

# Controlling water risks in tunnels

## The Hydrogeological Excavation Code- A value added methodology

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JASPERS - Roads Division



# Mutual interferences between tunnels and surrounding hydrogeology

By nature, tunnels interfere with surface and underground water flows. As soon as excavation begins, it starts to modify the hydrogeological set up and to attract water from aquifers. The risks of encountering water intrusions, infiltrations or leaks at some point in a tunnel's lifetime are high.

Water in tunnels may put safety at risk and cause irreversible damages to the environment. Both the construction phases and the long-term operation of a tunnel may be disrupted, resulting in losses of time and reputation. Cost overruns can also be sizeable.

Assessing the hydrogeological situation at a very early stage in the project cycle is crucial, as is the systematic monitoring of water levels throughout a tunnel's lifetime. As an example, areas that appear impermeable during test drillings can behave quite differently when excavating a tunnel in full scale.

With this in mind, JASPERS has adapted a methodology called Hydrogeological Excavation Code (HEC), to help transport infrastructure authorities manage the hydrogeological risks in major underground projects.

## Areas of risks and impacts



### Environment

- Impact on the hydrogeology
- Impact on the water table
- Unwanted diversion of water courses



### Tunnel

- Infringement with regulation
- Lack of environmental consent
- Delays in construction
- Flooding
- Erosion and corrosion
- Collapsing



### Society - Economy

- Accidents and fatalities
- Disruptions of traffic and delays
- Public resistance for various reasons
- Cost and value for money issues

## The Hydrogeological Excavation Code (HEC) is a 3-pillar protocol

The HEC, as originally defined by Coli and Tanzini (see Bibliography), has been used to assess water flows of various magnitudes (from a few litres to over a hundred litres per second), including in difficult circumstances such as Karst type geology. The HEC is compatible with FIDIC Red, Yellow and Silver Book contract types.

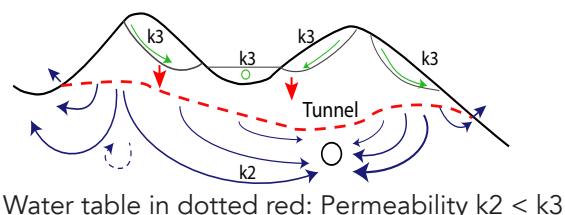
The HEC is a 3 pillar protocol to:

1	2	3
<p>Analyse the tunnel's expected interference with surface and underground water.</p> <p>Build a hydrogeological and hydrological model.</p> <p>Conduct a detailed hydrogeological risk assessment.</p>	<p>Design preventive and protective measures for the short and the long run, such as drainage, waterproofing and stabilisation systems.</p> <p>Achieve compliance with Article 4.7 of the Water Framework Directive (WFD).</p>	<p>Monitor water levels and their effects on ground water and water supply throughout the tunnel's lifetime.</p> <p>Adapt preventive and protective measures accordingly.</p>

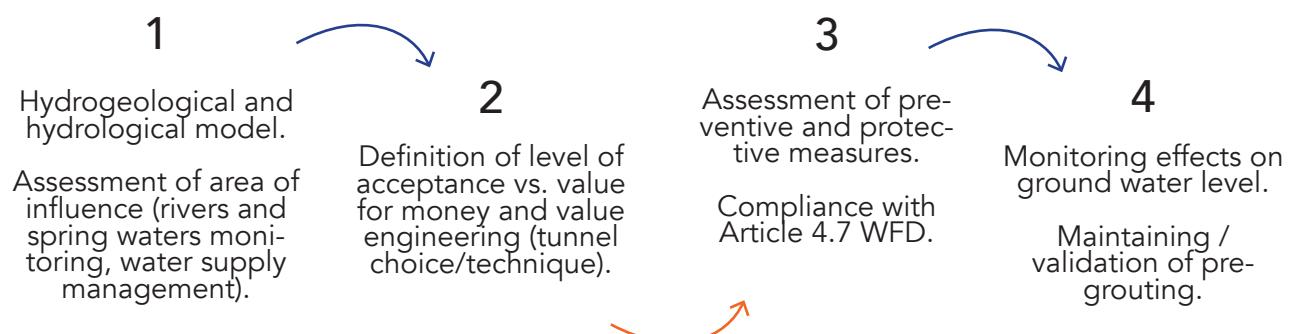
## JASPERS experience

JASPERS engineers have advised on numerous tunnel projects in Europe, in a variety of climates and hydrogeological situations. In recent years, they have supported the development of the Višnové twin Tunnel (7.5 km – Slovakia), the Cebrat twin Tunnel (4 km – Slovakia), the Divaça Koper – Karst Excavation and Management Code - KEMC (20 km – Slovenia), and the Prešov twin Tunnel (3 km – Slovakia).

The estimated water inflows in these tunnels range from few litres to real underground rivers (more than 3000 l/s). In the last scenario, as an alternative to sealing the tunnel, a bypass (for instance an underground bridge) is considered to keep the hydrogeological and hydrological set up unchanged.



## Methodological process steps



## Bibliography

- [1] Coli et Pinzani - Tunnelling and Hydrogeological Issues: A Short Review of the Current State of the Art; Springer-Verlag Wien (2013)
- [2] Coli et Tanzini - Water safeguarding in tunnelling: for execution and environment; GEO-SAFE2016 Xi'an, China 25-27 (May 2016)
- [3] Søren Degn Eskesen, Per Tengborg, Jørgen Kampmann, Trine Holst Veicherts - Guidelines for tunnelling risk management: International Tunnelling Association, Working Group No. 2; [www.elsevier.com/locate/tust](http://www.elsevier.com/locate/tust) (2004)

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JASPERS helped us address these issues in several road tunnel projects, allowing us to continue implementation with a better understanding of risks, thereby increasing public consent.”

J. Durisin. CEO, Slovak Motorways Company.

## Contact us

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