

**Addendum:**  
**Estimate of the Number and Costs of Excess Cancer Deaths Associated  
with Residence in the Oil-producing Areas of the Sucumbios and  
Orellana Provinces of Ecuador**

Prepared by:

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**September 15, 2010**

**Report Title: Addendum: Estimate of the Number and Costs of Excess Cancer Deaths Associated with Residence in the Oil-producing Areas of the Sucumbios and Orellana Provinces of Ecuador**

I was retained by plaintiff counsel to prepare this addendum to my September 12, 2010 report.



Daniel Rourke, Ph.D.

Date: September 15, 2010

**Addendum:**

***Estimate of the Number and Costs of Excess Cancer Deaths Associated with Residence in the Oil-producing Areas of the Sucumbios and Orellana Provinces of Ecuador***

The purpose of this addendum to my September 12<sup>th</sup> report, *Estimate of the Number and Costs of Excess Cancer Deaths Associated with Residence in the Oil-producing Areas of the Sucumbios and Orellana Provinces of Ecuador*, is to pursue the two recommendations I made in the earlier report. These recommendations were:

1. To estimate the number of excess cancer deaths for the total population residing in the four cantons of Lago Agrio and Shushufindi, in the province of Sucumbios, and La Joya de los Sachas and Orellana, in the province of Orellana; this is the same geographic area employed by Hurtig and San Sebastian (2002). And,
2. To model the impact of environmental remediation on the estimates of the number of excess cancer deaths.

I hypothesized that both of these recommendations would lead to larger estimates of the excess cancer deaths and, in fact, this turned out to be the case. This is because (1) the population in the four cantons is larger than any used in the September 12<sup>th</sup> report, and (2) environmental remediation must include newly "at risk" persons from 2010 until its completion after which no new persons will be at risk.

Before presenting these results, the means by which the population projections in the four cantons and the additional years (2010 to 2020) were determined and how the impact of remediation was modeled will be described.

**The Populations in the Concession Area and Within Five km of the Oil-production Facilities From 2010 to 2020, and  
The Population in Lago Agrio, Shushufindi, La Joya de los Sachas, and Orellana From 1967 to 2020**

Table 3 in the September 12<sup>th</sup> report showed projections of the population in the C.A. and within 5 km of the oil-production facilities from 1967 to 2009. In the following, an

expanded version of this will be presented that contains eleven additional rows (2010 to 2020) and one additional column (population in the four cantons).

Recall that two “index series” were used to trend these projections—one from 1967 to 2010 and a second from 2001 to 2009. The first series was developed by computing the annual growth rate between the populations at two points in time (1990 and 2001) and then using the rate to interpolate between 1990 and 2001 and extrapolate between 1967 and 1990 (using the multiplicative model: next year’s population = annual growth rate×this year’s population). The second index series was taken directly from the INEC report “Proyeccion de Poblacion por Provincias, Cantones, Areas, Sexo y Grupos de Edad” and spans the period from 2001 to 2010.

The projection of the population from 2011 to 2020 was obtained by fitting a linear trend to the 2001 to 2010 values and then extrapolating the trend from 2011 to 2020 (this model is additive: next year’s population = this year’s population + constant increase). This will be shown in New Table 3-a.

The following New Table 2-a shows the computation of the annual growth rate between the 1992 and 2001 populations of the four cantons. The population in 1992, 118,264 persons, is taken from Hurtig and San Sebastian (2002); the population in 2001, 164,567 persons, was computed from the 2001 census of Ecuador and is the total over the four cantons. The annual increase is about 3.7% per year.

***New Table 2-a:  
The Population of Lago Agrio, Shushufindi, La Joya de los Sachas, and Orellana Cantons in  
1990 and 2001 and Its Growth Rate***

<b><i>Year of Estimate</i></b>		<b><i>Growth Rate</i></b>	
<i>1992</i>	<i>2001</i>	<i>9 Years</i>	<i>Per Year</i>
118,264	164,567	1.392	1.037

New Table 3-a, which contains the original Table 3 from the September 12<sup>th</sup> report, shows the additional years (2010 to 2020) and the new population (Lago Agrio + Shushufindi + La Joya de los Sachas + Orellana); these new portions are shaded in the table for emphasis. Note that the population in the four cantons is now the largest.

***Addendum: Estimates of the Number and Costs of Excess Cancer Deaths in the  
Oil-producing Areas of Sucumbios and Orellana Provinces***

**New Table 3-a:**  
**Index Series Used to Estimate the Year-to-Year Increases in the Populations**  
**and the Resulting Yearly Estimates**

Year	Index Series		Within the C.A.	Within 5 km	In the 4 Cantons*
	67 to 01	01 to 09			
1967	40,932		25,346	14,869	47,236
1968	42,982		26,615	15,613	49,002
1969	45,134		27,947	16,395	50,834
1970	47,393		29,346	17,216	52,735
1971	49,766		30,816	18,078	54,707
1972	52,257		32,358	18,983	56,753
1973	54,874		33,978	19,933	58,875
1974	57,621		35,680	20,931	61,076
1975	60,506		37,466	21,979	63,360
1976	63,535		39,342	23,079	65,729
1977	66,716		41,311	24,235	68,187
1978	70,056		43,380	25,448	70,737
1979	73,564		45,551	26,722	73,382
1980	77,247		47,832	28,060	76,126
1981	81,114		50,227	29,465	78,972
1982	85,175		52,741	30,940	81,925
1983	89,439		55,382	32,489	84,989
1984	93,917		58,154	34,116	88,167
1985	98,619		61,066	35,824	91,464
1986	103,557		64,123	37,618	94,884
1987	108,741		67,334	39,501	98,432
1988	114,185		70,705	41,478	102,113
1989	119,902		74,245	43,555	105,931
1990	<u>125,905</u>		77,962	45,736	109,892
1991	132,208		81,865	48,026	114,001
1992	138,828		85,963	50,430	<u>118,264</u>
1993	145,778		90,267	52,955	122,686
1994	153,076		94,787	55,606	127,274
1995	160,740		99,532	58,390	132,033
1996	168,788		104,515	61,313	136,970
1997	177,238		109,748	64,383	142,092
1998	186,112		115,242	67,606	147,405
1999	195,430		121,012	70,991	152,917
2000	205,214		127,071	74,545	158,635
2001	<u>215,488</u>	180,949	133,432	78,277	<u>164,567</u>
2002		183,369	135,217	79,324	166,768
2003		191,651	141,324	82,907	174,300
2004		200,013	147,490	86,524	181,905
2005		207,438	152,965	89,736	188,658
2006		214,253	157,991	92,684	194,856
2007		222,531	164,095	96,265	202,384
2008		229,854	169,495	99,433	209,044
2009		236,422	174,338	102,275	215,018
2010		242,088	178,517	104,726	220,171
2011		250,424	184,663	108,332	227,752
2012		257,618	189,968	111,444	234,295
2013		264,812	195,273	114,556	240,837
2014		272,006	200,578	117,668	247,380
2015		279,200	205,883	120,780	253,923
2016		286,394	211,188	123,892	260,465
2017		293,588	216,492	127,004	267,008
2018		300,781	221,797	130,116	273,551
2019		307,975	227,102	133,228	280,093
2020		315,169	232,407	136,340	286,636

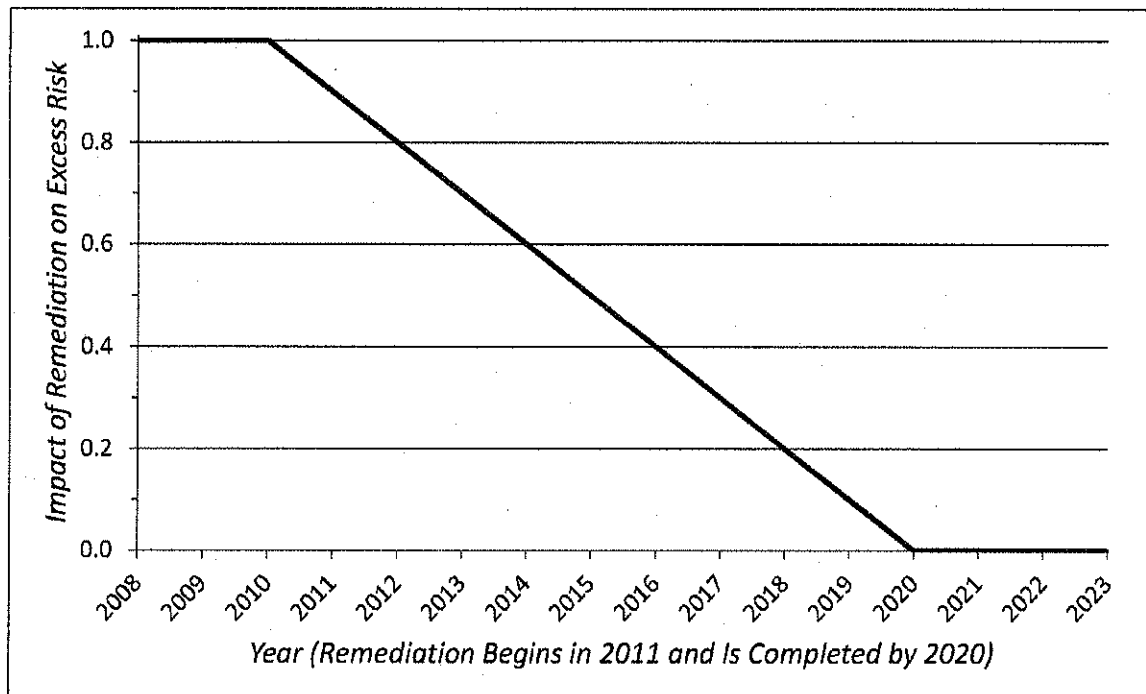
\*Lago Agrio, Shushufindi, La Joya de los Sachas, and Orellana

**Addendum: Estimates of the Number and Costs of Excess Cancer Deaths in the  
Oil-producing Areas of Sucumbios and Orellana Provinces**

### Modeling the Impact of Environmental Remediation on the Excess Risk of Cancer

The means by which environmental remediation is modeled is similar to the way in which the lag from exposure to manifestation was modeled, except now the impact on excess risk is diminishes over time. Clearly, compared to the current state of affairs, remediation has not yet begun. When it is begun, it will take some amount of time for its completion—it will not be done instantaneously.

The excess cancer death estimates to be presented here assume that remediation will begin in 2011 and will be completed by 2020. Over this period, as more and more areas are made cleaner and cleaner, excess risk of cancer will diminish. The following graph illustrates the impact on excess cancer risk assumed for these estimates.



As before, a value of 0 means no excess risk of cancer and a value of 1 means the excess risk of cancer is as appears in *Table 6: Age-specific Excess Risk Factors* of the September 12<sup>th</sup> report. However, unlike the “years of exposure” graph shown in that report, excess risk is now decreasing from 1 to 0—not increasing from 0 to 1. Also, the horizontal year axis in the above graph refers to the year of entry of newly exposed persons—not to years of exposure. This implies, for example, that because remediation is complete by 2020, the last year that newly exposed persons enter the process is 2019. None of the new persons from 2020 onwards are at an excess risk of cancer.

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### Estimates of the Number of Excess Cancer Deaths and Associated Costs

The excess cancer estimates are shown in New Table 7-a, which includes the original Table 7; the new sections of the table are shaded for emphasis.

**New Table 7-a:**  
**Estimates of the Number of Excess Cancer Deaths From 1967 to 2009 and From 1967 to the Last Death for the Three Areas and Three Last Years of Entry of the Exposed Population**

<b>Year of Last Entry of Exposed Population</b>	<b>Excess Cancers From 1967 to</b>	<b>Within the C.A.</b>	<b>Within 5 km</b>	<b>In the 4 Cantons*</b>
<b>2009</b>	<b>2009</b>	776	453	1,171
	<b>Last Death</b>	6,695	3,933	8,428
<b>1990</b>	<b>2009</b>	706	411	1,080
	<b>Last Death</b>	2,961	1,732	4,224
<b>2019 with Remediation from 2011 to 2020</b>	<b>2009</b>	776	453	1,171
	<b>Last Death</b>	7,909	4,639	9,950

*\*) Lago Agrio, Shushufindi, La Joya de los Sachas, and Orellana*

As expected, the number of excess cancer deaths in the four cantons is now the largest, and the total number of excess cancer deaths to the last one is the largest for any area because newly exposed persons from 2010 to 2019 are now included.

New Table 9-a, which includes the original Table 9 from the September 12<sup>th</sup> report, shows the results of valuing the total number of deaths (to the last death) using the average \$7 million amount. The new portions of the table are shaded for emphasis.

**New Table 9-a:**  
**Aggregate Value of Excess Cancer Death Estimates by Area Defining the Exposed Population and the Last Year of Entry of Newly Exposed Persons**

<b>Last Year of Entry of Newly Exposed Persons</b>	<b>Within the C.A.</b>	<b>Within 5 km</b>	<b>In the 4 Cantons*</b>
<b>2009</b>	\$46.9	\$27.5	\$59.0
<b>1990</b>	\$20.7	\$12.1	\$29.6
<b>2019 with Remediation from 2011 to 2020</b>	\$55.4	\$32.5	\$69.7

*\*) Lago Agrio, Shushufindi, La Joya de los Sachas, and Orellana*

Addendum: Estimates of the Number and Costs of Excess Cancer Deaths in the Oil-producing Areas of Sucumbios and Orellana Provinces

## References

Hurtig, A.-K. & San Sebastian, M. Geographical differences in cancer incidence in the Amazon basin of Ecuador in relation to residence near oil fields. **International Journal of Epidemiology**, 2002, **31**, 1021-1027.

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Addendum: *Estimates of the Number and Costs of Excess Cancer Deaths in the Oil-producing Areas of Sucumbios and Orellana Provinces*