OIL & GAS DEVELOPMENT COMPANY LIMITED

TENDER ENQUIRY NO. PROC-SERVICES/CB/RMD-4725/2020

KPD & TAY INTEGRATED RESERVOIR SIMULATION STUDY & NETWORK MODELING

(Kunnar Deep, Pasakhi Deep, Pasakhi West Deep, Kunnar West, Pasakhi NE, Thora Deep, Moolan, Tando Allah Yar, Tando Allah Yar North, Tando Allah Yar South West, Chandio, Unnar, Shah, Kunnar South, Pasakhi East, Dars, Dars Deep, Dars West and Saand)

Note:

Bid bond of **USD 16,000/- (US Dollar Sixteen Thousand Only)** must be submitted with the technical bid. Please see tender documents for further detail.

The master set of tender documents (services) uploaded on OGDCL website (www.ogdcl.com) is the integral part of this TOR.

Contents

Section – 1: Introduction

1. Project Overview

Oil and Gas Development Company Limited (OGDCL) is the operator of Kunnar Pasakhi Deep & Tando Allah Yar (KPD-TAY) project. The project is located in the lower Indus basin, a proven hydrocarbon province; geographically in Hyderabad & Tando Allah Yar Districts, Sindh, Pakistan.

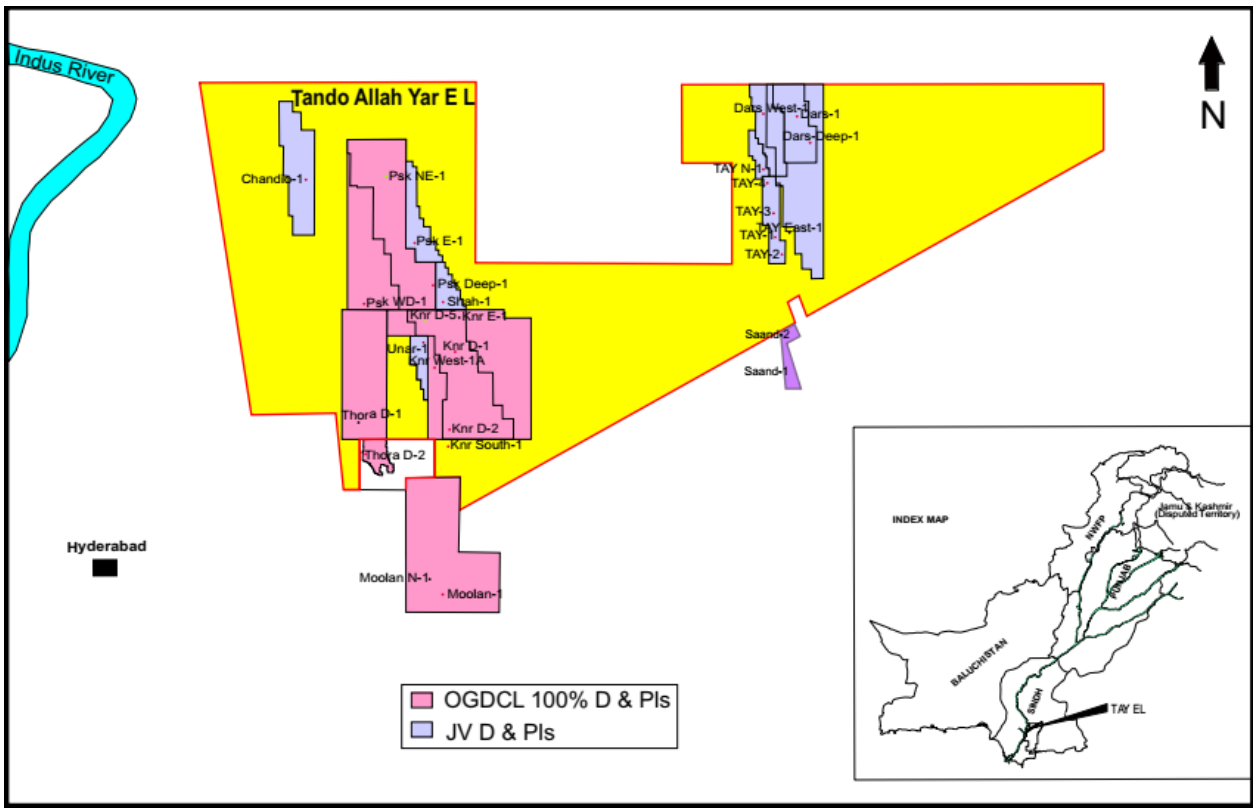

Figure 1. Location Map of KPD-TAY Fields

This project consists of nineteen small to medium sized fields and a total of 43 wells. For the sake of simplicity project is sub-divided into three divisions.

1. Kunnar – Pasakhi Deep (KPD) Fields
2. Tando Allah Yar and Nim Block Fields
3. KPD Satellite Fields

All the fields in this project produce from various sands of Lower Goru formation, a generalized stratigraphic column of which is given below in Figure 2.

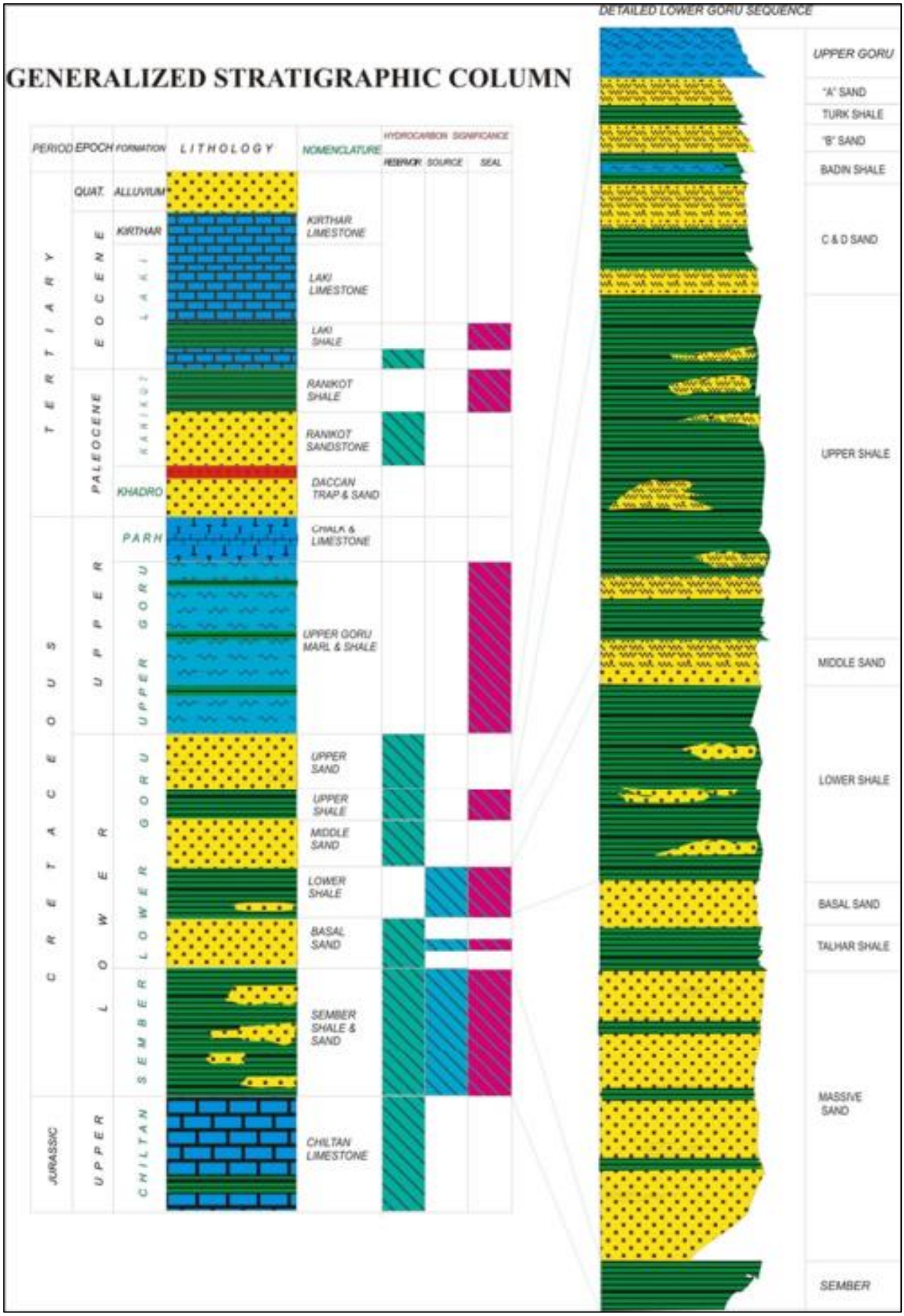

Figure 2. Generalized stratigraphic column of Lower Goru Formation

1.1. Kunnar – Pasakhi Deep Fields (KPD Fields)

Historically, OGDCL has produced Oil from Upper Sands (Lower Goru Formation) level in Kunnar & Pasakhi Oil fields since late 1980s, however, description and working on these oil fields is beyond the scope of work of this study. OGDCL discovered gas reservoirs in 2005 by drilling of Kunnar Deep-1 at Massive sands (Lower Goru Formation) level followed by Pasakhi Deep-1 (2005), Kunnar West-1A (2007) and Pasakhi West Deep-1 (2008). This deeper set of fields consist of four gas fields namely Kunnar Deep, Kunnar West, Pasakhi Deep and Pasakhi West Deep, some of which appear to be in hydrodynamic communication. These fields are relatively larger in size compared to other two categories. Kunnar Deep is the largest one followed by Pasakhi Deep, Kunnar West & Pasakhi West Deep. All four fields produce from Massive sands of Lower Goru formation and 100% owned by OGDCL.

1.2. Tando Allah Yar & Nim Block Fields

1.2.1. Tando Allah Yar Block

Tando Allah Yar Exploration License (TAY EL) was granted to OGDCL & GHPL on September 27, 1997, OGDCL being the operator. OGDCL holds 95% & 77.5% working interest pre-commerciality & post-commerciality respectively while GHPL holds 5% (carried) & 22.5% working interest pre-commerciality & post-commerciality respectively. Tando Allah Yar was the first oil & gas field discovered in this EL in 1998 by successful drilling & testing of Tando Allah Yar-1 in Upper sands of Lower Goru formation. Since then OGDCL drilled 26 wells (23 Exploratory & 03 Appraisal) making eleven (11) discoveries i.e. Chandio, Dars, Dars Deep, Dars West, Tando Allah Yar (TAY), TAY North (TAYN), TAY South West (TAYSW), Kunnar South, Pasakhi East, Unnar & Shah. All these discoveries produce from various sands of Lower Goru formation, a prolific reservoir target in the area. Most of these discoveries were brought on production in January 2017 through KPD-TAY Integrated Plant. The most challenging aspect of TAY EL discoveries is variety of reservoir fluids and diversity of reservoir sands.

1.2.2. Nim Block

Nim Exploration License (Nim EL) was granted to OGDCL & GHPL on December 29, 1999. OGDCL holds 95% & 77.5% working interest pre-commerciality & post-commerciality respectively while GHPL holds 5% (carried) & 22.5% working interest pre-commerciality & post-commerciality respectively. OGDCL being the operator has drilled 18 wells so far in this block (17 Exploratory & 01 Appraisal) making ten (10) discoveries including Saand Gas Field (02 wells). As Saand Gas Field is located in the vicinity of Tando Allah Yar facilities, so it is planned to be produced through KPD-TAY Integrated Plant.

1.3. KPD Satellite Fields

These are Moolan & Thora Deep gas fields, 100% OGDCL owned, located around KPD-TAY area. These fields belong to two separate leases i.e. Moolan belongs to Lashari Centre & South D&PL while Thora Deep belongs to Thora & Thora East D&PL. Both Lashari Center & Thora are oil fields at shallower horizons and produce through TOC (Tando Alam Oil Complex) Facilities. However, Moolan & Thora Deep Gas fields, owing to their closer proximity to KPD-TAY Integrated plant & processing capacity of the said plant are being produced through it.

Daily offtake is around 220 – 230 MMscfd raw gas, 200 – 205 MMscfd Sales gas, 3400 STBD condensate and 255 MTD LPG from KPD-TAY plant.

Project divisions are further elaborated in Figure 3.

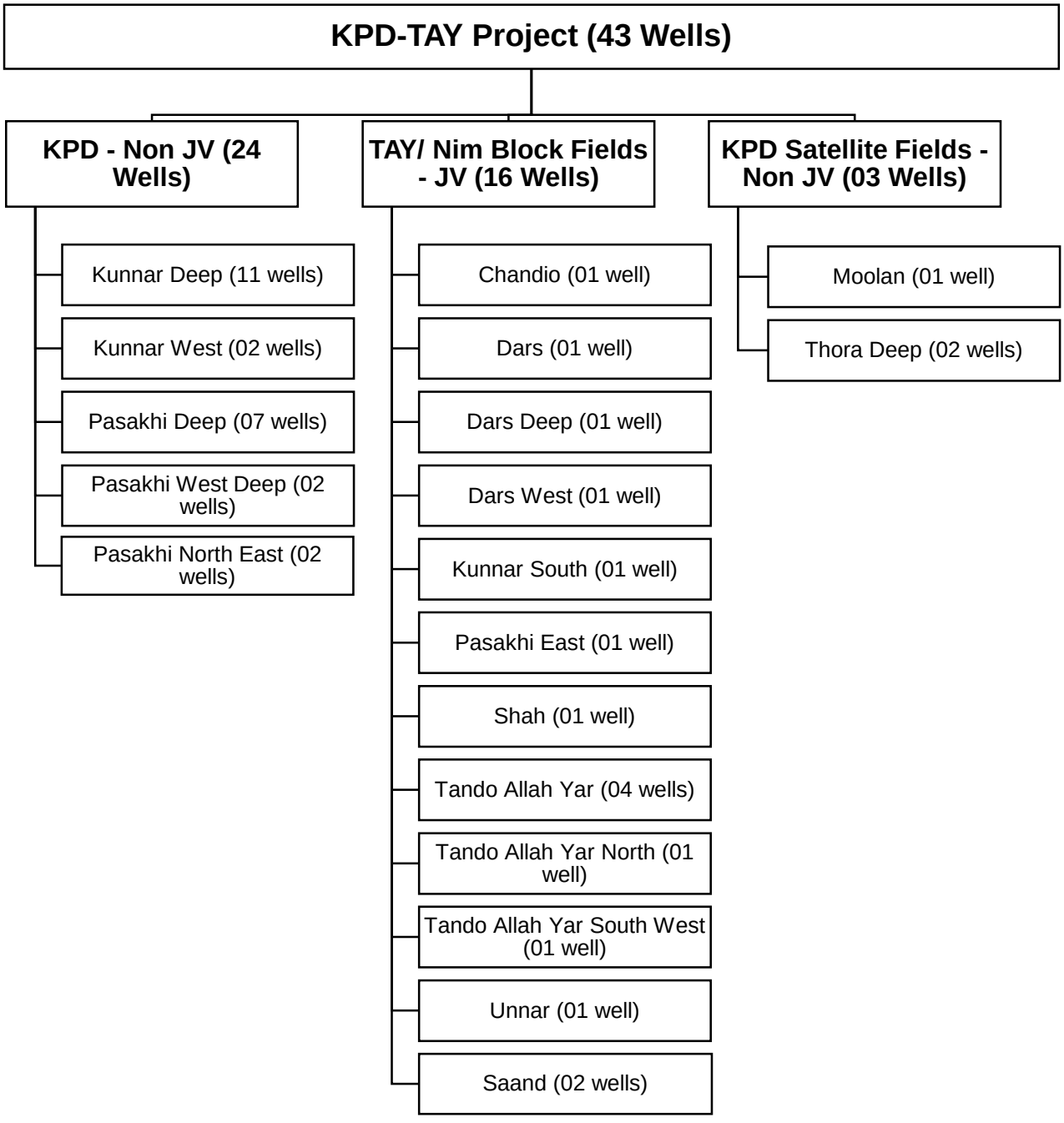

Figure 3. KPD-TAY Project Divisions

2. Technical Approach

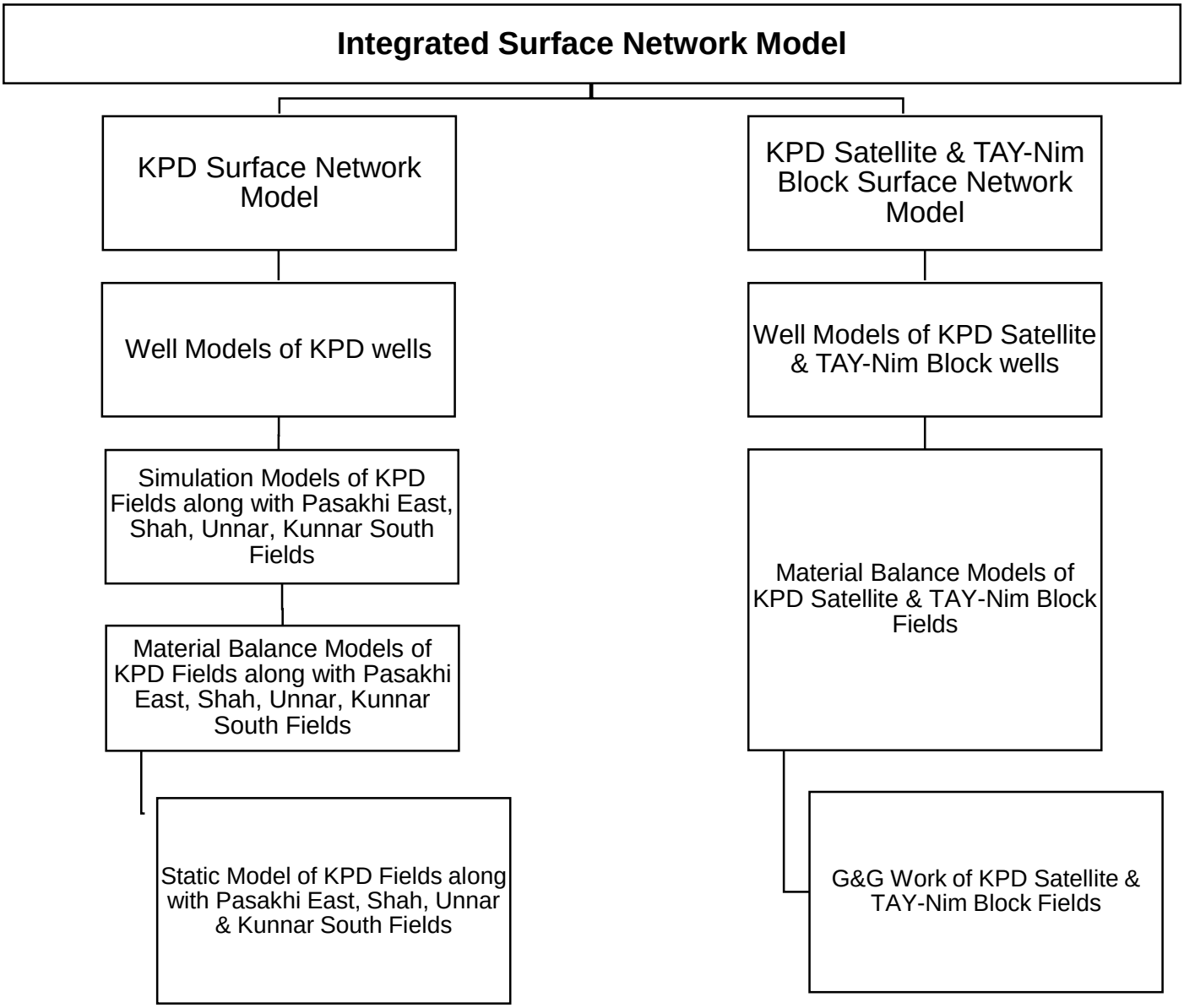

Figure 4. Study Structure

According to conceived study concept (as given in Figure 4), there will be one static model & one dynamic model (for Kunnar Deep, Pasakhi Deep & surrounding fields), Individual field material balance models (for all fields belonging to KPD, TAY & Nim blocks and KPD Satellite) and corresponding surface network models. The concept is further elaborated as follows;

2.1. A static model of Kunnar Deep, Pasakhi Deep, Kunnar West, Pasakhi West Deep, Pasakhi North East, Pasakhi East, Shah, Kunnar South and Unnar fields leading to

properly history matched dynamic & network models shall be built. Material balance models for individual fields shall also be built.

2.2. Complete G&G working of Dars, Dars Deep, Dars West, Tando Allah Yar, Tando Allah Yar North, Chandio, TAY SW & Saand leading to properly history matched material balance and Network models shall be carried out.

2.3. Complete G&G working and properly history matched Material balance models of Thora Deep & Moolan fields leading surface network model shall be built.

2.4. Surface network models of above three divisions (KPD, KPD Satellites & TAY-Nim Block fields) will be merged together to build an integrated Network model for the whole KPD-TAY Project.

2.5. All the work mentioned above shall be performed in accordance with the scope of work given in following sections.

2.6. The Study will be completed in five (05) **phases** as follows:

i. Seismic & Petrophysical interpretation, static modeling and Volumetric Estimation

ii. Basic Reservoir Engineering Analyses i.e. Rock & Fluid properties, RTA, PTA, Material Balance (Tank) modeling and estimation of aquifer strength if any.

iii. Dynamic modelling, History match

iv. Production Forecasting for various development options

v. Network modeling of KPD & TAY and their merger with network model of Satellite fields to build an integrated network model of whole project.

Section – 2: Kunnar – Pasakhi Deep Gas Fields

1. Fields' Introduction

1.1. Kunnar Deep

Kunnar Deep Gas Field was discovered in 2005 with successful testing of Kunnar Deep-1 in massive sands of the Lower Goru formation. The field was fully appraised with 5 wells and 5 Development wells were drilled later on. Kunnar Deep-1 has produced 22.6 MMscfd Gas, 195 STBD Condensate & 23 STBD Water against 3350 psi WHFP at 32/64" Choke size during post completion test. Regular Production from this field started in January 2012. At present 10 wells are producing while one well is shut in. Currently the field is producing 102 MMscfd Gas, 1064 STBD Condensate & 340 STBD Water. As of February 2020, it has recovered 237 Bscf Gas and 2135 MSTB condensate.

1.2. Kunnar West

Kunnar West is an extension of Kunnar Deep structure and was discovered in 2007 by exploratory well, "Kunnar West-1A". Initially Kunnar West-1 (Deviated) was drilled in 2006 where Basal Sands were tested with DST. However, no formation fluid was observed at surface therefore, well was declared as dry. Later, Kunnar West-1A was drilled where Massive Sands of the Lower Goru Formation proved to be productive. One (1) Development well was drilled later on. Kunnar west-1 has produced 11.02 MMscfd Gas, 170 STBD Condensate & 20 STBD Water against 2480 psi WHFP at 32/64" Choke size during initial testing. Regular Production from this field started in April 2014. At present only one well i.e. Kunnar West-1A is producing while Kunnar West-2 is awaiting Connection. Currently, the field is producing 8.8 MMscfd Gas, 138 STBD Condensate & 30 STBD Water. As of February 2020, it has recovered 21.3 Bscf Gas and 215 MSTB condensate.

1.3. Pasakhi Deep

Pasakhi Deep Gas Field was discovered in 2005 with successful exploratory well Pasakhi Deep-1 from massive sands of the Lower Goru formation. Two Appraisal were drilled in 2008 & 2010 and later on four (04) Development wells were added to the structure. Pasakhi Deep-1 has produced 15.4 MMscfd Gas, 150 STBD Condensate & 35 STBD Water against 3155 psi WHFP at 32/64" Choke size during DST-3. Regular Production from this field started in January 2012. At present 5 wells are producing (Pasakhi Deep-1, 2, 3, 4 & 5) while other wells are shut in. Currently the field is producing 38.7MMscfd Gas, 450 STBD Condensate & 127 STBD Water. As of February 2020, it has recovered 91.8 Bscf Gas and 770 MSTB condensate.

1.4. Pasakhi West Deep

Pasakhi West Deep Gas Field was discovered in May 2009 with successful testing of Pasakhi West Deep-1 (PSKWD-1) across Massive sands of Lower Goru formation during DST-2 however it didn't flow in DST-1 (also Massive Sand). The well is completed across tested zone of DST-2. The well produced 5.9 MMscfd Gas, 85 STBD Condensate & 125 STBD Water against 1450 psi WHFP at 32/64" Choke size during post completion test. Regular Production from this field started in January 2017 during commissioning phase of KPD-TAY Integrated plant. Currently the well is shut in. A development well, Pasakhi West Deep-2, has recently been drilled. During DST, in Massive Sands, the well produced 12.2 MMscfd Gas, 110 STBD

condensate & 75 STBD Water against 2185 psi WHFP at 32/64" choke size. The well has been completed in the tested interval of Massive sands and shut in at present. PSKWD-1 is producing 0.8 MMscfd Gas, 31 STBD Condensate & 40 STBD Water. As of February 2020, Pasakhi West Deep field has produced 482 MMscf Gas and 7.6 MSTB condensate.

1.5. Pasakhi North East

Pasakhi North East-1 was drilled in August 2006 in a structural extension of the main Pasakhi structure. Well was drilled down to 3555 m across LG formation. Three DSTs were performed, DST-1 & 2 in Massive Sands while DST-3 in Upper sands. In DST-1, medium to strong gas bubbles were observed with zero WHFP. In DST-2 in which the well produced 1130 STBD water with 5.4 MMscfd gas. DST-2 was repeated with PSP, in which the well produced 850 STBD water with 5.7 MMscfd gas while 7-10 MMscfd gas was estimated in PSP. DST-3 was carried out in upper sands, in which medium bubbles were observed in bucket, however during POOH wet pull (crude oil) was observed. Well was later completed with Jet pump in Upper Sands due to non-availability of gas processing facilities.

2. Concise Scope of Work

2.1. Objective

The main objective of this study is to carry out a detailed Simulation and Network modelling Study of KPD and surrounding TAY Block fields (Kunnar deep, Pasakhi Deep, Kunnar West, Pasakhi West Deep, Pasakhi North East, Pasakhi East, Shah, Kunnar South and Unnar) producing from Massive sands of Lower Goru Formation, in order to exploit the maximum possible reserves in the most economical way by incorporating available information from E&P domains (Geophysical, Petrophysical, Geological, Reservoir Engineering, Production engineering and facilities etc.).

2.2. Scope of Work

This Scope of Work shall be applied to KPD and surrounding TAY Block fields (as mentioned above).

2.2.1. Consultant will analyze the available geophysical, geological, core data, well logs, well structure and stratigraphic correlations/ cross sections, well tests data, BHP data (incl. MDTs), PVT data, production data, completion histories and all other relevant data related to the current or proposed well(s).

2.2.2. Consultant will carry out detailed seismic data interpretation of the 3D cube of area of interest at the TLG, Middle, Basal & Massive sand levels and use the available velocity data (VSP/ Well tops etc.) for depth conversion of the TWT surfaces. Seismic volume for KPD area including Chandio (A TAY Block field) would be around 197 Sq. Km. The consultant to generate seismic amplitude maps to identify sand prograde. Area Geophysicist shall vet consultant's Interpretation/ analysis/ working before proceeding further.

2.2.3. The integrated Petrophysical properties for all fields at various Lower Goru sand levels will be determined by the analysis of the wireline logs with incorporation of production, core and quantitative well log data. The objective of this analysis will be to determine the best possible evaluation of porosity, permeability, initial fluid saturations, fluid contacts, reducible & irreducible water saturations and total & residual hydrocarbon saturations. The consultant will develop well log correlations (Structural & Stratigraphic) across the length & breadth of the fields from Top Lower Goru (TLG) to top of Sembar Formation. Consultant's Petrophysical Interpretation/ analysis/ working shall be vetted by OGDCL's Petrophysicist before proceeding further.

2.2.4. Consultant should identify new conventional & unconventional prospects throughout Lower Goru Sequence. Potential Sand Stringers within all Shale Units of Lower Goru formation should keenly be evaluated.

2.2.5. The Consultant will build a new Geological Model (Static Model) for complete Lower Goru package including Sembar formation in Petrel software using the Geophysical, Geological and Petrophysical interpretations for all the fields. Consultant's Geological Interpretation/ analysis/ working shall be vetted by OGDCL's Area Development Geologist before proceeding ahead.

2.2.6. The Consultant will estimate layer-wise deterministic & Probabilistic Gas Initially in Place (GIIP) by volumetric method using newly generated Static Model for all producing/ tested formations in categories 1P, 2P and 3P in compliance with SPE PRMS. Consultant will also estimate volumetric in place for newly identified conventional/ Unconventional horizons/ sand packages in Petrophysical evaluation. Prospective resources should also be assigned to all the possible leads/ prospects in compliance with SPE PRMS. Consultant's Estimation/ working shall be vetted by OGDCL's Area Reservoir Engineer/ Geologist before proceeding ahead.

2.2.7. The Consultant will carry out basic Reservoir Engineering analysis including Rock & fluid properties for utilization in Tank & Simulation models. The consultant will use properly matched RTA (Rate Transient Analysis i.e. Fetkovich, Blasingame, FMB etc.) & PTA (Pressure Transient Analysis) to model reservoir behavior and calibrate material balance & well (IPR) models. Models used in PTA & RTA should be realistic and in agreement with the surface and subsurface available information. Number & choice of PTA and RTA candidates shall be made in consultation with OGDCL's Area Reservoir Engineer.

2.2.8. Consultant shall apply DCA and p/z techniques (Both well wise & field wise) for reserves & GIIP estimation. Consultant shall build properly history matched Material Balance Tank models (Havlena Odeh etc.) by using IAM or PETEX software to estimate the GIIP and determine the drive mechanisms & their effect on the performance of reservoir(s). All the Estimations/ working pertaining to Basic Reservoir Engineering shall be vetted by OGDCL's Area Reservoir Engineer to proceed further.

2.2.9. Consultant will develop a representative 3D black oil reservoir dynamic model for all the reservoir levels/Sands in Petrel as interface and Intersect as simulator. Consultant shall properly initialize and history match the fine scaled model in order to generate reliable predictions. History match shall be vetted by OGDCL's Area Reservoir Simulation Engineer to proceed further.

2.2.10. Any difference in GIIP from Static, Material balance and dynamic models as well as RTA should be resolved and final results to be summarized. This should be agreed upon by OGDCL's Area Reservoir Engineer before proceeding ahead.

2.2.11. The consultant will propose new development/ Infill well(s) locations based on their integrated analysis/ evaluation/ interpretation of static model, material balance model(s) & dynamic model in order to maintain production plateau rate.

2.2.12. The consultant will build well (IPR/ VLP) & Network models of KPD & surrounding TAY Block fields and integrate them with TAY block & KPD Satellite fields' network model to apply surface production conditions. Consultant will recommend optimization in the existing network in future after changes in well and reservoir behavior as predicted by material balance & dynamic models. This will be vetted by OGDCL's Area Reservoir Engineer.

2.2.13. The consultant will provide the optimum production operation conditions for maximum hydrocarbon recovery (i.e. Compression etc.). The Consultant will also provide forecast scenarios (Annual) including gas, oil and water recoveries with

BHFP and WHFP by applying different operating/ development conditions till the ultimate recovery of the field.

2.2.14. In the Study, consultant should address following (but not limited to) regarding compression to maintain the plateau production rate:

i. Timeline of Compression for each field/ Well
ii. Estimated Ultimate Recovery (EUR) with/ without compression
iii. Production forecasts against suction pressures i.e. 1200, 1000, 800, 600, 400, 200 & 50 psi.
iv. Comparison of EUR (of all fields) for Front End/ nodal compression vs wellhead compression scenarios
v. Required compression Nodes, Stages Capacity and timeline
vi. Possible modifications in current gathering system to accommodate stage wise compression

2.2.15. The consultant will submit techno-economical evaluation of the prediction scenarios along with recommendations.

2.2.16. Consultant shall select, in consultation with OGDCL's Reservoir Engineers assigned for this project, key wells for radial modeling to assess water coning phenomenon and define threshold(s) for future operation.

2.2.17. At the end consultant will provide a resource summary consisting of Reserves, Contingent resources and Prospective resources in three categories (1P, 2P, 3P etc.) in compliance with SPE PRMS. Resource volumes and economics shall be vetted by OGDCL's Area Reservoir Engineer.

2.2.18. The Study will be completed in five (05) **sub-phases** as follows:

i. Seismic & Petrophysical interpretation, static modeling and Volumetric Estimation
ii. Basic Reservoir Engineering Analyses i.e. Rock & Fluid properties, RTA, PTA, Material Balance (Tank) modeling
iii. Dynamic modelling, History match
iv. Production Forecasting for various development options
v. Network modeling of KPD & TAY and their merger with network model of Satellite fields to build an integrated network model of whole project.

3. Detail Scope of Work for Study Sub-Phases

3.1. Seismic & Petrophysical interpretation and Static Modeling

3.1.1. Seismic & Geological Analysis/ Interpretation

3.1.1.1. Structural and stratigraphic interpretation of the structure is to be carried out by using 3D seismic data and by establishing best well to seismic ties based on available data. Time to depth conversion would be carried out by using number of methodologies in order to build structure models and to establish best history match in dynamic modeling. Time and Depth structure maps would be generated on main producing reservoir sands as well as prospective reservoir levels (i.e. Ranikot, Upper sands (TLG, B or C Sand), Middle Sand, Basal Sand, Massive Sands, Sembar formation & Chiltan formation). Seismic interpretation should be performed on industry standard interpretation software i.e. Petrel G&G.

3.1.1.2. 3D volumes/Horizon Seismic attribute analysis would be carried out to establish relationship with Petrophysical parameters of the subsurface. The relationship so established would be used to reinforce future drilling/EOR opportunities.

3.1.1.3. Geological model/ models should be established to determine the pertinent geological features and geometry of the reservoirs in sufficient details to allow an adequate description of the reservoirs for reservoir simulation purposes. The available data will be provided to help in evaluation of geological interpretation and geological setting of the area.

3.1.1.4. The seismic interpretation should be carried out with complete involvement of OGDCL Geophysicist and all the aspects of seismic interpretation shall be approved by OGDCL Geophysicist before moving ahead.

3.1.1.5. Geological aspect (Structural/ Stratigraphic Cross Sections/ Correlations) needs to be discussed and approved by OGDCL Development Geologist. OGDCL may like to receive Structural/Stratigraphic Cross Sections/Correlations on OGDCL's approved format.

3.1.1.6. Geological model should be prepared using industry standard software i.e. Petrel G&G.

3.1.1.7. After completion/finalization of the Models, import the available data in the Geological Modeling software i.e. Petrel G&G (Also compatible with DSG), Integrate/ calibrate the interpreted seismic data (such as structural features/ faults and picked horizons) with the well data.

3.1.2. Petrophysical Analysis

3.1.2.1. The Petrophysical properties of the reservoir and formation water will be determined by the analysis of the production, core and quantitative well log data, The objective of this analysis will be to determine the best possible evaluation of porosity, permeability, capillary pressure, relative permeability, initial fluid saturation, saturation of reducible and irreducible water, total hydrocarbon saturation and residual hydrocarbon saturation. Water resistivity (Rw) measurement and methods used for it will also be determined.

3.1.2.2. All logs will be analyzed independently. The basic data for all wells will also be processed and interpreted independently. Normalization of the logs should be attempted wherever required. The whole interpretation should be carried out on Techlog software or any other software compatible with software used by OGDCL. The workflow of the interpretation module should be provided by the consultant.

3.1.2.3. Reconstruction of bad OH data due to washout hole condition, particularly in major reservoir zones (Density-sonic) by appropriate statistical methods.

3.1.2.4. **Clay Parameter Selection:** Log data will be cross-plotted to establish various clay parameters. Statistical techniques will be employed in an attempt to establish clay types, and also compared to any clay analyses that have been carried out in the laboratories if available. Shale parameters will be chosen from cross-plot techniques and from the individual logs as required.

3.1.2.5. **Shale Volume:** Shale volumes will be calculated using SP, Gamma Ray and CNL-FDC cross-plot methods as minimum requirements besides other indicators and as is applicable. If Spectral Gamma Ray and core data are available, the Vsh will be calculated and compare them for accuracy.

3.1.2.6. **Porosity Calculation:** Porosity will be calculated using multiple porosity log analysis which is available. The calculated porosity will be compared against core porosity to establish a log-core porosity relationship. This relationship will then be utilized to establish a core- derived porosity transformation for all the wells in the analysis. The consultant will be required to identify different rock types and produce transformation, correlations and curves for each rock type.

3.1.2.7. **Permeability:** Permeability should be computed using different approaches based on available data (logs, cores and testing results). However, the derived permeability index from different approaches will be provided to OGDCL with comparison and recommendations regarding the usage of which permeability for further working/ evaluation.

3.1.2.8. **Electro-Facies:** All appropriate wireline logs should be used to establish electro-facies using any statistical facies program and core facies calibration where available. Use neural network approach for reservoir characterization, create electro-facies logs using open hole logs and trained them with thee core data, and make synthetic logs of porosity, permeability and Sw and characterize the areas in the static model where there is no core data available.

3.1.2.9. Correlation between core and log derived data will be done for better understanding of geological/reservoir parameters.

3.1.2.10. **Porosity-Permeability:** Cross-plots of K-Max, K-Relative, K-Vertical and K-Horizontal of core versus log porosity will be created to establish relationship between permeability and log-derived porosity. These relationships will then be used to generate permeability logs for the zone of interest in all the wells evaluated.

3.1.2.11. **Water Saturation:** For water saturation calculation different models should be attempted using different available methodologies to come up with most suitable model. Formation water resistivity will be established from raw techniques and compared to water analysis from tests from the field and from analogue values as are available.

a. Saturation height functioning modeling will be carried out for the wells where SCAL data is available.
b. J-function modeling (capillarity) for defining transitional zone saturation.
c. Fluid contacts modeling will be reviewed and re-established.
d. Cut-off sensitivities will be re-established in the light of oil/gas production and reservoir behavior.
e. Based on bio-stratigraphy, SCAL and log data, reservoir characterization of all reservoir units will be established.
f. The interpreted results will be used to determine original OWC, GWC and GOC. The transition zone should be correlated with capillary pressure results.
g. Standard conventional log analysis will be carried out with color output of corrected Sxo (Water Saturation in Flushed zone), h, Vsh, Sw (Water Saturation of Water in Reservoir zone), Porosity, HCPV (Hydrocarbon Pore Volume), BVW (Bulk Volume of Water), Permeability, Vsh, moveable hydrocarbon and residual hydrocarbon etc.
h. C.P.I outputs of graphical plot will be in color along with log derived permeabilities. The plots will include produced formation analysis by volume (clay, matrix porosity and fluid analysis) and average grain density meter by meter in a scale of 1:200. Six copies of each plot will be prepared. All Cross/Pickett plots developed should also be provided to OGDCL with brief description and results on the same page.
i. Computer processed interpretation tabular output will include Sx, Sw, saturation of hydrocarbon, Vsh, moveable hydrocarbon, grain density, Φh, Φh(1-Sw), cumulative Φh (1-Sw)/Boi and cumulative Φh(1-Sw)/Bgi meter by meter.
j. Optimum numbers for porosity, Sw and clay volume cut-offs will be determined by testing data at variable sensitivities.

3.1.2.12. **Summary Tables:** A set of summary values for each zone in each well, listing pay, net pay, average porosity, water saturation, HCPV, BVW, porosity thickness, hydrocarbon thickness and permeability thickness will be generated, based on a series of cut-offs. A maximum of twelve sets of summary values will be generated and included in the final report. Accordingly, OWC, GWC and GOC will be established.

a. The log interpretation should be correlated to define reservoir scale parameters e.g. saturation profile or variation in OWC/ GWC/ GOC etc.
b. Consultant will provide all the answer log data on CD while summaries, spreadsheet/ Excel data will also be provided in respective formats. Petrophysical work is to be carried out on Techlog Software.
c. Consultant will review the current logging suit and recommend any changes for future wells.
d. All the logs should be evaluated for unconventional reservoir zones (tight oil/tight gas potential) in whole length of Lower Goru formation.

e. All the logs should be evaluated for the potential Shale-Sand Stringers within all Shale Units of Lower Goru formation (Top to Bottom).

3.1.3. Static Modeling

3.1.3.1. Static Model (Integrated Geophysical, Geological and Petrophysical Models) will commence after approval of Geophysical, Geological and Petrophysical work from OGDCL. Final Static Model should be provided in Petrel software.

3.1.3.2. Build consistent stratigraphic/structural models by picking up the stratigraphic surfaces based on geological, geophysical and Petrophysical information.

3.1.3.3. Formulate the depositional models by combining possibly the seismic attributes (e.g. reflection strength etc.) and well logs data as well as using the regional information such as available geological reports showing environment of deposition to describe the geological features and regional tectonic /structural configurations & ambiguities.

3.1.3.4. The vertical and lateral dimensions of various formation units will be delineated independently by the consultant. The consultant will prepare structure and stratigraphic cross sections using the logs and other data and will determine the gas water contact (GWC) specifying the transition zone.

3.1.3.5. For the purpose of reservoir description, each reservoir/zone will be subdivided into a number of layers as per geological model. Following maps should be generated for every producing / potential reservoir layer on 1:25000 map scale.

a. Time maps for all producing/potential reservoirs/layers
b. Depth structure maps for all producing/potential reservoirs/layers
c. Iso-velocity maps on for all producing/potential reservoirs/layers
d. All 3D volumes of attribute analysis/maps of horizon attributes / properties etc.
e. Isopachs maps
f. Calibrated Amplitude maps overlain by depth maps
g. Coherency maps
h. Gross hydrocarbon maps
i. Hydrocarbon pay maps
j. Net Pay maps (the cut Off values as used should be mentioned on each reservoir level map)
k. Maps to show Clay Volume distribution for each reservoir layer.
l. Net to Gross Ratio
m. Absolute & Effective Porosity maps
n. Permeability distribution maps
o. Hydrocarbon Pore Volume map
p. Water Saturation maps
q. Facies distribution map

3.1.3.6. A Facies model is to be constructed on Lower Goru reservoir sands using all finalized geophysical & petrophysical analysis/ evaluation/ estimations/ measurements. The model should address the vertical and lateral distribution of

different facies. A relationship between facies and reservoir quality/performance should also be established.

3.1.3.7. Potential for Tight Oil/Gas and Shale–Sand stringers in any layer/zone of Lower Goru formation should also be evaluated and the separate models to be prepared for all such prospective horizons.

3.1.3.8. Calculate volumetric gas in place for each geological layer. If, a modeled layer consists of two or more sub geological layers, or a geological layer has subdivisions in two or more further layers then the oil/gas in place to be estimated for each modeled geological layer as well as for subdivisions of same layer individually.

3.1.3.9. Total hydrocarbons in place has to be calculated using best possible cut off for porosity, water saturations and shale value with technical justification for each conventional reservoir/ zone/ layer, sand/ shale Stringers as well as for unconventional reservoir/ zone/ layer.

3.1.3.10. The Consultant should select a representative geological model (Using Geo-screening approach) for reservoir simulation modeling i.e. from static to dynamic and dynamic to static for proper reservoir properties population, fault/structural configuration and selection of permeability paths to capture the heterogeneity of the reservoir.

3.2. Basic Reservoir Engineering Analyses

3.2.1. Rock & Fluid properties

3.2.1.1. Review the PVT laboratory analysis reports on fluid samples. The reports will be reviewed for completeness and examined for systematic variation of key properties for final input into the Material Balance and Simulation Models.

3.2.1.2. Develop phase envelops of all fluid samples and identify reservoir fluid type.

3.2.1.3. Tune equation of state (EOS) in such a way that it will produce same fluid properties at any given pressure-temperature condition as reported in lab analyses.

3.2.1.4. Investigate flow assurance issues which may arise as a result of changing reservoir pressures.

3.2.1.5. For Wells/ Fields where PVT Studies are not available, Consultant will Utilize Compositional analyses (Gas/ Condensate/ Oil) to develop pseudo-PVTs keeping offset Well/Field behavior in consideration.

3.2.1.6. Review the rock properties data available for relative permeability and capillary pressure curves required for simulation models for each identified rock type.

3.2.2. Pressure & Rate Transient Analyses (PTA & RTA)

3.2.2.1. Review the Production data available, encompassing well test results carried out on different times, for their completeness and accuracy to be used for Simulation and Material balance (Tank Modeling).

3.2.2.2. Well test & Production data obtained from all the wells will be reviewed and analyzed by the consultant for reservoir parameter estimations and model validation. Consultant shall utilize traditional PTA and advanced RTA (Flowing material balance, Fetkovich, Blasingame etc.) to analyze/ interpret the Production/

Pressure data. The procedures to analyze the well test data should be clearly mentioned in the consultant's proposal.

3.2.2.3. The permeability estimated from the short- and long-term pressure transient analysis will be correlated with the data obtained from core analysis.

3.2.2.4. The skin from latest well test analysis should be evaluated further to estimate skin due to completion, partial penetration, turbulence and damage separately.

3.2.2.5. If more than one PTA or RTA models fit to data with reasonable assumptions and gets validated on available data, consultant will mention & match all such models.

3.2.2.6. The Model matching geological and geophysical data will be used to characterize the reservoir.

3.2.2.7. Well Test Analysis (PTA) on entire rate history must be provided along with de-convolution results. Apart from this; DST, BHP surveys of all wells prior to history matching shall be reviewed and results to be incorporated in the model.

3.2.2.8. Proposals for future testing procedures and practices should also be submitted.

3.2.2.9. The Consultant will apply Decline Curve Analysis (DCA) on all the wells by using OFM Software. The consultant will use at least 02 methods of Decline Curve (Exponential/ Hyperbolic/ Harmonic) depending on Production History and Reservoir Properties of wells. Difference between Reserves calculated by DCA, MB & Simulation should be justified &resolved reasonably.

3.2.2.10. The consultant will submit a separate report exclusively for well test analysis (PTA) & Rate Transient Analysis (RTA) for all wells/ fields.

3.2.3. Material Balance Tank Models

3.2.3.1. Develop reservoir tank models of all fields using industry standard software (IAM or PETEX etc.) to check possible pressure communication in different blocks at different reservoir levels.

3.2.3.2. Standard techniques must be utilized to identify presence of various pressure support sources (Aquifer etc.)

3.2.3.3. Tank models shall reasonably be history matched with application of aquifer modeling & Geopressure techniques (where required). Industry standard Aquifer Model(s) should be used to estimate the water influx rate & Voidage replacement for producing formation.

3.2.3.4. Perform sensitivity analyses on uncertain tank model parameters. Details of the matching procedures and sensitivity analysis results should be reported.

3.2.3.5. Following prediction cases will be run. Final decision on number of cases & scenarios will be made in consultation of OGDCL's Simulation Engineer at time of study. These prediction cases must be accompanied by economics.

a. Base case – to be run on the existing set up under prevailing operating conditions till field life to predict future performance of reservoirs/ fields till economical limit of the well/ field.
b. Consultant shall incorporate in various prediction scenarios, new development wells, infill wells, recompletion & stimulation cases, wellbore intervention/ work over jobs etc. in consultation with OGDCL's Reservoir Engineer and predict future performance for maximum gas recovery for reservoirs/ fields
c. The Consultant will report (Annual basis) oil, water and gas rates/ recoveries with BHFP and WHFP till the ultimate recovery (EUR) of the Wells & fields against guideline given in para a & b.

3.2.3.6. Estimate hydrocarbon volumes and reserves throughout the field life. Models, complete in all aspects, should be provided in digital format compatible with software available with OGDCL.

3.2.3.7. Results of Tanks models & RTA should be in close agreement with dynamic modeling.

3.3. Dynamic Modeling, History Match

3.3.1. Model Initialization

3.3.1.1. All simulation work must be performed on Intersect Simulator using Petrel Interface.

3.3.1.2. A Black Oil Simulation model would be required for the study (Choice of simulation type will be made after fluid typing). The areal grid size and layering of reservoirs will be dictated from the areal and vertical variation of the Petrophysical properties, facies studies and structure of the reservoir.

3.3.1.3. The aquifer should be represented by proper cells in all directions. After the completion of the Static Model, the consultant will propose the X-Y grid of the reservoirs, the number of cells to represent the reservoir and number of model layers.

3.3.1.4. The model will be initialized and History matched on "Fine Grid". However, if needed, grid may be upscaled if the results of both the fine grid and upscaled grid are reasonably matched & run time reduced significantly. This will be decided after discussion and concurrence of OGDCL's Reservoir Simulation Engineer.

3.3.1.5. After initialization, the model will be validated by comparing the open hole logs with synthetic logs of each well extracted from model.

3.3.1.6. A sensitivity run with no production to be run for five years or till the stability to understand the smoothness of initial data.

3.3.1.7. Corner point geometry of grid should be used in the Model.

3.3.1.8. Local Grid Refinement (LGRs) should be used around the wellbore region or away from the wells where we have no control on reservoir properties in case of upscaled model.

3.3.1.9. The location of hydrocarbon interfaces, the variation in pool composition and location of remaining recoverable hydrocarbons will be delineated.

3.3.1.10. The consultant will study the effects of aquifer strength on reservoir.

3.3.1.11. Consultant shall provide full field Simulation model along with sector models as required by OGDCL's Reservoir Engineer.

3.3.2. Radial Model Study

3.3.2.1. Key wells in each field will be selected for radial model study, to assess the coning behavior near the original contact(s) and condensate banking.

3.3.2.2. The selection of the wells will be made in consultation with OGDCL Reservoir Engineers and mutual understanding.

3.3.2.3. The results will be analyzed to allow development of well bore pseudo permeability curves for any water break through response.

3.3.2.4. Prediction of each case up to ultimate recovery will be conducted to determine the behavior of the well as a function of time.

3.3.2.5. The calibration of the model will be made with the well test, G&G and Petrophysical data available for the respective wells.

3.3.3. Full Field History Match

3.3.3.1. Prepare the recurrent data such as the well specification, perforation, rates, log of completion etc. and also evaluate the need to make Peaceman's correction to pressure data before history matching.

3.3.3.2. Carry out history match runs using the most appropriate time steps (to be agreed between OGDCL and the consultant) to maintain the necessary accuracy and consultant's model stability.

3.3.3.3. Adjust the reservoir parameters as necessary (within acceptable limits) to get the best well by well history match. A log of all the changes made on the parameters in order to obtain acceptable history match should be intimated to OGDCL and all computer runs be kept in record for OGDCL review.

3.3.3.4. Layer wise porosity, permeability, pressure and hydrocarbon saturation maps initially, in between and as well as at the end of history match will be provided to OGDCL. The match should account for all history parameters in addition to pressures.

3.3.3.5. Fully implicit model technique should be used in the single well, cross-sectional models and three-dimensional model studies to ensure the stability and accuracy of the solution.

3.3.3.6. The models should be able to perform accurately under stable conditions. The time step should be chosen in such a way which reduces the run time and proper convergence is achieved in shorter time.

3.3.3.7. Regardless of the number of the time steps proposed by Consultant, an acceptable history match should be obtained. However, the proposed number of time steps should be maintained as a minimum.

3.3.3.8. Adequate saturation change and a pressure difference in successive time steps will be maintained in any cell in all simulation studies. The incremental material balance tolerance should not exceed 0.1 percent in all studies (single well, cross section and full field). The parameters will be decided with consultation of OGDCL's Reservoir Simulation Engineer.

3.3.4. Prediction Performance

3.3.4.1. Consultant should perform one sensitivity prediction run excluding two years available pressure production data to validate model.

3.3.4.2. Following prediction cases will be run. Final decision on number of cases & scenarios will be made in consultation of OGDCL's Simulation Engineer at time of study. These prediction cases must be accompanied with economics.

a. Base case – to be run on the existing set up under prevailing operating conditions till field life to predict future performance of reservoirs/ fields till economical limit of the well/ field.
b. Consultant shall incorporate in various prediction scenarios, new development wells, infill wells, recompletion & stimulation cases, wellbore intervention/ work over jobs etc. in consultation with OGDCL's Reservoir Engineer and predict future performance for maximum gas/ condensate recovery for reservoirs/ fields
c. The Consultant will report (on annual basis) oil, water and gas rates/ recoveries with BHFP and WHFP till the ultimate recovery (EUR) of the field against guideline given in para a & b.

3.3.4.3. The optimum case will be selected & recommended after reviewing the results of all predication cases and discussions with OGDCL.

3.3.4.4. In each prediction case optimum number of wells (including the drilling techniques – Vertical or Horizontal) along with fracturing potential in tight sands packages will be investigated.

3.3.4.5. In all these cases, the reservoir simulator interfaced with surface facility network shall be used.

3.4. Network Modeling

3.4.1. Well Hydraulics Models (IPR/ OPR)

3.4.1.1. The consultant will develop calibrated (history matched) wellbore hydraulics models (in PETEX) and generate Vertical Flow Performance (VFP) tables for all the current and future wells

3.4.1.2. Well models and VFP curves must cover all the possible wellbore flowing conditions including natural flow & flow through compressor. This information will be used in various scenarios for production optimization in the simulation/ Network model.

3.4.1.3. The consultant will perform Nodal Analysis for all flowing wells and also for the wells (if any) which have loaded up or have seized to flow at present. This information will also be used for production optimization in the simulation model.

3.4.1.4. Consultant shall review completions of all the wells and suggest any change in light of Nodal/ System analysis, if required, for increasing the flow efficiently and convert to match with the simulation model layers at each well location.

3.4.1.5. Consultant shall, in light of his findings from Well models (Nodal Analysis); chalk out recommendations for future completions strategy for efficient well flow.

3.4.1.6. Well models shall be vetted by OGDCL's Area Reservoir Engineer.

3.4.2. Network Models

3.4.2.1. Consultant shall build Surface network models for KPD & surrounding TAY Block fields and properly calibrate it with the available data (This will later be integrated with Network models of rest of the TAY/ Nim block fields & KPD satellite fields).

3.4.2.2. Consultant shall study bottlenecks in the existing network, i.e. in well completions, well flow lines and facilities, trunk lines and plant and place recommendations for its optimization.

3.4.2.3. Consultant will couple the fully calibrated network model with their corresponding dynamic model for prediction runs.

3.4.2.4. Consultant shall merge network model of KPD & surrounding TAY Block fields with TAY Block & Satellite fields Network models to build an integrated network model of whole project.

3.5. Production Forecasting Through Integrated Network Model & Economic Analysis

Production Forecasting through integrated network models by using MBE (Tank) models of TAY-Nim block & KPD Satellite fields and Dynamic model of KPD & surrounding TAY Block fields shall be performed as follows.

3.5.1. Production Forecasting Through Integrated Network Model

3.5.1.1. Production Forecasting through integrated network model shall be carried out by using MBE (Tank) models of TAY-Nim block & KPD Satellite fields and Dynamic model of KPD & surrounding TAY Block fields.

3.5.1.2. The network simulation from wellhead to processing plant would be used to design and optimize the production.

3.5.1.3. Plant Inlet pressure requirement is 1050 psi which leads to 1200-1300 psi line pressure. Well head flowing pressure should be more than 1300 psi for injection in the system.

3.5.1.4. Consultant shall run a Base Case on the existing set up under prevailing operating conditions till field life with respect to existing network.

3.5.1.5. Consultant shall incorporate in various prediction scenarios, new development wells, infill wells, recompletion & stimulation cases, wellbore intervention/ work over jobs etc. in consultation with OGDCL's Reservoir Engineer and predict future performance for maximum gas recovery.

3.5.1.6. Simultaneously, the consultant will evaluate the reservoirs, production and pressure data to select the right time for compressor installation to maximize the gas recovery from the reservoirs.

3.5.1.7. The Consultant will report oil, water and gas rates/ recoveries with BHFP and WHFP till the ultimate recovery (EUR) of the field against guideline given in para 3.5.1.4 & 3.5.1.5.

3.5.1.8. The requirement for compression should be predicted to meet the contractual requirements of KPD-TAY project by using the network simulation.

3.5.1.9. Consultant will perform simulation run of the optimum compression to maximize the gas recovery. Number of simulation runs and other specifications will be decided with the consultation of OGDCL's Reservoir Engineer.

3.5.1.10. The Study should address following (but not limited to) regarding compression to maintain the plateau production rate:

a. Timeline of Compression for each field/ Well
b. Estimated Ultimate Recovery (EUR) with/ without compression
c. Production forecasts against suction pressures of 1200, 1000, 800, 600, 400, 200 & 50 psi.
d. Comparison of EUR (of all fields) for nodal compressor vs wellhead compressor scenarios in First Stage.
e. Required compression Nodes, Stages, Capacity and timeline

3.5.1.11. Stages are elaborated as below

a. First Stage: Front End Compression at KPD Plant with suction pressure of 600 psi and manageable up to 400 psi.
b. Second Stage: Nodal Compressors at different locations to meet the FEC suction pressures requirement. Suction pressure of this stage should range from 400-200 psi
c. Third stage: Wellhead compressors to meet the Nodal Compressor at suction pressures of 200 psi to 50 psi.
d. Forth Stage: Booster Compressors to be added between wellhead & Nodal Compressors to achieve minimum possible wellhead pressures (below 50 psi).

3.5.1.12. Possible modifications with complete layouts in current gathering system to accommodate stage wise compression.

3.5.1.13. Compressor's liquid handling capacity should also be studied & optimized in the compression design.

3.5.2. Economic Analysis

Field wise & Project Economic Analysis of Prediction scenarios/ Forecasts shall be carried out on full cycle and point forward basis. Consultant shall prepare economics cases in PEEP software. This shall be vetted by OGDCL's Area Reservoir Engineer. The consultant will report following;

3.5.2.1. Estimate ultimate recoverable reserves in proven, probable and possible categories as per SPE PRMS definitions.

3.5.2.2. For each prediction case, economic analysis (NPV at different discount rates, ROR/ IRR, Payout and other profitability ratios) must be furnished.

3.5.2.3. Based on the economic results, an optimum development plan should be provided by the consultant.

3.5.2.4. There will be a recommended plan of action to be followed to achieve maximum economic recovery based on the techno-economic analysis of the various prediction cases studies.

3.5.2.5. The plan must include recommendations for reservoir management, subsurface and surface facilities for the life of the field.

3.5.2.6. Provide field wise certification for reserves separately in proven, probable and possible categories in accordance with the definitions of reserves classifications carried by Society of Petroleum Engineers (SPE) / Petroleum Resources Management System (PRMS).

Section – 3: Tando Allah Yar and Nim Block (EL) Fields

1. Fields' Introduction

1.1. Chandio

Chandio Gas Field was discovered in May 2007 with successful testing of Chandio-1 across Basal and Massive sands of Lower Goru formation. The well has been completed in Basal sand. The well produced 2.6 MMscfd Gas, 70 STBD Condensate against 1800 psi WHFP at 32/64" Choke size during post completion test. Regular Production from this field started in June 2017 after commissioning of KPD-TAY Integrated plant through wellhead compressor. Currently the well currently shut in due to surface issues. As of February 2020, it has recovered 264 MMscf Gas.

1.2. Dars

Dars Gas Field was discovered in August 2003 with successful testing of Dars-1 across upper sands (B & C) of Lower Goru formation. The well has been completed across both B & C sands. The well produced 14.14 MMscfd Gas, 850 STBD Condensate & 8 STBD Water against 1800 psi WHFP at 32/64" Choke size during post completion test. Regular Production from this field started in June 2017 after commissioning of KPD-TAY Integrated plant. Currently the well is producing 3.9 MMscfd Gas, 115 STBD Condensate & 850 STBD Water. As of February 2020, it has recovered 5.7 Bscf Gas and 312 MSTB condensate.

1.3. Dars Deep

Dars Deep Gas Field was discovered in February 2006 with successful testing of Dars Deep-1 across Middle & Basal sands of Lower Goru formation. The well has been completed with gravel pack to avoid sand production across both the tested intervals. The well produced 11 MMscfd Gas, 475 STBD Condensate & 85 STBD Water against 2250 psi WHFP at 32/64" Choke size during DST-2. Regular Production from this field started in June 2017 after commissioning of KPD-TAY Integrated plant. Currently the well is producing 3.7 MMscfd Gas, 152 STBD Condensate & 120 STBD Water. As of February 2020, it has recovered 7.0 Bscf Gas and 125 MSTB condensate.

1.4. Dars West

Dars West Gas Field was discovered in July 2004 with successful testing of Dars West-1 across Upper sands (B & C) of Lower Goru formation. The well is completed across B sand interval. The well produced 8.5 MMscfd Gas, 590 STBD Condensate against 1930 psi WHFP at 32/64" Choke size during post completion test. Regular Production from this field started in June 2017 after commissioning of KPD-TAY Integrated plant. Currently the well is producing 7.7 MMscfd Gas, 562 STBD Condensate & 20 STBD Water. As of February 2020, it has recovered 8.7 Bscf Gas and 503 MSTB condensate.

1.5. Kunnar South

Kunnar South Gas Field was discovered in July 2008 with successful testing of Kunnar South-1 across two zones of Massive sands of Lower Goru formation. The well is completed across both tested zones. The well produced 16.6 MMscfd Gas, 275 STBD Condensate against 3000

psi WHFP at 32/64" Choke size during post completion test. Regular Production from this field started in June 2017 after commissioning of KPD-TAY Integrated plant. Currently the well is producing 11.6 MMscfd Gas, 162 STBD Condensate & 15 STBD Water. As of February 2020, it has recovered 10.5 Bscf Gas and 85 MSTB condensate.

1.6. Pasakhi East

Pasakhi East Gas Field was discovered in January 2008 with successful testing of Pasakhi East-1 across two zones of Massive sands of Lower Goru formation. The well is completed across both tested zones. The well produced 14.0 MMscfd Gas, 110 STBD Condensate & 70 STBD Water against 3100 psi WHFP at 32/64" Choke size during post completion test. Regular Production from this field started in June 2017 after commissioning of KPD-TAY Integrated plant. Currently the well is producing 4.8 MMscfd Gas, 78 STBD Condensate & 25 STBD Water. As of February 2020, it has recovered 8.6 Bscf Gas and 106 MSTB condensate.

1.7. Shah

Shah Gas Field was discovered in February 2010 with successful testing of Shah-1 across two zones of Massive sands of Lower Goru formation. The well is completed across both tested zones. The well produced 15.7 MMscfd Gas, 170 STBD Condensate & 95 STBD Water against 3000 psi WHFP at 32/64" Choke size during post completion test. Regular Production from this field started in June 2017 after commissioning of KPD-TAY Integrated plant. Currently the well is producing 7.7 MMscfd Gas, 122 STBD Condensate & 45 STBD Water. As of February 2020, it has recovered 10.3 Bscf Gas and 112 MSTB condensate.

1.8. Tando Allah Yar

Tando Allah Yar Gas Field was discovered in January 1998 with successful testing of Tando Allah Yar-1 across Upper sands (B & C) of Lower Goru formation. Three development well have been drilled in TAY Field namely TAY-2 (1998), TAY-3 (1999) & TAY-4 (1999). TAY-1 is dually completed in respective DST zones of B & C Sands while other wells are completed with single string in C sand. The well produced 14.5 MMscfd Gas, 180 STBD Condensate & 60 STBD Water against 3200 psi WHFP at 32/64" Choke size during post completion test. Regular Production from this field started in June 2017 after commissioning of KPD-TAY Integrated plant. At present only TAY-1 (SS & LS) are producing while others are shut in due to WHFP-line pressure equalization. Currently the field is producing 5.5 MMscfd Gas, 41 STBD Condensate & 37 STBD Water. As of February 2020, it has recovered 10.7 Bscf Gas and 323 MSTB condensate.

1.9. Tando Allah Yar North

Tando Allah Yar North Gas Field was discovered in July 2005 with successful testing of Tando Allah Yar North-1 across Upper sands (B) of Lower Goru formation. TAYN-1 is completed in the tested zone of B sand. The well produced 2.4 MMscfd Gas, 660 STBD Condensate & 75 STBD Water against 1325 psi WHFP at 24/64" Choke size during post completion test. The well is connected to KPD-TAY Integrated plant for regular production. Currently the field is

producing 1.6 MMscfd Gas, 2 STBD Condensate & 0 STBD Water. As of February 2020, it has recovered 0.02 Bscf Gas and 0.03 MSTB condensate.

1.10. Tando Allah Yar South West

Tando Allah Yar South West Gas Field was discovered in September 2017 with successful testing of Tando Allah Yar South West-1 across Massive sands of Lower Goru formation. TAYSW-1 is completed in the tested zone of Massive sands. The well produced 10 MMscfd Gas, 72 STBD Condensate & 70 STBD Water against 2440 psi WHFP at 32/64" Choke size during DST. The well is connected to KPD-TAY Integrated plant for regular production which has not started yet due to arrangement of surface facilities.

1.11. Unnar

Unnar Gas Field was discovered in November 2006 with successful testing of Unnar-1 across Massive sands of Lower Goru formation (DST-2). Chiltan formation was also tested (DST-1) but proved dry. The well is completed across DST-2 zone of Massive Sand. The well produced 14.5 MMscfd Gas, 180 STBD Condensate & 60 STBD Water against 3200 psi WHFP at 32/64" Choke size during post completion test. Regular Production from this field started in June 2017 after commissioning of KPD-TAY Integrated plant. Currently the well is producing 8.8 MMscfd Gas, 108 STBD Condensate & 65 STBD Water. As of February 2020, it has recovered 9.2 Bscf Gas and 93 MSTB condensate.

1.12. Saand

Saand Gas Field, located in Nim EL, was discovered in November 2013 with successful testing of Saand-1 (Re-entry) across Upper sands (B) of Lower Goru formation. The well produced 5.8 MMscfd Gas, 65 STBD Condensate & 0.6 STBD Water against 1580 psi WHFP at 32/64" Choke size during Post Completion Test. One appraisal well has also been drilled to delineate the Saand structure namely Saand-2 (2014) which produced 7.4 MMscfd Gas, 60 STBD Condensate & 15 STBD Water against 1530 psi WHFP at 32/64" Choke size during DST. Both the wells are completed in respective zones of B Sands. Regular Production from this field is yet to start through KPD-TAY Integrated plant due to pending connection.

2. Scope of Work

2.1. Objective

The main objective of this study is to carry out a detailed Reservoir, material balance and Network modelling Study of TAY/ Nim Block fields (Chandio, Dars, Dars West, Dars Deep, TAY, TAY North, TAY SW & Saand) & KPD Satellites fields (Thora Deep & Moolan) producing from various reservoirs of Lower Goru Formation, in order to exploit the reserves in cost effective manner by incorporating available information from E&P domains.

2.2. Scope of Work

This Scope of Work shall be applied to TAY/ Nim Block fields (Chandio, Dars, Dars West, Dars Deep, TAY, TAY North, TAY SW, and Saand) & KPD Satellites fields (Thora Deep & Moolan).

2.2.1. Consultant will review/ revisit the available geological data, core data, well logs, well structure and stratigraphic correlations/cross sections, well tests data, BHP data, PVT data, production data, completion histories and all relevant data of current and proposed well(s).

2.2.2. Consultant will carry out detailed seismic data interpretation of the 3D cube at respective reservoir levels and use the available velocity data for depth conversion of the TWT surface. Seismic volume for Dars and Saand area would be around 130 Sq. Km. The Consultant will provide DCMs for each field at Top Lower Goru (TLG) and each reservoir level encountered in the field. Consultant shall also look for any possible lead/ prospect from TLG to Top Sembar Fm. in the existing field (lease) area and report as prospective resource. Area Geophysicist shall vet consultant's Interpretation/ analysis/ working before proceeding.

2.2.3. The integrated Petrophysical properties for all fields will be determined by the analyses of the wireline logs with incorporation of production, core and quantitative well log data as given below.

2.2.3.1. The Petrophysical properties of the reservoir and formation water will be determined by the analysis of the production, core and quantitative well log data, The objective of this analysis will be to determine the best possible evaluation of porosity, permeability, capillary pressure, relative permeability, initial fluid saturation, saturation of reducible and irreducible water, total hydrocarbon saturation and residual hydrocarbon saturation. Water resistivity (Rw) measurement and methods used for it will also be determined.

2.2.3.2. All logs will be analyzed independently. The basic data for all wells will be processed and interpreted independently too. Normalization of the logs should be attempted wherever required. The whole interpretation should be carried out on Techlog software or any software compatible with software used by OGDCL. The workflow of the interpretation module should be provided by the consultant.

2.2.3.3. Reconstruction of bad OH data due to washout hole condition, particularly in major reservoir zones (Density-sonic) by appropriate statistical methods.

2.2.3.4. **Clay Parameter Selection:** Log data will be cross-plotted to establish various clay parameters. Statistical techniques will be employed in an attempt to establish clay types, and also compared to any clay analyses that have been carried out in the laboratories if available. Shale parameters will be chosen from cross-plot techniques and from the individual logs as required.

2.2.3.5. **Shale Volume:** Shale volumes will be calculated using SP, Gamma Ray and CNL- FDC cross-plot methods as minimum requirements besides other indicators and as is applicable. If Spectral Gamma Ray and core data are available, the Vsh will be calculated and compare them for accuracy.

2.2.3.6. **Porosity Calculation:** Porosity will be calculated using multiple porosity log analysis which is available. The calculated porosity will be compared against core porosity to establish a log-core porosity relationship. This relationship will then be utilized to establish a core- derived porosity transformation for all the wells in the analysis. The consultant will be required to identify different rock types and produce transformation, correlations and curves for each rock type.

2.2.3.7. **Permeability:** Permeability should be computed using different approaches based on available data (logs, cores and testing results). However, the derived permeability index from different approaches will be provided to OGDCL with comparison and recommendations regarding the usage of which permeability for further working/ evaluation.

2.2.3.8. **Electro-Facies:** All appropriate wireline logs should be used to establish electro-facies using any statistical facies program and core facies calibration where available. Use neural network approach for reservoir characterization, create electro-facies logs using open hole logs and trained them with thee core data, and make synthetic logs of porosity, permeability and Sw and characterize the areas where there is no core data available for better understanding of reservoir.

2.2.3.9. Correlation between core and log derived data will be done for better understanding of geological/reservoir parameters.

2.2.3.10. **Porosity-Permeability:** Cross-plots of K-Max, K-Relative, K-Vertical and K-Horizontal of core versus log porosity will be created to establish relationship between permeability and log-derived porosity. These relationships will then be used to generate permeability logs for the zone of interest in all the wells evaluated.

2.2.3.11. **Water Saturation:** For water saturation calculation different models should be attempted using different available methodologies to come up with most suitable model. Formation water resistivity will be established from raw techniques and compared to water analysis from tests from the field and from analogue values as are available.

a. Saturation height functioning modeling will be carried out for the wells where SCAL data is available.
b. J-function modeling (capillarity) for defining transitional zone saturation.

c. Fluid contacts modeling will be reviewed and re-established.
d. Cut-off sensitivities will be re-established in the light of oil/gas production and reservoir behavior.
e. Based on bio-stratigraphy, SCAL and log data, reservoir characterization of all reservoir units will be established.
f. The interpreted results will be used to determine original OWC, GWC and GOC. The transition zone should be correlated with capillary pressure results.
g. Standard conventional log analysis will be carried out with color output of corrected Sxo (Water Saturation in Flushed zone), h, Vsh, Sw (Water Saturation of Water in Reservoir zone), Porosity, HCPV (Hydrocarbon Pore Volume), BVW (Bulk Volume of Water), Permeability, Vsh, moveable hydrocarbon and residual hydrocarbon etc.
h. C.P.I outputs of graphical plot will be in color along with log derived permeabilities. The plots will include produced formation analysis by volume (clay, matrix porosity and fluid analysis) and average grain density meter by meter in a scale of 1:200. Six copies of each plot will be prepared. All Cross/Pickett plots developed should also be provided to OGDCL with brief description and results on the same page.
i. Computer processed interpretation tabular output will include Sx, Sw, saturation of hydrocarbon, Vsh, moveable hydrocarbon, grain density, Φh, Φh(1-Sw), cumulative Φh (1-Sw)/Boi and cumulative Φh(1-Sw)/Bgi meter by meter.
j. Optimum numbers for porosity, Sw and clay volume cut-offs will be determined by testing data at variable sensitivities.

2.2.3.12. **Summary Tables:** A set of summary values for each zone in each well, listing pay, net pay, average porosity, water saturation, HCPV, BVW, porosity thickness, hydrocarbon thickness and permeability thickness will be generated, based on a series of cut-offs. A maximum of twelve sets of summary values will be generated and included in the final report. Accordingly, OWC, GWC and GOC will be established.

a. The log interpretation should be correlated to define reservoir scale parameters e.g. saturation profile or variation in OWC/ GWC/ GOC etc.
b. Consultant will provide all the answer log data on CD while summaries, spreadsheet/ Excel data will also be provided in respective formats. Petrophysical work is to be carried out on Techlog Software.
c. Consultant will review the current logging suit and recommend any changes for future wells.
d. All the logs should be evaluated for unconventional reservoir zones (tight oil/tight gas potential) in whole length of Lower Goru formation.
e. All the logs should be evaluated for the potential Shale-Sand Stringers within all Shale Units of Lower Goru formation (Top to Bottom).

The objective of these analyses will be to determine the best possible evaluation of porosity, permeability, capillary pressure, relative permeability, initial fluid saturation, Fluid contacts, saturations of reducible and irreducible water and total & residual hydrocarbon saturations. Consultant's Petrophysical Interpretation/ analysis/ working shall be vetted by OGDCL's Petrophysicist before proceeding.

2.2.4. The Consultant will estimate the Gas/ Oil Initially in Place (GIIP /OIIP) by volumetric method using newly generated Time & Depth maps for all producing/ tested formations in category 1P, 2P and 3P.

2.2.5. The Consultant will evaluate the upside potential/ contingent resources (conventional/ unconventional) based on the newly generated dataset.

2.2.6. The Consultant will carry out basic Reservoir Engineering study by analyzing rock & fluid properties, reservoir & well performances, Pressure data to apply p/z and build Material Balance model (Tank Model) for estimation of the OIIP/ GIIP. To determine the drive mechanism and its effect on the performance of reservoir. The models should be reasonably history matched and agreed upon by the Area Reservoir Engineer. Further detail is as follows

2.2.6.1. Review the PVT laboratory analysis reports on fluid samples. The reports will be reviewed for completeness and examined for systematic variation of key properties for final input into the Material Balance Models.

2.2.6.2. Develop phase envelops of all fluid samples and identify reservoir fluid type.

2.2.6.3. Tune equation of state (EOS) in such a way that it will produce same fluid properties at any given pressure-temperature condition as reported in lab analyses.

2.2.6.4. Investigate flow assurance issues which may arise as a result of changing reservoir pressures.

2.2.6.5. For Wells/ Fields where PVT Studies are not available, Consultant will Utilize Compositional analyses (Gas/ Condensate/ Oil) to develop pseudo-PVTs keeping offset Well/Field behavior in consideration.

2.2.6.6. Review the rock properties data available for relative permeability and capillary pressure curves.

2.2.6.7. Review the Production data available, encompassing well test results carried out on different times, for their completeness and accuracy to be used for Material balance (Tank Modeling).

2.2.6.8. Well test & Production data obtained from all the wells will be reviewed and analyzed by the consultant for reservoir parameter estimations and model validation. Consultant shall utilize traditional PTA and advanced RTA (Flowing material balance, Fetkovich, Blasingame etc.) to analyze/ interpret the Production/ Pressure data. The procedures to analyze the well test data should be clearly mentioned in the consultant's proposal.

2.2.6.9. The permeability estimated from the short- and long-term pressure transient analysis will be correlated with the data obtained from core analysis.

2.2.6.10. The skin from latest well test analysis should be evaluated further to estimate skin due to completion, partial penetration, turbulence and damage separately.

2.2.6.11. If more than one PTA or RTA models fit to data with reasonable assumptions and gets validated on available data, consultant will mention & match all such models.

2.2.6.12. The Model matching geological and geophysical data will be used to characterize reservoir.

2.2.6.13. Well Test Analysis (PTA) on entire rate history must be provided along with de-convolution results. Apart from this; DST, BHP surveys of all wells prior to history matching shall be reviewed and results to be incorporated in the model.

2.2.6.14. Proposals for future testing procedures and practices should also be submitted.

2.2.6.15. The Consultant will apply Decline Curve Analysis (DCA) on all the wells by using OFM Software. The consultant will use at least 02 methods of Decline Curve (Exponential/ Hyperbolic/ Harmonic) depending on Production History and Reservoir Properties of wells. Difference between Reserves calculated by Volumetrics, DCA & MB should be justified & resloved reasonably.

2.2.6.16. The consultant will submit a separate report exclusively for well test analysis (PTA) & Rate Transient Analysis (RTA) for all wells/ fields.

2.2.6.17. The consultant will develop reservoir tank models of all fields using industry standard software (IAM or PETEX etc.) to check possible pressure communication in different blocks at different reservoir levels.

2.2.6.18. Standard techniques must be utilized to identify presence of various pressure support sources (Aquifer etc.)

2.2.6.19. Tank models shall be reasonably history matched with application of aquifer modeling & Geopressure techniques (where required). Industry standard Aquifer Model(s) should be used to estimate the water influx rate & Voidage replacement for producing formation.

2.2.6.20. Perform sensitivity analysis on uncertain tank model parameters. Details of the matching procedures and sensitivity analysis results should be reported.

2.2.6.21. Following prediction cases will be run. Final decision on number of cases & scenarios will be made in consultation of OGDCL's Reservoir Engineer at time of study. These prediction cases must be accompanied by economics.

a. Base case – to be run on the existing set up under prevailing operating conditions till field life to predict future performance of reservoirs/ fields till economical limit of the well/ field.
b. Consultant shall incorporate various prediction scenarios in consultation with OGDCL's Reservoir Engineer and predict future performance for maximum gas recovery for reservoirs/ fields
c. The Consultant will report oil, water and gas rates/ recoveries with BHFP and WHFP till the ultimate recovery (EUR) of the field against guideline given in para a & b.

2.2.6.22. Estimate hydrocarbon volumes and reserves throughout the field life. Models should be provided in digital format.

2.2.6.23. Results of Tanks models & RTA should be in close agreement with each other.

2.2.7. The consultant will propose number of new development well(s) based on their analysis/ evaluation/ interpretation of static data & material balance model(s) required to drain the reported reserves.

2.2.8. The consultant will provide the optimum production operation conditions for maximum hydrocarbon recovery (i.e. Compression etc.). The Consultant will also provide forecast scenarios including gas, oil and water recoveries with BHFP and WHFP by applying different operating/ development conditions till the ultimate recovery of the field.

2.2.9. In the Study, consultant should address following (but not limited to) regarding compression to maintain the plateau production rate:

2.2.9.1. Timeline of Compression for each field/ Well

2.2.9.2. Estimated Ultimate Recovery (EUR) with/ without compression

2.2.9.3. Production forecasts against suction pressures of 1200, 1000, 800, 600, 400, 200 & 50 psi.

2.2.9.4. Comparison of EUR (of all fields) for Front End/ nodal compression vs wellhead compression scenarios

2.2.9.5. Required compression Nodes, Stages Capacity and timeline

2.2.9.6. Possible modifications in current gathering system to accommodate stage wise compression

2.2.10. The consultant shall perform analytical analysis to assess water coning and to define operating conditions/ limits for future operation.

2.2.11. This Study will be completed in three (03) **sub phases** as follows:

2.2.11.1. Seismic & Petrophysical interpretation and Volumetric Estimation

2.2.11.2. Basic Reservoir Engineering Analyses i.e. Rock & Fluid properties, RTA, PTA, Material Balance (Tank) modeling

2.2.11.3. Network modeling of KPD Satellite, TAY/ Nim Block fields & its integration with KPD & Satellite fields network models

2.2.12. Field wise & Block level Economic Analysis of Prediction scenarios/ Forecasts shall be carried out on full cycle and point forward basis. Consultant shall prepare economics cases in PEEP software. This shall be vetted by OGDCL's Area Reservoir Engineer. Further detail is as follows;

2.2.12.1. Categorize ultimate recoverable reserves in proven, probable and possible categories as per SPE PRMS definitions.

2.2.12.2. For each prediction case, economic analysis (NPV at different discount rates, ROR/ IRR, Payout and other profitability ratios) must be furnished.

2.2.12.3. Based on the economic results, an optimum development plan should be provided by the consultant.

2.2.12.4. There will be a recommended plan of action to be followed to achieve maximum economic recovery based on the techno-economic analysis of the various prediction cases studies.

2.2.12.5. The plan must include recommendations for reservoir management, subsurface and surface facilities for the life of the field.

Section – 4: KPD Satellite Fields

1. Fields' Introduction

These fields are 100% OGDCL owned, producing through KPD-TAY integrated plant.

1.1. Moolan

Moolan Gas Field, located in Lashari Center & South D&PL, was discovered in November 2007 with successful testing of Moolan-1 across two zones of Upper sands of Lower Goru formation. The well is completed across both tested zones. The well produced 4.4 MMscfd Gas, 64 STBD Condensate & 35 STBD Water against 900 psi WHFP at 32/64" Choke size during DST-1 (C & D sands). The well produced 6.0 MMscfd Gas, 165 STBD Condensate & 40 STBD Water against 1240 psi WHFP at 32/64" Choke size during DST-2 (A & B sands). Regular Production from this field started in June 2017 after commissioning of KPD-TAY Integrated plant. Moolan-1 produces under Wellhead compression. Currently the well is producing 1.9 MMscfd Gas, 190 STBD Condensate & 50 STBD Water. As of February 2020, it has recovered 1.05 Bscf Gas and 85 MSTB condensate.

1.2. Thora Deep

Thora Deep Gas Field, located in Thora & Thora East D&PL, was discovered in May 2007 with successful testing of Thora Deep-1 across Massive sands of Lower Goru formation. The well produced 10 MMscfd Gas, 100 STBD Condensate & 120 STBD Water against 1880 psi WHFP at 32/64" Choke size during DST. One appraisal well have also been drilled to delineate the Thora deep structure namely Thora Deep-2 (2008) which have proved successful. Both the wells are completed in respective DST zones of Massive Sands. Regular Production from this field started in June 2017 after commissioning of KPD-TAY Integrated plant. At present both Thora Deep-1 & Thora Deep-2 are shut in due to Water hold up and low pressure. A third well Thora Deep-3 has been drilled and suspended in the field. As of February 2020, it has recovered 8.3 Bscf Gas and 92 MSTB condensate.

2. Scope of Work

Same scope of work described for TAY & Nim Fields shall apply here.

Section – 5: Deliverables and Terms & Conditions

1. Deliverables

The consultant shall submit an executive summary and a unified report of all the phases of the study along with the outputs described below (02 hard copies of all). These reports/ summaries will also be provided in digital formats (.docx & .pdf)

1.1. G&G and Static Model

1.1.1. Consultant shall submit following outputs both in hard and digital formats for all fields under study (Kunnar – Pasakhi Deep, Tando Allah Yar/ Nim Block & KPD Satellite fields)

1.1.1.1. Seismic interpretation Project(s)

1.1.1.2. Velocity modeling data & Velocity Maps

1.1.1.3. Depth & time contour maps (Along with GRVs, Area, Rock Properties etc.) at Ranikot, TLG, B or C Sand, Middle Sand, Basal Sand, Massive sands, Sembar & Chiltan levels; and of leads and prograde identified as result of Attribute analysis anywhere from TLG to Chiltan formation

1.1.1.4. Geological & Geophysical cross-sections

1.1.1.5. CPIs of all wells including coring/ Testing/ completion information wherever available

1.1.1.6. CPI Well correlations across length & breadth of the Structures (including Testing & completion Intervals)

1.1.1.7. Following maps should also be generated for every producing / potential reservoir layer on 1:25000 map scale.

a. Iso-velocity maps on for all producing/potential reservoirs/layers
b. All 3D volumes of attribute analysis/maps of horizon attributes / properties etc.
c. Calibrated Amplitude maps overlain by depth maps
d. Coherency maps
e. Facies distribution map
f. Gross reservoir maps
g. Gross hydrocarbon maps
h. Hydrocarbon pay maps
i. Net Pay maps (the cut Off values as used should be mentioned on each reservoir level map)
j. Maps to show Clay Volume distribution for each reservoir layer.
k. Net to Gross Ratio maps
l. Absolute & Effective Porosity maps
m. Permeability distribution maps
n. Hydrocarbon Pore Volume map
o. Water Saturation maps

1.1.2. Static model of KPD fields, complete in all aspects as described in Scope of Work.

1.1.3. Consultant to provide complete Petrel projects (including all above) and all working of Petrel given in sections-3 and 4.

1.2. Basic Reservoir Engineering

Consultant shall submit following outputs of the Basic Reservoir Engineering and simulation

1.2.1. PTA reports & files (Saphir) and field wise comparative summary (Inputs/ Results) tables & bubble maps

1.2.2. RTA reports & files (Topaz) and field wise comparative summary (Inputs/ Results) tables & bubble maps

1.2.3. Well wise and field wise DCA charts and results summary (OFM project as well)

1.2.4. Well performance models (IPR/OPR)

1.2.5. History matched Tank models with prediction cases

1.3. Reservoir Simulation

1.3.1. Summary of parametric tuning for History matching with rationales as remarks

1.3.2. History matched dynamic models with prediction cases

1.3.3. Tabulated Comparison of various prediction cases & their outcomes

1.4. Network Model & Economics

Consultant shall submit following outputs of the Network model

1.4.1. Pressure-Production forecasts against various plant conditions (on annual basis) as required in Scope of work (Qg, Qo, Qw, WHFP, BHFP)

1.4.2. PEEP project of all the prediction cases

1.4.3. Tabulated summary of Economic variables & indicators

1.4.4. Techno-commercial comparison of WHC & FEC

1.4.5. Proposed layouts (Facilities/ Gathering System/ Compression Nodes)

2. Terms & Conditions

2.1. General

2.1.1. It is highly preferred to have all phases of the study being conducted at one location. This is for information of those consulting firms who have various offices at different locations in which some parts of the study may be carried out at one location and some in other. OGDCL feels that the interfacing between various stages of the study is very important.

2.1.2. The study will be carried out by the same office invited to bid for the study.

2.1.3. The study will be conducted by the consultant with active participation and involvement of technical staff of OGDCL.

2.1.4. All phases will have to be accomplished in association with OGDCL Reservoir Engineer/ Simulation Professionals, Reservoir Geologists, Geophysicist, Facility Engineer & Petrophysicist assigned with the consultants. The responsibility of the accomplishment of all kind of work/ studies will be on the consultant's part. However, the OGDCL/JV professionals in different disciplines will be attached from time to time for necessary inputs/ training.

2.1.5. The personnel who will conduct the study should be dedicated fully to this study and will be available throughout their relevant phase of this study.

2.1.6. Consultant would mention their bid cost estimates of each phase separately but OGDCL will evaluate the bid on total cost basis along with other criteria i.e., personnel's experience, company's experience, experience on similar projects etc.

2.1.7. OGDCL may arrange a pre-bid meeting on request to explain the present status of field and objective of study. The consultants will participate in the meeting at their own cost.

2.1.8. Consultant will submit their invoices on each phase basis as described under section 1 part 2 (Technical Approach). The total cost of the study mentioned in the Financial Proposal by the consultant will be taxable as per Government of Pakistan Rules or any other amount announced time to time by GOP in this regard.

2.1.9. All geological, geophysical, drilling, testing, production, well logs, Wireline logs, core and fluid analysis data required for the study will be available to the consultant free of charge. Such material will be the property of OGDCL and the Consultant will treat all data and information supplied by OGDCL and those acquired by consultant during the implementation of the study with utmost confidentiality.

2.1.10. OGDCL reserves the right to discontinue any study/ any task/ any service related to above scope of work at any stage without assigning any reason. OGDCL reserves the right to reject the services of any consultant provided by the consultancy firm at any time/ any stage and hence it will be the responsibility of the consulting firm to provide the replacement without any delay accordingly.

2.1.11. Upon completion of the study, all the data shared for the purpose of study will be returned to OGDCL.

2.2. Timing

2.2.1. The project will commence with the signing of the contract A detailed work plan should be submitted with the Technical Proposal. The total time of the study should not exceed 41 weeks, however, data collection/review (03 weeks), presentation (02 weeks) and draft report review (02 weeks) will be exclusive of the mentioned time (48 weeks in total).

2.2.2. Consultant shall submit a proposal for study in OGDCL office, Islamabad by reasonably reducing the study time required as compared to international office.

2.3. Submission of Proposals

2.3.1. The consultants interested in undertaking this venture may submit their bid/proposal to the office of General Manager (GM) Supply Chain Management Department, OGDCL House, Jinnah Avenue, Blue Area, Islamabad.

2.3.2. Technical & Financial proposals should be given separately in two sealed envelopes clearly marked “Integrated Reservoir Simulation Study of Pasakhi, Pasakhi North, Pasakhi Northeast Oil Fields and Pasakhi Deep Gas Condensate Field”.

2.3.3. The technical proposal must contain a brief history of consulting firm, the nature of services provided, the key projects undertaken and its experience in the field of integrated reservoir simulation studies. A soft copy on CD/DVD of the technical proposal should also be submitted along the hard copy.

2.3.4. The **technical** part of the proposal should also contain a tentative work program and time schedule to complete each phase of study. They should indicate the other projects completed by the consulting firm and their manpower allocation and their Resume. The Resume should be submitted in the following format:

a. Academic Qualification.
b. Total overall relevant experience. Particularly emphasizing experience in Sandstone Reservoirs.
c. Overall experience/ description of job assignments of the personnel with the bidding company.
d. Total overall experience of each professional.

2.3.5. The **financial** section of the proposal should contain:

Phase-wise break down of the cost. And must be provided in the following format:

Sr. No.	Study Phase	Total Lump Sum Cost in USD
1	Phase I	
2	Phase II	
3	Phase III	
4	Phase IV	
5	Phase V	
6	Final Report/ Presentation	
7	Total Lump sum Cost inclusive of all applicable taxes duties and Levies etc except Provincial Sales Tax/ Islamabad Capital Territory Tax on Services in Pakistan.	

2.3.6. Phase-wise break down of the cost according to scope of work of KPD & KPD Satellite Fields and TAY & Nim Block Fields should also be provided separately.

2.3.7. The Proposal evaluation will be carried out as per Criteria given under 2.4 below.

2.4. Evaluation Criteria

2.4.1. The **Technical** evaluation will be based on the following criteria.

Sr. No.	Category	Points
1	Total Experience of the firm/consultant in Reservoir Studies	05
2	Experience of the firm/consultant in last 05 years	15
3	Number of similar projects completed during last five (05) years	05
4	Technical approach	25
5	Work plan including manning schedule	10
6	Skill/Technical transfer plan	10
7	Professionals' Qualification & Experience	30
	Total	100

2.4.2. Criteria for selection of the consultant will be based on Clause-3B of PPRA Rules (Quality & Cost Based Selection).

2.4.3. 80% weight age will be given for technical evaluation and 20% for financial evaluation. The lowest bidder will attain maximum marks in financial evaluation and others would be ranked on the sliding scale.

2.4.4. The points obtained in technical evaluation and financial evaluation will then be combined and bidder attaining maximum points in technical and financial evaluation as a whole will be awarded the contract.

2.4.5. The **financial** proposal of bidders obtaining less than 80% points in total and less than 70% points in each category in the technical evaluation will not be opened and treated as NON RESPONSIVE.

2.4.6. Complete detail of Evaluation Criteria is given in “Annexure-I”.

2.4.7. Apart from detailed CVs of dedicated professionals for this project, the consultant will also provide the following information required for technical evaluation:

a. The consultant shall provide at its own expense suitably qualified personnel to ensure efficient performance of the studies to achieve the objectives. The consultant will designate in writing one of its staff as Project Coordinator.

b. The Project Coordinator shall act on behalf of the consultant and shall be responsible for supervising all of the consultant’s Work responsibilities, and also for maintaining liaison between the Company and the consultant.

c. Consulting firm should submit the name, academic qualification and experience of the technical personnel to conduct the study. Alternative or substitute names should also be mentioned. The consultant should clearly mention team experience in similar studies and terrains (Pakistan, India, and Iran etc.).

d. A team comprised of geoscientist and Reservoir Engineers will work at all levels of study to ensure that the study meets all the requirements of OGDCL and for timely completion of work.

e. Team of professionals as per table below:

Sr. No.	**Discipline**	**Team Leader/ Alternate***	**Team Members***	
1.	Geophysics			
2.	Petrophysicist			
3.	Geology			
4.	Geo-Modeling			
5.	Reservoir Engineering			
6.	Simulation Engineering			
7	Network Modeling & Facility Design			

f. Each team excluding team leader must not exceed more than two professionals and the consultant will ensure, once assigned the team/personnel shall remain dedicated to the project till its completion and will not be engaged in any other project at the cost of OGDCL project.
g. The CVs of the dedicated team be submitted along with their present contact number and email address.
h. In case of defection of any dedicated team member, the consultant will be responsible to engage a professional of similar domain/caliber.

2.4.8. Following G&G and RE software are available with OGDCL. The consultants/firms will be required to provide all the work on the software listed below:

a. Petrel (G&G, RE)
b. Geoframe
c. Intersect
d. Ecrin (Saphir, Topaz)
e. PETEX Suite
f. OFM
g. PEEP
h. Techlog/ Interactive Petrophysics

2.4.9. The consultant must use the Intersect software for Reservoir Simulation. Optimum case of final data file should also be converted in the "Eclipse Office" format.

2.4.10. Software used for Geological, Petrophysical and Economic Analysis should be used as mentioned above.

2.5. OGDCL/ JV Partner Participation and Skill Transfer

2.5.1. OGDCL's seven (07) Professionals (including Geophysicist, Petrophysicist, Develop Geologist, Basic Reservoir Engineer, Simulation Engineer, Facility Engineer & Reservoir Monitoring Engineer) will participate in performing the full field 3D Reservoir Simulation Study of KPD fields including Geophysical, Geological, Petrophysical, Basic Reservoir Engineering (i.e. Well Test analysis, RTA, PTA, DCA & Material Balance Models), building of Static Model, building of Dynamic Model, Initialization, History Matching, Predictions runs, Network Modeling, Compression Study and Economics for their inputs.

2.5.2. OGDCL & JV Partners will also participate in TAY block fields study including Geophysical, Geological, Petrophysical, Basic Reservoir Engineering (including Well Test analysis, RTA, PTA, DCA & Material Balance Models), Network Modeling, Compression Study and economics for their inputs.

2.5.3. Consultant will involve OGDCL & JV Partner professionals in all five (05) phases of the study.

2.5.4. OGDCL & JV Partner may like to have this study accomplish in association with its professionals without any financial impact on the consultant. However, consultant will

provide computer, international phone, internet facility and office space for working. Consultant will also provide transport from residence to office. The responsibility of the accomplishment of all kind of Work/ Studies will lie on the consultant.

2.5.5. OGDCL & JV Partner professionals in different disciplines will be attached with the consultant time to time for crucial inputs and supervision. Due to importance and uniqueness of this study which includes multi-disciplinary work, combined modeling of 19 fields and its output will be utilized for compressor design of KPD-TAY fields, GM (RMD) will decide phase wise schedule & duration of participation of OGDCL & JV Partners' professionals after having discussion with consultant according to study volume and requirement.

Annexure – I

1. Total Experience of the Firm/ Consultant (05 marks)

Maximum marks will be given to the firm having maximum experience in terms of No. of years & Reservoir studies. Certificates for completion of initial studies and firm registration year as reservoir study consultant should be provided.

2. Experience of the Firm/ Consultant in last 05 years (15 marks)

3.1 Consultant's Experience with International E&P Companies (e.g. Exxon, Chevron, Shell, BP, Total, Statoil etc.) for reservoir studies.

3.2 Consultant's Experience in Pakistan for reservoir studies.

3.3 Number of 3D Seismic Interpretations projects.

3.4 Number of 3D static models developed.

3.5 Number of 3D static models developed for stratigraphic traps.

3.6 Number of depositional models developed.

3.7 Number of 3D dynamic Black Oil models developed.

3.8 Number of 3D dynamic Compositional models developed.

3.9 Number of Integrated Reservoir Management Studies done.

3.10 Field Development/ Network/ Compression Modeling Studies using 3D dynamic model done.

3.11 Reserves Evaluation as Per PRMS Guidelines.

3. Number of similar projects completed in last 05 years (05 marks)

Firm/Consultant Experience in Field Development/ Network/ Compression Modeling Studies using geo screened 3D dynamic models and material balance models in combination as given in scope of work.

Note:

i. All of the above criteria are mandatory
ii. Documentary evidence should be submitted for each of the requirement
iii. Consultant will have to mention International and Pakistan Experience separately wherever applicable
iv. Number of Integrated Reservoir Simulation studies as per scope of work carried out by consultant/firm in last five years will be considered and for Pakistan will be preferred.

4. Technical Approach (25 marks)

Maximum marks will be given to the firm having best Technical approach using software as per TOR. The technical part of the proposal will be evaluated point to point in the light of TOR

and each part will be marked by the relevant professional. The technical approach which fulfils the maximum requirement of the TOR will be given maximum marks.

5. Work plan including manning schedule (10 marks)

Firm/consultant giving study work plan schedule less than the proposed in TOR will be given maximum marks.

6. Skill/Technical Transfer Plan (10 marks)

Maximum marks will be given to the firms giving the best way of skill / technical transfer and training plan.

7. Professionals' Qualification & Experience (30 marks)

7.1. CVs of dedicated and back up teams

i. Maximum marks will be given to those personnel having highest relevant educational credentials and maximum experience of conducting Integrated Reservoir Simulation studies using software suites as mentioned in TORs.

ii. Following information about the professionals dedicated by the consultant/ firm will be required, supported by documentary evidence:

7.2. Project Coordinator

International and Pakistan experience of managing Integrated Reservoir Studies mentioning clearly the Number of projects, project name, Tectonic regime, Geology, Fluid type, Completion types, Black oil/ Compositional, Network size (No. of wells), Compression Strategy (FEC, Wellhead etc.) for each project in last five years

7.3. Geophysicist

International and Pakistan experience of team leader and team members to interpret 3D seismic data mentioning clearly the Number of projects, project name, Tectonic regime, Acreage for each project along with software(s) used in last five years

7.4. Development Geologist/Geo Modeller

International and in Pakistan experience of team leader and team members to build comprehensive geological model based on the available 3D seismic data, lithological & petrophysical characteristics, stratigraphic controls and depositional environment mentioning clearly the Number of projects, project name, Play type, Major Geological Challenge to work with for each project along with software(s) used in last five years.

7.5. Petrophysicist

International and in Pakistan experience of team leader and team members to analyse the available wireline logs (Conventional/ Advanced) in correlation with core analysis, well data clearly mentioning the Number of projects, project name and No. of Wells along with software(s) used in last five years.

7.6. Reservoir Engineer

International and in Pakistan experience of basic Reservoir Engineering, PVT analysis, fluid properties, Material balance technique, Pressure transient analysis (PTA), Rate Transient Analysis (RTA) both conventional & Advanced, Well Models (Pipesim/ Prosper etc) clearly mentioning the Number of projects, project name and No. of Wells, Fluid type, No. of Material Balance Models, No. of PTAs, No. of RTAs (Convention & Advanced Separately) & No. of Well Models for each project along with software(s) used in last five years.

7.7. Simulation Engineer

International and in Pakistan experience of developing a representative 3D Black Oil and Compositional Reservoir Dynamic Model clearly mentioning the Number of projects, project name and No. of Wells, Fluid type, Model Type (Black Oil or Compositional), No. of EOS models, No. of Well Models for each project along with software(s) used in last five years.

7.8. Facility Design Engineer

International and in Pakistan experience of designing optimum well & Network models integrated with Simulation models clearly mentioning the Number of projects, project name and No. of Wells, No. of Network models, Compression along with software(s) used in last five years.