



End of Well Report NLW-GT-02-S1

SodM Version

TRIAS WESTLAND B.V

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GLOSSARY

AH	Along hole	PJSM	Pre-job safety meeting
AKO	Adjustable Kick-Off	POA	Plan of action
BGL	Below ground level	POOH	Pull out of hole
BHA	Bottom hole assembly	ppf	pounds per foot
BOP	Blowout preventer	P/U	Pick Up
NLW-GT-01	Naaldwijk Geothermal 01	PUW	Pick up weight
NLW-GT-02	Naaldwijk Geothermal 02	PV	Plastic viscosity
CBL	Cement bond log	R/D	Rig Down
CHH	Casing head housing	RF	Rig Floor
C/O	Change Out	RIH	Run in hole
CP	Conductor Pipe	ROP	Rate of penetration
CRT	Casing running Tool	RSS	Rotary steerable system
DC	Drill Collar	RT	Rotary table
DP	Drill pipe	RTTS	Retrievable Test-Treat-Squeeze (packer)
DSV	Drilling supervisor	R/U	Rig Up
EMW	Equivalent mud weight	s.g.	Specific gravity
ESP	Electric submersible pump	SodM	Staatstoezicht op de Mijnen
FMS	Flush Mounted Spider	SOW	Slack off weight
FIT	Formation integrity test	Spm	Strokes per minute
FOSV	Full opening safety valve	SPP	Stand pipe pressure
GL	Ground level	TD	Total depth
GOT	German Oil Tools	TDS	Top Drive Swivel
GR	Gamma-Ray	TOC	Top of cement
HSE	Health, Safety & Environment	TOL	Top of liner
HWDP	Heavyweight drillpipe	TRS	Tubular Running Services
IR	Iron Roughneck	TP	Toolpusher
LCM	Lost circulation material	TSP	Top Set Packer
LOT	Leak Of Test	TVD	True vertical depth
LTI	Lost Time Incident	TWCV	Two Way Check Valve
MD	Measured Depth	USIT	Ultrasonic Imager Tool
MW	Mud Weight	VFD	Variable Frequency Drive
MWD	Measurement while drilling	WBM	Water Based Mud
NAP	Normaal Amsterdams Peil	WEP	Well Engineering Partners
NDSV	Night Drilling Supervisor	WOB	Weight on bit
NPT	Non-productive time	WOC	Wait on cement
OH	Open hole	WSG	Well Services Group
PBL	Circulation sub	WTF	Weatherford
PBR	Polished Bore Receptacle	WWS	Wire-wrapped screen
PDC	Polycrystalline diamond compact	YP	Yield point
PDM	Positive displacement (mud) motor		

1. General Project data

Field	Naaldwijk
Well Number:	NLW-GT-02-S1
Well Name	Naaldwijk-GT-02-Sidetrack-1
Well Type	Geothermal Production
Start operations	09-03-2018; 00:00 hr
Spud date	10-03-2018; 04:45 hr
Start rig down (end of well)	02-05-2018; 09:00 hr
Days Operational	53,6 days
Operator	Trias Westland

Surface Location	Latitude & Longitude	Geographical
	51° 59' 26,96"N 4° 14' 22,36"E	X: 76154m (RD) Y: 445230m (RD)

Grid Coordinate System Rijksdriehoeksmeting / Netherlands New

Drilling Contractor KCA Deutag

Drilling Rig T-207

Depth reference Rotary Table (RT), unless otherwise stated

Project Management:

Project Director	Marco van Soerland
Project Manager	Floris Veeger
Drilling Manager	Maarten Middelburg
Sr. Drilling Engineer	Bert Jan Koers
Drilling Engineer	Andrea Di Cicco
Sr. Well Site Geologist	Dick Stegers
HSE Manager	Peter v.d. Burg
HSE Coordinator	Arno Otten

Drilling Supervisors on 2 week rotational scheme:

Drilling Supervisor	Karl Gollob	09-03-2018 / 13-3-2018
		27-03-2018 / 10-04-2018
		24-03-2018 / 30-04-2018

Drilling Supervisor	Per Gwalter	13-03-2018 / 27-03-2018
		10-04-2018 / 24-03-2018

Night Drilling Supervisor	Joost van Tilborg	09-03-2018 / 19-03-2018
		02-04-2018 / 16-04-2018
		30-04-2018 / 02-05-2018 (DSV)

Night Drilling Supervisor	Barry Ross	19-03-2018 / 02-04-2018
		16-04-2018 / 30-04-2018

2. Well summary

Primary Objective	Lower Cretaceous reservoir (Delft Sandstone)	
Primary Objective Depth	2463 m MD	2367 m TVD
Total Depth	2680 m MD	2525 m TVD
Elevation	RT – GL GL – NAP NAP – RT	9.32 m -0.90 m (NAP is 0.9m below ground level) 8.42 m

Table 1: Well summary

Item	MD (m)	TVD (m)	Comments
30" Conductor	134	134	The 30" Conductor was pre-installed to 134m MD RT using a truck mounted unit as part of the drill site construction.
24" Hole TD	1105	1088	This vertical section was drilled with a TCI (IADC 415) bit type GO4BCPS below a PDM directional BHA. Shaker system of the rig, (x3 single deck shakers) and additional MD3 triple deck shaker were sufficient to allow proper flow rates. At 1188 m drilled through a fault, causing total losses. No success in curing losses and pipe stuck. Decided to sever pipe at 298 m. LCM pills not effective, pumped Zonelock S pill, losses stopped. POOH to run clean out BHA. Washed/reamed to 210 m, still losses. Decided to set cement plug for side track. Cleaned out cement plug to 141 m. Started sidetrack with Bentonite mud. Another LCM pill was needed to cure losses. At 442 m displaced well back to KCl Glydril mud and continued drilling to section TD at 1105 m.
20" Casing	1102	1085	RIH 20" casing and stood up at 142 m, POOH and ran 2 x clean out BHA. RIH casing without centralizers, stood up at 156 m but managed to work casing down to planned setting depth. Ran cement stinger and cemented casing as per program. Installed 21-1/4" wellhead and BOP's
17 1/2" Hole	2385	2304	The fault experienced in the first 24" hole section was now expected in this section in the Upper Holland Marl. A dumb-iron BHA was used to drill float equipment and performed a limit test to 1.45 s.g. at 1108 m MD. Continued drilling with same hold BHA to 1264 m. BHA was changed out for RSS to perform directional work. The BHA was showing a strong building tendency. High stick-slip was experienced from 1944m onwards. At 2185 m it was decided to POOH for steering issues, low ROP and high stick-slip. Drill collars were removed from the string and a stabilizer added. Bit was in good condition and although perhaps too aggressive (519) for the sandstones it was re-run. Drilled to section TD at 2385 m. BHA had to be pumped OOH due to overpulls when pulling only on elevators.
13 5/8" Liner	(TOL) 993 (SHOE) 2376		The 13 5/8" liner was run to setting depth 9m off proposed depth. Setting the liner hanger went as per plan. The cement job was carried out as per plan and the plugs bumped and liner tested. Reverse circulating showed 3m³ of pure cement. Set packer and circulated clean above TOL.

13-5/8" Tie-back	surface	1005	Run 12-1/4" Dress/Mill BHA into liner top and landed NO-GO 1m deeper than expected. Displaced well to inhibited water. Run tie-back string and pressure test casing and tie-back to 100 bar.
12 1/4" Hole TD	2680	2525	RIH 12 1/4" RSS with PDC bit. Drilled out shoe track and rat hole without any issues. Performed limit test to 1.50 s.g. below 13 5/8" shoe. Displace to drill-in fluid and commenced drilling. Overall performance was good with ROP's varying between 10 – 15 m/hr. Inclination was built to 45 deg. TD was called at 2680m. POOH on elevator to 2541m where 10ton overpull was observed. The tight spot was reamed and BHA pumped OOH to 13 5/8" casing shoe.
9 5/8" Liner	2642	2499	The 9-5/8", 53.5#, L80, VAM21 liner with Wire Wrapped screens was run with a 5 1/2" DP as inner string to 13 5/8" casing shoe. Upon entering the open significant drag was observed and the liner had to be worked all the down to setting depth at 2642 m. The liner hanger set successfully. While displacing the well to brine the annulus packed off. Decided to set packer and complete displacement via inside of 9 5/8" liner.
Suspend well			Installed tubing hanger + one 8 5/8" casing joint. X-mas tree installed and tested against TWCV. Removed TWCV after pressure test.
Welltest			<p>The welltest is performed with the rigless intervention unit (RIU) of Franks. Before installation of the ESP wireline logs (USIT- CBL- VDL) of the 13 5/8" liner and tie-back string were taken by Schlumberger. ESP run on 8 5/8" 32# L80 Polseal tubing to 749 m BGL with Expro memory P&T gauges on slickline suspended below the ESP centraliser. Depth of memory gauges is 2259 m MD BGL. Welltest is performed successfully, total volume produced 2991m³ water and 4591 Nm³ gas.</p> <p>After 24 hrs build up the ESP is POOH and memory gauges retrieved on slickline. A downhole fluid sample was taken at 2319 m MD. The well is suspended with tubing hanger + one 8 5/8" casing joint and X-mas tree installed. TWCV is removed after pressure test.</p>

2.1 Directional plots

SURVEY MANAGEMENT

Client:		Job No.:	17hol0035	Report Date:	18-May-18
Field:	Naaldwijk (Trias Westland)	Well Name:	NLW-GT-02	Borehole:	NLW-GT-02-S1
Stru/Slot:	NLW-GT-02/NLW-GT-02	Survey:		NLW-GT-02-S1 Def Survey	

Structure Reference:	445230.00	76154.00
	N 51° 59' 26.96188"	E 4° 14' 22.35732"
Slot Coordinates:	445230.00	76154.00
	N 51° 59' 26.96188"	E 4° 14' 22.35732"
Structure/Slot Uncertainty:	0.00 m(3.00 sigma)	0.00 m(3.00 sigma)
Grid Coordinate System:	Amersfoort * OGP-Nld / RD Dutch Onshore	
TVD Reference Datum:	Borehole: Unknown	
TVD Reference Elevation:	8.420 m above NAP	
Seabed/GroundLevel:	0.900 m below NAP	

Depth Units:	(m)
Survey Date:	3-Apr-18
Azimuth Reference:	Grid North
Mag. Model / Mag. Decl. Date:	HDGM 2017 4-Feb-18
Magnetic Declination:	1.102 °
Grid Convergence:	-0.90562969 °
Total Correction:	2.0078 °
Vertical Section Origin:	0.000 m, 0.000 m
Vertical Section Plane:	107.442 ° (Grid North)

DEFINITIVE SURVEY CONSTRUCTION - ORIGINAL WELL

Instrument Type	Survey From	Survey To	Hole Size	Casing Size
SLB_MWD+SAG-Depth Only	0.00	9.32		
SLB_MWD+SAG	9.32	137.00	30.00	30.00
SLB_MWD+SAG	137.00	137.00	30.00	30.00
SLB_MWD+SAG	137.00	1102.00	24.00	20.00
SLB_MWD+SAG	1102.00	2376.00	17.50	13.63
SLB_MWD+SAG	2376.00	2680.00	12.25	12.25
Projection to TD:		Type:		

WELL REFERENCE POINT LOCATION

MD	INC	AZ	TVD	VS	NS	EW	Northing	Easting	Latitude	Longitude
9.32	0.00	0.00	9.32	0.00	0.00	0.00	445230.00	76154.00	N 51° 59' 26.96188"	E 4° 14' 22.35732"

BOTTOM HOLE LOCATION

MD	INC	AZ	TVD	VS	NS	EW	Northing	Easting	Latitude	Longitude
2680.00	45.00	108.05	2525.60	724.20	-213.54	692.02	445016.47	76845.98	N 51° 59' 20.40543"	E 4° 14' 58.79969"

BOTTOM HOLE LOCATION COMPARISON

SOURCE :

MD	INC	AZ	TVD	VS	NS	EW	Northing	Easting	Latitude	Longitude

COMMENTS

Surveys in 24" section and partially in 17.5" section corrected for drillstring magnetism (DMAG).

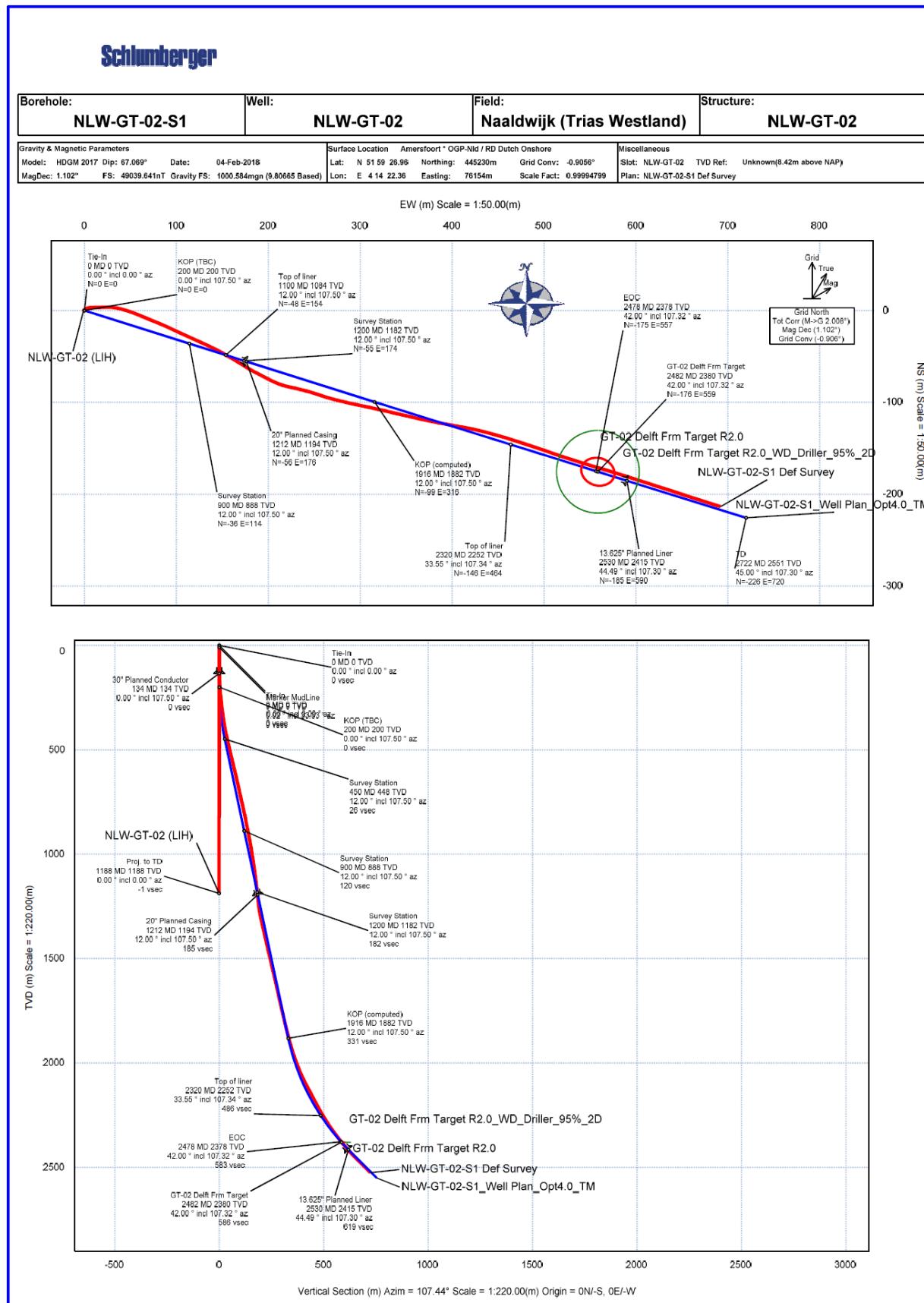


Figure 1: NLW-GT-02-S1 Vertical Section plot and plan view plot- drilled vs. planned

2.2 Technical summary

2.2.1 Casing

Table 2: NLW-GT-02-S1 tubular summary

Item	Top (m MD)	Bottom (m MD)	Weight	Grade	Connection
30" Conductor	0	134	0.5" WT	S355	Welded
20" Conductor	0	1102	133 ppf	NT95	BTC
13 5/8" Tie-back	0	1005	88.2 ppf	L80	VAM21
13 5/8" Liner	993	2376.5	88.2 ppf	L80	VAM 21
9 5/8" WWS Liner	2325	2642	53.5 ppf	L80	VAM 21

2.2.2 Cement

Table 3: NLW-GT-02-S1 cement summary

Item	TOC (m MD)	Lead Slurry Volume (m ³)	Lead Slurry Weight (s.g.)	Tail Slurry Volume (m ³)	Tail Slurry Weight (s.g.)	Type
20" Casing	Surface	153	1,57	38	1,67	PozzoCemoil w/Cemnet fibres
13 5/8" Liner	Liner Top	107	1.67	21	1.88	PozzoCemmoil lead G class Tail

3. Drilling fluid summary

Per section the following drilling fluid types have been used:

Table 4: NLW-GT-02-S1 drilling fluid summary

Section	Type	Density (s.g.) Min – Max	PV (cP) Min – Max	YP (lbf/100ft ²) Min – Max
24"	Bentonite spud mud & KCl Glycol WBM	1,05– 1,26	13 – 20	14 – 18
17 ½"	KCl Glycol WBM	1,24 – 1,28	15-29	17 - 25
12 ¼"	Drill-in Fluid (Flo Pro)	1,13 – 1,15	14 - 16	15 - 26

The figure below shows the mud weight, PV and YP versus depth during drilling operations.

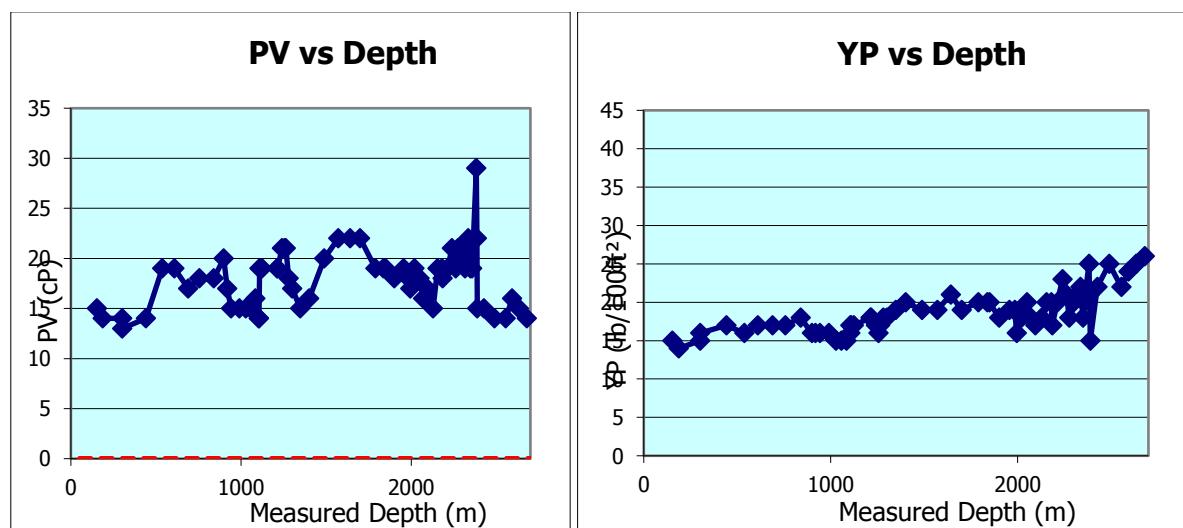
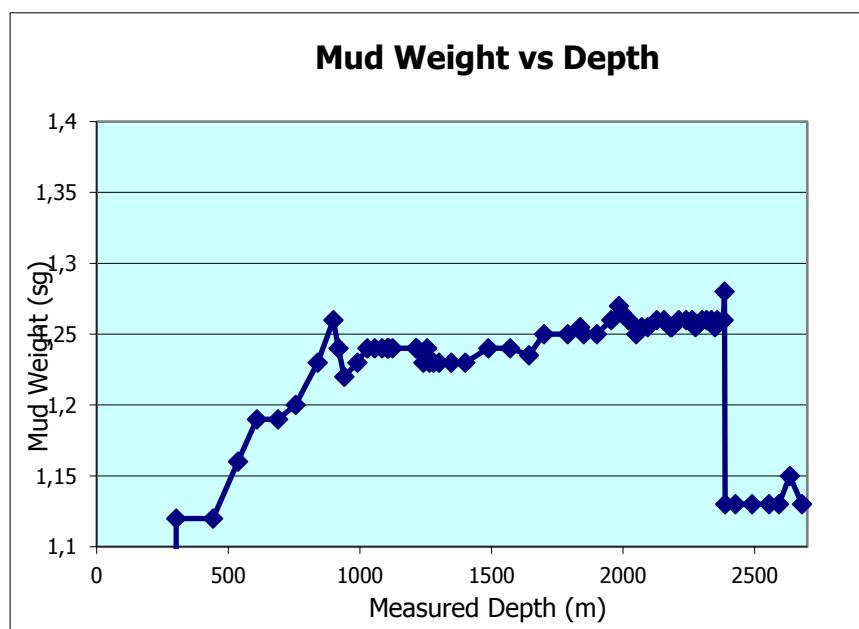


Figure 2: NLW-GT-02-S1 mud weight vs. depth

4. Geology

Below the geological column with vertical and along hole depths below RT.

PROGNOSED STRATIGRAPHY				RT: 8.42	Depth	AHRT ¹	TVDRT	TVDSS ²	+/-	AHRT	TVDRT	TVDSS ²
Group	Formation	Member	Description									
NLW-GT-02-S1	Quaternary	"Various"										
NU	Oosterhout		Succession of sands, sandy clays, and grey and greenish clays.		220	220.0	211.6		220	220	212	
	Breda		Sequence of marine, glauconitic sands, sandy clays and clays.		398	398.0	388.6		398	397	389	
NM	Rupei		Mainly dark brown-grey clays. May become more silty towards base and top.		437	437.0	428.6		438	436	428	
NL	Dongen		Formation of dark-grey, green and brown, slightly calcareous clays, with few intercalated glauconitic sands. The lowermost part of the formation is characterised by tuffaceous clays.		467	457.0	448.6	+/- 20	461	458	450	
Landen	Landen Clay		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. White, chalky limestones containing rare white and grey nodular and bedded chert layers, and thin, grey to green clay laminae.		714	714.0	705.6		717	708	700	
OK	Houthem / Ekaofisk		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. Tongue of sandstone may be present.		720	720.0	711.6		729	719	711	
Ommelanden			Dark-grey, partly black, calcareous, laminated claystone. White to light-grey limestones and marly chalks, becoming more marly and clayey to the base.		749	749.0	740.6		763	752	744	
Tevel	Pleinus Marl		Greenish, glauconitic, calcareous sandstones with intercalated marls.		1194	1194.0	1185.6		1213	1195	1187	
	Texel Marlstone		Grey and/or reddish brown marls and calcareous claystones.		1196	1196.0	1187.6		1216	1198	1190	
	Texel Greensand		Grey and/or red-brown calcareous shaly claystone, with a distinctly lower lime content than the under- and overlying members. Traces of siltstone.		1239	1239.0	1230.6	+/- 50	1258	1238	1230	
KN	Holland	Upper Holland Marl	Alternation of greenish grey, very glauconitic, or sideritic cement and olive-grey sandstones, locally silt-stones with calcareous or sideritic concretions and olive-grey claystones.		1257	1257.0	1248.6		1267	1249	1241	
	Middle Holland Claystone		Grey and red-brown marl or calcareous, fissile shale, and sandstone. Alternation of thin-bedded, very fine- to fine-grained, argillaceous sandstones, generally glauconitic and lignitic, and sandy claystones. Glauconite and shell fragments common.		1431	1431.0	1422.6		1448	1425	1417	
	Holland Greensand		Dark brownish-grey to grey claystone. Mica and very fine lignitic matter are common. Claystones very slightly calcareous. Can be become very silty to sandy with many intercalated siltstone and/or sandstone.		1516	1515.0	1506.6		1519	1495	1487	
	Lower Holland Marl		Sandstone, light-grey, very fine- to fine- and medium- to coarse-grained. Locally gravelly, lignitic, locally glauconitic or with sideritic concretions. Especially in upper part, calcareous cemented beds are common.		1618	1615.0	1606.6		1649	1622	1614	
Vlieland	De Lier		Alternation of fine-grained, argillaceous sandstones and brown-grey silty to sandy claystones. Locally sideritic concretions are present.		1753	1743.0	1734.6	+/- 75	1788	1755	1747	
	Vlieland Claystone		Light- to medium-grey sandstones with a very fine to medium and locally gravelly grain size; mica, lignitic matter and sideritic concretions are common.		1905	1880.0	1871.6		1930	1895	1887	
Berkel	Berkel Sandstone		Alternation of fine-grained, argillaceous sandstones and sideritic sandstone.		2171	2095.0	2086.6		2141	2092	2084	
Rijswijk			Medium- to dark-grey, silty to sandy lignitic claystones with common laminated or contorted bedding, and lignitic/sodal beds. Mollusc shells and siderite are common.		2205	2120.0	2111.6		2187	2133	2125	
Berkel	Sand-Claystone		Light-grey massive sandstone sequence, fine to coarse-gravels, fining upward, lignitic. Interbedded brownish grey claystones in between sandstone bodies.		2432	2280.0	2271.6		2324	2253	2245	
Rodenrijs	Rodenrijs Claystone		Brownish grey clay- and siltstones with interbedded fine to medium grained sandstones. Coal and lignite beds are associated with the grey claystones.		2722	2485.0	2476.6		2562	2442	2434	
SL	Nieuwerkerk	Delft Sandstone	Medium- to dark-grey, silty to sandy lignitic claystones with common laminated or contorted bedding, and lignitic/sodal beds. Mollusc shells and siderite are common.		TD 2815	2551.0	2542.6		2680	2527	2519	
		Alblasserdam										

¹ Based on initial trajectory NLW-GT-02
² Depth to NAP

Table 5: NLW-GT-02-S1 geological lithostratigraphic column

5. Well schematic

A detailed well schematic summarizing all casing sizes is shown below.

Nr.	Item Description Production well All depths from RT <i>RT = 9,32 m above GL</i> <i>RT = 8,42 m above NAP</i>	Wellhead and Xmastree NLW-GT-02-S1 1x joint 8 5/8" 32# L80 installed below tubing hanger.	Depth	Depth	Hole ID	Pipe OD	Collar	Pipe ID	Pipe ID
			m	m	in	in	in	(nom)	in
tvd	ah								(drift)
1	30" 0,5" WT S355 Conductor		134	134	35,433	30,000	welded	29,000	29,000
2	20" x 16" liner hanger & packer X/O to 13 5/8" 20" 133# NT95DE ERW BTC Casing		976	992	Top of liner				
			1085	1102	24,00	20,000	21,000	18,730	18,542
			1089	1106	section TD				
3	13 5/8" x 9 5/8" Liner Hanger + Packer 13 5/8" 88.2# L80 VAM21 Liner + Tie back		2254	2325	Top of liner (50 m liner lap)				
			2297	2376	17,5"	13,625	14,699	12,375	12,250
			2304	2385	section TD				
			2365	2460	Top Screens				
			2368	2464	Top Delft Sandstone				
			2453	2578	Bottom Screens				
4	9 5/8" 53,5# L80 VAM21 WWS		2499	2642	12,25"	9,625	10,542	8,535	8,500
			2525	2680	TD				
*Not in scale.									

Figure 3: NLW-GT-02-S1 well schematic

Figure 4 shows the well schematic during the welltest. The installation of the ESP was done with a crane based operations in May 2018. (note all depths referred to Ground level).

Nr.	Item Description Production well All depths from GL GL - NAP: -0,9 (NAP is 0,9 m above GL)	Wellhead and Xmas tree NLW-GT-02-S1 Static fluid level: 95m BGL Measured with E-line on 29-05-2018	Depth	Depth	Hole ID	Pipe OD	Collar	Pipe ID	Pipe ID	
			m	m	in	in	in	in	(drift)	
		tvd	ah							
1	30" 0,5" WT S355 Conductor		125	125	35,433	30,000	welded	29,000	29,000	
	8 5/8" 32# L80 Polseal tubing ESP on 8 5/8" tubing						8,625	9,650	7,921	7,796
							ESP intake at: 721,7 m MD / 711,6 m TVD			
							ESP P/T gauge at: 747,8 m MD / 737,1 m TVD			
2	20" 133# NT95DE ERW BTC Casing						967	983	Top of liner	
	20" 133# NT95DE ERW BTC Casing						1076	1093	24,00	20,000
							1080	1097	section TD	18,542
							P&T gauges at: 2259,8 m MD / 2197,1 m TVD			
3	13 5/8" x 9 5/8" Liner Hanger + Packer						2245	2316	Top of liner	
	13 5/8" 88,2# L80 VAM21 Liner + Tie back						2287	2366	17,5"	13,625
							2295	2376	section TD	14,699
							2356	2451	Top Screens	12,375
							2359	2455	Top Delft Sandstone	12,250
							2444	2569	Bottom Screens	
4	9 5/8" 53,5# L80 VAM21 WWS						2490	2633	12,25"	9,625
							2516	2671	TD	10,542
										8,535
										8,500

*Not in scale.

Figure 4. Well schematic during welltest

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	Revision No.	1.0
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6. HSE performance

6.1 General

To ensure that the operation was carried out in a safe manner, several HSE tools were implemented both by Trias Westland and KCA Deutag.

KCA Deutag's Permit to Work system was a tool used in order to perform additional activities outside regular drilling activities that carry a potential risk. Both the Toolpusher's and DSV's approval were required for a Permit to Work to come into effect.

Other HSE tools utilized on location were:

- Toolbox meeting during every shift change of rig contractor (06:45 & 18:45)
- Pre-job safety meetings (PJSM) before every non-drilling operation (casing running, cementing, well-test etc.)
- General safety meetings with rig crews
- Local Fire brigade location visit and acquaintance to operations
- SET card system of KCA Deutag
- Regular HSE inspections carried out by HSE coordinator
- Weekly HSE meeting

6.2 Incidents

- 1x collision outside the site with scooter – Injured person was brought to hospital for medical treatment.

6.3 Drills / Emergency exercises, inspections & audits

Drill / emergency exercises:

- Fire drills 28/02/2018, 24/03/2018,
- Muster drills 28/02/2018, 24/03/2018
- Kick drills 06/04/2018, 28/4/2018
- BOP tests 04/04/2018, 23/04/2018