

THE TUNNEL BORING MACHINE

What is a tunnel boring machine (TBM)?

A tunnel boring machine (TBM) is like a giant drill, but one that builds as it drills.

The TBM arriving in Auckland in July is going to drill two holes, each big enough for a three lane motorway. It will first travel north from Owhiraka to Waterview to dig one tunnel, then turn around at Waterview and begin its journey back to Owhiraka.

Why is the tunnel boring machine referred to as a TBM?

Saying the words tunnel boring machine is a bit of a mouthful so we call it a TBM for short.

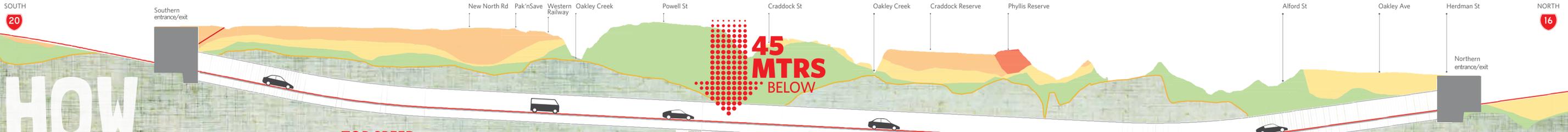
Why do we need the TBM?

By digging the tunnel and taking the motorway underground for 2.4 kilometres, we save the existing roads, parks, rivers, houses and businesses that are along the route.

It's a practical solution to easing traffic congestion and building new roads, though an extremely challenging one. The Waterview Connection is a Road of National Significance, meaning the benefits of the motorway go beyond the use of people in Auckland. All of New Zealand benefits as it will be a major road that is used to transport goods and services around the country.



If you want to learn more about New Zealand's 7 Roads of National Significance visit: www.nzta.govt.nz/network/rns/



HOW DOES IT WORK?



The simple answer is that the TBM is like a giant drill and it will drill the two holes that will be the north and southbound tunnels.

The front section of the TBM is called the shield. At the front of the shield is the cutting face. The cutting face is like a giant, round circular cheese grater.

The shield has two jobs, it drills through the ground to create a large hole which it then lines with concrete segments to form complete rings. These concrete segments are 2 metres wide and 450 millimetres thick.

So the TBM could also be called a TMM – a tunnel making machine because it not only digs the tunnel, it also lines the hole that it has dug with concrete segments and completes the process of making the tunnel.

TOP SPEED:
8CM PER/MIN

How fast does it go?

Depending on the ground strength the TBM can travel at a top speed of 8 centimetres a minute, but like any new engine – it is going to need to be broken in and gradually taken up to work at its top speed. Eight centimetres a minute is also the top speed of a snail.

How deep underground does the tunnel go?

The tunnels dive to a maximum of 45 metres below ground at certain points of the TBM's journey. The TBM will travel beneath a layer of incredibly hard volcanic rock, formed by the eruption of a volcano in the region a long, long time ago.

DRILL TO THE CENTRE OF THE EARTH:
2655 YEARS

If our TBM was to bore straight down into the earth, how long would it take to reach the centre of the world?

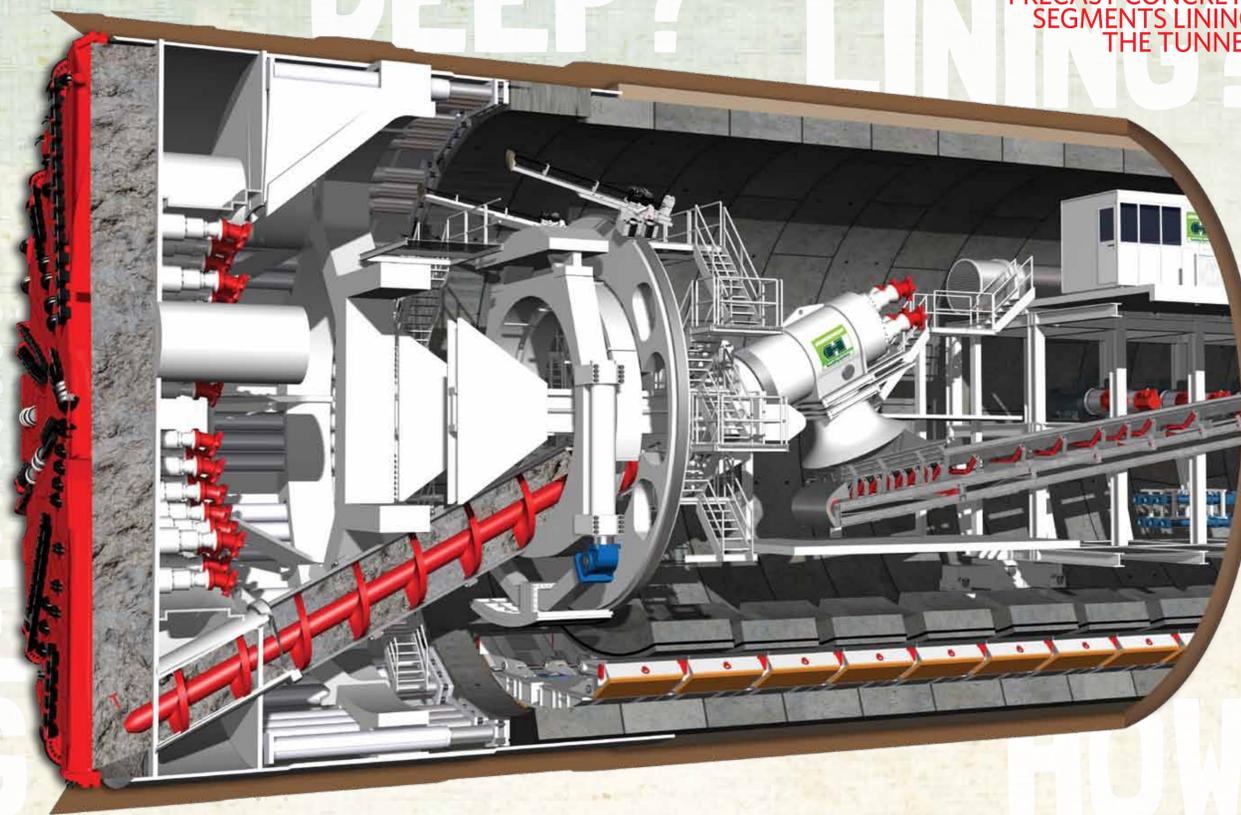
It is going to take about a year for our TBM to travel 2.4 kilometres. This includes downtime while the machine is being maintained.

The centre of the earth is approximately 6371 kilometres down. If we take the TBM to be running at the same speed that it will be travelling while it digs the Waterview tunnel, then it would take approximately 2655 years for the TBM to bore a tunnel to the centre of the earth.

INJECT FOAM INTO THE SOIL

What happens if the cutting face gets stuck in the ground?

This won't happen as a material that has the consistency of foam is injected into the soil through pipes in the cutting head, along with water, to help turn the soil into a slurry which can then be more easily excavated.



HOW DEEP?

THE LINING?

24,040
PRECAST CONCRETE SEGMENTS LINING THE TUNNEL

Where does the lining come from?

A purpose-built facility in East Tamaki will make the 2 metre wide segments. Pre-cast segments are made by casting concrete in a reusable mould. Concrete is poured into the moulds and then cured in the best conditions to ensure that it is strong. Curing concrete does not mean we heal it of what ails it, but we make it stronger than it would be if it was not cured. We take the utmost care to properly cure the concrete so that it achieves the required strength and hardness.

The moulds are then used over and over again to cast the rest of the segments as it ensures that all the rings will be of the exact size. There will be 24,040 concrete segments in total used to line the tunnel.

THE CREW?

16
How many people do you need to work the machine?

At any one time there will be about 16 people working in the TBM. It will house a crew headed by the TBM pilot in the machine's operating cabin.

SOIL?

800,000M³
OF SOIL TO WIRI QUARRY

What happens to the soil that is removed from the tunnel?

The soil that has been grated away by the TBM is referred to as 'spoil' and it is taken out of the tunnel on a continuous conveyor belt to a special building made just for it.

It sits in this building for 24 hours while the water that was sprayed into the ground along with the foam, slowly seeps out of the spoil. Once it has 'de-watered' the spoil is then trucked to a quarry in Wiri, South Auckland.

For every two metres that the TBM progresses, that is the width of one tunnel ring, the TBM will remove approximately 330 cubic metres of spoil.

When the TBM has done its job, it will have excavated 800,000 cubic metres of ground. That is enough to fill 320 Olympic sized pools.

AS HEAVY AS 5.25 AIRBUS A380s

How big is the machine?

The machine has a diameter of 14.4 metres, which is larger than the trunk of Tane Mahuta, New Zealand's oldest and biggest Kauri tree, and about the same height as a four storey building.

The TBM will be used in Waterview ever the largest tunnel boring machine (TBM) ever used in Australasia.

The TBM will weigh about 3000 tonnes. That is equal to 3,000,000 kilograms or 750 elephants. Or the same as 5 and a quarter Airbus A380s.

The total length of the TBM is 87.7 metres, almost as long as a rugby field.

THE CUTTING FACE

HOW HEAVY?

DID YOU KNOW?

Who is building it?

The New Zealand Transport Agency has commissioned the Well-Connected Alliance to build the Waterview Connection. The Well-Connected Alliance is a group of leading engineering companies that are working closely together, as their name implies.



Why must the TBM have a female name?

This tradition dates back to Saint Barbara who is the patron saint for artillerymen, armourers, military engineers, gunsmiths, miners and anyone else who worked with cannons and explosives.

Tunnellers, as underground workers, look to Saint Barbara for protection and as a result machines that work underground are always given female names.



How much does it cost?

The machine cost \$50 million dollars to build and transport to New Zealand. It has been built by Herrenknecht, a leader in manufacturing this type of machine, in their plant in Guangzhou China and arrives from China in July 2013.



When will it start work?

It starts work in October, after it has been assembled and passed its Warrant of Fitness (WOF). It will take three months to put it together after it arrives in Auckland, having been broken down into parts to be transported to Auckland.



Will people be able to cross over from one side of the tunnel to the other?

People who work in the tunnel will be able to use one of the seventeen cross-passages that will connect the north and south bound Waterview tunnels.



What is it made of?

The machine is made from a number of materials but the main ones are:

- the structure is made from a special sort of steel that has been made to handle extreme pressure
- the wiring and motor cables are all made of copper and weigh about 10 tonnes alone
- gold wiring on the computer systems and programmable controllers
- conveyor belts are made from layered rubber with steel wire reinforcing for strength.

If it isn't the largest machine of its kind, how large is the largest in the world?

The TBM that is going to be used in Waterview is the 10th largest in the world with a diameter of 14.46 metres. The largest machine in June 2013 has a diameter of 17.526 metres and is currently in Seattle beaver away beneath the ground.

THE BIGGEST: 17.526m **10th BIGGEST: 14.46m**