

Traditional Cost Estimates: Single Number Estimate



TASKS	COST
Additional Investigation	
Source Area Soil Investigation	\$ 25,000
On-site Ground Water Investigation	\$ 40,000
Install Off-Site Ground Water Wells	\$ 45,000
Remedial Action	
Excavation of Source Area Soil	\$ 230,000
Long Term Ground Water Monitoring	
Annual Ground Water Monitoring	\$ 150,000
TOTAL	\$ 490,000

WHAT IF ...

*Off-site ground water wells are
not needed?*

More soil needs excavation?

*A ground water extraction system
needs to be installed?*

*Ground water monitoring lasts for
10 years?*

**These factors are NOT
incorporated into the cost
presented.**

SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

MOST LIKELY COST ESTIMATE

Traditional Cost Estimates: Weighted Average Estimates



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

**GIVES YOU A
RANGE OF
POTENTIAL
COSTS:
\$0.3 to \$1.7 M**

TASKS	BEST CASE	MOST LIKELY	WORST CASE
Additional Investigation			
Source Area Soil Investigation	\$25,000	\$25,000	\$30,000
On-site Ground Water Investigation	\$40,000	\$40,000	\$40,000
Install Off-Site Ground Water Wells	\$0	\$45,000	\$45,000
Remedial Action			
Excavation of Source Area Soil	\$175,000	\$230,000	\$460,000
Install & Operate P&T System	\$0	\$0	\$950,000
Long Term Ground Water Monitoring			
Annual Ground Water Monitoring	\$100,000	\$150,000	\$250,000
TOTAL	\$340,000	\$490,000	\$1,775,000
Chance of Scenario Occurring	10%	60%	30%
Total x Chance Occurring =	\$34,000	\$294,000	\$532,500
WEIGHTED AVERAGE TOTAL		\$860,500	

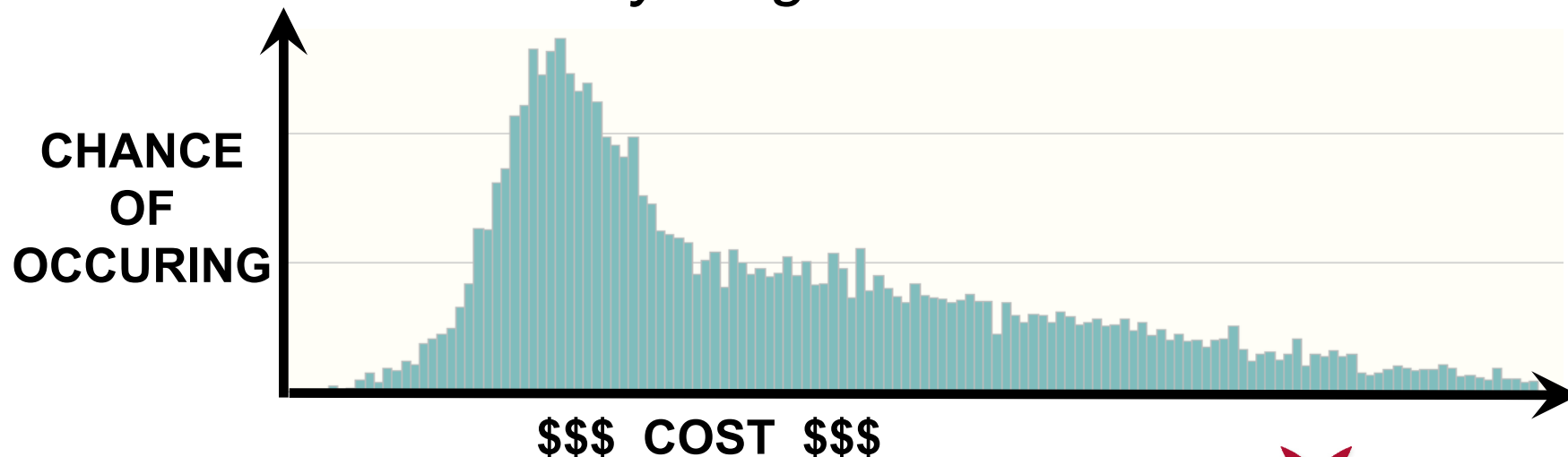
EXPECTED VALUE

What does a Probabilistic Cost Model Provide?



The FULL RANGE of POSSIBILITIES

Instead of getting a snap-shot view of the “most likely” cost, you can see the worst case number, the “if-everything-happens-perfect” number, and *everything in between.*



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

What does a Probabilistic Cost Model Provide?



A TOOL to ASSESS WHAT REALLY MATTERS

The results of a probabilistic cost model lets you see what factors are *quantitatively* effecting the range of costs. Allowing you to focus your investigations and research in areas that will better refine the cost estimate.

SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

#1
Tons of Soil Requiring Excavation

~~Number of Monitoring Wells~~

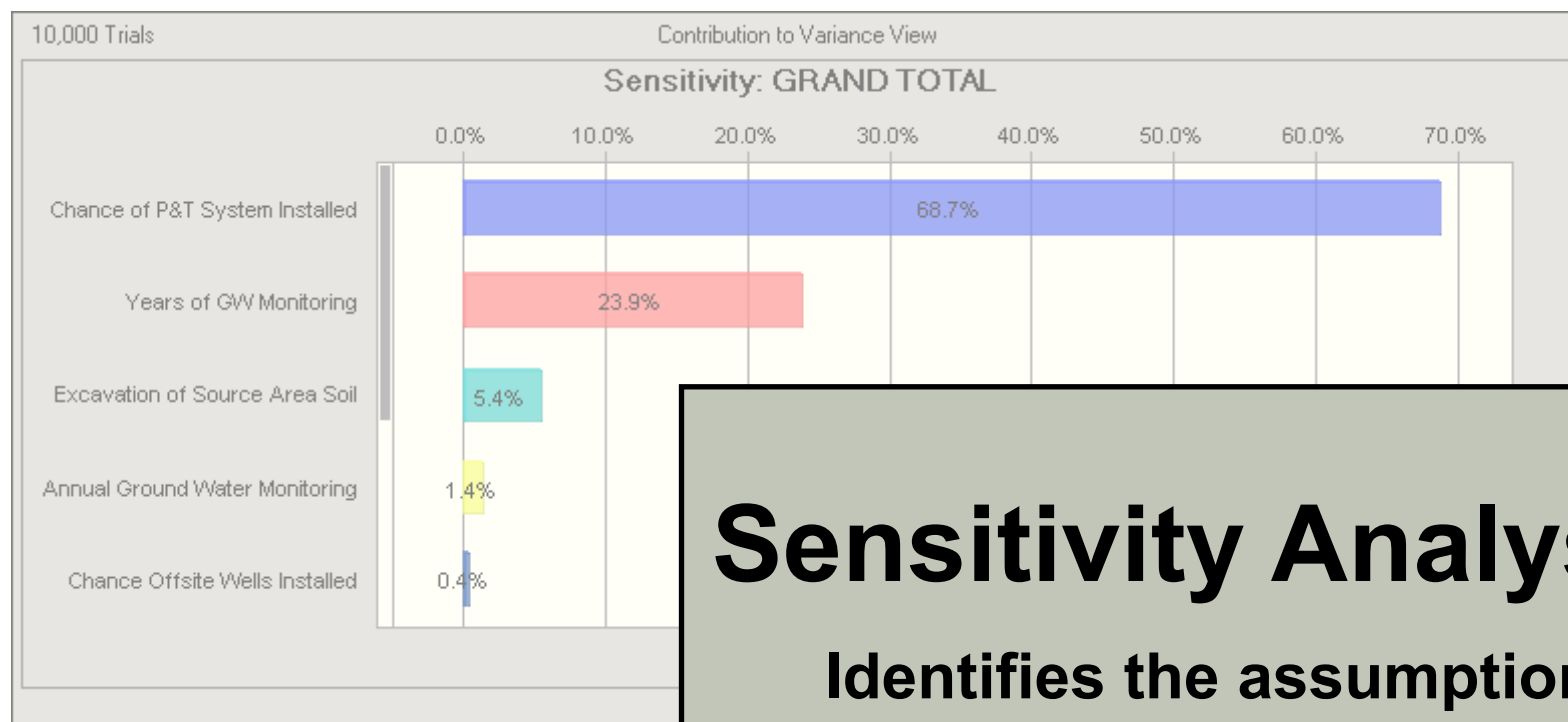
~~Pump & Treat vs. Chemical Oxidation~~

#2
Years of Operation

~~Years of Monitoring~~

~~Cost of Analytical~~

What does a Probabilistic Cost Model Provide?



Sensitivity Analysis:

Identifies the assumptions
that contribute most
to the variation in cost.

SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

What is a Probabilistic Cost Model?



- It's a cost model in which you assign probabilities and ranges to all of the values (unit costs, quantities, chance of a task being necessary) in the model that uncertainty is associated with.
- Then using a software such as Crystal Ball®, you run a Monte Carlo Simulation.

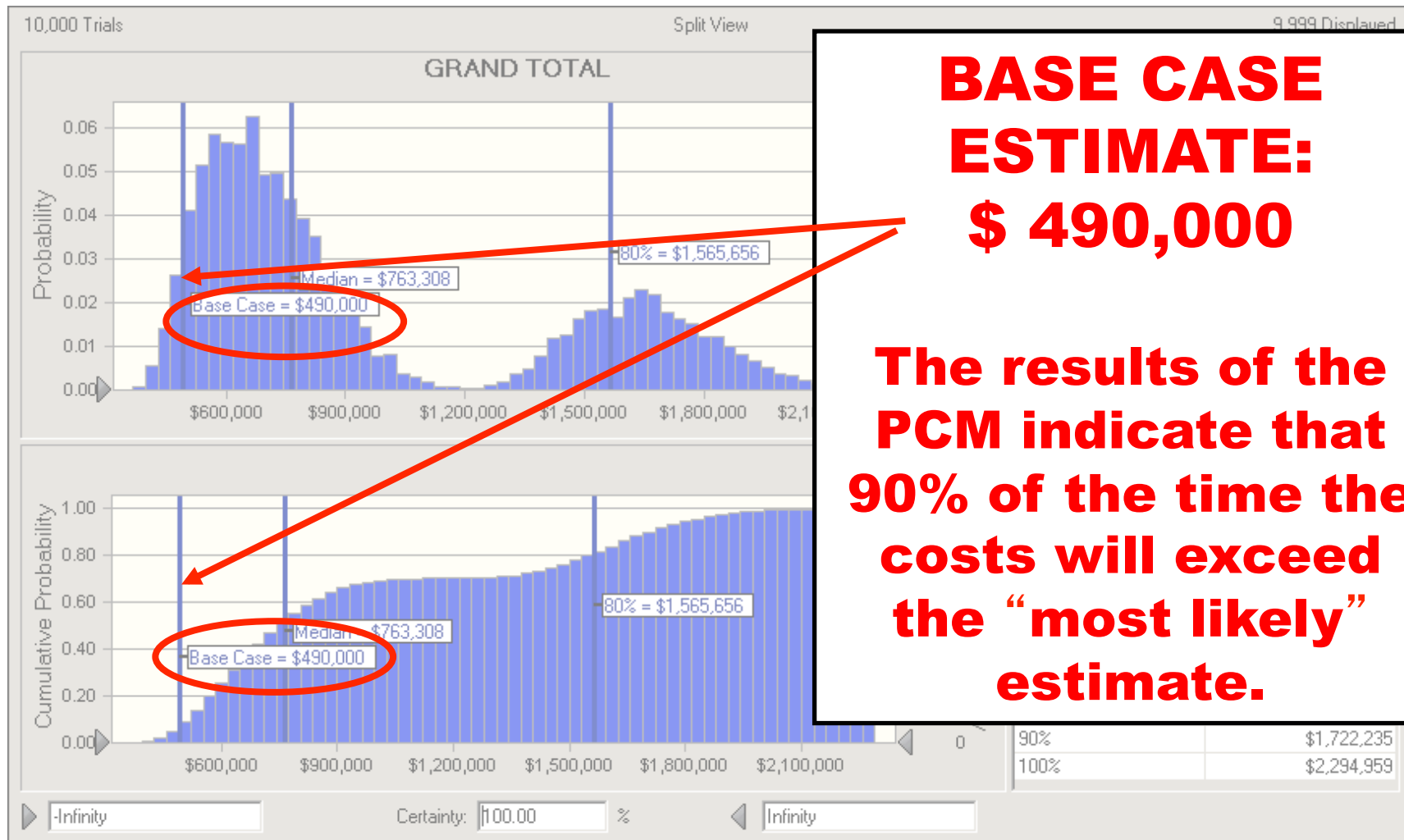
Like dice, Crystal Ball uses Excel to generate random numbers within the specified ranges for each of the Assumptions



Probabilistic Cost Model Results



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS



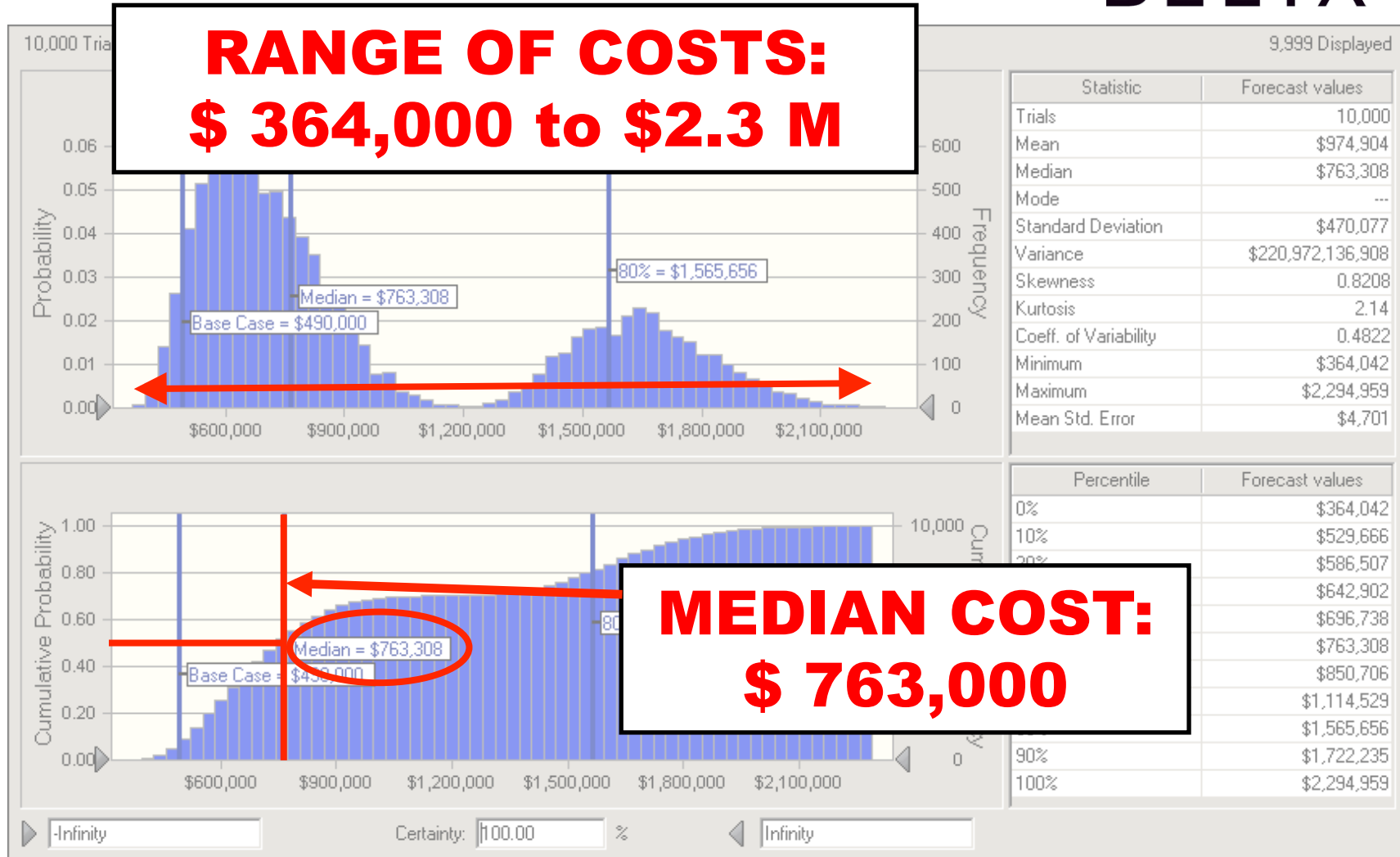
**BASE CASE
ESTIMATE:
\$ 490,000**

**The results of the
PCM indicate that
90% of the time the
costs will exceed
the “most likely”
estimate.**

Probabilistic Cost Model Results



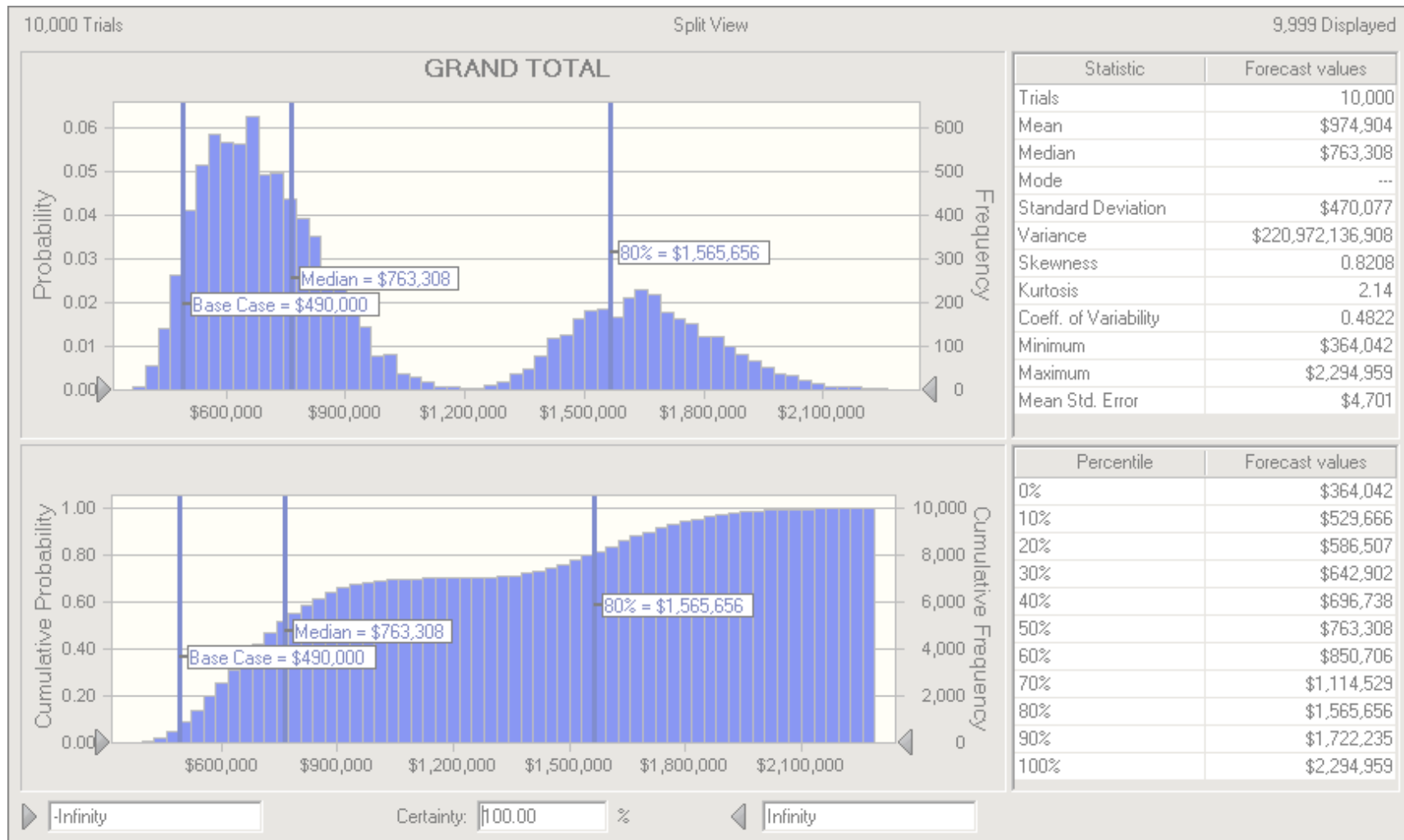
SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS



Probabilistic Cost Model Results



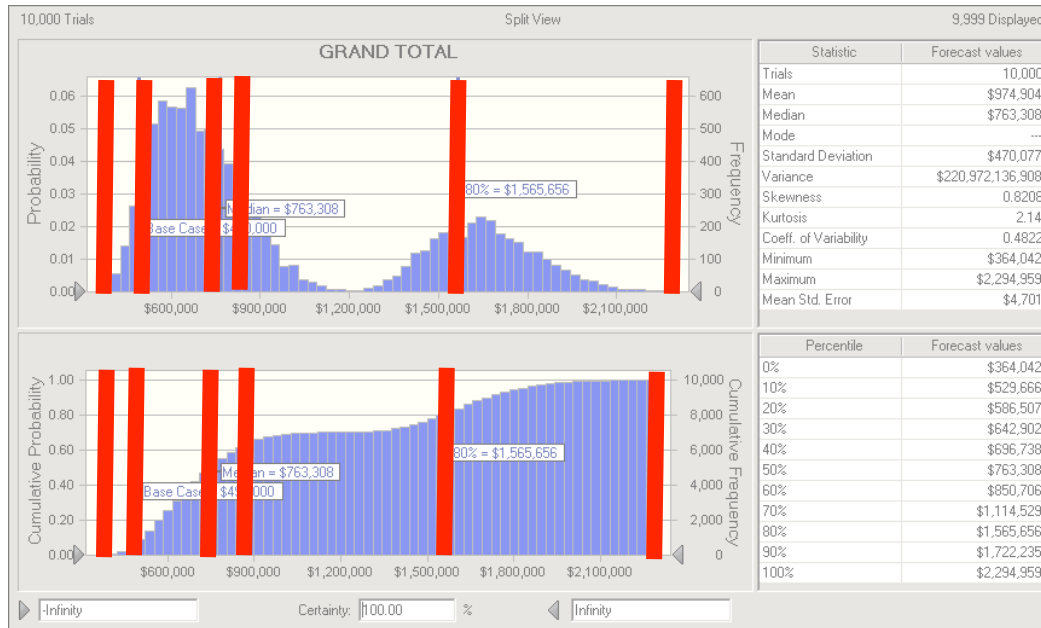
SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS



Probabilistic Cost Model Results



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS



WHAT VALUE DO YOU USE?

- **Comfort Level with Uncertainty & Risk**
- **Business Decision**
- **Purpose of the Model**

\$ 364,042.3 M
\$ 800,000
\$ 1,565,656
Base Case or 80th Percentile?
Average Result?

Probabilistic Cost Model Applications



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

- **Litigation, Settlement & Mediation**
- **Environmental Reserve Setting**
- **Risk Transfer Transactions**
- **Remedial Approach Decision Making**

Probabilistic Cost Models: Litigation, Settlement & Mediation



Approach Used:

- Evaluate the potential environmental costs to closure.
- Account for all **foreseeable** scenarios.

Results Given:

- A wide range of potential costs that incorporates the possible scenarios.

Benefits of Using PCMs for Litigation, Settlement & Mediation:

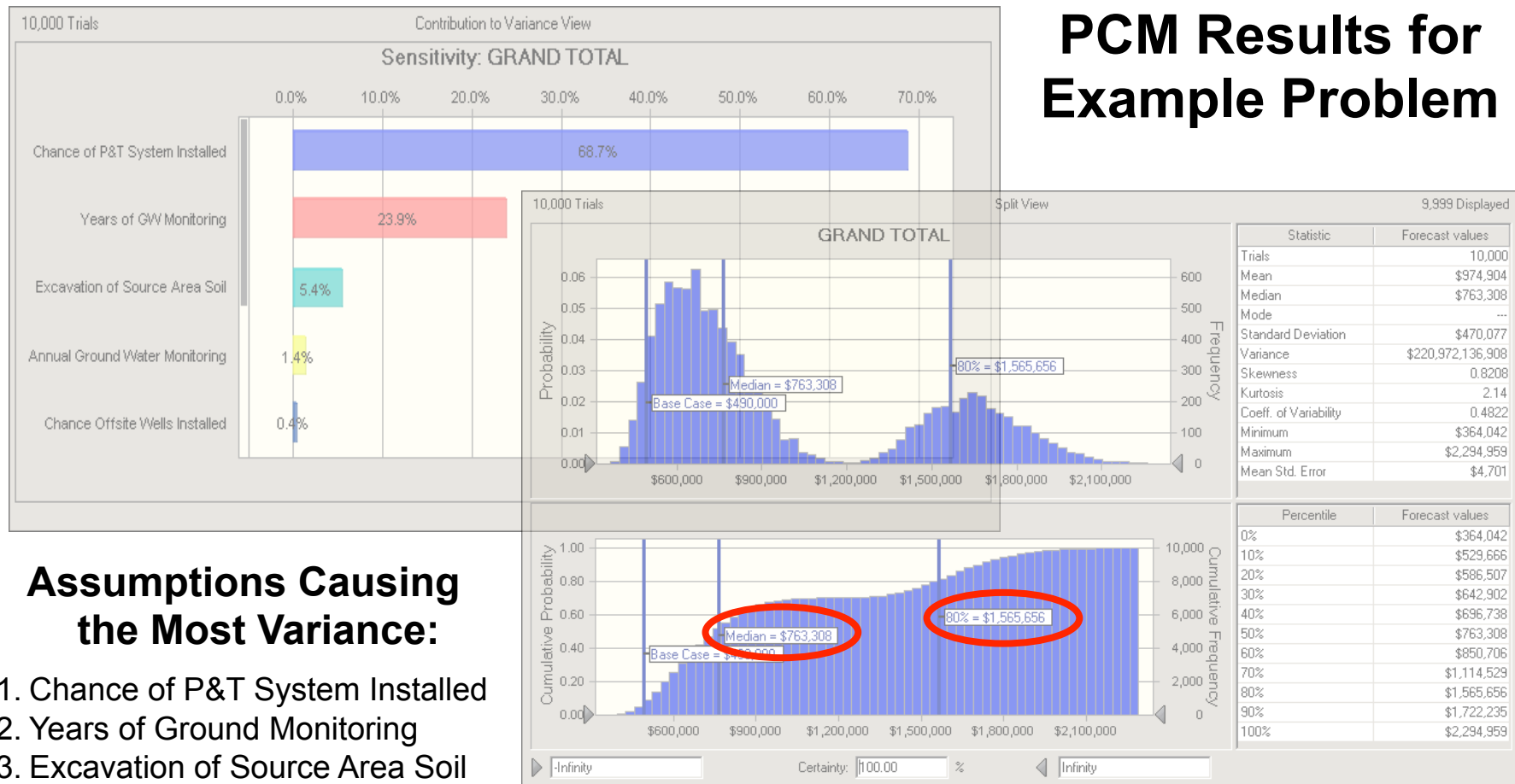
- Provides a clear, visual representation of the damages.
- Accounts for variation and uncertainty.
- Identifies which assumptions contribute most to the variation.

Probabilistic Cost Models: Litigation, Settlement & Mediation



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

PCM Results for Example Problem



Probabilistic Cost Models: Environmental Reserve Setting



Approach Used:

- Evaluate the reasonable and foreseeable environmental costs to closure given the **known** conditions at the site. This includes all costs to the company – legal support, internal employees time & resources.

Results Given:

- A wide range of potential costs that incorporates the possible scenarios.

Benefits of Using PCMs for Environmental Reserve Setting:

- Provides a clear, well documented method of calculating what the reserve setting should be.
- Accounts for variation and uncertainty in how closure may be obtained.

Probabilistic Cost Models:

Hierarchy of Approaches for Estimating Costs and Liabilities for Environmental Matters



*Increasing
Robustness &
Comprehensiveness*

Expected Value (EV):
An estimate of the **mean value** of an unknown quantity that represents a **probability-weighted average over the range of all possible values.**

SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

From ASTM E 2137-06

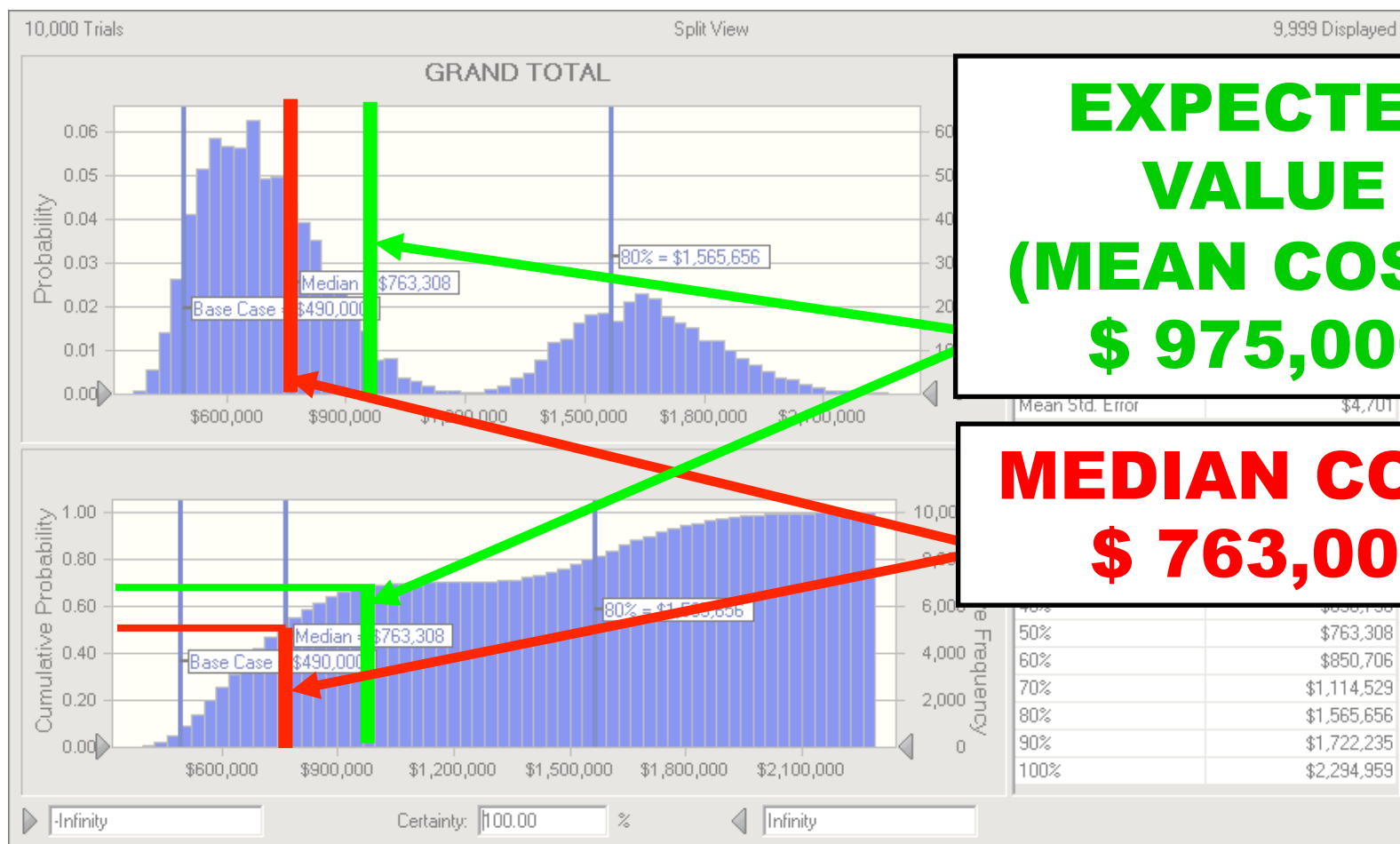
www.deltaenv.com



Probabilistic Cost Models: Environmental Reserve Setting



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS



**EXPECTED
VALUE
(MEAN COST):
\$ 975,000**

**MEDIAN COST:
\$ 763,000**

Probabilistic Cost Models: Risk Transfer Transactions



Approach Used:

- Evaluate the potential environmental costs to closure.

Results Given:

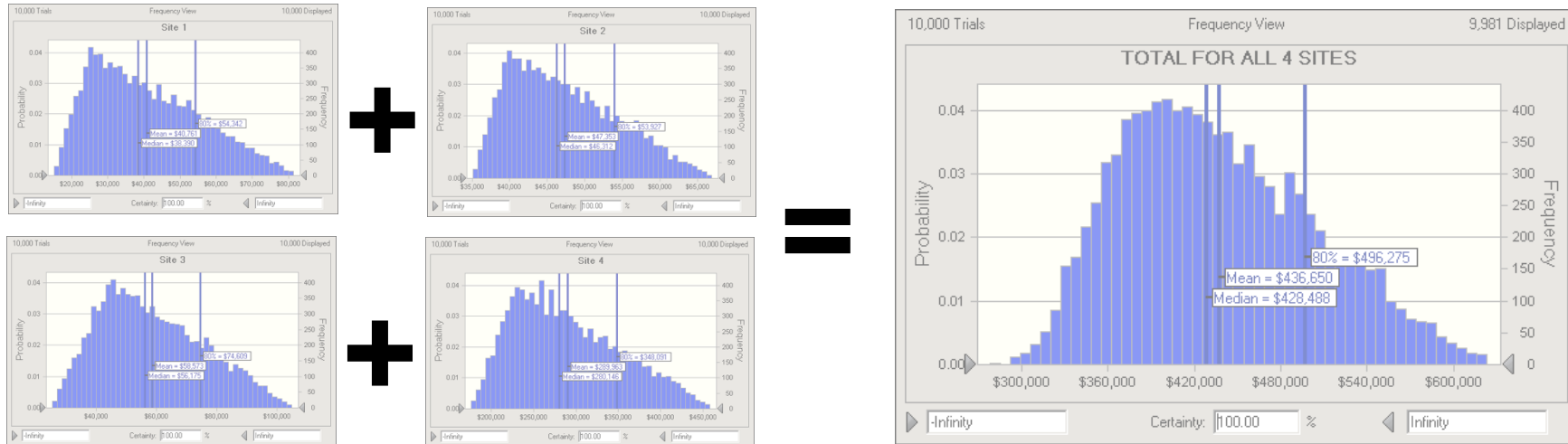
- A wide range of potential costs that incorporates the possible scenarios.

Benefits of Using PCMs for Risk Transfer Transactions:

- Provides a clear, visual representation of the range of costs.
- Accounts for variation and uncertainty.
- Identifies which assumptions contribute most to the variation.

When working with a portfolio of sites, demonstrates that risk is NOT STRICTLY CUMULATIVE.

Probabilistic Cost Models: Risk Transfer Transactions



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

PCM COST MODEL RESULTS					ADDING THE RESULTS	PCM's RESULT FOR TOTAL OF 4 SITES	Difference Between Totals
Statistics	Site 1	Site 2	Site 3	Site 4			
Mean	\$40,761	\$47,353	\$58,573	\$289,963	\$436,650	\$436,650	\$0
Median	\$38,390	\$46,312	\$56,175	\$280,146	\$421,023	\$428,488	\$(7,465)
Minimum	\$15,168	\$35,104	\$25,484	\$176,015	\$251,771	\$277,752	\$(25,981)
Maximum	\$81,443	\$66,907	\$104,870	\$458,285	\$711,505	\$664,081	\$47,423
80% Percentile	\$54,342	\$53,927	\$74,609	\$348,091	\$530,969	\$496,275	\$34,693

Probabilistic Cost Models: Remedial Approach Decision Making



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

Approach Used:

- Evaluate the installation and operating costs for various remedial technologies being considered for at a site.

Results Given:

- The range of potential costs for each technology that can assist in determining what the most cost effective and appropriate remedial approach may be.

Benefits of Using PCMs for Risk Transfer Transactions:

- Provides a clear, visual representation of the range of costs that can be included in reports.

Probabilistic Cost Models: Remedial Approach Decisions



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

TWO REMEDIAL ALTERNATIVES CONSIDERED:

Option 1: Groundwater Extraction & Treatment System

Most Likely Value Cost: \$ 1,255,000

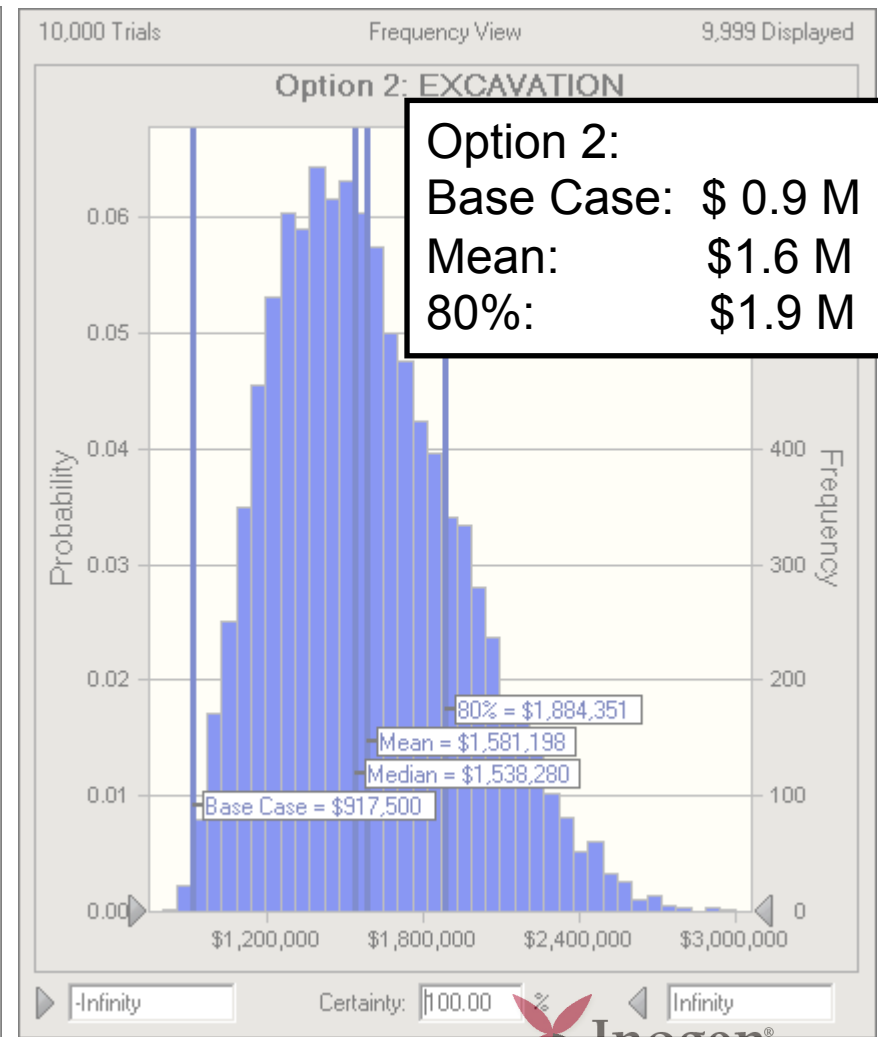
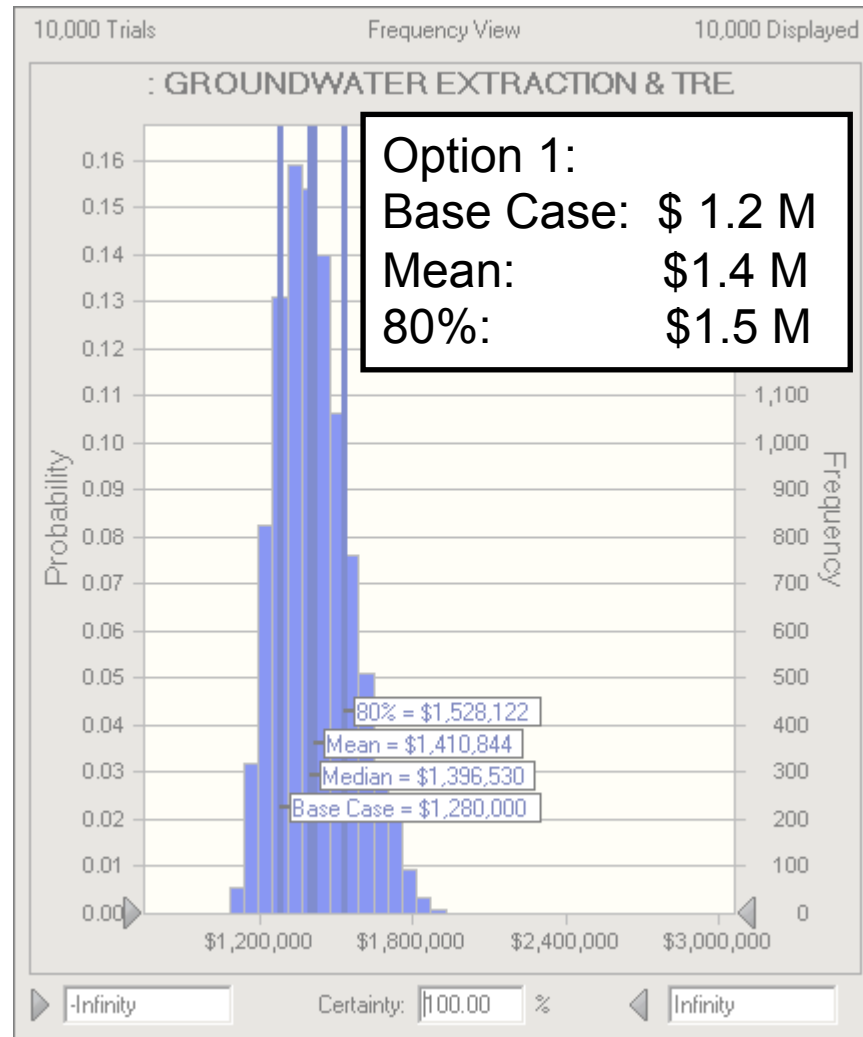
Option 2: Excavation

Most Likely Value Cost: \$ 921,000

Both alternatives are technically feasible, and meets all regulatory & client requirements....

So, you would recommend Option 2, correct?

Probabilistic Cost Models: Remedial Approach Decisions



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

Probabilistic Cost Models



- **Provides A Robust Estimate of Future Costs that is Not One Dimensional**
- **Provides Clear, Easy to Understand Results that can be Presented to a Wide Audience.**
- **Answers the What-If-Questions and Allows Uncertainty to be Incorporated into the Estimate.**
- **A Useful Tool to Estimate Future Environmental Costs for a Variety of Purposes.**



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS