


SUSTAINABLE DRILLING

Energy efficient water-powered
DTH technology

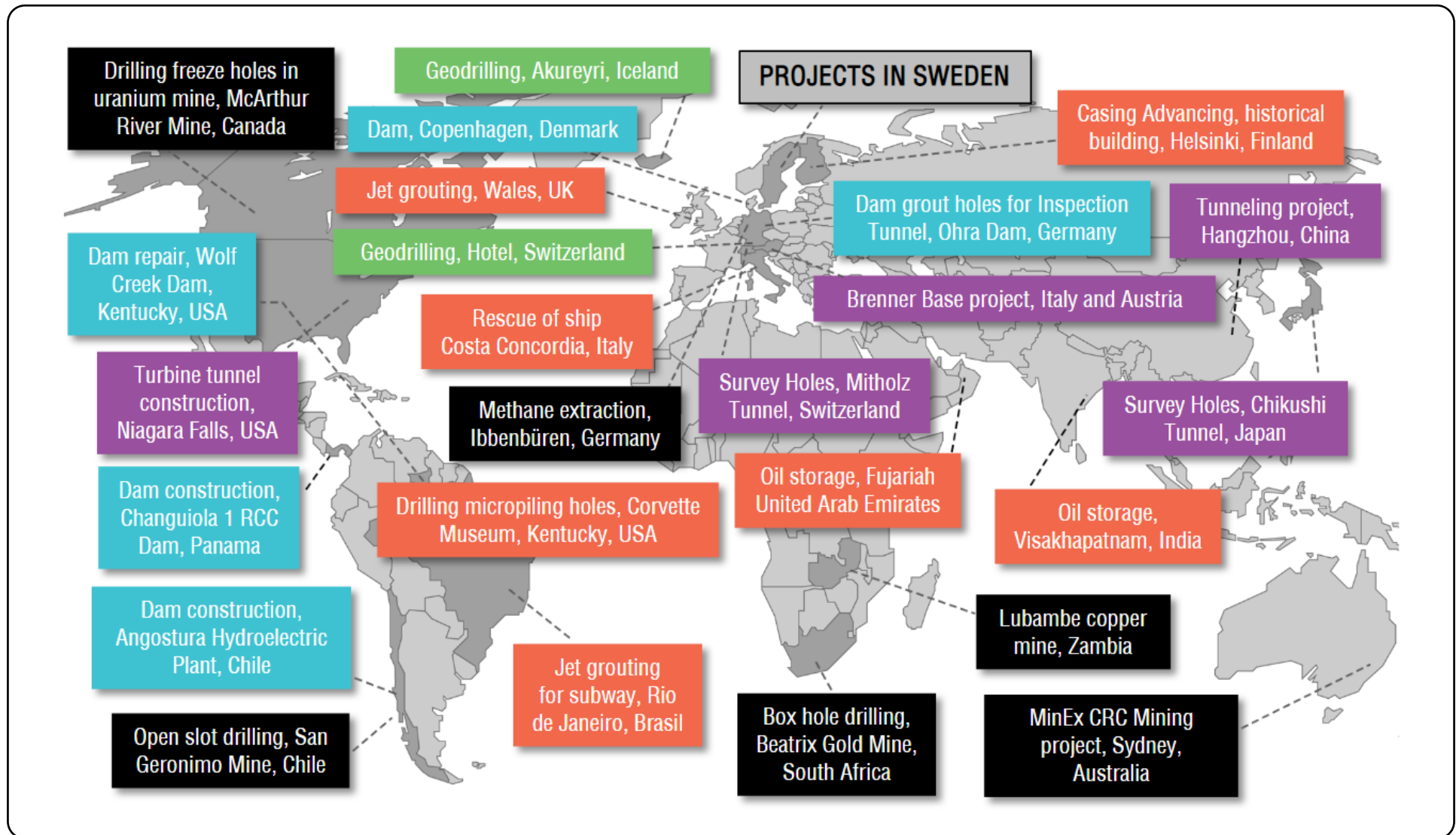
FEATURED ARTICLES
& PRODUCTS



We are very proud of our water-powered DTH hammer. Intense development work through the years has given an absolutely unique product where water is used to power a drill system. The water-powered drilling has numerous features and benefits, proven by over 20 million meters of boreholes in LKAB mines alone.

Johan Jeansson, R&D Manager, [LKAB Wassara](#)

OUR PRODUCTS ARE USED WORLDWIDE




WATER-POWERED DRILLING

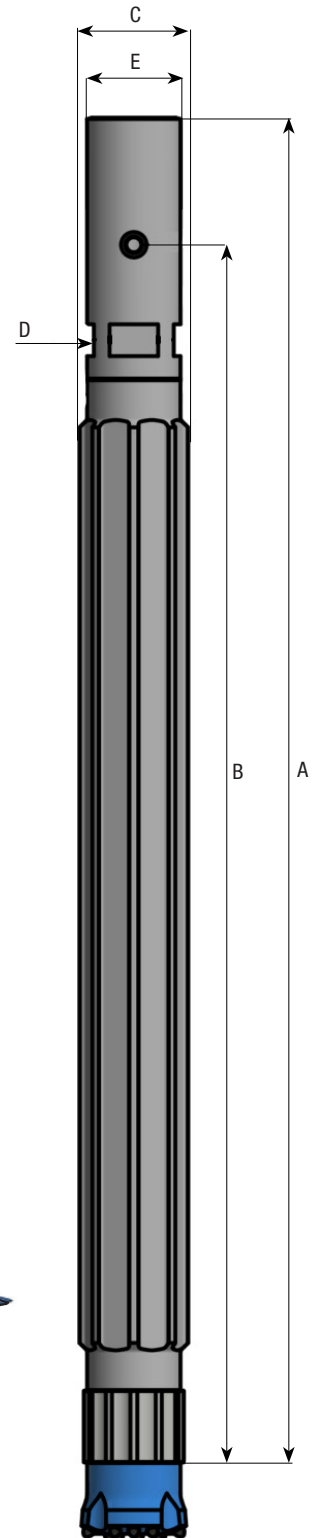


Wassara

TECHNICAL SPECIFICATION: W120.G3 HAMMER WITH JET-GROUT MONITOR

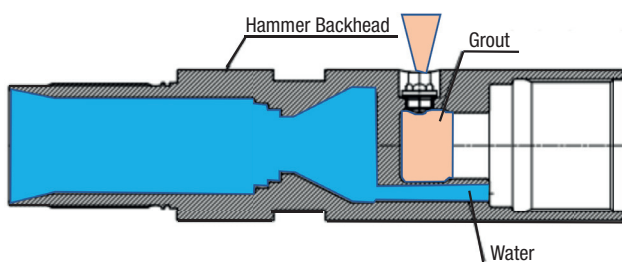
The combination of W120.G3 hammer and JG-Monitor offers excellent performance and will drill in basically all formations. For applications where the percussion from the hammer is essential for reaching good ROP this combination is the best set up for productive Jet-Grouting. The Monitor can be purchased as a complete product, W120.G3 hammer with mounted Monitor or as an add-on for an existing Wassara W120 hammer (to replace the standard back-head).

Technical specifications – W120.G3 with Jet-grout monitor	
Length A (over all)	1690 mm (66,5")
Length B (active)	1500 mm (59")
Diameter C	Ø 136 mm (5,4")
Size D 	100 mm x 40 mm (3,9" x 1,6")
Diameter E	Ø 117 mm (4,6")
Weight, Hammer + Monitor	111 kg (245 lb)
Weight Monitor	17,4 kg (38 lb)
Bit diameter	Ø 152 mm (6")
Nozzel size	Ø 2 mm up to Ø 8 mm (0,08" – 0,31")
Operating pressure interval	60-18 bar (870 – 2610 psi)
JG Pressure, max	400 bar (6090 psi)
Water consumption interval	240 – 500 l/min (63 – 132 USgpm) new to worn
Frequency at max operating pressure	54 Hz (3240 blows/min)
Feed force, formation dependent	12 000 – 24 000 Nm (1 100 – 2 210 ft-lb)
Rotation speed, formation dependent	45 75 rpm
Drill rod	Drill Tube Duplex, CRM Ø 114 mm, CRM thread
Bit shank	Wassara 350

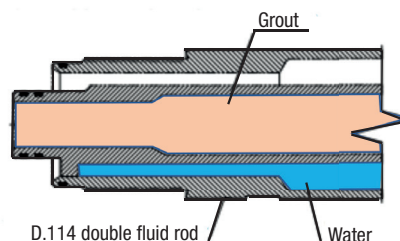


Principle function of Wassara JG-Monitor:

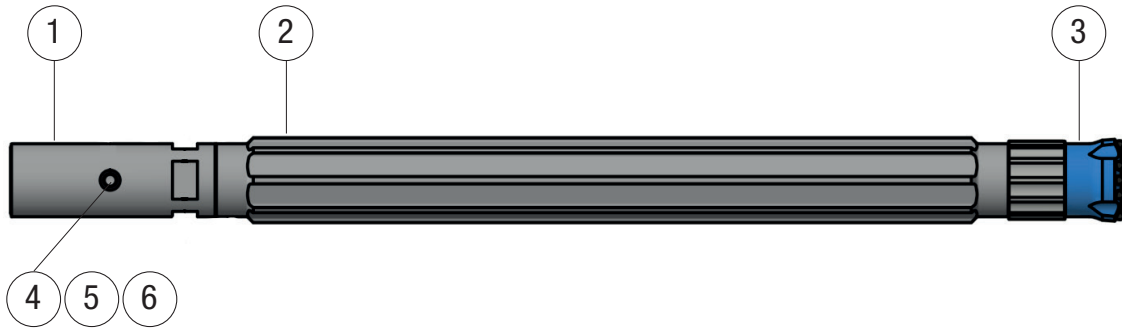
Wassara Jet-grout monitor



Duplex Jet-grout Drill rods



PARTS LIST: W120.G3 HAMMER WITH JET-GROUT MONITOR





Pos	Detail	Part no
1	JG-Monitor	1504133
2	W120.G3 with JG-Monitor	1504130
3	Drill bit 152 mm, W120 Convex, SB	3000061
4	Nozzle blind, M20 CRM	1003771
5	Grout Nozzle Copper Seal	1003731
6	Nozzle Wassara Monitor CRM	
	d = 3,0 mm	1002734-3,0
	d = 3,5 mm	1002734-3,5
	d = 4,0 mm	1002734-4,0
	d = 4,5 mm	1002734-4,5
	d = 5,0 mm	1002734-5,0
	d = 5,5 mm	1002734-5,5
	d = 6,0 mm	1002734-6,0
	d = 6,5 mm	1002734-6,5
	d = 7,0 mm	1002734-7,0
	W120.G3 Spare parts	Please see W120.G3 - Product Data Sheet

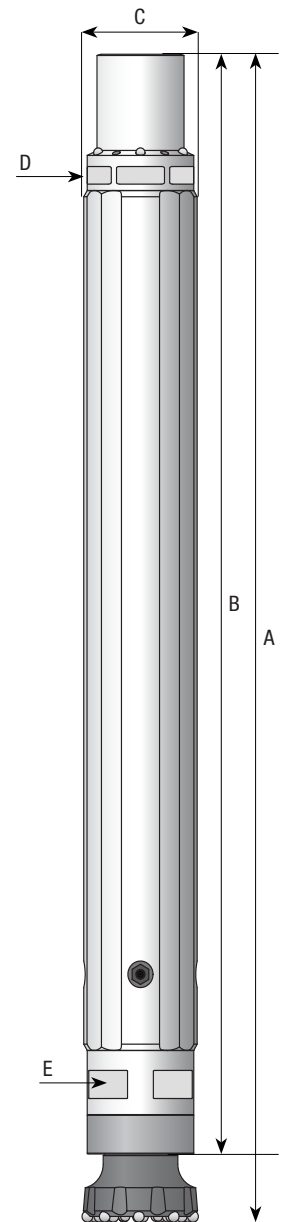
WATER-POWERED DRILLING

TECHNICAL SPECIFICATION: W100 JET GROUTING HAMMER

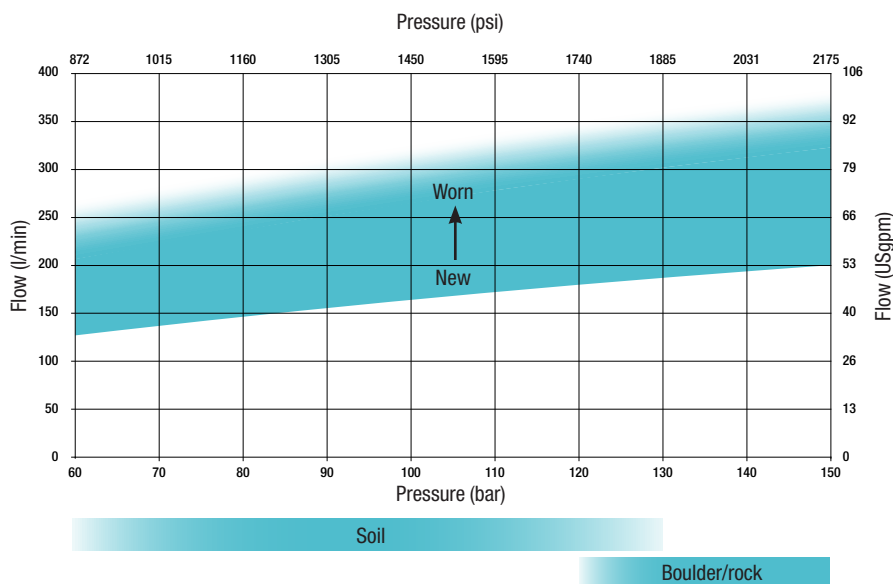
The combination of a down-the-hole hammer with an integrated jet monitor enables drilling and jet grouting in difficult formations. The innovative Wassara Jet Grouting Hammer provides a solution for single pass jet grouting with single fluid in most formations. Where boulder and other obstacles have made jet grouting complicated, the Wassara Jet Grouting Hammer makes it easier. This hammer features an integrated check valve in the backhead.



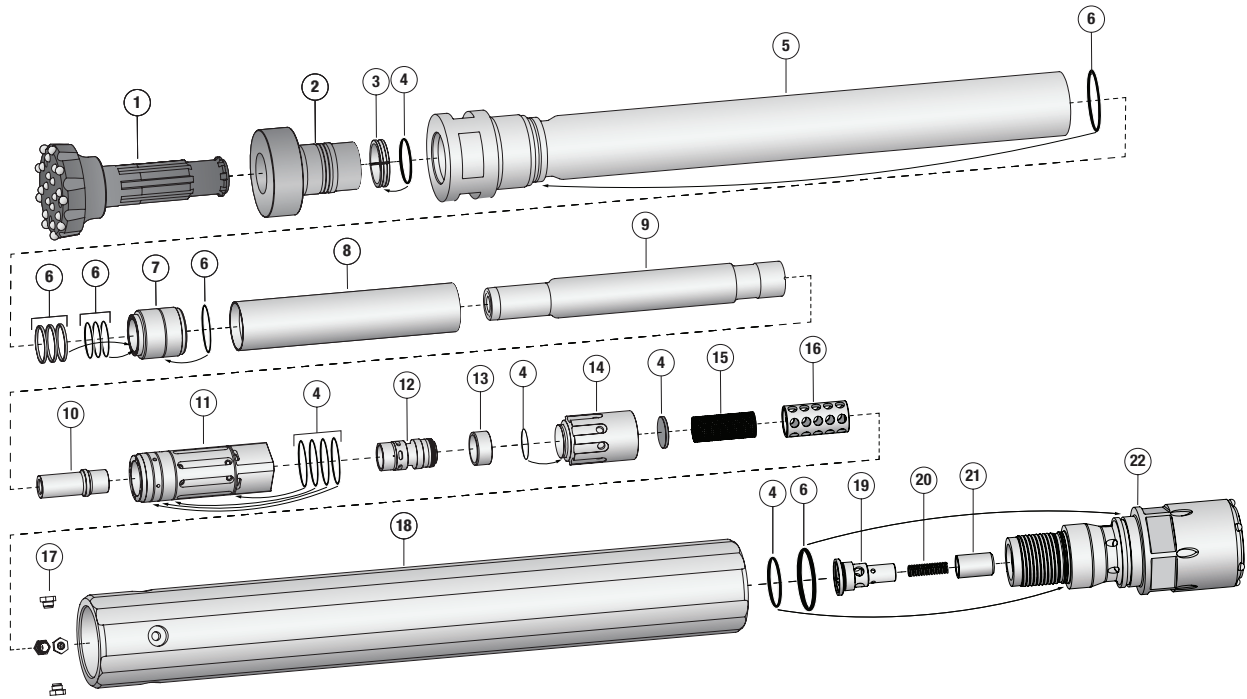
Technical specifications – W100 JG.430	
Length A	1 457 mm (57.4")
Length B	1 372 mm (54")
Diameter C	Ø 149 mm (5.7")
Size D 	125 x 44 mm (4.9 x 1.7")
Size E 	120 x 35 mm (4.7 x 1.4")
Weight (excl. drill bit)	140 kg (309 lbs)
Bit diameter	Ø 153 / 165 mm (6 / 6.5")
Operating pressure interval	60 - 150 bar (870 - 2 175 psi)
Water consumption interval	130 - 354 l/min (34 - 94 USgpm) new to worn
Frequency at maximum operating pressure	55 Hz (3 300 blows/min)
Feed force, formation dependant	5 000 - 20 000 N (2 000 - 4 500 lbf)
Rotation speed, formation dependant	40 - 70 rpm
Rotation torque, formation dependant	1 000 - 4 000 Nm (740 - 2 950 lbf-ft)
Drill pipe	W Drill rod Duplex Ø 114.3 mm (4½"), special JG-thread
Recommended water pump	WASP100D / WASP100E VSD, 360 l/min (95 USgpm) @ 200 bar (2 900 psi)
Grout	
Nozzle (4 sockets available)	3.0 - 7.0 mm (0.118 - 0.276")
Flow, max	550 l/min (145 USgpm)
Pressure, max	450 bar (6 526psi)



WATER PRESSURE/FLOW CHART



PARTS LIST: W100JG.430



Pos	Detail	Part no
	Jet Grouting Hammer W100JG, Ø 149 mm	1501437
1	Drill bit Ø 153 mm, Convex SB	3000194
	Drill bit Ø 165 mm, Flat SB	3000201
2	Chuck	1001105
3	Bit retainer	1002879
4	Seal kit	1,2 1003493
5	Hammer case	1501436
6	Seal kit grout	1002411
7	Piston bushing	1,2 1501115
8	Inner tube	1000129
9	Piston	1,2 1501124
10	Sliding case	0043007
11	Valve house	2 0013008
12	Valve	1000345
13	Sleeve	1000165
14	Guided lid	1000999
15	Filter	1,2 1500940
16	Filter support	1500939

Pos	Detail	Part no
17	Nozzle Ø 3.0 mm M20	1003212-3.0
	Nozzle Ø 3.5 mm M20	1003212-3.5
	Nozzle Ø 4.0 mm M20	1003212-4.0
	Nozzle Ø 4.5 mm M20	1003212-4.5
	Nozzle Ø 5.0 mm M20	1003212-5.0
	Nozzle Ø 5.5 mm M20	1003212-5.5
	Nozzle Ø 6.0 mm M20	1003212-6.0
	Nozzle Ø 6.5 mm M20	1003212-6.5
	Nozzle Ø 7.0 mm M20	1003212-7.0
	Nozzle blind M20	1003213
	18	Grout case
19	Check valve steering	1500936
20	Check valve spring	CV 1002139
21	Check valve shutter	CV 1000364
22	Backhead with check valve W100JG	1501439

<i>Spare part kit 1 JG</i>	1003126
<i>Spare part kit 2 JG</i>	1003127
<i>Spare part kit JG Check valve</i>	1003143



SUSTAINABLE DRILLING
Environmentally friendly and energy efficient

WASSARA EXPLORER™

STRAIGHT FORWARD SURVEYING

The Wassara Explorer™ is a durable rate gyro instrument for survey of boreholes in magnetically disturbed formations in all inclinations. It combines reliable performance, design simplicity and exceptional value for the customer. The following are some of the key benefits:

- High speed surveying in Continuous Mode
- Live survey data in Wireline Mode
- High positioning accuracy and survey repeatability
- Component and data redundancy
- High-rate capability of up to 2000 °/s
- Wireline or battery configurations
- 40mm / 25mm OD housings



This durable and versatile tool designed for demanding performance and environments, comes in different diameters, powering options and with a range of accessories. Well suited for different types of holes and drilling setups such as in-rod, RC (reverse circulation), open holes, blast holes etc.

Together with its user-friendly software, The Wassara Navigator™, designed with the needs and demands of the end user in mind. The easy and intuitive design, together with use of unique and patented technology make the Wassara Explorer™ the most attractive gyro system out there.

LKAB Wassara's special position in the mining world as developer, manufacturer and user of the sustainable and environmentally friendly water powered DTH hammers coupled with its in-house knowledge and expertise of drilling systems and surveying technology has been instrumental in the design and development of this surveying tool.

The Wassara Explorer™ performance has been independently verified and its modular design makes it a versatile as well as a very capable instrument.

Designed and manufactured in Sweden with a 5-years warranty!



The Wassara Explorer™ about to be pumped down for an OUT-run survey of an exploration hole in the Kiruna mine.



The Wassara Explorer™ (40mm version) with a pair of bow spring slip-on centralisers.



The Wassara Explorer™ (battery version) in a blast-hole fan survey configuration at Kiruna mine.



The Wassara Explorer™ being used to survey a near-vertical hole in a winch and wireline configuration.

1. Wassara Explorer™ - Accuracy	
Position	0.24 % (max 2.4m/1000m)
Inclination	± 0.1°
Azimuth	± 0.5°
Toolface	± 0.25°
Gravity Highside	± 0.25°
Repeatability	2 sigma
Rate Capability	± 2000 °/s

2. Wassara Explorer™ - Gyro Probe	
Diameter	40mm / 25mm
Length	700mm / 460mm
Type	Wireline / Battery (Live/Memory)
Technology	MEMS (Micro electro mechanical systems)
Power Consumption	1.2 W
Memory Size	8 GB
Communications	Serial RS-485 / PLC
Battery Type	Rechargeable NiMH
Battery Charge Lifetime	8 hours

3. Wassara Explorer™ - Useful data	
Computer	Algiz 10 Rugged Tablet PC (MIL-STD-810G)
Computer OS	Windows 10
Software	Wassara Navigator™ (For Surveying, QC, Reports)
Running Gear	Built-in 200 bar pressure rated
Control Unit	LKAB Wassara Survey Winch Controller MKII

We offer a warranty of 5 years on our Wassara Explorer™!

Key:

RC: reverse circulation

MEMS: micro electro mechanical systems

RS-485: recommended standard 485

PLC: power line communications

NiMH: nickel metal hydride

MIL-STD-810G: military standard 810g

QC: quality control

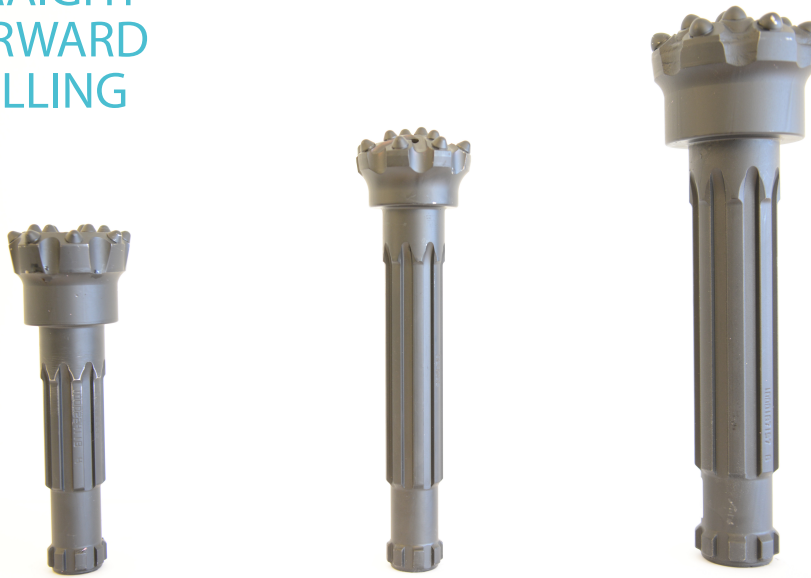
MKII: mark 2 (second series /version)



“When I joined LKAB straight from mining school, I believed that straight drilling and air DTH went hand in hand. I soon learned that there was a much better alternative available from Wassara. Today, drilling long and straight production blast holes is a requirement for the continuous improvement of our overall mining costs. And it’s with Wassara technology that we are achieving this...”

Monica Quinteiro, Production Manager [LKAB Kiruna mine, Sweden](#)

STRAIGHT FORWARD DRILLING



WASSARA DRILL BITS FOR OPTIMAL DRILLING

LKAB Wassara is offering drill bits optimized for water-powered drilling technology, built to ensure a long hammer life. Our drill bits cover our full range Hammer-sizes, as well as a unique and patented W-bit-design for our W70 Hammer.

Why choose a Wassara Drill Bit?

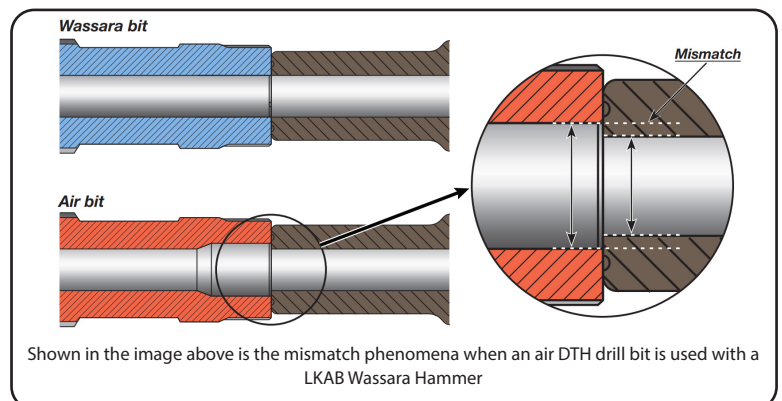
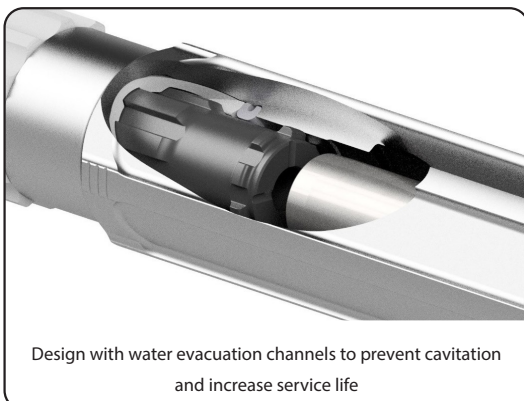
When drilling with a LKAB Wassara Hammer, it is important to use a drill bit that is designed specifically for water-powered DTH drilling.

A mismatch between the hole size in the Wassara Hammer piston and the hole size in, for example an air hammer bit, may cause substantial damage. Both the striking surface of the piston and the top of the bit shank might be affected by such a mismatch.

The LKAB Wassara drill bits also have multiple water evacuation channels incorporated in the design on top of the shank to prevent cavitation damages, which can occur while using an air DTH drill bit.

Wassara drill bit design features

- **Open front spacing** - Allows drill cuttings to evacuate gently and efficiently
- **Semi ballistic inserts** - High-quality inserts for effective drilling and clearing of drill cuttings
- **Matching striking surfaces** - Optimized matching of piston and drill bit
- **High quality steel** - Allows for a more sustainable drilling operation and longer service intervals



WATER-POWERED DRILLING

TECHNICAL SPECIFICATION: W-BIT FOR W70 HAMMER



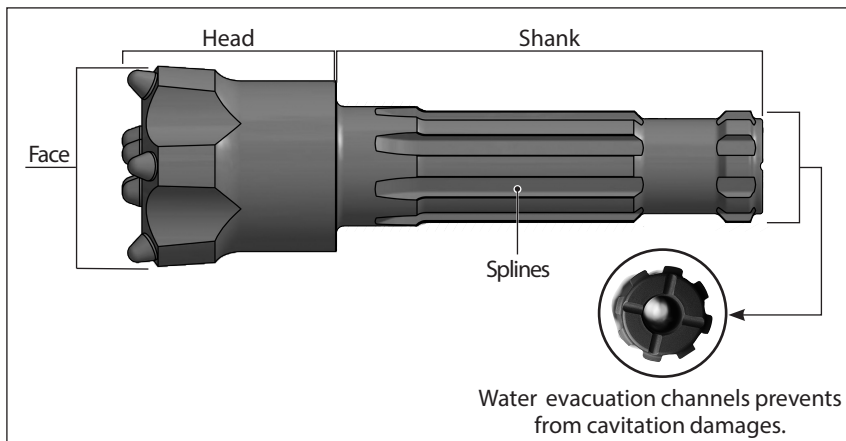
The Wassara W-bit is a unique and patented drill bit from LKAB Wassara, designed for water-powered drilling together with our W70 and W80 Hammer.

With roughly a 10 % higher efficiency of the shockwave transfer from Hammer to drill bit, the W-bit stands out as the optimal choice during water-powered drilling operations.

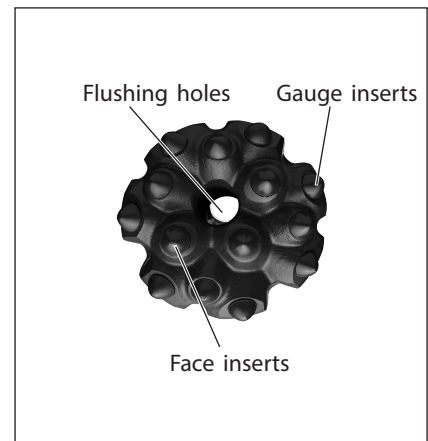
What enables this increased efficiency is a longer-than-average shank design, but with a weight similar to that of a standard bit.

The longer shank also gives a 43% larger spline area which increases the service intervals and the straightness of the boreholes.

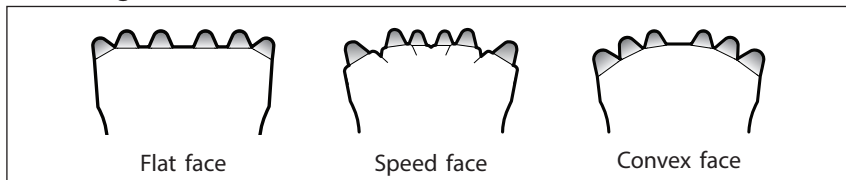
Bit design



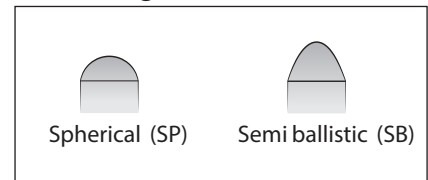
Head design



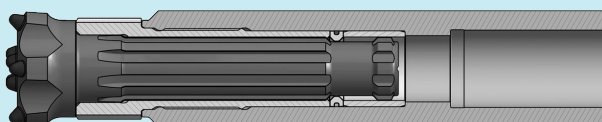
Face design



Insert design

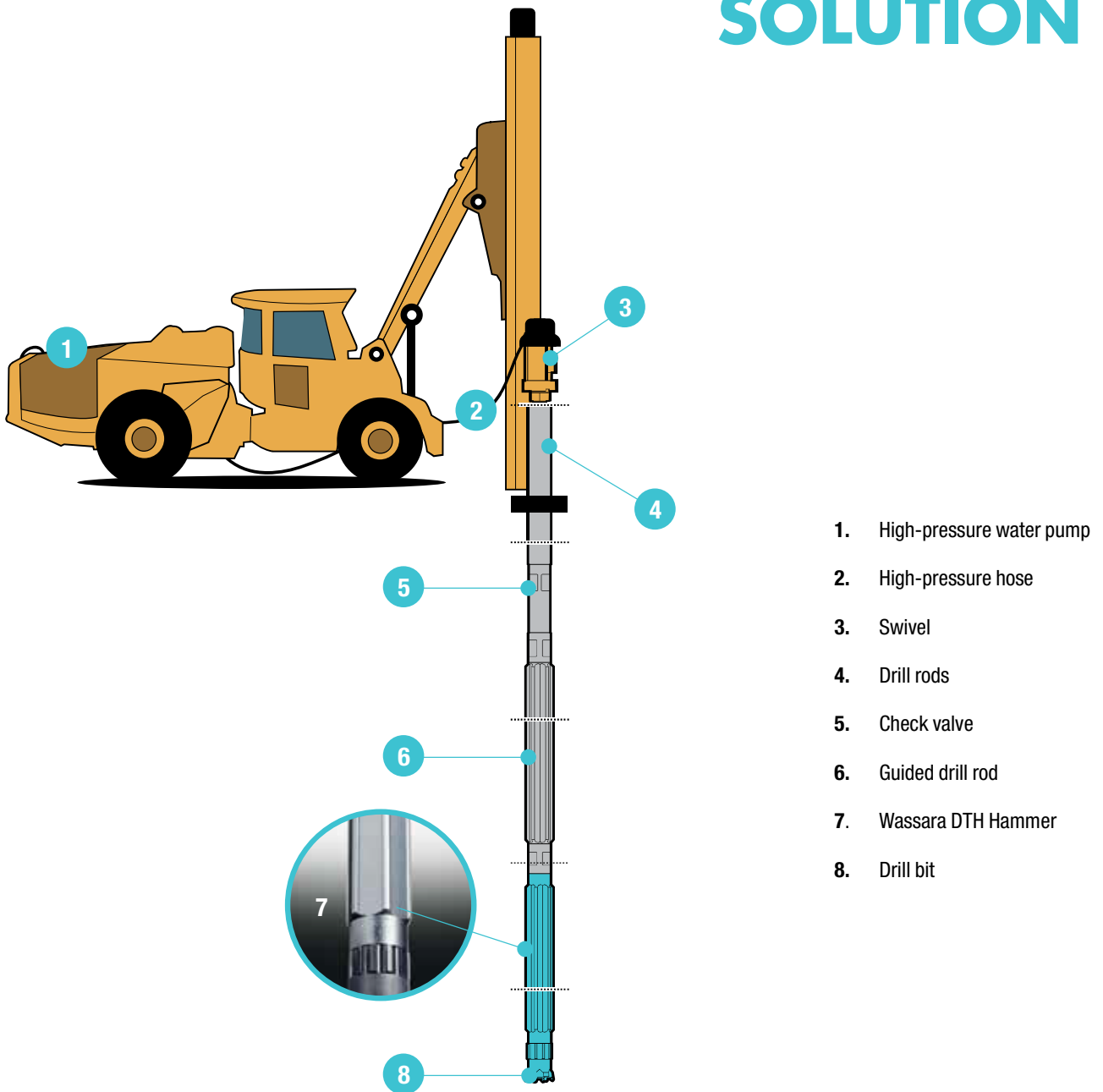


Wassara W-bit (currently available for W70 and W80)



The unique and patented W-bit incorporates a longer shank design, but with a similar weight as a standard bit. This gives a more efficient energy transfer, reduced spline wear and straighter boreholes.

THE WASSARA SOLUTION



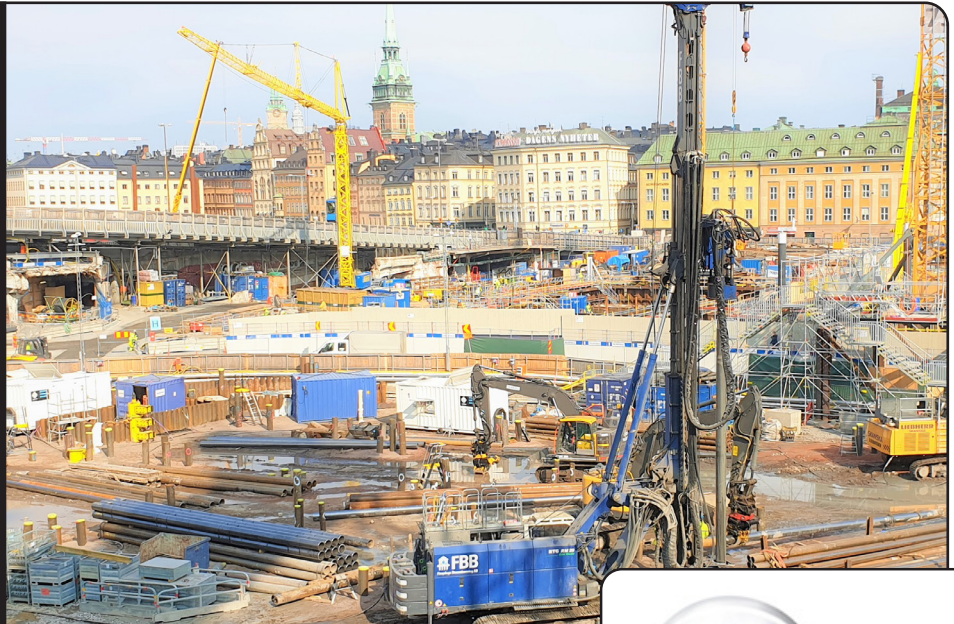
Hammer range

Hammer	Ø Drill bit	Water consumption	Max operating pressure
W50 (2")	60 mm, 64 mm (2 3/8", 2 1/2")	80-160 l/min (20-35 USgpm)	180 bar (2600 psi)
W70 (3")	82 mm, 89 mm (3 1/4", 3 1/2")	130-260 l/min (35-70 USgpm)	180 bar (2600 psi)
W80 (3.5")	95 mm, 102 mm (3 3/4")	130-260 l/min (35-70 USgpm)	180 bar (2600 psi)
W100 (4")	115 mm, 120 mm (4 1/2", 4 3/4")	225-350 l/min (60-95 USgpm)	180 bar (2600 psi)
W120 (5")	130 mm, 140 mm (5 1/8", 5 1/2")	300-450 l/min (80-120 USgpm)	180 bar (2600 psi)
W150 (6")	178 mm, 190 mm, 203 mm (6 1/2")	350-570 l/min (95-130 USgpm)	180 bar (2600 psi)
W200 (8")	216 mm, 254 mm (8 1/2", 10")	470-670 l/min (125-180 USgpm)	150 bar (2200 psi)



Wassara

**STRAIGHT
FORWARD
DRILLING**



WATER-POWERED DRILLING STRAIGHT TO SUSTAINABILITY

Minimizing the environmental impact and drill sustainably has become a key factor in modern Urban Ground Engineering. With water-driven Hammers and fuel-efficient Pumps, Wassara leads the way towards environmentally sustainable drilling operations.

High efficiency, low energy

Ground Engineering can become more environmentally friendly and sustainable by adopting and integrating innovative technology, social, environmental and economic developments that will minimize the environmental impact of drilling operations.

The amount of energy used is an effective unit to measure sustainable development, since the consumption is always available to be measured.

Since Wassara uses a pump instead of an compressor to power the hammer, the energy consumption is decreased by a factor 5. The large iron ore mining company LKAB makes annual saving of roughly 30 000 000 KWh, which corresponds to the annual energy production of 10 wind turbines.

The WASP gets it done

The WASP100D is an optimal pump for all types of drilling, ranging from deep holes to casing-advancement, anchoring, piling, exploration, water wells, geothermal, production blast holes, etc.

Its outstandingly mobility and low operating noise-levels makes the WASP well suited for drilling operations in sensitive urban areas.





In the city-center of Stockholm, the WASP100D is set-up for geothermal drilling underneath an apartment complex. Together with the Wassara Hammer W70, this set-up enables a drilling operation with low noise and low environmental impact.

Hammer and water

With only water both powering and lubricating the W70 Hammer, water-powered drilling is by default a sustainable option compared to other drilling technology. No oil-lubricants are released down the hole and since water is used to drive the drill cuttings out, no particles are jettisoned out of the hole through high-pressure air.

Since the Wassara technique itself uses water, it drills through water-rich formations without problems. The high penetration rate also provides very efficient and fast drilling through almost any material, from boulders and wood to dense clay and old foundations.

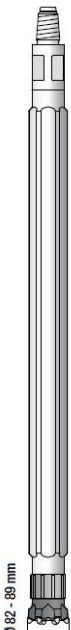
W70 Hammer

Hole size:
 \varnothing 82 / 89 mm (3.2 / 3.5")

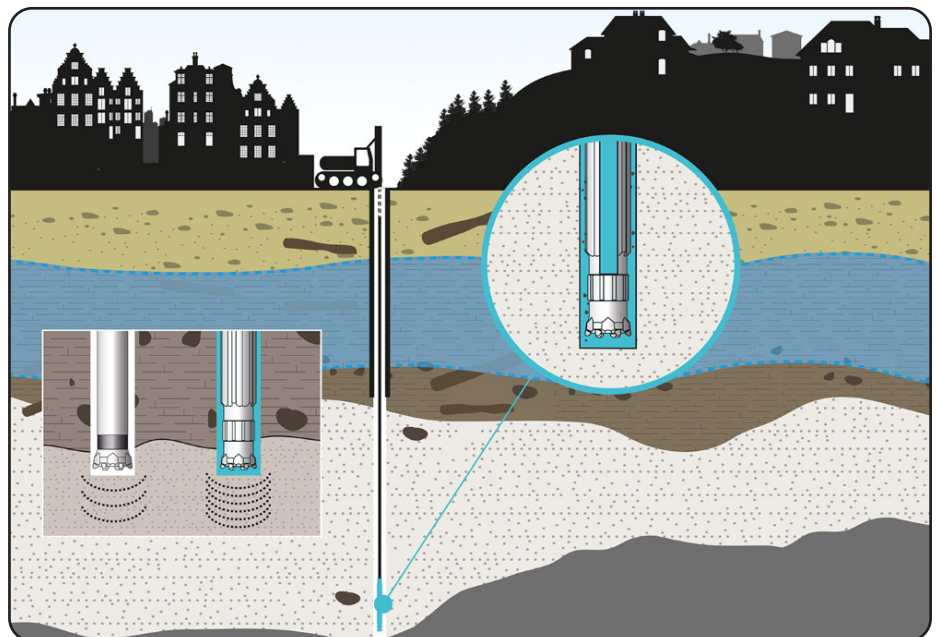
Water consumption:
 80 - 270 l/min (20 - 70 USgpm)

Max operating pressure:
 180 bar (2 610 psi)

Recommended pump:
 WASP100D /
 WASP100E



0 82 - 88 mm



The water-powered hammer is capable of penetrating almost any formation while maintaining speed and accuracy.



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SUSTAINABLE DRILLING

**Environmentally
friendly and energy
efficient**



LKAB WASSARA LAUNCHES NEW BOREHOLE SURVEYING SERVICE - AVAILABLE IN SCANDINAVIA AND FINLAND

The Wassara Borehole Surveying technologies, the gyro Wassara Explorer and its user-friendly software Wassara Navigator, has long been used in the LKAB mines for surveying services.

Since 2021, LKAB Wassara has been performing surveying services all over Scandinavia for external customers.

The technology

The Wassara Explorer™ is a durable and versatile tool designed for demanding performance and environments, comes in different diameters, powering options and with a range of accessories. Well suited for different types of holes and setups such as in-rods, RC (reverse circulation), open holes, blast holes etc.

Together with its user-friendly software, The Wassara Navigator™, designed with the needs and demands of the end user in mind. The easy and intuitive design, together with use of unique and patented technology and continuous survey mode, makes the Wassara Explorer™ the most attractive gyro system out there.

Our offer

The Wassara Surveying Team are available for on-site surveying projects all over Scandinavia and Finland, within short notice. A Surveying Technician will travel to your drill site with the Wassara Explorer and all its necessary accessories and perform the surveying of the boreholes of your choosing.

Documentation

After the completion of the Surveying operations, the Wassara Technician is able to provide the documentation and borehole measurements within 24 hours.

Contact

For more technical details and offers, please contact **Area Manager Johan Knöös**.

Telephone: +46 702 75 35 50

E-mail: johan.knoos.wassara@lkab.com



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WASSARA PUT TO THE TEST AT SLUSSEN, STOCKHOLM, SWEDEN

A busy traffic junction in central Stockholm, Sweden is under re-construction. The contractor carefully needed to choose the right drilling techniques. Wassara's newest and largest water-powered 12" hammer W280 was successfully tested in a pile-drilling application.

Background

The Slussen project is a large ongoing infrastructural project in the Stockholm city centre with Skanska as the main contractor. The aim of the project is to rejuvenate a busy junction for traffic and pedestrians that is slowly sinking because of out-of-date foundations.

During this project, the technique that is most frequently used for foundations is pile-drilling using the Wassara water-DTH solution. Amongst many different hammer sizes being used at the site (5"-8"), Skanska also tested the newly developed 12" Wassara hammer, the so-called W280.

The W280 hammer was used when bored pile retaining walls with 406 mm OD casing needed to be set up. During drilling in 2018, RD-pile retaining walls were produced for use as foundation. The piles were drilled down through overburden and then continued 0.5 m to 4 m into competent rock. The piles drilled in 2019 however, were meant for use as temporary support structures during the building of a new pier area.



W280 in action at Slussen, Stockholm, Sweden

Benefits of using the Wassara technology

The reason behind choosing Wassara for the project lay in the highly sensitive and water rich formation of Slussen. Moreover, the area around the project has historically been a busy junction for traffic and pedestrians and will continue to be used during the whole project, further emphasising the need for a gentle drilling method. Compared to air-DTH, when using Wassara's water-powered hammer there is no dust or cuttings contaminating the surrounding area and the risk for ground settlement is decreased.

Project size

During the first phase of drilling with the Wassara 12" hammer, 116 RD-piles (RD 406) were drilled down to depths varying between 6 and 16 m. In total, 1 w000 m were drilled.

During the second phase, 72 piles were drilled to a depth of approximately 14 m.

The hammer delivered a total of 2 000 m of drilling without needing service.

Water source and handling

The water source used for drilling was fresh water taken from lake Mälaren with a high-pressure pump passing it through a filter in order to remove algae and larger particles. When drilling in rock around 1 000 l/min were used.

The amount of upcoming water was not substantial therefore a water handling solution was not required.

Drill rig and pump

A Liebherr rig was used during both drilling phases. In order to ensure enough water capacity for the hammers, the contractor used either a grout pump rated at 1 400 l/min or two WASP200 pumps used in parallel to deliver the same flow rate.

Test results

The Wassara W280 hammer performed according to the goals set beforehand. Even after 2 000 m of drilling, judging by its performance and water consumption, the hammer did not exhibit excessive wear. Measurements to that effect made on critical performance parts, found them to be well within tolerance. A successful test!



Drilling with Wassaras water-powered hammer gives a nice and clean work environment



No water handling solution was required

Used equipment	
DTH hammer	W280
Pump	2 x WASP200 pumps
Rig	Liebherr
Drilling fluid	Fresh water from lake Mälaren
Drill rod	273 x 12,5 mm (11") Thread API 6 5/8 Reg
Casing	406 mm OD
Borehole length	6 -16 m
Scope of drilling	2 000 m
Formation	Construction aggregate, esker, oak piles and competent rock
Project time	August 2019



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BRENNER BASE – JET-GROUTING FOR TUNNEL BETWEEN AUSTRIA AND ITALY

The Brenner Base Tunnel is one of Europe's most comprehensive and important infrastructure projects in modern time. LKAB Wassara's W120 water-powered hammer played a decisive role in the making of the tunnels going under the river Isarco, near Fortezza in Italy.

Background

The Brenner Base Tunnel (BBT) is the main segment of a new railway line that will connect Munich with Verona. BBT runs between Innsbruck and Fortezza. The new tunnel will lead to an improvement for, above all, the truck traffic through the so-called Brenner Pass. The two-tube tunnel system will be 55 km long, making it the longest underground railway stretch in the world

Stabilization of the ground

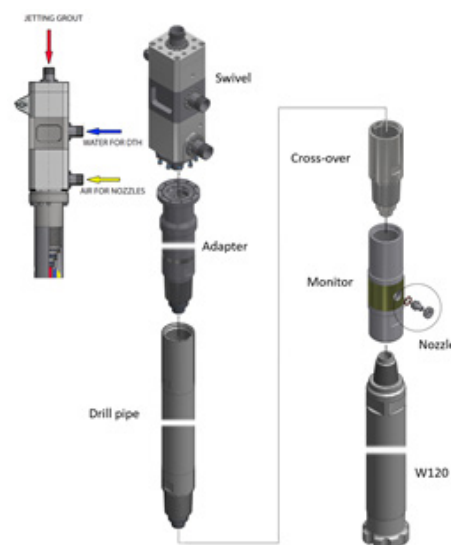
The excavation of the tunnel started from 4 shafts on the riverbanks, two on each side (see the main picture above). Before the excavation of the shafts could start ground improvement by jet-grouting was needed. The jet-grouting was to be performed both to stabilize and to seal of the water in the shaft, as well as improving the ground from the surface before excavating the tunnels.



Brenner Base Tunnel location

Columns were made with the Wassara W120 hammer

The columns were made up to 40m in one single pass. LKAB Wassara's W120 water-powered hammer with a Ø152mm drill bit was used for this. Above the W120 hammer a monitor was mounted. The monitor worked both as a nozzle holder for the Jet-grouting and a flow diverter that diverts water from the water channel in the drill pipe to the hammer. The monitor is of a double flow type where compressed air is used to improve the performance of the jet-grouting. The water, air, and jet grout are supplied through a 127 mm triple wall drill tube securing that the fluids are not mixed.



PREFERRED SOLUTION - Water-powered drilling

Rotary-Drilling - Rotary drilling is normally used when jet-grouting, but was discarded due to the complicated soil conditions with frequent boulders and large blocks. Water-Power drilling solved the problem of drilling through the block and boulders.

Air DTH technology - In a comparing test in the beginning of the project, Wassara's water-powered hammer outperformed a pneumatic DTH hammer, drilling more than double as fast as the pneumatic hammer.

A 36-meter deep hole was drilled with the two different techniques. The Wassara hammer drilled the 36 meters in 40 minutes and the pneumatic DTH hammer used 1 ½ hour for the same depth. Each rig could now produce 7-8 columns per day during 24-hour operation. The low performance of the air hammer was most likely caused by the high water-table.

“The Wassara DTH technology outperformed other alternative methods.”

Magnus Hörman, Senior Engineer, LKAB Wassara.

Special thanks to:

Antonio Celot /Project Manager at Webuild and Valerio Salvi, Research & Development, CRM



Left: W120 Hammer and monitor, Middle: Monitor and triple fluid rods, Right: Solimec SM 28 in action

Equipment used	
DTH Hammer	W120, with integrated check valve
Water Pump	Electric 400 L/min, 180 Bar, PTC
Drilling fluid	Clean water
Rig	SM 28, Soilmecc
Drill rods	Triple fluid 127 mm, CRM
Drill bit	Ø 152 mm
Monitor	Double fluid air/grout, CRM
Swivel	Grout-Water-Air, CRM
Total meters drilled/grouted	250 000 m
Borehole length	Up to 40 m
Formation	Loose deposits, gravel, rounded sand, boulders and large granite blocks
Project year/time	2018 and ongoing (per March 2022)



Wassara – cost-efficient and environmentally-friendly drilling

LKAB Wassara is a Swedish company developing and manufacturing unique water-powered drilling systems for high performance in surface as well as underground drilling operations. The heart of the Wassara drilling system is the world patented water-powered down-the-hole hammer.

Wassara's drilling systems have been used for more than 25 years in various applications within many industries; mining, exploration, ground engineering, dams, geothermal, marine, oil & gas storage. Our experience covers more than 25 million metres drilled in different locations around the world. Reference studies can be found on our website.

LKAB Wassara was founded in 1988 and is owned by LKAB. LKAB is an international high-tech minerals group that produces iron ore products for the steel industry and other mineral products for many other industries and applications.

Explore more at www.wassara.com