Appendix C02 – Background information

Applicable to the European public procurement procedure for the design, delivery and deployment of 4 borehole monitoring strings

Contents

C02 - 1 Middenmeer Geothermie

The Middenmeer geothermal project is located in the northwest of the Netherlands. The project targets the Slochteren Sandstone Member of the Permian Rotliengend Group. The top reservoir depth lies at 2100 – 2300 m depth (Figure 1), and the reservoir temperature is up to 92 °C. The project consists of four doublets. The well of interest for the deep tool string in this tender document is MDM-GT-03-S2, the former injector of Doublet 2 (Figure 1).

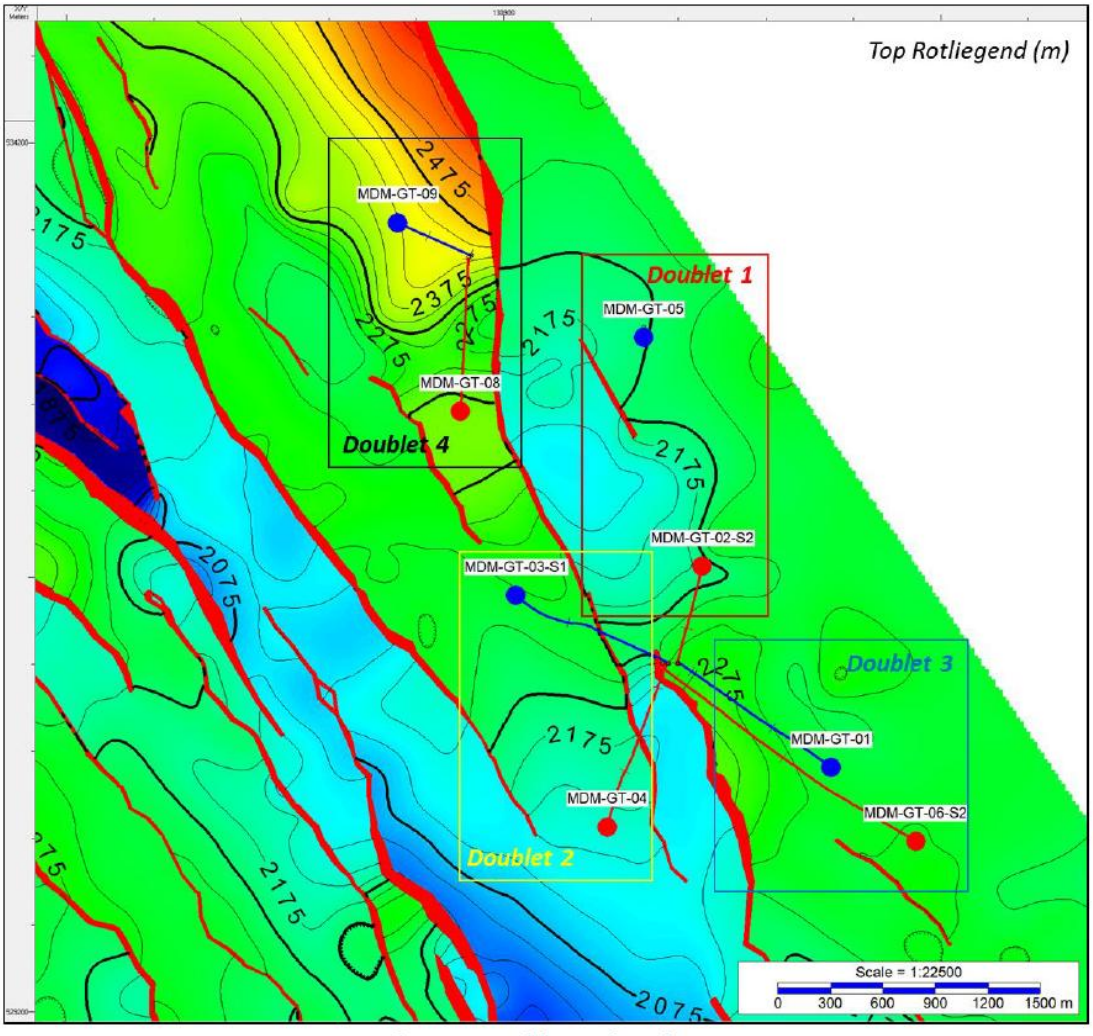

Figure 1 Top view of the Middenmeer geothermal project. Colors indicate top depth of the reservoir. Blue wells: injection wells, red wells: production wells. (ECW Geo Holding BV, 2021).

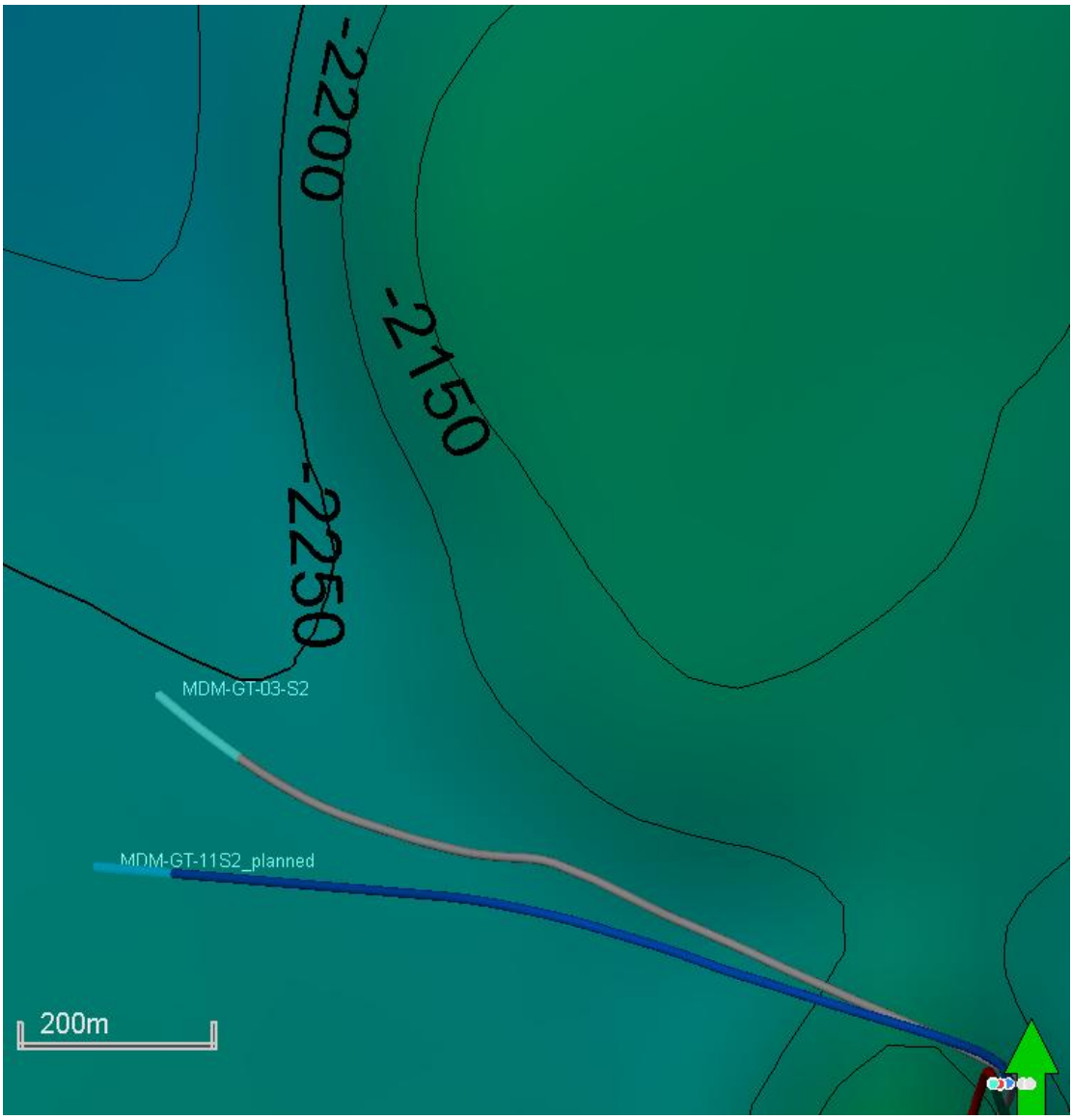

Figure 2 Close up of well MDM-GT-03-S2 and planned MDM-GT-11-S2 cutting through the top Slochteren.

Table 1 Coordinates and depth of MDM-GT-03-S2. Coordinates in Rijksdriehoek New.

Information MDM-GT-03-S2		
X-coordinate wellhead	m	131846.05
Y-coordinate wellhead	m	5312014.6
X-coordinate at final depth	m	130970.7
Y-coordinate at final depth	m	531595.8
Final depth (along-hole)	m	2708
Final depth (true vertical)	m	2449

The MDM-GT-03-S2 well was spudded on 09 – 11 – 2013 and completed on 08 – 05 – 2014. It was drilled to a true vertical depth of 2449 m through the reservoir formation of the Slochteren Sandstone Member into the Ruurlo Formation. MDM-GT-03-S2 has been re-injecting the geothermal brine produced by MDM-GT-04 until the end of 2024. In 2024 new wells MDM-GT-11 and MDM-GT-07 were drilled to replace respectively MDM-GT-03-S2 and MDM-GT-04. The new wells have an improved well design. The two new wells were drilled subparallel to MDM-GT-03-S2 and MDM-GT-04, at a distance of ~150 m at the reservoir level. This leaves the MDM-GT-03-S2 and MDM-GT-04 in a suspended state; MDM-GT-03-S2 is to be instrumented with a deep geophone tool string. The aim is to record potential microseismicity related to injection in the new wells MDM-GT-11/07 and, if possible, record pressure and temperature changes related to injection in MDM-GT-11.

C02 – 1.1 Well completion diagram and abandonment situation

The MDM-GT-03-S2 well contains various casing and liner sections (Figure 3). The lowermost part in the reservoir consists of a 5 ½" liner with wire-wrapped screens (WWS). This liner is not cemented. The liners above the reservoir are cemented.

The operator will prepare the 5 1/2" liner for abandonment, which will be addressed after shut-in of the well and prior to installation of any monitoring equipment. The exact abandonment scenario is under investigation by the operator. One scenario is that squeeze cement will be injected behind the 5 ½" liner in the section 2124 m AH – 2453 m AH, and a (retrievable) plug will be set around 2429 m AH, isolating the reservoir section (Figure 4). The envisioned scenarios for monitoring take into account this abandonment scenario. Further questions regarding the status of the abandonment can be asked during the tender procedure.

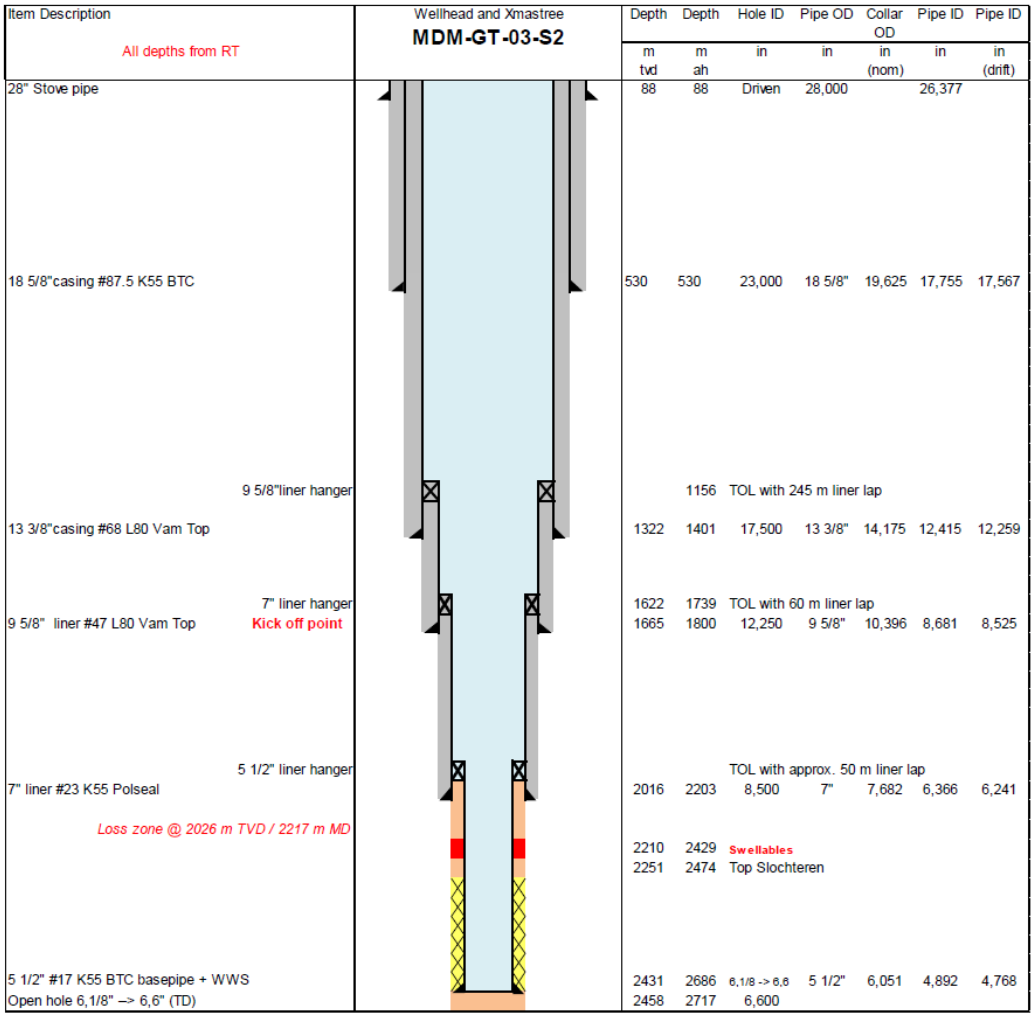

Figure 3 Well completion diagram of MDM-GT-03-S2 (End of Well Report, 2014)

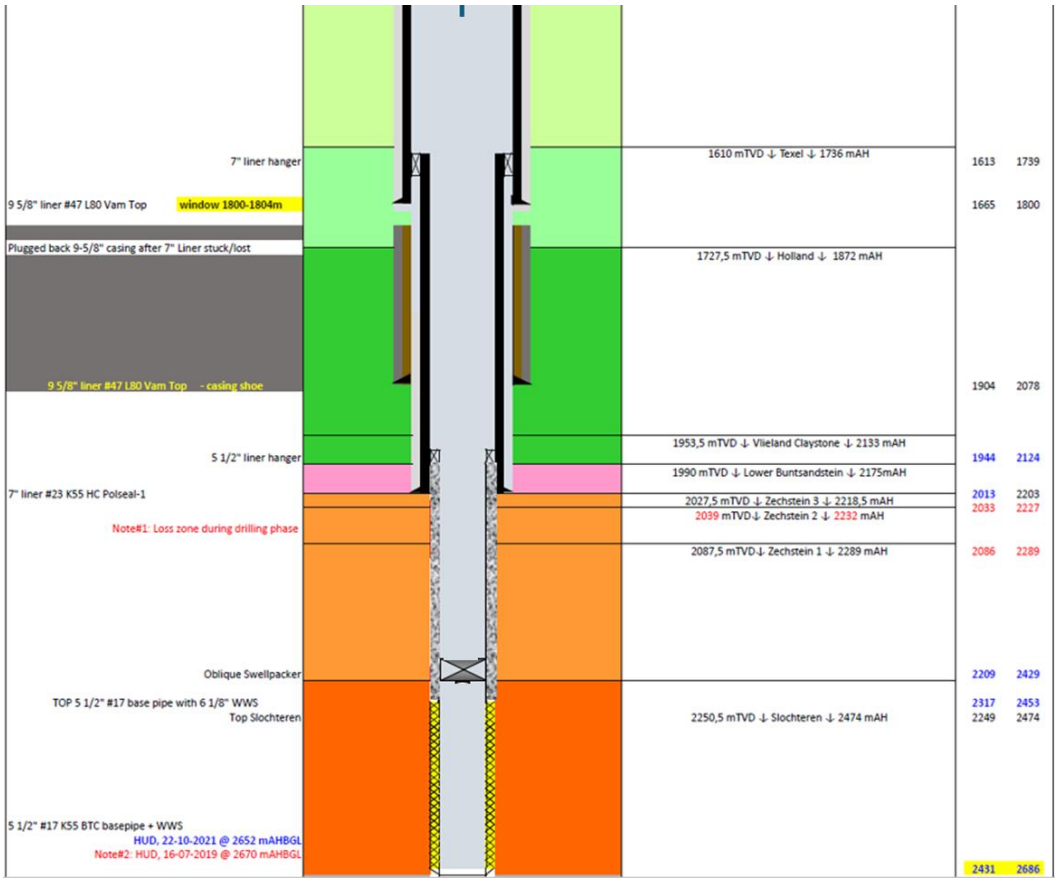

Figure 4 Possible abandonment scenario MDM-GT-03-S2.

C02 – 1.2 MDM-GT-03-S2 Tool string set-up

In the Base Request a tool string with 5 geophones at depths of 200, 1500, 2100, 2250, and 2350 m along-hole depth is requested (Figure 5). In the following sections the various Extensions are illustrated.

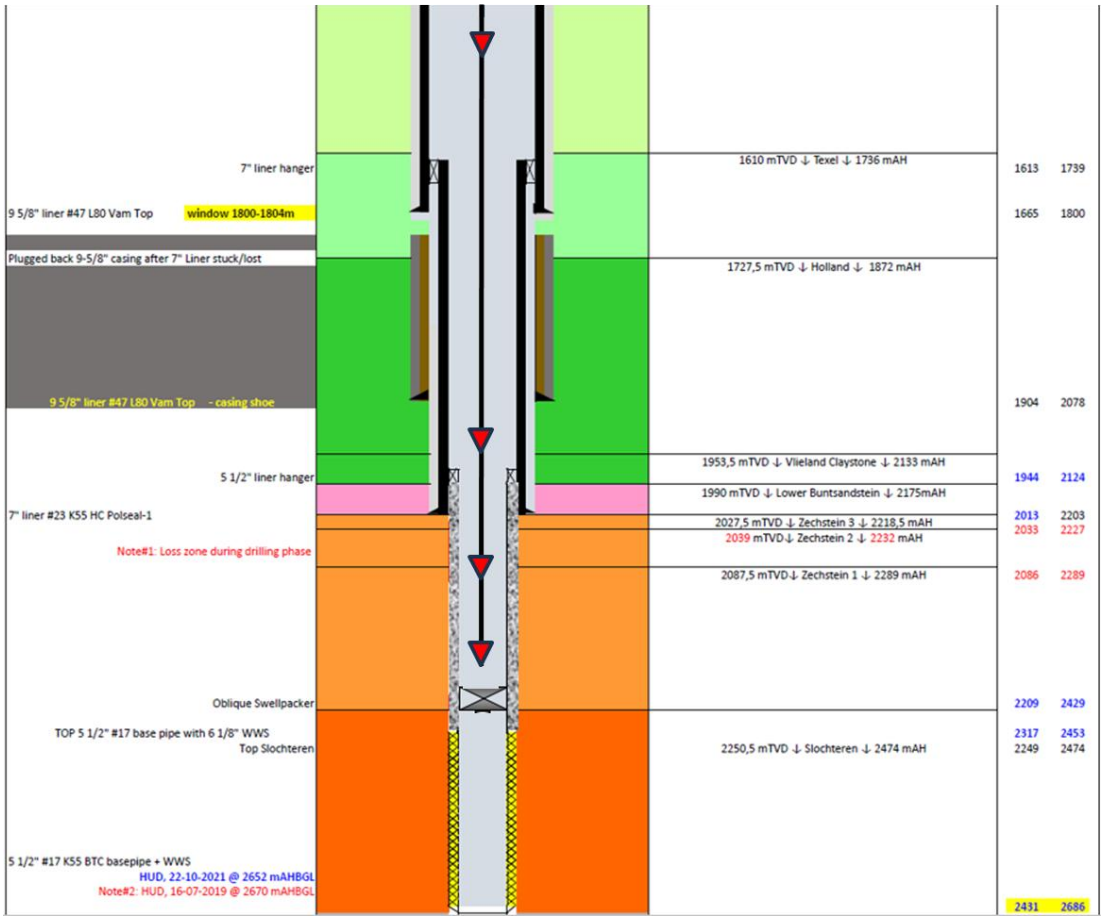

Figure 5 Tool String 1A schematic design. Red triangles: geophones.

Extension 1 (Tool string 1B)

Extension 1 (Tool string 1B) is intended for monitoring of pressure and temperature in the reservoir interval. The reservoir interval needs to be isolated with a plug/packer; therefore Extension 1 contains a request for both a retrievable plug and a pressure and temperature gauge below the plug. The pressure and temperature gauge should be within the reservoir, preferably in the middle of the reservoir. The plug can be installed before the tool string or be a part of the tool string.

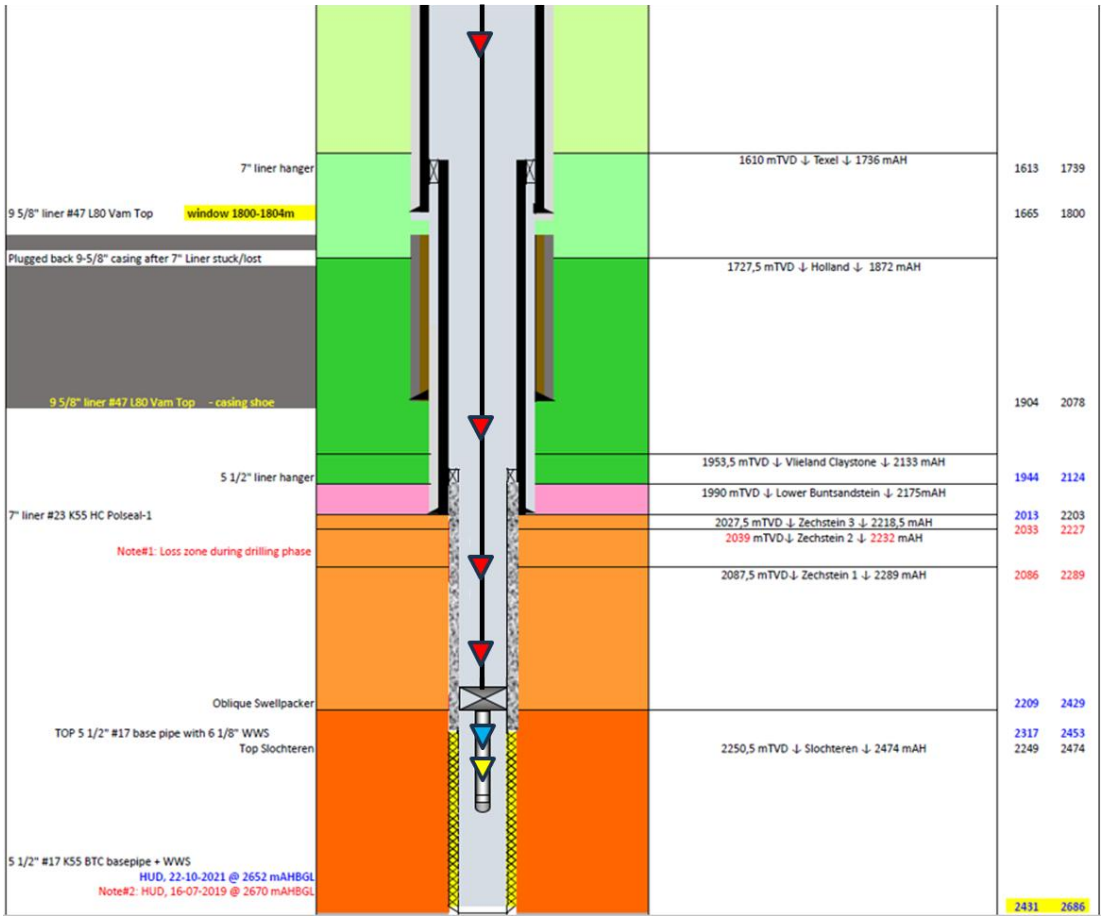

Figure 6 Tool String 1B (Extension 1) schematic design. Red triangles: geophones, blue/yellow triangles: pressure and temperature gauge.

Extension 2 (Tool string 1C)

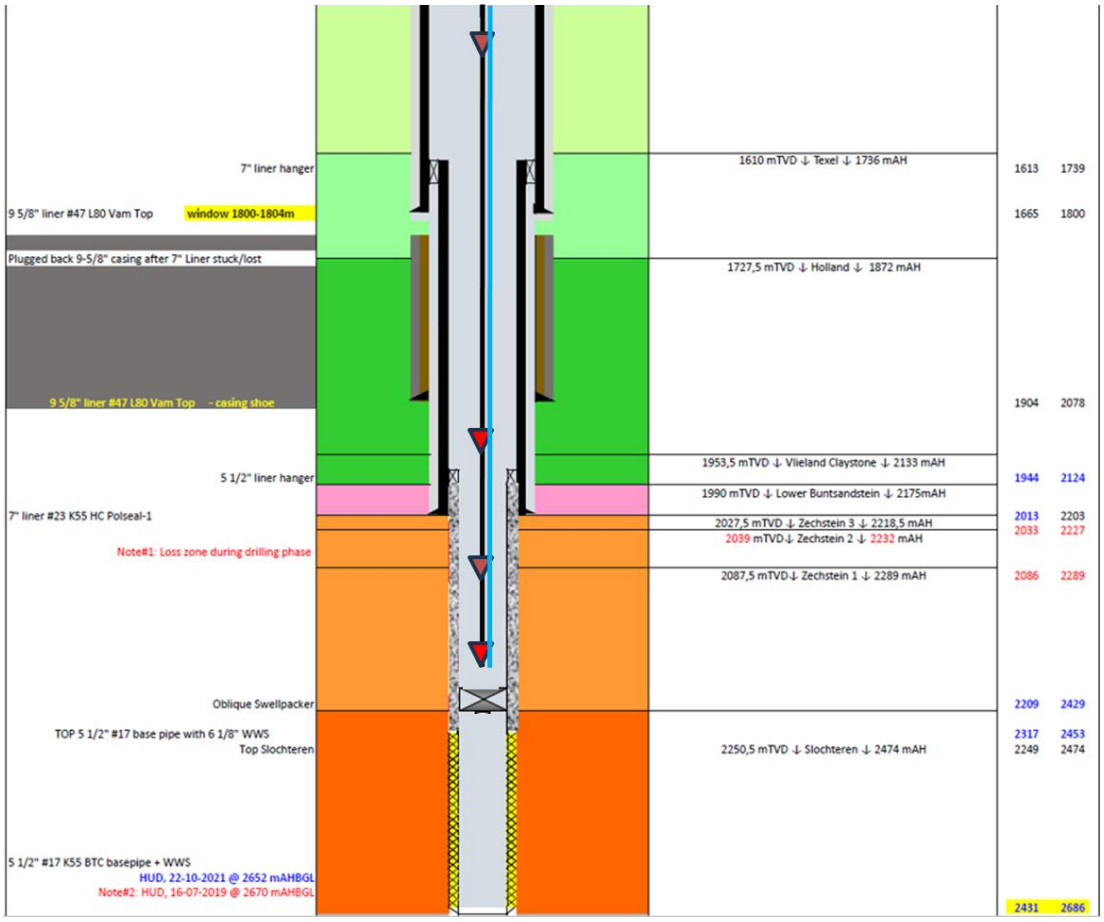

Figure 7 Tool String 1C (Extension 2) schematic design. Red triangles: geophones of Base Request (Tool string 1A), blue line: DAS/DTS cable.

C02 – 1.3 Further information on MDM-GT-03-S2

In this section more information is provided on the well geometry, wells material, fluids and pressures and temperatures. These are important boundary conditions for the difference requested scenarios.

Lithostratigraphy

Lithostratigraphic Column Middenmeer J.Smeulders							MDM-GT-03-S2	
Era	Group	Period	Formation	Epoch (Age)	Member	Lithology definition	TV-RT	AH-RT
Cenozoic	Upper North Sea NU	Quaternary	"Diverse"	Holocene-Pleistocene		Diverse continental deposits, mostly fluvial sands and silts intercalated by some thin layers of grey or greenish-grey, silty clays.	0	0
			Maassluis NUMS	Early Pleistocene		Deposits of coastal sands, very fine to medium coarse, calcareous, shell and wood bearing, mica rich. Silty to sandy, grey to dark grey clay containing shells and mica.	290	290
		Tertiary	Oosterhout NUOT	Pliocene		Succession of sands, sandy clays, and grey and greenish clays. The lower part of the formation often consists of sands that are extremely rich in shells and bryozoans.	505	505
			Breda NUBA	Miocene		Sequence of marine, glauconitic sands, sandy clays and clays. In places a glauconite-rich layer occurs at the base.	690	690
	Middle North Sea NM		Rupel NMRF	Oligocene (Rupelian - Early Chattian)	Rupel Clay NMRFC	Clays that become more silty towards basis and top. It is rich in pyrite, contains hardly any glauconite and calcium carbonate tends to be concentrated in the septaria layers.	811	815
				Eocene -Oligocene (Priabonian - Rupelian)	Vessem NMRFV	Silty to clayey sands with a low glauconite content, flint pebbles or phosphorite nodules commonly occur at the base.	833	840
	Lower North Sea NL		Dongen NLFF	Middle - Late Eocene (Lutetian to Bartonian)	Asse NLFFB	Dark greenish-grey and blue-grey, plastic clays. The unit locally shows indications of bioturbation, and may be glauconitic and somewhat micaceous.	838	845
				Early to Middle Eocene (Ypresian to Lutetian)	Brussels Sand NLFFS	Succession of green-grey, glauconitic, very fine-grained sand with, mainly in the upper part, a number of hard, calcareous sandstone layers. Towards the base of the unit the clay content increases, and the calcium carbonate content and amount of glauconite decreases.	901	915
				Early Eocene (Ypresian)	Ieper NLFFI	A soft, tough and sticky to hardened and friable clay. The lower part is characterised by its brown-grey colour, tending to beige or red-brown locally. The upper two-thirds have a green-grey colour. It has a sandy upper part.	949	970
					Basal Dongen Tuffite NLFFT	Tuffaceous clays, blue to violet-grey in colour, alternating with dark-grey and red-brown clays.	1167	1220
			Landen NLLF	Late Paleocene (Thanetian)	Landen Clay NLLFC	Generally dark-green, hard, flaky clay, somewhat silty, containing glauconite, pyrite and mica. The basal part of the member can be marly and of a lighter colour.	1180	1235
Mesozoic	Chalk CK	Cretaceous	Ommelanden CKGR	Upper Cretaceous (Turonian to Maastrichtian)		Succession of white, yellowish-white or light-grey, fine grained limestones, in places argillaceous. Layers of chert nodules can be very common over thick intervals. Along the basin edge coarse, bioclastic limestones and tongues of sandstone occur.	1224	1286
			Texel CKTX	(Cenomanian)	Plenus Marl CKTXP	Dark-grey, partly black, calcareous, laminated claystone. Its thickness generally does not exceed a couple of metres.	1610	1736
					Texel Marlstone CKTXM	White to light-grey (locally pinkish) limestones, marls and marly chalks.	1614	1740
	Rijnland KN		Holland KNGL	Lower Cretaceous (Late Albian)	Upper Holland Marl KNGLU	Light-grey and red-brown marls, characterised by a carbonate content which gradually increases towards the top.	1728	1872,5
					Middle Holland Claystone KNGLM	Grey and/or red-brown calcareous shaly claystone with a distinctly lower lime content than the under- and overlying members.	1942	2120
			Vlieland Claystone KNNC			Dark brownish-grey to grey claystone. Mica and very fine lignitic matter are common. Generally, the claystones are only very slightly calcareous.	1965,5	2147
	Lower Germanic Trias RB	Triassic	Lower Buntsandstein RBSH	Latest Permian - Early Triassic	Main Claystone RBSHM	The member consists of a succession of red-brown to green silty, sometimes anhydritic claystones. Some thin sandstone beds and oolitic beds also occur. The base is characterized by a, generally thin, sandstone bed which overlies the Zechstein fines.	1990	2175
Paleozoic	Zechstein ZE	Permian	Zechstein Upper Claystone ZEUC	Upper Permian (Thuringian)		The formation is composed of red-brown to pale brown, occasionally grey-green claystones with some anhydrite and/or carbonate stringers. In the upper part thin, well-cemented, sandy beds may occur.	2003	2190
			Zechstein 3 (Leine) ZEZ4		Z3 Carbonate ZEZ3C	'Plattendolomit'. A brownish, slightly argillaceous, dolomitic limestone or coarse-crystalline dolomite.	2027,5	2219
					Grey Salt Clay ZEZ3G	A grey claystone with a high gamma-ray response and corresponding low velocities on the sonic log.	2036	2229
			Zechstein 2 (Stassfurt) ZEZ2		Z2 Basal Anhydrite ZEZ2A	A massive body of relatively pure anhydrite.	2039	2232
					Z2 Carbonate ZEZ2C	"Stinkschiefer', a thin, finely laminated, argillaceous, black and often bituminous limestone. It's charact. by an increasing amount of clay towards the top.	2039	2232
					Red-Brown Salt Clay ZEZ2R	A red to red-brown, finely laminatedbed with a high gamma-ray reading.	2084	2285
			Zechstein 1 (Werra) ZEZ1		Z1 Anhydrite ZEZ1W	A massive anhydrite body which attains a huge thickness in the sub-basins. Dolomite stringers occur frequently within the unit.	2088	2289
					Z1 Lower Claystone ZEZ1G	A grey to brown claystone or marl, in places dolomitic or anhydritic.	2242	2465
					Coppershale ZEZ1K	A microlaminated, brownish-black bituminous shale with a thickness of 0,5 to 1 m. It is characterized on wire-line logs by high gamma-ray and low acoustic velocity readings.	2249	2472
	Upper Rotliegend RO		Slochteren ROSL	Lower Permian (Saxonian)		Sequence of usually pink to pale red-brown, occasionally yellow or grey, sandstones with subordinate amounts of intercalated dark red, red-brown or green-grey silty claystones.	2250,5	2474
	Limburg DC	Carboni-ferous	Ruurlo DCOR	Middle Carboniferous (Late Westphalian A - Early Westphalian B)		Succession of light to dark-grey or black, silty claystones, mudstones and shales containing a variable number of coal seams, and grey or buff, very fine- to fine-grained, fairly- to poorly-sorted, argillaceous or silty sandstone beds. Note: Top 16m MD consists of an alteration of sandstone and claystone beds. From about 2711m, the majority of cuttings showed varicolored claystones.	2430	2695
							2440,5	2711
RT-NAP: 5,3m; NAP-GL: 3,7m (GL below NAP)							TD	2446	2717

Figure 8 Lithology in MDM-GT-03-S2.

Deviation

Well MDM-GT-03-S2 is a deviated well. The initial part of the well is subvertical but below 650 m the well starts to deviate reaching a deviation of up to ~35 °C in the section between 900 and 2400 m TVD(Figure 9). The spike in deviation is near the starting point of the sidetrack.

Figure 10 shows MDM-GT-03-S2 in relation to the other wells at Middenmeer (excluding newer wells).

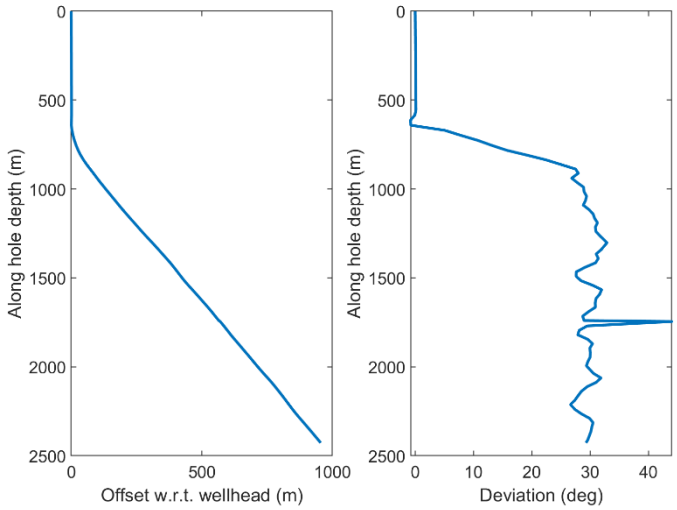

Figure 9 Geometry of MDM-GT-03-S2. Left: horizontal offset from the wellhead vs depth. Right: wellbore deviation or tilt with respect to the vertical.

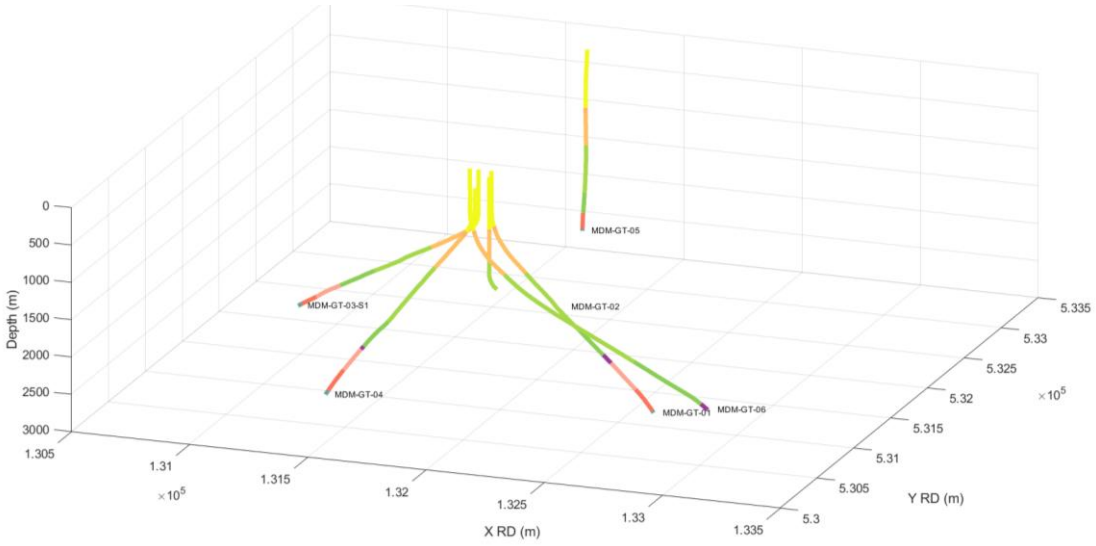

Figure 10 Wells MDM-GT-01 to MDM-GT-06-S2.

Completion

Element naam	Top (MD)	Base (MD)	Top (TVD)	Base (TVD)	OD (“)	ID (“)	roughness (mm)[1]	Staalsoort	Type koppelingen
Conductor 28”’	0	79	0	79	27.953	26,377	0.15-4.0	X70	gelast
Injectie tubing	0	72	0	72	8.625	7.921	0.15-4.0	L80	Polseal
Casing 1 18 ⅝”	0	521	0	521	18,625	17,755	0.15-4.0	K55	BTC
Casing 2 13 ⅜”	0	1392	0	1313	13,375	12,347	0.15-4.0	L80	VAM TOP
Liner 1 9 ⅝”	1147	1791	1103	1656	9.625	8.875	0.15-4.0	L80	VAM TOP
Liner 2 7”	1730	2194	1604	2020	7.000	6.276	0.15-4.0	K55	Polseal
Liner 3 5 ½” blank pipe	2141	2464	1958	2239	5.500	4.950	0.15-4.0	K55	BTC
5 1/2” WWS 300 Mircron	2464	2493	2239	2436	6.125	4.950	0.15-4.0	L80/316L	BTC
Blank pipe 5 1/2””	2493	2699	2436	2442	5.500	4.950	0.15-4.0	K55	BTC

Figure 11 Well completion table. Staalsoort = steel type.

Item Description All depths from RT	Wellhead and Xmastree MDM-GT-03-S2	Depth m tvd	Depth m ah	Hole ID in	Pipe OD in	Collar OD in (nom)	Pipe ID in	Pipe ID in (drift)
28" Stove pipe		88	88	Driven	28,000		26,377	
18 5/8"casing #87.5 K55 BTC		530	530	23,000	18 5/8"	19,625	17,755	17,567
9 5/8"liner hanger			1156	TOL with 245 m liner lap				
13 3/8"casing #68 L80 Vam Top		1322	1401	17,500	13 3/8"	14,175	12,415	12,259
7" liner hanger		1622	1739	TOL with 60 m liner lap				
9 5/8" liner #47 L80 Vam Top Kick off point		1665	1800	12,250	9 5/8"	10,396	8,681	8,525
5 1/2" liner hanger				TOL with approx. 50 m liner lap				
7" liner #23 K55 Polseal		2016	2203	8,500	7"	7,682	6,366	6,241
Loss zone @ 2026 m TVD / 2217 m MD		2210	2429	Swellables				
		2251	2474	Top Slochteren				
5 1/2" #17 K55 BTC basepipe + WWS		2431	2686	6,1/8 -> 6,6	5 1/2"	6,051	4,892	4,768
Open hole 6,1/8" –> 6,6" (TD)		2458	2717	6,600				

Figure 12 Well completion diagram.

Table 2: MDM-GT-03 tubular summary

Item	Top m MD	Bottom m MD	Weight	Grade	Connection
28" Conductor	9.32 (GL)	88	20mm W/T	n/a	n/a
18 ⅝" Casing	9.32 (GL)	530	87.5 ppf	K55	BTC
13 ⅜" Casing	9.32 (GL)	1401	68 ppf	L80	VAM Top
9 ⅝" Liner	1156	1800	47 ppf	L80	VAM Top
7" Liner	1739	2203	23 ppf	K55	Polseal
5½" Liner	Approx. 2153	2686	17 ppf	K55	BTC

2.2.2 Cement

Table 3: MDM-GT-03 cement summary

Item	TOC (MD)	Lead Slurry Volume (m^3)	Lead Slurry Weight (s.g.)	Tail Slurry Volume (m^3)	Tail Slurry Weight (s.g.)	Type
18 ⅝" Casing	Tagged 218 m	123	1.6	27	1.9	Lead: Class C Tail: Class G
18 ⅝" Casing (Top-fill)	Surface	273	1.6	n/a	n/a	Class C
13 ⅜" Casing	Surface	117	1.6	18	1.9	Class G + bentonite
9 ⅝" Liner	1156 (TOL)	50	1.6	8	1.9	Class G
7" Liner	1739 (TOL)	10.5	1.91			Class G

Figure 13 Casing descriptions and cement description of MDM-GT-03-S2 (End of Well Report, 2014)

Fluids

The fluid composition is indicated in the figures below.

After suspension of the well, it is expected that brine will be used with an inhibitor.

The supplier can indicate if they have special wishes for additives.

KATIONEN		
(Methode BPB)		
Aluminium	mg/l	<0.1
Antimoon	mg/l	<0.1
Barium	mg/l	4.1
Boor	mg/l	37
Cadmium	mg/l	<0.1
Calcium	mg/l	7600
Chroom	mg/l	<0.1
Koper	mg/l	<0.1
IJzer	mg/l	62
Lood	mg/l	0.6
Lithium	mg/l	14
Magnesium	mg/l	1200
Mangaan	mg/l	2.7
Molybdeen	mg/l	<0.1
Nikkel	mg/l	0.3
Kalium	mg/l	1100
Silicium	mg/l	18
Natrium	mg/l	60000
Strontium	mg/l	320
Vanadium	mg/l	<0.1
Zink	mg/l	5.5
Arseen	mg/l	<0.1
Kwik	µg/l	<0.10
(ISO 12846)		
ANIONEN		
(SGS SPI 164)		
Fluoride	mg/l	<10
Chloride	mg/l	106300
Nitriet	mg/l	<10
Bromide	mg/l	230
Nitraat	mg/l	<10
Ortho Fosfaat	mg/l	<10
Sulfaat	mg/l	500

ORGANISCHE ZUREN		
(SGS SPI 154)		
Formiaat	mg/l	<10
Acetaat	mg/l	80
Propionaat	mg/l	<10
Butyraat	mg/l	<10
Valeriaat	mg/l	<10
ALKALINITEIT		
(WAC/III/A/006)		
Total alkalinity	mg/l	127
Phenolphtalein alkalinity	mg/l	<2.5
Bicarbonaat	mg/l	127
Geleidbaarheid @ 20ºC (BPB)	mS/cm	193
Ammoniak (NH3) (BPB)	mg/l	75
pH @ 20ºC (ASTM E 70)		5.7
Total Dissolved Solids (NEN EN 15216)	mg/l	241600
Minerale Olie (NEN EN ISO 9377-2)	µg/l	<100
Dichtheid @ 20ºC (ASTM D 4052)	kg/l	1.118
IJzer II / III		
Fe2+	mg/l	25
Fe3+	mg/l	37

Figure 14 Fluid content of degassed water from one of the Middenmeer wells.

Table 3 - Composition of Flashed Gas from Surface Sample 1

Component		Mole%	Weight%
H_2	Hydrogen	0.000	0.000
H_2S	Hydrogen Sulphide	0.000	0.000
CO_2	Carbon Dioxide	22.760	39.411
N_2	Nitrogen	20.416	22.503
C1	Methane	54.365	34.317
C2	Ethane	1.626	1.923
C3	Propane	0.516	0.895
C4	i-Butane	0.033	0.075
C4	n-Butane	0.123	0.281
C5	i-Pentane	0.010	0.029
C5	n-Pentane	0.038	0.108
C6	Hexanes	0.026	0.087
	MC Pentane	0.004	0.013
	Benzene	0.019	0.057
	Cyclohexane	0.003	0.009
C7	Heptanes	0.012	0.046
	MC Hexane	0.003	0.011
	Toluene	0.014	0.049
C8	Octanes	0.003	0.011
	E-Benzene	0.000	0.001
	M/P Xylene	0.000	0.001
	O-Xylene	0.000	0.001
C9	Nonanes	0.001	0.006
	1,2,4 TMB	0.000	0.001
C10	Decanes	0.001	0.007
C11+	Undecanes +	0.027	0.158
	Total	100.000	100.000

Calculated Gas Properties	
Gas Density (kg m^{-3} @ 15°C)	1.135
Gas Mole Weight (g mol^{-1})	25.416
Real Relative (to air) Density of Gas	0.878
Mole weight of Heptanes Plus (g mol^{-1})	108.213
Density of Heptanes plus (g cm^{-3} at 60°F)	0.799
Mole Weight of Undecanes plus (g mol^{-1})	147.000
Density of Undecanes plus (g cm^{-3} at 60°F)	0.789
Calorific Value (MJ m^{-3})	23.747

Figure 15 Flashed gas composition from MDM-GT-03-S2 (Well Test Analysis, 2014)

Table 5 - Physical Properties of Samples

Sample no.	pH @ 25°C of flashed water	Density (g/cm^3) of flashed water @ 15°C	GWR (ncm^3/cm^3) of live water	Bubble Point Pressure (psig) & 90°C
Sample 1	6.1	1.1150	0.4230	350
Sample 2	6.0	1.1166	0.5019	390

Figure 16 Fluid properties MDM-GT-03-S2 sample (Well Test Analysis, 2014)

Reservoir pressure and temperature

The static reservoir pressure at 2272 m TVD is 24.3 MPa (Panterra, 2014).

Temperature in the reservoir are ~92 °C.

Wellhead and surface situation

A feed-through through the wellhead needs to be machined.

Surface connection and installation of the tool string at the surface needs to be provided for, in consultation with the supplier.

Electricity connection is present within 30 m.

Figure 17 Wellhead of MDM-GT-03-S2 (in operational setting).

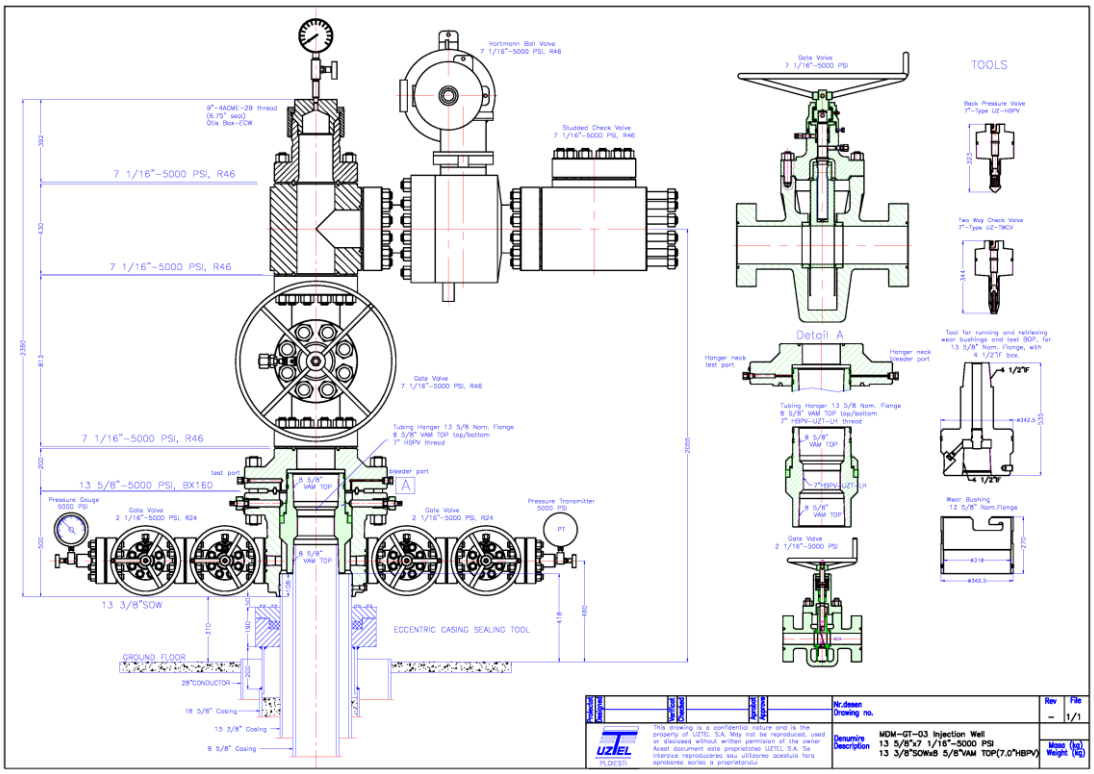

Figure 18 Wellhead diagram of MDM-GT-03-S2.

Figure 19 Location of the wellhead in satellite view.

C02 – 2 Bleiswijk Geothermie

The Bleiswijk and Bleiswijk 1b permits of the Bleiswijk Geothermie project are located in the west of the Netherlands.

In 2006 and 2007 wells VDB-GT-01-S1 and VDB-GT-02-S1 were drilled (Bleiswijk permit). These were taken into production in 2009. In 2019, production stopped, and in 2022 VDB-GT-01-S1 was abandoned.

In 2009 wells VDB-GT-03-S1 and VDB-GT-04 were drilled (Bleiswijk 1b permit). These produced until 2019. In 2021, a cement plug was set in VDB-GT-03-S1 at a depth from 730 m. VDB-GT-04 was left suspended, and still has an open connection to the Delft Sandstone Member reservoir.

In 2024 five wells were (re)drilled in both Bleiswijk projects; one well was redrilled sub-parallel to VDB-GT-01-S1, two wells were redrilled sub-parallel to VDB-GT-03 (VDB-GT-05) and VDB-GT-04 (VDB-GT-06), and two new wells were drilled on the northwest side of Bleiswijk 1b permit (VDB-GT-07 and VDB-GT-08), forming two doublets at the Verweijweg location. The doublets are expected to start producing in 2025.

The designated wells for the three tool strings (Tool Strings 2, 3 and 4) at Bleiswijk are VDB-GT-01-S1, VDB-GT-03-S1, and VDB-GT-04.

Figuur 2: Beoogd eind situatie, waarbij uiteindelijk IPS voor alle installaties beoogd uitvoerder van de vergunningen zijn.

Figure 20 Bleiswijk license areas and (planned) well layouts

Well name	XRD	YRD	Comment
VDB-GT-01 wellhead	95240.85	447568.26	Plugged from ~350 m depth
VDB-GT-01 @TD 2000 m	96788.27	446550	
VDB-GT-03 wellhead	93045.34	448649.05	
VDB-GT-03 @700 m	95165.23	447511.94	
VDB-GT-04 @TD	95118.26	449143.5	Centre of cold front (approximately). The new injector VDB-GT-06 is located ~100 m from VDB-GT-04 at the reservoir level.

C02 – 2.1 Tool String 2 at VDB-GT-01-S1

The VDB-GT-01-S1 well has been abandoned at >368 m depth (Figure 21). Two cement plugs were placed in the 9 5/8" casing in 2022 at depth > 368 m along-hole, leaving the top of the well open. The exact top of the topmost cement plug was not known, but should be between 368 and 436 m along-hole depth.

The requested geophones are intended to be deployed at depths of 30 m and 350 m (Figure 21). The deviation of the well at these depths is 0 °. The maximum temperature at 350 m depth is ~25-30 °C, and the maximum pressure 4 MPa. The well is filled with a brine with a density of 1.06 sg, in which the geophones are to be suspended for multiple years. The exact composition of the wellbore fluid is unknown.

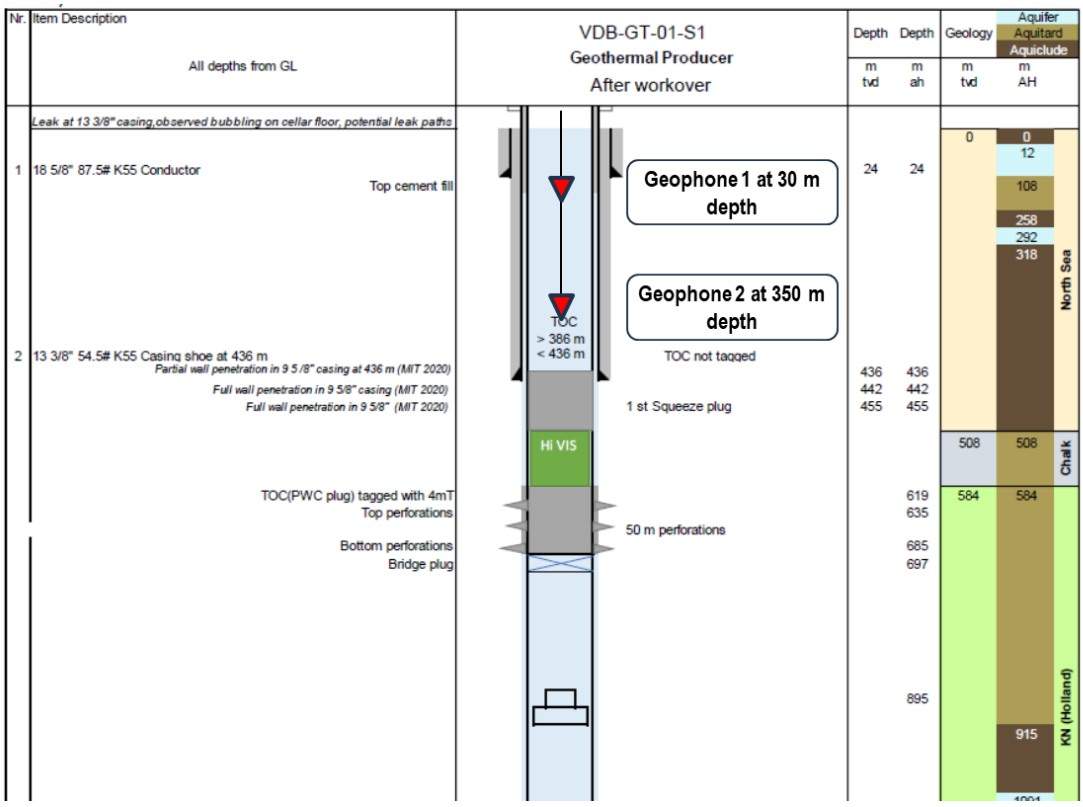

Figure 21 VDB-GT-01-S1 well diagram after completion (EOJR, 2022) and requested geophone setup.

Wellhead

Figure 22 shows an indicative figure of the wellhead and Xmas tree after completion. For more information, photos and questions please consult TNO so that additional information can be obtained from the operator.

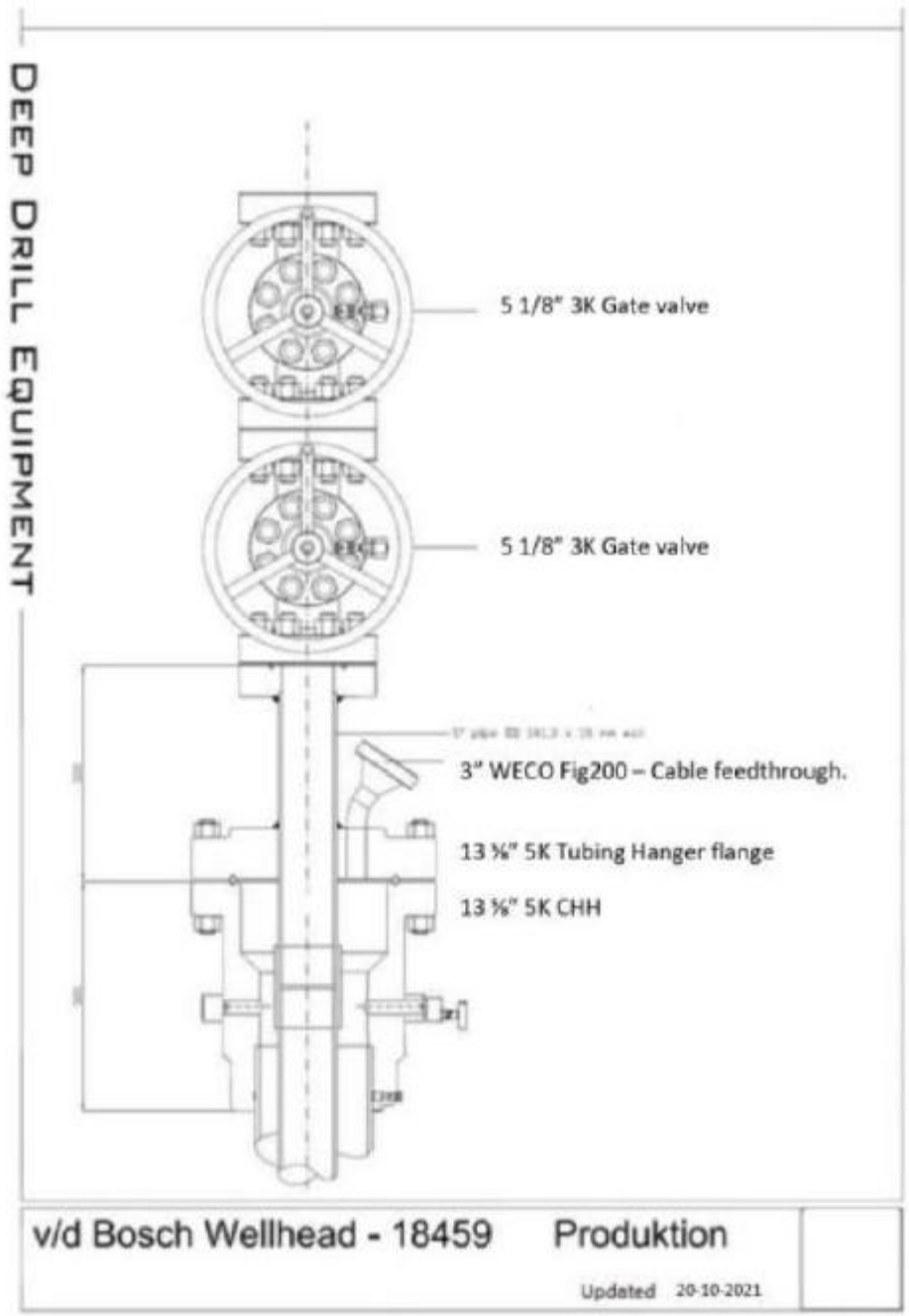

Figure 3: Wellhead & Xmas tree schematic (indicative only)

Figure 22 VDB-GT-01-S1 wellhead and Xmas tree diagram after completion (EOJR, 2022)

C02 – 2.2 Tool String 3 at VDB-GT-03-S1

In the VDB-GT-03-S1 well a cement bridge plug was set in the 9 5/8" casing over the interval 740 – 873 m along-hole, leaving the top 730 m of the well open.

The two requested geophones are intended to be deployed at depths of 490 m depth in the Chalk Group and at 750 m in the Rijnland Group (Figure 21). The deviation of the well at these depths is 0 °. The maximum temperature at 730 m depth is ~40 °C, and the maximum pressure 9 MPa. The well is filled with a brine with a density of 1.06 sg, in which the geophones are to be suspended for multiple years. The exact composition of the wellbore fluid is unknown.

In the extended scenario 3B an extra geophone is requested at 200 m depth (Figure 24).

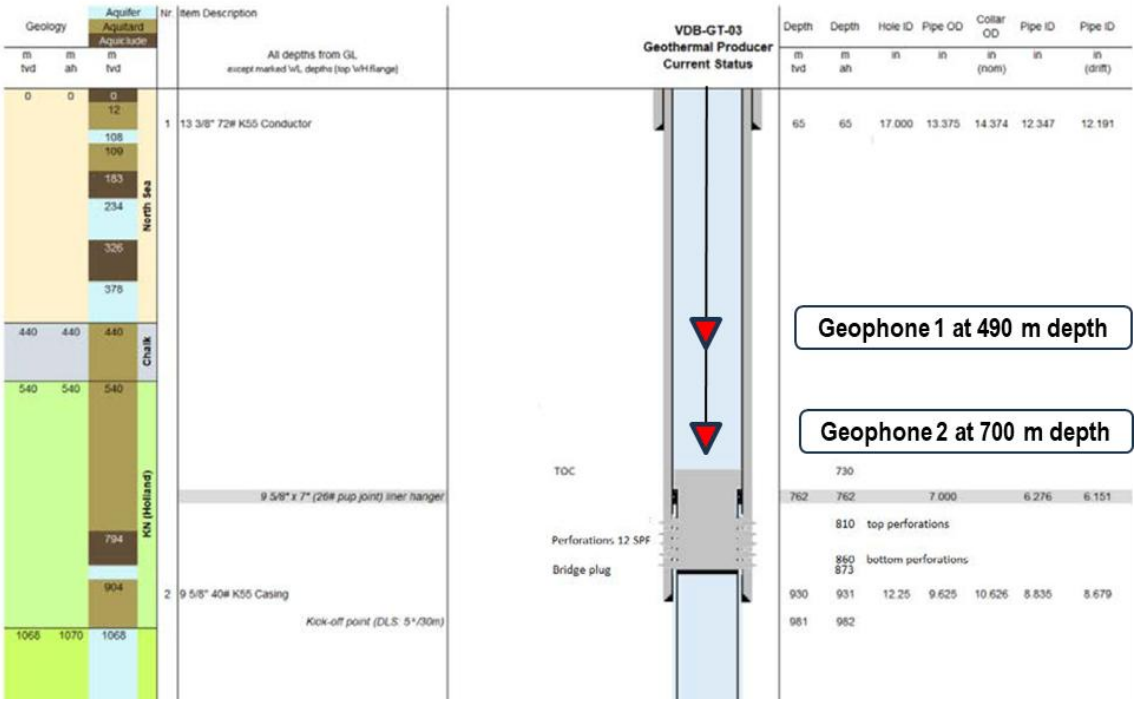

Figure 23 VDB-GT-03-S1 well diagram after completion (EOJR, 2022) and requested geophone setup (Tool String 3A).

Extension 3 (Tool string 3B)

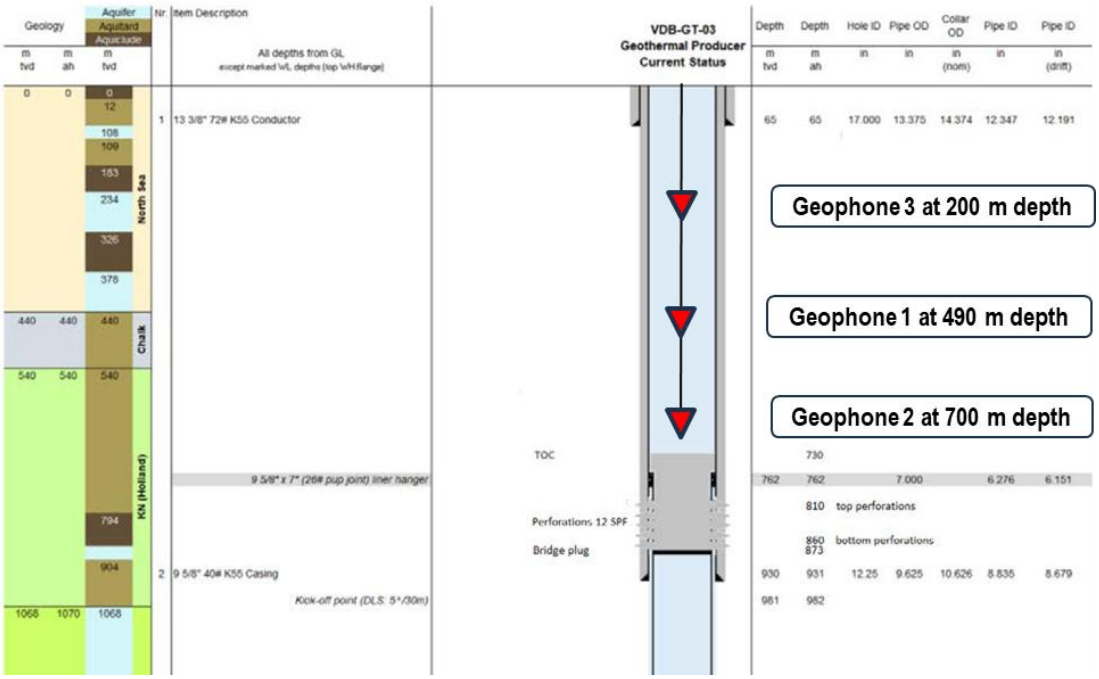

Figure 24 VDB-GT-03-S1 well diagram after completion (EOJR, 2022) and requested geophone setup (Tool String 3B).

Wellhead and surface setting

Figure 25 shows an indicative figure of the wellhead and Xmas tree after completion. For more information and questions please consult TNO so that additional information can be obtained from the operator.

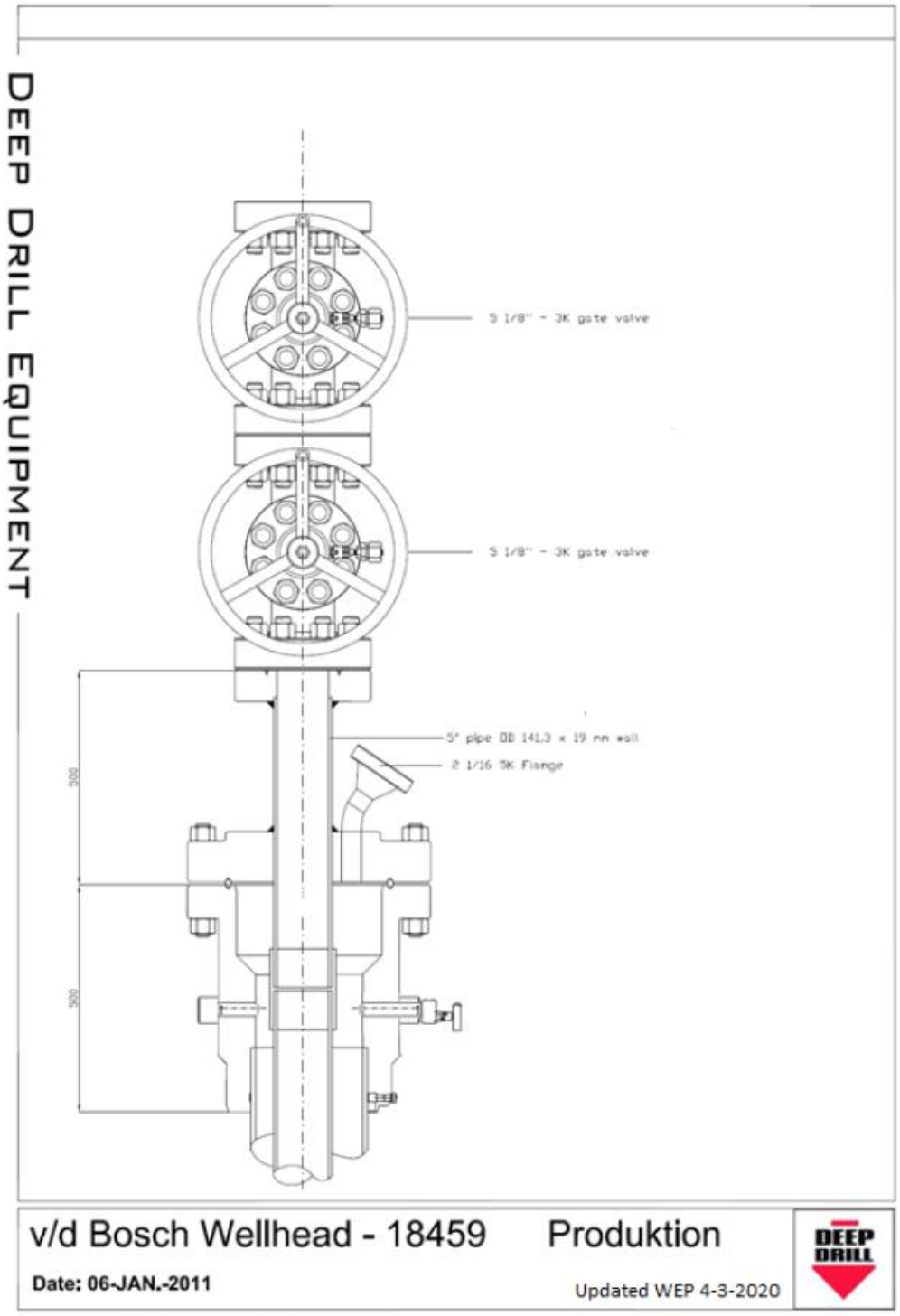

Figure 3: Wellhead & Xmas tree schematic

Figure 25 VDB-GT-03-S1 wellhead and Xmas tree diagram after completion (EOJR, 2022)

C02 – 2.3 Tool String 4 VDB-GT-04

The VDB-GT-04 well is suspended, and has still an open connection to the reservoir (Figure 26). The reservoir is the Delft Sandstone Member, the top of which was encountered at 1899 m along-hole depth (1758 m TVD).

Base Request - Tool string 4A

The two requested geophones are to be deployed in the 9 5/8” casing at 750 m along-hole depth and in the 7” liner at 1800 m along-hole depth, just above the reservoir. The deviation of the well is <5 ° at 750 m depth and 45 ° at 1800 m along-hole depth; geophones should be able to handle these deviations.

In addition to the two geophones a pressure and temperature gauge are requested within the reservoir.

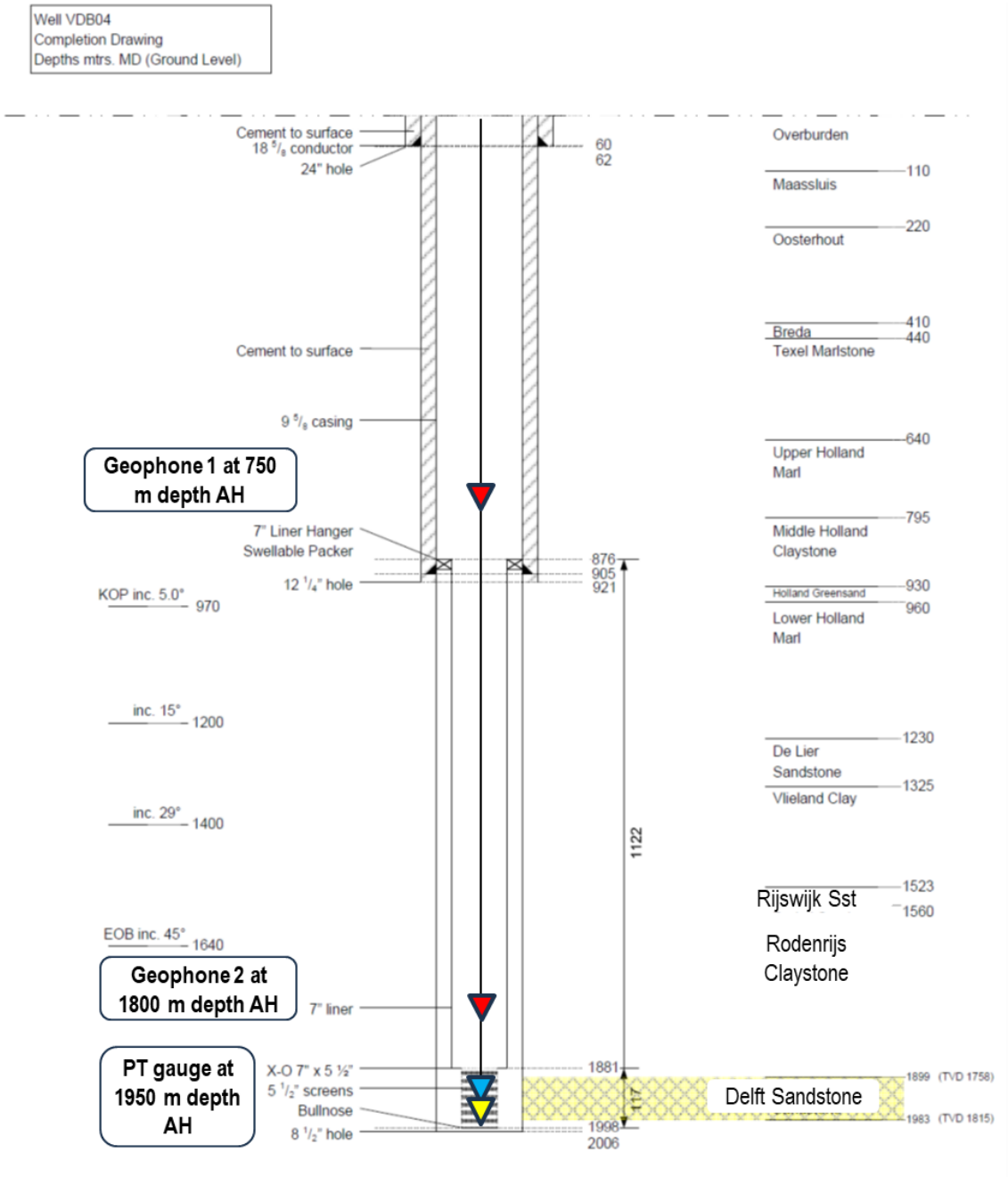

Figure 26 VDB-GT-04 well diagram after completion (EOWR, 2009) and requested tool string setup (Tool String 4A).

Extension 4 (Tool string 4B)

For the extension of the tool string (Tool String 4B) a co-located fiber optic cable is requested. The primary aim of this cable is to measure temperature (DTS) along the wellbore, and the secondary aim is to perform explorative acoustic measurements (DAS).

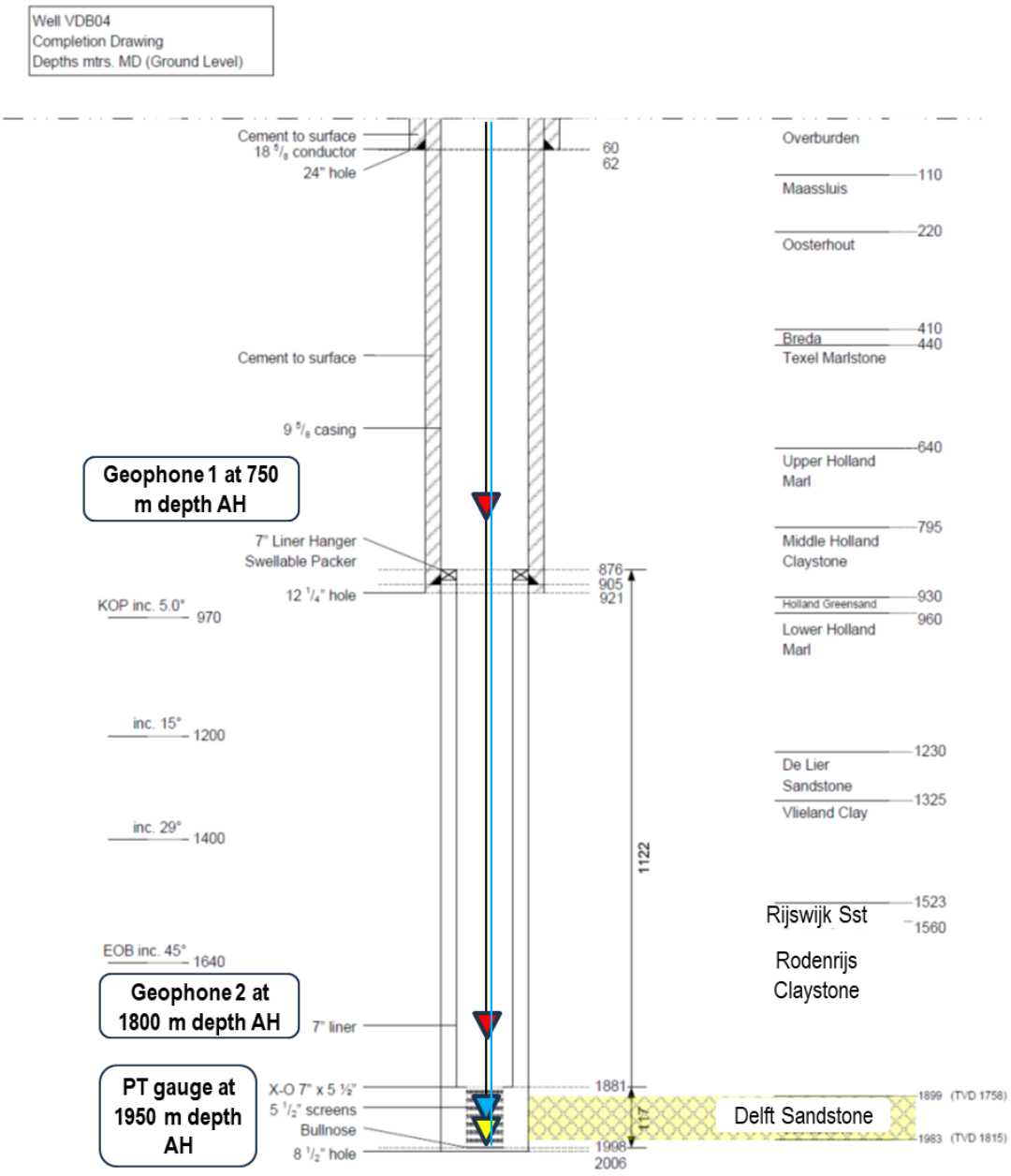

Figure 27 VDB-GT-04 well diagram after completion (EOWR, 2009) and requested tool string setup including a fiber optic cable down to the reservoir (Tool String 4B).

Extension 5

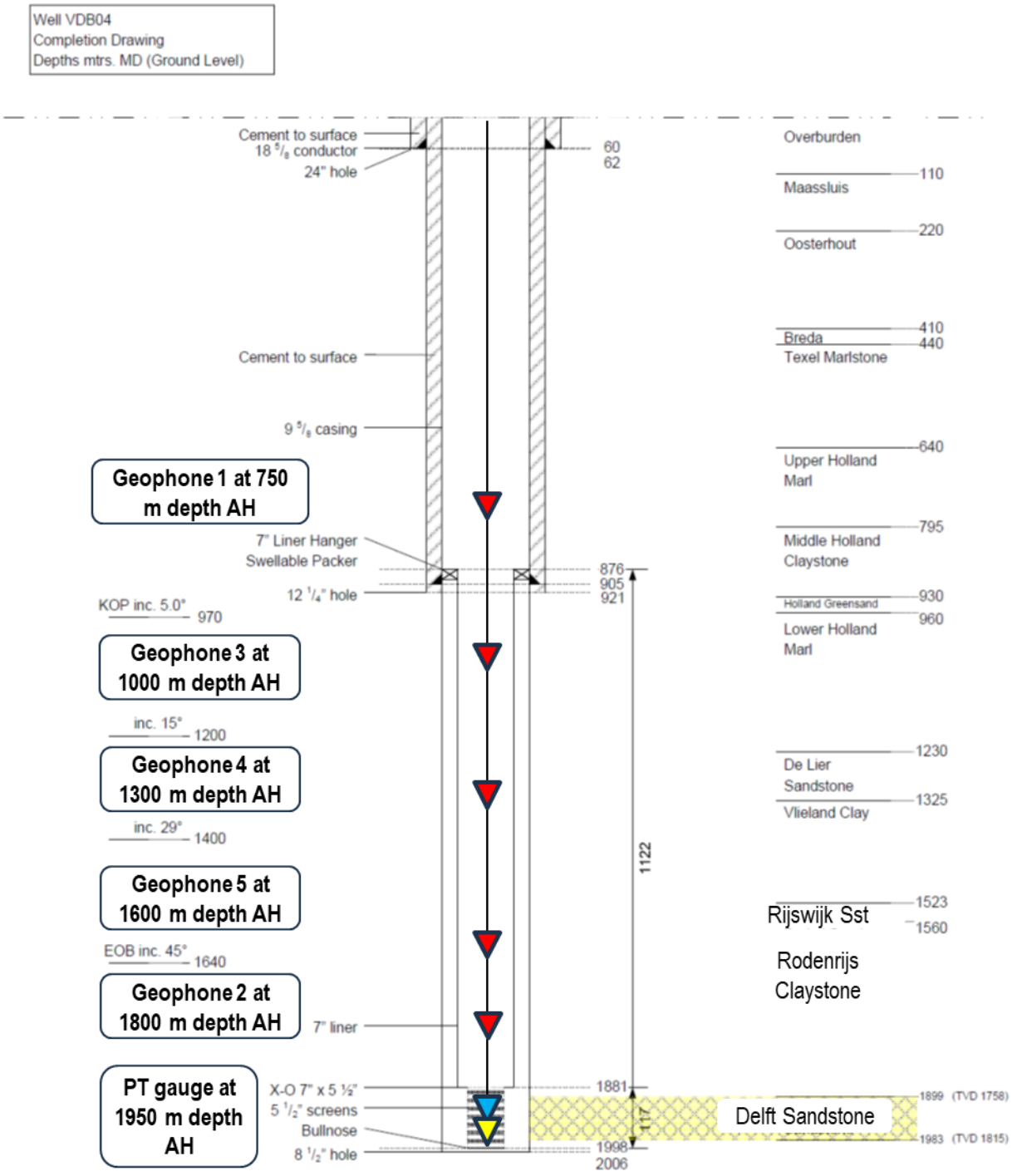

Figure 28 VDB-GT-04 well diagram after completion (EOWR, 2009) and requested tool string setup of Extension 5 with additional geophones (Tool String 4C).

C02 – 2.4 Further information on VDB-GT-04

The reservoir temperature at the maximum well depth is <60°C and the reservoir pressure is <20 MPa.

Fluid content

The exact fluid composition of VDB-GT-04 is not known. However, fluids from the newly drilled VDB-GT-05 and VDB-GT-07 wells were analysed. In the table in Figure 29 the contents of the degassed (dead) water are shown in the left two columns, which may be representative for the fluids in VDB-GT-04 as degassed fluids have been injected into this well in the past. Note that biocide is present in the well to prevent bacterial growth.

3.5 Water Mineralogical Composition

Parameter	Unit	Results		
		VDB-GT-05 dead water	VDB-GT-07 dead water	VDB-GT-07 Bottomhole Samples Combined
Anions (CFA)				
Chloride as Cl (EN-ISO 15682)	mg/l	65,000	61,000	72,000
Anions (Conform ISO 15923-1)				
Sulfate as SO4	mg/l	120	<1.7	<25
Acidity/Alkalinity [Conform WAC/III/A/006]				
Acidity up to pH 4.5	mmol/l	<0.050	<0.050	<0.050
Alkalinity up to pH 4.5	mmol/l	2.1	2.1	2.7
Alkalinity up to pH 8.3	mmol/l	<0.050	<0.050	<0.050
Bicarbonate as HCO3	mg/l	130	130	170
Carbonate as CO3	mg/l	<1.5	<1.5	<1.5
Hydroxyl content as OH-	mg/l	<0.85	<0.85	<0.85
Dry Residue (Conform WAC/III/A/001)				
Dry residue	mg/l	130,000	120,000	120,000
Hardness [Calculated] (A)				
Hardness	mg CaCO3/L	16,231	15,478	15,256
Metals [Conform NEN 6961/NEN 6966/C1 (EN-ISO 11885)] (A)				
Aluminum	µg/l	1000	1600	13000
Barium	µg/l	31,000	32,000	33,000
Calcium	µg/l	4,900,000	4,700,000	4,600,000
Iron	µg/l	29,000	24,000	40,000
Lithium	µg/l	600	400	380
Magnesium	µg/l	960,000	930,000	930,000
Potassium	µg/l	940,000	880,000	900,000
Natrium	µg/l	37,000,000	35,000,000	38,000,000
Strontium	µg/l	400,000	380,000	370,000
Density [Gravimetric]				
Density	kg/l	1.07	1.08	1.09
pH [Conform ISO 10523]				
pH	-	6.5	6.4	6.5
Temperature pH-measurement	°C	20.8	19.6	20.6
Conductivity [Conform NEN-ISO 7888]				
Ec at 25°C after automatic temperature correction	µS/cm	140,000	140,000	140,000
Temperature Ec measurement	°C	19.7	18.8	20.4
Mercury [Conform ISO 12846] (A)				
Mercury	µg/l	0.10	<0.10	<0.10
Chrome (VI) (Conform CMA/2/I/C.7 & WAC/III/C/050)				
Chroom (VI) as Cr	µg/l	<5.0	<5.0	<5.0

Figure 29 Fluid content in VDB-GT-07 (GAIA Energy, personal communications).

Wellhead & surface facilities

Wellhead is located in a cylindrical cellar of ~2.5 m high and ~2.5 m in diameter.

Electricity connection and some housing (greenhouses, old production facilities) are nearby (<15 m).

References

Documents for Middenmeer

ECW Geoholding BV (2021). *Aanvraag tijdelijk winningsplan aardwarmte Middenmeer III*. Report versie 14 October 2021.

Content: Request for temporary production license geothermal Middenmeer III

https://mijnbouwvergunningen.nl/attachment/entity/6d82a83e-9548-4517-b527-0462f1d511b9

ECW Geoholding BV (2014). *End of Well Report MGM-GT-03*.

Content: Drilling summary, well completion, geology, etc.

https://www.nlog.nl/brh-web/rest/brh/document/1709690965

Panterra (2014). *Well test analysis report well MDM-GT-03*. Report for ECW, 21 May 2014

Content: well test analysis

https://www.nlog.nl/brh-web/rest/brh/document/1709690932

Wellhead https://www.nlog.nl/brh-web/rest/brh/document/1672319480

See further:

Mijnbouwvergunningen.nl (mining licenses)

www.nlog.nl

Deviation survey MDM-GT-03-S2:

https://www.nlog.nl/brh-web/rest/brh/document/1647932171

Lithology log MDM-GT-03-S2: https://www.nlog.nl/brh-web/rest/brh/document/1647932168

Documents for Bleiswijk

End of Well Report VDB-GT-03

https://www.nlog.nl/brh-web/rest/brh/document/1033369697

See further:

Mijnbouwvergunningen.nl (mining licenses)

www.nlog.nl