SHELL PETROLEUM DEVELOPMENT COMPANY OF NIGERIA LIMITED

DIEBU CREEK 012T
WATER SHUT-OFF, PERFORATION EXTENSION AND SCON PROPOSAL
(CO LOG, WHM & FLOWLINE REPAIR REQUIRED)

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II. TABLE OF CONTENT

1. OBJECTIVE

WELL:	DIEBU CREEK 012T
TYPE:	Water Shut-off, Perforation Extension, SCON, WHM and FLRR Proposal
OBJECTIVE:	To restore production on Diebu Creek 012T on the E1000X sand by carrying out water shut-off, perforation extension, chemical sand consolidation, well head maintenance and flowline repair and/or replacement. This activity is expected to unlock a potential of 700 bopd and develop resource volume of 1.37 MMstb.

2. WELL HISTORY/ PRESENT STATUS

DIEBU CREEK 012T: E1000X: 10,279 – 10,288; 10,302 – 10,308 ftah (10,223 - 10,233; 10,248 - 10,253 ftss) SCON

Diebu Creek 012T was drilled in November 1974. It was later completed as a single string dual completion in June 1975 and came on stream in August 1975 at an initial rate of 961 bopd on bean 20/64". It attained a peak rate of 3,719 bopd by March 1976 on bean 40/64''. The well was beaned up to 48/64'' in January 1979, resulting to water ingress (water cut recorded was 2%). In July 1979 the interval was beaned down to 30/64'' due to excessive gas production at a rate of 6,500 scf/bbl and increasing water cut, which stood at 10%.

The interval continued to produce at a rate of 1,400 bopd dry, until August 1984 when it started producing sand at an average rate of 8pptb. The interval though beaned down to 24/64" continued to produce sand until the well quit in November 1990. A subsequent drift run made in January 1991 revealed that the well was sanded up. Subsequently, a sand wash and re-consolidation, using Eposand – 212 was carried out in 1992 to restore the well's production. Production performance post-sand wash indicated that the well was producing with 98% water cut. Further investigation revealed that the lower set of perforations were flooded with water. Thus in 1993, the lower sets of perforations were temporarily isolated behind plug and the upper perforations opened.

The well was opened in 1994 post sand wash & lower perforation isolation and the well-produced intermittently until water broke through in 2002 with BS&W rising from 14% to 62% in August 2006. The well eventually quit production due to HBSW. The last recorded production in December 2006 was 781 bopd, GOR of 1395 scf/bbl, water cut of 61.31 and a THP of 1015 psi on bean 24/64''.

3. JUSTIFICATION AND PROPOSED ACTION

Diebu Creek 012T is one of the completed conduits on the E1000X reservoir and has historically produced satisfactorily with a cumulative production of ca. 7.80 MMstb. The well quit on vertical lift challenges as a result of HBSW in December 2006.

A review of historical well performance showed that the existing perforation is currently flushed but has scope for water shut-off and perforation extension. Based on the MBAL estimated present contacts (PGOC & POWC), there is ca. 50ft of oil column below the PGOC that can be targeted by this well on the E1000X reservoir. Hence, it is proposed to carry out a Water shut-off activity on the existing perforations (10,279 – 10,288; 10,302 – 10,308 ftah (10,223 - 10,233; 10,248 - 10,253 ftss) and shoot new perforations between 10,260 – 10,270 ftah (10,205 – 10,215 ftss). The proposed perforation must be validated/further optimized based on results of Pulsed Neutron (CO/Sigma) log data from Diebu Creek 012T. If Pulsed Neutron (CO/Sigma) log is not acquired the entire activity will be regretted.

It is therefore necessary to acquire CO logs to optimize the proposed perforation interval due to inherent reservoir heterogeneity, fault pattern, uncertainty in the MBAL predicted present contacts and uneven reservoir sweep observed from the producing conduits on the E1000X reservoir. Furthermore, the available CO log data in the E1000X reservoir was acquired on the North block of the reservoir (Diebu Creek 009T) in 1994, there has been significant production thereafter necessitating the need to acquire fresh CO log data.

Diebu Creek 012T was initially completed with SCON. Historically, sand cut has been below the Shell cut-off of 10 pptb in this well. However, to forestall future sand production from the new perforations, the interval will be treated with SCON as remedial sand control. Flow line repair and/or replacement (FLRR) will also be carried out as the flowlines have been inactive since 2006. Consequently, the well head valves will be serviced and maintained.

It is therefore proposed to carryout water shut-off, perforation extension, SCON treatment, WHM and FLRR activity to restore potential of 700 bopd and develop contingent oil resource of 1.37 MMstb.

4. PROPOSAL SUMMARY

1. Acquire Pulsed Neutron Log data (CO & Sigma mode).
2. Carry out Chemical WSO & add perforations to the E1000X sand.
3. Deploy SCON across new perforations and allow to cure. If injectivity is poor (<1bbl/min), carry out acid soak to improve injectivity. (See Appendix 14 for Decision Tree)
4. Carry out wellhead repairs
5. Open well to flow.
6. Hand back well to Production.

5. SCON RECIPE

Analysis of Diebu Creek 012T historical performance suggests that sand control is required to maintain the sand below the acceptable limit of 10pptb to safeguard the well equipment and facilities. Although the depth of the target sand is >10,000 ft-tvd, Chemical Sand Consolidation (SCON) will still be deployed as a sand exclusion mechanism to sufficiently retain the formation sand post perforation extension

Chemical Sand Consolidation Fluid Schedule and Perforation Details:

NB: Preliminary Sand Trap 225 Schedule – E1000X Interval

Fluid Schedule –	Rate	E1000X – 10 ft perforation
Preflush 1 – 100 gal/ft.: 7% KCl + 0.5% ES 5	1.0 bpm	23.81 bbl.
Preflush 2 – 100 gal/ft.: Musol	1.0 bpm	23.81 bbl.
Main Treatment – 150 gal/ft.: Sand Trap 225 resin	1.0 bpm	35.71 bbl.
Spacer – 100 gal: Diesel	1.0 bpm	2.4 bbl.
After flush – 150 gal/ft.: 7% KCl + 0.5% ES 5	1.0 bpm	35.71 bbl.
Displacement	1.0 bpm	CT Volume

Perforation:

Production data suggests that the existing perforation has been flushed, hence the need to perforate shallower and target the oil above the existing perforation. The proposed perforation depths were selected based on the estimated PGOC and POWC from MBAL model (PGOC / POWC at 10202/ 10,252 ftss respectively), while integrating the open hole data and production performance from the producing conduits.

	Existing Perforation		Proposed Perforation	
Reservoir	ftah	ftvdss	ftah	ftvdss
E1000X	10,279 - 10,288 10,302 - 10,308	10,223 - 10,233 10,248 - 10,253	10,260 – 10,270	10,205 – 10,215

Note:
- The existing interval perforations will be squeezed-off and 10ft of new perforations will be added across the E1000X during the STOG activity.
- Perforation is a safety critical operation and must be conducted in line with all required safety precautions during gun arming, running in hole and pulling out of hole.
- The proposed perforation must be validated/further optimized based on results of Pulsed Neutron (CO/Sigma) log data from Diebu Creek 012T.

The proposed intervals will be perforated overbalance using a deep penetrating gun, 60 deg. phasing, 6 shots per foot.

6. POTENTIAL ESTIMATION

The well performance evaluation software, PROSPER, was used to determine the potential for Diebu Creek 012T on the E1000X reservoir. The SPOT IPR model was used to define the IPR for the proposed 10 ft perforations. Water cut of ca. 20% was assumed considering the expected breakthrough of water post intervention. Sensitivity on different choke sizes was made (16/64" to 32/64") while noting the impact on the drawdown applied to the reservoir. Bean 24/64" potential was used for the economic and technical evaluation of this activity resulting to a net oil potential of ca. 1019 bopd.

A risk factor of 70% was applied to the net potential based on OP18 premise for NFA (WO) technical risks assumptions on historical success rate for Water Shut-off, Perforation Extension and Chemical Sand Consolidation (SCON) and the risk of high gas production was also considered resulting to a risked potential of 700 bopd. Further sensitivity on starting water cut was done to provide a range of potentials expected from the proposed activity on the conduit.

DBUC 012T: E1000X Assuming 20% BSW and Current Av. Reservoir Producing GOR							
Bean (/64-in)	Gross Rate (bpd)	Net Rate (bopd)	FBHP (psig)	Drawdown (psi)	Water cut (%)	GOR (scf/bbl)	FTHP (psig)
16	620	496	3869	241	20	2450	1689
20	936	749	3739	371	20	2450	1654
24	1274	1019	3597	513	20	2450	1584
28	1626	1301	3440	670	20	2450	1505
32	1961	1568	3285	825	20	2450	1409

Conduit	Well Potential (bopd)		
	Low	Base	High
Diebu Creek 012T	500	700	840

7. RESOURCE ESTIMATION

The resource associated with this opportunity was estimated using Material balance model that was history matched with the performance and reservoir pressure data for the E1000X. The MBAL model indicates that the reservoir aquifer is responding strongly to production and leading to re-saturation of the gas cap. This is further supported by stable historical pressure in the reservoir despite the huge off-take from the reservoir. Potential of 700bopd used in the MBAL model was generated using the performance curves of the calibrated prosper model as the initial rate and applied the abandonment conditions to determine the recoverable volumes. The MBAL model gave a base case resource estimate of 1.37MMstb to be developed from the E1000X. The MBAL plot is shown in Appendix 8. The table below shows the range of resource volumes expected from the proposed activity on the conduit.

Interval	Reservoir	Planned DUR (for the interval)- MMstb	Np (for the interval) MMstb	Contingent Resources to be Developed by activity- MMstb		
				Low	Best	High
Diebu Creek 012T	E1000X	9.17	7.80	1.07	1.37	3.54

8. DATA ACQUISITION PLAN

Pulsed Neutron (Carbon Oxygen & Sigma) logs will be acquired during the rig less intervention activity to delineate present fluid contact (PGOC and POWC) on the northern part of the E1000X reservoir and further optimize the proposed perforation interval on Diebu Creek 012T. (Ref. DBUC-012 Pulsed Neutron Log proposal) Gamma Ray/ Casing Collar Locator (GR/ CCL) log will be acquired on wireline to depth match wireline perforation tool with the open hole logs to ensure perforation gun is on depth.

The logging details are captured in Table 1 below. Logging risk and mitigation plan are covered in Table 2.

Table 1: Detailed Logging Plan

Survey	Formation	Interval (ftah bdf)	No. of Pass	Original Fluid Type
Drift Run	All	0 – 10390	1	Gas/ Oil / Water
Sigma Pass	E1000X / E1800	10390 – 10080	1	Gas/ Oil / Water
Sigma Pass (Repeat)	E1000X	10390 – 10080	1	Gas/ Oil / Water
C – O Pass	E1000X/E1800X	10390– 10080	4	Gas/ Oil / Water
C- O Pass (Calibration)	Water leg	9456 - 9356	4	Water

Note:

1. *All depths with respect to PDL and status diagram.*
2. *Correlate and log one pass of the gas view/ sigma mode. For the inelastic mode, a minimum of 4 passes is required.*
3. *Additional pass may be required if Signal to Noise ratio is poor.*
4. *If HUD is encountered, contact operations Petrophysicist to advise forward plan.*

Log Required	Logging Interval (ftah)	Remark
GR/ CCL	10000 – 10290	For correlation to put perforating gun on depth

Table 2: Logging Risk and Mitigation Plan

RISKS	POTENTIAL RISK ASSEMENT FOR DATA ACQUISITION (RAM MATRIX)		MITIGATION/MANAGEMENT
	LIKELIHOOD	IMPACT	
Well Control situation during wireline perforation run.	B	4P, 4A, 1E, 2C	▪ Ensure proper well conditioning before commencement of logging. ▪ Recommended tool speed for each logging run should be maintained. ▪ Appropriate Wire line BOP/ lubricator should be provided as contingency.
Surface gun discharge, gun misfiring and depth correlation mismatch	B	4P, 2A, 1E, 2C	▪ Use radio frequency safe detonators during wireline perforation operations. ▪ "Perforate Well on Paper" will be carried out in line with DEP ahead of operations. ▪ Run GR/ CCL correlation and interpretation to be carried out to put gun on depth for perforation. ▪ Gun firing must have redundancy mechanism. ▪ Inspect all charges to ensure full gun firing downhole.
Personnel exposure to radiation	B	3P, 1A, 4C, 4E	▪ Key logging personnel should wear dosimeters to check exposure to radiation and follow the required guidelines on RA logging tool handling as applicable. ▪ The logging tool should be kept and secured with perimeter protection and CAUTION sign before and after operation. ▪ The logging tools should be handled by trained and certified personnel ONLY. The lead engineer is responsible for handling the tool during transfer from/ to rack to/ from the logging tool. ▪ The logging tool must be 400ft below the surface while RIH and POOH before the neutron generator is switched on and before the continuation of normal operations on the well.
Getting stuck with radioactive tool in hole	C	0P, 3A, 0C, 0E	▪ Ensure the neutron generator is deactivated/ turned off. ▪ Ensure availability of appropriate fishing tools at the well site during WL logging. ▪ Pre-job safety meeting to hold before operation to intimate everyone of risk involved in deploying radioactive tool.

RISKS	POTENTIAL RISK ASSEMENT FOR DATA ACQUISITION (RAM MATRIX)		MITIGATION/MANAGEMENT
	LIKELIHOOD	IMPACT	
Inability of the tool to go downhole due to well inclination or borehole conditions (HUD Shallower than Target Zone)	C	0P, 1A, 0C, 0E	▪ Ensure that drift and dummy runs are carried out in all the wells before the execution of the logging program. ▪ Maximum deviation is about 5deg, hence minimal restriction is expected
Logging tool unable to go beyond XN Nipple	C	0P, 1A, 0C, 0E	▪ Contractor is required to provide a 1-11/16" tool as well as carry out drift run. Acquire data over revised depths. ▪ Risk to be adequately discussed during SWOP/ LWOP to identify mitigation plans for the activity.

9. WELL & RESERVOIR DATA SHEET

S/N	WELL/ SAND:	UNIT	Disc.	DIEBU CREEK 012T (E1000X)
1	a) Perforated interval b) Perforated interval c) Proposed Perforation interval d) Proposed perforation interval	ftah ftss ftah ftss	PP	10,279 – 10,288; 10,302 – 10,308; 10,223 – 10,233: 10,248 – 10,253; 10,260 – 10,270 10,205 – 10,215;
2	a) Maximum Deviation Angle and Depth b) Derrick Floor Elevation c) Vertical Correction to mid- Perforation + DFE	° @ ftah ft ft	PG	2.97° @ 7254 54 N/A
3	a) Last Production Rate	bopd	PT	781 bopd @ Dec. 2006
4	a) Reference Depth for Reservoir Pressures b) Original Reservoir Pressure * c) Present Reservoir Pressure d) Present Gradient e) Bubble Point Pressure f) Specific Gravity of Oil 60/60 g) Oil Viscosity at Reservoir Condition h) Solution Gas-Rsi (initial condition) i) Formation Volume Factor (initial condition) j) Static Reservoir Temperature	ftss psig psig psi/ft psig SG cP scf/stb - ° F	RE	10250 4480 4122 0.402 4480 0.82 0.23 1753 1.751 189
5	a) Other Wells Producing from the same Block b) Last production from Block (@ Aug. 2019) c) Ultimate Recovery (@ Aug. 2019) d) Cumulative Production from Block (@ Aug. 2019) e) Cumulative Production from Well (@ Aug. 2019) f) Resource volume from Well	- bopd MMstb MMstb MMstb MMstb	RE/PT	1 2543 9.17 139.5 7.80 1.37
6	a) Porosity b) Shale Percent c) HC Saturation d) Permeability e) Sand Thickness as per PDL f) Net Oil Sand g) Net/Gross Ratio h) Original estimated GOC in Well (or Reservoir) i) Present estimated GOC in Well (or Reservoir) j) Change in GOC from original GOC k) Distance Between Highest Perforation and PGOC	% % % mD ftvd ftvd frac ftss ftss ft ft	PP	25 12 91 1993 250 78 0.88 10192 10202 (MBAL 2019) 10 3
7	a) Original Estimated OWC in Well (or Reservoir) b) Present Estimated OWC in Well (or Reservoir) c) Change in OWC From Original OWC d) Distance Between Lowest Perforation and POWC	Ftss Ftss ft ft tvd	PP	10316 10252 (MBAL 2019) 64 37
8	a) Tubing Size/Weight b) Casing Size/Weight c) Liner Size/Weight	in/ibs/ft in/ibs/ft in/ibs/ft	PT	3-1/2"/ 9.2 7"/ 23 N/A
9	a) Average Hole Size across Completion Interval	in	PP	8.5
10	a) Is there a barrier between top of completion Interval and the present estimated GOC. b) Is there a barrier between lowest completion Interval and the present estimated OWC		PG	Yes No

NA – Not Available, N/A - Not Applicable

10. RECENT WELL TEST DATA

Well	Date	Choke	BS&W	Gross	Net	GOR	Sand	FTHP	CHP
DBUC012T	May 2006	26	56	2000	880	949	1.20	957	0
DBUC012T	June 2006	26	60	2092	833	1273	0.70	957	0
DBUC012T	July 2006	26	60	1939	769	1167	1.40	957	0
DBUC012T	August 2006	26	62	1877	719	1435	1.50	1015	0
DBUC012T	September 2006	26	61	1990	785	1328	0.20	1015	0
DBUC012T	November 2006	26	62	2009	772	1249	0.20	1015	0
DBUC012T	December 2006	26	60	1967	781	1395	0.20	1015	0

11. COST ESTIMATE

The total cost of the 4.8 KM flowline replacement **is $1,342,398.52,** while the total cost of the CO log, Water Shut-off, Perforation Extension and SCON is **$2,286,833.40**

S/N	DBUC 9T & 12T - WSO, PERF EXT, SCON, N2 LIFT	$
1	Mobilization	63,860.62
2	WHM package	39,000.00
3	Slickline package	28,950.00
4	Coiled Tubing Package	254,921.78
5	Swamp Logistics	675,610.00
6	Sand Trap (10ft interval)	132,000.00
7	Back Stop Treatment	116,715.30
8	QA/QC Engineer	11,964.00
9	Perforation	105,000.00
10	Liquid Nitrogen (3 tanks)	48,000.00
11	Chemicals (salts)	83,087.00
12	Demobilization	63,860.62
13	FTO/Security	108,153.00
14	AGO	20,800.00
15	Crew Flight	144,000.00
16	OH personnel	15,000.00
17	Wellhead Refurbishment	58,000.00
18	CCU Actuator / Control Panel	45,000.00
19	CO Logging	272,911.08
	Total	**2,286,833.40**

12. HSSE/ SPECIAL WELL/LOCATION CONDITION

CONDITION OF WELLHEAD	Not Ok
ANNULUS PRESSURE MEASUREMENT/DATE	CHP A = 0psi.; CHP B = 0psi. (25/05/2019)
MAASP / MAWOP	99 bar / 74 bar (A-annulus), 17 bar / 13 bar (B-annulus)
WELL INTEGRITY SUMMARY	Well has overdue Preventive Maintenance Actions due to Location inaccessibility. Location is planned to be dredged prior to intervention activity.
CONDITION OF PRODUCTION STRINGS	Tubing is ok.
ANY PROBLEM DURING PRIMARY CEMENTATION OR LAST RE-ENTRY	No
SPECIAL FISHING TOOL REQUIRED	No
LOCATION CONDITION	Location is silted, requires dredging.
COMMON CELLAR	No
SEASONALLY FLOODED	Yes
SIZE LIMITATION	No

13. RISKS AND MITIGATION

RISKS	TECOP	LIKELIHOOD/ IMPACT	IMPACT	MITIGATION/ MANAGEMENT
Loss of well control during intervention.	Operational	M/H	▪ Well kick ▪ Spills into the environment ▪ Fire/blowout ▪ Company reputation	▪ Use of appropriately rated PCE (Wireline BOP/ lubricator) ▪ Robust pore pressure and fracture gradient predictions has been made to indicate expected reservoir pressure.
Poor injectivity of the formation prior to SCON pumping	Technical	M/H	▪ Inability to deploy SCON for the interval ▪ No sand control for the interval ▪ Reduced production from the well	▪ Produce well at low bean to minimize sand production.
Well unable to flow due to insufficient lift post intervention activity.	Technical/ Operational	L/H	▪ Delay in OSD & cash flow deficit post intervention activity. ▪ Rig-less intervention cost escalation.	▪ Ensure adequate planning with robust contingency for N2 lift post intervention. ▪ Lift entire tubing capacity plus volume of fluid pumped into the wellbore.
Well unable to sustain flow for an extended period because of reservoir pressure depletion.	Technical	L/M	▪ Potential impact on recovering of resources.	▪ Ensure that the withdrawal is managed to allow the aquifer to kick in.
High associated gas production after Perforation activity	Technical	H/H	▪ Potential impact on well rates if GOR creaming is required. ▪ Cost implication resulting from increase in Gas flaring penalty.	▪ Optimal bean control/ GOR creaming will be used to mitigate excessive AG production. ▪ Well offtakes will be managed to produce well at acceptable Rsi limit (3*Rsi).
Potential for drop objects during Well Intervention operations	Technical/ Operational	H/H	▪ Potential for Near misses and/or injury to personnel. ▪ Inability to continue the workover operation based on the severity of the above impact.	▪ Ensure DROP zones are identified prior to operations and proper barriers are in place. ▪ Ensure strict adherence to JHA and PTW processes during operation.
Possible HUD inside Tubing	Technical/ Operational	M/H	▪ Inability to access sand face to stimulate interval. ▪ Impact on intervention cost from excessive time spent on removing restriction.	▪ Drift tubing and tag XN profile prior to job execution. ▪ Run LIB if HUD is encountered to confirm nature of HUD. Contact PTW/O/NG or UPO/G/UVC ▪ Mobilize necessary fishing/ jetting tool to manage hole restriction/ HUD during operation.
Contamination risk from SCON chemicals.	Technical	L/H	▪ Tubing restriction if SCON chemical congeals during deployment impacting well promise and cost. ▪ HSSE impact from exposure to SCON chemicals.	▪ Proper chemical compatibility test and appropriate field supervision during SCON deployment. ▪ SCON chemicals should be properly bulked in the contractor's base and transported to the field locations

RISKS	TECOP	LIKELIHOOD/ IMPACT	IMPACT	MITIGATION/ MANAGEMENT
				▪ Ensure all connections are pressure tested and leak tight before pumping SCON chemicals ▪ STOP work authority to be in place to avoid any HSE exposure during SCON treatment. ▪ Unused chemicals should be returned to contractor base for proper disposal.
Tubing burst during pressure test.	Technical/ Operation	L/M	▪ Prolonged well operation and increased cost.	▪ Clearly define maximum allowable burst load and maximum allowable surface test pressure for the tubing.
Exposure to NORM	Technical/Organizational	L/H	▪ Health hazard to staff. ▪ Environmental and reputational impact and additional cost for clean-up.	▪ Safety measures as stipulated in the HSSE and SP Control Framework (Ionizing Radiation Manual) should be followed. ▪ A radiation protection officer should be appointed for the operation. ▪ Ensure exposure control and adequate dosimetry. ▪ Appropriate PPE should be worn by staff handling tubulars and other well accessories.
Community preventing access to location	Political	M/H	▪ Delays in well execution/ increased cost.	▪ Early engagement as per SCD / MoU. ▪ Ensure FTO is secured prior to commencement of operations.
Security	Political	M/H	▪ Delays in well execution/ increased cost.	▪ Security surveillance and intelligence evaluation should be conducted prior to equipment mobilization to site. ▪ Follow Journey Management Plan for all inter/ intra state commuting – crew change, supplies delivery, mobilization/de-mobilization. ▪ Maintain visible JTF presence within and around location as a deterrent to invasion or kidnapping.

14. LIST OF APPENDICES

Appendix 1: HSE Critical Activities

Appendix 2: Diebu Creek 012T Well Status Diagram (Current Status)

Appendix 3: Diebu Creek 012T Well Status Diagram (Proposed Status)

Appendix 4: Diebu Creek 012T Well Performance Plot

Appendix 5: Diebu Creek 012 Petrophysical Data layout

Appendix 6: Diebu Creek E1000X Hydrocarbon Distribution Plot

Appendix 7: Diebu Creek 012T Inflow/outflow Plot

Appendix 8: Diebu Creek 012T Well forecast plots.

Appendix 9: Diebu Creek E1000X Top Structure Map

Appendix 10: Geological Cross Section through E1000X Reservoir

Appendix 11: Correlation Panel with existing completions

Appendix 12: Pore Pressure Prediction for Diebu Creek 012T on E1000X Reservoir

Appendix 13: H2S Prediction for Diebu Creek 012T on E1000X Reservoir

Appendix 14: Diebu Creek 012T Intervention Decision Tree

Appendix 1: HSE Critical Activities

HSSE Critical Activities (Rig-less Activities -Wells)

HSE Critical Task			Discipline	Close Out of HSSE Critical Task
Activity		Potential HSE Impact		
4a	Predict H2S presence. **DEP 25.80.10.18**	Loss of life and material integrity.	PT/PG*	The consequence of presence of H_2S is loss of life and material integrity. However, available PVT data in Diebu Creek & nearby fields do not indicate H2S presence. The H2S prediction chart in Appendix 13, shows negligible H2S risk in the target Reservoir (E1000X). Also, focused evaluation of the reservoir using the SPDC souring potential chart highlighted that the souring tendency of the reservoir is minimal.
5b	Predict pore and fracture pressure in an undeveloped reservoir **DEP 25.80.10.10**	Loss of Well Control and Integrity	PP	Not Applicable. Target reservoir is developed.
5c	Predict pore and fracture pressure in an already developed reservoir **DEP 25.80.10.10**	Loss Well Control and Integrity.	RE	Pore pressure/fracture gradient prediction for developed reservoir has been done and endorsed by technical authority (ref. appendix 12).
7a	Plan logging – Wireline and LWD operations **DEP 25.80.10.15**	Well control, human exposure	PP	A risk assessment has been carried out for the logging program and is included in this proposal. A LWOP session will be planned and will cover job planning and job hazard analysis. Every logging run will be preceded with a Pre-Job Safety Meeting and comprehensive Job Hazard Analysis (JHA); the perforating run(s) will be subjected to the Permit-to-work process. The Logging Program and Risk Assessment are presented in Table 1 & Table 2
7b	Plan logging – radioactive sources **DEP 25.80.10.15**	Environmental impact, surface handling risks to people, loss of sources in the hole	PP	Radioactive sources will be deployed in execution of the logging program. Radioactive handling permit (from NNRA) will be obtained prior to logging activity, and availability of contractor's valid permits will be ensured. LWOP session will be held prior to logging operation to discuss HSE risks and mitigation to ensure safe operational procedures in achieving a successful logging operation.
7c	Plan logging – explosives **DEP 25.80.10.15**	Potential for loss of life. HSSE management of surface and downhole operations	PP	• Personnel should follow the required guidelines on explosive tool handling as applicable. • The explosives should be kept secure in a dedicated location with perimeter protection and CAUTION sign, before and after operation. • Explosives should be handled by trained and certified personnel ONLY; Lead

				engineer is responsible for handling the tool during operations transfer.
7d	Plan logging - Pressurised formation fluid samples. **DEP 25.80.10.15**	surface handling: potential for loss of life.	PP	Not applicable.
7e	Plan logging - TZ and VSP survey operations **DEP 25.80.10.15**	Explosives, Airguns – Potential loss of life.	PP*/GP/WE	Not applicable.
10	Interpret cement bond integrity and casing wear log.	Zonal isolation and potential casing integrity.	PT*/PP	No cement bond log sighted. However, based on production history of this conduit, zonal isolation is not an issue and casing integrity is intact since no casing head pressures till date
11	Plan perforation and guns retrieval. **(Integrated as part of DEP 25.80.10.21)**	Hazards to life and facilities (misfired or unfired charges to surface).	PT*/WE	Radio silence will be observed while running in and running out of hole with the gun.
12	Predict sand production. **DEP 25.80.10.19**	Facility / flow-line integrity and loss of containment (LOC)	PT	Sand production is anticipated during well life and it is proposed to carry out Chemical sand consolidation to mitigate sand influx into wellbore.
13a	Predict produced fluid composition, especially contaminants like CO2, H2S, and mercury and potential formation water composition.	Corrosion and material integrity.	PT	PVT data from Diebu Creek E1000X reservoir indicates the absence of H2S. The souring tendency of the reservoir is also analysed to be minimal. Fluid sample analysis also show insignificant amount of CO2 in the reservoir as observed from applicable Diebu Creek E1000X PVT report. Hence CO2 and H2S corrosion is highly unlikely.
13b	Predict and manage scaling + reservoir souring impact from water flooding /water injection	Corrosion and material integrity including hazard to life	PT	Not Applicable. Water flooding / water injection is planned for the target reservoir.
14	Predict well-head and produced fluid temperature.	Well head growth, surface flowlines limitation and stress integrity.	PT	The predicted / expected wellhead fluid temperature of between 80 - 95degF falls within the range seen in Wells in the nearby fields and are not expected to pose a threat during this operation and indeed in the life of the well. Also, the surface casing is cemented in place and no wellhead movement have been seen when this well was producing.
15	Plan (and execute) stimulation. **DEP 25.80.10.21**	Unsafe handling of chemicals (SHOC), equipment failure due to acid corrosion.	PT*/WE	Chemical treatment is planned in the scope of this intervention. Hence, SHOC card procedures are available for these chemicals. Appropriate PPE will be used by personnel on this job. Tool box talk and job hazard analysis will be conduction. Also, CWI have local experience handling these chemicals as these

				chemicals are deployed regularly in SPDC operation.
16	Establish safe operating boundaries (MAASP, closed in pressure, erosion and corrosion limits, etc.) for well integrity management.	Loss of well integrity.	PT	MAASP for the well and indeed well integrity boundary parameters are actively managed in e-WIMS. Presently, Diebu Creek 12T has action code 0 (November 2019) and no record of annulus pressure. Preventive maintenance/well integrity assurance activities are routinely carried out.
17a	Top-seal integrity assessment for primary recovery, waterflood, EOR and CO2 storage DEP 25.80.10.22	Human exposure, environmental and asset damage	PP	The risk of top-seal leakage due to primary recovery is considered low based on observations in the field and regional experience (Fields within the NUNR/ DBUC axis have produced for above 30 years with no recorded incidents). Geomechanical screening risk assessment carried out in Diebu Creek does not indicate risk of Top seal integrity issues.
17b	Prepare Abandonment Design option and program	Human exposure, environmental and asset damage.	PT	Not applicable.
18	Predict and monitor reservoir compaction and subsidence. DEP 25.80.10.16	Loss of wells, facility/platform integrity.	PP	The risk of compaction and subsidence is considered low based on the field and regional experience (Fields within the NUNR/ DBUC axis have produced for above 30 years with no recorded incidents). Geomechanical screening risk assessment carried out in Diebu Creek field does not indicate any risk of reservoir subsidence and compaction.
24	Prepare and maintain data to support emergency response. **DEP 25.80.10.12**	Lack of data or wrong data during emergency response may aggravate the emergency.	PT/PG*	All relevant well data and latest well information required for emergency response have been loaded in the SIRUS CATALOG and Sharepoint (see links below): SIRUS CATALOG Share point
26	Identify Hazards (HAZID) and prepare Hazard Register	Integral part of HSSE Case development. To confirm selected concept/process can be developed into a safe and operable plant.	WE	This intervention is planned on existing well. Hence, well design is not applicable. HSSE risks and mitigation for this Intervention will be built into the execution program

*Accountable Discipline, as per Published DEP

Appendix 2: Diebu Creek 12T Well Status Diagram (Current Status)

INITIAL COMPLETION STATUS AS AT JUNE 1975 — **WELL : DIEBU CREEK-12**

CASING

SIZE	GRADE	WT.	DEPTH	CEMENT	SG
24	STOVE PIPE		207	DRIVEN	
10-3/4	N80	51.0	2007	1500 POZ	
"	J50	40.5	3513	TOC 1080	
"	N80	51.0	4003	REC 300 POZ	
7"	N80	23	972	850 'G' TOC 6900	
"	J55	23	5469	"	
"	N80	23	7471	"	
"	N80	26	9968	"	
"	N80	29	10489	"	

WELLHEAD

ITEM	TYPE	SIZE (INS)	WP (PSI)
GATE VALVE			
XMAS TREE	SSB	6 x 3-1/8 F x N	5000
ADAPTOR FL	SPECIAL	6 x 6	5000
TUBING HANGER	DC-FBB	6 x 3-1/2 HCS	
TUBING HEAD	DCB	10 x 6	3000 x 5000
SPOOL			
CSG. H. HOUSING	WF	10-3/4 x 10	3000
SEAL BUSHING	'X'	10 x 7	ENERGISED

TUBING

STRING	SIZE	WT	GRADE	TYPE
SINGLE	3-1/2	9.2	N80	HCS
	2-3/8	4.7	N80	EU

DEVIATION

MAX 3.0 AT 6742 FT

DEF 53.8 FT

ORDE-TOP CHH 34 FT

ORDE-TOP XMT 16.50 FT

HOLE

14-3/4 - 4007

9-5/8 - 10500

OPEN HOLE PLUGS

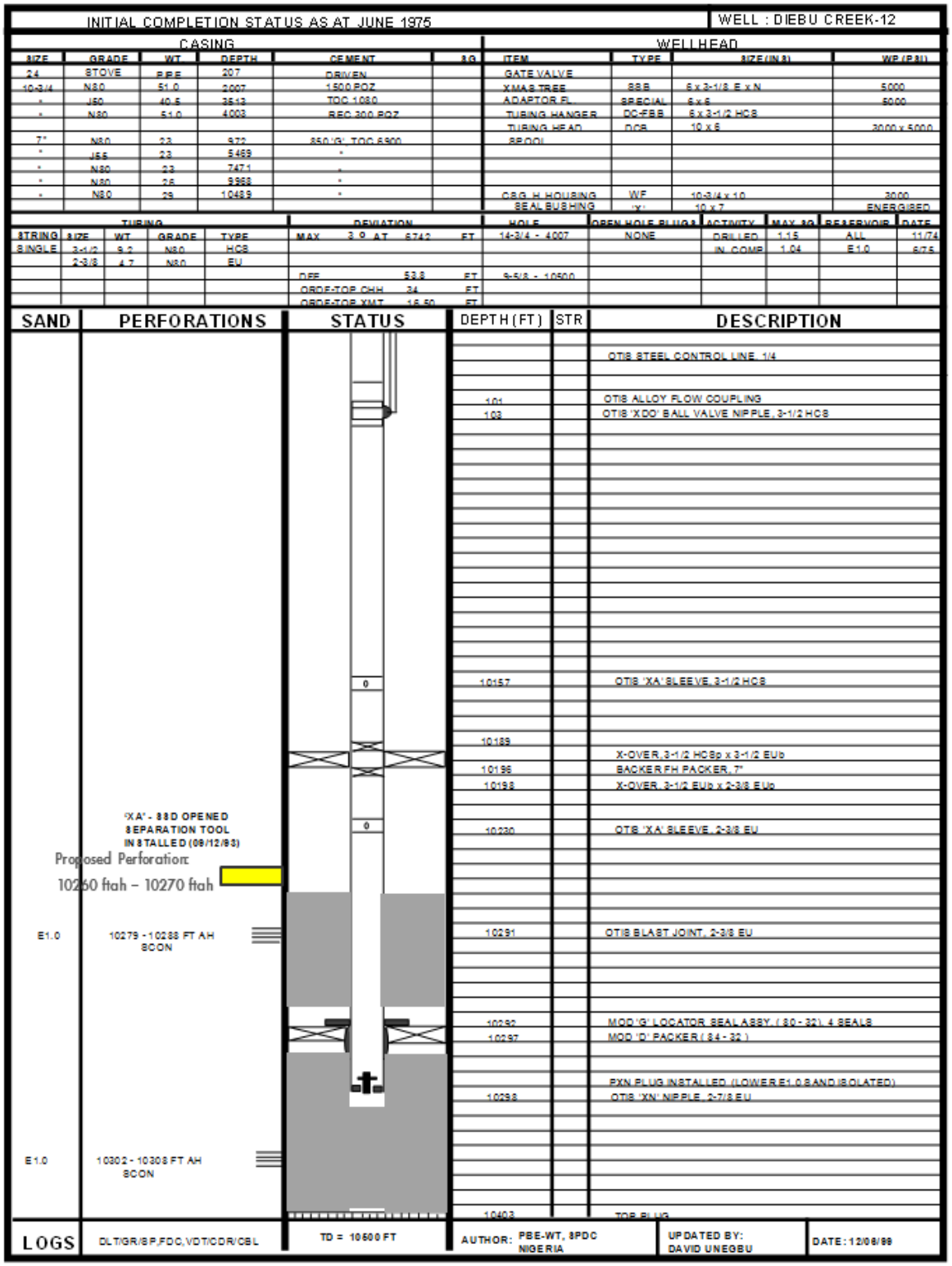
NONE

ACTIVITY	MAX SG	RESERVOIR	DATE
DRILLED	1.15	ALL	11/74
IN COMP	1.04	E1.0	6/75

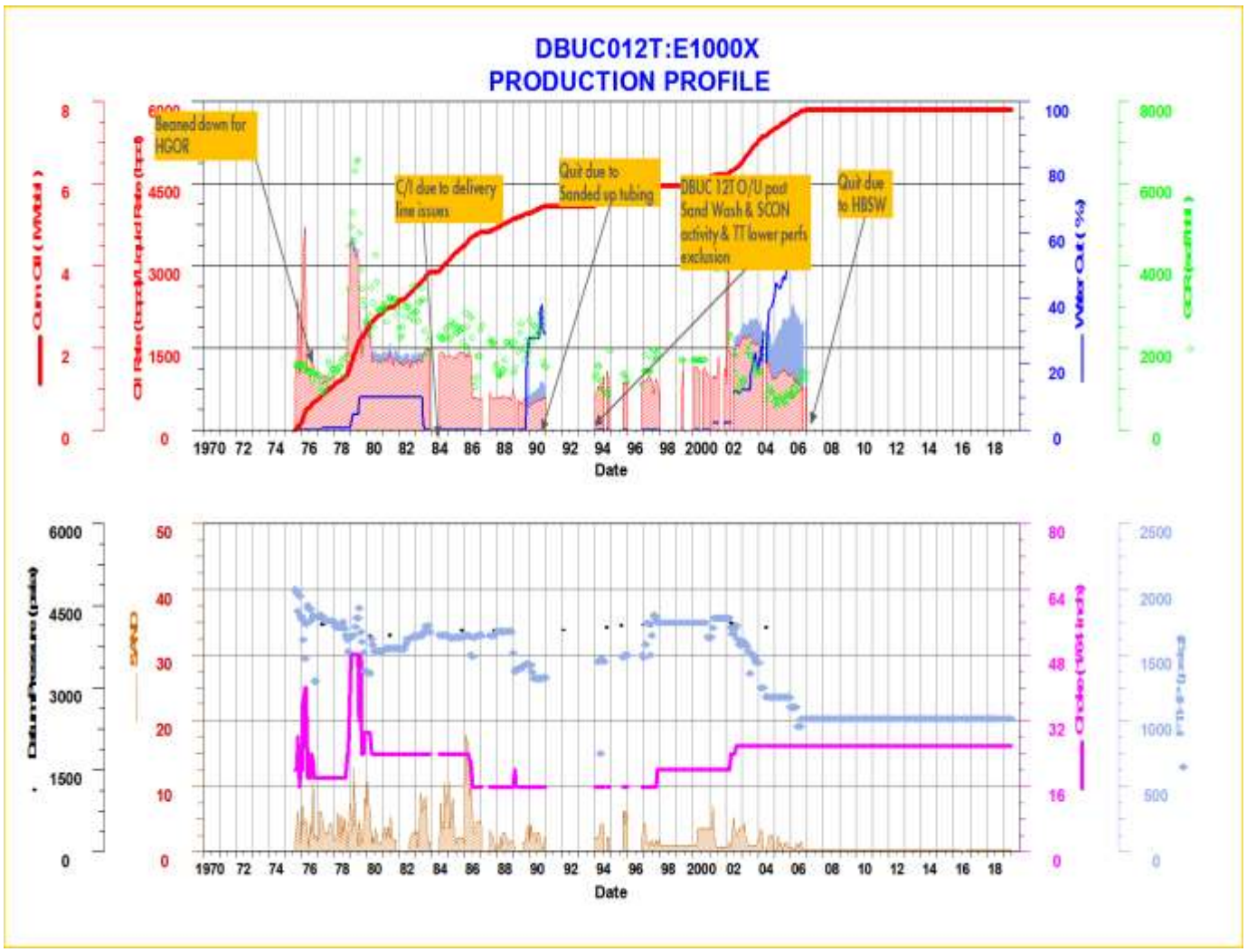
SAND	PERFORATIONS	STATUS	DEPTH (FT)	STR	DESCRIPTION
					OTIS STEEL CONTROL LINE, 1/4
			101		OTIS ALLOY FLOW COUPLING
			103		OTIS 'XDO' BALL VALVE NIPPLE, 3-1/2 HCS
			10157		OTIS 'XA' SLEEVE, 3-1/2 HCS
			10189		X-OVER, 3-1/2 HCSp x 3-1/2 EUb
			10196		BACKER FH PACKER, 7"
			10198		X-OVER, 3-1/2 EUb x 2-3/8 EUp
	'XA' - SSD OPENED SEPARATION TOOL INSTALLED (09/12/93)		10230		OTIS 'XA' SLEEVE, 2-3/8 EU
E1.0	10279 - 10288 FT AH SCON		10291		OTIS BLAST JOINT, 2-3/8 EU
			10292		MOD 'G' LOCATOR SEAL ASSY, (80 - 32), 4 SEALS
			10297		MOD 'D' PACKER (84 - 32)
					PXN PLUG INSTALLED (LOWER E1.0 SAND ISOLATED)
			10298		OTIS 'XN' NIPPLE, 2-7/8 EU
E1.0	10302 - 10308 FT AH SCON				
			10403		TOP PLUG

LOGS DLT/GR/SP,FDC,VDT/CDR/CBL — **TD = 10500 FT** — **AUTHOR:** PBE-WT, SPDC NIGERIA — **UPDATED BY:** DAVID UNEGBU — **DATE:** 12/06/99

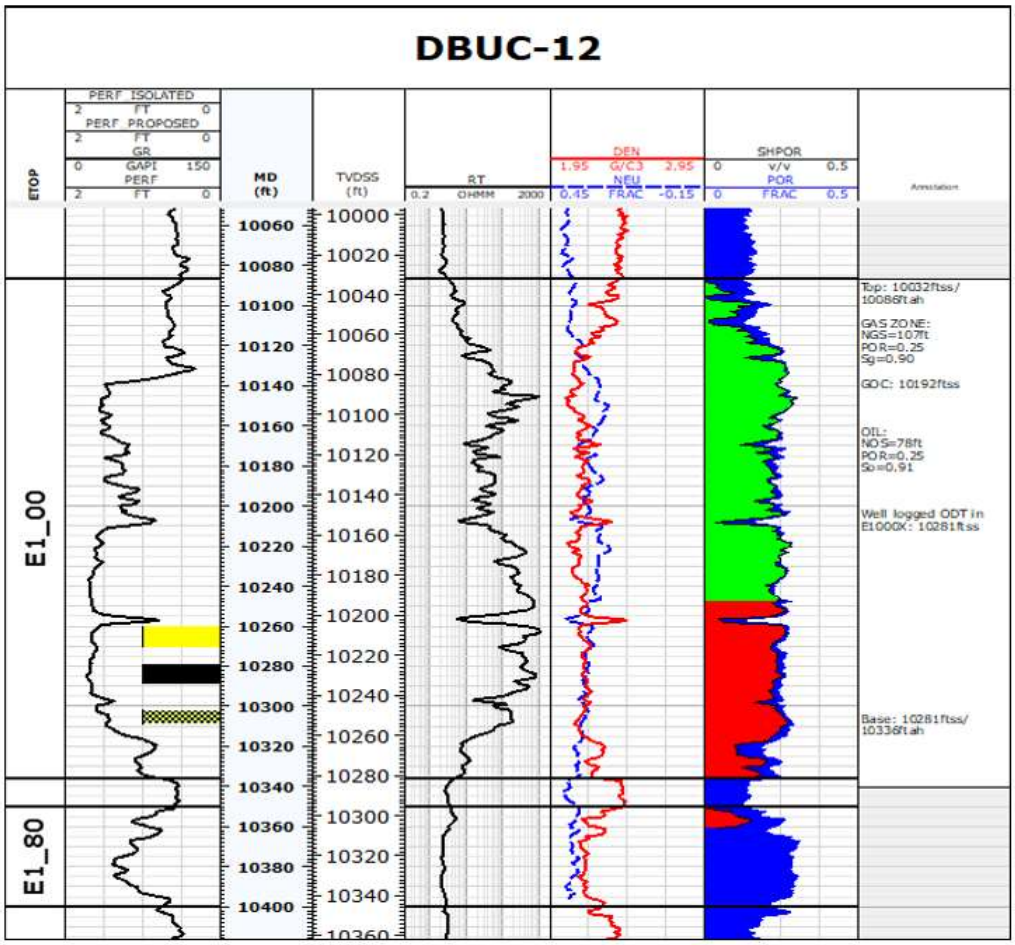
Appendix 3: Diebu Creek 012T Well Status Diagram (Proposed Status)



Appendix 4: Diebu Creek 012T Well Performance Plot



Appendix 5: Diebu Creek 012 Petrophysical Data Layout

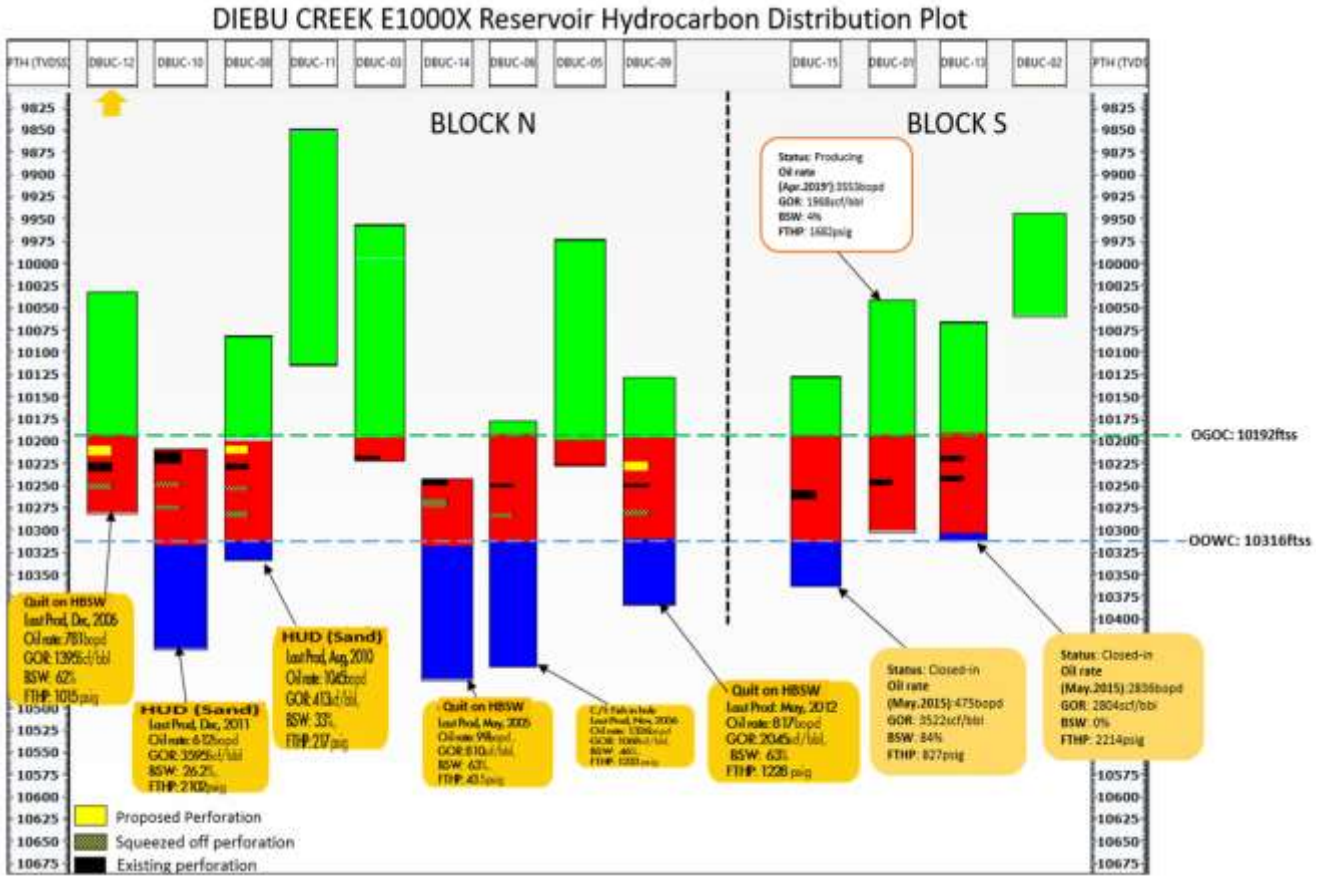


Proposed Perforation: 10260ftah – 10270ftah

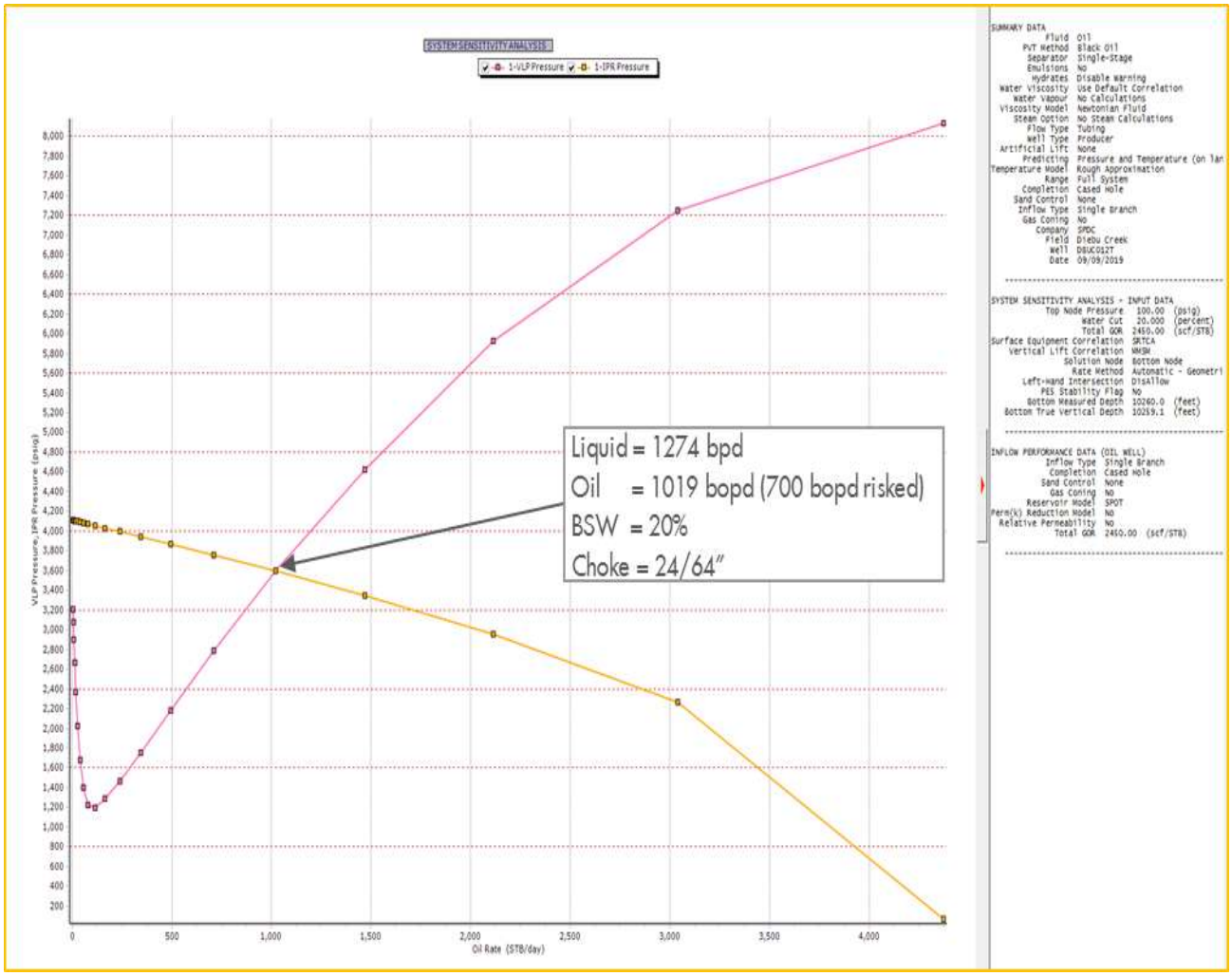
Isolated perforation

Existing perforation

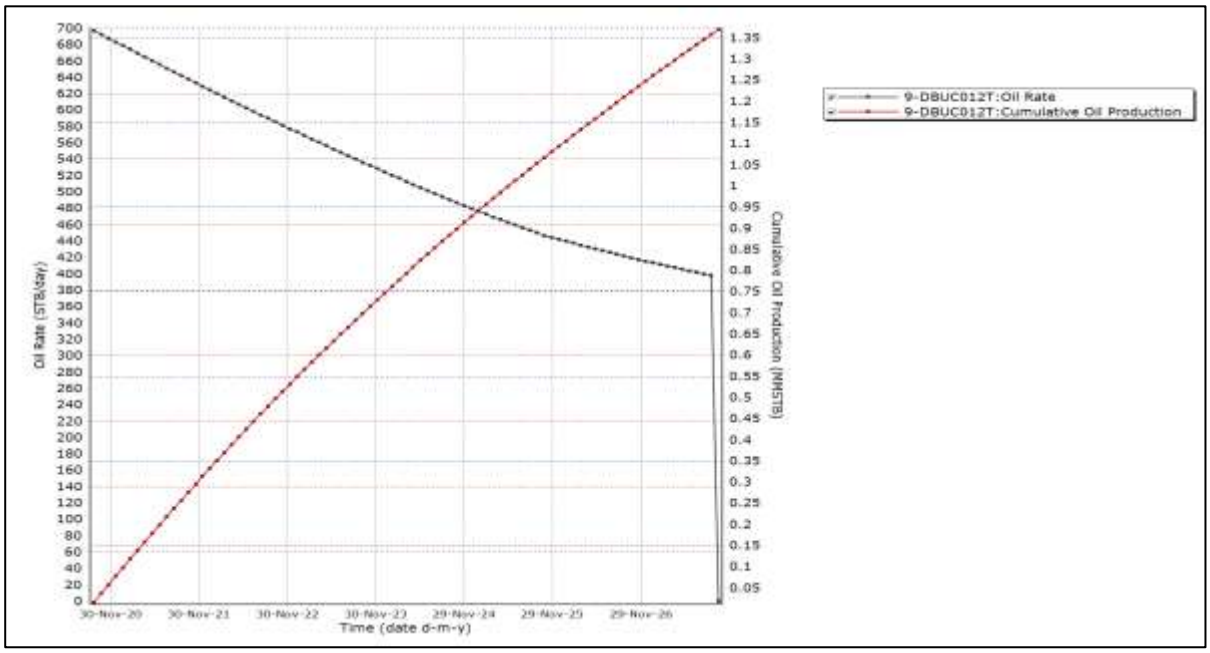
Appendix 6: Diebu Creek E1000X Hydrocarbon Distribution Plot

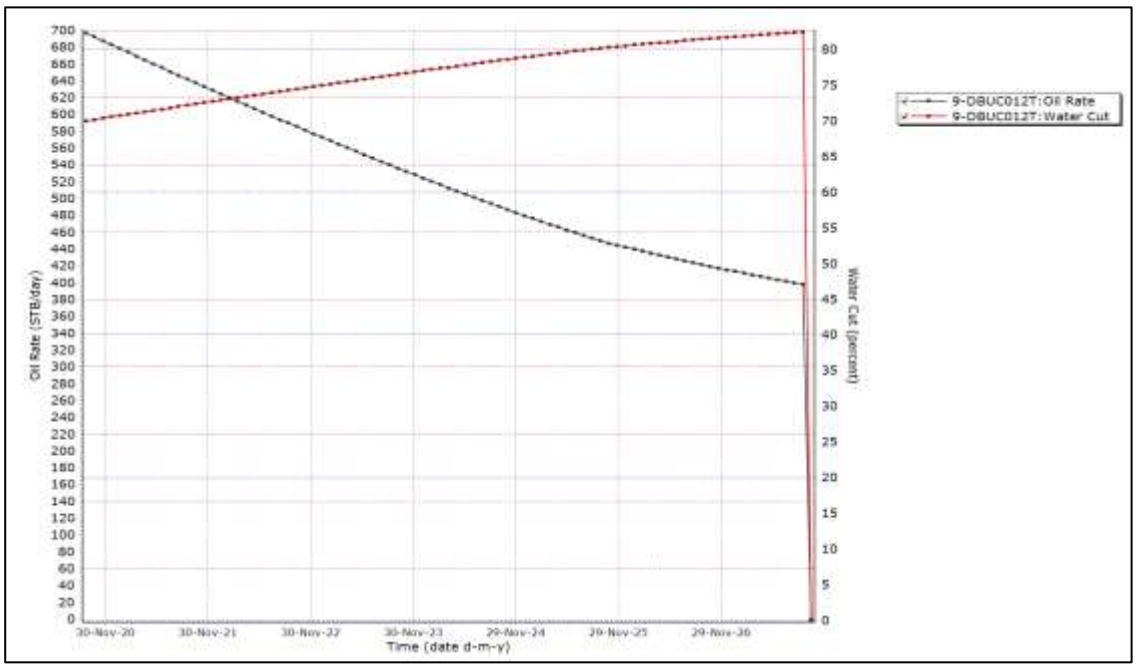


Appendix 7: Diebu Creek 012T Inflow/outflow Plot

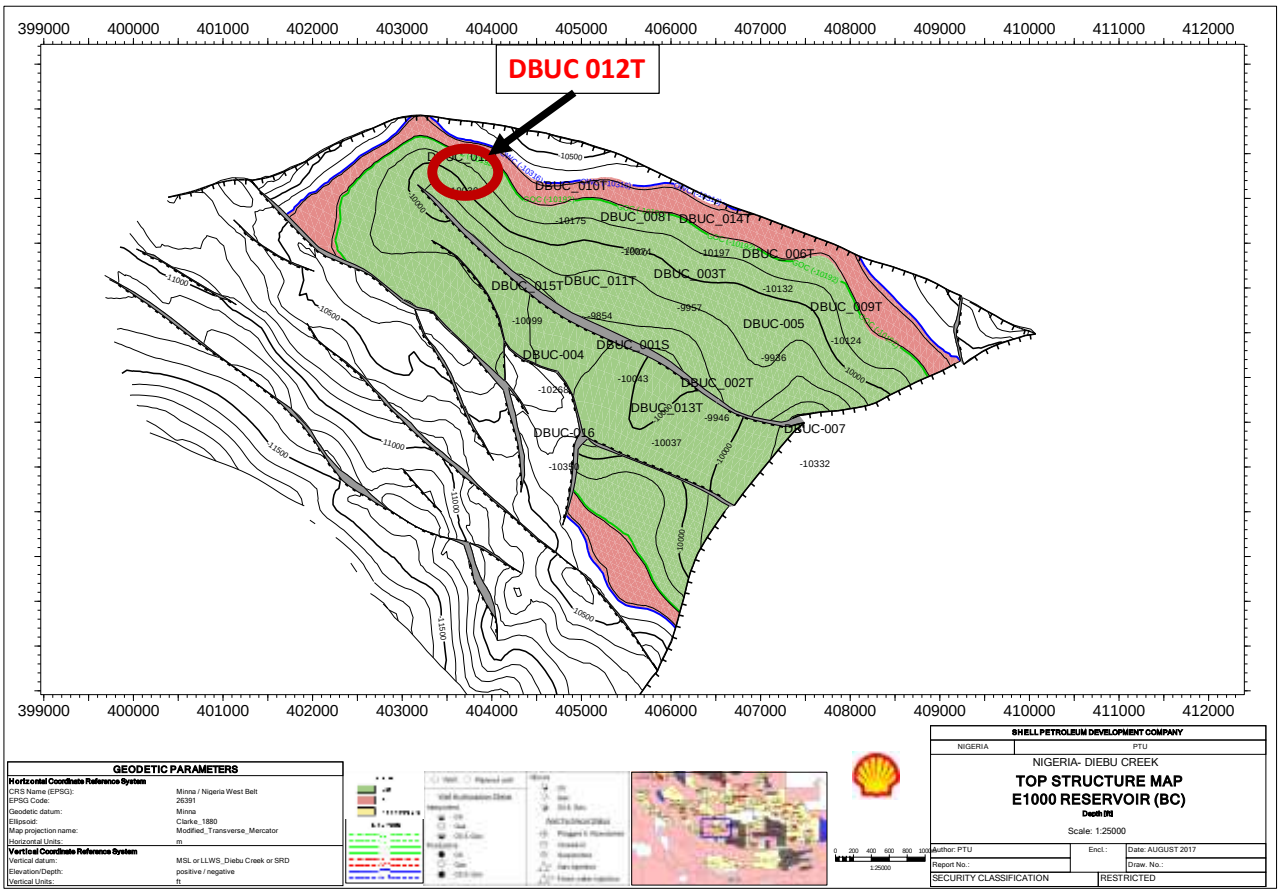


Appendix 8: Diebu Creek 012T Well MBAL Forecast plots

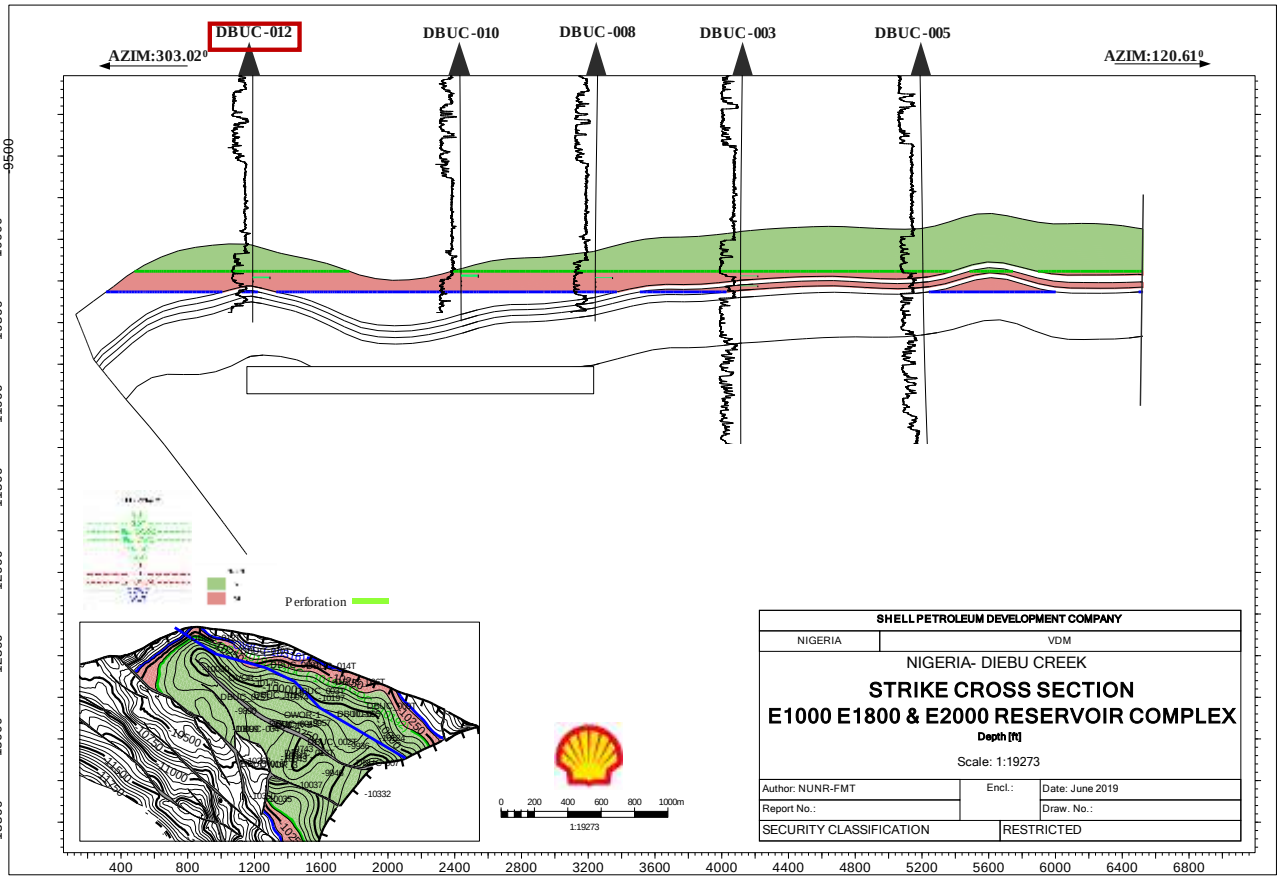




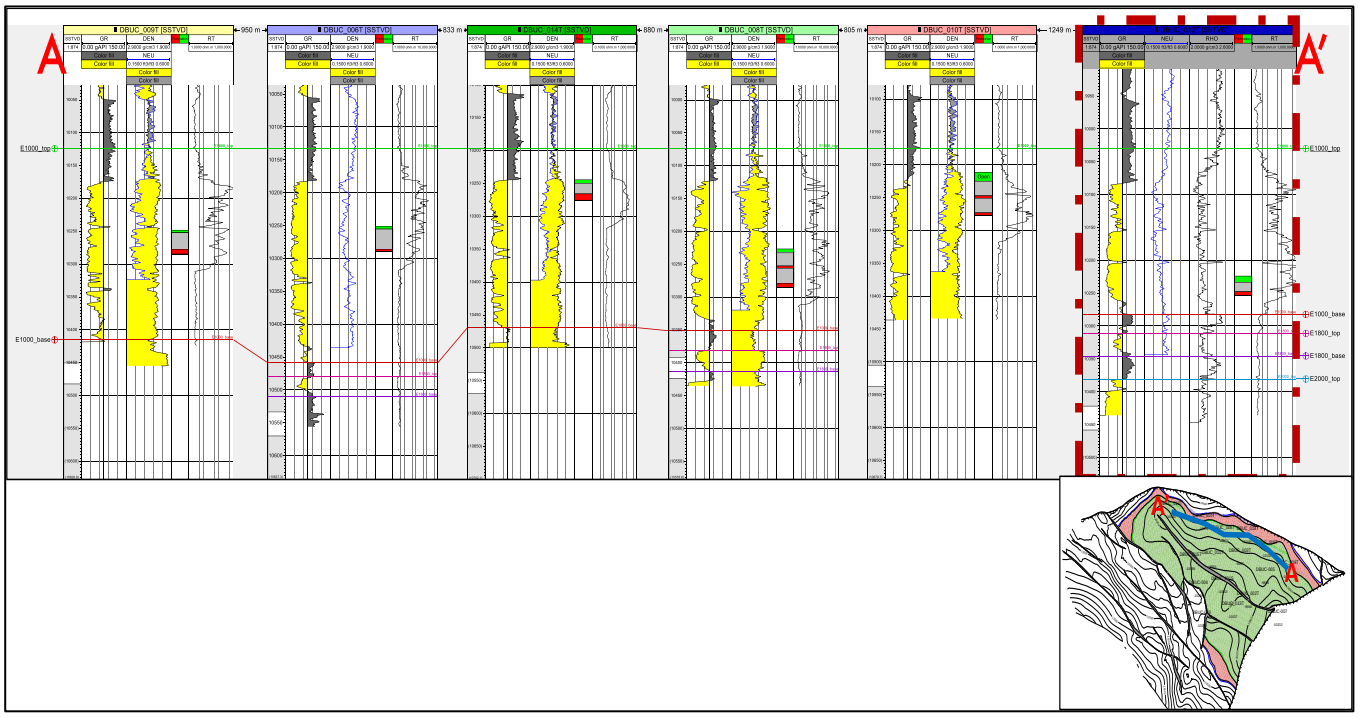
Appendix 9: Diebu Creek E1000X Top Structure Map



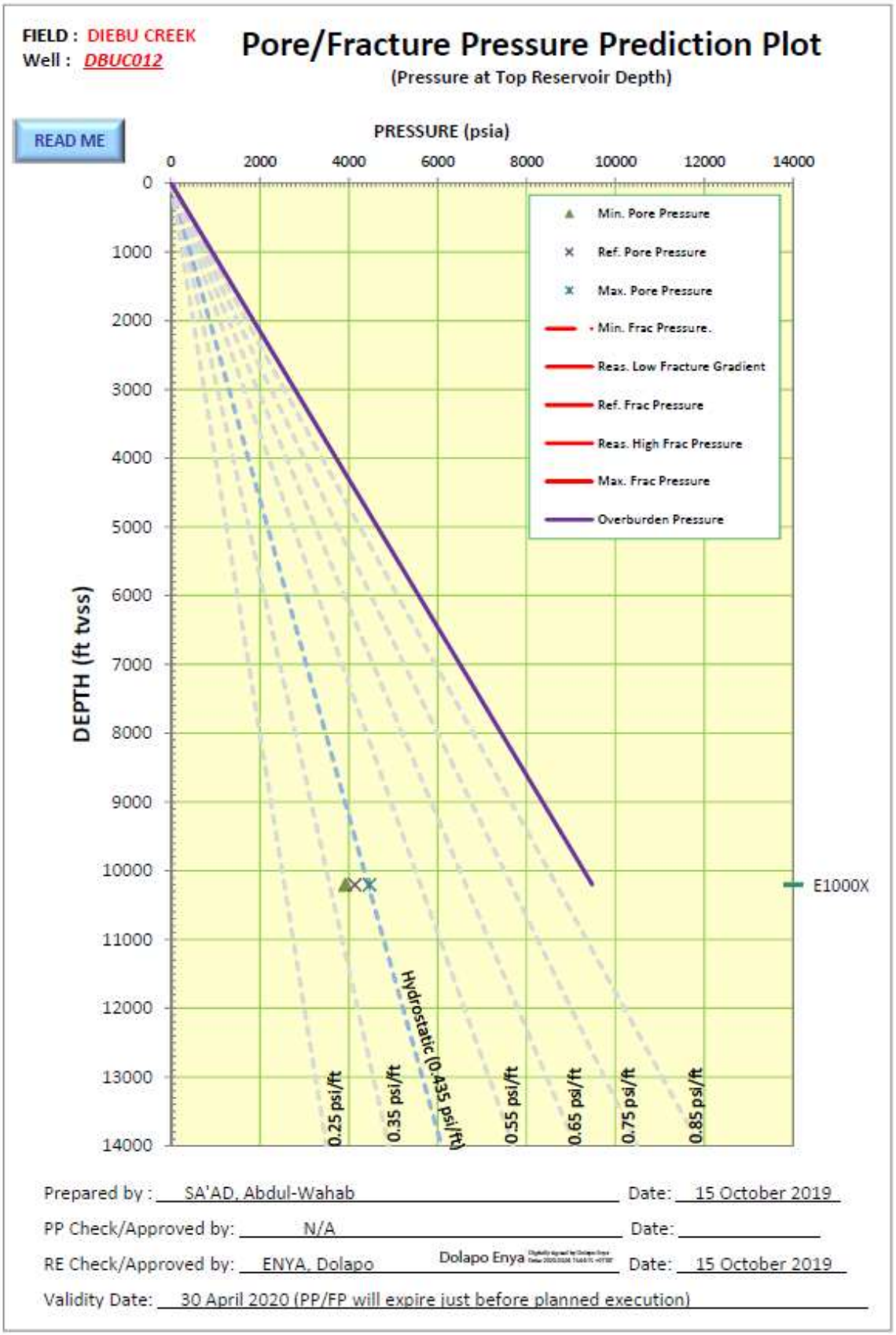
Appendix 10: Geological Cross Section through E1000X Reservoir



Appendix 11: Correlation Panel through E1000X Reservoir



Appendix 12: Pore Pressure Prediction for Diebu Creek 012T on E1000X



FIELD:	DIEBU CREEK
WELL NAME:	DBUC012
PLATFORM/RIG:	[illegible]
PREPARED:	[illegible]
CHECKED BY:	[illegible]
ISSUED DATE:	[illegible]
REVISION NO:	1
SPUD DATE:	16 March 2020
EXPIRY DATE:	30 April 2020

Pore Pressure Prediction at Top Reservoir for well DBUC012

	TV-Depth of Pressure Prediction and Reference Depth (e.g., ss or bdf)			Fluid Type Prognosis at Top of Sand along Well Trajectory	Is Reservoir Developed		Formation Pore Pressure Prognosis at Top of Sand along Well Trajectory					Formation Pore Pressure Gradient Prognosis at Top of Sand along Well Trajectory					Fracture Pressure Prognosis at Top of Sand along Well Trajectory					Fracture Gradient Prognosis at Top of Sand along Well Trajectory					
Formation	Shallow (ft.ss)	Most Likely (ft.ss)	Deep (ft.ss)	Reference Case	(Y/N)	Expected Fluid Gradients	Minimum (psia)	Reasonable Low (psia)	Reference Case (psia)	Reasonable High (psia)	Maximum (psia)	Minimum (psi/ft)	Reasonable Low (psi/ft)	Reference Case (psi/ft)	Reasonable High (psi/ft)	Maximum (psi/ft)	Minimum (psia)	Reasonable Low (psia)	Reference Case (psia)	Reasonable High (psia)	Maximum (psia)	Minimum (psi/ft)	Reasonable Low (psi/ft)	Reference Case (psi/ft)	Reasonable High (psi/ft)	Maximum (psi/ft)	Remarks
E1000X	10050	10095	10095	Oil	Y	0.55	3902	4060	4130	4250	4471	0.384	0.399	0.406	0.417	0.436	7344	7556	7756	8060	8175	0.698	0.712	0.760	[illegible]	[illegible]	Depleted reservoir

Prepared By:	SANAI, Abdul-Wahab (Name)	UPO/G/UVC (Team Indicator)	16th October 2019 (Date)
PE Check:	ENYA, Gologo (Name)	Gologo Enya (Signature)	3rd-Mar-2020 (Date)
Validity Date:	30 April 2020 (Note: FPFP must be revalidated prior to re-entry as FP will expire before planned execution date)		

Appendix 13: H2S Prediction for Diebu Creek 012T on E1000X Reservoir

DIEBU CREEK 012T H_2S PREDICTION FOR E1000X RESERVOIR

- Diebu Creek 012 is completed as a SSS oil producer on the E1000X sand. It is proposed for Through Tubing Perforation Extension and Chemical Sand Consolidation on the E1000X reservoir.

PVT Report and Production History

- There is PVT Report for the E1000X reservoir from DBUC 006 and the report did not mention H2S in the fluid composition from the reservoir. Gas samples from the HP separator taken in 2002 shows no H2S in the fluid composition from the reservoir (See snapshot of PVT report on the next slide).
- Well head samples taken from DBUC 0015 in December 2018 indicates no H2S in the fluid composition from the reservoir.
- No H_2S has been produced from the E1000X reservoir to date.

Souring Potential

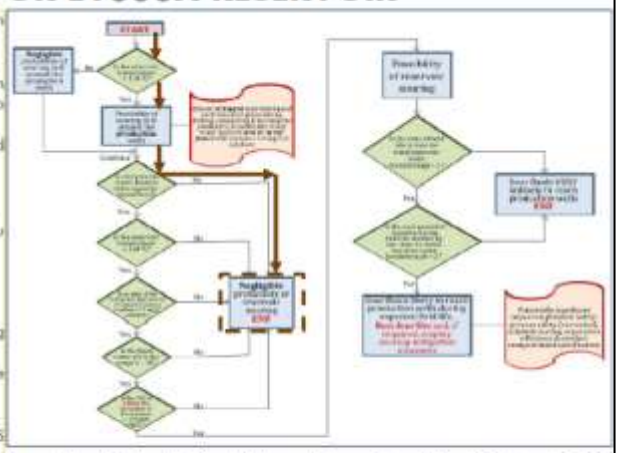
- The consequence of H_2S is loss of life and material integrity. However, available PVT data in Diebu Creek & nearby fields do not indicate H_2S presence.
  - The maximum reservoir temperature for the target sand (E1000X) is 87.22 °C (below 110 °C).
  - No water injection in Diebu Creek & nearby fields that can lead to reservoir souring.
  - No secondary or Tertiary recovery processes are being practiced in the field.
- Also, due to these reasons the souring tendency of the reservoir is minimal (refer to the souring potential chart in attachment1).
- The fresh saline water interface in DBUC 012 is 5028 ftss, which is about 5002 ftss away from the E1000X reservoir. The possibility of fresh water migration into this reservoir (E1000X) is low.

External Risks

- There is a risk of the Equipment (e.g. CT, Tanks) to be used in this operation, introducing some H_2S based on residue from their previous operations reacting with the acid to be used now.

Mitigations

- Check and Confirm that previous use of the equipment would not intentionally give rise to H_2S after contacting HCL.
- H_2S Gas monitors will be utilized during Well Intervention execution to alert the crew of any latent threats.
- Appropriate PPE's to be worn as mitigation.



Prepared by	Unukogbon Obaro (PG)	Nwosu Obiora (PT)	05/ August / 2019
Checked by	Ahmed Suleiman (PG TA2)	Suleiman Ahmed	
Approved by	Komolafe Gbenga (PT TA2)	Gbenga Komolafe	
Approved by	Arochukwu Elias (PG TA2)	Elias Arochukwu	

RESTRICTED August 2019 2

Appendix 14: Diebu Creek 012T Intervention Decision Tree