

END OF WELL REPORT

HON-GT-01-S2

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Contents

1. Ge	neral Project data	3
2. We	Il summary	4
2.1.	Directional plot	5
2.2.	Casing	6
2.3.	Cement	6
2.4.	Drilling fluid summary	6
3. Ge	ology	7
4. We	Il schematic	
5. HS	E performance	9
5.1.	General	9
5.2.	Incidents	9
5.3.	NORM	9
5.4.	Drills / Emergency exercises	9
6. Op	erations Review	
6.1.	Time summary	
6.2.	Mobilize and Rig Up HWU	12
6.3.	Fishing run	
6.4.	Set Bridge plug on wireline	13
6.5.	Whipstock and window milling	14
6.6.	Drill sidetrack	15
6.7.	Run 5" liner w/ screens	
6.8.	Rig down	

APPENDICES

Appendix I.	GR log
Appendix II.	Survey report
Appendix III.	BHA's
Appendix IV.	5" liner tally
Appendix V.	Wellhead / Xmas tree Details
Appendix VI.	Liner hangers
Appendix VII.	Daily Drilling Reports
Appendix VIII.	Daily Mud Reports
Appendix IX.	Drilling Parameters



Glossary

BGL	Below ground level
BHA	Bottom hole assembly
BHR	Basket handrail
BOP	Blowout preventer
BPC	Balance Point Control
DP	Drill pipe
DSV	Drilling supervisor
GL	Ground level
GR	Gamma-Ray
HSE	Health, Safety & Environment
HWU	Hydraulic workover unit
MD	Measured depth
MWD	Measurement while drilling
NAP	Normaal Amsterdams Peil, standard water table in the Netherlands
NORM	Naturally occurring radioactive material
NPT	Non-productive time
PDM	Positive displacement motor; or mud motor
PJSM	Pre-job safety meeting
POOH	Pull out of hole
ppf	pounds per foot
RIH	Run in hole
ROP	Rate of penetration
RSS	Rotary steerable system
sg	Specific gravity
TD	Total depth
TOL	Top of liner
TVD	True vertical depth
UBHO sub	Universal bottom hole orientation sub
WWS	Wire-wrapped screen



1. General Project data

Field Well Number: Well Name Well Type Start rig mobilisation Spud date End Date Days Operational Operator Honselersdijk HON-GT-01S2 Geothermal Well HON-GT-01S2 Geothermal Well Producer 08-06-2015; 07:00 hr 12-06-2015; 19:00 hr 02-07-2015; 18:00 hr 25 Green Well Westland BV

Surface Location

Grid Coordinate System Drilling Contractor Drilling Rig Depth reference

Project Management: Project Director Project Manager Drilling Manager Lead ops Engineer HSE Manager

Drilling Supervisors: Drilling Supervisor Drilling Supervisor Latitude & LongitudeGeographical52° 00' 58.74"NX= 75242.83 E4° 13' 32.21"EY= 448081.04 N

Rijksdriehoeksmeting / Netherlands New BPC HWU SpaceSaver II Groundlevel (BGL), unless otherwise stated

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Bas Kaldenbach Art de Vetter 08-06-2015 / 24-06-2015 24-06-2015 / 30-06-2015



2. Well summary

Goals of the well operations were the following:

- 1. Retrieve (part of) the damaged/plugged 4-1/2" liner with liner hanger
- 2. Seal off the original well bore of HON-GT-01-S1
- 3. Drill window inside 7" liner as close as possible to the top of the 4-1/2" liner hanger
- 4. Drill sidetrack through Delft Sandstone & complete same with 5" liner w/ screens
- 5. No accidents or incidents

From the above only the first goal was not achieved.

Below the well summary of the well operations.

Primary Objective		Delft Sandstone	
Primary Objective E	Depth	2531 m MD	2346 m TVD
Total Depth		2615 m MD	2419 m TVD
Elevation	Ground level (GL) BHR – GL GL – NAP	17.93 m Basket hand - 0.57 m (GL below N	drail (BHR) IAP)

Table 1: HON-GT-01-S2 well summary

Item	m MD	m TVD	Comments
4-½" Liner hanger	2400	2230	Fill up well with 1,09 sg brine. Attempted to retrieve the part of the 4-1/2" liner with the 7" x 4-1/2" liner hanger without success. LIH spear & grapple. Minor losses after fishing attempt
6-⅓" Hole TD	2615	2419	Set permanent bridge plug @ 2391m & test same to 50bar/20mins – OK. Set whipstock at 2391m. Milled window to 2393m. (top window @ 2386m & bottom window @ 2389m). Displace well to 1,10 sg DrillCarb drill-in fluid. P/U 6-1/6" drilling assembly & drill hole to 2615m. POOH & L/D BHA without hole issues.
5"Liner	2354 - 2606	2193 - 2411	 P/U & RIH 5" liner with crane. RIH 2-1/8" inner string. Wash down last 3 jnts. Displace well to 1,09 sg NaCl brine. Set liner hanger packer & test to 50bar/20mins – OK. Try to release setting tool; unable. Run free-point wireline: free 4m above TOL. Run wireline & perforate liner hanger setting tool to allow circulation. Circulate successful and retrieve string: sediments had settled on TOL after displacement and during packer pressure test.



2.1. Directional plot



Figure 1: HON-GT-01S2 Vertical Section plot and plan view plot- drilled vs. planned



2.2. Casing

In the casing scheme below the original casings from HON-GT-01 & S1, which are part of the existing well structure, are included.

Table 2: HON-GT-01-S2 tubular summary

Item	Top m MD	Bottom m MD	Weight	Grade	Connection
9 %" casing	0	1103	53,5 ppf	L80	TSH Blue
7" liner	1022	2386	29 ppf	L80	VAGT
5" Liner	2354	2606	18 ppf base pipe 5-½ OD WWS*	L80	VAGT

*Screen interval from 2530 m - 2592 m

2.2.1. Pressure tests:

During the well operations on HON-GT-01-S2 the following pressure tests on the well have been performed:

- Against permanent bridgeplug @ 2391m 50bar/20mins w/ 1,09 sg brine in the well
- Against 5" liner hanger packer @ 2354m 50bar/20mins w/ 1,09 sg brine in the well

2.3. Cement

No cement jobs have been performed in the drilling of sidetrack HON-GT-01-S2

2.4. Drilling fluid summary

Per section the following drilling fluid types have been used:

Table 3: HON-GT-01-S2 drilling fluid summary

Section	Туре	Density
		Min – Max
4-1/2"	Viscosified brine (YP>25)	1.09 sg
6-1⁄8"	Drill-in Fluid (AMC drillCarb)	1.10 – 1.14 s.g.
6-1⁄8"	Brine (NaCl)	1.09 sg



3. Geology

The actual and expected geology for the sidetrack section are listed below in Table 4.

Lithostratigraphic Column Green Well Westland 24-06-2015					HON-GT-01- S1		HON-GT-01-S2			
Era	Group	Perio d	Formatio n	Epoch (Age)	Member	Lithology	TV- <mark>GL</mark> Depth (m)	AH- <mark>GL</mark> Depth (m)	TV- <mark>GL</mark> Depth (m)	AH- <mark>GL</mark> Depth (m)
	Rijnland ^{KN}		Vlieland Sandstone KNNS	Lower Cretaceous Late Hauterivian to Early Barremian	Berkel Sand/Claystone KNNSC	Alternation of fine-grained, argillaceous sandstones and brown-grey silty to sandy claystones. Locally sideritic concretions are present.	2113	2261	Bit star @ 2218	t depth D 2389
esozoicum	<mark>Schieland</mark> s∟	sne		Hauterivian	Rijswijk Sandstone KNNSR	Light- to medium-grey sandstones with a very fine to medium and locally gravelly grain size; mica, lignitic matter and siderite concretions are common.	2251	2425	2255	2428
		Cretaced	Cretaced	Nieuwerkerk SLDN	Late Valanginian to Early Hauterivian	Rodenrijs Claystone SLDNR	Medium- to dark-grey and dark brown, silty to sandy lignitic claystones with laminated or contorted bedding, and lignite/coal beds. Traces of mollusc shells, pyrite and siderite.	2278	2457	2285
Σ				Valanginian	Delft Sandstone SLDND	Light-grey massive sandstone sequence, fine to coarse-gravelly, fining upward, lignitic.	2351	2544	2346	2531
				Lower Cretaceous to Upper Jurassic Ryazanian to Valanginian	Alblasserdam SLDNA	A succession of typically red and dark to light (brownish) grey clay(stones) and variegated clay- and siltstones, fine to medium grained sandstones and massive, thick-bedded, coarse grained sandstones. Coal & lignite	2401	2602	2402	2594
									TD	2615

 Table 4: Lithostratigraphic column HON-GT-01-S2

The geology of the well HON-GT-01-S2 is very similar to the prognosis due to the close vicinity of the nearby wellbore of HON-GT-01-S1.

The top of the Delft Sandstone at HON-GT-01-S1 was found at 2351m TVD. A similar depth was expected at HON-GT-1-S2 but it was found at 2346m TVD

There are a series of geological possibilities which could explain the 5 meters. Most likely a slope of a point bar or a lens has been drilled into, as the Delft Sandstone is a fluvial deposit.

Alternative theories which could explain the large depth difference include the presence of a fault or a strong formation dip. The nearest fault should be at least hundreds of meters away, based on the seismic data. A strong formation dip of the Delft Sandstone Formation (at about 23 degrees to the southwest) does not match the formation tops in to the original HON-GT-01 and the well HON-GT-02. In addition both of these options are not considered likely because the gamma-ray logs of the Delft Sandstone of S1 and S2 are very similar.



4. Well schematic

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

Note: well depth is not to scale.



Figure 2: HON-GT-01S2 well schematic



5. HSE performance

5.1. General

To ensure that the operation is carried out in a safe manner, several HSE tools were in place during the operation:

- Pre-spud meeting
- Toolbox meetings
- Pre-job safety meetings (PJSM)
- Operation specific HSE plan (GW-HSE-20150423)
- NORM plan (GW-NORM-20150423)

5.2. Incidents

No incidents have occurred during the well operations

5.3. NORM

During the operations all incoming and returned equipment was measured for NORM on the drilling location. No NORM contamination was found in any of the measurements.

This matches the expectations as the NORM was only found in the surface equipment during earlier measurements. This is expected to be related to the bubble point of the production fluid.

5.4. Drills / Emergency exercises

Regular drill / emergency exercises have been performed:

- Muster drills (27-06-2015, 14-06-2015)
- Fire drills (14-06-2015)
- Kick drills (27-06-215, 14-06-2015)



6. Operations Review

Below a summary is given of the various steps of the operation. For a detailed description of daily activities, see Appendix VII for daily reports.

6.1. Time summary

The summary for the operations are listed in Table 5. Actual timing is compared to the planned. After completing the operations the total delay is 9 days as a result of:

- 1. Some delays during rigging up
 - a. Working around production lines
 - b. Offloading operator equipment on small working location
- 2. Slow running in hole with the fishing BHA#1
 - a. Difficulty handling the 4-3/4" DC's
 - b. Difficulty entering the top of the 7" liner (3,5 hrs)
- 3. Delays running the whipstock assembly
 - a. Difficulty making up the MWD (6hrs)
- 4. Delays while drilling 6-1/8" hole section
 - a. Sliding sections taking significant time less efficient than on a rig
 - b. ROP lower than expected from offset data (2 m/hr actual vs. 6m/hr expected)
- 5. Delays while running the 5" WWS section
 - a. Making up liner slower than expected (crane based operations through HWU)
 - b. Long time (5 hrs) for rigging up to run the 2-7/8" inner string
 - c. Difficulty retrieving the setting tool (total 37hrs)
- 6. Slower tripping speeds and BHA handling than expected (for all trips).
 - a. For tripping the average was 140m/hr actual vs. 180m/hr planned (incl. lubrication, PJSM, drills & breaks etc.)

Some time was saved in comparison to the plan as a result of:

- 1. Fast & efficient wireline operations (both rigging up/down & operations)
- 2. Smooth rig down



Table 5: Summary timing planned vs. actual

	F	Planne	d	Actual				
Cased hole sidetrack	hrs	day	cum	Start	hrs	day	cum	total delay
Rig up (incl. P-testing)	78,0	3,3	3,3	8-jun 7:00	108	4,5	4,5	1,3
Attempt fish liner	38,8	1,6	4,9	12-jun 19:00	61	2,5	7,0	2,2
Set mechanical bridgeplug on wireline	16,3	0,7	5,5	15-jun 8:00	5	0,2	7,2	1,7
Set whipstock & mill window	48,6	2,0	7,6	15-jun 12:45	73	3,0	10,3	2,7
Drill cased hole sidetrack to 2520m	40,6	3,4	11,0	18-jun 13:15	181	7,5	17,8	6,8
RIH liner	43,2	1,8	12,8	26-jun 2:00	100	4,2	22,0	9,2
Rig down	64,0	2,7	15,4	30-jun 6:00	60	2,5	24,5	9,0
Total	393,8	16,4			587,0	24,5		
Contingency	15%	2,5						
Total		18,9						



6.2. Mobilize and Rig Up HWU

Started:	08/06/2015	07:00 hr
Finished:	12/06/2015	19:00 hr
Planned:	78 hrs	
Actual:	108 hrs	
NPT:	0 hrs	

6.2.1. Summary

Rig move and rig-up of the hydraulic workover unit

6.2.2. Highlights / Lowlights

- + Efficient and safe rig-up with no major problems despite the small location.
- Had to reposition the lower BOP section to be able to fit the remaining BOP sections with respect to the flowline of GT02.

6.3. Fishing run

Started:	12/06/2015	19:00 hr
Finished:	15/06/2015	08:00 hr
Planned:	38.8 hrs	
Actual:	61 hrs	
NPT:	0.0 hrs	

6.3.1. Summary

The first BHA was made up to fulfill two purposes,

1) attempt to fish the 4-1/2" liner out of hole and

2) drift / scraper the 7" casing.

At the top of the 7" rotary was required to get inside the top of the liner hanger and the second 6-1/8" string mill-stabilizer also had to be rotated into the 7", thereafter RIH went ok till the top of the 4-1/2" liner.

Before the itco spear (3.885" nominal) was latched on the wellbore fluid was circulated and made viscous w/ 3 kg/m³ XanBore.

The liner was latched on in the first attempt and straight pull up to 150mT overpull was applied, without success. Thereafter jarring commenced, and on the seventh jar cycle the BHA came loose, after checking the up weight against the original weight the BHA was POOH. At surface it was observed that the Itco spear and bullnose were lost down hole.







Figure 3: Stripped connection inspected at surface

6.3.2. Highlights / Lowlights

- + Successfully run the fishing BHA combi run with 6-1/8" string mills and non-rotating scraper to the top of the liner (6-1/8" > standard 7" 29# regular drift).
- + All BHA items were retrieved without increased LSA activity.
- Unable to retrieve the liner
- Lost the Itco spear and bullnose down hole

6.4. Set Bridge plug on wireline

Started:	15/06/2015	08:00 hr
Finished:	15/06/2015	12:45 hr
Planned:	16.25 hrs	
Actual:	4.75 hrs	
NPT:	0.0 hrs	

6.4.1. Summary

Good and efficient operations setting the 5.61" Owen Core-lab bridgeplug 1.93m above the first 7" connection above the liner hanger. The plug is set at 2391m BGL.

As on the fishing run 2x 6-1/8" stabilizers and a non-rotating casing scraper was run the initially planned dummy run was skipped.

After setting the bridge plug it was successfully pressure tested to 50bar with 1.09SG viscous brine in the well.

6.4.2. Highlights / Lowlights

+ Very efficient Bridge plug installation



6.5. Whipstock and window milling

Started:	15/06/2015	12:45 hr
Finished:	18/06/2015	13:15 hr
Planned:	48.6 hrs	
Actual:	72,5 hrs	
NPT:	6.0 hrs Broke	n MWD pulser sleeve

6.5.1. Summary

The Whipstock was picked up with the laydown winch of the HWO unit and lowered and hung off in the window where the mill assembly was connected and lowered until the MWD carrier collar. During the attempt to load the MWD probe the MWD pulser sleeve got broken and the tungsten carbide pieces were not all retrieved. All BHA components were laid down to check if there were any tungsten carbide pieces had dropped inside the string. Some pieces were retrieved from the mill. The backup sleeve and pulser sub were picked up.

The BHA was RIH to setting depth, the Whipstock orientated to 270° and set. The window was cut in 3.5 hr's and the additional 4m rathole in 6.5 hr.

Milling the rathole was consuming a lot of time and in conjunction with the DD it was decided to stop milling for more rathole (initial objective was 10m).

The window was reamed and a dry run in and out was performed successfully.

Prior of pulling out, the well was displaced to 1.10SG Drill-Carb Drill-in fluid with 700 to 800 lpm.

The return fluid was stored inside two containers (respectively 70m³ and 28m³), including a total of 5m³ mist zone. After the displacement the BHA was POOH and laid down. The mills were found up to spec passing the no-go ring gauge test.



Figure 4: Broken MWD pulser sleeve



Figure 5: Mill with no-go gauge ring

6.5.2. Highlights / Lowlights

- + Spot on orientation of the Whipstock
- + Good release of the mill and good progress milling steel.
- + Mill's came out and were checked with the "no-go" ring \rightarrow OK.
- Difficulties loading the MWD and time delay due to the broken pulser sleeve



6.6. Drill sidetrack

Started:	18/06/2015	13:15 hr
Finished:	26/06/2015	02:00 hr
Planned:	40,6 hrs	
Duration:	180,75 hrs	
NPT:	2.0 hrs Miss	Measurement of UBHO sub

6.6.1. Summary

Prior of picking up the BHA, the 475 PDM (Frontline 4563 w/ 1.5° bent) was sent to WTF Den Helder to have the Bit made up as this was not possible to be made up in the HWO Unit. While making up the BHA, it was found that the UBHO sub was not properly measured, The MWD was reconfigured and loaded into the assembly and surface tested. RIH commenced and entered the top of the 7" without any problems.



At the window, on the first attempt to run the bit out of the window dry, some weight loss was observed, the string was picked up and rotated 30

degrees where after the bit was run outside the window without any hold up. The BHA was pulled back, also without problems. Drilling started. Throughout the section 1050 to 1100 lpm was used mainly to provide sufficient hole cleaning in the 9-5/8" casing section.

From the Rodenrijs claystone cavings throughout the section were observed (see below).



It was found that the ROP was significantly lower than initially expected (1.5-2 m/hr); GT-01 & GT-02 showing average on-bottom ROP of >8m/hr. In addition some efficiency loss accounts for the difference in average daily progress due to connection making: a Topdrive system (super single and triple systems) can add the next section immediately at connection depth where the HWO unit works with a wash joint (similar as a Kelly system) first having to pull back the Kelly / wash joint, add the next section of pipe and lower this into the hole and make up the Kelly / wash joint again.

Despite the fact that S2 was drilled in close vicinity of the original borehole and S1 (separation of ca. 16m) the top of the DelftSand was found higher than expected (2346 m MD actual vs. 2351m MD expected). See chapter 3 for further details

Drilling was continued to 2615m. GR signal was lost after 2578m. Circulated hole clean with 2x B/U. POOH to surface, initial drag on first 2 singles. No further drag was encountered. Laid down BHA and found the bit severely damaged with damaged cutters and washouts on the side. (grading: 6-4-WO-A-X-1-ER-TD), no cutters were missing. PDM shaft/bearing also showed signs of washout.





6.6.2. Highlights / Lowlights

- + Good departure of the wellbore from the existing well
- + Drill to well TD in single trip
- Two unexpected doglegs of 17.5°/30m 2431m bgl and 9.6°/30m 2450m bgl without the influence of sliding.
- Caving's coming over the shakers since drilling the rodenrijs claystone
- Limited to no ability to treat the mud (no centrifuges and limited screens on site)
- On-bottom ROP significantly lower than forecasted (1,5-2 m/hr vs. 5-12 m/hr)
- Bit severely damaged/worn & 1/16" undergauge. Washed out.
- PDM shaft/bearing showed signs of washout
- Lost GR signal while drilling from 2578m to 2615m



6.7. Run 5" liner w/ screens

Started:	26/06/2015	02:00 hr
Finished:	30/06/2015	06:00 hr
Planned:	43,2 hrs	
Duration:	100 hrs	
NPT:	37 hrs unable	to retrieve setting tool

6.7.1. Summary

Picking & making up the screen section with the HWU required a heavy crane for assistance, since the HWU could not run the screen section without risking damage to the screens. Total screen & inner sting weight w/ liner hanger was 11t. Due to the crane reach and weight of the string a 200t crane was required.

Made up the liner/screen section with 5 jnts screens and hung off string in lower stationaries. Preparations to install the inner string with gooseneck/jackplate & extensions took over 5hrs as the HWU is not ideally suited for this type of operation.

Inner string was run further without issues and Liner hanger was made up OK.

String was RIH without drag up to 5jnts above TD.When the string weight was reduced the string was washed/rotated with 200lpm/15rpm to depth successfully (shoe @ 2606 BGL, TOL @ 2354m BGL).

Well was displaced to brine (550lpm/72bar, limited by liner hanger setting pressure).

Set the liner hanger & packer OK. Tested successfully to 50bar.

While retrieving the liner hanger setting tool the tool could not be retrieved. There was ca. 1,5m free travel and rotation could be achieved. Due to the setting of the packer circulation was not possible. On wireline a free-point indicator was run, which found the free-point 4m above the TOL. From these observations it was expected that the situation was caused by hole fill – sands from the displacement which had now settled above the top of the liner.

2 perforations were then made just above the liner hanger to allow circulation to attempt to loosen the sediment to allow the setting tool to be retrieved. These perforations were placed successfully at exactly the planned location.



Figure 6: Planned location of perforations (inside red circle)



Figure 7: Perforations after POOH

Initially a packer inside the 2-7/8" (below the liner hanger) was also considered to prevent



injecting into the reservoir but due to unavailability at short notice an initial attempt was made without packer.

Circulation could be achieved and the first two joints were washed out. Thereafter POOH the string successfully without further circulation.

6.7.2. Highlights / Lowlights

- + Successful screen placement to TD
- + Perforations successful to retrieve setting tool
- Unable to retrieve setting tool, required to perforate tool to allow circulation
- 2jnts inner string (out of 40) did not pass drift due to damage at tool joint



6.8. Rig down

Started:	30/06/2015	06:00 hr
Finished:	02/07/2015	18:00 hr
Planned:	64 hrs	
Duration:	60 hrs	
NPT:	none	

6.8.1. Summary

Rig down went smooth.

All rental items were returned to the respective suppliers. All equipment was accounted for.

6.8.2. Highlights / Lowlights

- + Smooth operations
- + All (rental) equipment accounted for

