



Statistical Analysis of Post-Election Audit Data for the November 7, 2017 Municipal Elections

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Summary

This report presents an analysis of the returns from the post-election audit performed in the State of Connecticut following the November 7, 2017 municipal elections. This report is based on audits conducted in 2017 but not reflected in an official VoTeR Center report from that period. The analysis in this report was performed by the authors in 2023.

The audit involved analysis of 21 selected precincts, shown in Table 1, in which ballots were cast. In each precinct so selected, the ballots cast on election day were hand-counted or counted with electronic assistance.¹ The audit data received by the Center contains 253 records. The breakdown of discrepancy as a percentage of the number of ballots cast is as follows:

1. 153 records with no discrepancy,
2. 19 additional records with a discrepancy of at most .1%,
3. 16 additional records with a discrepancy of at most .2%,
4. 8 additional records with a discrepancy of at most .3%,
5. 19 additional records with a discrepancy of at most .5%,
6. 20 additional records with a discrepancy of at most 1%,²
7. 14 additional records with a discrepancy of at most 1.5%, and
8. 4 records with a discrepancy greater than 1.5%:

- (a) A record for mayor where the hand count for the losing candidate was reported to receive 19 fewer votes than reported by the tabulator. This resulted in a discrepancy of 1.7%.

¹Auditors are allowed to use an electronic audit assistance tool, provided that they visually examine each ballot to confirm bubble interpretations.

²There is a single record in this category with an apparent clerical error where the vote total has 100 subtracted and two columns of reporting are inconsistent, we discuss this in more detail in the body of the report. We report the discrepancy with this clerical error corrected.

Town	District
Berlin	District-2
Bridgewater	District-1
Bristol	District-1
Canton	District-1
Fairfield	District-5
Farmington	Farmington High School Municipal
Groton	District-6
Hartford	District-15
Litchfield	District-1
Manchester	District-1
Manchester	District-6
Middletown	District-4
Middletown	District-12
New Fairfield	District-108
New Hartford	District-1
Norwalk	Fox Run School
Sterling	District-1
Watertown	District-68-04
West Haven	District-2
West Haven	District-6
Woodbridge	Center School Gym

Table 1: Audit precincts analyzed

- (b) Three records for boards (Education and Directors) with discrepancies of 2.7%, 1.8%, and 1.6%. Races where voters can specify multiple candidates frequently generate higher error rates from hand counting.

These are discussed in more detail below. This distribution of discrepancies is consistent with anticipated errors arising from hand counts; in particular, this does not offer conclusive evidence of tabulator malfunction in the 2017 municipal election.

1 Analysis Description

1.1 Audit Records

The audit returns are presented in a result report in which auditors record information about the precinct under audit, the result of their count, and the corresponding count value from the tabulator. This analysis considers the vote totals for each candidate as a separate record. Each record consists of three items: the total votes as reported by the tabulator, the number of bubbles containing an “undisputed mark,” and the number of bubbles containing a “questionable mark.” An “undisputed mark” is a mark that covers the majority of the bubble and is dark enough that all auditors agree that it should have been read as a mark by a working tabulator. A “questionable mark” is a mark that is not large or dark enough to convince all of the auditors that a working tabulator would have recorded it as a mark.

1.2 Expected Vote Ranges

For each record, the undisputed hand-counted mark total and questionable hand-counted mark total are used to define an *expected tabulator total range*. The range is defined as having a minimum that is equal to the undisputed mark count and a maximum that is equal to the sum of the undisputed mark count and questionable mark count. If the total as reported by the tabulator is at least the undisputed mark count and no more than the sum of the undisputed and questionable mark counts, the tabulated results are consistent with the hand-counted results. In this case, the tabulator is considered to be functioning properly.

1.3 Discrepancies

Total Ballot Count Discrepancies. If the tabulator total falls outside of this expected range then it is considered an unexplained discrepancy. If the total ballot count is different from the total number of ballots counted during the audit, and the discrepancy value falls somewhere between zero and the ballot count difference, then the source of the discrepancy is potentially attributable to the difference in the ballot count. For this reason, it is important that auditors reconcile the tabulator ballot count and the audit ballot count. To be conservative, we evaluate discrepancy as a percentage of the minimum of the tabulator total as reported on the tape and the total hand-counted ballots indicated in the audit report. (This convention can only increase the reported discrepancy in comparison with use of either of the individual numbers.) We call this method **Known Ballots Cast**.

If the total number of tabulated or hand-counted ballots was not recorded on the audit report we instead adopt the total number of votes cast in the largest single-choice race in the district under consideration. This may lead to an underestimate of the total number of cast ballots, and hence can only increase the reported discrepancy as it is treated as a percentage of cast ballots. When this method has been used for either (or both) the total number of tabulated or hand-counted ballots, we say that discrepancies are determined by **Inferred Ballots Cast**. Note that this alternate convention is only relevant for records with nonzero discrepancy so we treat records with a discrepancy of 0 as a single category.

Anticipated Human Error. We anticipate that a small amount of error will be present in a hand count. This error presumably depends on a wide variety of factors, including the complexity of the race to be audited, the operational details of the hand counting procedure, and the physical details of the ballots themselves. The study of Goggin, Byrna, and Gilbert [GBG12] observed an empirical error rate of 1.87% (with a standard error of .678%) for Optical Scan ballots; the study adopted simple two-candidate races and averaged over several counting methods. The study also measured human miscounting of the total ballot population, observing an empirical error rate of 0.95% (with a standard error of 0.328%).

Records of Interest With this as a guide, we treat discrepancies of approximately 1% of the audit ballot count as consistent with errors arising from human hand counting; in particular, such error rates are not a conclusive indicator of tabulator malfunction. Historically, the majority of our observed individual discrepancies are less than 1% of the total number of cast ballots, though discrepancies tend to be higher on complicated races where one can specify multiple candidates.

We treat discrepancies exceeding 1.5% as records of special interest, and include in the report any additional information we have that may put the errors in context.

2 Analysis Results

The discrepancy percentages are shown in Table 2. As shown, 153 (60.5%) exactly confirmed the tabulator count, the remaining 100 (39.5%) records showed a nonzero discrepancy. There are four records showing a discrepancy of at least 1.5%.

Further discussion of discrepancies. Of the 100 records showing a discrepancy between the audit count and the machine count, 82 are within 1% of the audit ballot count; 14 additional records are between 1% and 1.5%. There are four records that are above 1.5% and are of special interest.

As mentioned above, there is a single record where the “Undisputed Vote Totals” and “Overall Hand Count” differ by 100 despite no recorded data for “Questionable Vote Totals.” We use the

Discrepancy Calculation	Discrepancy %	#
Either	0	153
Known Ballots Cast	>0 and $\leq .1\%$	19
	>.1% and $\leq .2\%$	12
	>.2% and $\leq .3\%$	5
	>.3% and $\leq .5\%$	11
	>.5% and $\leq 1\%$	8
	>1% and $\leq 1.5\%$	13
	1.6%	1
	1.8%	1
	2.7%	1
Inferred Ballots Cast	>0 and $\leq .1\%$	0
	>.1% and $\leq .2\%$	4
	>.2% and $\leq .3\%$	3
	>.3% and $\leq .5\%$	8
	>.5% and $\leq .1\%$	12
	>1% and $\leq .1.5\%$	1
	1.7%	1
Total		253

Table 2: Discrepancy percentage across records.

“Overall Hand Count” entry to define the *expected tabulator total range*. This record displays a discrepancy of .9%.

We remark on the four records with a discrepancy percentage of at least 1.5%.

1. One of these is a single-candidate race with a discrepancy percentage of 1.7%. For this record the number of ballots cast was not reported so the denominator is inferred.
2. The other three races are in Boards of Education and Directors where voters can specify multiple preferences. We historically observe a higher discrepancy in such races. We note that two of these arose in the same district (and hence from the same tabulator and hand count).

3 Conclusion

The State of Connecticut conducted post-election audits after the November 7, 2017 municipal election. The University of Connecticut Center for Voting Technology Research (VoTeR Center) analyzed this data in 2023.

The audit involved 21 randomly selected precincts at which ballots were cast; the audit returns were conveyed by the Office of the Secretary of the State (SotS) to the VoTeR Center. The audit data analyzed by the Center contains 253 records, where each record represents information about a given candidate: date, district, office, candidate, machine counted total, hand counted total of the votes considered unquestionable by the auditors, hand counted total of the votes considered questionable by the auditors, and the hand counted total, that is, the sum of undisputed and questionable votes.

While one always wishes for no discrepancies, the magnitude of the numbers for precincts that submitted complete information is consistent with human error. To conclude, the analyzed audits offer no conclusive evidence of tabulator malfunction in the 2017 municipal election.

References

- [GBG12] Stephen N. Goggin, Michael D. Byrne and Juan E. Gilbert. Post-Election Auditing: Effects of Procedure and Ballot Type on Manual Counting Accuracy, Efficiency, and Auditor Satisfaction and Confidence. *Election Law Journal: Rules, Politics, and Policy*. 11(1): 36–51. March, 2012.