decision FRAMEWORKS
REAL PEOPLE · REAL INSIGHTS · REAL DECISIONS

Valuing Information Plans

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DAAG 2006, Baltimore

Background: Possible Maps of Gas Discovery

Medium Reservoir

Large Reservoir

Small Reservoir

Gas Discovery
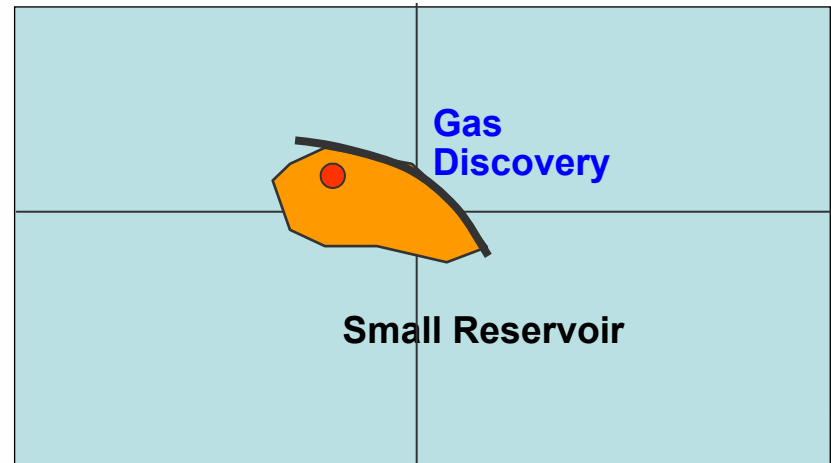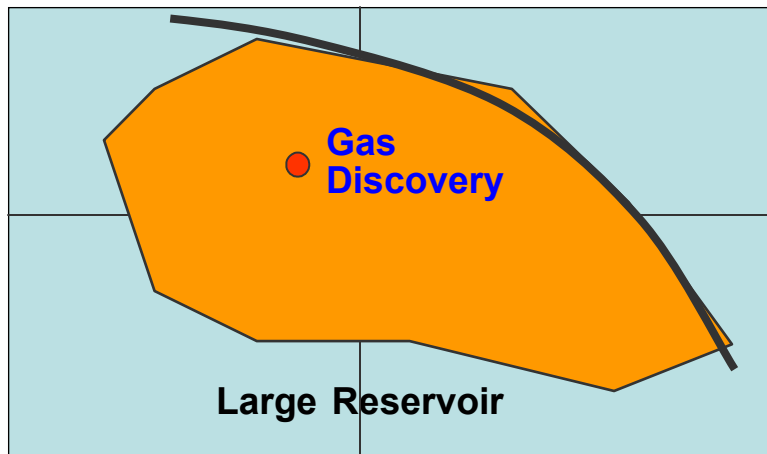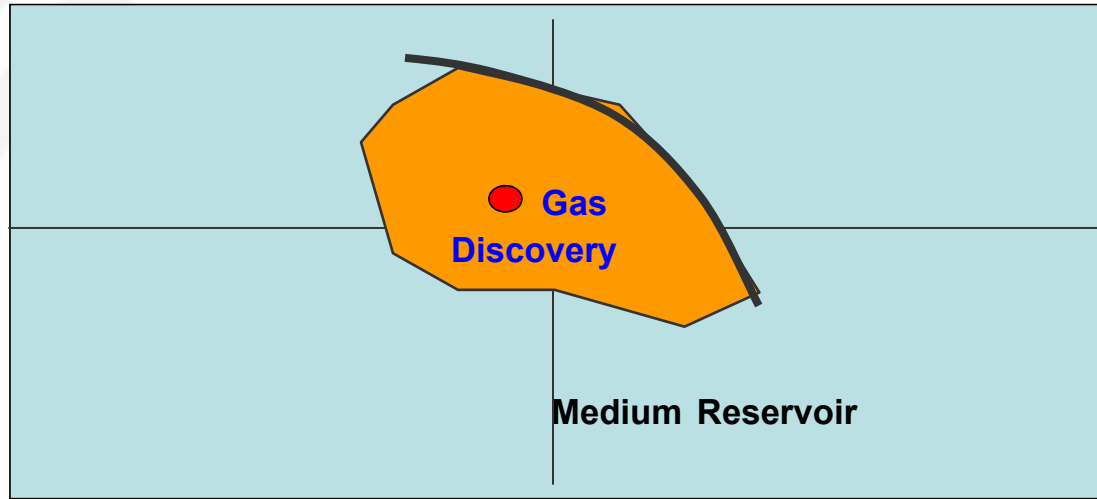
Background: Summary

Well discovered unexpected gas zone

Tested at 35 mmcf/d but test was only a few hours long

Uncertain of gas reserves

- 30% chance of large reserves, expected NPV 41 MM$
- 40% chance of medium reserves, expected NPV 21 MM$
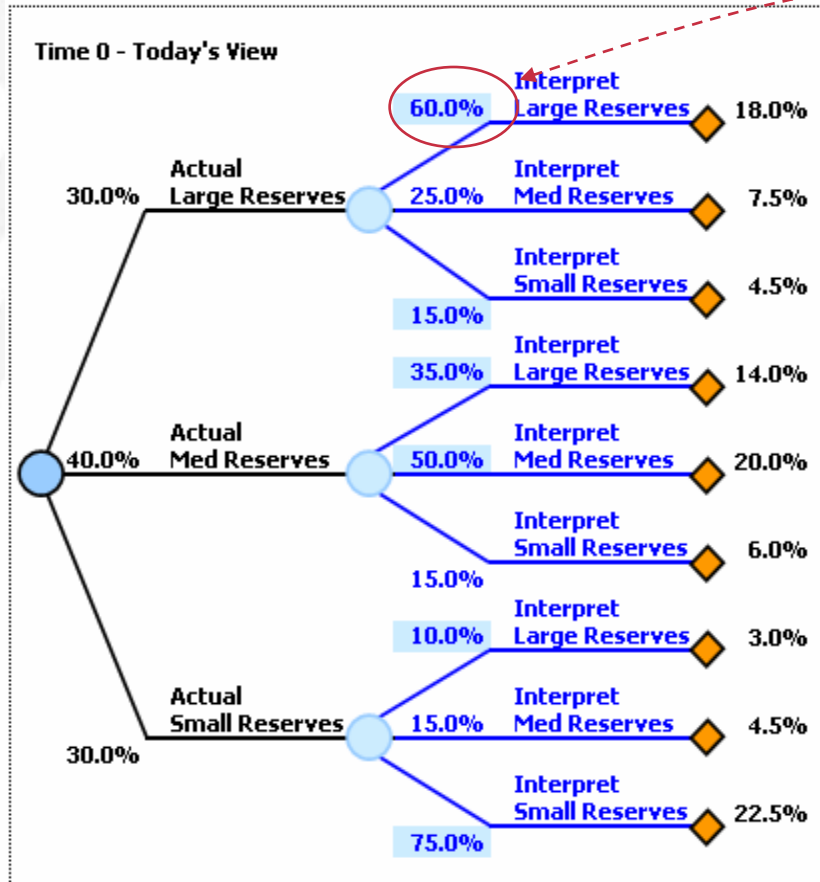- 30% chance of small reserves, expected NPV -36 MM$

Plan to drill two more appraisal wells

- Provides an opportunity to test the gas discovery
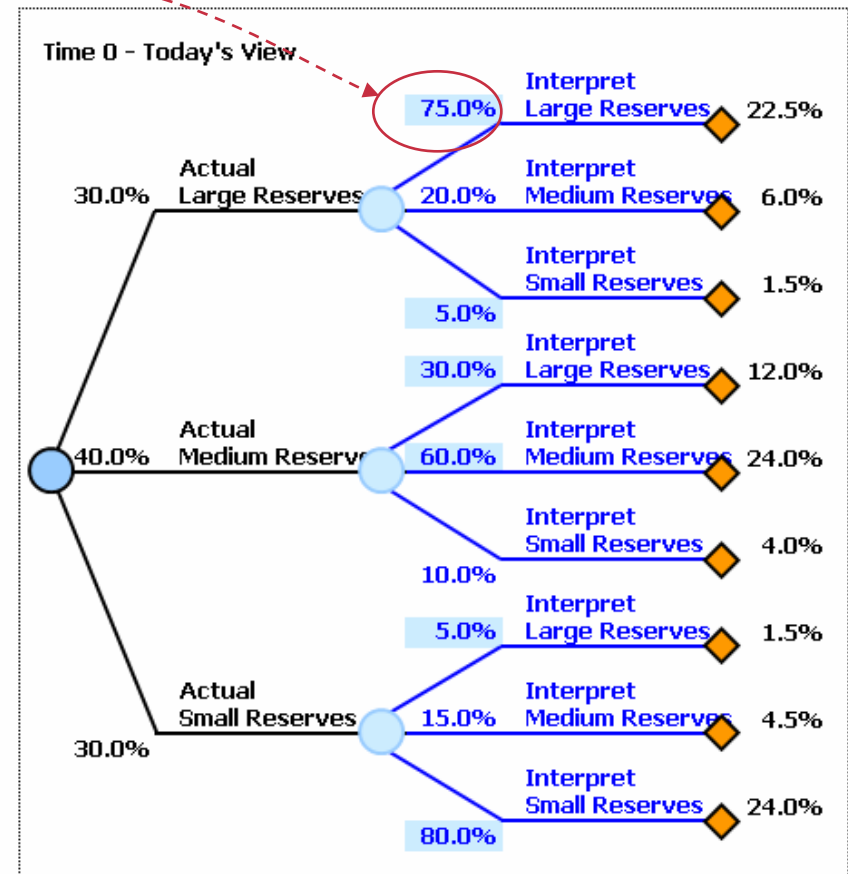- Debating a two-week test at 0.5 MM$ cost versus a two-month test at 3.0 MM$ cost

Background: Reliability of the Tests

Reliability Two-Week Test

Time 0 - Today's View

Actual Large Reserves 30.0%
- 60.0% Interpret Large Reserves — 18.0%
- 25.0% Interpret Med Reserves — 7.5%
- 15.0% Interpret Small Reserves — 4.5%

Actual Med Reserves 40.0%
- 35.0% Interpret Large Reserves — 14.0%
- 50.0% Interpret Med Reserves — 20.0%
- 15.0% Interpret Small Reserves — 6.0%

Actual Small Reserves 30.0%
- 10.0% Interpret Large Reserves — 3.0%
- 15.0% Interpret Med Reserves — 4.5%
- 75.0% Interpret Small Reserves — 22.5%

Reliability Two-Month Test

Time 0 - Today's View

Actual Large Reserves 30.0%
- 75.0% Interpret Large Reserves — 22.5%
- 20.0% Interpret Medium Reserves — 6.0%
- 5.0% Interpret Small Reserves — 1.5%

Actual Medium Reserves 40.0%
- 30.0% Interpret Large Reserves — 12.0%
- 60.0% Interpret Medium Reserves — 24.0%
- 10.0% Interpret Small Reserves — 4.0%

Actual Small Reserves 30.0%
- 5.0% Interpret Large Reserves — 1.5%
- 15.0% Interpret Medium Reserves — 4.5%
- 80.0% Interpret Small Reserves — 24.0%

Decision Problem

Problem Statement

What kind of well test, if any, should be run prior to developing the gas discovery?

Key Questions

- Does the increased reliability of the two-month test justify the cost?
- How confident can we be in our estimate of the reserves from both tests?

Issues

Strategic Decision Type	Decision Type	Issue Type	Issue
Information	Focus	Decision	Should we run a two-week production flow test?
Information	Focus	Decision	Should we run a two-month production flow test?
Future Impact	Focus	Decision	Should we develop the gas discovery?
	Implementation	Decision	Will we be able to produce the gas using a dual-completion?
	Implementation	Decision	Should we develop the gas using horizontal or vertical wells?
	Made/Givens	Decision	Our decision criterion will be Expected Net Present Value (ENPV).
	Made/Givens	Decision	We have budget approval to drill an appraisal well this year.
		Fact	The gas discovery well tested at 35 mmcfd in a three hour DST.
		Uncertainty	Gas reserves range is estimated at P10 = 100 bcf, P50 = 25 bcf, P10 = 5 bcf.
		Uncertainty	The two-month test will be more reliable in predicting the volume of gas reserves.
		Uncertainty	Given that we develop the gas, what decline will we see in production rates?
		Uncertainty	The two-month test is expected to cost about 3.0 MM$.
		Uncertainty	The two-week test is expected to cost about 0.5 MM$.
		Uncertainty	What sustained production rates will we get from the wells if we develop?

Decision Focus

Decisions Made / Givens

Our decision criterion will be Expected Net Present Value (ENPV).

We have budget approval to drill an appraisal well this year.

Focus Decisions

Information

Should we run a two-week production flow test?

Should we run a two-month production flow test?

Future Impact

Should we develop the gas discovery?

Implmentation Decisions

Will we be able to produce the gas using a dual-completion?

Should we develop the gas using horizontal or vertical wells?

Uncertainties

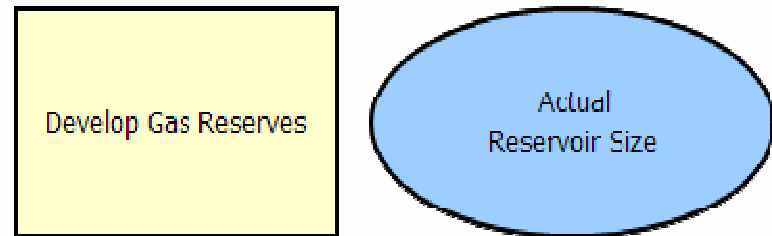| Key uncertainties inherent in the asset	Reservoir Size	Production Rate
Future decisions which could change	Develop Gas Reserves	Develop Gas Reserves
Information sources to consider	2-week Test	2-week Test
	2-month Test	2-month Test
	3D Seismic	3D Seismic
Select	◉	○

Evaluation Focus

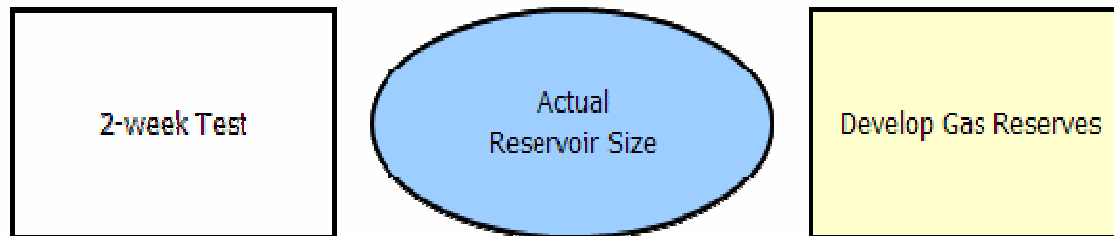|	
Key uncertainties inherent in the asset	Reservoir Size
Future decisions which could change	Develop Gas Reserves ▼ Develop Gas Reserves
Information sources to consider	2-week Test ▼ 2-week Test

Evaluation Structure

Go Now with No More Information

Develop Gas Reserves

Actual Reservoir Size

Perfect Information (100% Reliable)

2-week Test

Actual Reservoir Size

Develop Gas Reserves

Imperfect Information

2-week Test

Interpret Reservoir Size

Develop Gas Reserves

Actual Reservoir Size
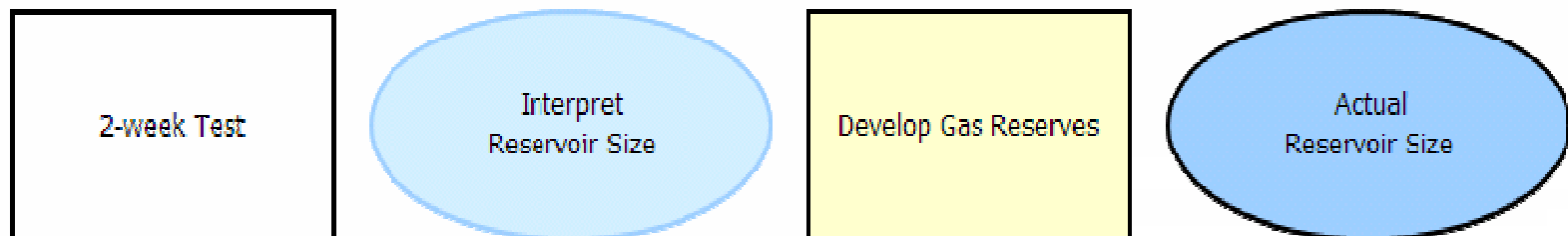
Go Now Case – Without More Info
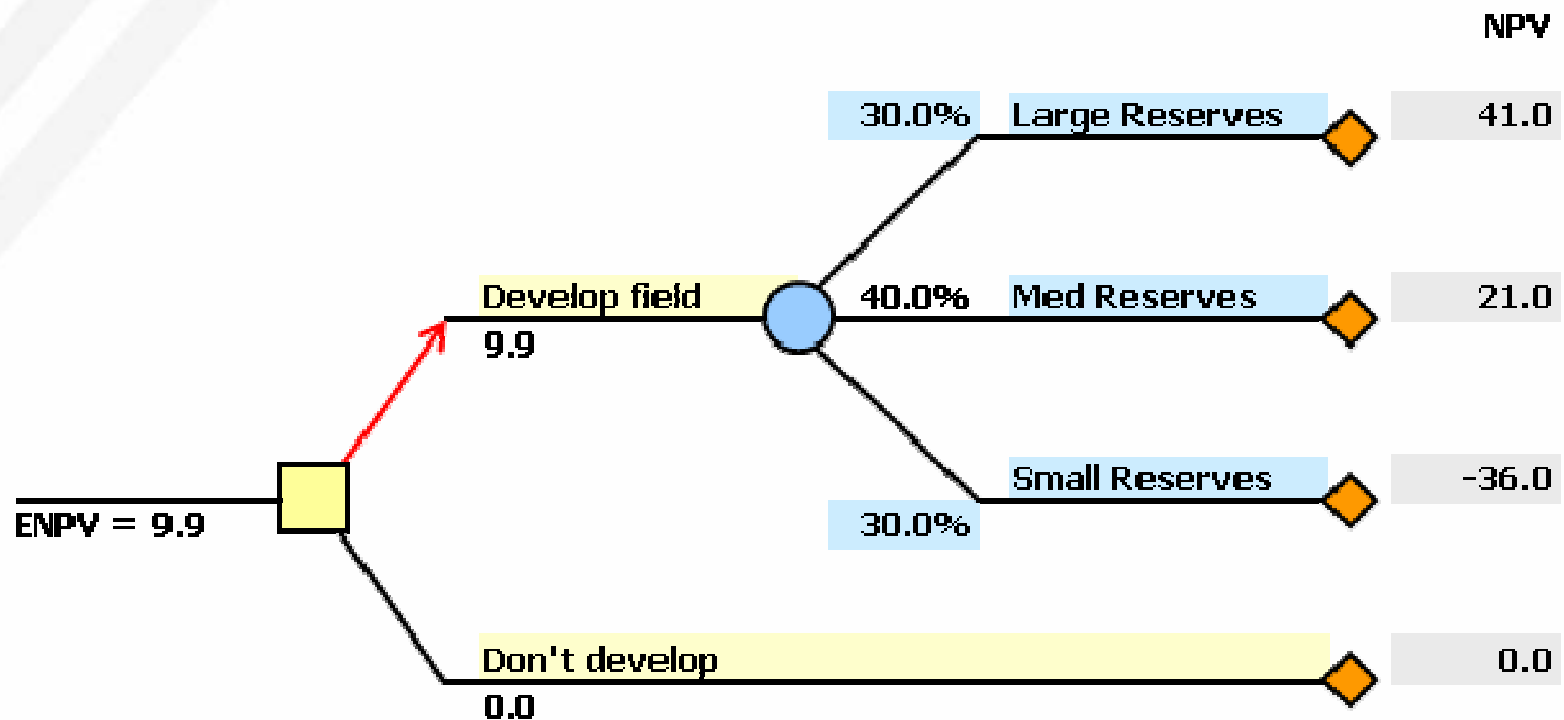
100% Reliable Information

Value of Information (VOI)
= Value with Info - Value without Info
= 20.7 - 9.9
= 10.8

NPV

Test 20.7

30.0% Large Reserves 41.0 — Develop field 41.0 → 41.0
Don't develop 0.0 → 0.0

40.0% Med Reserves 21.0 — Develop field 21.0 → 21.0
Don't develop 0.0 → 0.0

30.0% Small Reserves 0.0 — Develop field -36.0 → -36.0
Don't develop 0.0 → 0.0

ENPV = 20.7

Don't test 9.9 → 9.9
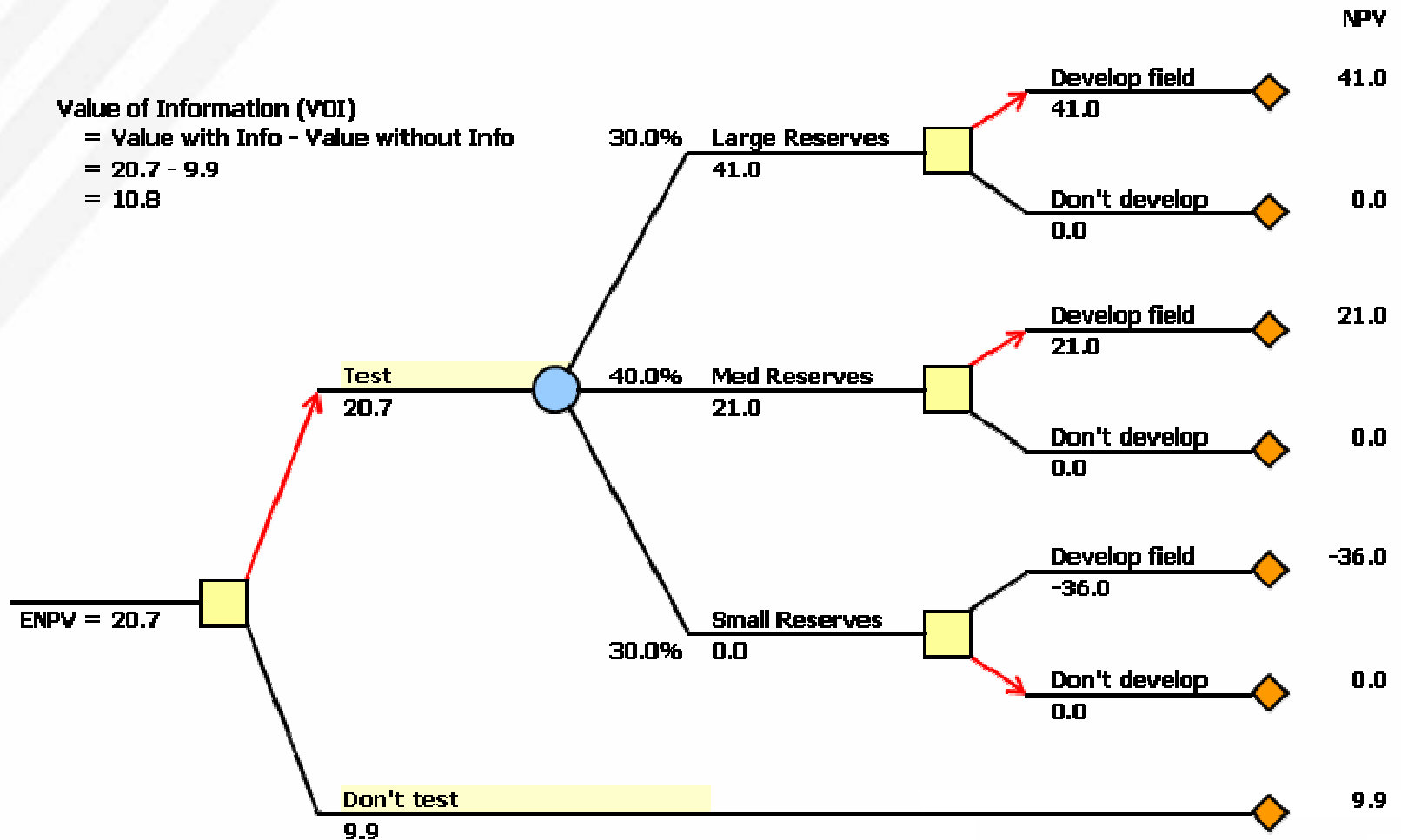
Structure of the Imperfect Tree
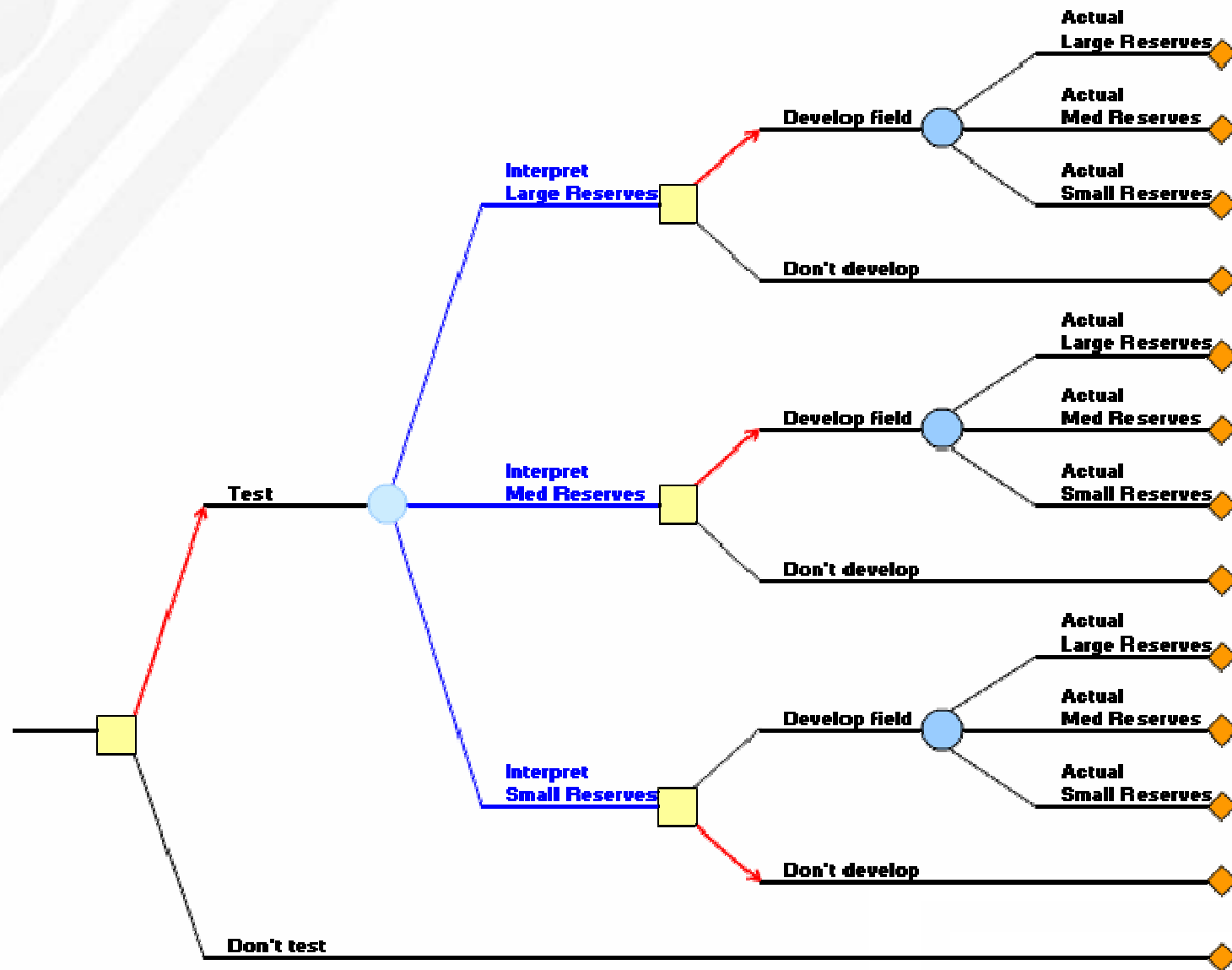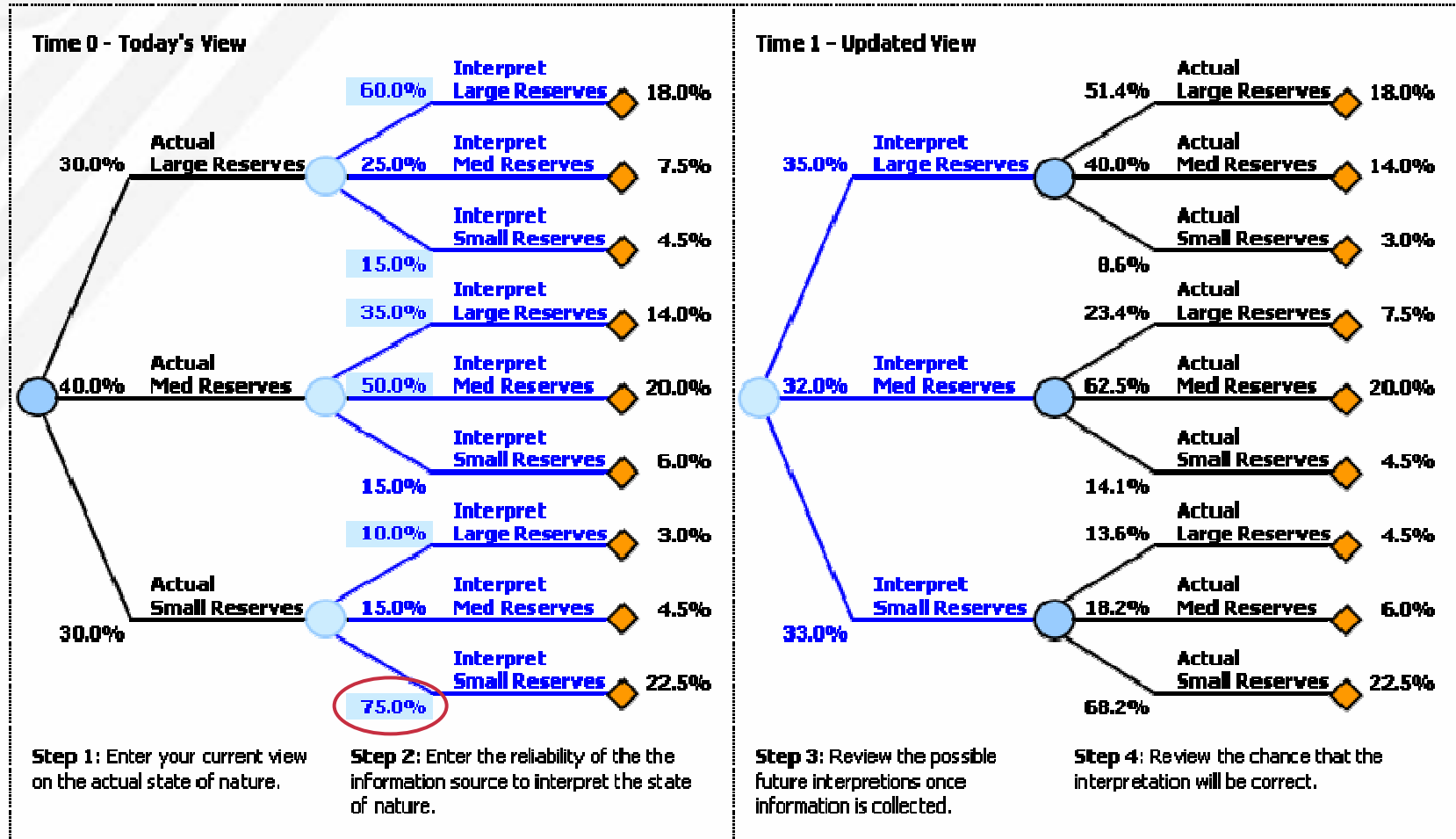
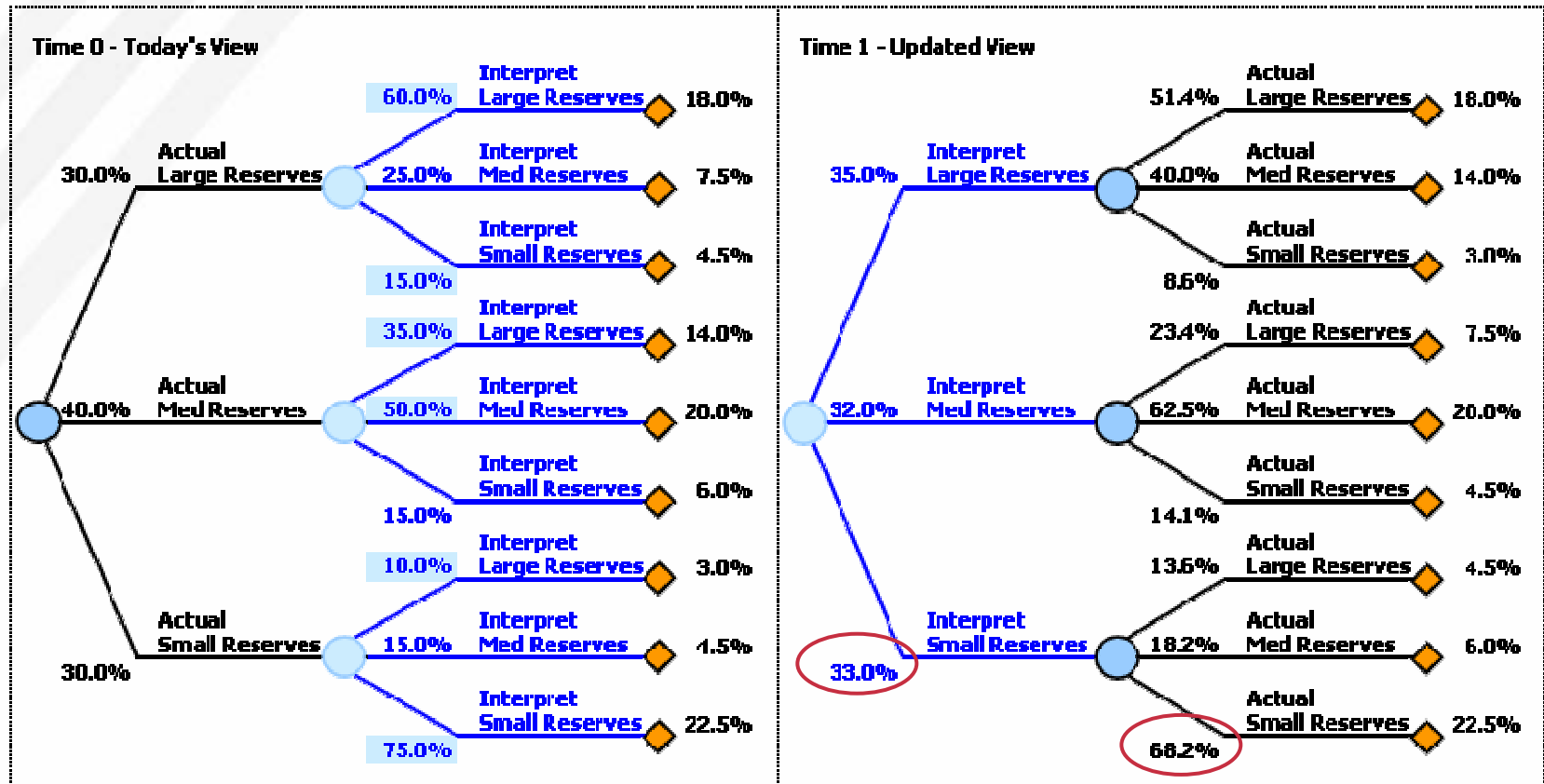# Reliability Interview: Two-week Production Test

Interview Question: Given the reserves really are small, what is the chance the team will correctly interpret that they are small with the two-week test? 75%, in this case.

Reliability Interview: Two-week Production Test

When the team interprets small reserves from the short test (33% of the time), there will really be small reserves about 68.2% of the time.

Function of the Reliability of Information Interview

The reliability interview provides a means to get a glimpse of the future, with new information.

It helps us see the possible interpretations of a particular variable we may have in the future, with new information, given:

- Our view of the particular variable today, and
- Our ability to achieve a particular reliability in our interpretation of that variable, once the new information is acquired.

The Result of the Reliability Interview
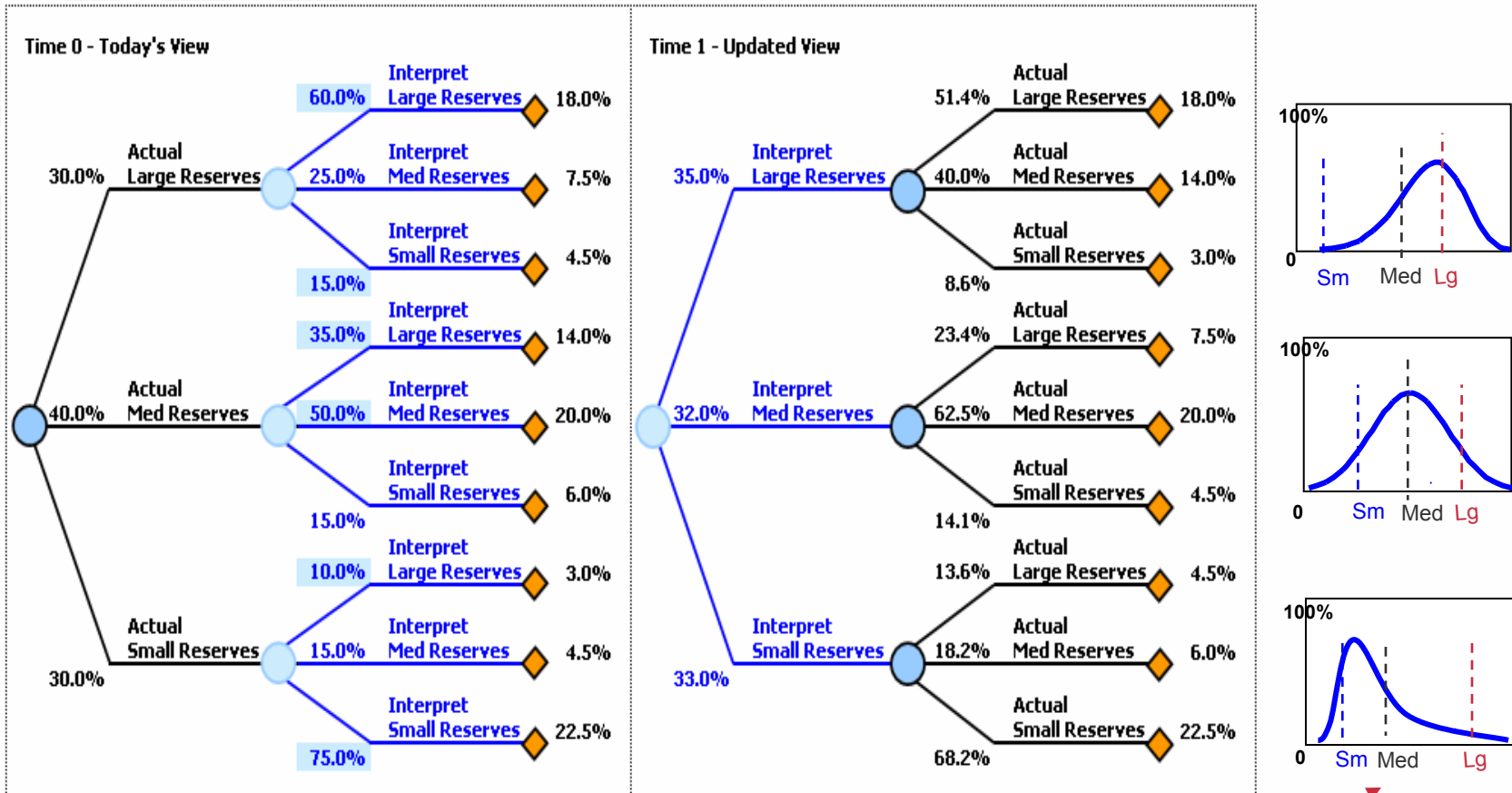
Three new possible distributions of the variable, post getting the information.

Imperfect Tree – Two Week Test

Value of Information (VOI)

- = Value with Information – Value without Information
- = 14.9 – 9.9
- = 5.0

ENPV = 14.9

Test 14.9

Don't test 9.9

Interpret Large Reserves 35.0% 26.4

Interpret Med Reserves 32.0% 17.7

Interpret Small Reserves 33.0% 0.0

Develop field 26.4
Don't develop 0.0

Develop field 17.7
Don't develop 0.0

Develop field -15.1
Don't develop 0.0

	Actual	
51.4%	Large Reserves	41.0
40.0%	Med Reserves	21.0
8.6%	Small Reserves	-36.0
	Don't develop	0.0
23.4%	Large Reserves	41.0
62.5%	Med Reserves	21.0
14.1%	Small Reserves	-36.0
	Don't develop	0.0
13.6%	Large Reserves	41.0
18.2%	Med Reserves	21.0
68.2%	Small Reserves	-36.0
	Don't develop	0.0
	Don't test	9.9

Reliability Interview – Two-Month Test

Time 0 - Today's View

- 30.0% Actual Large Reserves
  - 75.0% Interpret Large Reserves → 22.5%
  - 20.0% Interpret Medium Reserves → 6.0%
  - 5.0% Interpret Small Reserves → 1.5%
- 40.0% Actual Medium Reserves
  - 30.0% Interpret Large Reserves → 12.0%
  - 60.0% Interpret Medium Reserves → 24.0%
  - 10.0% Interpret Small Reserves → 4.0%
- 30.0% Actual Small Reserves
  - 5.0% Interpret Large Reserves → 1.5%
  - 15.0% Interpret Medium Reserves → 4.5%
  - 80.0% Interpret Small Reserves → 24.0%

Time 1 - Updated View

- 36.0% Interpret Large Reserves
  - 62.5% Actual Large Reserves → 22.5%
  - 33.3% Actual Medium Reserves → 12.0%
  - 4.2% Actual Small Reserves → 1.5%
- 34.5% Interpret Medium Reserves
  - 17.4% Actual Large Reserves → 6.0%
  - 69.6% Actual Medium Reserves → 24.0%
  - 13.0% Actual Small Reserves → 4.5%
- 29.5% Interpret Small Reserves
  - 5.1% Actual Large Reserves → 1.5%
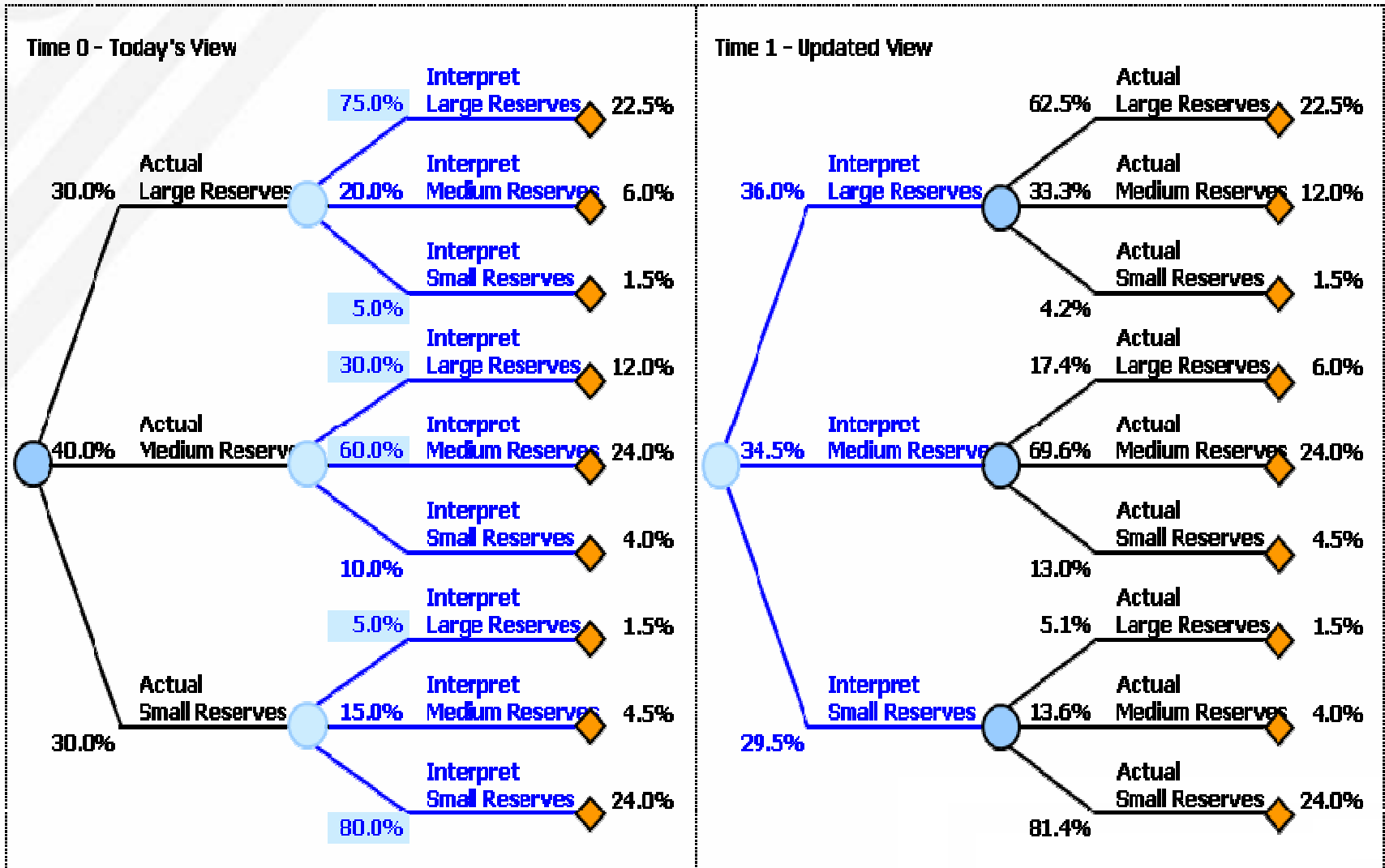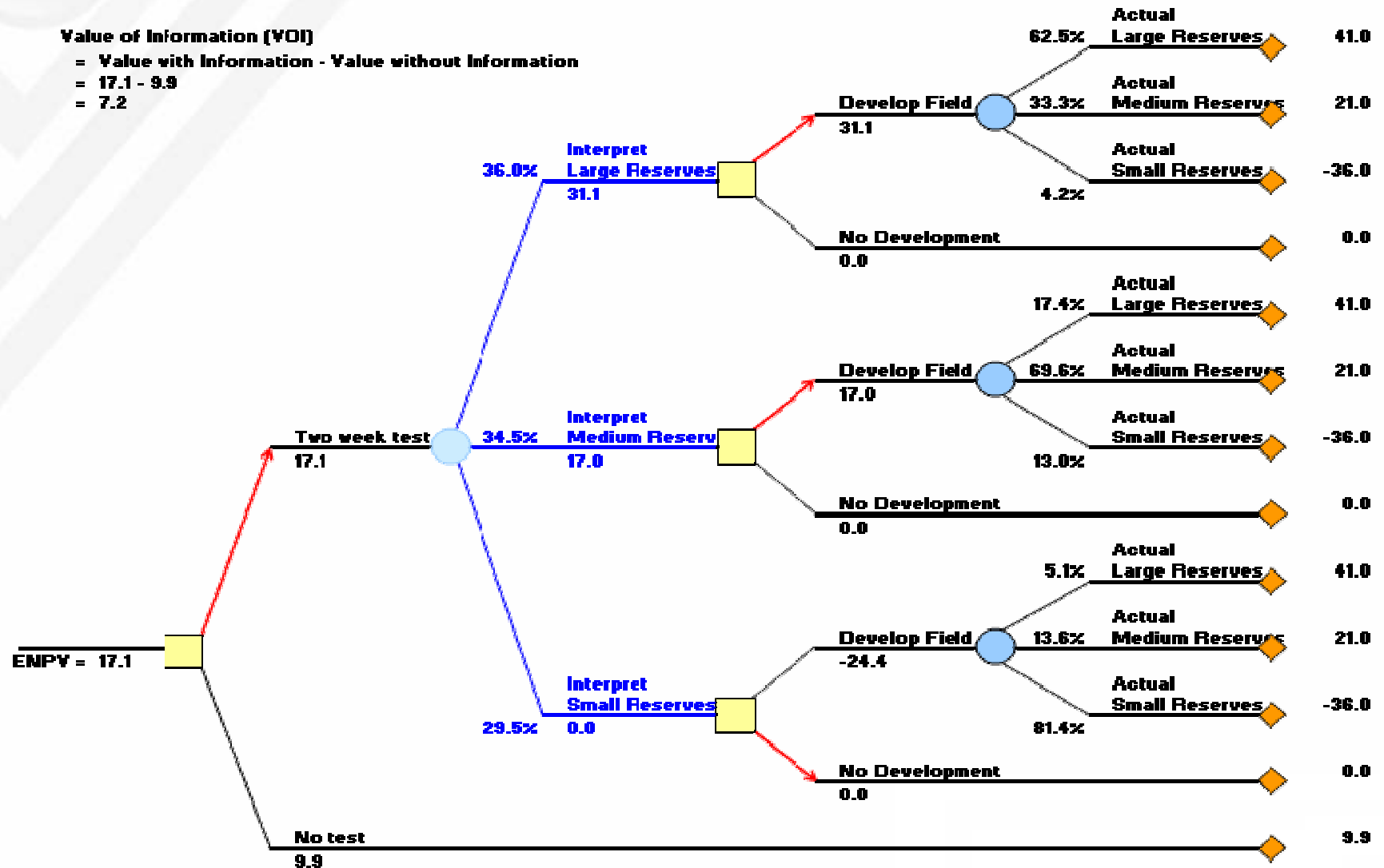 - 13.6% Actual Medium Reserves → 4.0%
  - 81.4% Actual Small Reserves → 24.0%

Imperfect Tree – Two-Month Test

Value of Information (VOI)

= Value with Information - Value without Information
= 17.1 - 9.9
= 7.2

| | | Actual Large Reserves | 41.0 |
| | | 62.5% | |

Interpret Large Reserves 31.1 — 36.0%

Develop Field 31.1

- 62.5% Actual Large Reserves → 41.0
- 33.3% Actual Medium Reserves → 21.0
- 4.2% Actual Small Reserves → -36.0
- No Development 0.0 → 0.0

Two week test 17.1 — 34.5%

Interpret Medium Reserv 17.0

Develop Field 17.0

- 17.4% Actual Large Reserves → 41.0
- 69.6% Actual Medium Reserves → 21.0
- 13.0% Actual Small Reserves → -36.0
- No Development 0.0 → 0.0

Interpret Small Reserves 0.0 — 29.5%

Develop Field -24.4

- 5.1% Actual Large Reserves → 41.0
- 13.6% Actual Medium Reserves → 21.0
- 81.4% Actual Small Reserves → -36.0
- No Development 0.0 → 0.0

ENPV = 17.1

No test 9.9 → 9.9

Summary of Initial Results

	Two-week Test	Two-month Test
VOI (Excluding Cost of Information)	5.0 MM$	7.2 MM$
Cost	0.5 MM$	3.0 MM$
VOI (Accounting for Cost of Information)	4.5 MM$	4.2 MM$

Which test would you choose?

Might you want to consider running the short test first and then, depending on the interpretation from the short test, consider running the long test?
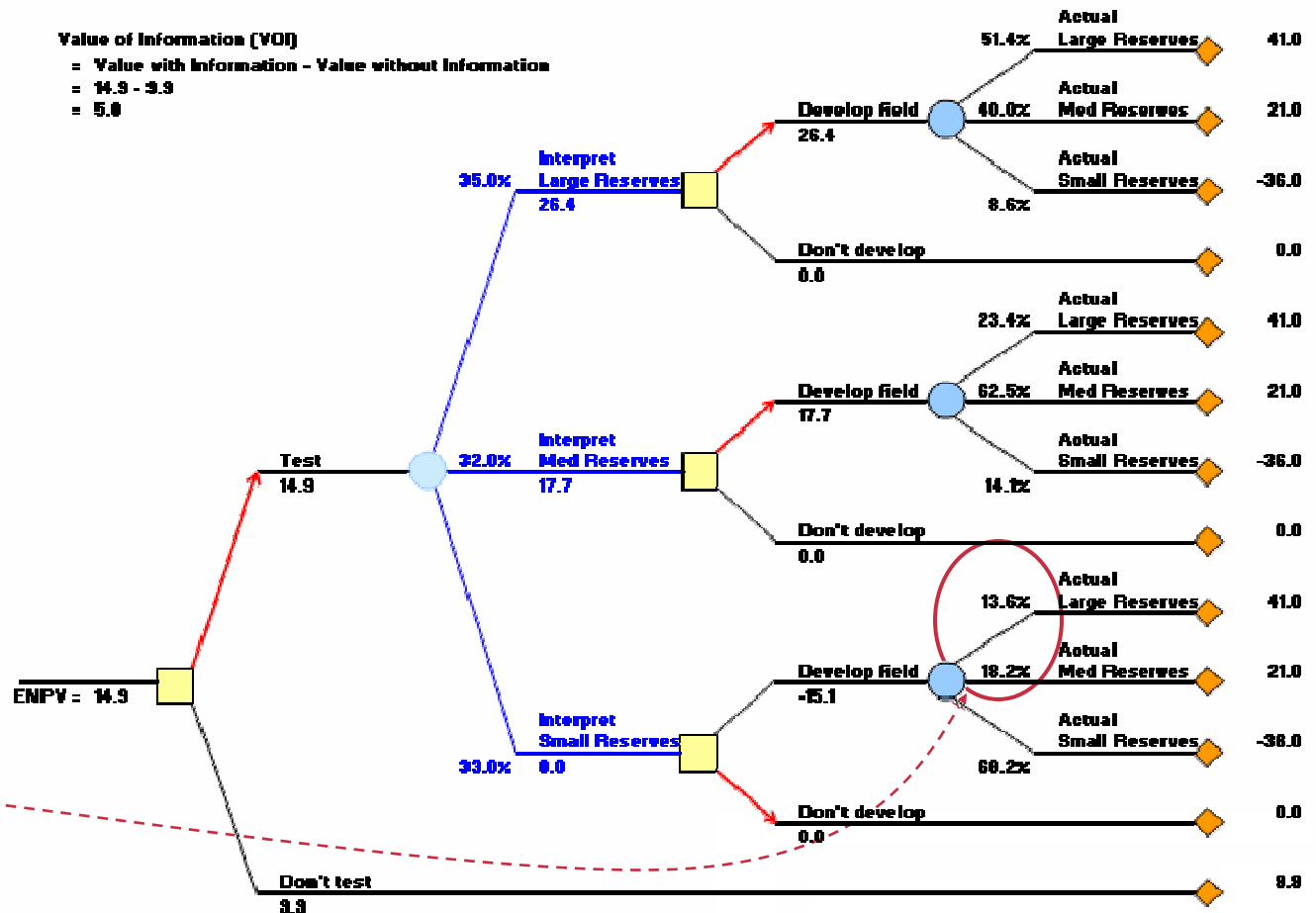
Insights on the Two-Week Test

When we interpret small reserves from the short test, there is still about a 32% chance of encountering large or medium reserves.
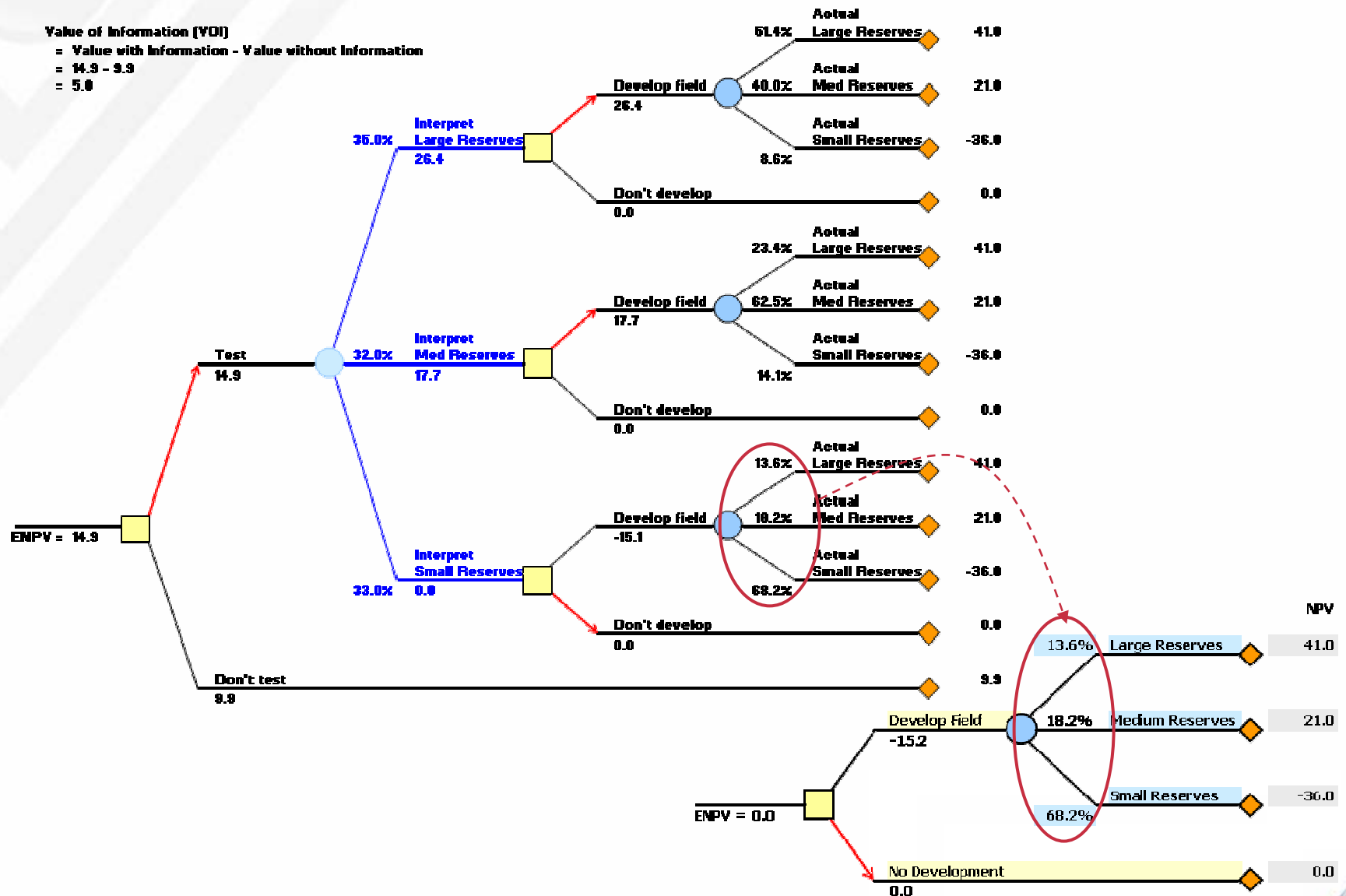
This may drive you to evaluate extending to a two-month test, to ensure that you do not walk away from economic reserves.
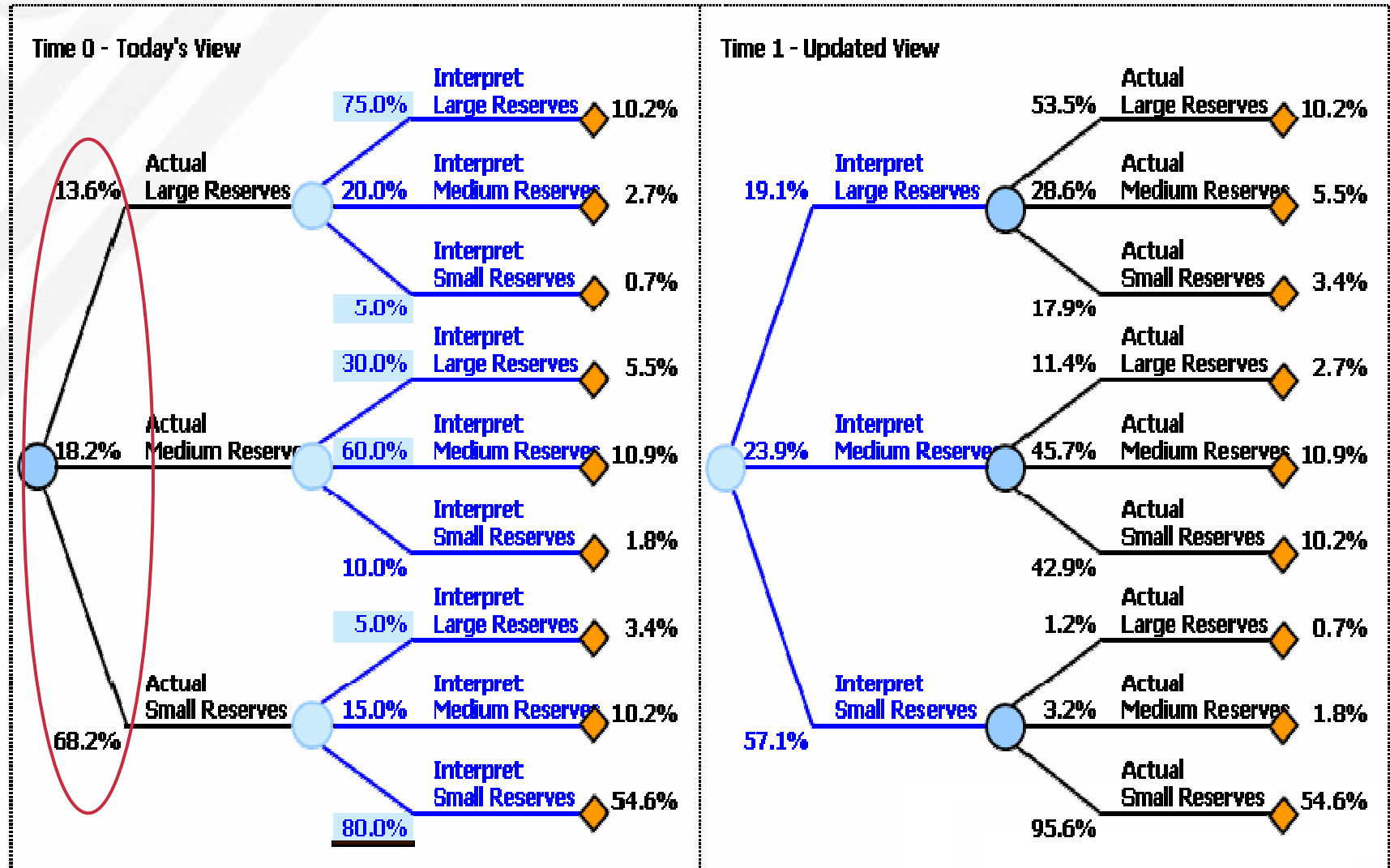
Extended Test – Go Now Tree

Value of Information (VOI)
= Value with Information – Value without Information
= 14.9 – 9.9
= 5.0

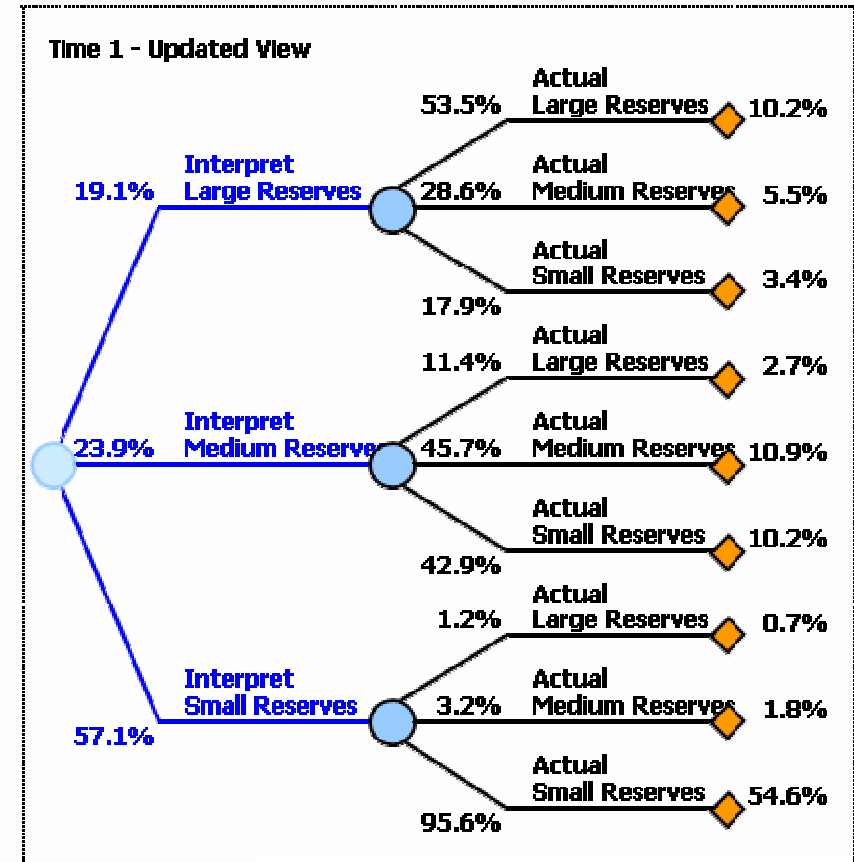# Reliability Interview – Extended Test

Reliability Interview – Extended Test

57% of the time, we will interpret small reserves. When we do, we will be correct about 95% of the time.

24% of the time, we will interpret medium reserves. When we do, we will be correct about 46% of the time.
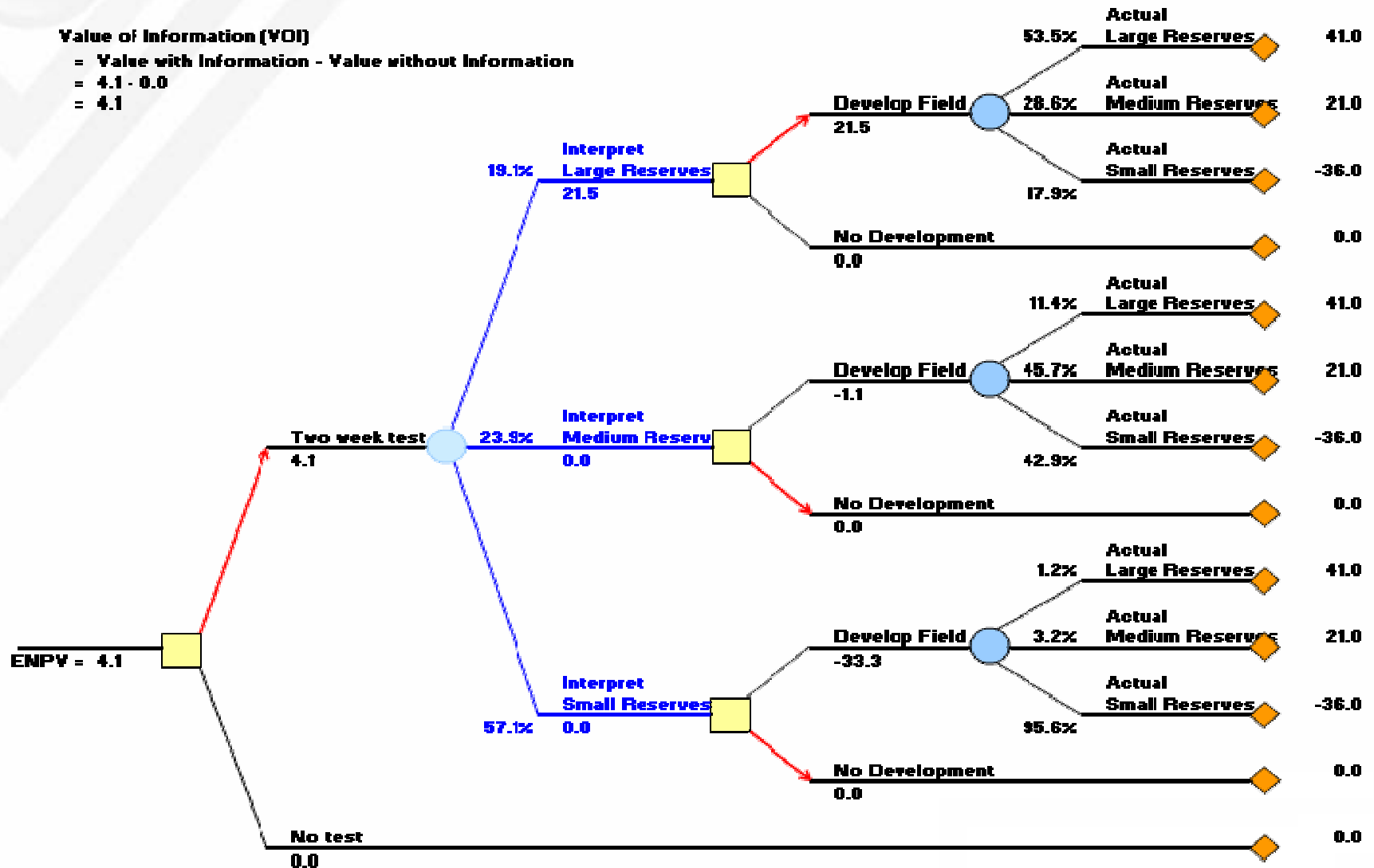
19% of the time, we will interpret large reserves. When we do, we will be correct about 54% of the time.

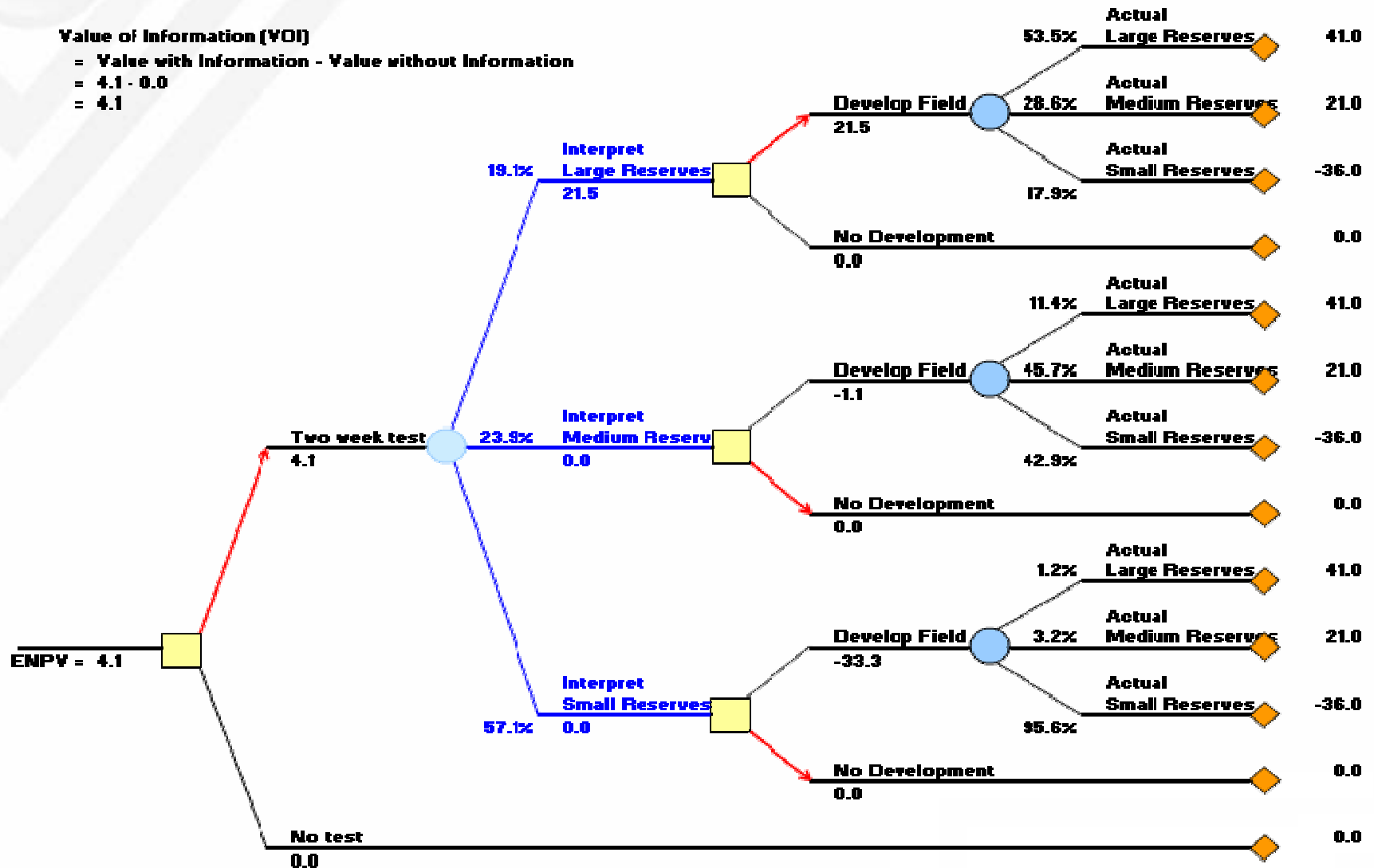# Imperfect Tree – Extended Test

Value of Information (VOI)
= Value with Information - Value without Information
= 4.1 - 0.0
= 4.1

Imperfect Tree – Extended Test, After Short Test Interprets Small
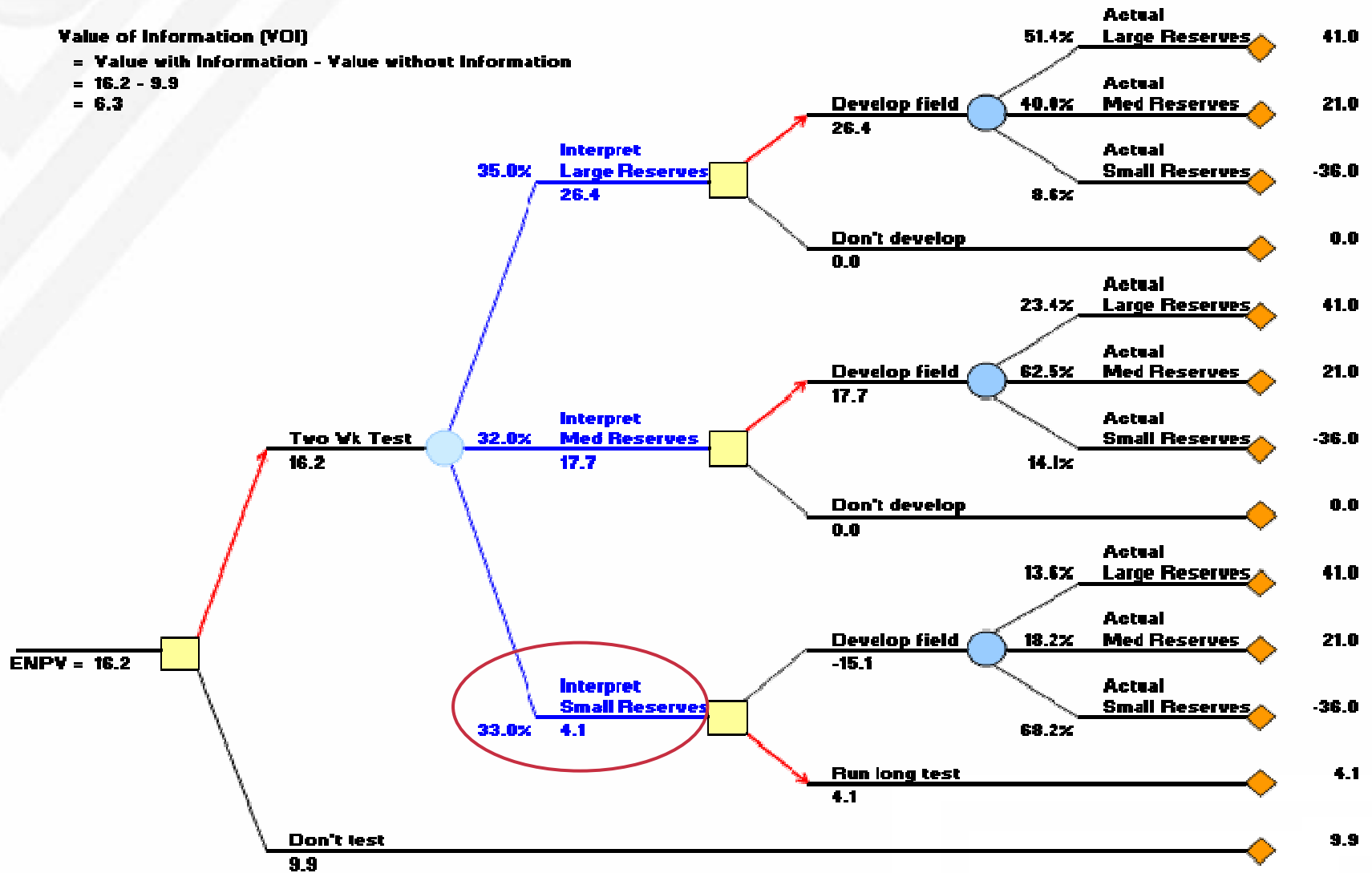

Value of Information (VOI)
- = Value with Information – Value without Information
- = 4.1 – 0.0
- = 4.1

Interpret Large Reserves 21.5 (19.1%)	Develop Field 21.5	Actual Large Reserves (53.5%) → 41.0
		Actual Medium Reserves (28.6%) → 21.0
		Actual Small Reserves (17.9%) → -36.0
	No Development 0.0 → 0.0

Two week test 4.1

ENPV = 4.1

Interpret Large Reserves 21.5 (19.1%)

Interpret Medium Reserv 0.0 (23.9%)

Interpret Small Reserves 0.0 (57.1%)

Develop Field 21.5 — Actual Large Reserves 53.5% → 41.0; Actual Medium Reserves 28.6% → 21.0; Actual Small Reserves 17.9% → -36.0
No Development 0.0 → 0.0

Develop Field -1.1 — Actual Large Reserves 11.4% → 41.0; Actual Medium Reserves 45.7% → 21.0; Actual Small Reserves 42.9% → -36.0
No Development 0.0 → 0.0

Develop Field -33.3 — Actual Large Reserves 1.2% → 41.0; Actual Medium Reserves 3.2% → 21.0; Actual Small Reserves 95.6% → -36.0
No Development 0.0 → 0.0

No test 0.0 → 0.0

Extended Test

Which test would you choose?

	Two-week Test	Two-month Test	Extended Test (Info Plan)
Project Value with Info	14.9	17.1	16.2
Project Value without Info	9.9	9.9	9.9
VOI (Excluding Cost of Info)	5.0	7.2	6.3
Expected Cost	0.5	3.0	1.5
VOI (Accounting for Cost of Info)	4.5	4.2	4.8

Budgeting for information plans will lower the expected cost of information gathering.