Nedmag

Getting you closer to perfection

Meeting with SodM on VE-5 (VDM-5) Drilling Program

Den Haag, 11-04-2018

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- Project Organization
- Target VE-5
- Location
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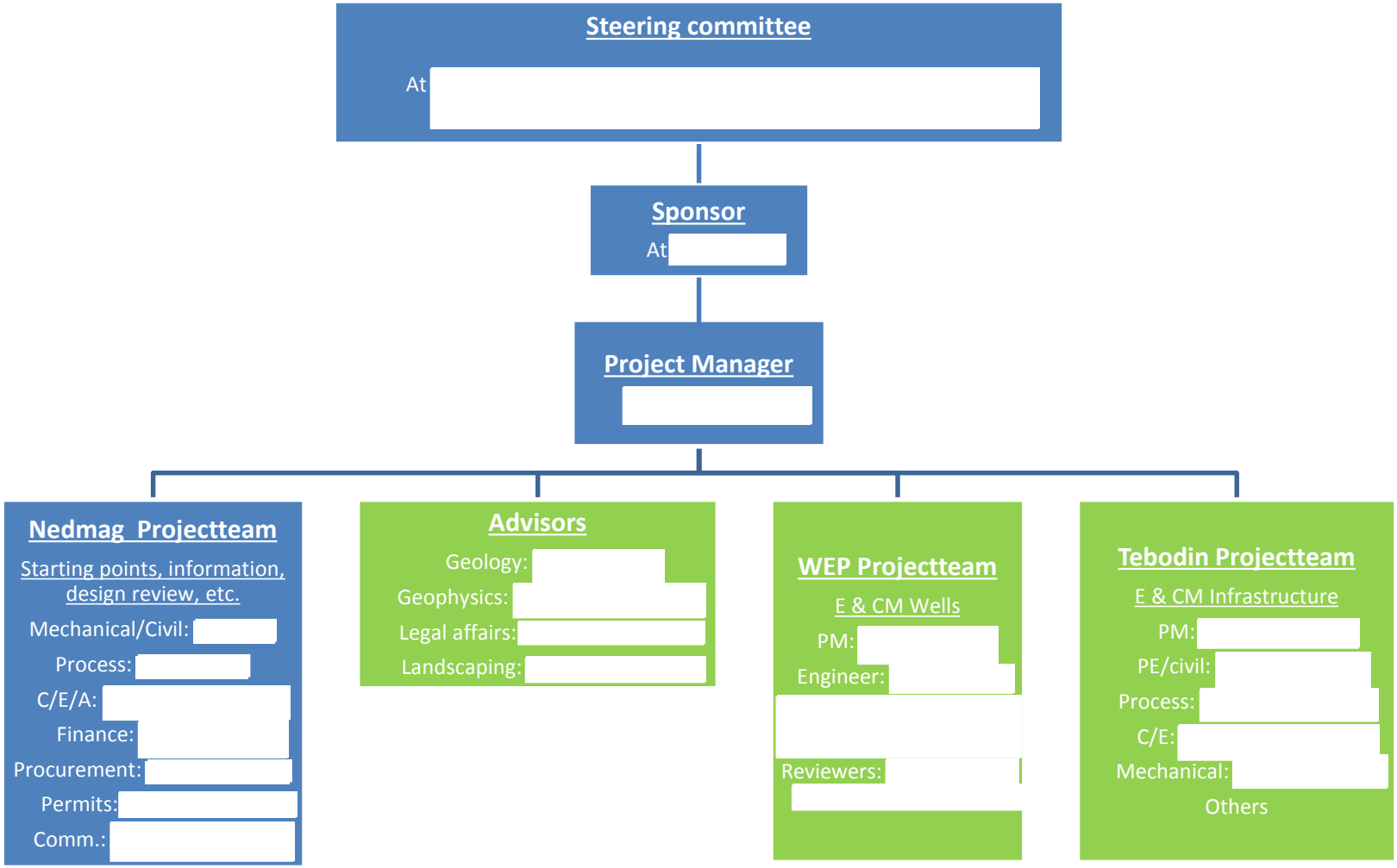
Introduction

- For continuity of $MgCl_2$ brine production, 2 new wells are planned to be drilled.
- VE-5 & -6 (VDM-5 / 6)
  - Large outstep wells, from existing WHC-1
    - WHC-1 planned to be extended in summer 2018 to accommodate wells
  - Included in existing winningsplan (with preliminary targets)
  - Drilling permit application submitted on 27/03/2018
  - Estimated start date drilling following permit processes ASAP in Q4

- Purpose of this meeting
  - Present well design and program
  - Discuss contingency scenario in the event that the well is dry.

Project organisation VE-5 and -6

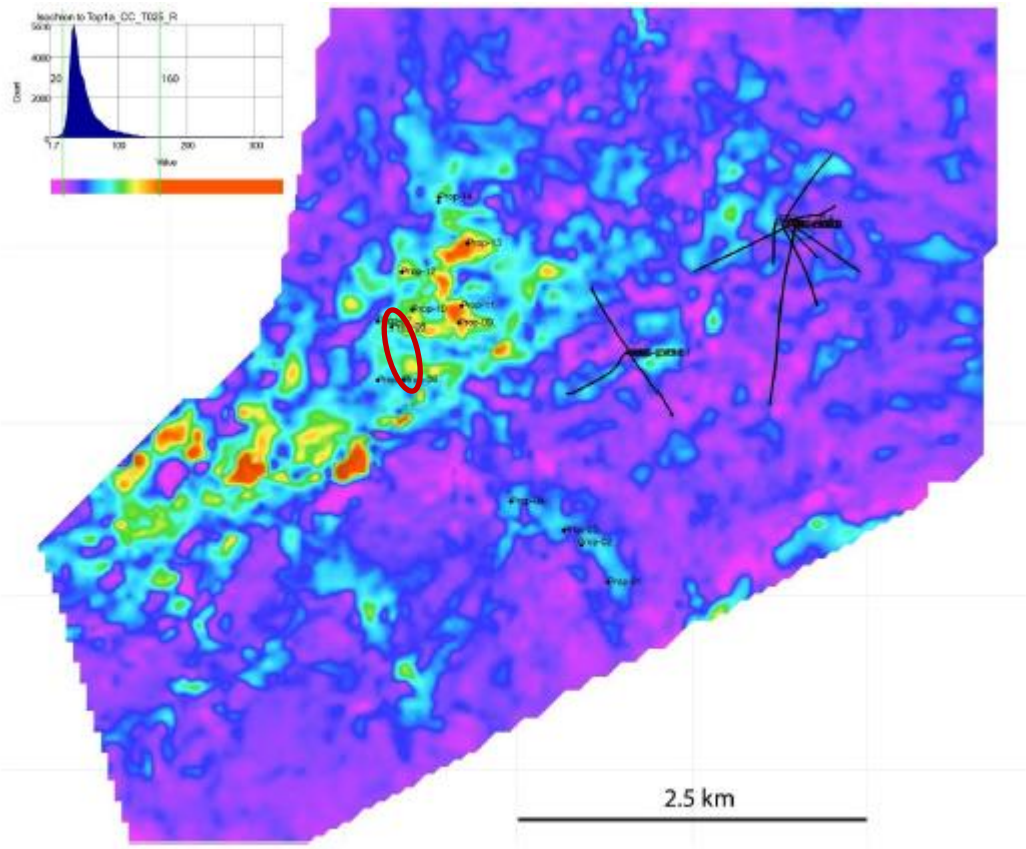


Target VE-5/VE-6

- For VE-5 & -6 wells, target locations have been selected on the Western side of WHC-1
- Main criteria: thickness of 1b layer and AI value of 1b layer
- The wells are planned to be drilled from the southern part of WHC-1
  - 1600 – 1700 metres outstep
- Target depths
  - VE-5: ca. 1695 m TVD
  - VE-6: ca. 1815 m TVD

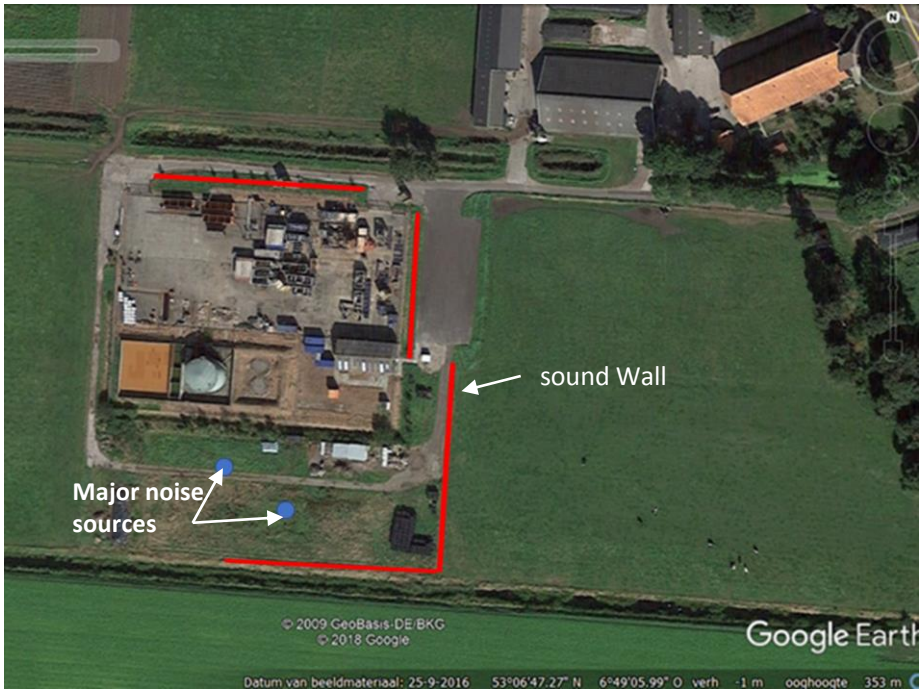
TARGET COORDINATES	
Well	VE-5
X-Coordinate RD	249.195
Y-Coordinate RD	570.319
Expected top 1b depth	1695m TVD below NAP
Expected 1b thickness	85 meters

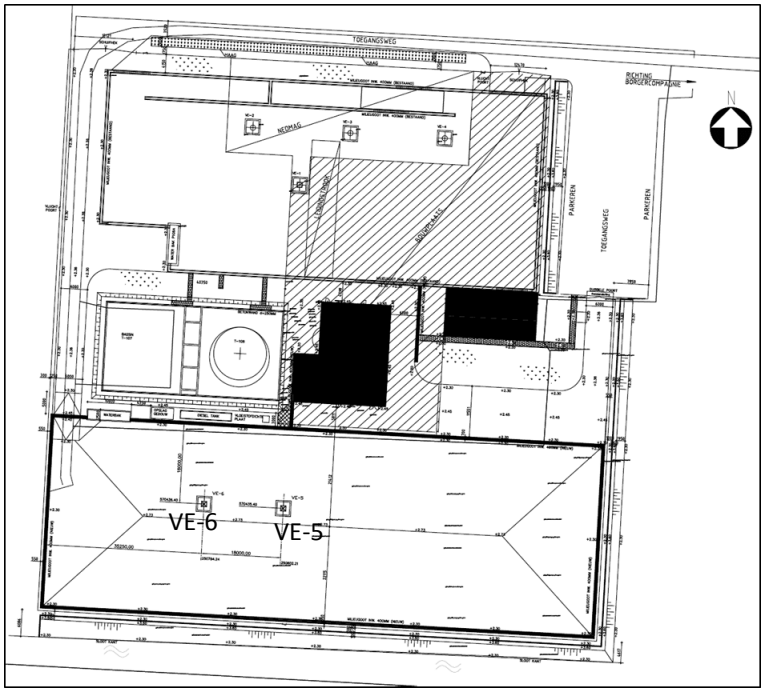
- Some finetuning target (X, Y) planned for Q2 2018

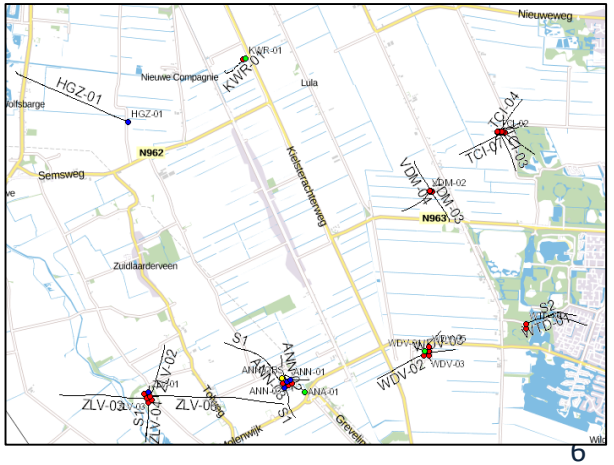


ZE-III 1b thickness

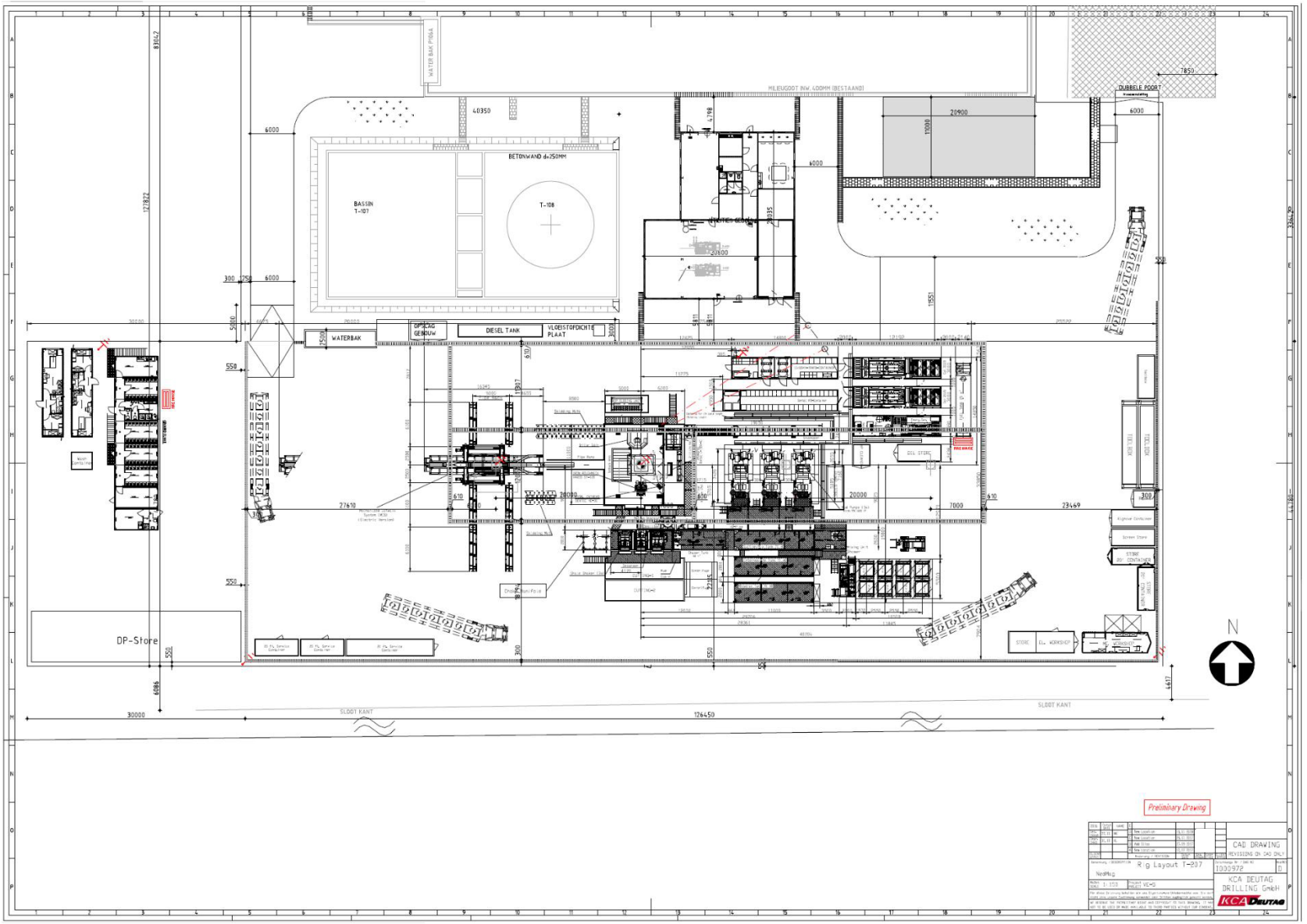
Location (Concept)



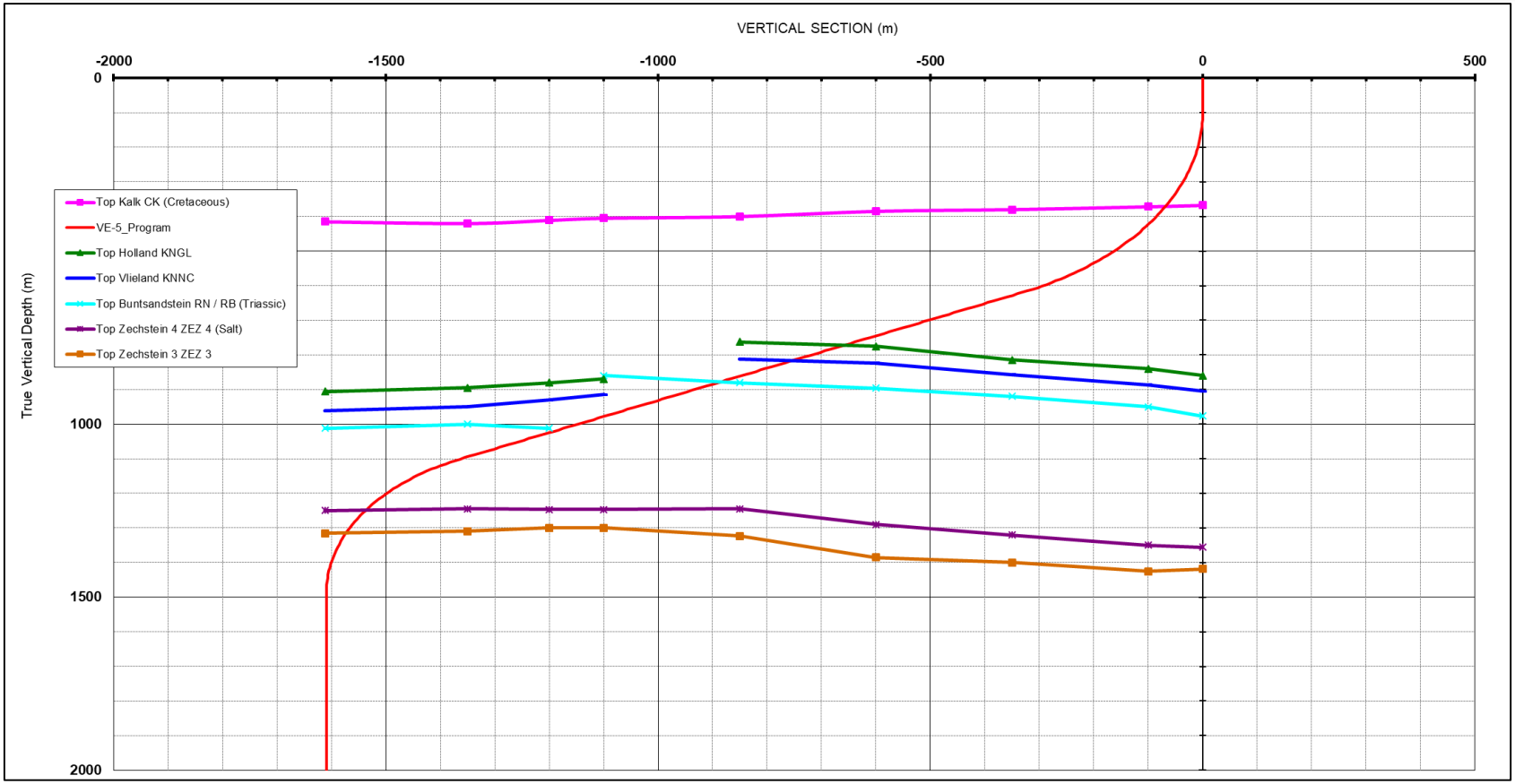




Location - Rig Layout



VE-5 Well Trajectory



options	VE-5				
	MD	TVD	inc	azi	BUR/DOR (°/30m)
Tie-down	0	0	0	0	0
KOP	100	100	0.00	265.86	3.00
EOB	750	619	65.00	265.86	0.00
SOD	1890	1101	65.00	265.86	-4.05
EOD	2380	1494	0.00	265.86	0.00
TD	2675	1784	0.00	265.86	0.00

Well Design

VE-5 (VDM-05)

Well name:	VE-5 (VDM-05)
Concession:	Veendam Zout
Well Type:	Solution mining producer & injec
Classification:	Deviated / S-shaped

Well Location

Rijksdriehoek Coordinate System
Surface Coordinates:
X: 250,802m Y: 570,437m
Target Coordicates:
X: 249,195m Y: 570,319m
Z: 1695m TVD NAP

Rig Information

Rig name: T207 KCA Deutag
BOP: 21 1/4" 5K psi
13 5/8" 10K psi

Well Objectives

Drill bischofitic brine well into layer 1b, Zechstein-3 formation
- core reservoir section
- bischofitic brine producer
- when cavern connects with VE-6 cavern convert well to water injector

Wellhead

Manufacturer:	Uztel
Type:	Spool
Size:	16" 5K psi

Geological Age & Formation Name			Depth (BRT) m AH	Depth (BRT) m TVD	Casing Design
Drilling Floor			0	0	
Ground Level					
NAP					
U. North Sea			69	69	24" Stove pipe
L. North Sea			251	250	
			297	294	20" Conductor 106.5# BTC
Chalk Group	Ommelanden		387	375	
	Texel				
Rijnland	U. Holland Marl		1154	790	
			1187	809	16" Surface csg 84# L80 BTC
	M. Holland Claystone				
	L. Holland Marl				
	Vlieland claystone	Fault 3			
RN	Solling Claystone		1331	865	
Rijnland	Holland	Fault 2	*1389*	*893*	
	Vlieland claystone				
Germanic Trias	Solling Claystone		1509	940	
	Volpriehausen	Fault 1			
	L. Buntsandstein		*2067*	1209	9 5/8" 47# L80 VAM TOP
					9 5/8" 53,5# L80 VAM TOP
Zechstein	Zechstein 4		2087	1230	
	Zechstein 3		2184	1315	
			2232	1349	9 5/8" 53,5# L80 VAM TOP
					10 3/4" 109# L80 VAM MUST
	ZEZ3, 2a		2461	1588	
			2540	1654	2 7/8" 6,4# L80 VAM TOP
			2555	1669	7" 29# L80 VAM TOP
					7" 46.4# L80 VAM SLIJ-II
					5" 15# L80 VAM TOP
			2555	1669	3 1/2" 10.2# L80 VAM FJL
			2585	1699	10 3/4" Produc csg 109# L80 VAM MUST
	ZEZ3, 1b		2590		
			2655	1769	7" 46.4# L80 VAM SLIJ-II
	ZEZ3, 1a				
			2675	1789	3 1/2" 10.2# L80 VAM FJL

Drill Bits & BHA	Drilling Fluid Design	Cementing Design
Pre-installed		
22" bits - XR+C PDM TD: 320m AHD	**KCl-Polymer** Density: 1,08-1,12 sg PV: ALAP YP: 20 - 25 pH: 9 - 10.5	Stinger type TOC: Surface Lead: 238m Tail 50m Density: 1.60 / 1.75 s.g
18 1/2" bits - GS03 - XC+C PDM Multi-cylce circ. sub TD: 1195m AHD	**KCl-Polymer** Density: 1,15-1,32 sg PV: ALAP YP: 20 - 30 pH: 8 - 8.5 MBT: <70 kg/m³ K+ >90 g/l Fluid loss: <3mls (API)	Stinger type TOC: Surface Typ: Class G Lead: 1028m 1.60 sg Tail 150m 1.75 sg OH Excess: 150%
BHA #1 12 1/4" bits - MDSiZ616 - MDSi616 RSS Multi-cylce circ. sub	**KCl-Polymer-Glycol** Density: 1.30-1.40 sg PV: ALAP YP: 22 - 28 pH: 9 - 10.5 MBT: <70 kg/m³ K+ >90 g/l Fluid loss: <3mls (API)	Plug type TOC: 1078m Type: Class G Lead: 1248m 1.70 sg Tail 150m 1.90 sg OH Excess: 75%
End of fault zone		
BHA #2 12 1/4" bit - MDSiZ616 - MDSi616 RSS Multi-cylce circ. sub TD: 2590m AHD	**OBM** Density: 1.45 sg PV: ALAP YP: 22 - 28 OWR: 75 / 25 ES: 500 - 800 V WPS: > 180 g/l Fluid loss: <3 mls	
8 1/2" Corehead EMS + XTU Reamer to ream hole to 15" TD: 2688m AHD	**OBM** Density: 1.70+ sg PV: ALAP YP: 18 - 25 OWR: 75 / 25 ES: 500 - 800 V WPS: > 300 g/l Fluid loss: <3 mls	Free hanging String

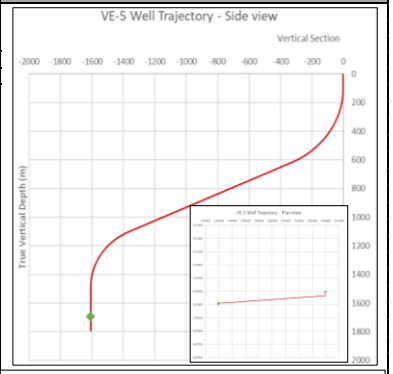
Potential Hazards:

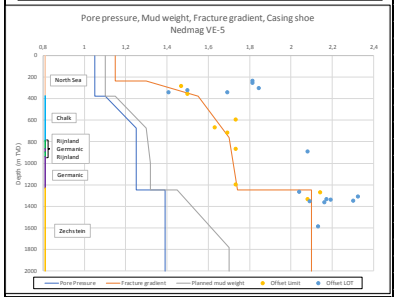
North Sea group:	**Rijnland:**
Swelling clays; bit balling	Swelling clays; bit balling; fault
Zechstein:	**Germanic Triasic:**
Squeezing salts	Mud losses; differential sticking; fault

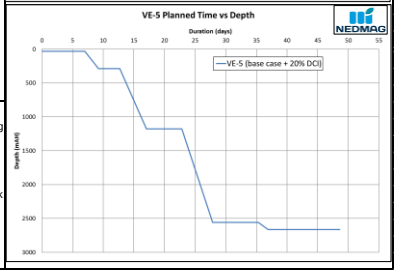
Data Acquisition Requirements

Mud logging	Logging & Surveying	Testing
69 - 320 m: 1 sample every 25 m Wet: 2 x 0,5kg; Dry: 2 x 0,1kg **320 - 1195m:** 1 sample every 20 m Wet: 2 x 0,5kg; Dry: 2 x 0,1kg	22" OH: MWD - GR / D+I 20" Casing: CBL / CCL / VDL 18 1/2" OH: MWD - Directional (D+I) - GR 16" Casing: Wireline - CBL / CCL / VDL	20" Casing: No test Cementing loads is Worst Case 16" Casing: Greycement 145 bar at surface with 1.32 sg mud
1190 - 2580 m: 1 sample every 10 m Wet: 2 x 0,5kg; Dry: 2 x 0,1kg **Near fault zone & Zechstein formation** : 1 sample every 5m Wet: 2 x 0,5kg; Dry: 2 x 0,1kg	12 1/4" OH: MWD - Directional (D+I) - GR RSS - Near-bit GR - Near-bit D+I LWD 1 - Lithodensity - Resistivity LWD 2 - Az. Sonic - Lithodensity 9 5/8" x 10 3/4" Casing: Wireline - USIT / CBL / CCL / VDL	LOT: 3m below 16" casing 9 5/8" Casing: Green cement 345 bar at surface with 1.45 sg mud
n/a	8 1/2" OH: Wireline - GR / BHC Sonic / Caliper/LD / CNL Completion strings: Wireline - CCL	LOT: 3m below 10 3/4" casing Completion: Test against WRBP/Lock 320 bar at surface with 1.70 s.g. mud

General Information







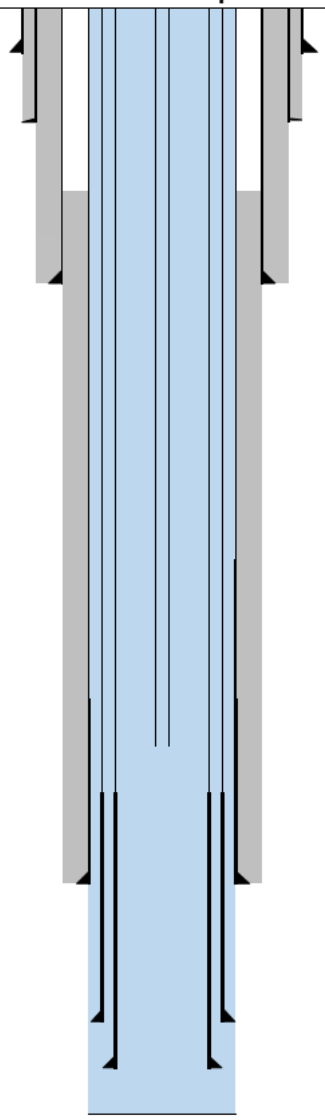
Well outline for VE-5

Author	EK	Prepared by:	Reviewed by:
Rev. No.	1	Leon de Villiers / Efe Kermen	Wouter Vink
Date	6-3-2018		

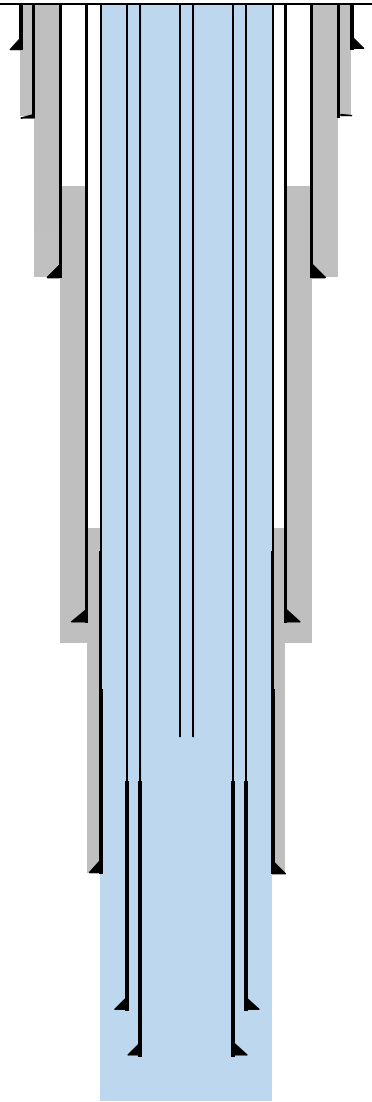
Approved by: Abel-Jan Smit

File Name: 1 page well summary.xls

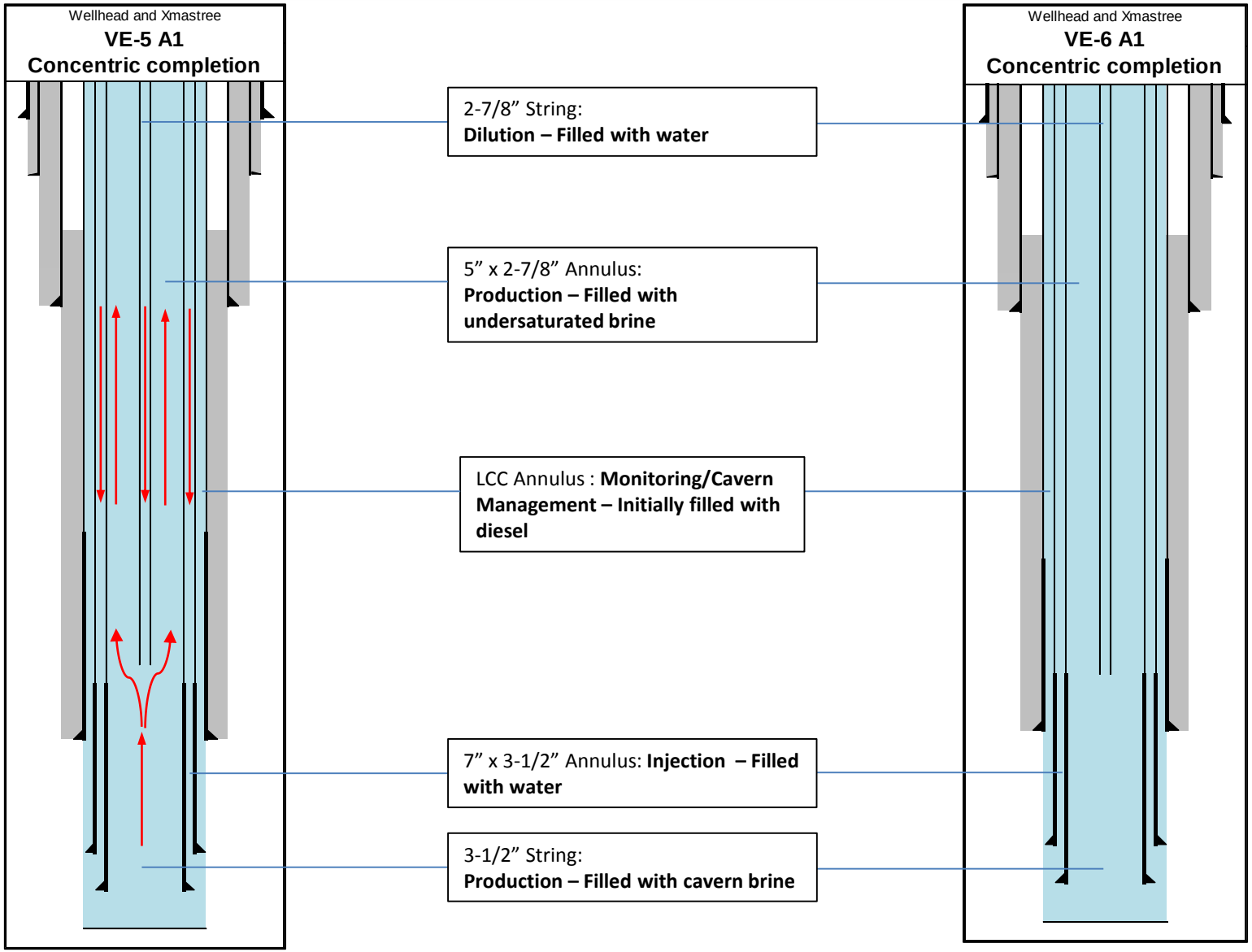
Well Design – Well Schematic

Nr.	Item Description Production / Injector well Depth ref RT	Wellhead and Xmastree VE-5 Concentric completion	Approx. Depth m tvd	Approx. Depth m ah	Hole ID standard in	Pipe OD in	Collar OD in (nom)	Pipe ID in	Pipe ID in (drift)
0	24" 125.7#		69	69		24.000		23.000	
1	20" 106,5# K55 BTC		294	297	22" OH	20.000	21.000	19.000	18.813
	TOC 16" x 9-5/8"		767	1087					
2	16" 84# L80 BTC		809	1187	18 1/2" OH	16.000	17.000	15.010	14.823
4	9,625" 47# L80 VAM TOP w/ X-O t/ 9,625" 53,5# L80 VAM TOP		1209	2067		9.625	10.396	8.681	8.525
	9,625" 53,5# w/ X-O t/ 10.75" 109# L80 VAM MUST		1349	2232		9.625	10.520	8.535	8.500
9	2,875" 6,4# L80 VAM TOP		1654	2540		2.875	3.222	2.441	2.347
6	7" 29# L80 VAM TOP w/ X-O t/ 7" 46,4# L80 VAM SLIJ-II		1669	2555		7.000	7.644	6.184	6.059
8	5" 15# L80 VAM TOP w/ X-O t/ 3.5" 10,2# L80 VAM FJL		1669	2555		5.000	5.470	4.408	4.283
3	10,75" 109# L80 VAM MUST		1699	2585	12 1/4" OH	10.750	10.750	8.684	8.528
5	7" 46,4# L80 VAM SLIJ-II		1769	2655		7.000	7.323	5.626	5.501
7	3,5" 10.2# L80 VAM FJL		1789	2675		3.500	3.500	2.922	2.797
			1802	2688	8 1/2" x 15" UR				

Well Design – Contingency

Nr.	Item Description Production / Injector well Depth ref RT	Wellhead and Xmastree VE-5 CONTINGENCY	Approx. Depth m tvd	Approx. Depth m ah	Hole ID standard in	Pipe OD in	Collar OD in (nom)	Pipe ID in	Pipe ID in (drift)
0	24" 125.7#		69	69		24.000		23.000	
1	20" 106,5# K55 BTC		294	297	22" OH	20.000	21.000	19.000	18.813
	TOC 16" x 13-3/8"		766	1087					
2	16" 84# L80 BTC		809	1187	18 1/2" OH	16.000	17.000	15.010	14.823
	TOC 9-5/8" Casing		1166	2006					
5	9,625" 47# L80 VAM TOP w/ X-O t/ 9,625" 53,5# L80 VAM TOP		1209	2067		9.625	10.396	8.681	8.525
3	13,375" 68# L80 VAM TOP		1239	2106	12 1/4" x 16" UR	68.000	14.175	12.415	12.259
	9,625" 53,5# w/ X-O t/ 10.75" 109# L80 VAM MUST		1374	2259		*9.625*	10.520	8.535	8.500
10	2,875" 6,4# L80 VAM TOP		1654	2540		2.875	3.222	2.441	2.347
7	7" 29# L80 VAM TOP w/ X-O t/ 7" 46,4# L80 VAM TOP		1669	2555		7.000	7.644	6.184	6.059
9	5" 15# L80 VAM TOP w/ X-O t/ 3.5" 10,2# L80 VAM TOP		1669	2555		5.000	5.470	4.408	4.283
4	10,75" 109# L80 VAM MUST		1699	2585	12 1/4" OH	10.750	10.750	8.684	8.528
6	7" 46,4# L80 VAM SLIJ-II		1769	2655		7.000	7.323	5.626	5.501
8	3,5" 10.2# L80 VAM FJL		1789	2675		3.500	3.500	2.922	2.797
			1799	2685	8 1/2" x 15" UR				

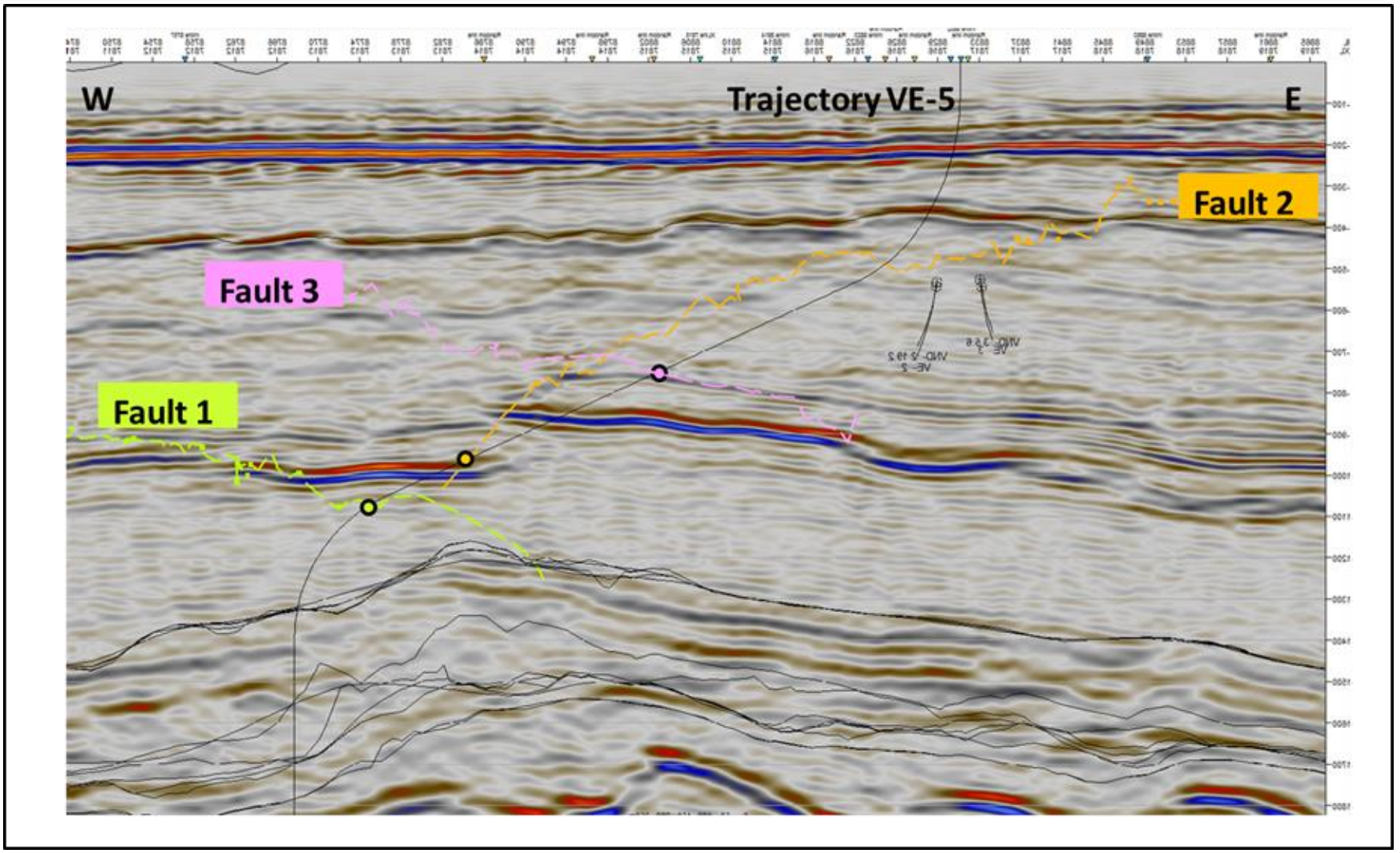
Well Design – In Production



Well design – Challenges

- Hole cleaning in 22” & 18-1/2” sections
  - 22” section
    - 30-meter rathole
    - Solids control equipment
  - 18-1/2” section
    - Pump out of hole
    - Multi-cycle circulation subs
    - Contingency: Check trip BHA
- Faulted region & potential loss zone
  - Up to three faults have been identified along the well trajectory
    - Fault 1 → Top Triassic (Solling Claystone)
    - Fault 2 → Base Cretaceous (Vlieland Claystone / Sandstone)
    - Fault 3 → Cretaceous (Lower Holland Marl / Vlieland Claystone)
  - Inactive faults
    - Most likely clay smeared, therefore sealing.
  - No faults seen when drilling offset wells
  - Potential loss zone identified in Rogenstein Member of Lower Buntsandstein Formation
    - Total losses reported in HGZ-01 (@6,5km distance)
- Dry-well scenario

Faults along Well Trajectory



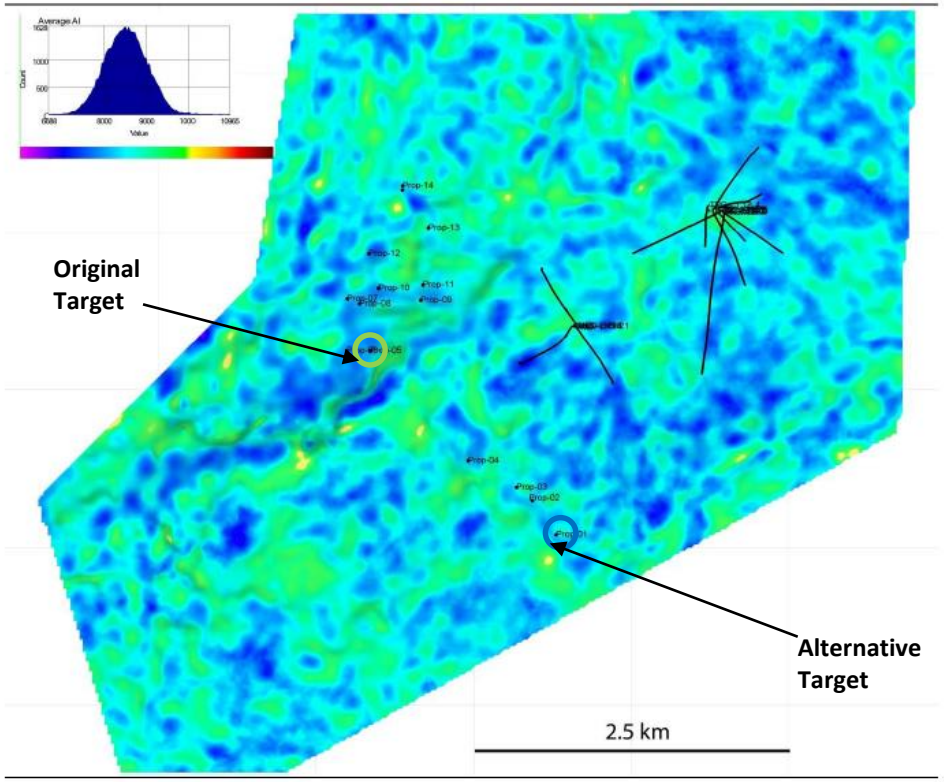
Dry-well Scenario

- Well acceptance criteria have been set to determine if the well is sufficient for production
  - The characteristics of the target formation will be determined by a combination of
    - Coring, including chemical analysis
    - E-line Logging
    - Geological evaluation
  - VE-5 well will be considered ‘dry’, if any of the following criteria is met
    - Halite roof thickness Ze III 4 / Ze IV <40 meters
    - Cumulative bischofite column thickness <±10meters

- In the event that VE-5 is dry, the well will be plugged and abandoned; and a new well will be drilled (from the same surface location), targeting a different location.

Dry-well Scenario - Options

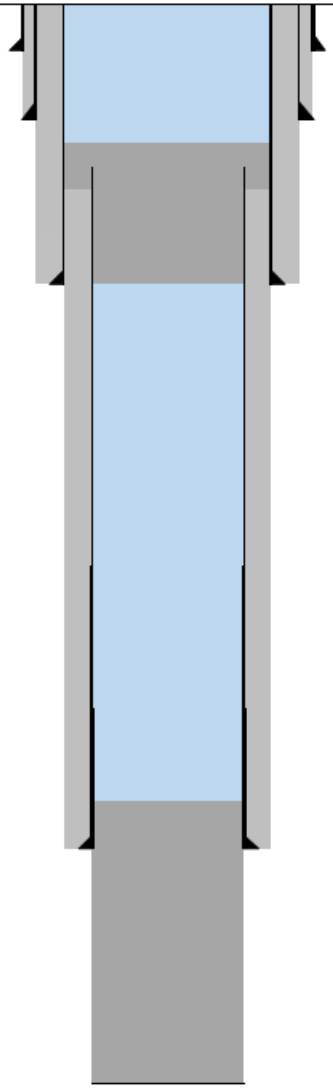
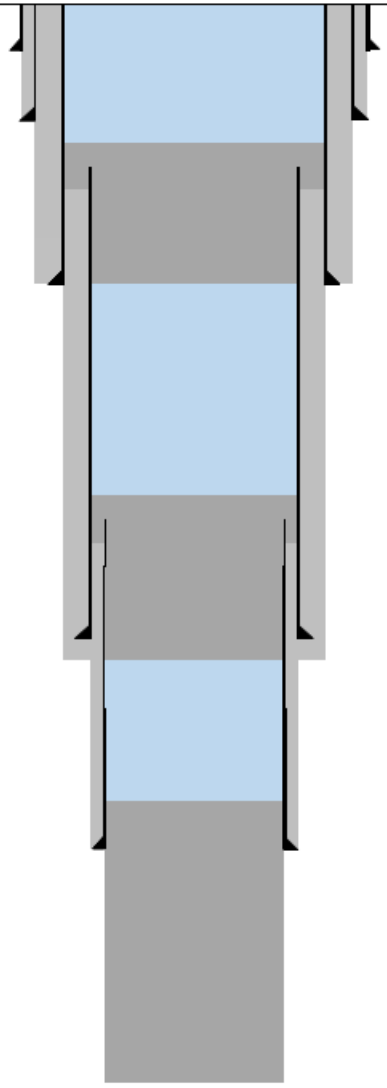
- In the event of a dry well in primary target coordinates, the new well (and the subsequent VE-6 well) will target a different zone, towards the South of the surface location.



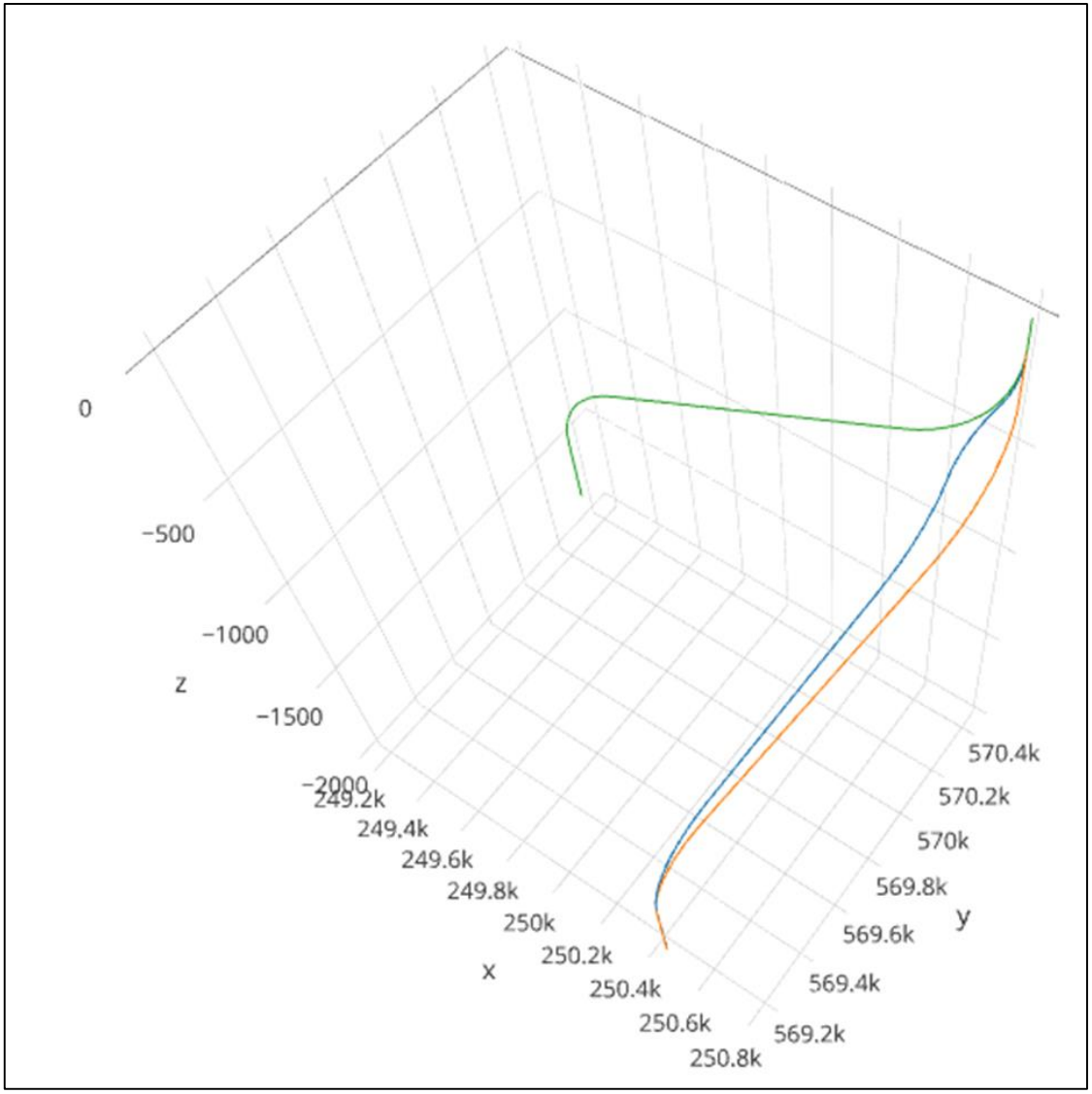
- New well will be drilled from VE-5
  - Exit below conductor of VE-5
- Second well (VE-6 slot) depended on availability of casing

RD coordinates (m)			
Target (ZEZ3-1b)	X	Y	Depth
VE-5S1	250.452	569.154	1820

Dry-well Scenario – P&A

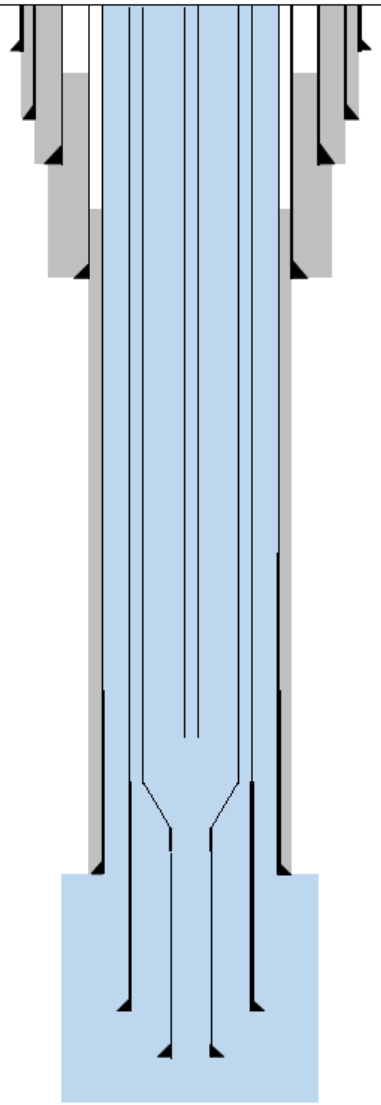
Item Description Production / Injector well Depth ref RT	Wellhead and Xmastree **VE-5 A1 - P&A** **no completion**	Wellhead and Xmastree **VE-5 A1 P&A** **CONTINGENCY**	Approx. Depth m tvd	Approx. Depth m ah	Formation tops
24" 156.2#			69	69	Upper North Sea
20" 106,5# K55 BTC			294	297	Lower North Sea
TOC 16" x 9-5/8" / 13-3/8"			766	1087	
16" 84# L80 BTC			809	1187	Holland Fm
					Vlieland Clayst. (KNNC) Germanic Trias. (RN/RB) Fault Holland Fm Vlieland Clayst. (KNNC)
					Germanic Trias.
					Fault
TOC 9-5/8" Casing			1166	2006	
9,625" 47# L80 VAM TOP w/ X-O t/			1209	2067	
9,625" 53,5# L80 VAM TOP 13,375" 68# L80 VAM TOP			1239	2106	
					Zechstein 4 Zechstein 3
9,625" 53,5# w/ X-O t/ 10.75" 109# L80 VAM MUST			1374	2259	ZE Z3, 2a
10,75" 109# L80 VAM MUST			1699	2585	
					ZE Z3, 1b
			1799	2685	ZE Z3, 1a

Dry-well Scenario – Well Trajectory



VE-5-S1			
Item	Depth		Comments
	mD	TVD	
KOP	100	100	Original wellbore; azimuth 265,9°
Exit	330	324	Also EOB initial section
Start of turn	340	333	Turn rate: 7,38°/30m (DLS 3,0°/30m)
End of turn	650	616	Azimuth 190,10°
KOP 2	660	625	Build-up rate (BUR): 3°/30m
EOB	1070	912	Maximum inclination: 65°
SOD	1830	1233	Drop-off rate (DOR):4,05°/30m
EOD	2310	1616	Well vertical ≥ 40m before ZEZ3-3b
Well TD	2590	1896	

Dry-well Scenario – Well Schematic VE-5-S1

Item Description Production / Injector well Depth ref RT	Wellhead and Xmastree VE-5 S1	Approx. Depth m tvd	Approx. Depth m ah	Hole ID standard in	Pipe OD in	Collar OD in (nom)	Pipe ID in	Pipe ID in (drift)
24" 156.2#		69	69					
TOC 16" x 13-3/8"		196	197					
20" 106,5# K55 BTC		294	297	22" OH	20,000	21,000	19,000	18,813
16" 84# L80 BTC / whipstock exit		315	320	18 1/2" OH				
TOC 9-5/8" Casing		737	790					
13,375" 68# L80 VAM TOP		850	950	12 1/4" x 16" UR	13,375	14,175	12,415	12,259
9,625" 47# L80 VAM TOP w/ X-O t/ 9,625" 53,5# L80 VAM TOP		1200	1752		9,625	10,396	8,681	8,525
9,625" 53,5# w/ X-O t/ 10.75" 109# L80 VAM MUST		1667	2361		9,625	10,520	8,535	8,500
2,875" 6,4# L80 VAM TOP		1785	2480		2,875	3,222	2,441	2,347
7" 29# L80 VAM TOP w/ X-O t/ 7" 46,4# L80 VAM TOP		1790	2485		7,000	7,644	6,184	6,059
5" 15# L80 VAM TOP w/ X-O t/ 3.5" 10,2# L80 VAM TOP		1790	2485		5,000	5,470	4,408	4,283
10,75" 109# L80 VAM MUST		1820	2515	12 1/4" OH	10,750	10,750	8,684	8,528
7" 46,4# L80 VAM SLIJ-II		1890	2585		7,000	7,323	5,626	5,501
3,5" 10.2# L80 VAM FJL		1910	2605		3,500	3,500	2,922	2,797
8,5 x 15" hole section		1920	2615	8 1/2" x 15" UR				

Current Planning

Permit drilling mid September
Drilling Q4
VE-5 ~50 days
VE-6 ~50 days

VE-5 Drilling program + HSE documents mid July
VE-6 Drilling program + HSE documents mid September

Stove pipe:
Installation begin August
BARMM begin July