The Deepest Tunnel in London

Lee Tunnel - Setting New Industry Standards

ConsMa 2014 – Seoul, Korea

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Lee Tunnel

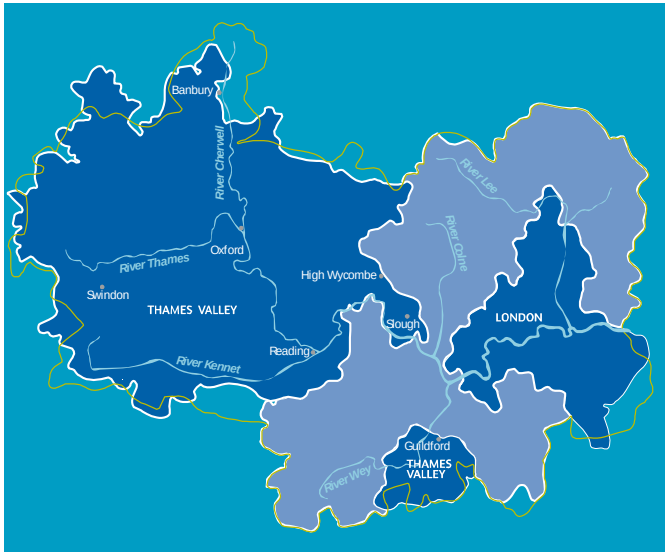
Creating a cleaner, healthier River Thames

Thames Water

What I Will Cover

- Why Lee Tunnel
- What Are We Building
- Parties, Contract, Cost, Schedule
- How Far Along Are We
- Managing the Challenges
- The Future

Thames Water is the UK's largest water and sewerage company



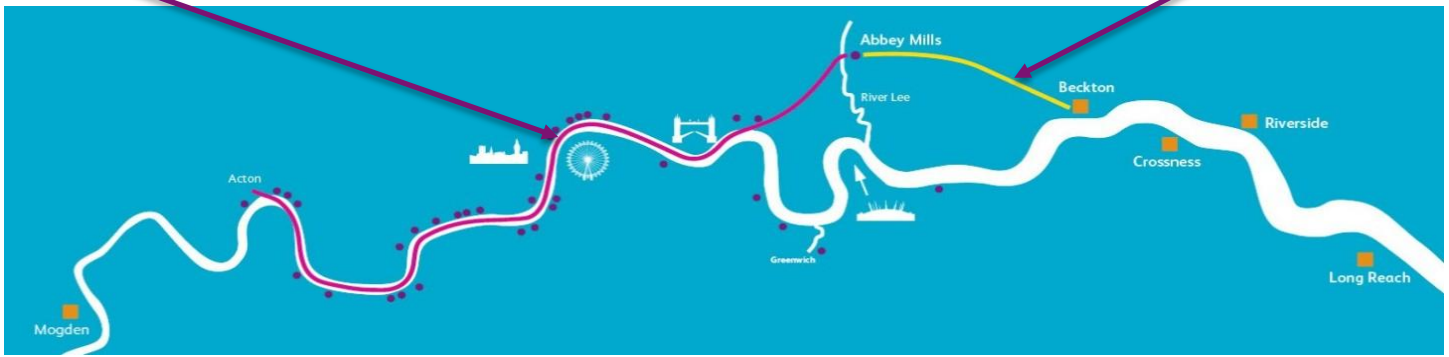
Biggest capital delivery programme in the industry, worth £5bn over five years

- 14 million wastewater customers
- 350 sewage treatment works
- 66,500-miles of sewer network

Lee Tunnel is part of the Thames Tideway Improvements

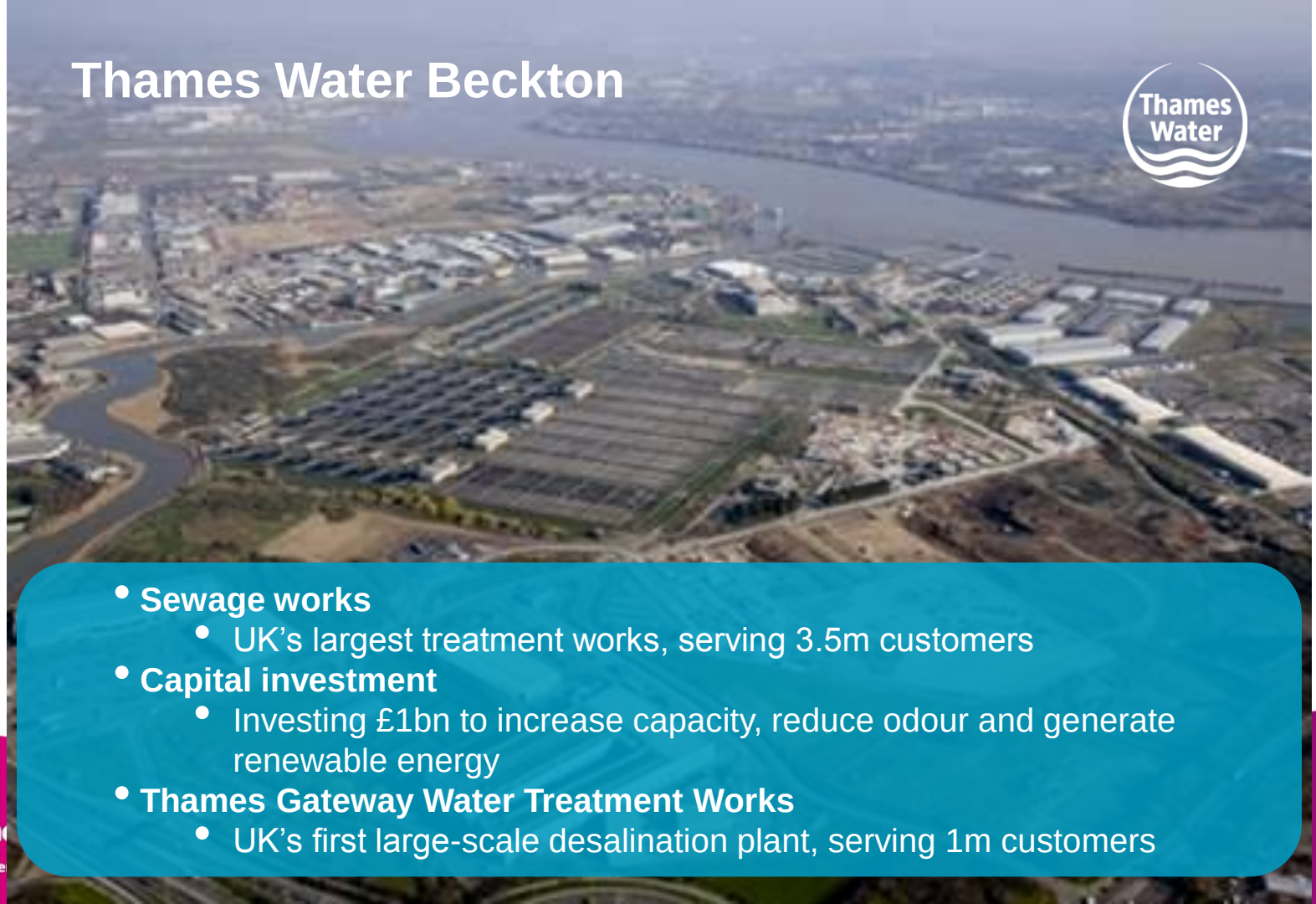
Tideway Tunnel

Lee Tunnel



- Sewage Works Upgrades - £675m
- Lee Tunnel - £635m
- Proposed Thames Tideway Tunnel - £4.2bn

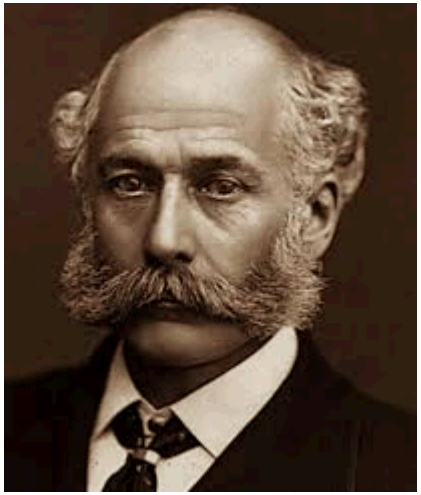
Thames Water Beckton



- **Sewage works**
  - UK’s largest treatment works, serving 3.5m customers
- **Capital investment**
  - Investing £1bn to increase capacity, reduce odour and generate renewable energy
- **Thames Gateway Water Treatment Works**
  - UK’s first large-scale desalination plant, serving 1m customers

Why Lee Tunnel

- London’s sewer system is a combined system built in the 1860’s for 2.4 million people
- London now has over 8 million people
- Each year 39 million tons of raw sewage and rain flow into Thames
- Abbey Mills pumping station is the largest overflow point – 40% of discharges



Sir Joseph Bazalgette
Chief Engineer

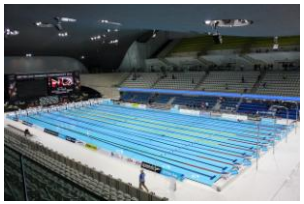
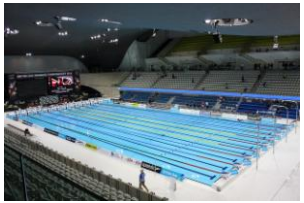
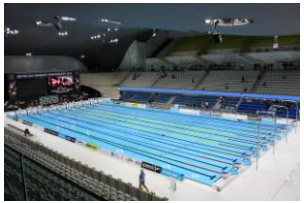
Abbey Mills storm overflow

How Will Lee Tunnel Stop the Discharges?

In Two Parts

Build a tunnel to store the excess combined sewage and rain

- How big? - 375,000m^3 – 150 Olympic sized swimming pools
- Based upon expected storms and future flow from Tideway Tunnel

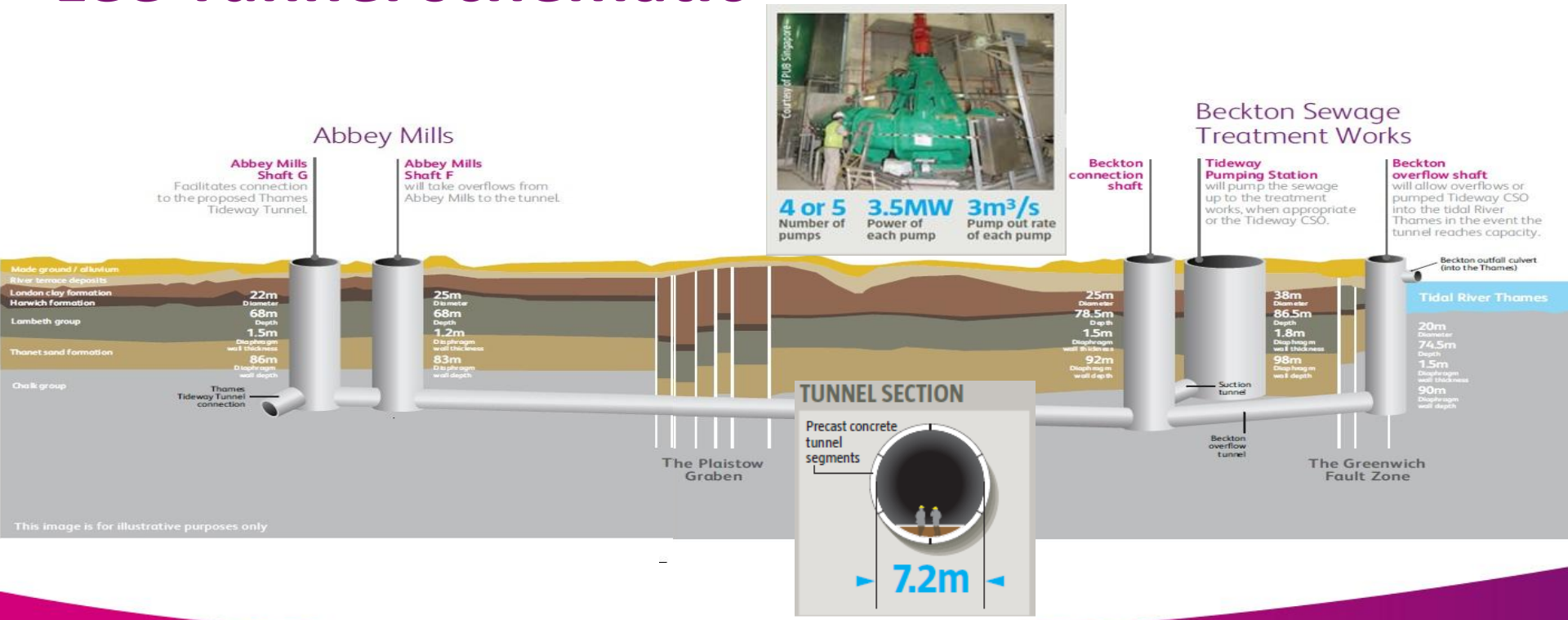




150 Pools

Expand Capacity of Beckton Sewage Works

- Capacity expanded from 17 m^3/s to 27 m^3/s (388 MGD to 616 MGD)
- Treatment works area expanded from size of 85 football pitches to 101 pitches

Lee Tunnel schematic



Lee Tunnel
Creating a cleaner, healthier River Thames

Thames Water

Building London's deepest ever tunnel

- £635 million – original budget, scope increased to £678 million
- Thames Water's biggest ever engineering project
- Four mile (6.9km) tunnel
- 7.2m diameter tunnel - the width of three London buses
- 80m deep – the height of a 25 storey building
- Five shafts – the deepest shafts in London

Who is Building the Lee Tunnel?

- The Client - Thames Water – Owner, operator

- MVB – Designer/Contractor
  - Morgan Sindall, Vinci Construction Grands Projets, Bachy Soletanche

- Project Manager – CH2MHILL

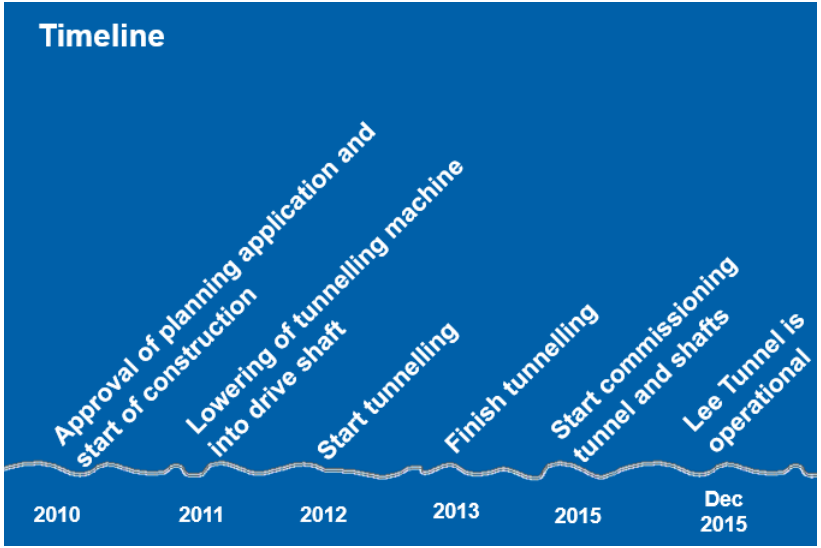
How Much Does it Cost?

- Total Project Budget - £678 million ($1.09 billion)
- MVB Contract Target Price
  - Original Target Price - £422 million ($675 m)
  - Current Target Price - £579 million ($926 m)
- CH2MHILL Contract - £46 million ($74 m)
- Thames Water Overheads- £53 million ($85 m)
- Thames Water risk
  - Original - £86 million ($137.6 m)
  - Current – included in MVB Target Price

Project Schedule

- Original Completion – 19th April 2015
- Current Completion – 18 Dec 2015
- Regulatory Date – 31 December 2015
- Master schedule uses Primavera P6
- 11,000 activities

We Are On Schedule



How Far Along Are We?

The Tunnel

- Main Tunnel completed 26 Jan 2014
- Maximum rings production:
  - 136 rings/ week,
  - 29 rings/ day
- Believed to be best production ever for a slurry TBM

Next Phase – secondary lining

Beckton Shafts and Outfall Culvert

- Connection Shaft:
  - Lining completed
- Pumping Shaft:
  - Civil works ongoing
  - Piping, electrical to start
- Outfall Culvert:
  - Land installation underway
  - Marine works underway

Abbey Mills Pumping Station

- Shaft G:
  - Diaphragm walls complete
  - To be excavated
- Shaft F:
  - Lining complete
  - Preparing to remove TBM
  - Cascade platforms to start
- Culvert connections to Shaft F:
  - Nearly complete
- Pumps, electrical refurbishment
  - design and procurement ongoing

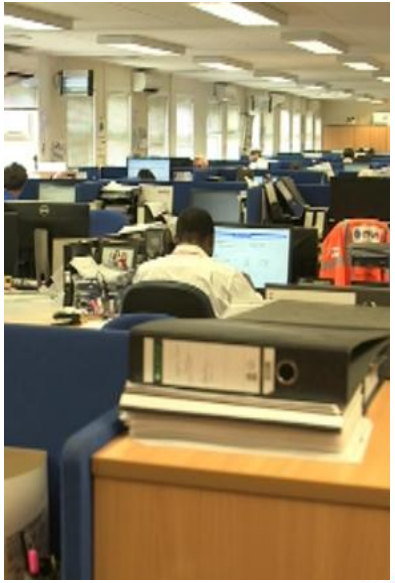
Managing the Challenges

Our Biggest Challenge

- People!
- Multiple parties and levels
  - Client
  - Stakeholders and regulators
  - The public
- Client, Contractor, Project Manager now in a Contractual Partnership
  - Share all project risk and rewards - agreed gain/pain incentive
  - Project Manager integrated with Contractor to manage design and construction

Managing the People Challenge

- Communication, communication, communication
  - verbal
  - written
- Trust and collaboration
  - Foundation of the NEC3 contract
    - Clause 10.1 – "*The [Parties] shall act as stated in this contract* ***AND in a spirit of mutual trust and co-operation****.*"
    - Prompt identification and resolution of issues
  - Co-location facilitates trust and collaboration



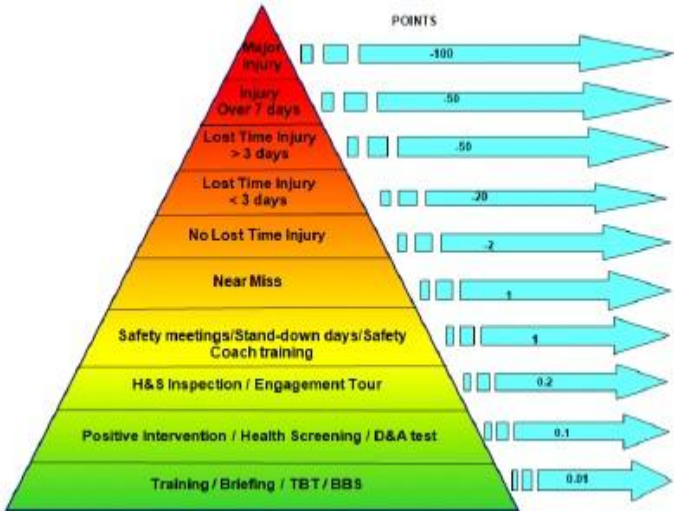
Keeping Everyone Safe – Our Highest Value!

- We keep the metrics for health and safety
- We use all the tools
  - Safety built into design – CDM regulations
  - Work method statements
  - Risk assessments of each work task
  - Safety training, toolbox talks
- But, it takes more than metrics and tools

It requires a belief and a culture!

Workers who feel safer work better

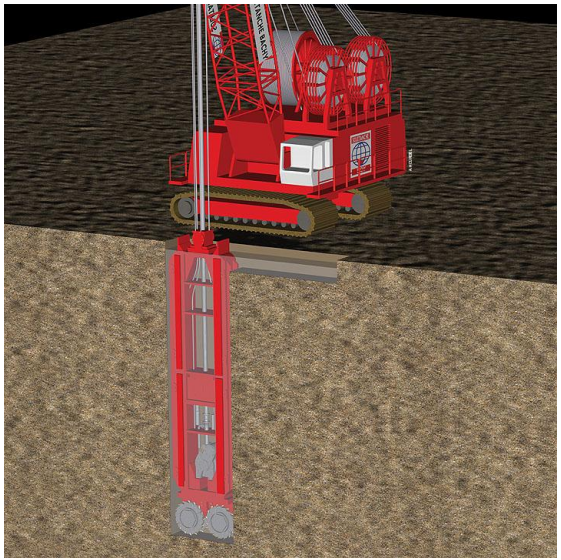
Result – better than every other tunnel project

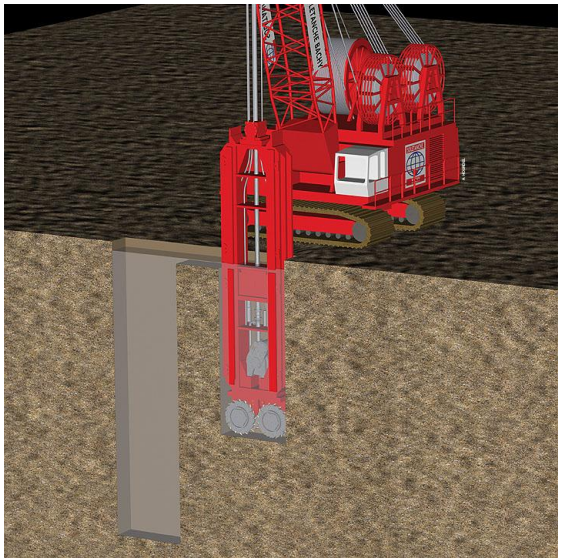


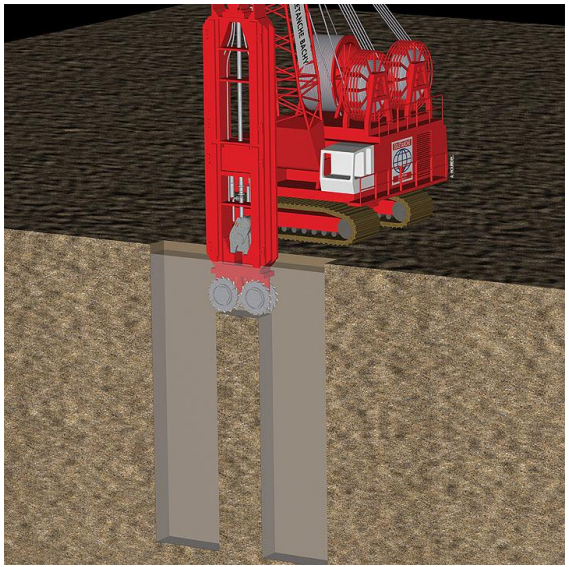
Outstanding Technical Achievements in Tunnel and Shafts

- Deepest tunnels and shafts in UK
- Shaft lining – slip form, no rebar, no cracking
- TBM – work under high water pressures (6 bar)
- Fibre reinforced concrete
- All tunnel spoil transported by river barges to disposal sites - Over 1.4 million tons
  - Avoided over 80,000 trucks

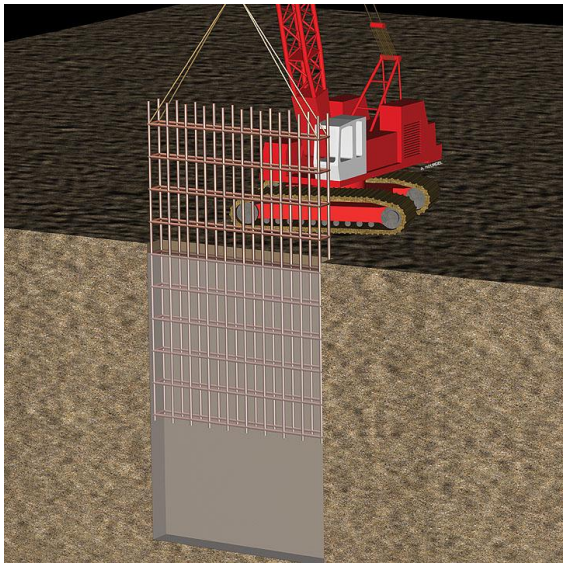
Diaphragm wall panel excavation

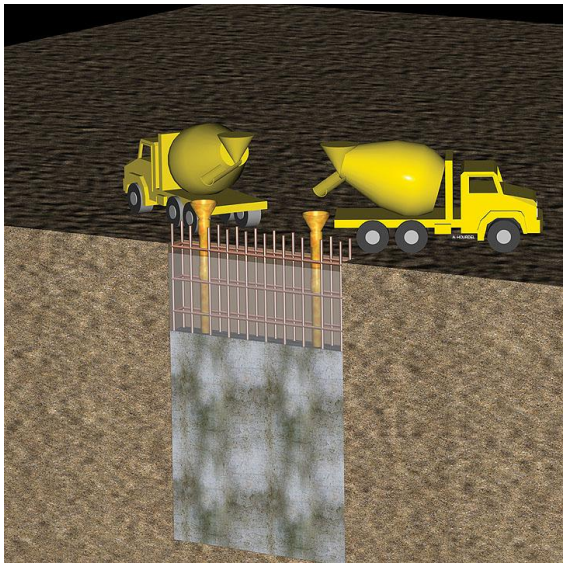


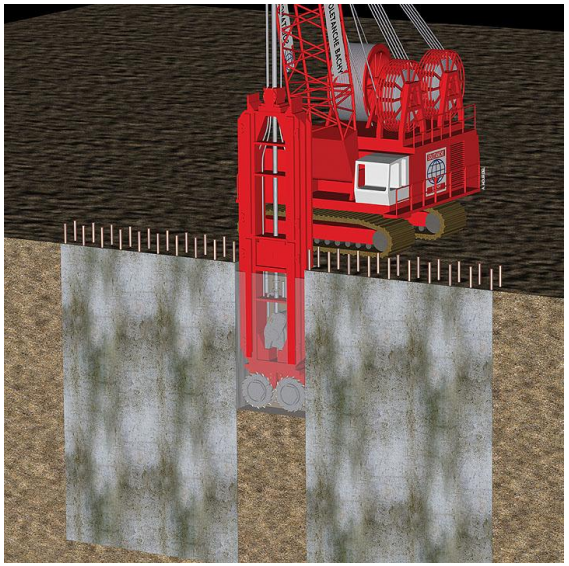




Diaphragm wall reinforcing & concreting







Installing 6 Main Pumps 80 meters deep

6 x 3.5 m^3/s pumps

Pumping Station Bottom with Suction Tunnel Intake

Renovating Historic Abbey Mills Pump Station

- Built in 1868 – registered with English Heritage
- Pumps combined sewage, rain to Beckton plant
- 8 main pumps
- Pumps and electrical system to be upgraded
- Building structure to be improved

Secondary Lining

- 2 no. 30 m shutters
- 2 curing gantries
- Concrete pumped 250m
- 360m per week
- Fibre reinforced concrete

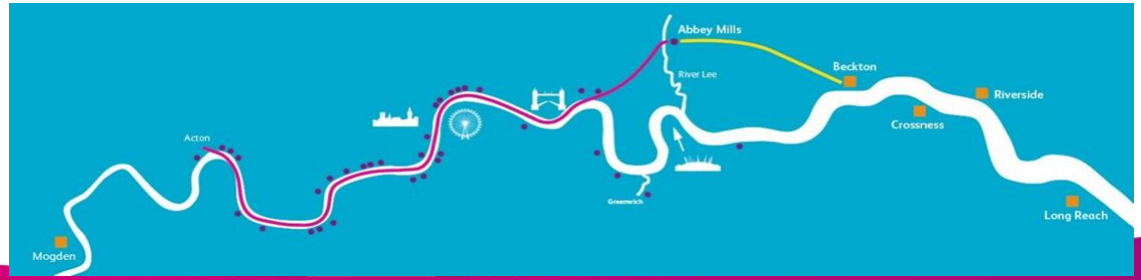
Never Been Done Before!

Many Awards Already!

Awarding Body or Paper	Award or Event	Subject or Title	Submission Date
ICE London	Best Infrastructure Project	Lee Tunnel Diaphragm Walls	2011
ICE London	Greatest contribution to London	Lee Tunnel Diaphragm Walls	2011
Ground Engineering Magazine	Health and Safety	Diaphragm Wall Edge Protection	2011
Soletanche Bachy	Innovation for Health and Safety	Diaphragm Wall Edge Protection	2011
Thamems Water	AMP5 Health and Safety	Common Standards	Mar-12
Ground Engineering Awards	Editor's Award		2012
Ground Engineering Awards	Heatlh and Safety Awards	Lee Tunnel Protection to Large Diaphragm Wall Excavations	2012
ICE London Civil Enginering Awards	ICE	Infrastructure Award	2012
Ice London Civil Engineering Awards	ICE	Greatest Contribution to London	2012
Vinci Innovation Awards	Vinci		2013
Fleming Award	Fleming	Lee Tunnel, Abbey Mills, Stratford – Shaft F	2013

The Future

- Lee Tunnel complete end of 2015
- MVB to provide 2 years Operation and Maintenance
- Will eliminate 40% of total CSO discharges
- Thames Tideway Tunnels projects to start 2016, complete 2023



Keys to Our Success

- Trust and collaboration among everyone
- Excellent contract (NEC3) – encourages trust, early resolution of issues
- Strong safety culture, driven from top leadership
- Good contractor and PM – willing to work with each other
- Client engaged but does not try to manage
- Change was managed without schedule impact
- COMMUNICATE, COMMUNICATE, COMMUNICATE!!!