ASSOCIAÇÃO PORTUGUESA DOS RECURSOS HÍDRICOS

APRH

PRACTICAL ENGINEERING RECHARGE TECHNIQUES USED TO CONSERVE GROUNDWATER DURING CONSTRUCTION DEWATERING

9th Seminar of the APRH Northern Regional Centre

OGI
GROUNDWATER SPECIALISTS

Extreme hydrological phenomena: the challenges of the coming decades

Presented at the
Faculdade de Engenharia
da Universidade do Porto
by

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16 November 2023

PRACTICAL ENGINEERING RECHARGE TECHNIQUES USED TO CONSERVE GROUNDWATER DURING CONSTRUCTION DEWATERING

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9º Seminário do Núcleo Regional do Norte - APRH

Turn Weak, Wet Ground

PRACTICAL ENGINEERING RECHARGE TECHNIQUES

Into Strong, Dry Ground

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PRACTICAL ENGINEERING RECHARGE TECHNIQUES

For the construction a shallow excavation of circa 4m deep in a silty sand, a vacuum wellpointing, or a suction well system is normally used.

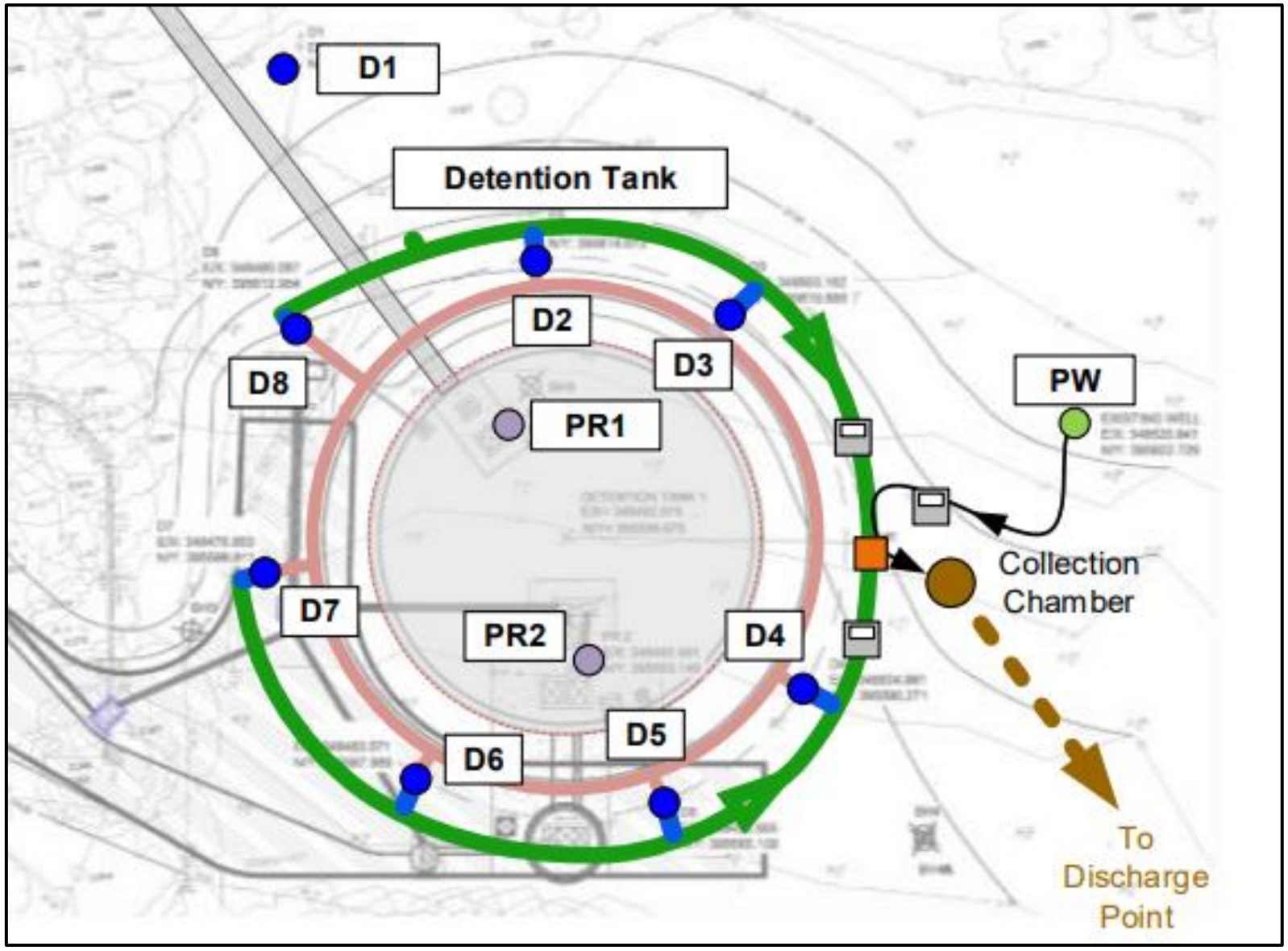
Example of a Suction Dewatering System

Crystal-clear groundwater abstracted from filtered wells

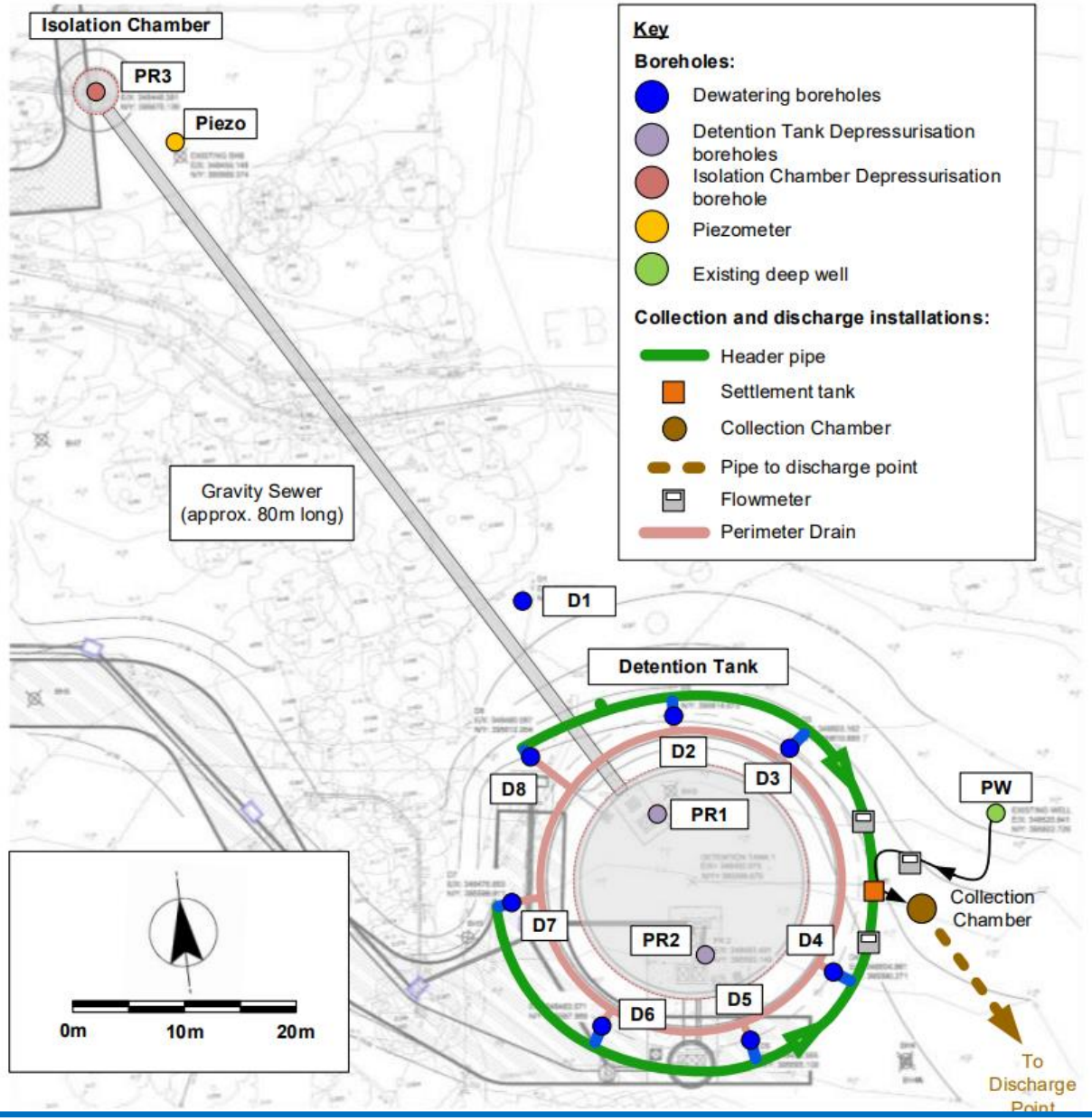
Water Management during Construction of a standard Stormwater Detention Tank

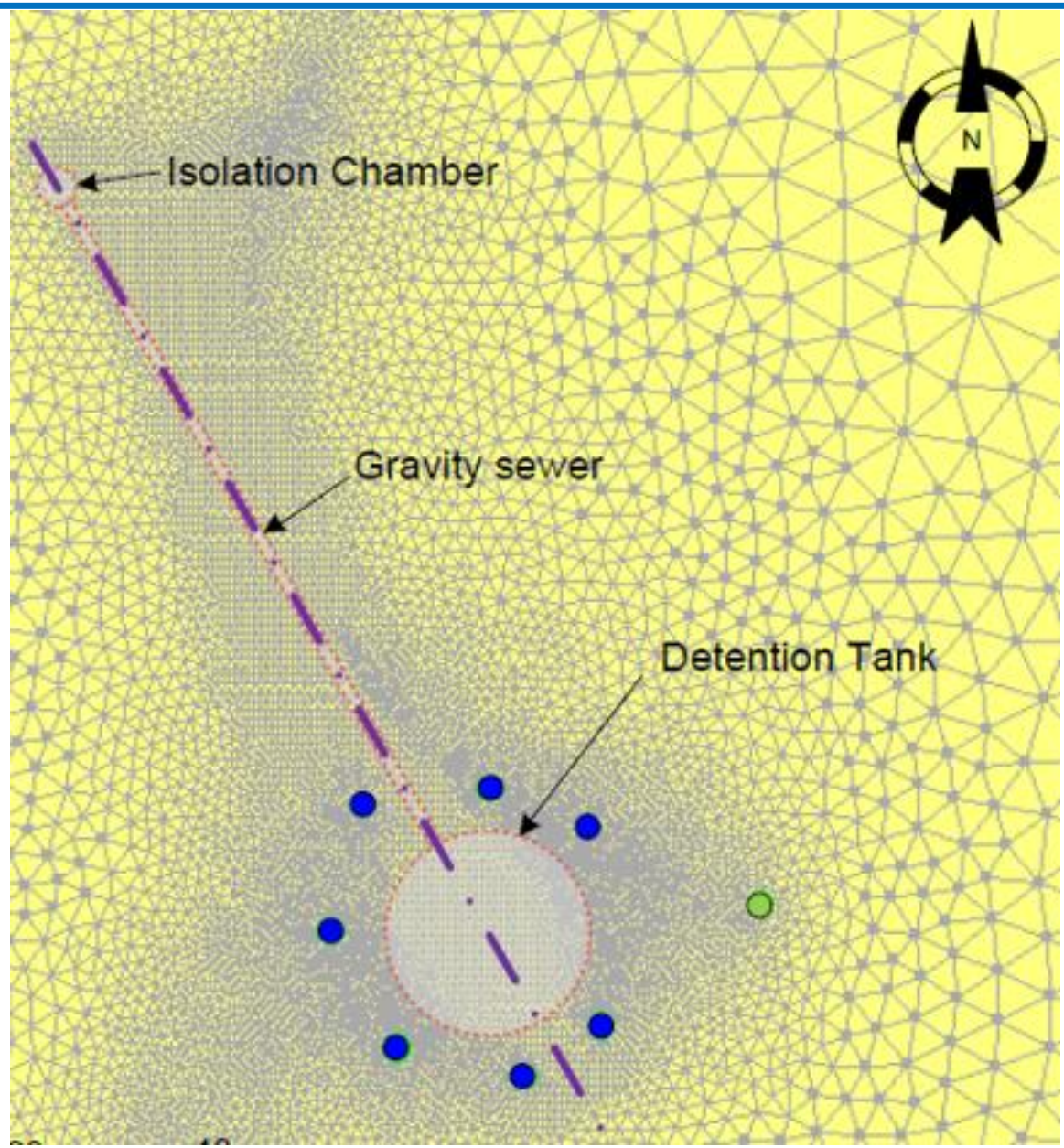
Initial high water table

PRACTICAL ENGINEERING RECHARGE TECHNIQUES

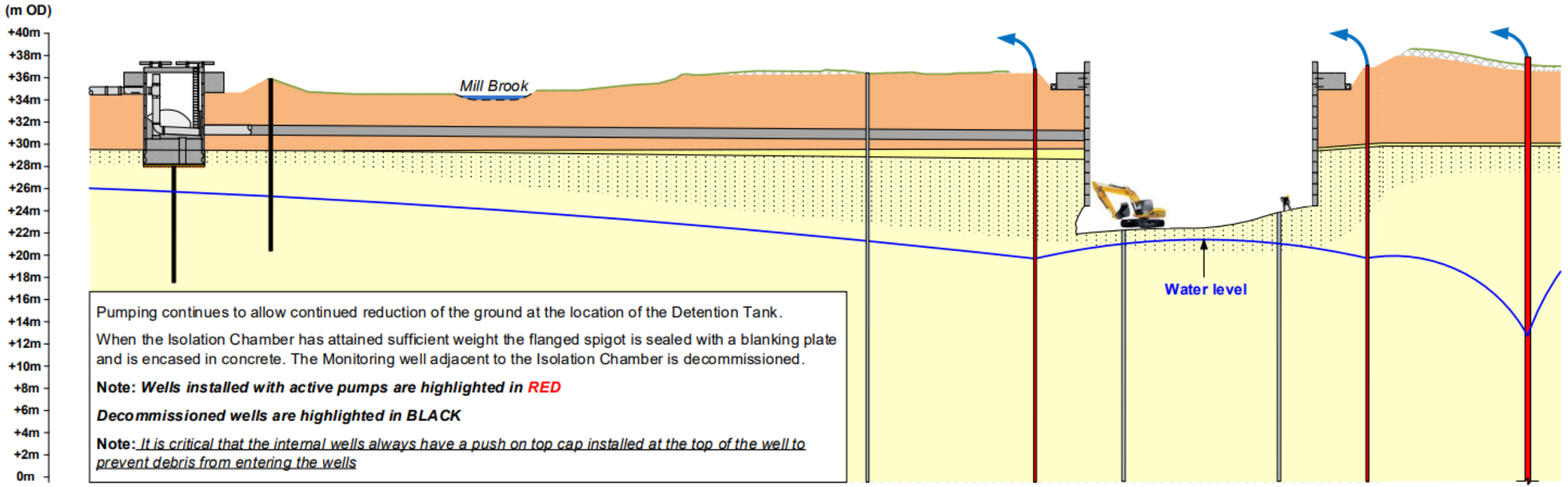


PRACTICAL ENGINEERING RECHARGE TECHNIQUES





PHASE 5: Isolation Chamber Completed, Excavation of Detention Tank to Final Formation Level



Regularly communicating with key stakeholders

Electro-submersible borehole

Underpinning Segmental Shaft Construction Technique

Clear Water Abstraction

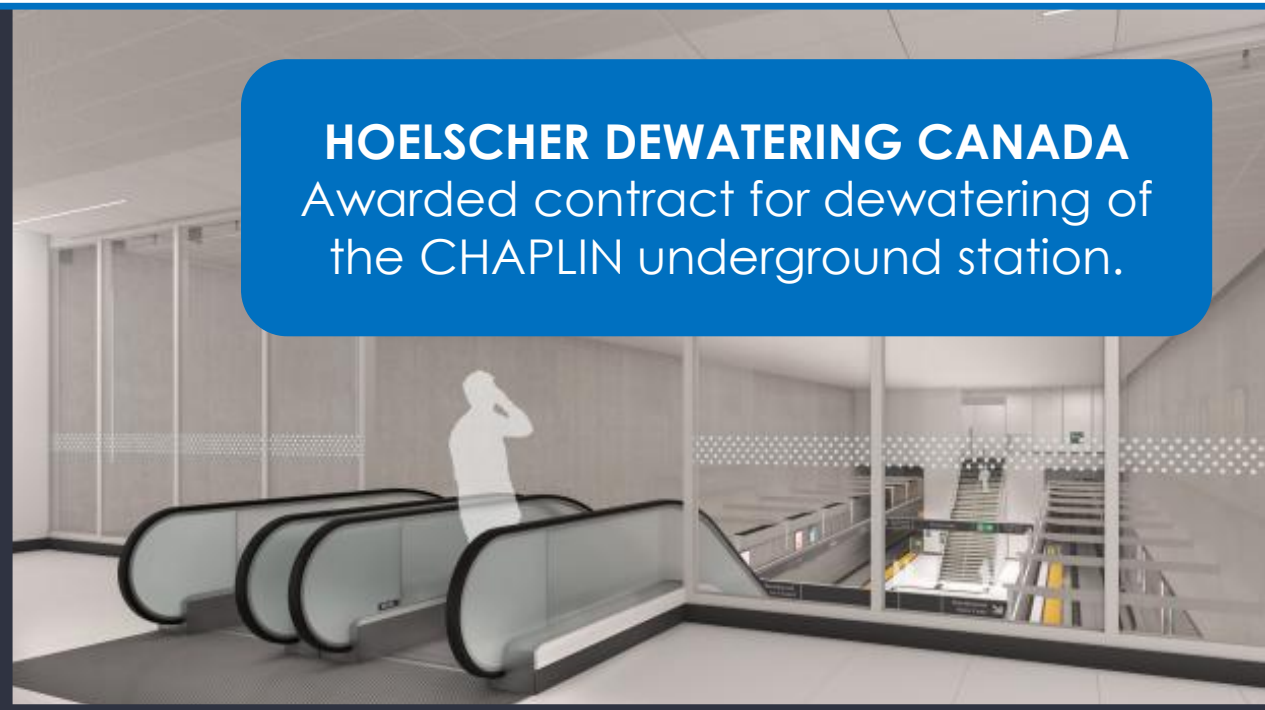
c. 62 Lit/s

Clear Water Abstraction

c. 62 Lit/s

Crane View

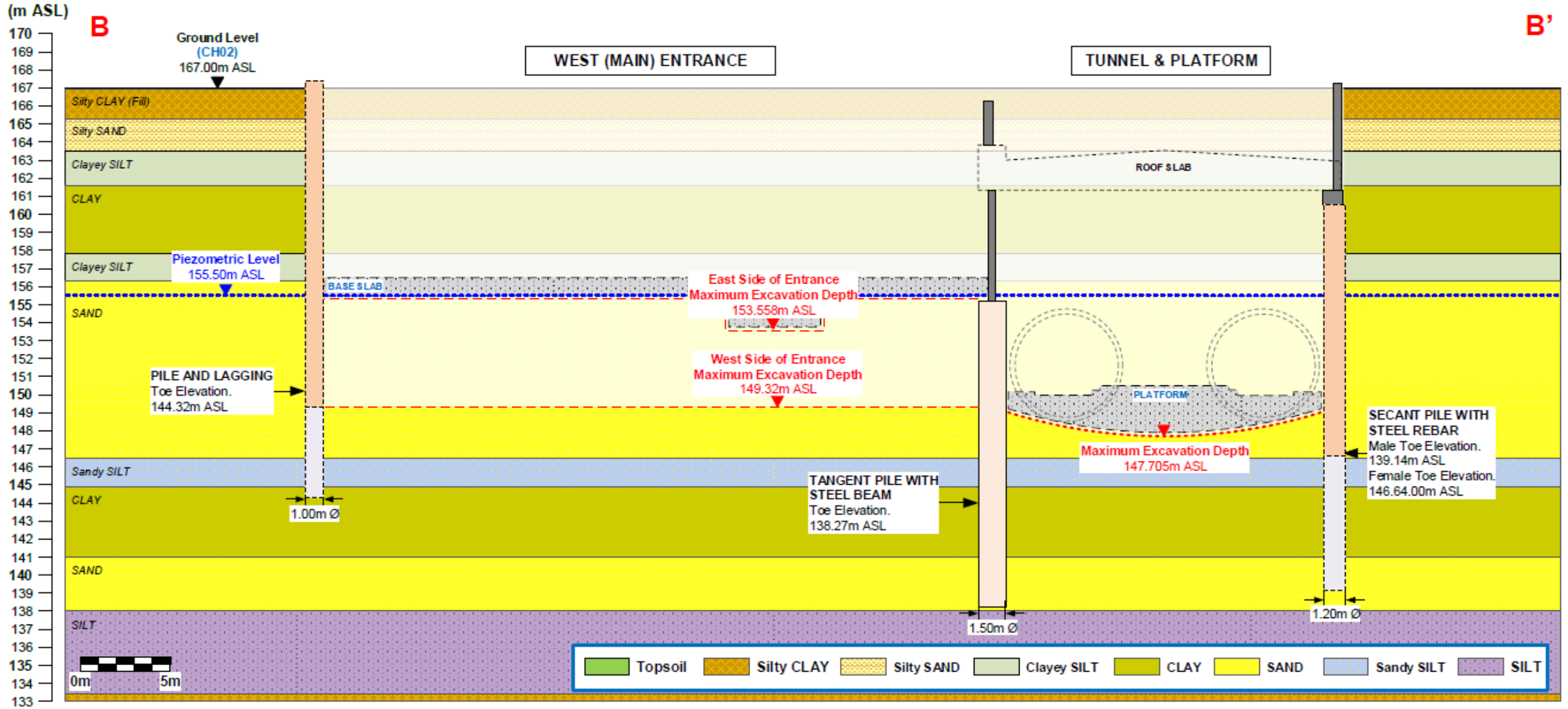
PRACTICAL ENGINEERING RECHARGE TECHNIQUES



HOELSCHER DEWATERING CANADA
Awarded contract for dewatering of the CHAPLIN underground station.

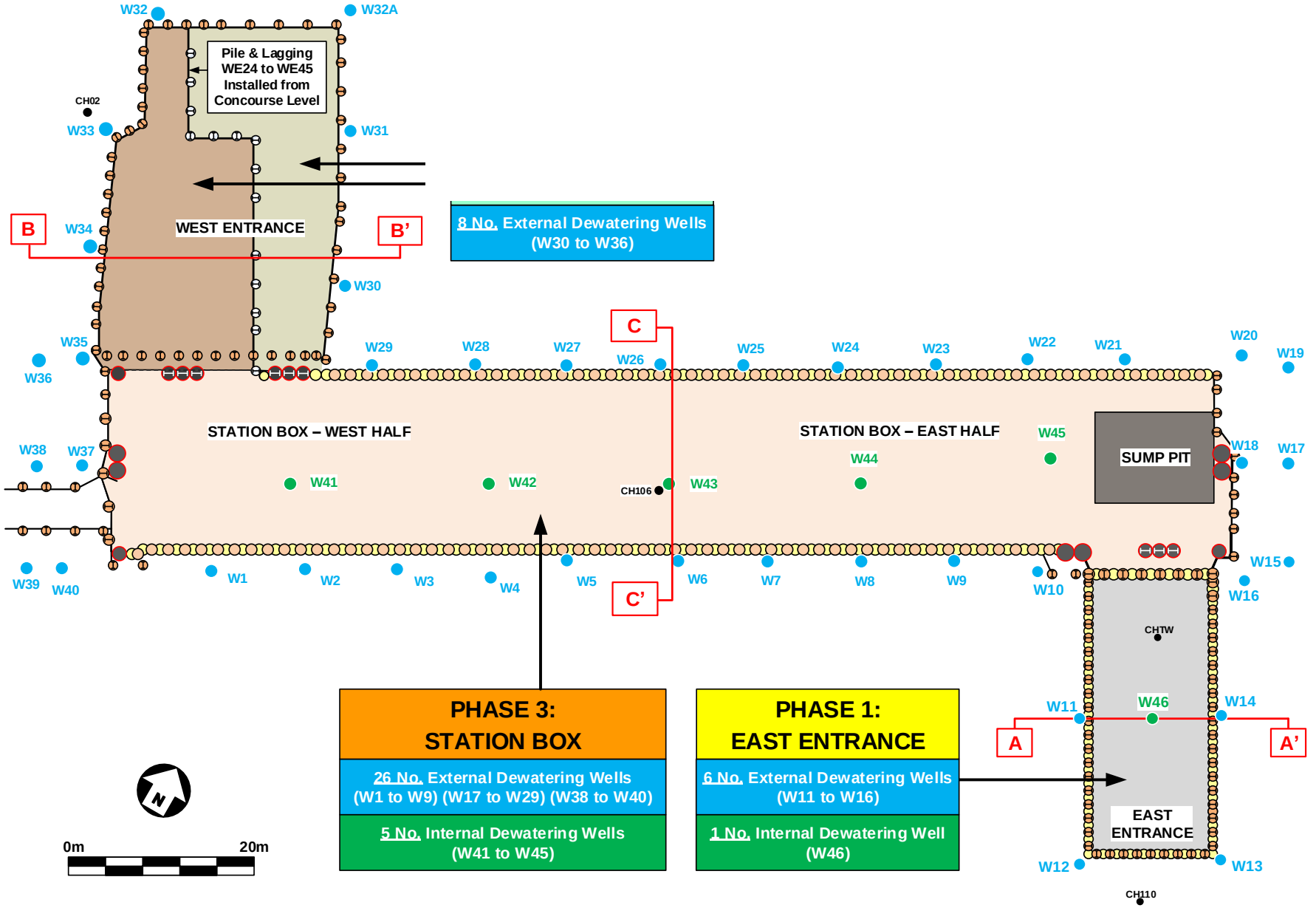
PRACTICAL ENGINEERING RECHARGE TECHNIQUES

OGI prepare Plan & Conceptual Model Drawings of the Underground Station in order to get a good understanding of the Geology and Structure.



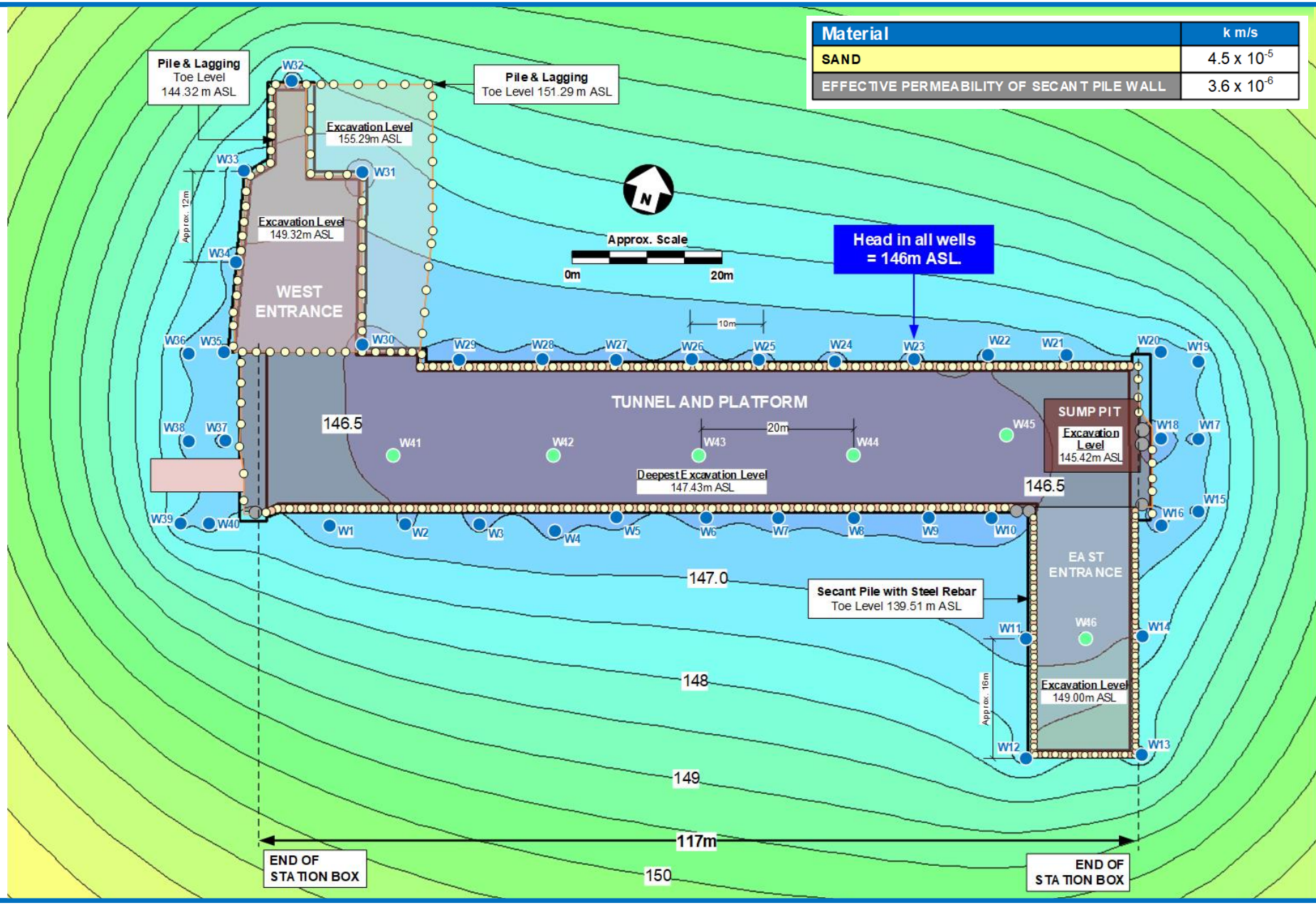
PRACTICAL ENGINEERING RECHARGE TECHNIQUES

OGI OPTIMISED DESIGN WITH 40 NO. SUBMERSIBLE BOREHOLE PUMPS AND 5 NO. PRESSURE RELIEF WELLS



PRACTICAL ENGINEERING RECHARGE TECHNIQUES

GROUNDWATER MODELLING UNDERTAKEN TO OPTIMISE THE WELL LAYOUT AND ASSESS DRAWDOWN AND FLOW RATES



PRACTICAL ENGINEERING RECHARGE TECHNIQUES

Successful Dewatering Operation

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For a deep structure constructed in a highly permeable soil or rock, groundwater control produces a safe & stable working environment

Abstracting Clear Filtered Groundwater

Example of Clear Water

Successful Dewatering Operation

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OGI GROUNDWATER SPECIALISTS

Example of Dewatering Operation

Successful Dewatering Operation

Video showing xxxxx

Average 62 Litre/sec groundwater abstracted

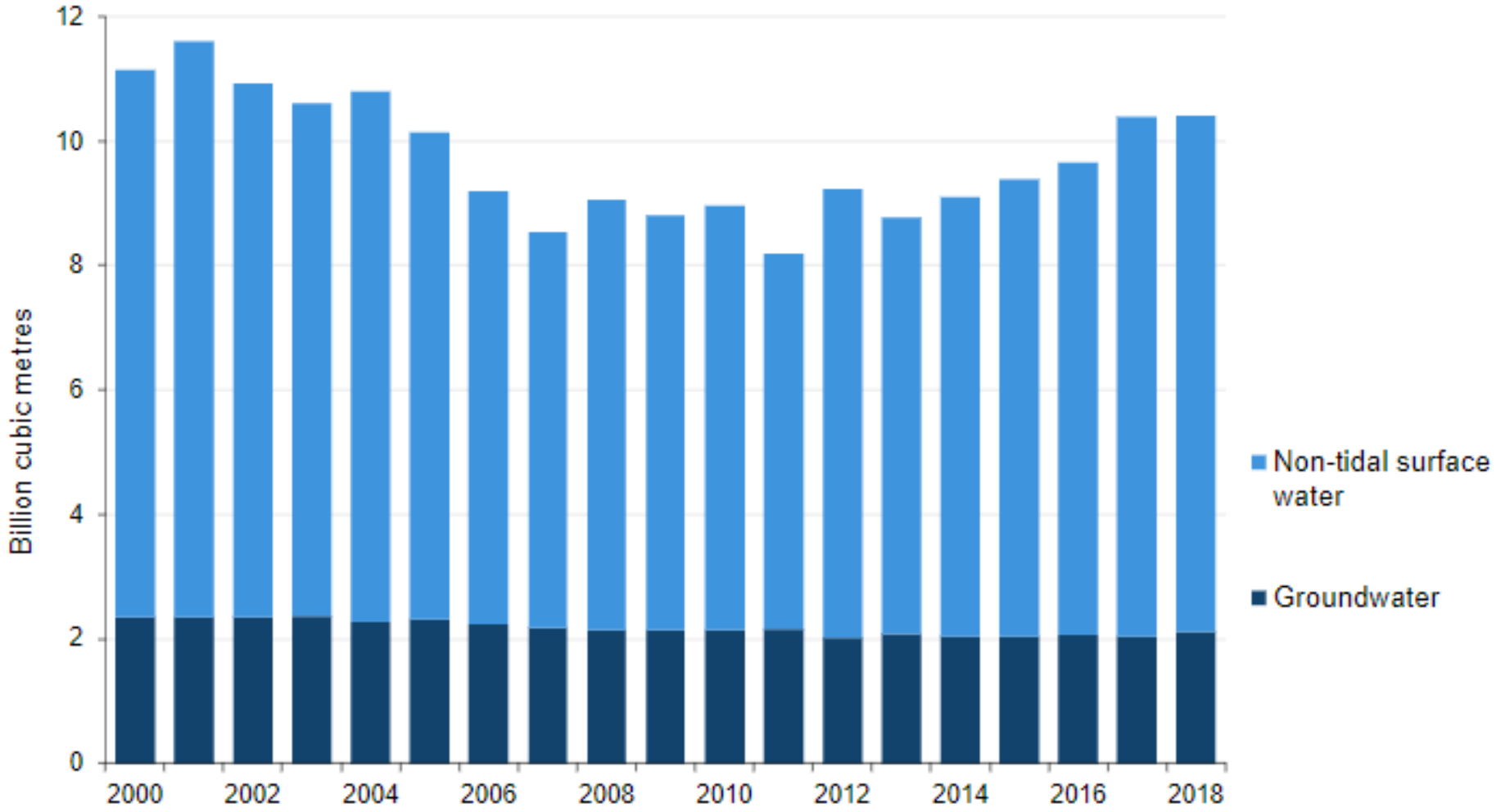
Over a six month construction period

=

c. One Billion Litres

Demand on Groundwater

Estimated abstractions from non-tidal surface water and groundwater in England by source, 2000 to 2018



Typical annual abstraction of Groundwater in England

c. 2 km^3, or

2 Million MegaLitres, or

2 Billion cubic metres, or

2 Trillion Litres

Loss by Construction Industry could be 10% of All Groundwater Abstracted in England

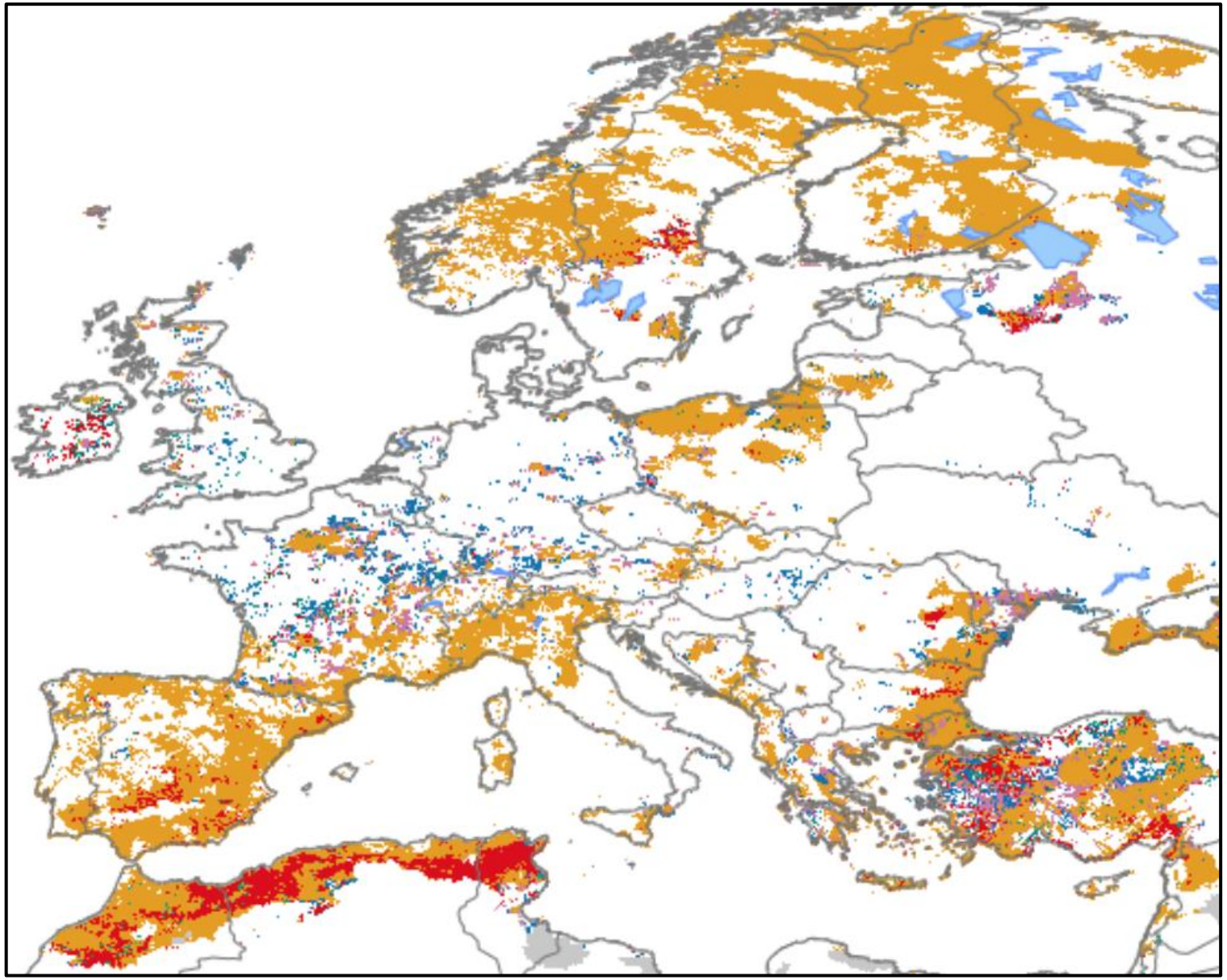
Drought in England

BBC Your account Home News Sport Weather iPlayer

NEWS

England drought: Everyone must rethink their water use, experts say

Drought in Europe



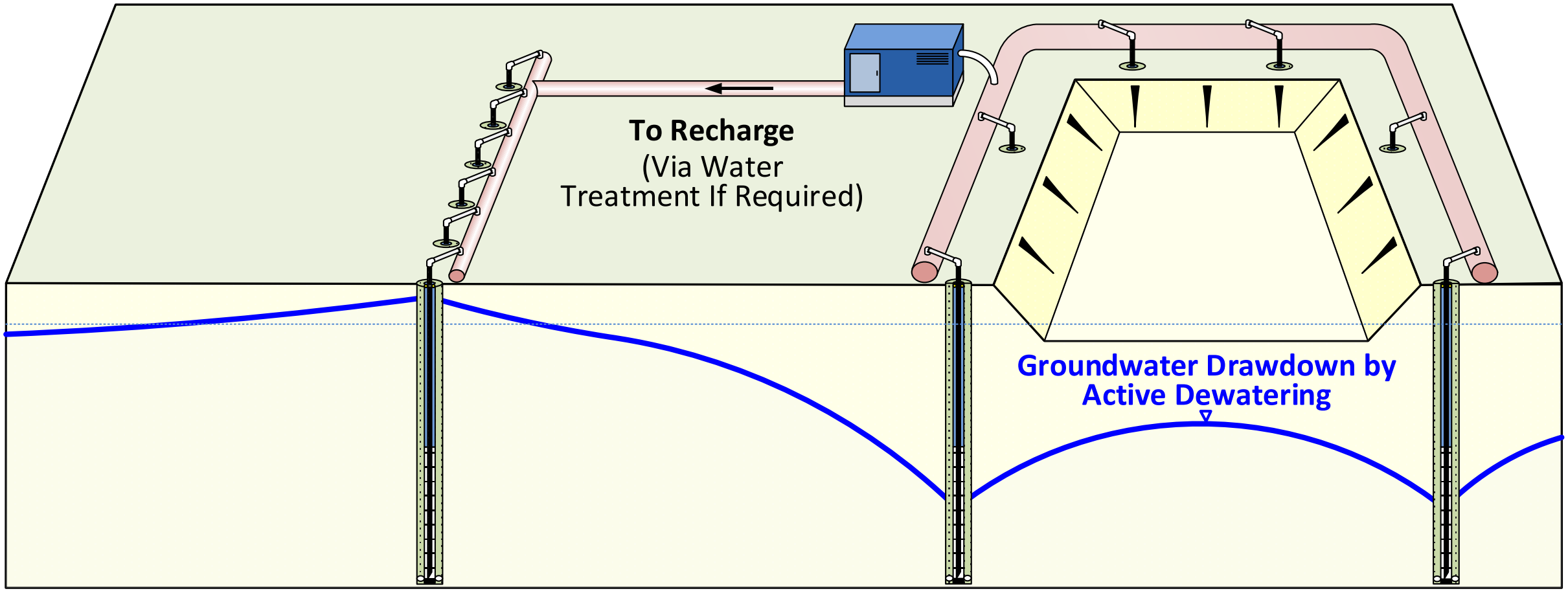
Drought map for the first 10 days of April 2023, showing that much of Europe faces a water problem.

Warning

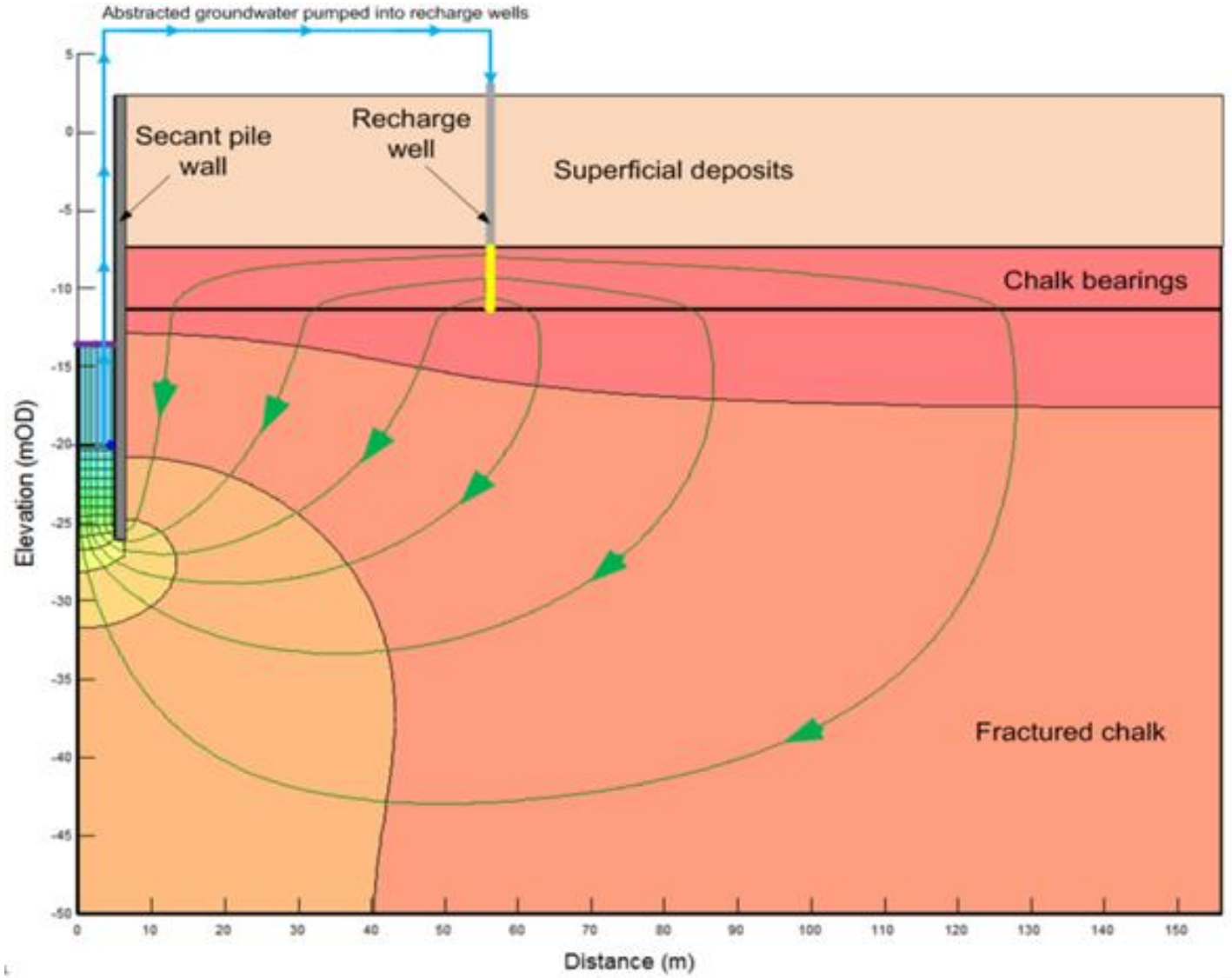
Alert

Principle of Recharge System

Schematic Model of a Pumping & Recharge System for Excavation Construction



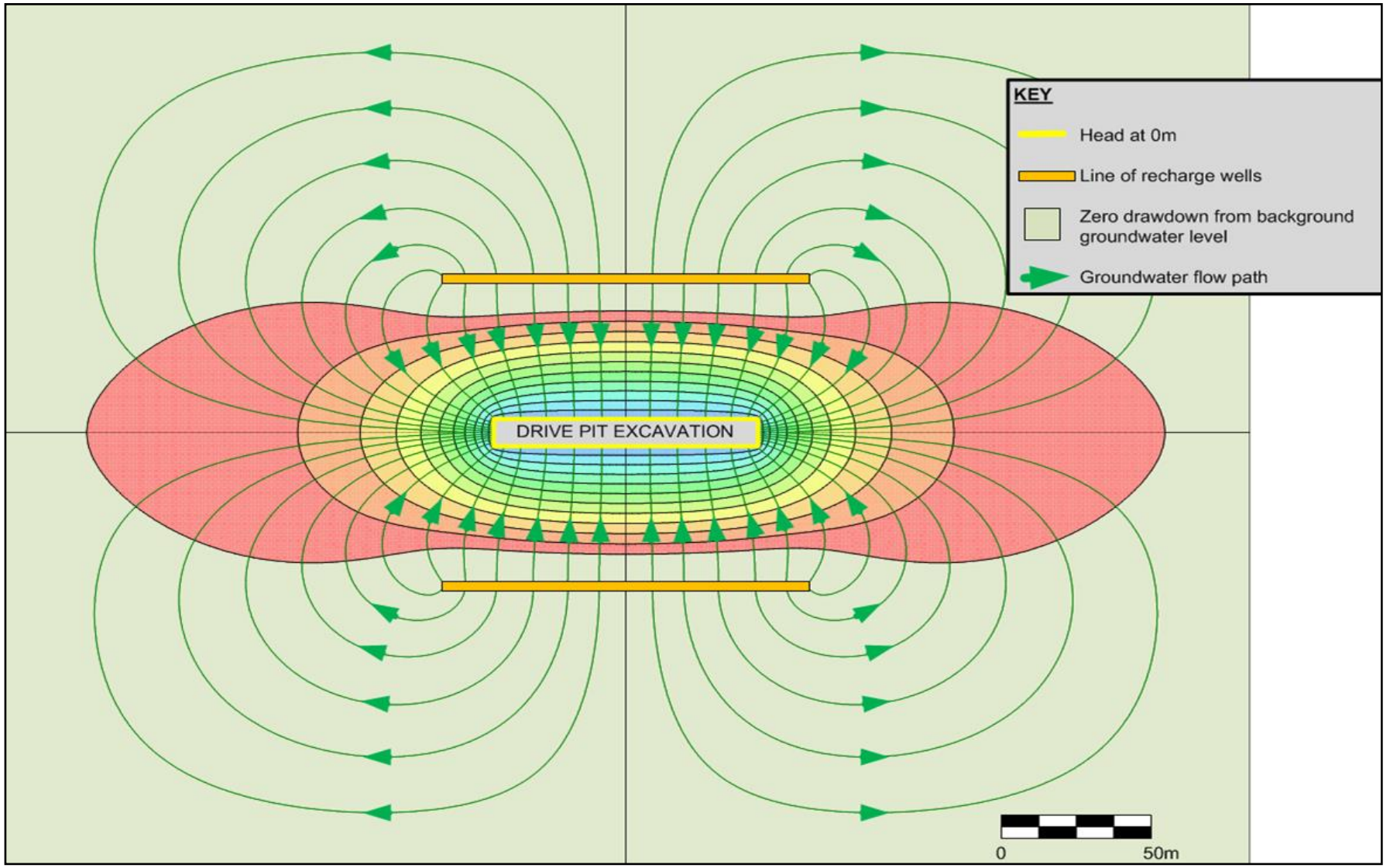
Cross Section Analysis of Pumping & Recharge System



Example of Recharge System

Example of a deep well groundwater recharge system

Areal Analysis of Pumping & Recharge System



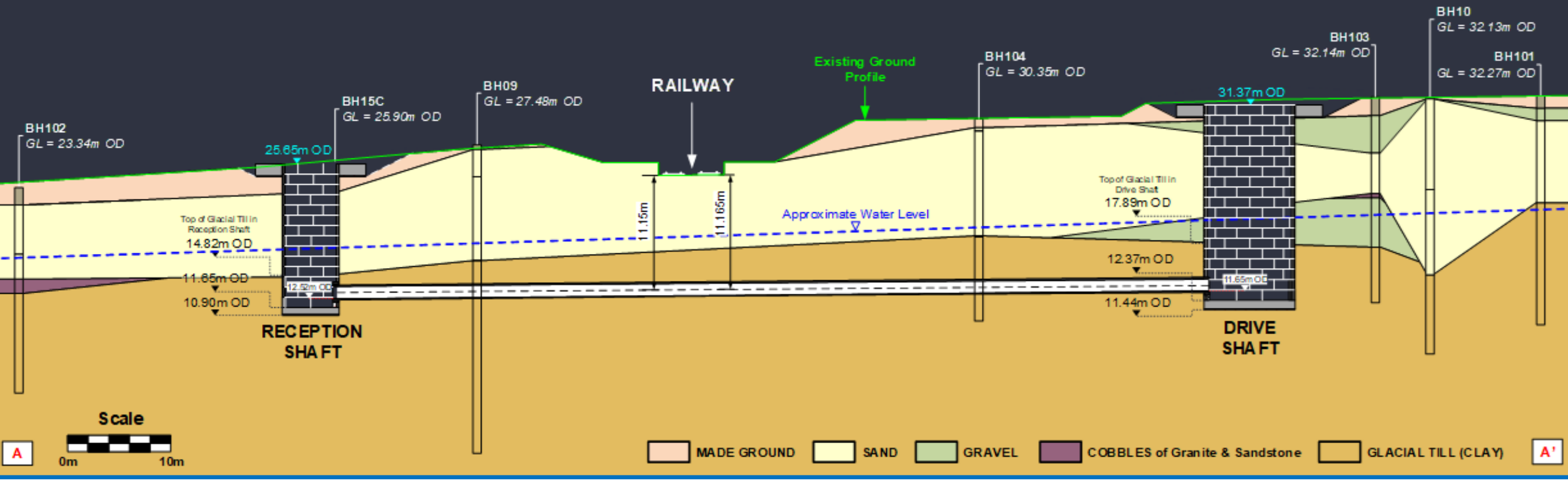
Case Study 1

Erskine Bridge

Gas Pipeline Replacement
Renfrewshire, Scotland

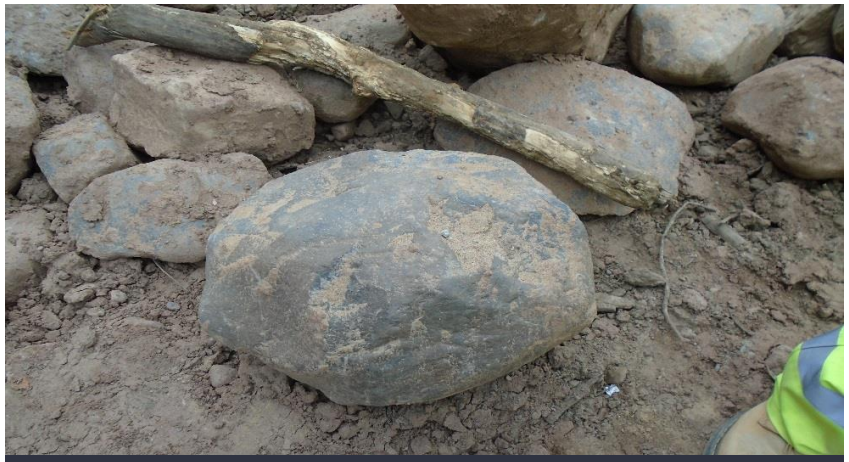
Conceptual Model of Drive Shaft, TBM Route & Reception Shaft

The geology at the site generally comprised silty sands and gravels, overlying glacial till containing cobbles and boulders. Stakeholders were concerned with two main mechanisms for ground settlement at the site; settlement from ground loss, and settlement from a reduction in pore water pressure in shallow deposits.



Location of Deep shaft near Existing Infrastructure

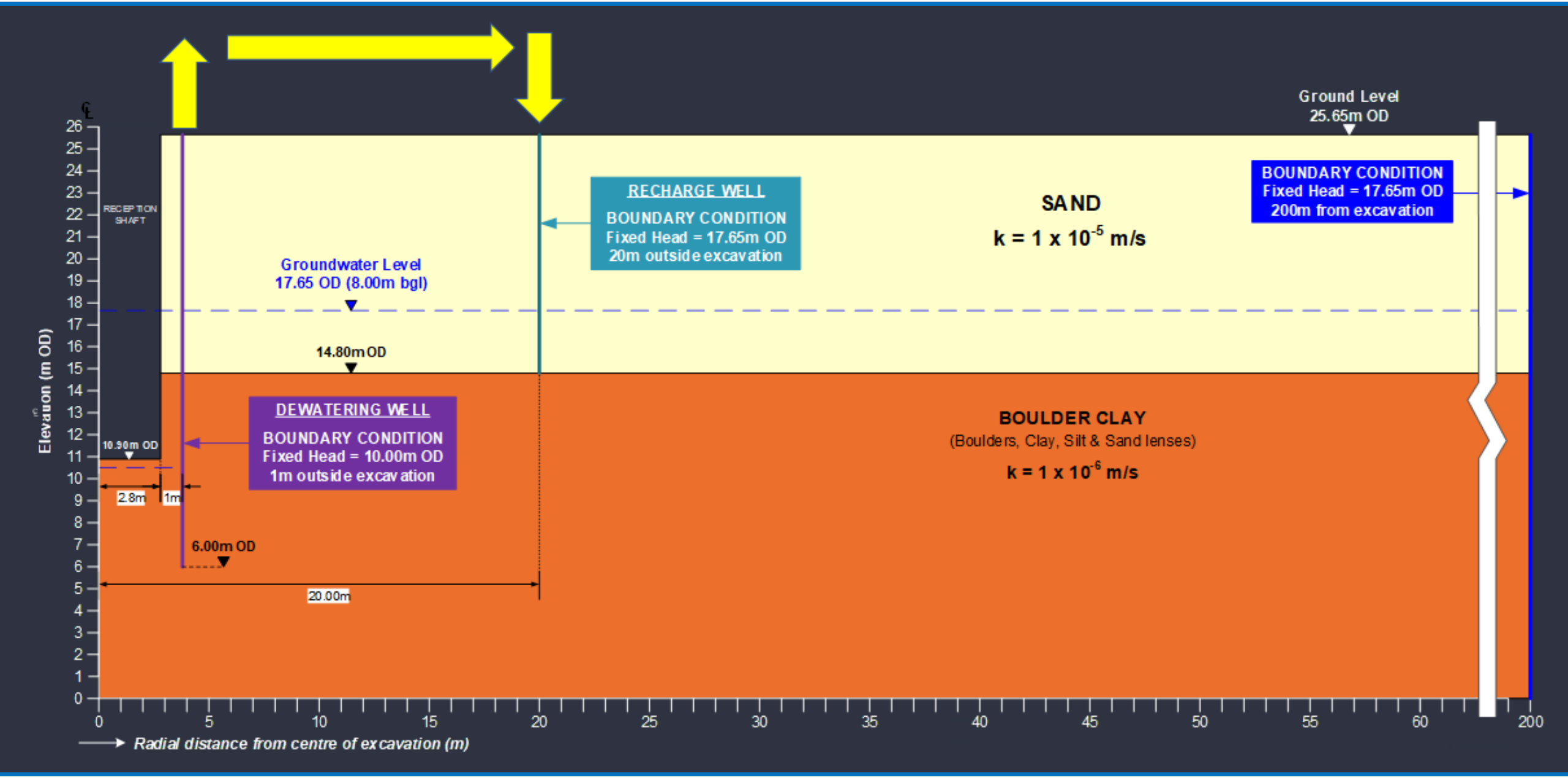
Shaft construction requiring dewatering close to Erskine bridge piers



Boulders encountered

Shaft during dewatering

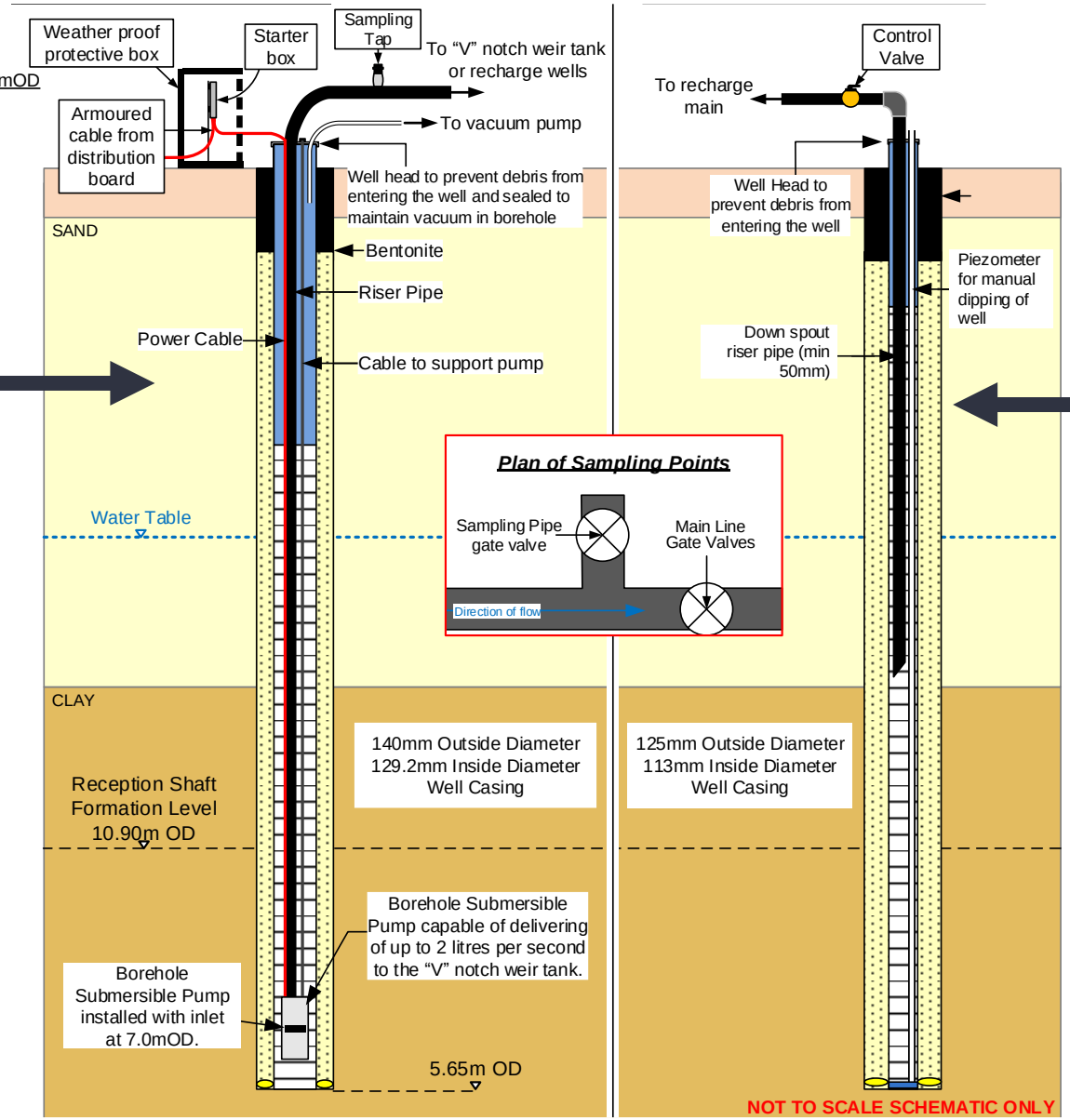
Principle of Recharge



Abstraction & Recharge Well Specifications

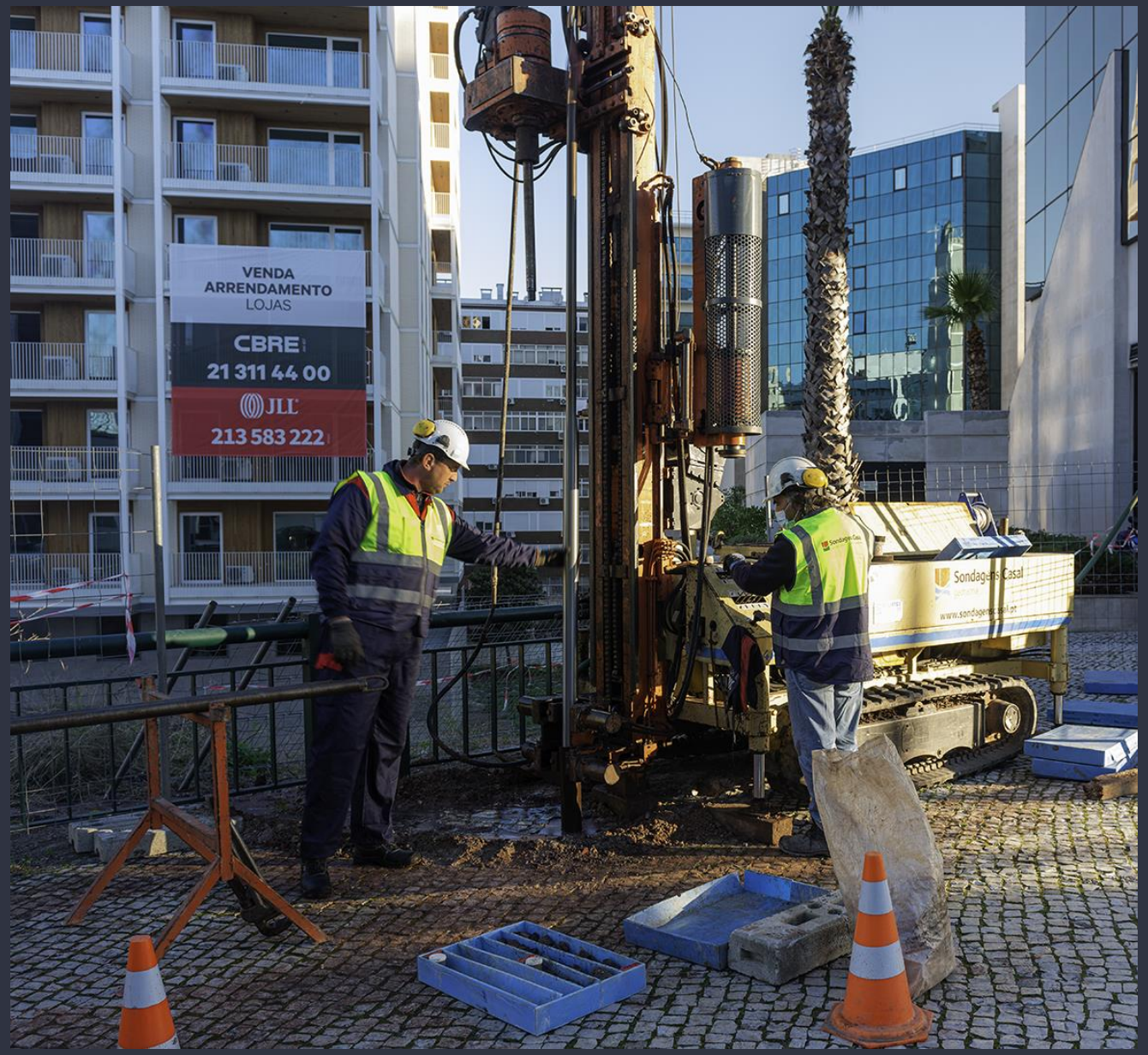
Pumping Well

Electro-submersible Pump – with Vacuum Boost



Pressurised Recharge Well

Drilling of Borehole



Installation of Abstraction WII

Abstraction Well

Pumping Well

Electro-submersible Pump – with Vacuum Boost

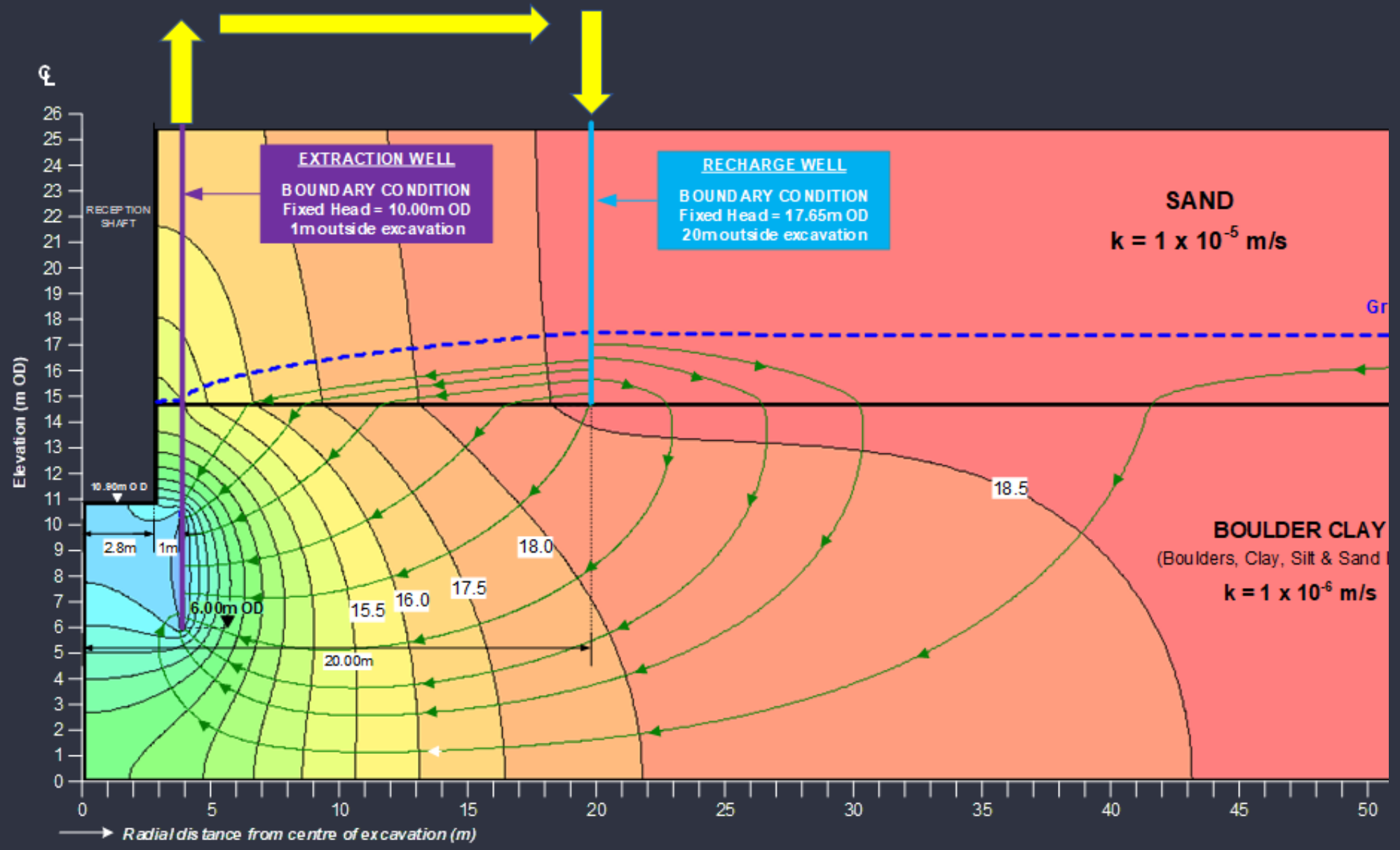
Recharge Well

Pressurised Recharge Well

Congested site

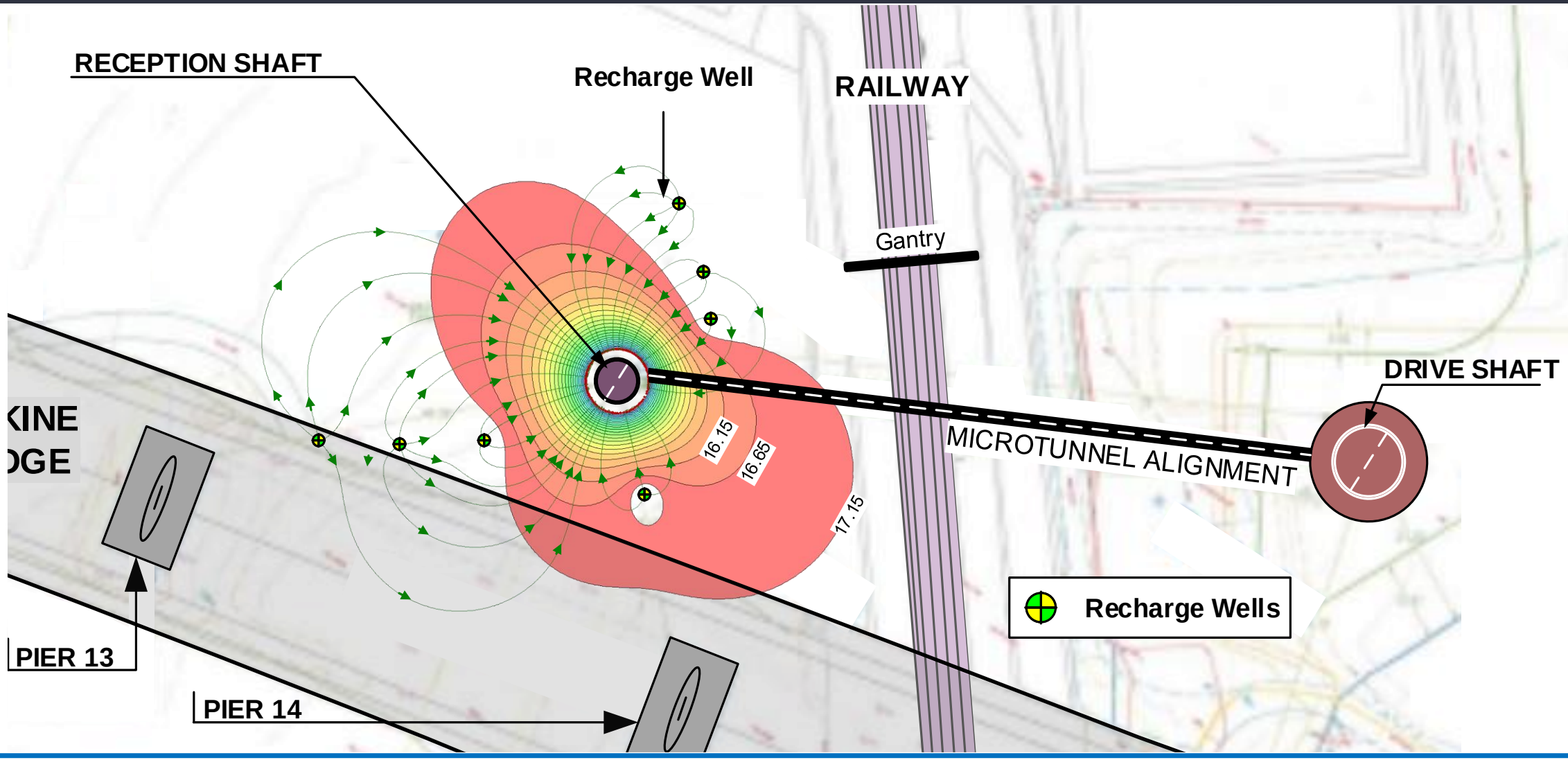
PUMPING & RECHARGE SYSTEM

Head contours & flow lines from Recharge to Abstraction Wells



Modelling of the Protection of Infrastructure & Resource

Finite element modelling demonstrated that a recharge system was feasible and would prevent drawdown in excess of 0.5m below the bridge piers or the railway line



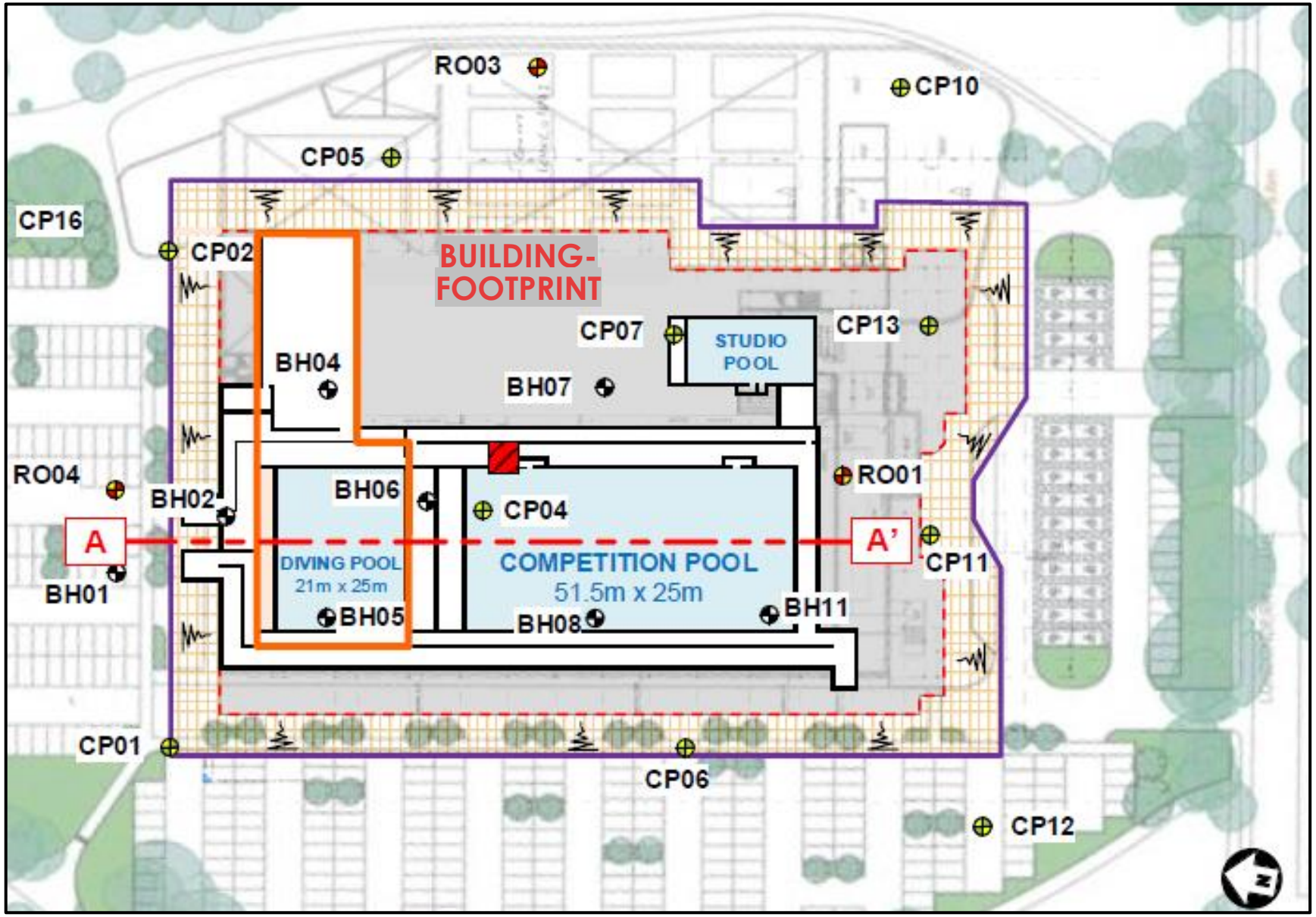
Case Study II

The Commonwealth Games Aquatic Centre

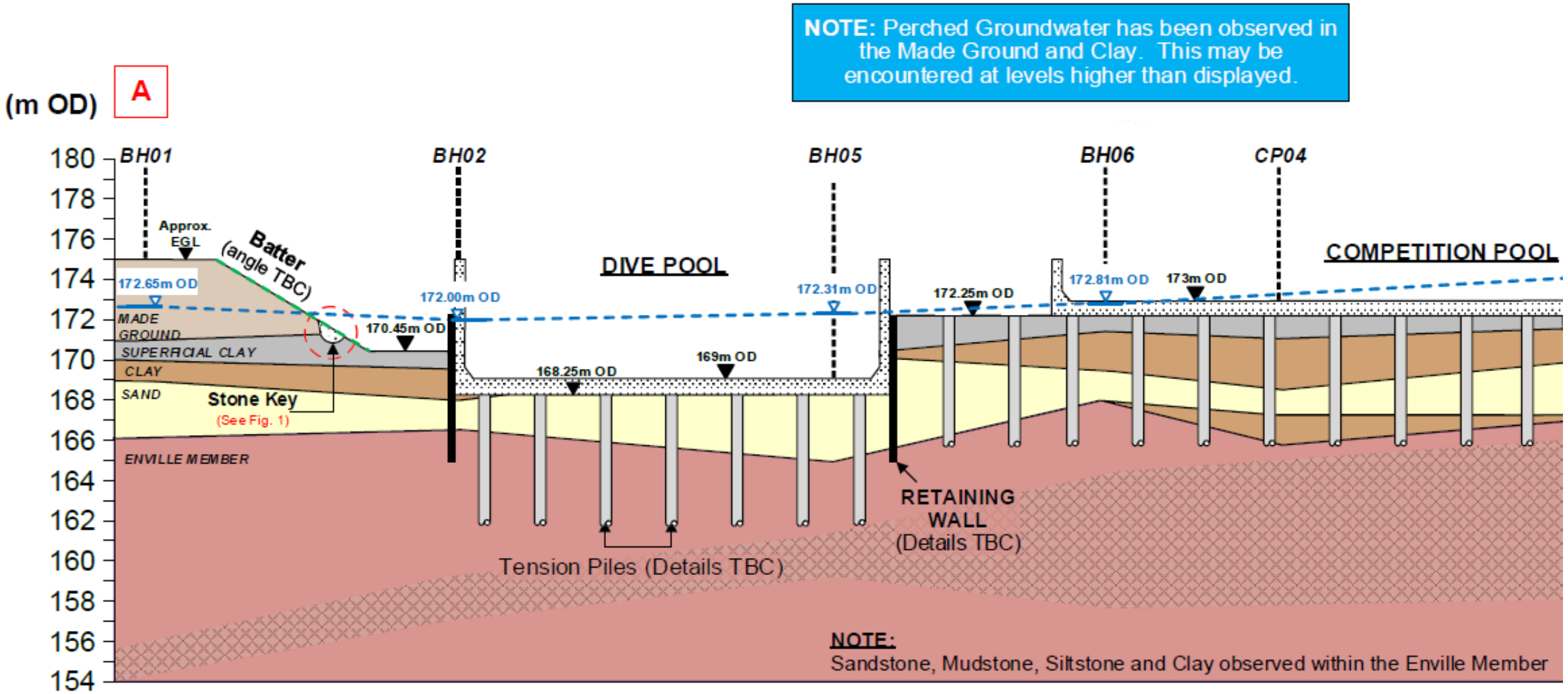
Sandwell, Birmingham

View of Sandwell Aquatics Centre during construction (Courtesy of Wates Construction)

Commonwealth Games Aquatic Centre - Plan



Commonwealth Games Aquatic Centre - Section



Suction Header Pipe surrounding Excavation

Producing a Safe Working Environment

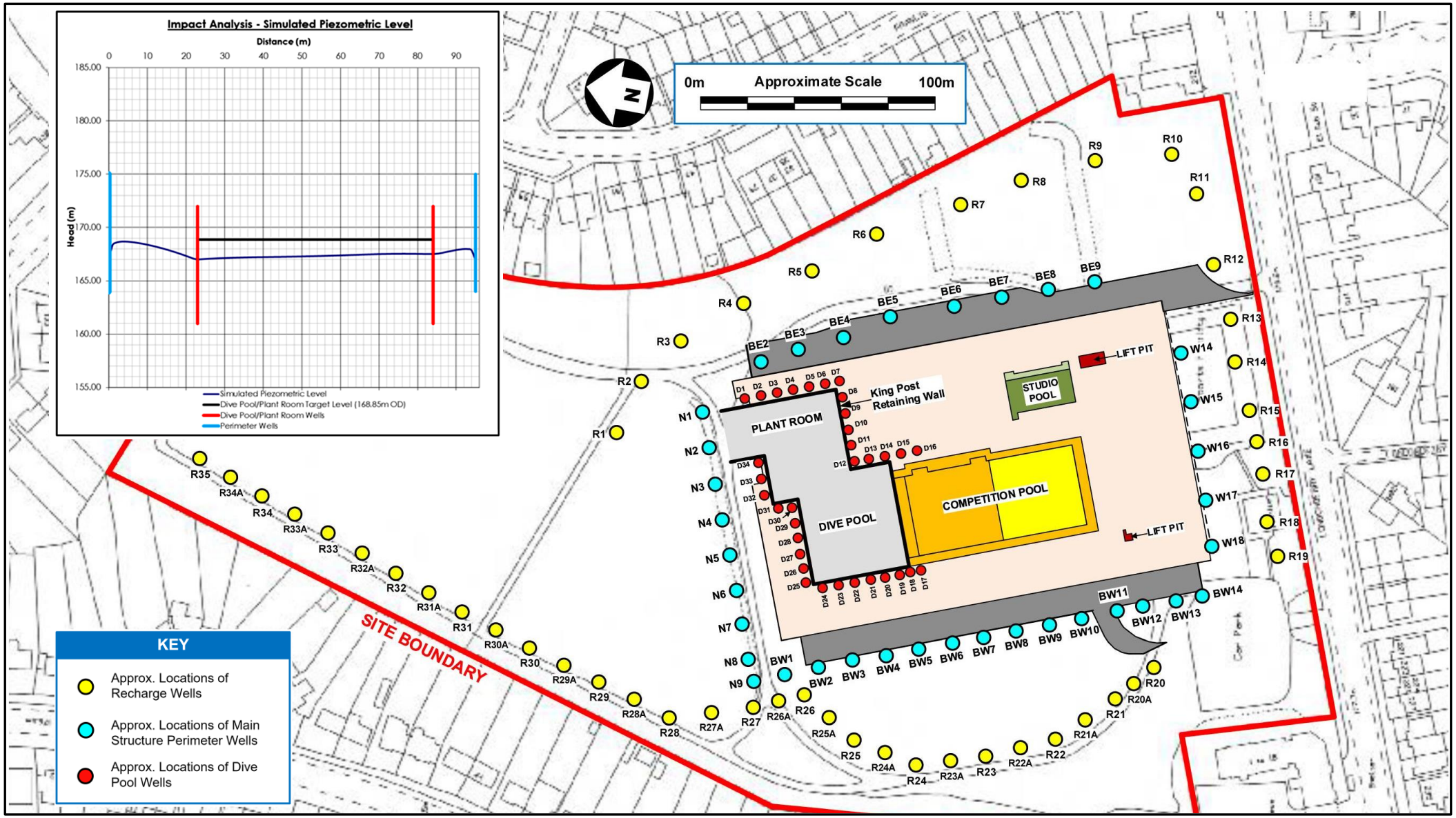
LICENSING

In England, the Environment Agency generally grants a licence to abstract groundwater within an agreed pre-determined rate.

However, due to the current over-abstraction of groundwater from the Principal Aquifer underlying Birmingham (the Chester Formation), the EA specified the net abstraction rate as **Zero** for the Sandwell Commonwealth Games Aquatics Centre Project.

Regularly communicating with key stakeholders

Location of Abstraction & Recharge Wells



Collection and Recharge Tank

The system required over 120 abstraction wells and 50 recharge wells, with each well individually specified so groundwater abstraction and recharge were targeted at the appropriate aquifer

A traditional approach would have resulted in the loss of groundwater in the order of 250 (ML) MegaLitres (250 Million Litres)

However, during the construction of the Aquatic Centre

100%

of the abstracted groundwater was recharged back to the same aquifer from which abstracted.

Commonweath Games Aquatic Centre – Diving Pool

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