

RYDER SCOTT COMPANY

PRESENTATION TO

THE ENERGY AUTHORITY

*HYDROCARBON RESERVE ESTIMATES
AND UNCERTAINTY*

Presented by

Fred P. Richoux

Managing Senior Vice President

713-651-9191

Presented July 1, 2004



Outline

- 1) What are reserves?
- 2) How are they estimated?
- 3) How certain are the estimates?
- 4) What questions should I ask to better understand the uncertainty?

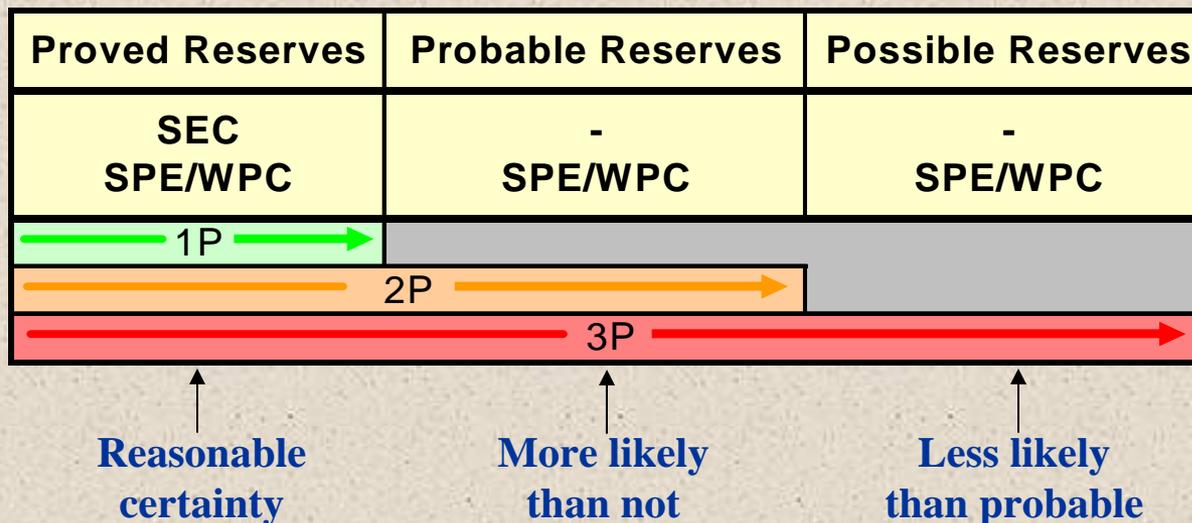


What are reserves?

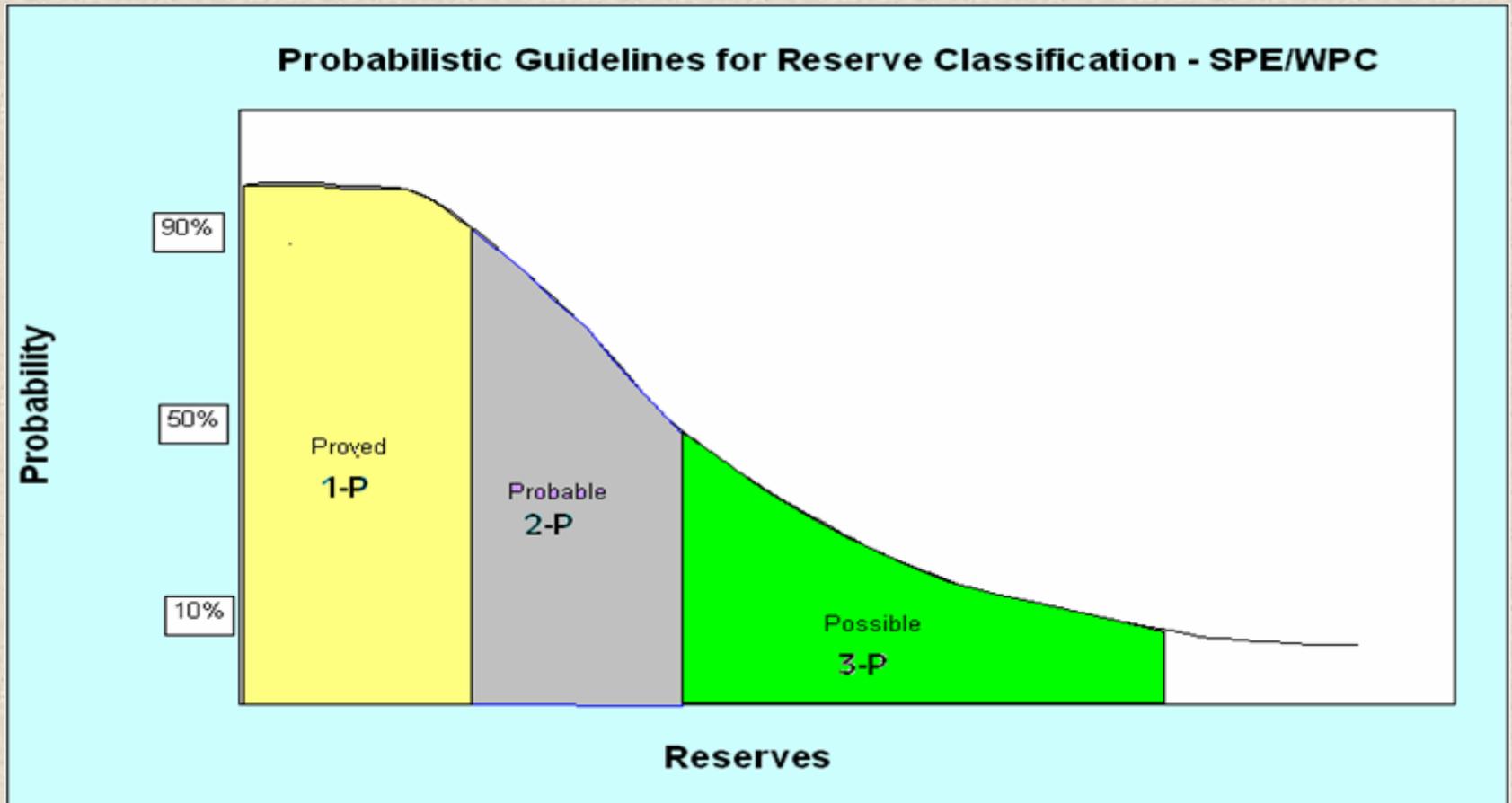


Reserve Definitions

- **SEC**
 - Securities & Exchange Commission (SEC)
- **SPE/WPC**
 - Society of Petroleum Engineers (SPE)
 - World Petroleum Congress (WPC)



Reserve Categories



SEC Reserve Definitions

SEC 1978 –Current Definition *(Rule 4.10 Regulation S-X)*

Proved oil and gas reserves are:

- the estimated quantities of crude oil, natural gas, and natural gas liquids, which
- geological and engineering data demonstrate with reasonable certainty
- to be recoverable in future years
- from known reservoirs
- under existing economic and operating conditions;
- i.e., prices and costs as of the date the estimate is made.



SEC Reserve Definitions

Proved Reserve Status

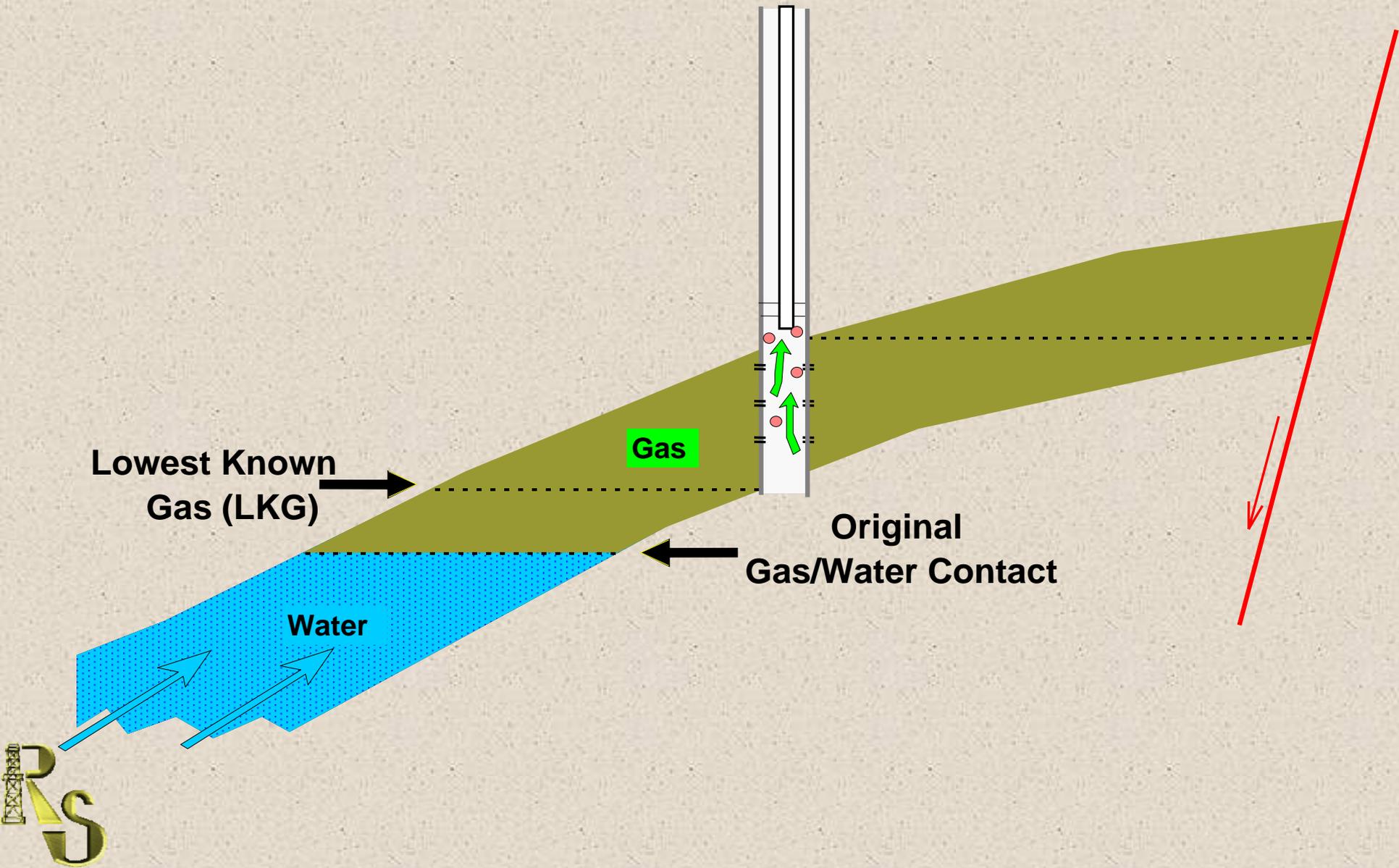
Developed

- Producing - PDP
- Shut In – SI or PDNP
- Behind Pipe – BP or PDNP

Undeveloped - PUD



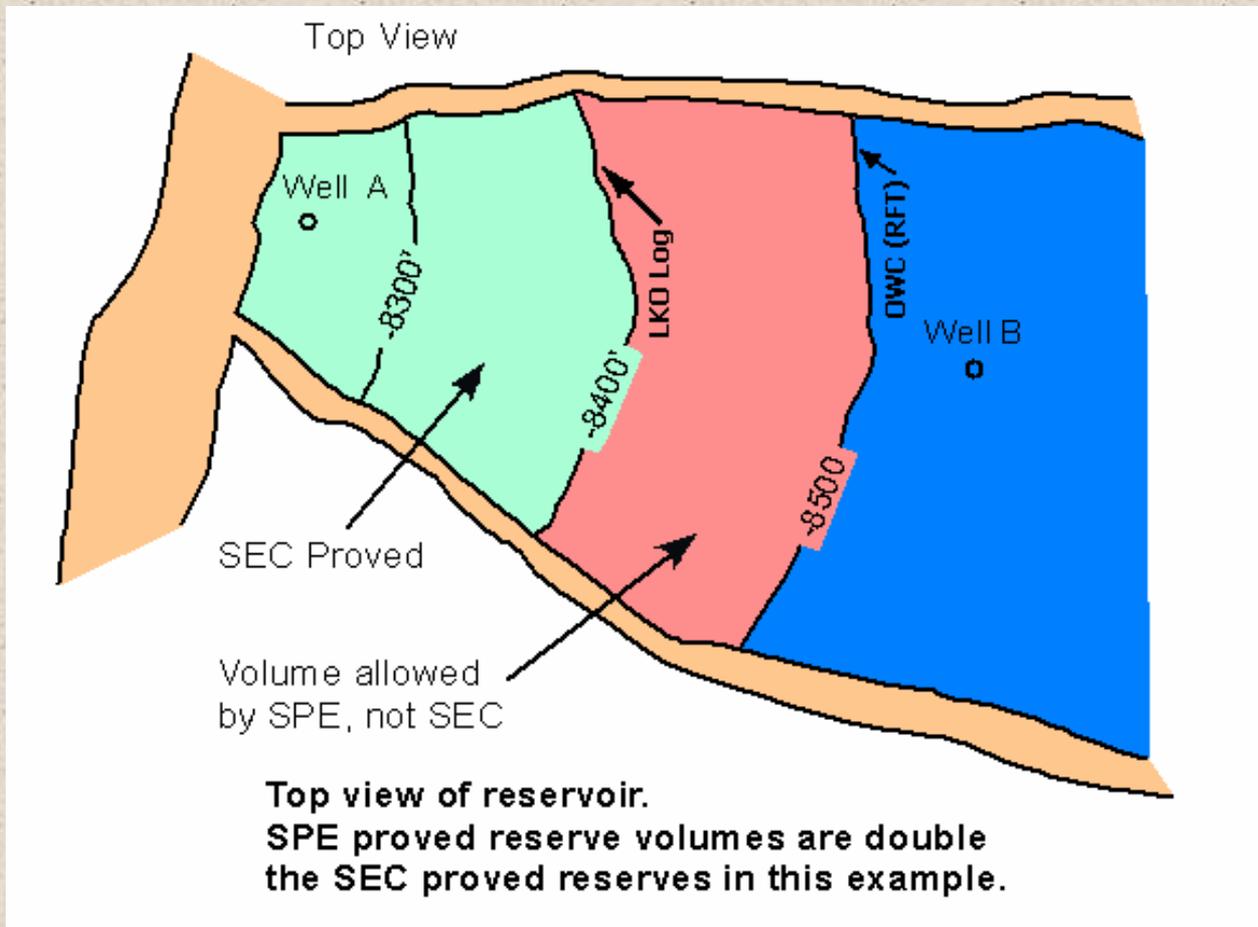
SEC Reserve Definitions



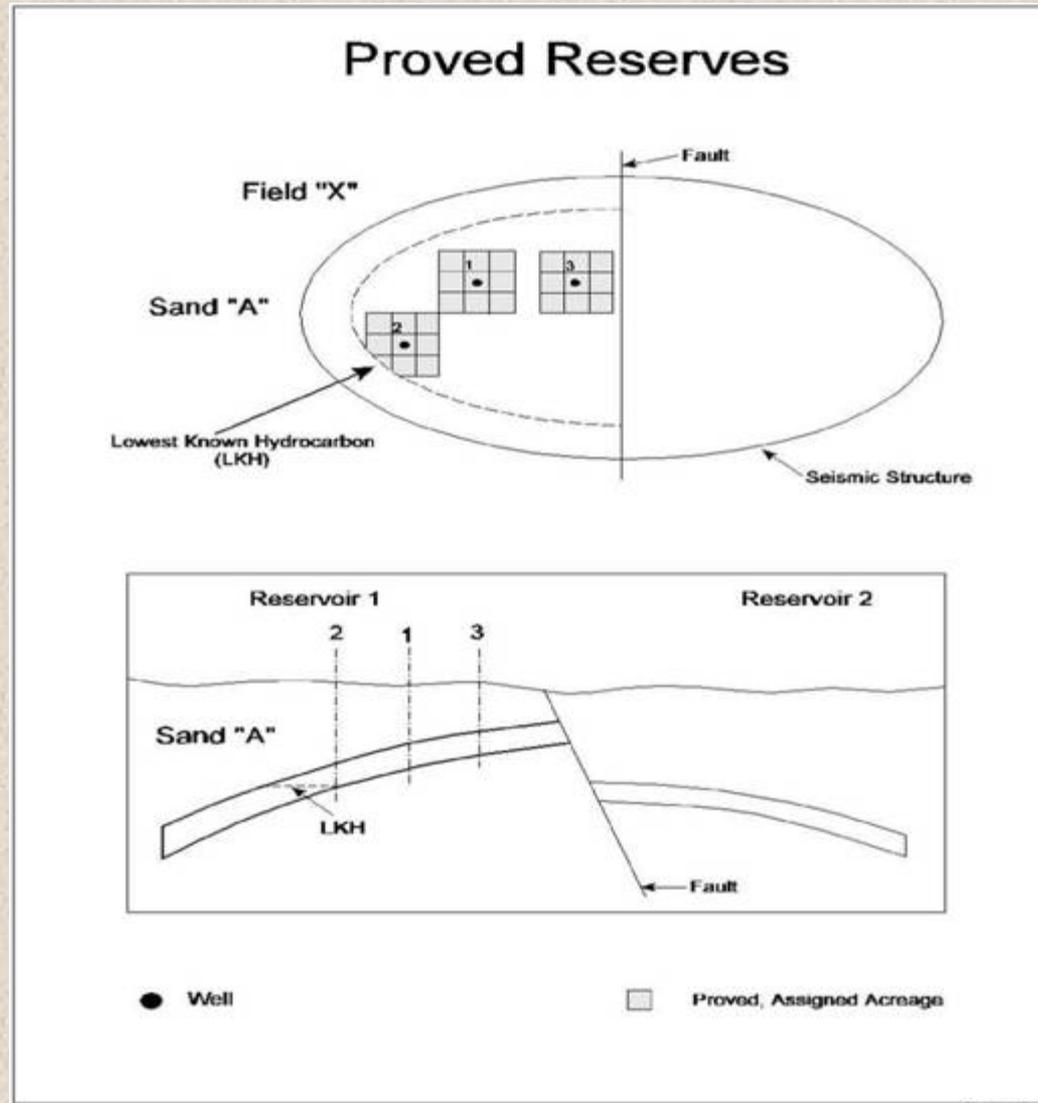
SEC vs. SPE/WPC – “Proved Area”

SIGNIFICANT DIFFERENCES IN SEC AND SPE / WPC RESERVES DEFINITIONS

- **Determination of Lowest-Known Hydrocarbons**



SEC Reserve Definitions



SPE/WPC Reserve Definitions

Probable Reserves

- Probable reserves are reserve estimates in known reservoirs which cannot yet be considered reasonably proved on the basis of **current** geologic and engineering information. However, **these volumes are expected to become proved** as additional information becomes available, and it is important to be able to define the event which will allow the reserves to become proved.

This is an industry definition. Not recognized by SEC

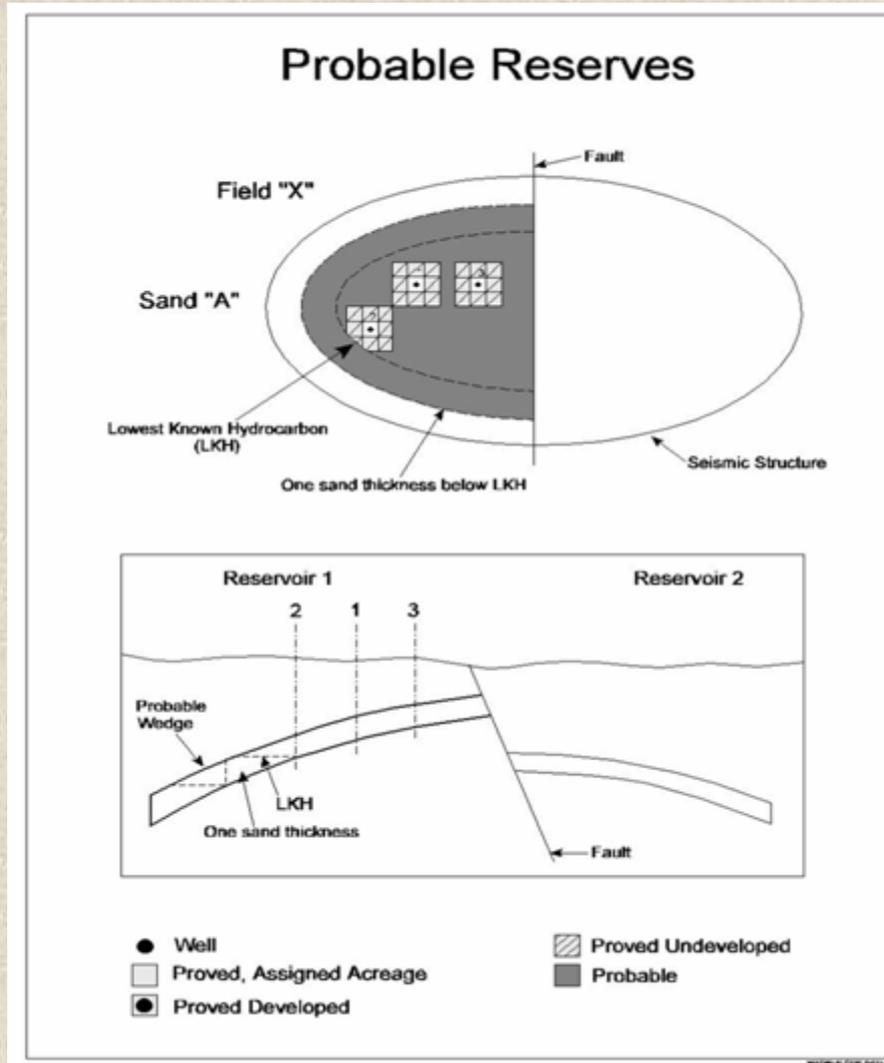


SPE/WPC Reserve Definitions - Probable

- Typical Examples
 - Volumes below “lowest known” hydrocarbons
 - Recovery factor greater than proved volumes
 - Untested zones
 - Questionable log analysis – low R_t , high S_w , low porosity
 - Fault blocks without penetrations
 - Down-spacing without regulatory approval
 - Down-spacing with questionable drainage patterns
 - Market, contract limitations
 - Enhanced recovery without successful testing
 - Certain step-out development wells
 - Work-over treatments without analogies
 - Alternative performance interpretation



SPE/WPC Reserve Definitions - Probable



SPE/WPC Reserve Definitions

Possible Reserves

Possible reserves are **less certain** than probable reserves and can be estimated with a **low degree of certainty**, insufficient data to indicate whether they are more likely to be recovered than not.

This is an industry definition. Not recognized by SEC



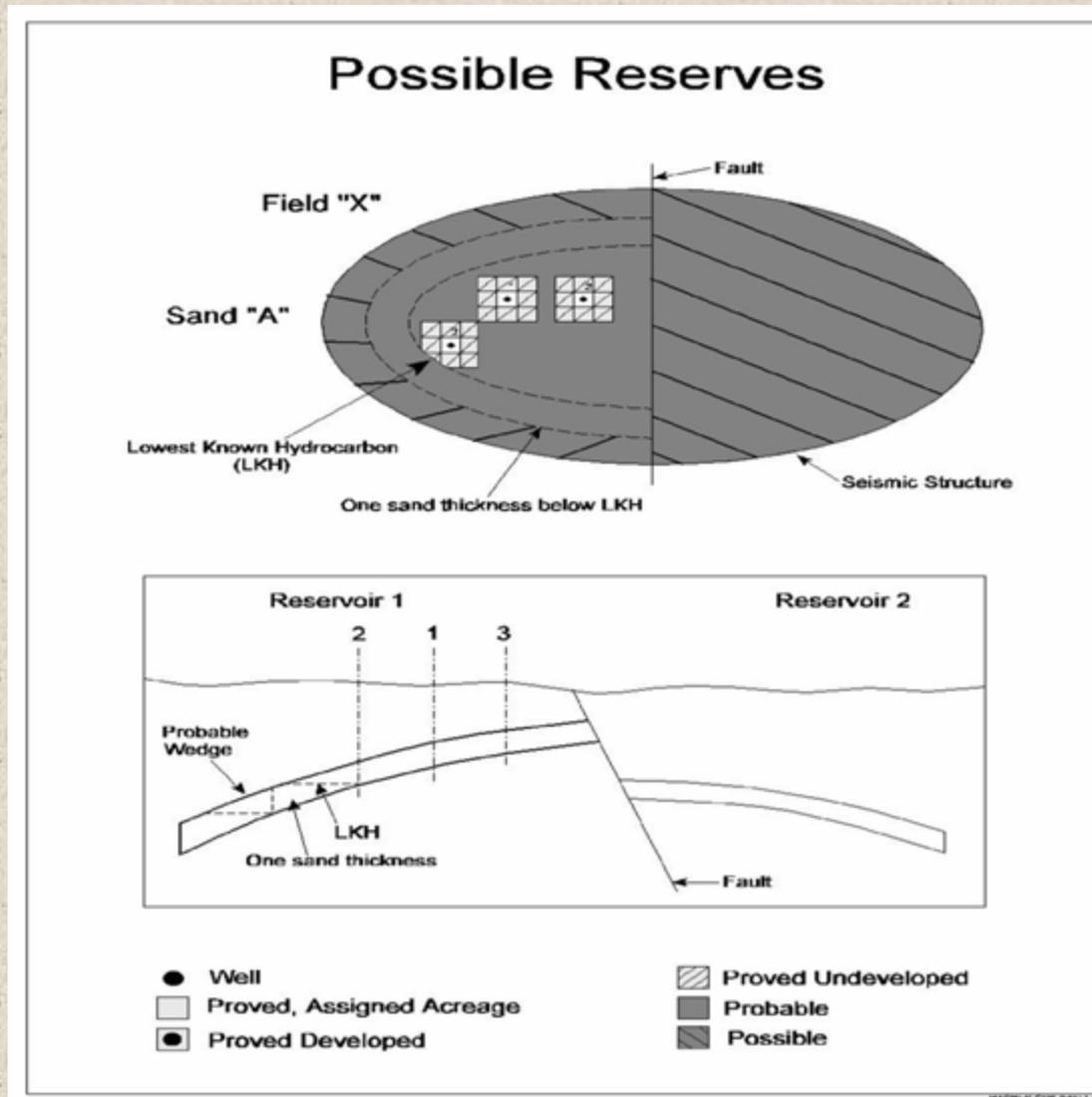
SPE/WPC Reserve Definitions - Possible

■ Typical examples

- Areas removed from geologic control
- Geophysically defined limits
- Some Untested Amplitudes
- Questionable log analysis
- Questionable commerciality
- Untested fault segments that do not qualify as probable
- Enhanced recovery possibilities



SPE/WPC Reserve Definitions – Possible



Reserve Reports/Audits/Reviews

- **Reserves report** is a “grass roots” study of all underlying data
- **Reserves audit** is an examination of a Reserves report (by others) for the purpose of expressing an opinion
- **Reserves review** is an analysis of the process and procedures underlying reserves report



How are reserves estimated?



Reserve estimation is not an exact science

Estimates are based on limited data which must be extrapolated over large areas
or long periods of time

Hydrocarbon recovery may be affected by outside sources

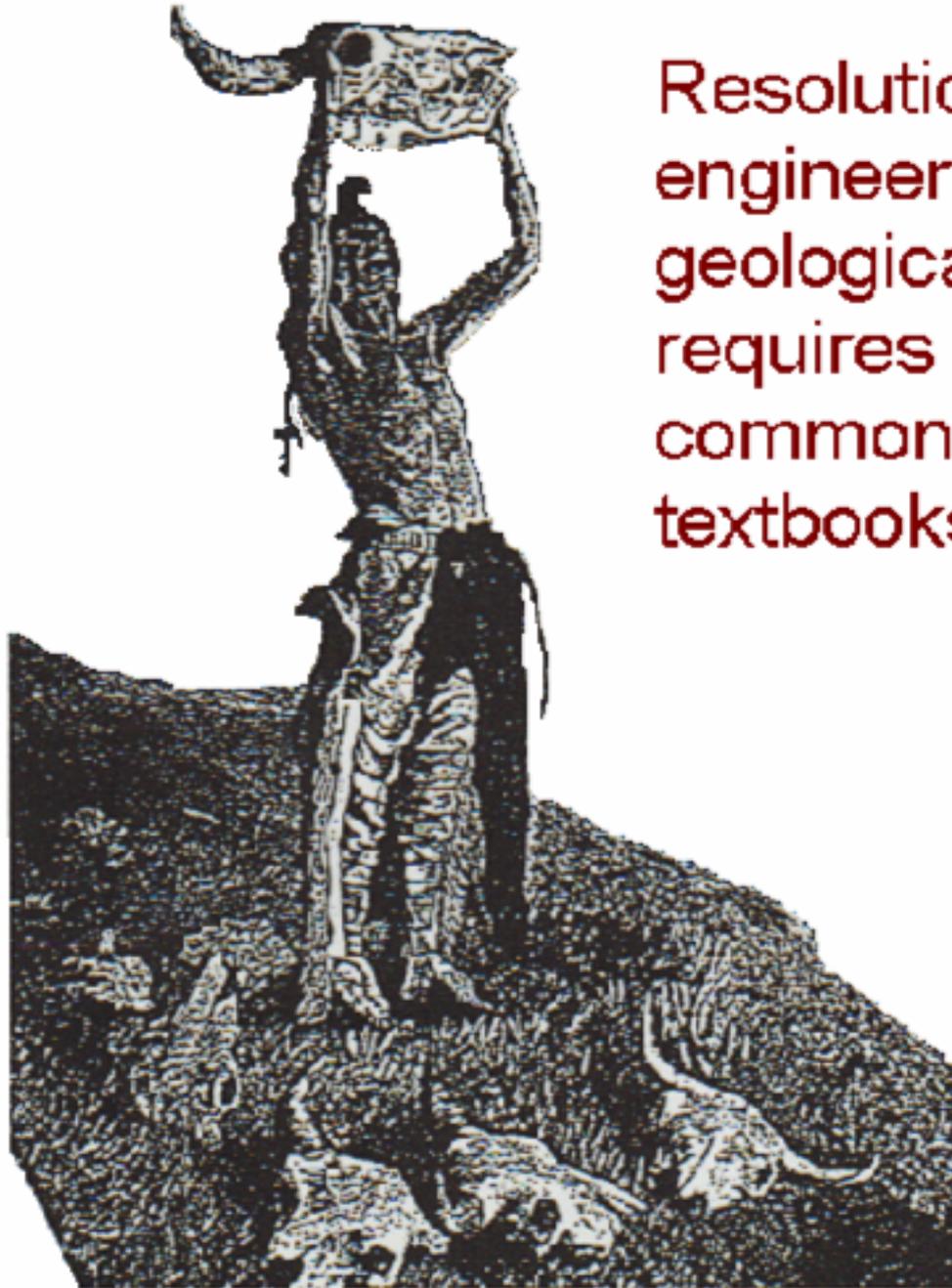
Market

Prices

Government Regulation

Mechanical Issues





Resolution of some engineering and geological difficulties requires techniques not commonly found in textbooks.

Various methods are employed to estimate remaining recoverable reserves

Volumetric

Production Decline Extrapolation

Material Balance

Simulation

Analogy

Assignment

The method used is determined by the information available at the point in time that the estimate is prepared



How certain are the estimates?



RESERVE ADJUSTMENT FACTORS USED FOR ACQUISITIONS (%)

	Average	Median	Std. Dev.	Min.	Max.	Mode
Proved Producing	96.9	100.0	5.2	70.0	100.0	100.0
Proved Shut In	81.1	80.0	12.4	50.0	100.0	90.0
Proved Behind Pipe	73.5	75.0	13.8	25.0	100.0	75.0
Proved Undeveloped	55.9	50.0	19.0	0.0	100.0	50.0
Probable Producing	34.8	37.5	26.1	0.0	100.0	50.0
Probable Behind Pipe	27.5	25.0	22.2	0.0	80.0	0.0
Probable Undeveloped	22.6	20.0	20.4	0.0	80.0	0.0
Possible Producing	10.4	0.0	16.6	0.0	75.0	0.0
Possible Behind Pipe	6.7	0.0	10.8	0.0	60.0	0.0
Possible Undeveloped	5.7	0.5	7.7	0.0	30.0	0.0

↑
Center

↑
Most Often

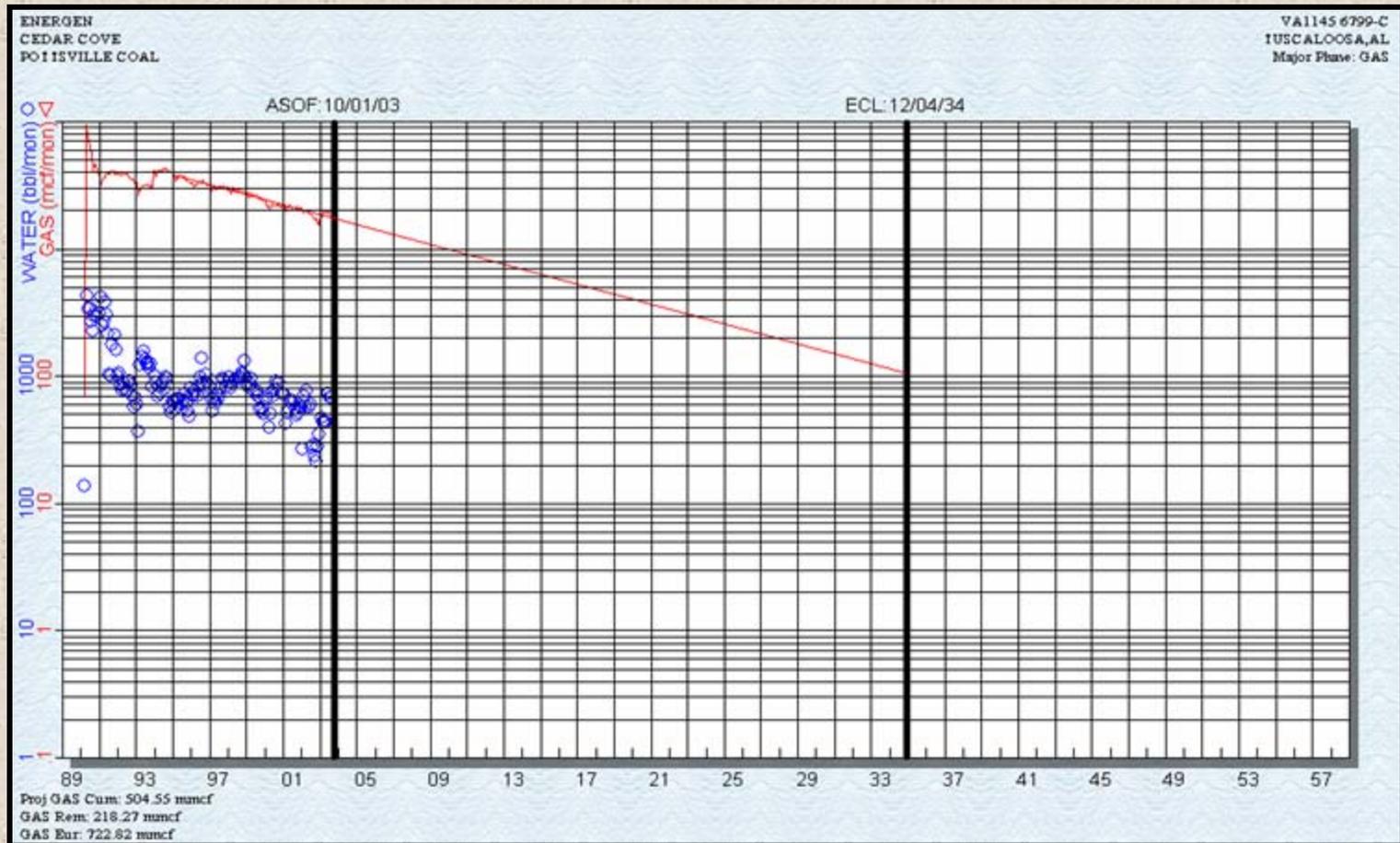
From Society of Petroleum Evaluation Engineers (SPEE)



The method of calculating the remaining reserve for a producing well is determined by the information available at the point in time that the estimate is prepared.

Examples:

1. Shallow coal bed gas well in Alabama

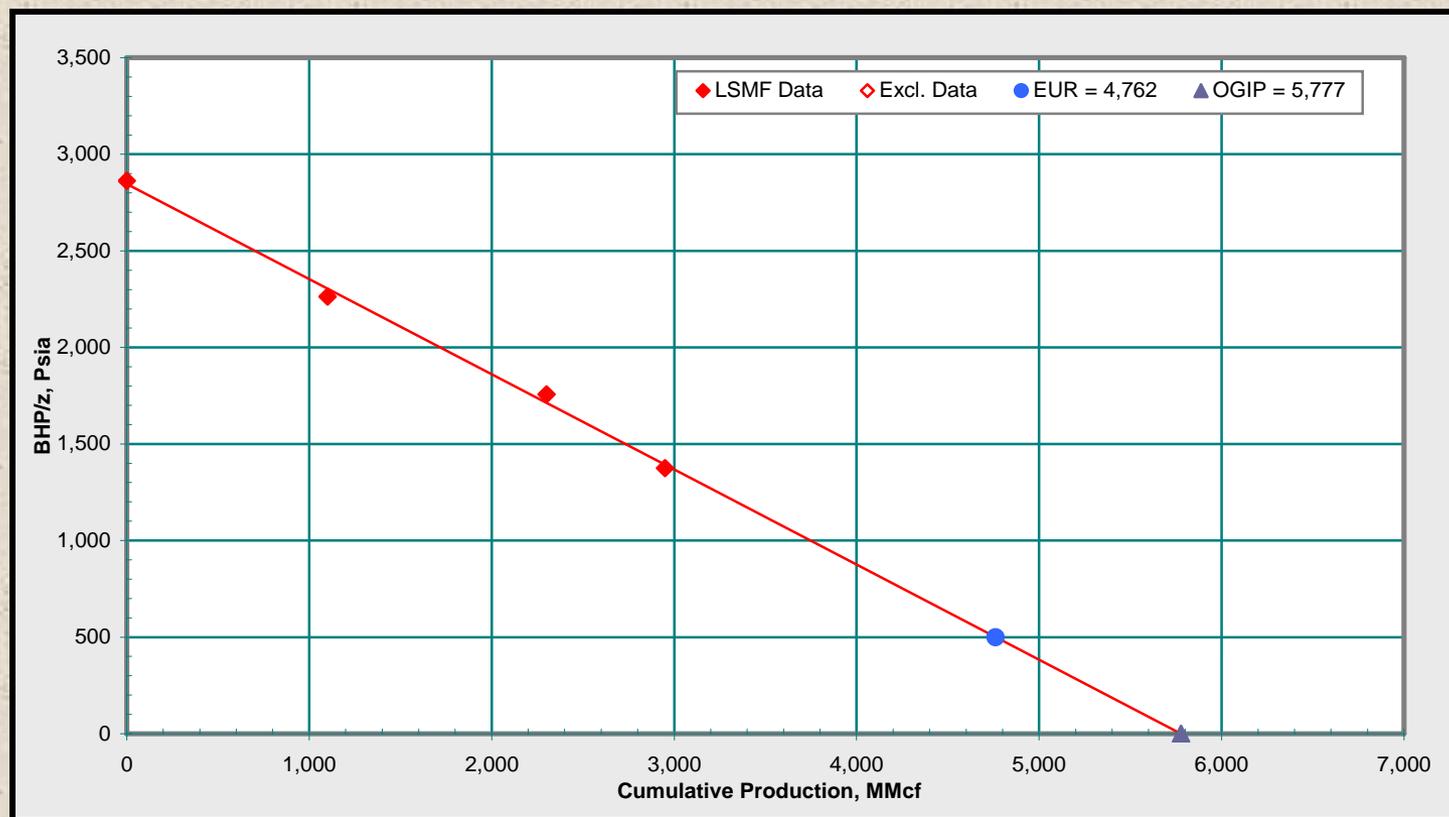


This is a high confidence estimate.

next...



2. Gas reservoir with good pressure history and a reasonable material balance

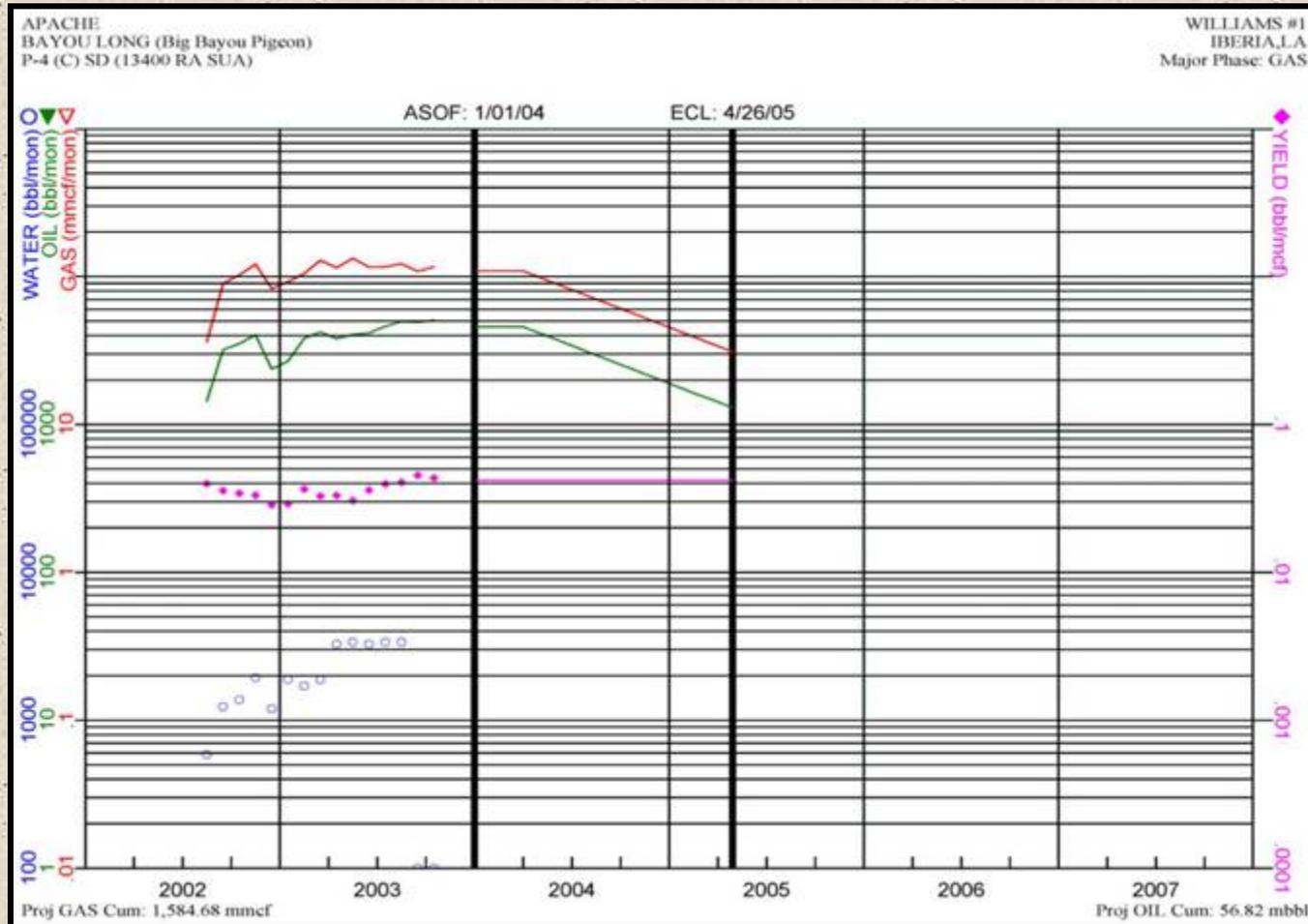


This is also a high confidence estimate if production trend does not conflict with material balance.

next...



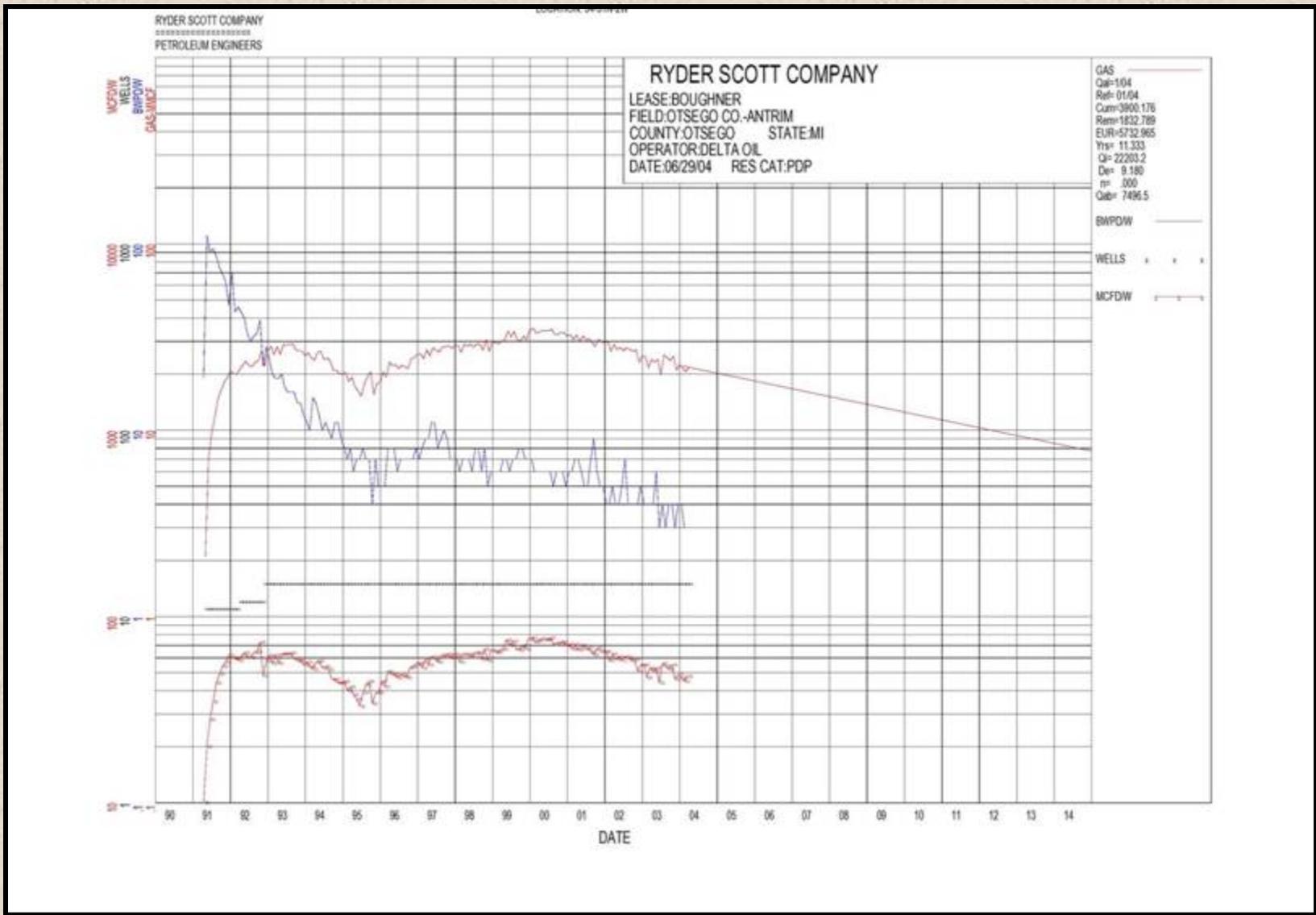
3. Gas reservoir with a moderate amount of water influx and an unknown original gas water contact.



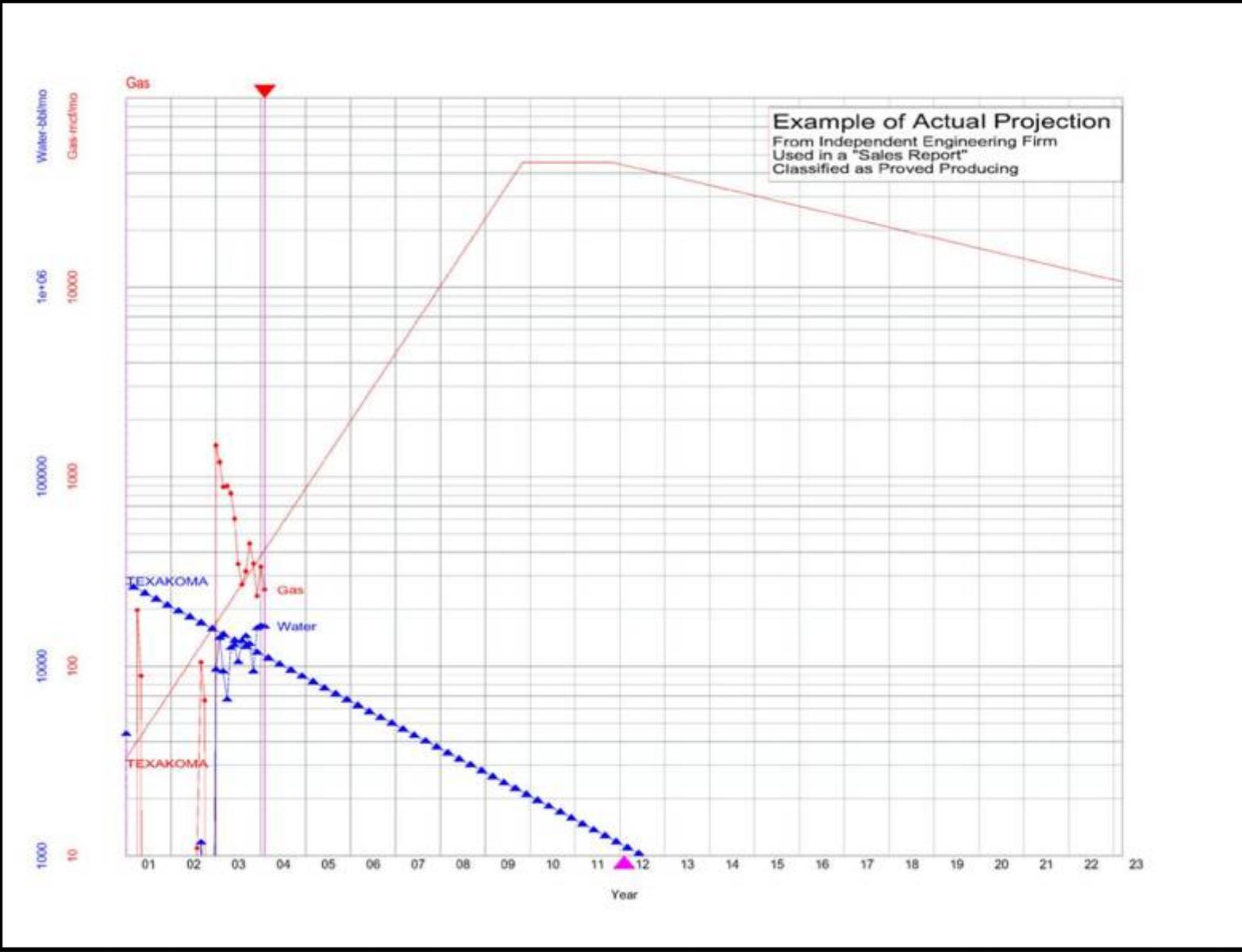
There is a great deal of uncertainty with this estimate.
Reserve could go up or down.



4. Antrim shale well



5. Coal bed well with poor performance and questionable forecast.



The least uncertainty in reserve estimates would be in those mature areas that exhibit predictable decline characteristics such as in the first example. Examples of areas where such reservoirs are commonly found are:

- 1) Coal bed methane
- 2) Appalachia
- 3) Antrim shale (Michigan)
- 4) Rocky Mountain states
- 5) Mid-continent (Oklahoma, Kansas)
- 6) Permian Basin (West Texas)
- 7) Delaware Basin (New Mexico)



Questions...

... that should be asked to help assess the degree of reserve uncertainty associated with a company's reserves.



1.

**Who did the underlying
reserves evaluation?**

**Internal engineering
or
independent consulting firm**



2.

How long has the independent consulting firm been doing the company's reserves?

Is the engineering firm familiar with special issues that might be involved with the company's properties?



3.

Where are the reserves located?

How knowledgeable is the company of the areas where the reserves are located?

Are they in an area where assessment of reserves carries greater risk (i.e. Gulf Coast vs. Mid-Continent)?

Are the reserves in areas that require higher operating and development costs (i.e. profit margin is smaller and expenditure demands are higher on the company)?

Are the reserves in areas that are environmentally very sensitive?

Are the reserves all domestic, or do they include international properties?



4.

Is the independent
consulting firm
familiar with the
areas where the
reserves are
located?



5.

Does the independent consulting firm look at all of the company reserves or just a percentage?



6.

Are the company's reserves concentrated in a small number of properties, or is the portfolio of properties more diverse?

What type of interest position does the company hold in its different properties?



7.

Are the reserves
mature,
or relatively new with
minimal production?

Is the reserve analysis
primarily based on
performance methods or
volumetrics?

Are the reserves strictly
primary, or do they include
secondary and EOR projects?



8.

Are most of the properties operated or non-operated?

If a high percentage of the company's reserves are non-operated, what is known about the operators?

Are the various operators substantial from a technical and business standpoint?

Do the operators have an established track record of operations in the areas where the reserves are located?



9.

What is the distribution of proved reserve status categories (i.e. producing, shut-in, behind pipe and undeveloped)?

Are the reserves fairly well split between categories, or is there a high percentage in the non-producing and particularly in the undeveloped?



10.

Are the reported reserves based on
reasonable economic
parameters?

Did the reserve appraiser use current
economic conditions?

Do the economic parameters
approximate the buyers perception
of future economic conditions?



11.

Do future revenue
projections appear
reasonable considering
recent historical company
revenues?



12.

Do future cost projections appear reasonable considering recent historical company expenditures?

Have the appropriate operating costs been applied against the reserve projections?

Does the company have sufficient cashflow to carry their burden of operating costs and service other necessary company expenditures?

Have sufficient development costs been included to develop the stated non-producing and undeveloped reserves?

Does the company have an established track record and the financial stability to spend the amounts of capital dollars necessary to fund the development?



13.

How does the company compare over time
in regard to “revisions of previous
estimates”?

Have the revisions consistently been significant
in size in relation to the company’s base reserves?

Are the revisions consistently negative?

Are the negative revisions consistently associated
with the non-producing and undeveloped
reserve categories?



14.

“Extensions, discoveries, other additions”
are an indicator of how well the company is moving
proved undeveloped and probable reserves into the
developed reserve base of the company
Is the company historically demonstrating an ability to
do so?

How well is the company finding new reserves through the drill bit?

Does the company have an active exploration and development drilling
program?

Does the company have a good acreage position around its developing
properties?

What kind of exploratory acreage position does the company hold?



15.

Does the company typically grow through acquisitions or the drill bit?

Is there a good mix of both?

Does “purchase of reserves in place” contribute significantly to the company’s reserve base?

If the company traditionally grows through acquisitions, is the company paying an appropriate amount for reserves?

Could too much success with competitive bids mean they are over-paying for the reserves?



16.

Does the company “sell reserves in place”
to divest themselves
of non-strategic reserves?

Is the company burdened with a large number of low
margin wells in non-core areas?



17.

How recent is the reserve evaluation
that is the source of the company's reserves ?

Based on the answers to some of the previous questions,
are the reserves of a nature that significant changes in
reserve quantities can occur over a limited period of time?

Is the reserve evaluation a recent study of a prior study
that has been mechanically adjusted to a specific as-of
date for public reporting purposes?



“Mr. Richoux, may I be excused? My brain is full.”



Additional Supporting Information



SEC Reserve Definitions

- Proved reserves only
- Approved in 1978
- Applications Modified in part by
 - Staff Accounting Bulletins
 - Web site releases
 - Letters to operators
 - SEC-SPEE Forums



SEC Reserve Definitions

SEC 1978 –Current Definition -continued

- (i) Reservoirs are considered proved if economic producibility is supported by either:
 - Actual Production
 - Conclusive Formation Test.



SEC Reserve Definitions

SEC 1978 –Current Definition -continued

- **The area of a reservoir considered proved includes**
 - **that portion delineated by drilling and defined by gas-oil and/or oil-water contacts, if any and**
 - **the immediately adjoining portions not yet drilled, but which can be reasonably judged as economically productive on the basis of available geological and engineering data.**
- **In the absence of information on fluid contacts,**
 - **the lowest known structural occurrence of hydrocarbons controls the lower proved limit of the reservoir**



SEC Reserve Definitions

SEC 1978 –Current Definition -continued

(ii)

- Reservoirs which can be produced economically through application of improved recovery techniques (such as fluid injection) are included in the “proved” classification when:
 - successful testing by a pilot project, or
 - the operation of an installed program in the reservoir provides support for engineering analysis on which the project or program was based.



SEC Reserve Definitions

SEC 1978 –Current Definition -continued

(iii)

- Estimates of proved reserves do not include the following:
 - Crude oil, natural gas, and natural gas liquids, the recovery of which is subject to **reasonable doubt** because of **uncertainty as to geology, reservoir characteristics or economic factors**
 - Crude oil, natural gas, and natural gas liquids, that may occur in **un-drilled prospects**
 - Crude oil, natural gas, and natural gas liquids, that may be recovered from oil shale, coal, gilsonite and other such sources.-**Unconventional sources.**
 - **By-products** such as Sulfur, Helium, or CO₂
 - Technically must adjust volumes for non-hydrocarbons, but SEC considers 3-5% immaterial, if pipeline will accept



SEC Reserve Definitions

SEC 1978 –Current Definition -continued

- Proved Developed Reserves:
 - Those reserves that can be **expected to be recovered** through **existing wells** with **existing equipment** and operating methods.
 - Additional oil and gas expected to be obtained through the application of fluid injection or other improved recovery techniques for supplementing the natural forces and mechanisms of primary recovery should be included as “Proved Developed Reserves” only after **testing by a pilot project** or after the operation of an installed program has **confirmed** through **production response** that increased recovery will be achieved.
 - Expansion of an improved recovery operation is still **undeveloped**



SEC Reserve Definitions

SEC 1978 –Current Definition -continued

- Proved Undeveloped Reserves (PUD's):
 - Those reserves that are expected to be recovered from **new wells** on **un-drilled acreage**, or from **existing wells** where a relatively **major expenditure** is required for recompletion. (This may include compression)
 - Reserves on undrilled acreage shall be **limited** to those drilling units **offsetting** productive units that are **reasonably certain** of production when drilled.
 - Proved reserves for other undrilled units can be claimed **only** where it can be demonstrated with **certainty**, that there is **continuity** of production from the existing productive formation.
 - Under no circumstances should estimates for proved undeveloped reserves be attributable to any acreage for which an application of fluid injection or other improved recovery technique is contemplated, unless such techniques have been proved effective by actual tests in the area and in the same reservoir.



SEC Reserve Definitions

- Improved recovery
 - Reserves cannot be classified as proved undeveloped reserves based on improved recovery techniques **until**
 - such time that they have been proved effective in **that reservoir** or an **analogous reservoir** in the **same geologic formation** in the **immediate area**.
 - An analogous reservoir is one having **at least** the **same** values or **better** for porosity, permeability, permeability distribution, thickness, continuity, fluid properties, and hydrocarbon saturations.



SEC Reserve Definitions

- Natural gas in storage is not considered reserves
 - Gas once removed from its native reservoir and injected into another for any purpose can not be considered reserves
 - gas re-injected into its native reservoir can be considered reserves until produced and sold.



PUD Summary

- Direct offset to production above LKH
- May require significant capital well work
- Requires New or Modifications to Facilities
 - Changes to facility or facility design
 - Compression / Treatment / Gathering
 - Transmission to market
- Improved Recovery based on pilot or analogy
- SEC engineers expect revisions to be positive most of the time
- Operator should have “track record”, plus
 - **commitment to do the work**
 - **financial resources to do the work**

