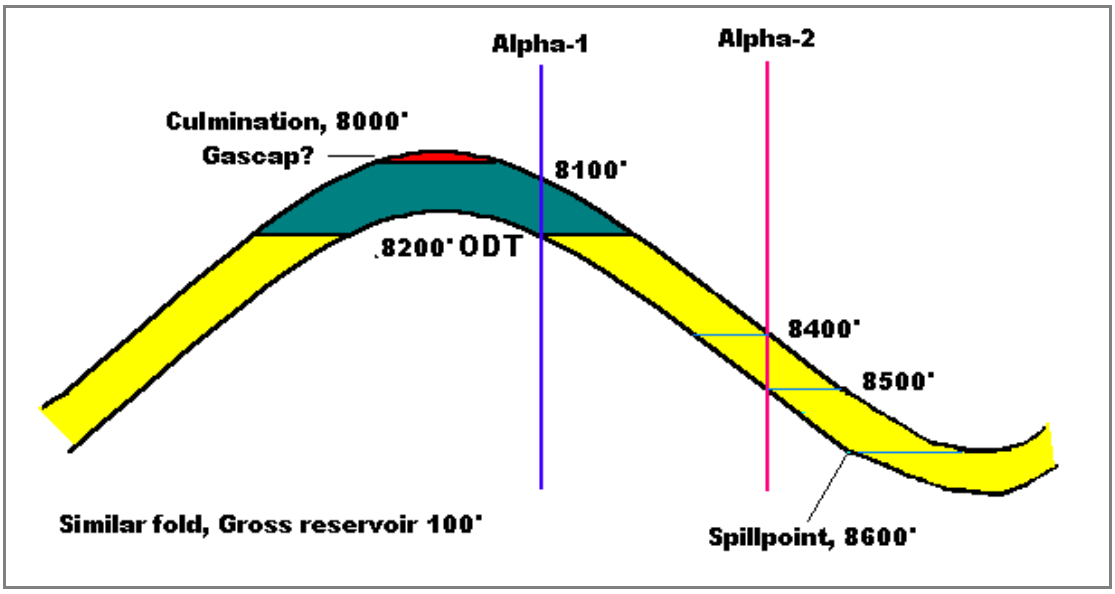
Decision tree -- an example

Description

The Alpha structure in the offshore of the Netherlands was discoverd by Alpha-1. The 100' gross sand reservoir was filled with oil in the well: an Oil-down-to (ODT) situation Alpha-1 was drilled 100 feet downflank. The total vertical closure, based on the seismic structural spillpoint is 600', but lateral spill or failure of topseal may occur above that.The Oil-Up-To (OUT) is at 8100'. The oil was at bubblepoint, so there is a possibility that there might be a primary gascap at the culmination. Taking all this into account. a Column evaluation with Gaeapas shows an expectation (equal to the MSV at 100% POS) of 75 million barrels recoverable. The economic cutoff in this area at the 35 m waterdepth is 10 million barrels. The evaluation shows a POS = 100% for an MSV of 75 million barrels. The oil has a gravity of 30° API.

On this basis a platform might be built, but the uncertainty about the ultimate recovery (UR) is still considerable (from 24 to 217). If the UR turns out to be small, the platform based on MSV may be too large, in the other case the platform may be planned too small, possibly requiring a second platform.

The production geologists propose an outstep well further downflank, Alpha-2, that would hit the the top reservoir at 8400'. The cost of this well would be $ 12 million. The drawback is that this well can not be produced later if a platform is built in the success case.

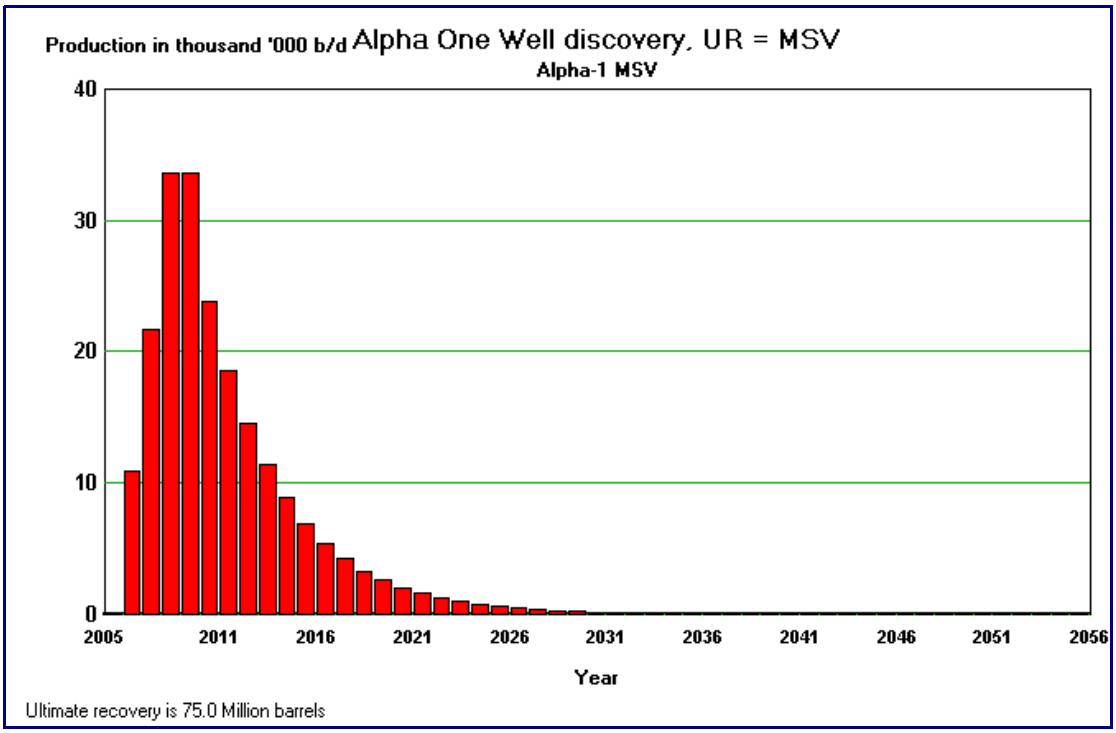


Net Present Value Cash Surplus (NPVCS) and investment efficiency (IE)

To calculate the unit technical cost per barrel (UTC) we assume here that an **optimal** platform has a UTC = $15/b.
Oil price scenario is $35/b constant and over the life of this field we reckon a PV value of this to be $20/b as the life of the field is stretching over a fair amount of time (see the production profile on the next page). The profit per barrel is then $20 - $15 = $5/b.
To calculate the the Net PV Cash Surplus (NPVCS) of a situation we multiply the profit per barrel with the MSV. For instance: for Alpha-1 the MSV is about 75 mb. The NPVCS = 75 * 5 = 375 m$.

What happens when the platform is **sub-optimal**? Both too large and too small are bad and we arbitrarily assume that there is a penalty related to the deviation of the observed UR from the optimal number of barrels the platform was planned for. For this exercise we take $ 0.10 per million barrels. If the UR found is the "Low MSV" of 45 million, the 75 mb platform is too

large. This means that the UTC becomes 15 + |75-45|*0.10 = $18/b. The revenue is hence 45 * (20-18) = 90 m$.



The following questions arise:

1. What can we learn from Alpha-2? We can simplify all possible outcomes of Alpha-2 into discrete cases. (Alpha-2 gives “imperfect information”.)

From the whole range of possibilities we select three simplified cases:

A) the well does not find oil. Then the OWC is between 8200 and 8400’.
B) the well finds an OWC within the 100’ of gross reservoir. the OWC is between 8400 and 8500’.
C) the well finds the gross reservoir full of oil: an ODT. The OWC is between 8500 and 8600’. The latter limit is the structural spillpoint.

2. What are the estimates for the probability of these outcomes, based on the Alpha-1 evaluation? This information is obtained from the Gaeapas output called "Expectation curve of the HC column length".

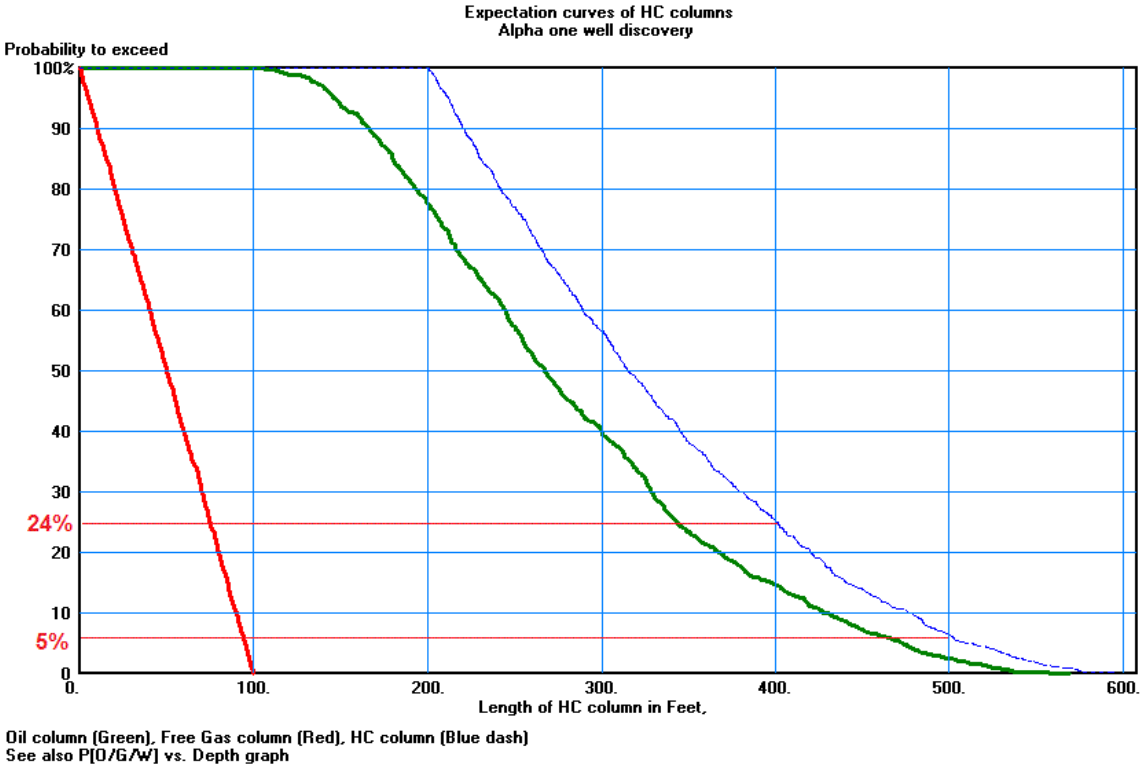
Here we estimate the probabilities of three mutually exclusive cases. When we look at the **HC-column expectation curve** output of Alpha-1. This shows the following probabilities:

a) OWC 8200’ or deeper 100%.
OWC 8400’ or deeper: 24%
Conclusion: Case a) has 100 – 24 **= 76%** probability, column length 200 to 400’

b) OWC 8400’ or deeper: 24%
OWC 8500’ or deeper: 5%
Conclusion: Case b) has 24 – 5 = **19%** probability, column length 400 to 500’

c) OWC 8500’ or deeper below culmination: 5%.
Conclusion: Case c) has a **5%** probability, column length 500 to 600 feet

For good order: 76 + 19 + 5 = 100%.



The three cases are now evaluated with the Gaeapas option "HC **contacts"":**

AlphaOutstep-CaseA.txt
AlphaOutstep-CaseB.txt
AlphaOutstep-CaseC.txt

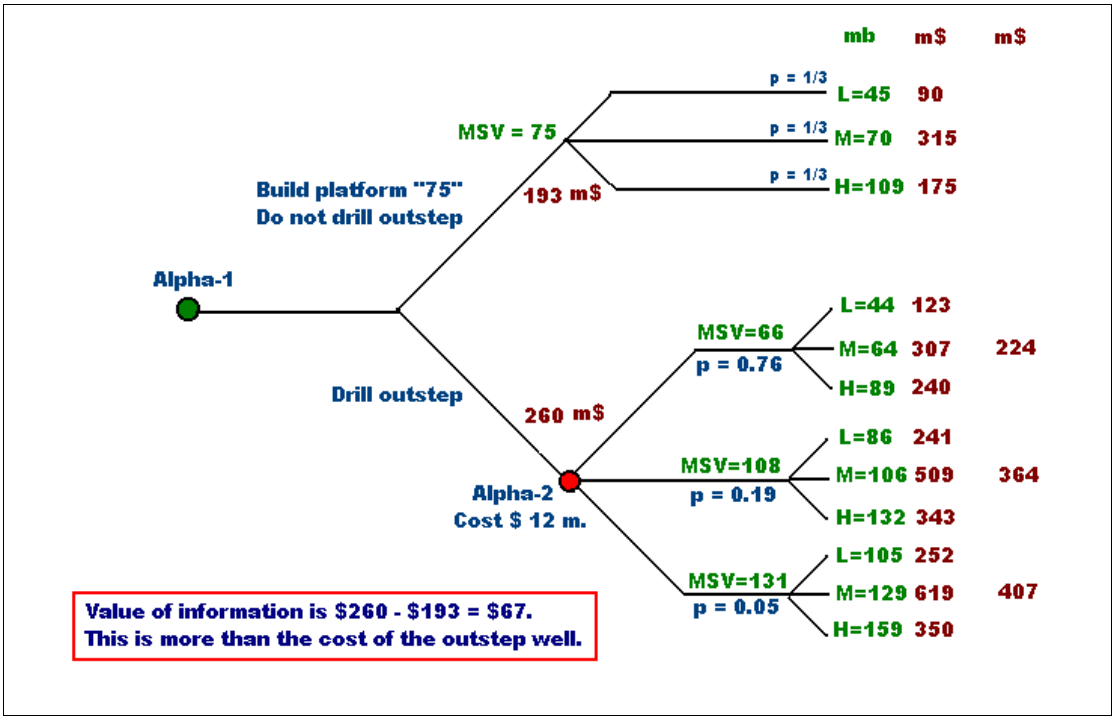
Note that part of the uncertainty for all of these is due to the uncertainty about the free gascap.

The results for primary recoverable oil at a cutoff of 10 mb are tabulated as follows:

Case	POS	MSV	Low MSV, PVNCS	Middle MSV, PVNCS	High MSV, PVNCS	Prob. of the case
Alpha-1, no second well	1.00	75	45	70	109	1.00
Alpha-2, Case A)	1.00	66	44	64	89	0.76
Alpha-2, Case B)	1.00	108	86	106	132	0.19
Alpha-2, Case C)	1.00	131	105	129	159	0.05

3. Is the cost of possible over- or under-investment greater than the cost of the appraisal well? The basis for such analysis is a decision tree. The required tree is drawn below. Note that the uncertainty of the Alpha-1 evaluation can be summarised as a Low, Middle and High

MSV. The same counts for each of the Alpha-2 possibilities, each having their L,M and H MSV.



4. The red numbers are the NPV of the different branches. The numbers are calculated with the penalty rule for the "75"platform. For instance, Case A, middle MSV is closest to the 75 mb, and has the best profit per barrel, the higher and lower MSV's having a disadvantage. We take the first one with the low MSV = 45 mb. Assume the platform is built on the MSV of 75. The actual UR is 45, The absolute difference is 30. This means that the UTC becomes 15 + |75 – 45|*0.10 = $18/b. The revenue is then $20 - $18 = $2/b. This results in a total revenue for this branch of 45 * 2 = $ 90 million.
Because L,M and H are equally likely, the node before this three-wise split becomes the mean of the individual branches. For option 1 this is (90 + 315 + 175)/3 = $ 193 million. The branch probabilities are indicated in blue. For the outstep we have the three branches for case a, b and c. The actual "decision branch" is the choice between outstep well or not. The rest are chance branches to quantify the different possible outcomes.

5. Is Alpha-2 is worth drilling? **Yes**, because the NPVCS of $260 million for the outstep well is higher than the $ 193 million in case we risk it to build the platform straight away. We may call the difference the "**Value of Information**" provided by the outstep. **The difference, $ 67 million is larger than the cost of the well ($ 12 miillion).**