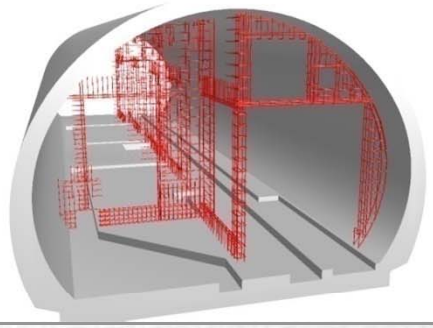
Public Retirement and Nursing Home in Wallsee, Austria

HVB – Headquarters, Hungary

Monastery of Klosterneuburg, Austria

MIA Malta International Airport, Malta

Kaiserin Elisabeth Hospital, Austria



Lainzer Tunnel, Austria

Wienerwald Tunnel, Austria

U2 Underground Vienna, U2/5 Section, Interconnecting Track, Austria

Sentvid Tunnel, Slovenia

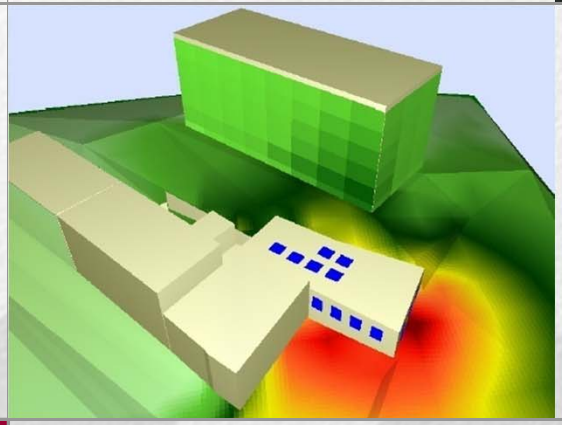
Cine Dam Project, Turkey

Egnatia Odos Motorway, Greece

T U N N E L L I N G & G E O T E C H N I C S

Investigation, design, project management and supervision for underground projects.

Geological, hydro-geological and geophysical investigations;
geotechnical and structural design of tunnels, caverns and shafts using conventional (NATM) or mechanical (TBM) tunnelling methods;
environmental impact studies, risk analyses, geotechnical measurements;
studies und design of measures for air quality, noise and vibration protection



Waste to Energy in Koprivnica, Cost-Benefit-Analysis, Croatia

Energy Efficiency Audits for 4 Industries in Moldova, Kyrgyzstan, Georgia

Energy Efficiency, MIA Malta International Airport, Malta

Biomass Plant Göpfritz, Austria

Vienna Central Railway Station, Noise/ Air Quality / Vibrations, Austria

Vibration Engineering Koralm Railway, Austria

Building Physics Design Europlaza - Construction Phases 4 & 10, Austria

E N E R G Y & E N V I R O N M E N T

Biomass plants, district heating networks, solar energy, geothermal energy, co-generation, biofuels, alternative cooling systems, small hydropower plants.

Immission protection: noise, vibrations, air pollutants, electromagnetic fields, public approval, environmental impact assessment, services during construction, commissioning, commercial enterprises, industrial plants, shopping centres, road, rail.

Extensive measuring equipment: remote controlled immission monitoring, air quality measurement container, VibroScan ®, acoustic camera etc.

Studies, consulting, planning, project management and site supervision for water supply installations and sewage disposal; special services such as leakage analyses, water loss evaluation, water management concepts; waste analyses, planning of waste management facilities.

Development of waste management concepts and development and optimisation of logistics of waste management systems.

W A T E R & W A S T E M A N A G E M E N T

Development of the Water & Waste Water System in Eastern Latvia and Rezecne City, Latvia

Rehabilitation of Sewage System and Waste Water Treatment Plant Pascani, Romania

Water Supply System Gjirokaster, Albania

European Waste Management Cluster, Europe

Drava River Basin Project, Croatia

Water, Waste Water and Waste Management Konjic, Bosnia-Herzegovina

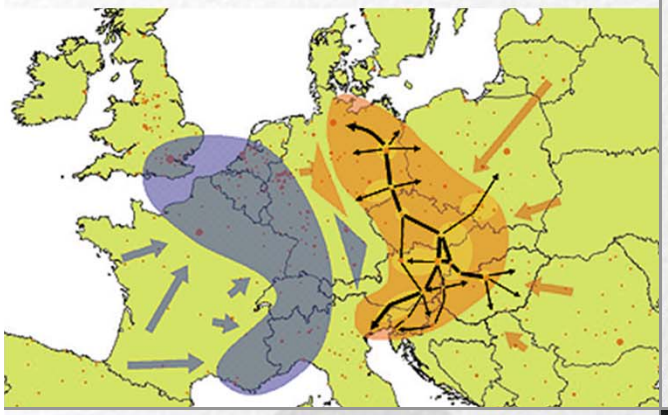
Sustainable Transport Infrastructure and Intermodal Transport Concepts for Northern Central Europe

IMONET - Intermodal Cargo Transport Node Network - Central Europe

Optimisation of Local Traffic Westbahn, Austria

Qaf Thane – Pogradec Road, Conceptual Design, Albania

Development of Design Standards for Road Construction, Kosovo



T R A N S P O R T & L O G I S T I C S

Transport concepts, feasibility studies and master plans for public transport and individual traffic, investment assessment, cost calculation and controlling for transport projects, regional development, site analysis and optimisation, transport telematics, airports, road and railways.

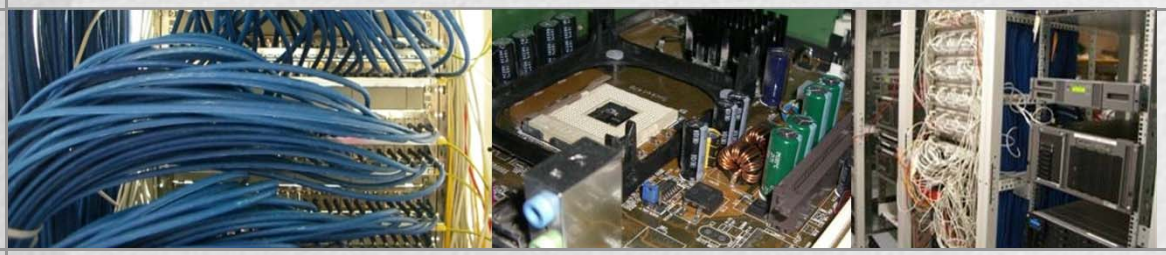
GO Tolling System for Bus and Truck, Austria

Science Centre Vienna – Network Consulting, Austria

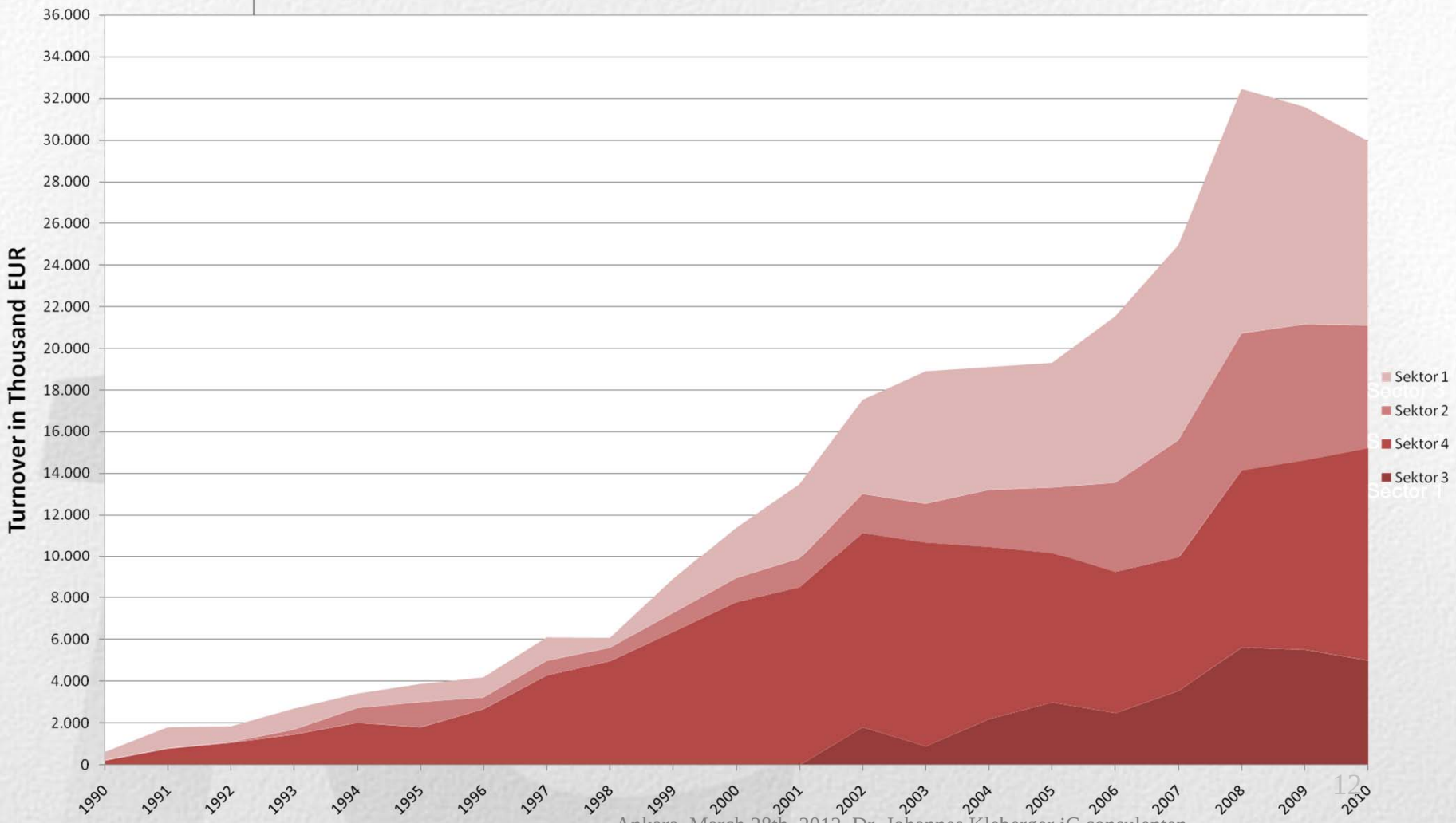
Business and Economic Software Efficiency Analysis Based on Linking Sales Data and In-house Costs

I N F O R M A T I O N & T E C H N O L O G Y

Consulting, system analysis, concept development, network infrastructure, licensing, (structured) cabling, project planning and management, controlling, quality management;
IT security, firewalls, virus protection, VPN solutions, security audit, maintenance, training, tailor-made software solutions.



D E V E L O P M E N T



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