GCA FOCUS
Gaffney, Cline & Associates
Issue No. 45 - July 2008

Technical Due Diligence in the Upstream Petroleum Business

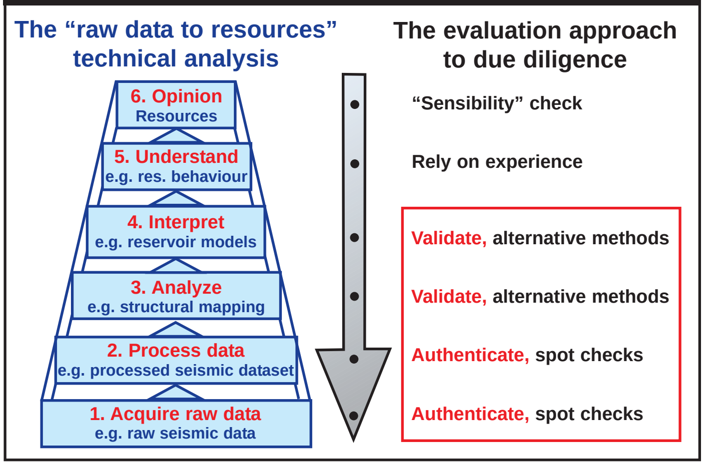
We frequently encounter the term "due diligence" within the petroleum industry. What does technical due diligence really mean, and what is implied by a claim that "technical due diligence has been carried out"? Here, Shane Hattingh provides some insight into the technical due diligence process as it relates to the subsurface.

What we expect from technical due diligence clearly depends on how the results are to be used. For example, technical due diligence may be undertaken to underpin the estimation of an asset value for a purchase, or for the compilation of a Competent Person's Report (CPR) by a Competent Person (CP), typically required as part of a public listing, or it may be undertaken simply to provide assurance to a concerned party regarding some specific technical matter.

Unlike the explicit application of due diligence to surface facilities, the technical due diligence of a subsurface asset is based on a completely different type of dataset and is far more implicit in nature. Different approaches and techniques are employed according to the class of the Resource being evaluated. For example, technical due diligence of a new discovery would require a different approach from that of a mature producing field.

There is limited published guidance available as to what technical due diligence of subsurface assets should comprise. In this regard, the compilation of a CPR for admission to the London Stock Exchange's (LSE) vibrant Alternative Investment Market (AIM) is probably a good example of a subsurface technical due diligence process that is fairly well defined in certain respects. The LSE published a "Guidance Note for Mining, Oil and Gas Companies", dated March 2006, which contains concise notes on the requirements for compilation of a CPR for inclusion in the admissions document. The intention of this is to establish a degree of consistency amongst professionals carrying out due diligence. It is telling that the LSE deems that only resource companies (mining, oil and gas) are required to submit a CPR as part of their admissions document, emphasizing the unique circumstances of subsurface assets. The CP has a responsibility to the listing company to portray its assets in an objective and unbiased manner and, at the same time, a "duty of care" to the potential investor. The admissions process incorporates various checks and balances intended to ensure the independence of the CP.

Fig. 1: Technical Analysis and Due Diligence



The AIM guidance note for CPRs describes the minimum expectations for the reporting of due diligence carried out on upstream assets. The guidance covers two important items, namely reporting standards for the estimation of resource volumes and the amount of technical detail reported in a CPR. Both of these are key considerations that generally apply whenever subsurface due diligence is carried out and the results reported. By adopting a reporting standard, such as the Society of Petroleum Engineers' Petroleum Resource Management System (SPE PRMS), we attempt to provide a benchmark for comparison. The SPE PRMS is especially useful in this regard, as it is relatively simple and easy to understand by users of the information such as investors who may not be experts in estimating and reporting resources. The SPE PRMS framework for resource reporting further addresses two elements that can help investors make informed investment decisions, namely volumetric uncertainty and certain aspects of project risk.

While the reporting standards and the scope of a due diligence report may be widely recognized, arguably the most important aspect of any technical due diligence process, the technical evaluation itself, is left entirely up to the professional responsible for carrying out the evaluation. Universal guidelines explaining the depth and detail of the technical work that should be carried out during due diligence are seldom provided. The standard of technical work can vary considerably, particularly with respect to the estimation and reporting of resource volumes. Important factors that affect the integrity of the technical evaluation are the availability of data, time constraints and the experience of the evaluator.

continued on page 2

An important question therefore is: How thorough must an evaluation be in order to satisfy the intent of the term “due diligence” and allow us to understand and report volumetric uncertainty satisfactorily? In order to appreciate the detail of technical work that is required for us to be satisfied that we have arrived at a defensible position of opinion, it is useful to recognize how our understanding of an asset evolves when we carry out a systematic “raw data to resources” study.

The systematic approach to analyzing a producing field can be represented simplistically by the pyramid on the left hand side of Figure 1. We usually begin with raw data (level 1 at the base of the pyramid), such as seismic or wireline data, which are then processed (level 2) before being analyzed (level 3) by, for example, seismic mapping or petrophysical analysis. We then interpret the data (level 4) by, for example, integrating individual datasets and constructing reservoir models and carrying out numerical simulation history matches. Through this process, our appreciation of the reservoir and its behaviour evolves to the point where we can claim to have an understanding of the reservoir (level 5). It is only then that we can confidently consider ourselves qualified to step back and express an opinion on the resources (level 6).

By contrast, it is often tempting to work in the opposite direction when carrying out due diligence, as represented on the right hand side of Figure 1. We may begin by reviewing resource opinions that have already been expressed, drawing on the understanding of the reservoir presented by others. However, if we restrict our evaluation to these levels (5 and 6), we must rely on what appears “sensible” based on our own experience. Generally, a shallow evaluation of this nature cannot reasonably be considered due diligence. It is imperative that existing interpretations and analyses are validated (levels 3 and 4) and it is almost always necessary to extend the work to the lower levels (1 and 2) to authenticate certain elements of raw and processed data.

Regardless of technical direction, confidence is enhanced where different approaches furnish similar results, e.g. material balance, decline curve analysis, static volumetrics. More generally, it is a fundamental principle that successful due diligence is strongly dependent on the experience of the evaluator. There is no substitute for this.

Dr Shane Hattingh is a Senior Manager based in GCA’s UK office. He has 23 years’ experience in the earth sciences and in reservoir engineering: more recently he has been actively involved in a variety of reserve estimation and certification projects.

Reserve Estimation in Fields with Horizontal Wells

When the definitions and guidance for the estimation of reserve volumes were originally contemplated, most oil and gas wells were vertical. It has since become commonplace for fields to be developed utilizing horizontal wells. In this article, Brian Rhodes addresses the key question of how to apply the "rules" within this new development scenario.

The question is, perhaps, most relevant when applying the United States Securities and Exchange Commission (SEC) requirements for Proved Reserves, although it also applies to the Society of Petroleum Engineers/World Petroleum Council/American Association of Petroleum Geologists/Society of Petroleum Evaluation Engineers March 2007, Petroleum Resource Management System (SPE PRMS), which recognizes all categories of Reserves.

The SEC states: *"If there is an indication of economic producibility by either formation test or production, the reserves in the legal and technically justified drainage area around the well projected down to a known fluid contact or the lowest known hydrocarbons, or LKH may be considered to be proved".*

In terms of whether a well is classified as proved developed or proved undeveloped, the SEC advises: *"Proved developed oil and gas reserves are reserves that can be expected to be recovered through existing wells with existing equipment and operating methods",* and *"Proved undeveloped oil and gas reserves are reserves that are expected to be recovered from new wells on undrilled acreage, or from existing wells where a relatively major expenditure is required for recompletion. Reserves on undrilled acreage shall be limited to those drilling units offsetting productive units that are reasonably certain of production when drilled".*

It is easiest to create the framework and understanding of how to build horizontal wells into the reserves estimation process by first applying these principles to Proved Reserves. The same principles can then be applied generally to other categories of reserves.

In beginning the Proved Reserves estimation exercise, the first task is to define the well drainage area. This is that portion of a reservoir that can be drained effectively by a single well. It must be supported by sufficient technical evidence to establish productive continuity over that area. The effectiveness of recovery must also be considered and must be consistent with the defined drainage area. This area then becomes the Proved Area, although in reality it is three-dimensional since the thickness of the reservoir is included in the calculation.

In determining the radius of investigation of a well and whether any surrounding drilling units can be included under the offset rules, the reservoir parameters and the structure must be considered carefully. Evidence of continuity is important in determining that the criteria for Reasonable Certainty have been met that would qualify an area as "proved". It therefore follows that geology

Figs. 1, 2 & 3: Proved Area for Horizontal Wells

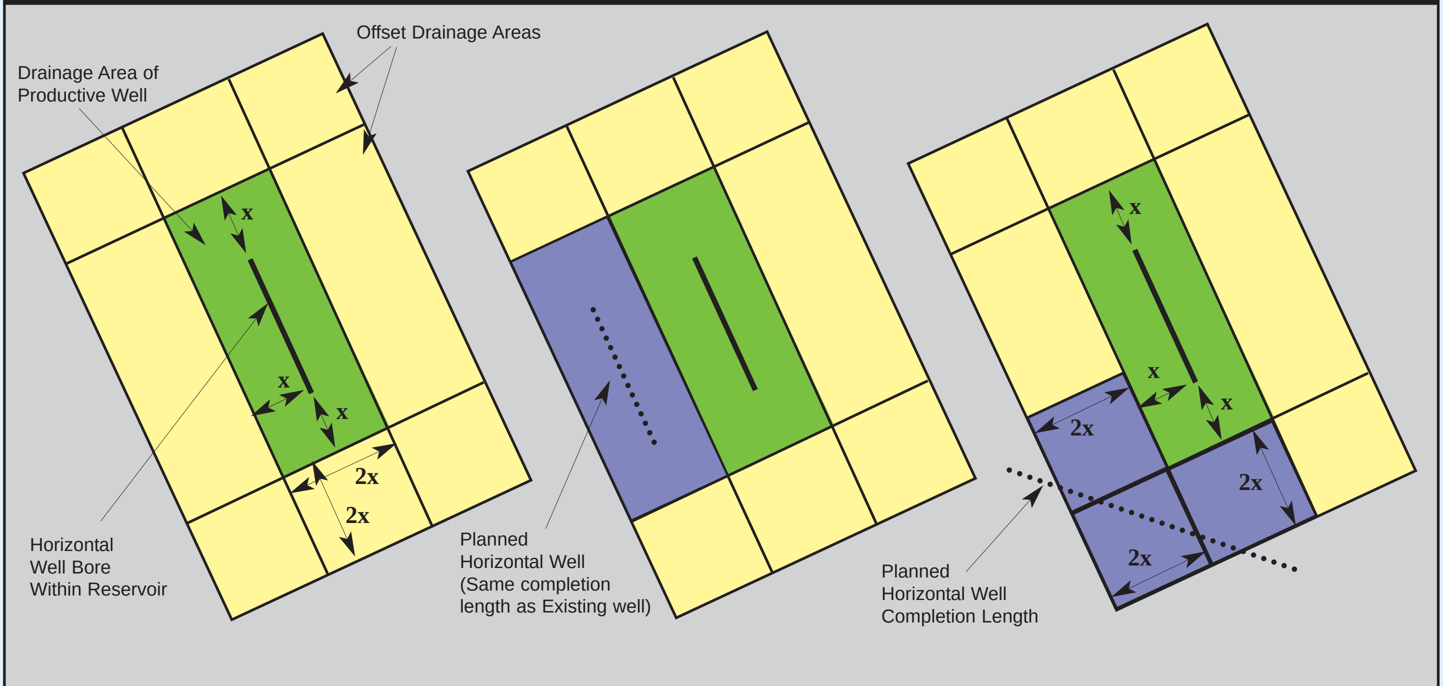


Fig. 1.

x = Drainage Radius (usually from vertical well text)

Proved Area

Unproved Offset Areas (no planned wells)

Fig. 2.

Proved Developed Area

Proved Undeveloped Area

Unproved Offset Areas (no planned wells)

Fig. 3.

Legend as for Fig. 2.

Minimum Proved Area with either a vertical well or part of a horizontal well bore in an offset is a square with sides 2x.

must be respected when placing the drainage area around a well together with its eight offset locations.

With the advent of horizontal wells in field development, it is necessary to determine how that impacts on well drainage area. In basic terms, the Proved Area is increased when a horizontal well is drilled because data are available over a larger area to confirm the continuity of the reservoir. Figure 1 describes how a rectangle is defined for a single productive horizontal well's drainage area. The distance from the horizontal drain-hole to each of the long edges of the rectangle is equal to the distance over which continuity has been proved. Likewise, the rectangle extends beyond the toe and the heel of the horizontal drain-hole to a distance equal to that over which continuity has been proved.

The question is then how to determine the offset drainage area, which is necessary to estimate the Proved Undeveloped Reserves. As shown on Figure 2, the offset locations adjacent and parallel to the horizontal wellbore have the same rectangular shape and size as that of the productive well. All other offset locations are squares, and equal in size, with the length of each square equal to twice the distance over which continuity has been established.

There are a number of variations to consider when determining the offset drainage areas and thus the Proved Undeveloped Reserves. These can include the deviation of a proposed well, the length of the wellbore completion within the reservoir, the position of the well with respect to the current well and its offset locations, and the orientation at which the new well to be drilled. There is a minimum size that can be added to the Proved Area by an offset location to an existing horizontal well completion that contains either a planned vertical well or part of a horizontal well bore completion. This is a square with each side equal in length to twice the distance over which continuity has been proved. However, if the length of a proposed horizontal wellbore completion creates an Undeveloped Proved Area greater than the basic square, the area is limited by either the extent of the offset location or by a distance equivalent to that over which continuity has been established, as illustrated by Figure 3.

The area drained by a well, be it vertical or horizontal, which is used to define the drainage area and thus the Proved Area, must be based on the information that is available at the time the estimate is made and one that provides for a Reasonably Certain estimate. It is entirely feasible and, indeed, common that every well will exhibit different characteristics. It follows that a field will have a number of differently-sized Proved Areas. Over time as more information becomes available, the area being drained by a well can also change.

The above procedures should be applied to estimating Proved Reserves under both the SEC and SPE PRMS definitions. The same processes can be applied to Probable and Possible Reserves under SPE PRMS, to expand the estimation to cover the whole field. As an example, the ends of the planned horizontal well in Figure 3 falling outside the Proved Area would qualify as Probable Reserves under the SPE PRMS.

Brian Rhodes is a Principal Adviser working mainly in GCA's Corporate and Strategic Advisory Group. He also provides guidance within GCA and to clients on the interpretation of the definitions and rules of resource estimation and booking as well as presenting reserves courses and undertaking related speaking roles at conferences.

Making It Work Internationally

Combining high level management and technical skills with cultural sensitivity to solve challenges within the oil and gas industry; whether for Governments, National, Major or Independent Oil, Gas and Power Companies, Banks, International agencies, or the Private Sector

Integrated Technical & Management Advice
Financial and project evaluations, energy economics, project finance advice, corporate and asset valuations, fiscal systems, loan modelling, taxation and insurance issues

International Oil & Gas Exploration
Basin and prospect evaluation, seismic and geophysical log interpretation, and frontier petrophysics

Reservoir Appraisal
Reservoir description and characterization, core and log analysis, computer mapping and volumetrics, and reservoir simulation

Field Development
Development studies, practical engineering solutions, reserves estimation and certification, unitization and re-determination, integrated petroleum engineering studies, and geotechnical studies

GCA
Gaffney, Cline & Associates

Technical and Management Advisers to the Petroleum Industry Internationally Since 1962

Production Operations, Development Feasibility & Field Management
Project management, field feasibility studies, operations, mature field and EOR, and safety issues

Refining and Marketing
Refining and petrochemical studies, energy supply, demand and pricing, distribution and marketing, and contract formulation

Gas and Power
Gas reserves, markets and conservation, gas deliverability and field studies, transportation and utilization projects, gas-to-power generation, and project development advice

Corporate Advisory Services
Strategic direction for boards and management, government strategy and oil and gas policy, litigation and arbitration advice, public offering and shareholder documentation

GCA International Offices

Europe, Africa and the Middle East
Bentley Hall
Blacknest, Alton
Hampshire, GU34 4PU
England
Tel: + 44 1420 525366
Fax: + 44 1420 525367
email: gcauk@gaffney-cline.com


Bentley Hall, England

North America
1360 Post Oak Blvd
Suite 2500, Houston
Texas 77056 USA
Tel: + 1 713 850 9955
Fax: + 1 713 850 9966
email: gcah@gaffney-cline.com

South America
Avenida Pte. Roque Saenz
Pena-917, 2o Piso, Of. 1
C1035AAE-Capital Federal,
Buenos Aires, Argentina
Tel: + 54 11 4394 1007
Fax: + 54 11 4326 0442
email: gcaba@gaffney-cline.com


Houston, Texas

Asia Pacific
80 Anson Road, #31-01C
Fuji Xerox Towers
Singapore 079907
Tel: + 65 6225 6951
Fax: + 65 6224 0842
email: gcas@gaffney-cline.com


Singapore

Australia
Level 16, 275 Alfred Street
North Sydney, NSW 2060
Australia
Tel: + 61 2 9955 6157
Fax: + 61 2 9955 0624
email: gcasyd@gaffney-cline.com

Russian Federation
8th Floor, Radisson SAS Slavyanskaya
Hotel & Business Centre
2 Europe Square, Moscow 121059
Russian Federation
Tel: + 7 495 941 8710
Fax: + 7 495 941 8711
email: gcarussia@gaffney-cline.com

Sydney, Australia

If your contact details require updating, or if you would like to be added to our mailing list for future issues, or would like to receive a back-issue of GCA's Focus publication, please contact Suzanne Binfield at our UK office address or by email: sbinfield@gaffney-cline.com

Quality Assurance
GCA is certified
under ISO 9001:2000 in the UK

Visit our website at www.gaffney-cline.com