THE TWO-DIMENSIONAL (2D) SIMULATION TOOL

Risk analysts must often consider two sources of variation in their models:

- Uncertainty, where assumptions are uncertain because you have insufficient information about a fixed, but unknown, value (e.g., the return on an investment, the costs during a stage of drug development, the amount of oil in a reservoir)

- Variability, where assumptions change because they describe a population of different values (e.g., individual body weights in a population, the daily number of products sold over a year, ages of products in inventory).

Many risk assessments contain both uncertainty and variability, and you should treat the two sources of variation separately to accurately characterize the risk. The 2D Simulation tool distinguishes the effects of the two types of variation by running two simulation "loops": an outer loop for the uncertainty and an inner loop for the variability.
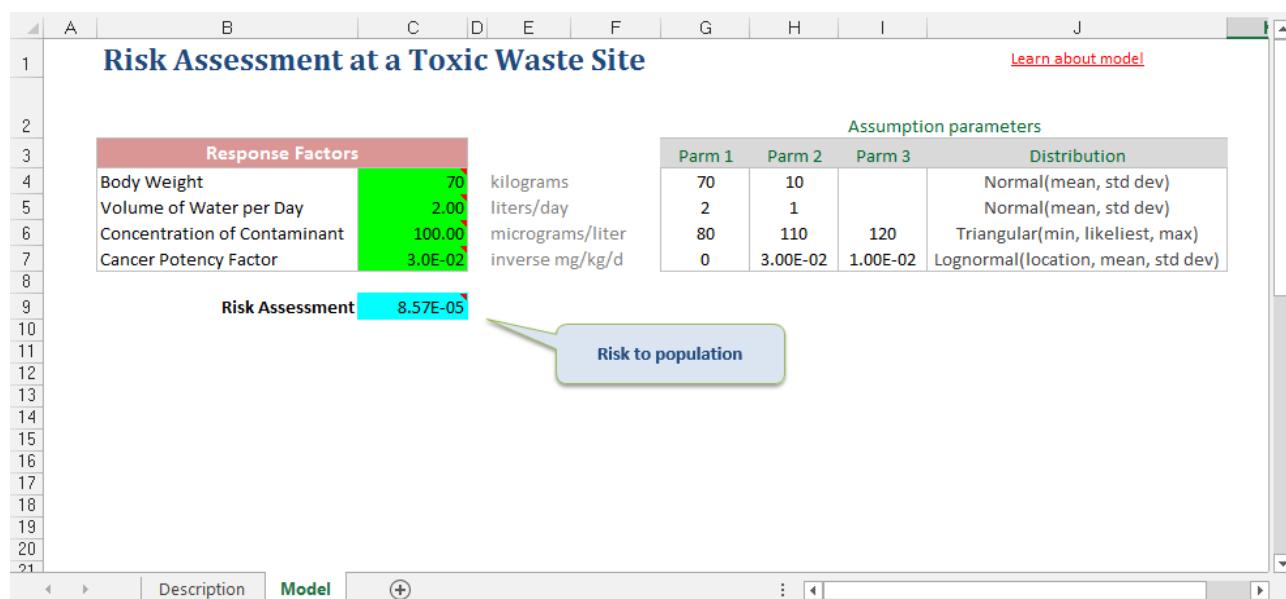
This spotlight will use the 2D simulation tool to assess the risk at a toxic waste site. You have defined the four variables as assumptions and the Risk Assessment formula as the forecast.

2D Simulation, continued

OPENING THE TOOL AND SELECTING A FORECAST

You can open the 2D Simulation tool through the Run -> Tools menu.

When the tool opens, you will see a Welcome screen. Click on Next and select the Target Forecast from the list (there is only one forecast in this example). Click on Next to move to Assumption Types.
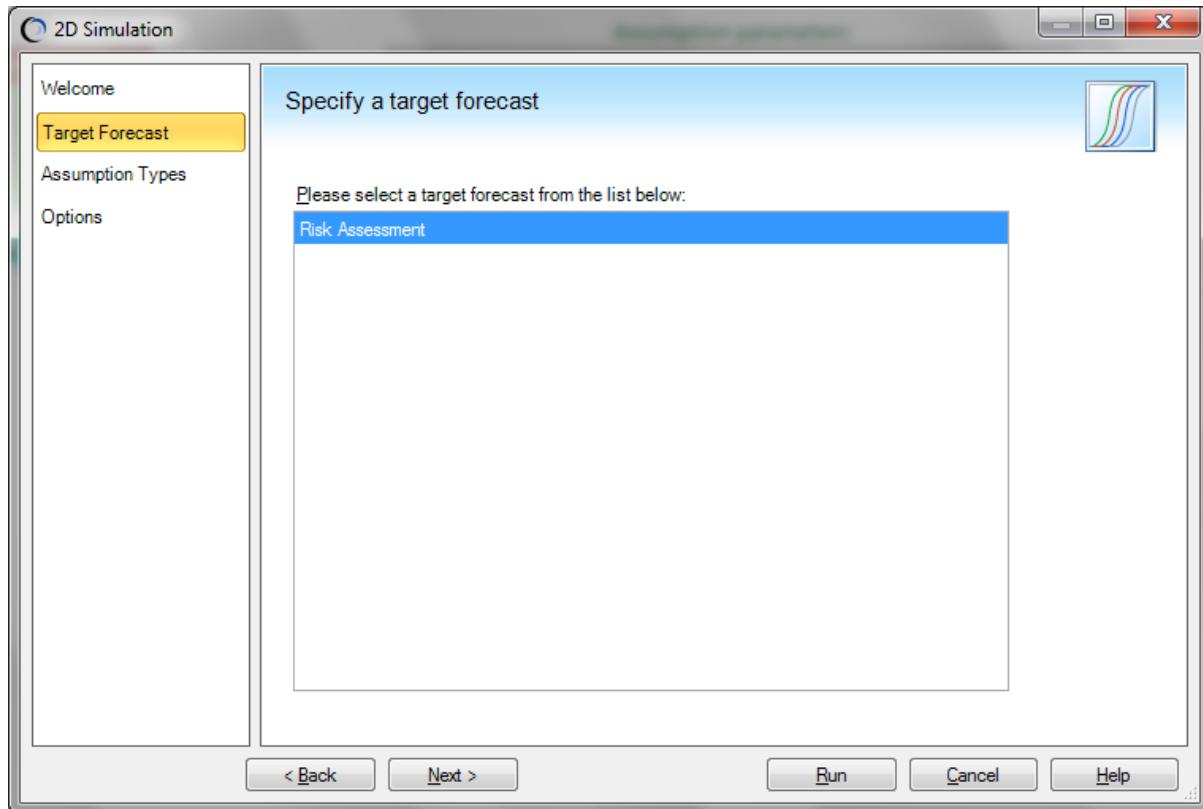
2D Simulation, continued

SPECIFYING THE ASSUMPTIONS

This step lets you identify and separate the two types of assumptions.

In this example, the uncertain variables are the Concentration of Contaminant in Water and the CFP (cancer potency factor). While there is a single, fixed value for each, they are uncertain because you cannot directly measure them.

Body Weight and Volume of Water per Day vary naturally per person across the population, so these two assumptions are identified as variability. Click on Next to move to Options.
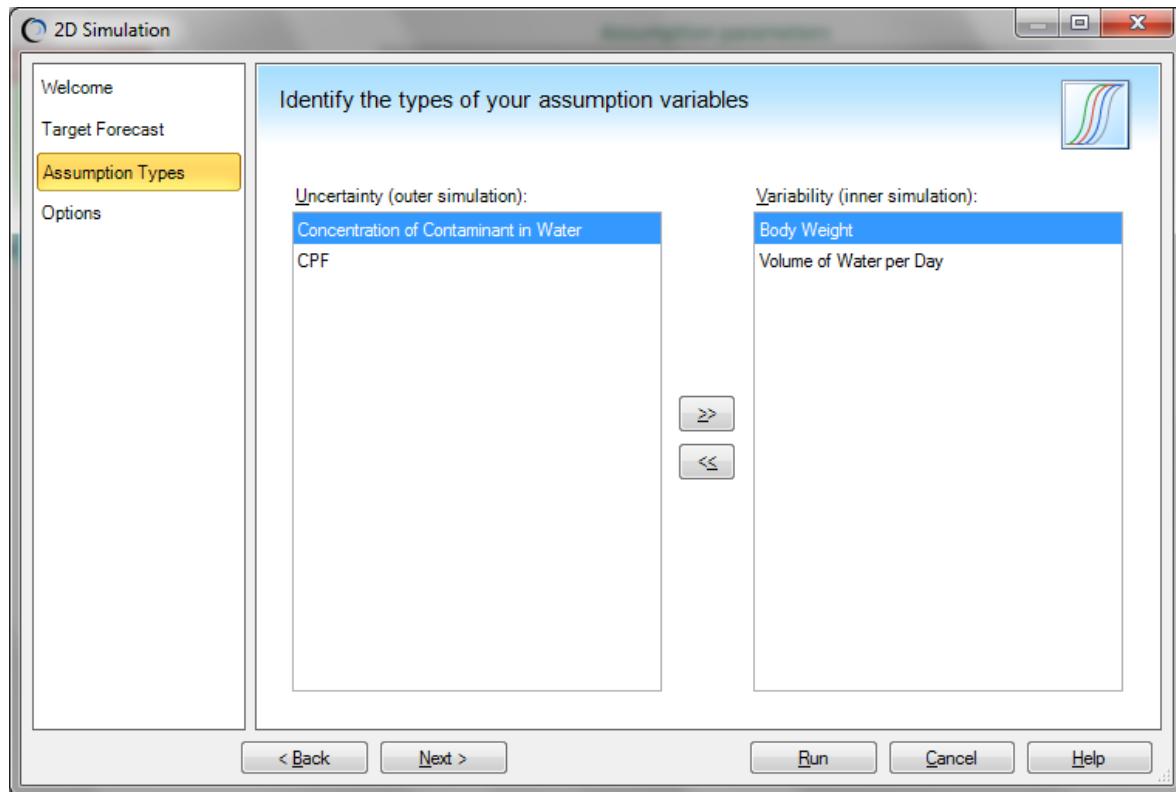
2D Simulation, continued

SPECIFYING THE SIMULATION OPTIONS

The final step lets you define how many outer and inner loops you wish to run as well as how you want to view the output. For this model, you decide to run 100 simulations (outer loop) of 1000 trials (inner loop) each. Click on Run to run the tool.
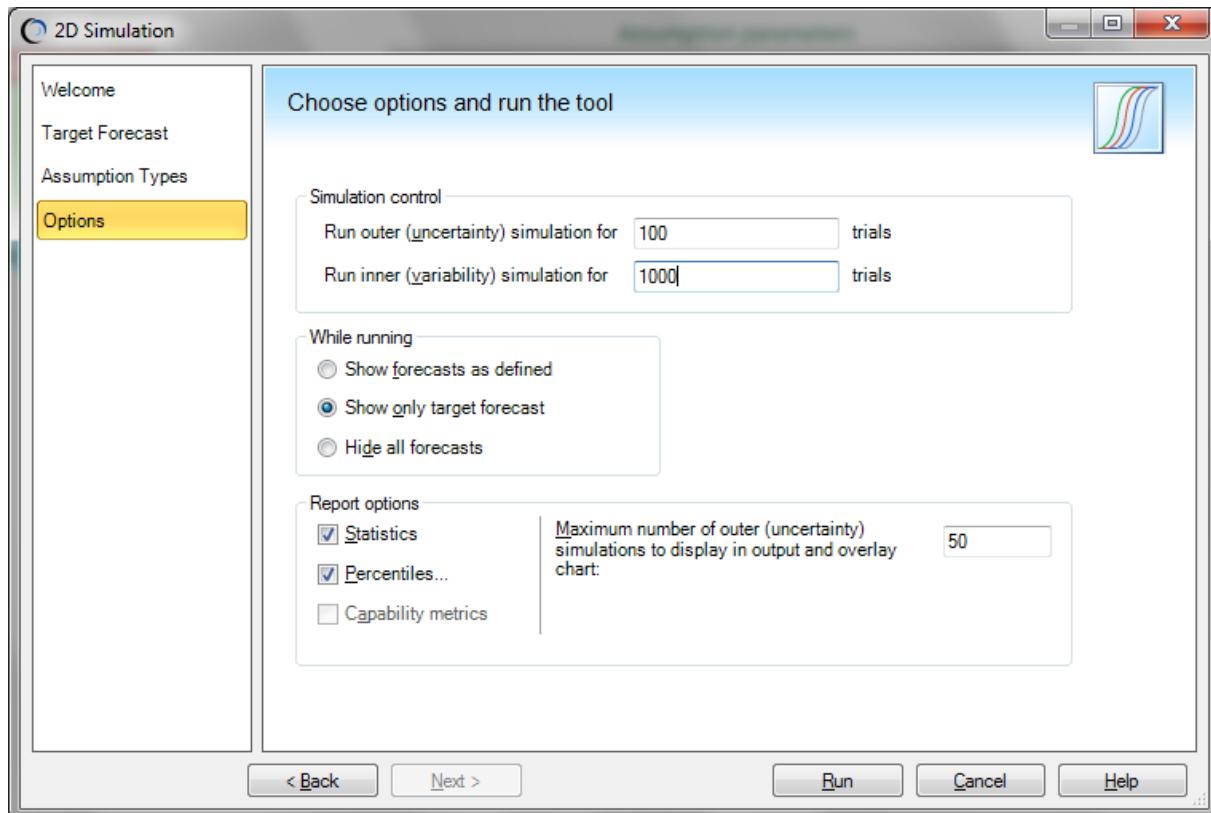
Crystal Ball first single-steps one trial (set of random values) for the two uncertain assumptions (outer loop). Then, with these assumption values frozen, Crystal Ball runs 1000 trials on the two variability assumptions (inner loop). Crystal Ball saves the results and repeats this process 99 more times.

2D Simulation, continued

ANALYZING THE RESULTS

After completing the simulations, the tool creates a separate workbook with the 2D simulation results. The results of the simulations appear in a table containing the forecast means, the uncertainty assumption values, and the statistics (including percentiles) of the forecast distribution for each simulation. In the results table below, you can view the 95th-percentile statistics (for the 100 uncertain simulations) in row 39. The mean value for the 95th-percentile is 1.67E-4.

		Summary	Risk Assessment(21)	Risk Assessment(10)	Risk Assessment(85)	Risk Assessment(37)	Risk Assessment(53)	Risk Assessment(14)	Risk Assessment(83)	Risk Assessment(72)	Risk Assessment(65)	Risk Assessment(19)	Risk Assessment(28)
			A	B	C	D	E	F	G	H	I	J	K
2			4.55E-05	4.84E-05	5.09E-05	5.32E-05	5.39E-05	5.55E-05	5.75E-05	6.05E-05	6.51E-05	6.78E-05	6.93E-05
3	**Assumptions:**												
4	Concentration of Contaminant in Water		100.70	99.71	94.10	93.13	98.25	93.60	102.09	99.80	97.76	98.78	91.10
5	CPF		1.5E-02	1.6E-02	1.8E-02	1.9E-02	1.8E-02	1.9E-02	1.8E-02	2.0E-02	2.2E-02	2.3E-02	2.5E-02
6													
7	**Statistics:**												
8	Mean	9.30E-05	4.55E-05	4.84E-05	5.09E-05	5.32E-05	5.39E-05	5.55E-05	5.75E-05	6.05E-05	6.51E-05	6.78E-05	6.93E-05
9	Median	8.97E-05	4.39E-05	4.67E-05	4.91E-05	5.13E-05	5.20E-05	5.35E-05	5.55E-05	5.84E-05	6.27E-05	6.54E-05	6.68E-05
10	Standard Deviation	4.35E-05	2.13E-05	2.27E-05	2.38E-05	2.49E-05	2.52E-05	2.60E-05	2.69E-05	2.83E-05	3.04E-05	3.17E-05	3.24E-05
11	Variance	2.07E-09	4.53E-10	5.14E-10	5.67E-10	6.20E-10	6.36E-10	6.75E-10	7.24E-10	8.02E-10	9.26E-10	1.01E-09	1.05E-09
12	Skewness	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
13	Kurtosis	3.43	3.43	3.43	3.43	3.43	3.43	3.43	3.43	3.43	3.43	3.43	3.43
14	Coeff. of Variation	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
15	Minimum	9.87E-09	4.82E-09	5.14E-09	5.40E-09	5.64E-09	5.72E-09	5.89E-09	6.10E-09	6.42E-09	6.90E-09	7.19E-09	7.35E-09
16	Maximum	2.66E-04	1.30E-04	1.39E-04	1.46E-04	1.52E-04	1.54E-04	1.59E-04	1.64E-04	1.73E-04	1.86E-04	1.94E-04	1.98E-04
17	Range	2.66E-04	1.30E-04	1.38E-04	1.46E-04	1.52E-04	1.54E-04	1.59E-04	1.64E-04	1.73E-04	1.86E-04	1.94E-04	1.98E-04
18													
19	**Percentiles:**												
20	0%	9.87E-09	4.82E-09	5.14E-09	5.40E-09	5.64E-09	5.72E-09	5.89E-09	6.10E-09	6.42E-09	6.90E-09	7.19E-09	7.35E-09
21	5%	2.79E-05	1.36E-05	1.45E-05	1.53E-05	1.59E-05	1.62E-05	1.66E-05	1.72E-05	1.81E-05	1.95E-05	2.03E-05	2.08E-05
22	10%	3.81E-05	1.86E-05	1.98E-05	2.08E-05	2.18E-05	2.21E-05	2.27E-05	2.35E-05	2.48E-05	2.66E-05	2.78E-05	2.83E-05
23	15%	4.73E-05	2.31E-05	2.46E-05	2.59E-05	2.70E-05	2.74E-05	2.82E-05	2.92E-05	3.08E-05	3.30E-05	3.45E-05	3.52E-05
24	20%	5.59E-05	2.73E-05	2.91E-05	3.06E-05	3.19E-05	3.24E-05	3.33E-05	3.45E-05	3.64E-05	3.91E-05	4.07E-05	4.16E-05
36	80%	1.29E-04	6.32E-05	6.73E-05	7.07E-05	7.39E-05	7.49E-05	7.71E-05	7.99E-05	8.41E-05	9.04E-05	9.42E-05	9.62E-05
37	85%	1.37E-04	6.71E-05	7.15E-05	7.51E-05	7.85E-05	7.95E-05	8.19E-05	8.49E-05	8.93E-05	9.60E-05	1.00E-04	1.02E-04
38	90%	1.49E-04	7.29E-05	7.76E-05	8.15E-05	8.52E-05	8.63E-05	8.89E-05	9.21E-05	9.70E-05	1.04E-04	1.09E-04	1.11E-04
39	95%	1.67E-04	8.19E-05	8.72E-05	9.16E-05	9.58E-05	9.70E-05	9.99E-05	1.04E-04	1.09E-04	1.17E-04	1.22E-04	1.25E-04
40	100%	2.66E-04	1.30E-04	1.39E-04	1.46E-04	1.52E-04	1.54E-04	1.59E-04	1.64E-04	1.73E-04	1.86E-04	1.94E-04	1.98E-04

TwoDSimulationOutput   Sheet1

2D Simulation, continued

The tool also presents the results of the 2D simulations in an overlay chart and a trend chart.
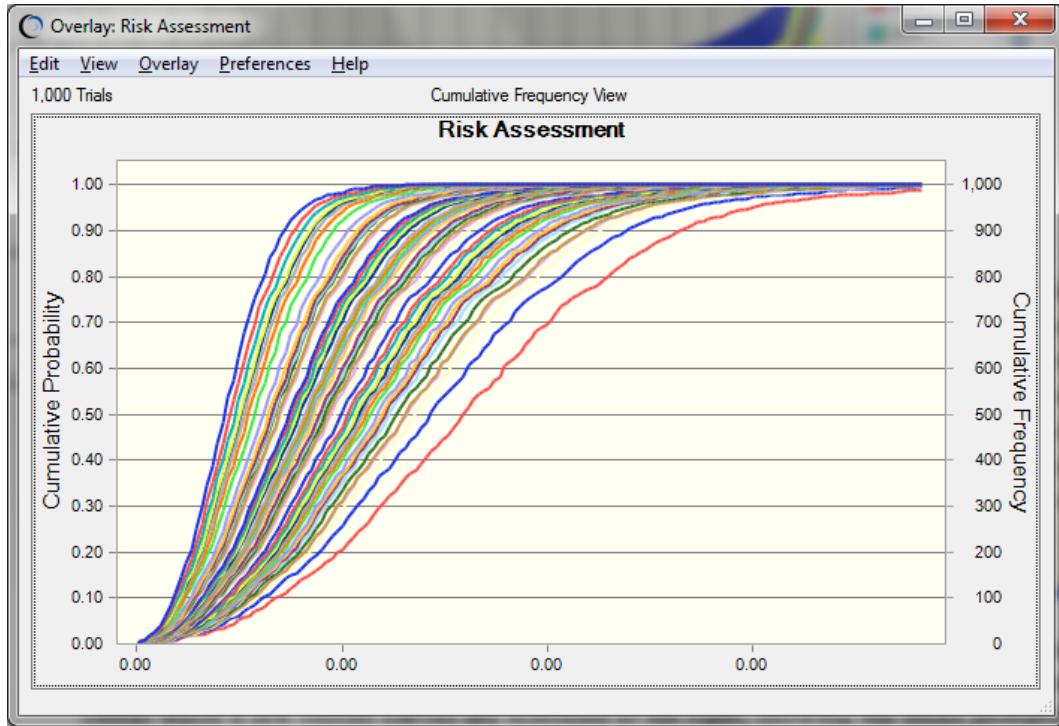

The overlay chart shows the risk curves (cumulative distributions) for different sets of uncertainty assumption values. In the chart below, most of the risk curves are clustered densely toward the center while a few outlier curves are scattered to the right, showing the small probability of a much greater health risk.

2D Simulation, continued

COMPARING 2D SIMULATION TO 1D SIMULATION

An easy, quick way to gauge the effectiveness and importance of 2D simulation is to run a one-dimensional simulation, that is, a simulation where all assumptions are treated alike.

In the 2D simulation, you found that the mean for the 95th-percentile statistics (for the 100 uncertain simulations) was 1.67E-04. In the 1D simulation, shown below, the 95th percentile risk was 2.06E-04, indicating a higher level of risk.
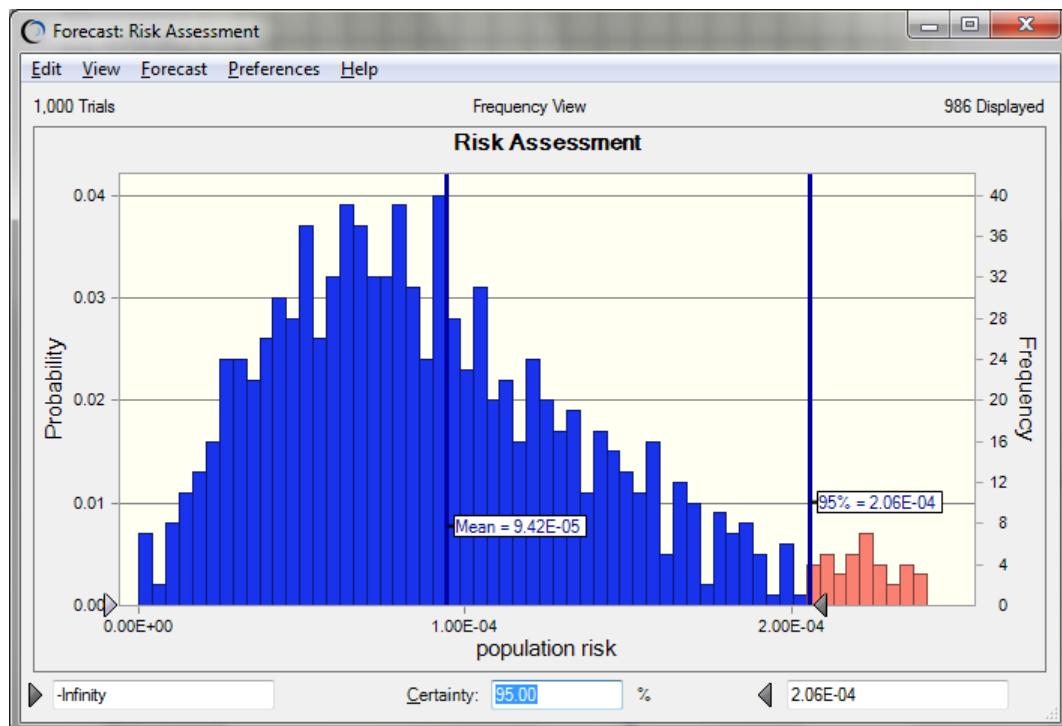
By treating all the variables alike rather than breaking out the two types, the 1D simulation appears to have overestimated the level of risk, resulting in possibly unnecessary remediation costs. The 2D simulation, which addressed the sources of variation in a more precise way, delivered a more realistic simulation result.

For more information or to contact us, browse to
http://www.oracle.com/technetwork/middleware/crystalball/overview/index.html.