GAE Public Hearing Regarding SB1311
February 28, 2007

Good morning Mr. Chair and members of the committee. My name is Ralph Morelli. I live in Wethersfield and I am a professor of computer science at Trinity College. I am also a member of TrueVoteCT, an advocacy group dedicated to election integrity. I appreciate the opportunity to address you regarding Senate Bill 1311.

Before I begin, let me congratulate the GAE for passing the voter-verified paper ballot law (Public Act 05-188) last year. I also want to congratulate the Secretary of the State for her wise selection of optical scan machines for CT and for her decision to conduct a voluntary random audit in last November's election. All of these are positive steps toward assuring the security and integrity of CT's elections.

I strongly support the need for good audit legislation. Having a paper trail is a necessary condition for assuring the integrity of our elections, but it is not sufficient. Only a properly designed audit process will suffice to protect us against accidental or deliberate counting errors in the electronic voting machines.

SB1311 would require an audit of not less than 20% of the voting districts in the state. This is a very strong percentage. It may be the largest audit percentage in the entire country. I can certainly live with this number.

However, I would like to call the Committee's attention to an alternative model of selecting audit percentages, a model that is used in the "Holt Bill" (the Voter Confidence and Increased Accessibility Act of 2007) and supported by some of the top computer scientists and election integrity experts in the country. The model is known as a ***tiered*** approach because the audit percentage is chosen from among several tiers based on the margin of victory in any given race. Here is a four-tiered model:

Margin of Victory	Audit Percentage	Probability of Detecting a Miscount
0.5% - 1.5%	20%	85.4% (at 0.5%) to 99.7% (at 1.5%)
1.6% - 3%	10 %	82.1% (at 1.6%) to 96.3% (at 3%)
3.1 % - 5%	5%	88.1% (at 3.25%) to 96.3% (at 5%)
> 5%	3%	81% and up

The tiered model is based on statistical analysis of the probability of detecting a miscount given a certain margin of victory and a certain audit (or sample) size. For example, if the margin of victory is 1.5% and you audit 20% of the votes in that race, you would have a 98% chance of detecting a miscount (if one existed).

The advantage of the tiered model is that it would reduce the burden on election officials while not sacrificing security in close elections. I am not myself a statistician but I would be happy to answer whatever questions I can about this approach. I will also leave the committee with references. Thank you.

Respectfully submitted,
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References

Kathy Dopp and Frank Stenger. The election integrity audit, 2006. http://electionarchive.org/ucvAnalysis/US/paper-audits/ElectionIntegrity.pdf

Ronald Rivest. On estimating the size of a statistical audit. November 2006. Available at: http://theory.csail.mit.edu/~rivest/Rivest-OnEstimatingTheSizeOfAStatisticalAudit.pdf

Howard Stanislevic. Random auditing of e-voting systems: How much is enough?, revision August 16, 2006. Available at: http://www.votetrustusa.org/pdfs/VTTF/EVEPAuditing.pdf

USCountsVotes. Spreadsheet audit calculator. Available at: http://electionarchive.org/ucvAnalysis/US/paper-audits/

Four-Tiered Audit Model

Margin of Victory	Audit Percentage	Probability of Detecting a Miscount
0.5% - 1.5%	20%	85.4% (at 0.5%) to 99.7% (at 1.5%)
1.6% - 3%	10%	82.1% (at 1.6%) to 96.3% (at 3%)
3.1 % - 5%	5%	88.1% (at 3.25%) to 96.3% (at 5%)
> 5%	3%	81% and up

Three Tier Election Audit Evaluation (Recommendations Outlined in Blue)			INPUT	Total Vote Counts =						400
			INPUT	Vote Shift/Count =						20%
			INPUT	Minimum Probability - (used only to estimate a recommended Minimum Audit Amount) =						55%
Margins Ranges			**0.1% to 1%**		**1%+ to 5%**		**5%+ up**			
Audit Rate Choices			**30%**	**20%**	**10%**	**5%**	**3%**	**2%**	**1%**	
Floor Audit Amount for Margins			**127**		**24**		**8**			
Actual Audit Amount for N = 440			127	127	40	24	12	8	8	
Actual Audit Rate for N = 440			31.8%	31.8%	10.0%	6.0%	3.0%	2.0%	2.0%	
Margins Between Candidates Exact	**Corruption Rate That will Alter Outcome**	**#Corrupt Counts to Alter Outcome**	**RESULTS: Probabilities for Detecting At Least One Corrupt Vote Count for Each Margin Between Candidates**							
0.10%	0.25%	1	**31.7%**	31.7%	10.0%	6.0%	3.0%	2.0%	2.0%	
0.20%	0.50%	2	**53.5%**	53.5%	19.0%	11.7%	5.9%	4.0%	4.0%	
0.30%	0.75%	3	**68.3%**	68.3%	27.2%	17.0%	8.8%	5.9%	5.9%	
0.40%	1.00%	4	**78.5%**	78.5%	34.5%	22.0%	11.5%	7.8%	7.8%	
0.50%	1.25%	5	**85.4%**	85.4%	41.1%	26.7%	14.2%	9.7%	9.7%	
0.60%	1.50%	6	**90.1%**	90.1%	47.1%	31.2%	16.8%	11.5%	11.5%	
0.70%	1.75%	7	**93.3%**	93.3%	52.5%	35.4%	19.3%	13.3%	13.3%	
0.80%	2.00%	8	**95.4%**	95.4%	57.3%	39.3%	21.8%	15.0%	15.0%	
0.90%	2.25%	9	**96.9%**	96.9%	61.6%	43.0%	24.2%	16.8%	16.8%	
1.00%	2.50%	10	**97.9%**	97.9%	65.6%	46.5%	26.5%	18.5%	18.5%	
1.10%	2.75%	11	98.6%	98.6%	**69.1%**	49.8%	28.8%	20.2%	20.2%	
1.20%	3.00%	12	99.1%	99.1%	**72.3%**	52.9%	31.0%	21.8%	21.8%	
1.30%	3.25%	13	99.4%	99.4%	**75.1%**	55.8%	33.1%	23.4%	23.4%	
1.40%	3.50%	14	99.6%	99.6%	**77.7%**	58.6%	35.2%	25.0%	25.0%	
1.50%	3.75%	15	99.7%	99.7%	**80.0%**	61.1%	37.2%	26.5%	26.5%	
1.60%	4.00%	16	99.8%	99.8%	**82.1%**	63.6%	39.2%	28.1%	28.1%	
1.70%	4.25%	17	99.9%	99.9%	**84.0%**	65.8%	41.1%	29.6%	29.6%	
1.80%	4.50%	18	99.9%	99.9%	**85.6%**	68.0%	42.9%	31.0%	31.0%	
1.90%	4.75%	19	99.9%	99.9%	**87.1%**	70.0%	44.7%	32.5%	32.5%	
2.00%	5.00%	20	100.0%	100.0%	**88.5%**	71.9%	46.4%	33.9%	33.9%	
2.25%	5.63%	23	100.0%	100.0%	**91.8%**	76.9%	51.4%	38.0%	38.0%	
2.50%	6.25%	25	100.0%	100.0%	**93.4%**	79.7%	54.4%	40.6%	40.6%	
2.75%	6.88%	28	100.0%	100.0%	**95.3%**	83.4%	58.7%	44.3%	44.3%	
3.00%	7.50%	30	100.0%	100.0%	**96.3%**	85.5%	61.3%	46.7%	46.7%	
3.25%	8.13%	33	100.0%	100.0%	**97.4%**	88.1%	64.9%	50.1%	50.1%	
3.50%	8.75%	35	100.0%	100.0%	**97.9%**	89.6%	67.2%	52.3%	52.3%	
3.75%	9.38%	38	100.0%	100.0%	**98.5%**	91.6%	70.3%	55.3%	55.3%	
4.00%	10.00%	40	100.0%	100.0%	**98.8%**	92.6%	72.3%	57.3%	57.3%	
4.25%	10.63%	43	100.0%	100.0%	**99.2%**	94.0%	75.0%	60.1%	60.1%	
4.50%	11.25%	45	100.0%	100.0%	**99.4%**	94.8%	76.6%	61.9%	61.9%	
4.75%	11.88%	48	100.0%	100.0%	**99.5%**	95.8%	78.9%	64.4%	64.4%	
5.00%	12.50%	50	100.0%	100.0%	**99.6%**	96.3%	80.3%	66.0%	66.0%	
5.1%	12.75%	51	100.0%	100.0%	99.7%	96.6%	81.0%	**66.8%**	66.8%	
5.2%	13.00%	52	100.0%	100.0%	99.7%	96.8%	81.7%	**67.5%**	67.5%	
5.3%	13.25%	53	100.0%	100.0%	99.8%	97.0%	82.3%	**68.3%**	68.3%	
5.4%	13.50%	54	100.0%	100.0%	99.8%	97.2%	82.9%	**69.0%**	69.0%	
5.5%	13.75%	55	100.0%	100.0%	99.8%	97.4%	83.5%	**69.7%**	69.7%	
6.0%	15.00%	60	100.0%	100.0%	99.9%	98.2%	86.2%	**73.1%**	73.1%	
6.5%	16.25%	65	100.0%	100.0%	99.9%	98.8%	88.5%	**76.1%**	76.1%	
7.0%	17.50%	70	100.0%	100.0%	100.0%	99.2%	90.4%	**78.9%**	78.9%	
7.5%	18.75%	75	100.0%	100.0%	100.0%	99.4%	92.0%	**81.3%**	81.3%	
8.0%	20.00%	80	100.0%	100.0%	100.0%	99.6%	93.4%	**83.5%**	83.5%	
8.5%	21.25%	85	100.0%	100.0%	100.0%	99.7%	94.6%	**85.5%**	85.5%	
9.0%	22.50%	90	100.0%	100.0%	100.0%	99.8%	95.5%	**87.3%**	87.3%	
9.5%	23.75%	95	100.0%	100.0%	100.0%	99.9%	96.3%	**88.8%**	88.8%	
10.0%	25.00%	100	100.0%	100.0%	100.0%	99.9%	97.0%	**90.2%**	90.2%	
10.5%	26.25%	105	100.0%	100.0%	100.0%	99.9%	97.6%	**91.5%**	91.5%	
11.0%	27.50%	110	100.0%	100.0%	100.0%	100.0%	98.0%	**92.6%**	92.6%	
11.5%	28.75%	115	100.0%	100.0%	100.0%	100.0%	98.4%	**93.5%**	93.5%	
12.0%	30.00%	120	100.0%	100.0%	100.0%	100.0%	98.7%	**94.4%**	94.4%	
12.5%	31.25%	125	100.0%	100.0%	100.0%	100.0%	99.0%	**95.2%**	95.2%	
13.0%	32.50%	130	100.0%	100.0%	100.0%	100.0%	99.2%	**95.8%**	95.8%	
13.5%	33.75%	135	100.0%	100.0%	100.0%	100.0%	99.3%	**96.4%**	96.4%	
14.0%	35.00%	140	100.0%	100.0%	100.0%	100.0%	99.5%	**96.9%**	96.9%	
14.5%	36.25%	145	100.0%	100.0%	100.0%	100.0%	99.6%	**97.4%**	97.4%	
15.0%	37.50%	150	100.0%	100.0%	100.0%	100.0%	99.7%	**97.8%**	97.8%	

Reference: http://electionarchive.org/ucvAnalysis/US/paper-audits/