



AuditEngine

2020 Election Ballot Image Audit of Dane County WI

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<http://citizenoversight.org>

Executive Summary

This document summarizes results of an audit of the November 2020 ballot images in Dane County, Wisconsin. This audit was performed using the "AuditEngine" platform developed by Citizens' Oversight Projects, also known as "Citizens Oversight" or "COPS".

This audit was conducted to demonstrate the capabilities of AuditEngine and the approach of ballot image audits in general, and to provide information about the reliability of the 2020 General Election.

The primary audience for this report are election officials in Dane County, but we anticipate the general public will also be interested in these readily accessible results.

AuditEngine is an election auditing platform which performs "Ballot Image Auditing". Modern voting machine ballot scanners capture relatively high-resolution digital images of each ballot in polling places or central count operations. AuditEngine processes these ballot images to create an independent tabulation, and then it compares its evaluation of each ballot with the official cast vote record (CVR), which provides ballot-by-ballot detail of the official evaluation by the voting system.

AuditEngine can provide detailed reports which detail discrepancies between the official records and our independent tabulation. Comparing results from two systems like this can expose errors in each system which would be very hard to find otherwise. While election systems are usually accurate, various factors can introduce problems by mistake or on purpose¹. Software updates, changes in the election definition, or malicious activity may change the outcome.

Most voters have doubts. Only 13% of Republicans and 4% of Democrats in 2018 were "very confident that election systems are secure from hacking and other technological threats."² The 2020 Election was more secure than recent elections because of the use of paper ballots in more districts but improvement is still possible.

AuditEngine's analysis of the 2022 General Election in Dane County, WI found:

- Among the ballots processed in the audit, there was no evidence of significant inconsistencies that would cast any contest into doubt.
- 345,645 ballots were cast in the official election results. The ballot image audit processes ballots based on the sheets involved. In this election, all ballots had only one sheet, so we expect to review 345,645 images.

¹ Norden, Lawrence "Voting System Failures: A Database Solution"

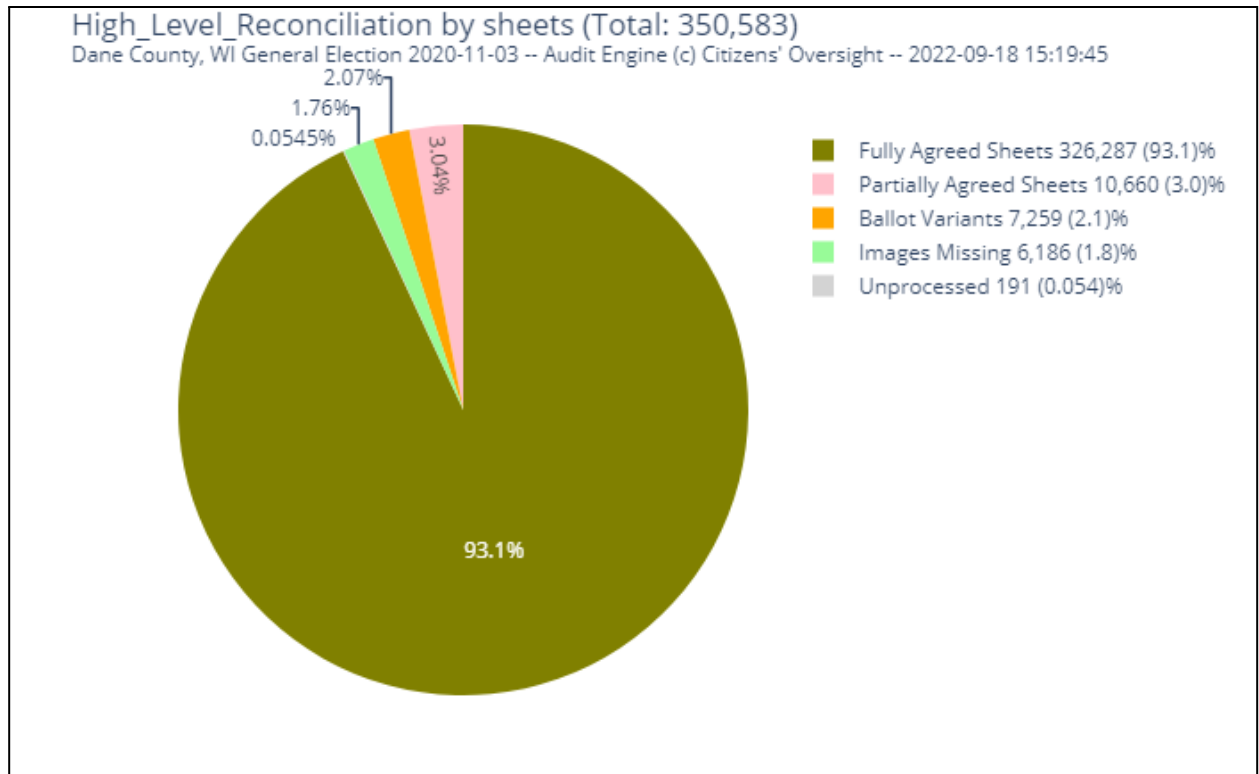
https://www.eac.gov/sites/default/files/document_library/files/Norden-2010-Voting_Machine_Failures_Online.pdf

² Pew Research: <https://www.pewresearch.org/politics/2018/10/29/election-security/>

- Unfortunately, there were a number of reasons the images and Cast Vote Records (CVRs) were not an exact match.
 - There were 347,416 ballot images in the ballot image archives.
 - 3,069 ballot images were repeated with the same ballot_id and were marked to be skipped in the archives and not included. These were repeated only because of the way the archives were constructed and these repeated ballots were not repeated in the official canvass.
 - There were 344,347 unique ballot_ids in the ballot image archives.
 - 1,298 ballots cast were missing from the archives. These ballot images were not provided due to several reasons that were provided by the Dane County officials, The reason for the missing images or missing CVR records is detailed in the report.
 - There were 343,322 records in the CVRs.
 - There were no repeated ballots in the CVRs.
 - 7,211 ballots which had images did not have CVRs. This was because those images were from an adjoining county and they had a cooperation agreement with that county to process some of the ballots from Dane County, while Dane processed one area from that county. The result is that these ballots with images did not have the CVRs. The details of these discrepancies are included in the report.
 - 6,186 ballot ids were in the CVRs but images were not available.
 - There were 26,358 BMD ballots.
 - 191 ballots were corrupted and could not be processed due to bad images that could not be aligned. This is a relatively high number.
- When the voting system and AuditEngine disagree on voter intent, the correct interpretation becomes clear by looking at the disputed ballot image. By “correct interpretation” we mean the human eye determination, which is the deciding

interpretation under Wisconsin voter intent law.³

- The first pie graph below shows the total ballot sheets in the election, the number of images analyzed by AuditEngine.



- 2,955,032 votes were on 350,583 ballot sheets (including blank votes and 191 unprocessed sheets). There were 6,186 images missing and 7,259 without CVR or other issues.
- The **Fully Agreed** sheets (326,287, 93.1% of all ballots cast) were completely agreed between AuditEngine and the voting system and had no variations, such as write-ins, overvotes, or gray-flags.
- **Partially Agreed Sheets:** 10,660 sheets (3.1%) had 67,706 contests (2.3%) that were non-variant and agreed, while 26,017 contests (0.88%) on those same sheets were classified as "variant contests" and were "pulled" from the partially agreed records and

³ <https://law.justia.com/codes/wisconsin/2012/chapter-7/section-7.50> -- "If an elector marks a ballot with a cross (7), or any other marks, as |, A, V, O, /, ✓, +, within the square to the right of a candidate's name, or any place within the space in which the name appears, indicating an intent to vote for that candidate, it is a vote for the candidate whose name it is opposite."

individually classified in separate records for each contest, for further reporting categorization.

- **Total of Nonvariant Contests:** Thus, a total of 2,929,015 votes (aka, ballot-contests) (99.1%) on these ballots were interpreted the same and non-variant in every respect by AuditEngine and the voting system, and there was no additional scrutiny required due to write-ins, overvotes, or disagreements.
- **Contest Variants:** The "Contest Variants" (26,017 votes, 0.88%) were further categorized by AuditEngine. These are the individual contests ("votes") which had either write-ins, overvotes, gray-flags, or were "disagreed" when AuditEngine and the voting system did not interpret the vote exactly the same. Please note this is across all contests, and there were 34 contests in the election, and these variants are spread over all contests.
- **Normal Disagreed:** Of those, 1,057 (4.1% of contest variants) were classified as "disagreed", while the rest (95.94%) were write-ins and overvotes or gray only.
- **Closest Contests:** Contests were individually considered. The 2 most discrepant contests had disagreements between 0.85% to 0.59% of the margin of victory:
 - **Question 1 Wisconsin Heights School District**
 - Margin of victory: 234 votes (5.93%)
 - 2 votes "Disagreed" (0.85% of margin)
 - 4 contest variants (1.71% of margin)
 - **Question 1 T York Wd 1**
 - Margin of victory: 169 votes (0.59%)
 - 1 vote "Disagreed" (0.59% of margin)
 - 1 contest variant (0.59% of margin)

The **Presidential Contest** was of particular interest in this election:

- County Margin of Victory: 179,715 (52.48%)
- Statewide Margin of Victory: 20,682 votes (about 0.63%)
- 30 votes disagreed (0.02% of county, 0.14% of statewide margin)
- 1,394 contest variants (0.78% of county, 6.7% of statewide margin)

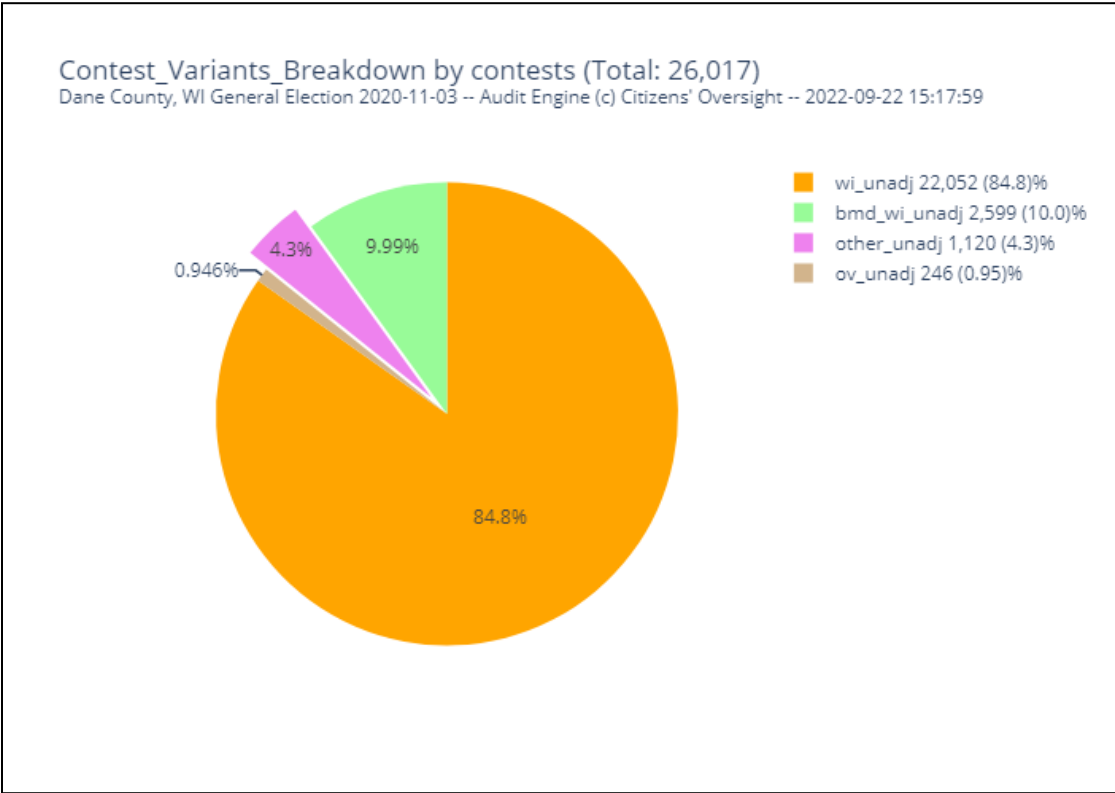
Across all contests:

- **Most Variant:** 3.33% was the highest level of variant votes in any contest, as % of the margin of victory in the contest (State Senator District 14) with 2 variants out of the very close margin of only 60 votes. But there were no disagreed variant cases.
- **AuditEngine Correct Evaluations when Voting System required adjudication:** 373 votes were potentially correctly interpreted by AuditEngine while the ES&S voting system initially misinterpreted those votes. However, without manual review of those we can only guess that probably most of those (perhaps over 90%) are correctly interpreted by AuditEngine while the voting system did not.

The most common reasons for discrepancy were:

- where the voter circled or checkmarked the oval, but did not darken the middle of the oval, and the election system did not look outside the oval.
- where the voter hesitated and slightly marked one oval and then definitely marked the other one
- where the voter scratched out one oval with a very large mark while marking the desired option with a correct but smaller mark.

The second pie chart shows the major categories of votes with write-ins or overvotes, with the "other" category including the disagreed votes where there were no write-ins or overvotes.



There were a number of interesting quirks in this audit that we discuss further:

About Dane County

Dane County uses the ES&S voting system (Election Systems & Software). We were able to compare the results between AuditEngine and the voting system down to each contest on each individual ballot, because those systems can provide the ballot-level "Cast Vote Record" (CVR) file, which is the digital record of voter intent for every contest on that ballot.

This table provides the overall profile for a ballot image audit of this election:

Election Name	Dane County Wisconsin, 2020 General Election
Population in 2019	546,695
Eligible voters	387,274 (active voters, 60 days pre-election)
Ballots Cast:	345,645
Outcome Bias ⁴ :	Deep Blue, 75% Biden over 23% Trump

⁴ The outcome bias is how the county voted in the presidential contest, and whether those who voted were evenly split, or "Red" (Republican) or "Blue" (Democratic) outcome.

Voting System:	ES&S
BMD Ballots Cast	26,358
Sheets	One sheet for all voters
Ballot images	347,416
Repeated Ballot Images	3,069
Missing Ballot Images	6,186
BMD Images	26,358
Missing CVR records	7,211

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1. Background

To reduce the size and complexity of audit reports, background information has been moved to a companion document:

"Auditing Elections Using Ballot Images and AuditEngine -- General Background"

<https://docs.google.com/document/d/18A1K8mXXHnhisLqBQigx0ibboz39FAh9hOSykcR-jT4/edit?usp=sharing>

Please fully read and study this document before attempting to digest the rest of this report, particularly with respect to the terminology defined.

A note on writing style

Throughout this document, we will use "programmer" style quotes, which always frame the terms and do not include punctuation. Also, as a matter of style, numbers are always shown in numerical form, commas will always be included in conjunctive lists, and all quotes are straight.

2. Details of this audit

Regarding some of the issues described in the general description above, we can refine this description as follows:

1. Dane County was able to provide the vast majority of ballot images, but there were some quirks in the data that were explained by Dane County officials. The details of these discrepancies are as follows:

a. Ballotids in CVR but not in Ballot Image Archives (BIA)

These ballot sheets were found in the Cast-Vote Record but the images were not provided, for the reasons described below.

precinct	count	Description
T Oregon Wds 1-4	2,279	"Poll workers were required to write the voter number on the back of these ballots, so the images were withheld"
T Cottage Grove Wds 1-2, 4-5, 7	1,716	
T Cottage Grove Wds 3, 6	985	
C Madison Wd 140	18	Ballots for this small ward were hand-counted and not tabulated by election equipment. Therefore, no ballot images exist.
V Belleville Wd 3	325	Dane County programs the equipment for these wards, but these wards lie outside Dane County. When extracting the CVR file from our election management system, we do not have the option to
V Brooklyn Wd 2	254	

V Cambridge Wd 1	66	exclude precincts. This results in the CVR including records for these wards, but as these wards are not in Dane County, we do not post the ballot images.
Subtotal	5,643	
C Madison Wd 097	203	An error in the ballot image extraction process resulted in the extraction process ending prematurely. A complete ballot image file is now available online alongside the original file.
C Madison Wd 098	300	
C Madison Wd 038	27	
V Deerfield Wds 1-3	13	--> Can download a new archive for these. This was already done.
Total	6,186	

b. Ballotids in BIA but not in CVR

These ballots had images but not cast vote records.

precinct	count	Description
C Madison Wd 038	2,613	
C Madison Wd 098	1,799	These were not explicitly mentioned but they did say there was a problem with the image extraction process and perhaps the CVR is also incorrect.
C Madison Wd 091	1,420	
C Madison Wd 097	1,379	
Total	7,211	

2. Dane County was cooperative and they posted their images on-line. Officials were able to answer our questions regarding the issues with the data above. Given that the number of missing ballots is a very small fraction, we believe these issues can be practically ignored.

3. Setup and Mapping Comments

3. The ballot images were published by Dane County for access by the public.
4. For this audit, we used computer-assisted manual mapping using our TargetMapper application, as we did not have access to the Ballot Style Masters to allow automated mapping. There were 67 styles in this election with 36 different patterns of contests and 33 different contests.

4. Discrepancy Report

5. **Vote Evaluation Method:** Wisconsin is a voter-intent state. This means that the intent of the voter is to determine the vote rather than based on how the machine would read it. For example, if a voter fills in an oval, then crosses it out, and writes "No" next to it, and fills in another oval, then the second oval would be interpreted as the intent of the voter.
6. **Comparison.** After the vote is extracted and evaluated by AuditEngine, it is compared with the cast vote record. This is the most sophisticated stage in the process, and our reporting methodology is superior to other ballot image auditing solutions.
7. This process was performed for Dane County because we were provided with the complete detailed CVR.
8. The detailed discrepancy report as prepared for this election by AuditEngine is extensive and provides images of the ballots of concern. It is not intended nor recommended that this report is printed out on paper. Instead, it is best to review it in a browser so the hot links will operate and so that specific patterns can be searched for. Here, we will summarize the important points from this report.

If there is any discrepancy between this narrative report and the machine produced report linked below, the machine produced report may have been slightly updated and should be considered the official audit result. Here is the link to the report.

https://us-east-1-audit-engine-jobs.s3.amazonaws.com/US/WI/US_WI_Dane_20201103/reports/Discrepancy_Report.html

9. In Dane County, we encountered a relatively high number of hand-marked paper ballot images that could not be aligned and the vote extracted by AuditEngine. This is likely due to older ES&S equipment and may indicate a need to improve maintenance. However, despite the images being corrupted for our use, the voting machines appeared to properly process the votes from those ballots.

4.1 Discrepancy Report -- High Level Reconciliation

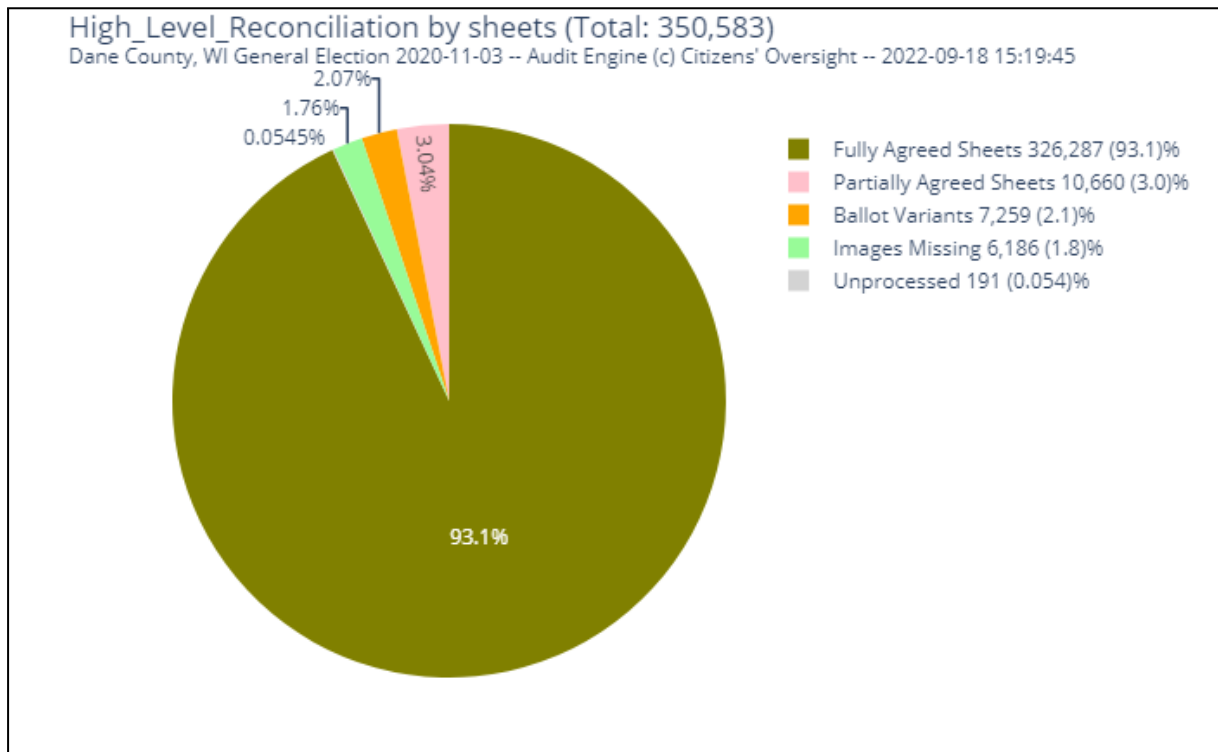
10. **Contest Variant Definition:** Before proceeding, this definition is required. A contest variant is a contest on one ballot where AuditEngine disagreed with the voting system evaluation of that contest, or where there were write-ins, overvotes, or "gray" marks.

Undervotes are not considered a variant unless they are considered "disagreed" or are flagged as "gray".

11. Agreed Undervotes: If undervotes are disagreed, then we do treat it as a contest variant. We do not routinely treat all agreed undervotes as contest variants. If this is done, it will result in a vast number of contest variants, one for every contest that voters skipped. Yet, this can be an important consideration on hand-marked ballots, particularly in critical contests where voters might circle the ovals, circle names, or other reasons. The total number of undervotes in any specific contest is provided in the contest summary in the contest detail report. A planned enhancement for AuditEngine is to treat agreed undervotes as contest variants in critical contests.

12. High-Level Reconciliation by Sheets:

The following pie chart shows the High Level Reconciliation by Sheets.



13. No Images: 6,186 sheets (1.8%). The election officials in Dane County provided the explanation as summarized in section 2.

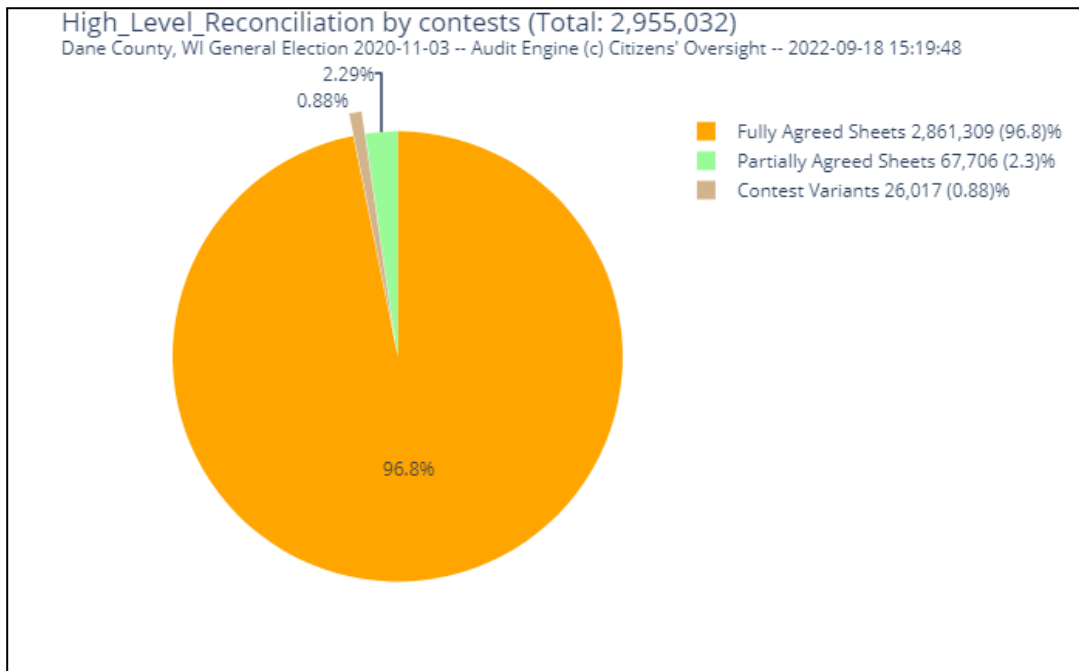
14. Fully Agreed sheets: 326,287 sheets (93.1%): The AuditEngine evaluation for all contests on these ballot sheets agreed with the CVR from the voting system, although

they may have had undervotes. Any ballots with write-ins, overvotes, or gray marks would mean the ballot sheet would be categorized as Partially Agreed, and the contests that deviated would be logically "pulled" from those sheet records and included in Contest Variants.

15. Partially Agreed sheets: 10,660 sheets (3.0%): At least one contest was found that disagreed or they had write-ins, overvotes or were gray-flagged on these sheets. Each record in the Partially Agreed set is for one entire sheet but with at least one contest logically removed from that record if it is a variant and a separate record is created for each contest in the group "Contest Variants". There were 67,706 contests on these sheets that agreed with no variations.

16. Sheets with Contest Variants: 10,660 sheets (3.0%), where each sheet had at least one or more contest variants.

17. High-Level Reconciliation by Contests: When we view the same data by ballot-contests, for clarity we will leave out all the images that are missing and consider only the sheets we could process. "Fully Agreed Sheets" and "Partially Agreed Sheets" categories are the number of contests remaining in those sheet records after Contest Variants have been removed. Please note that these numbers are for the contests on those sheets that were agreed and had no variations.



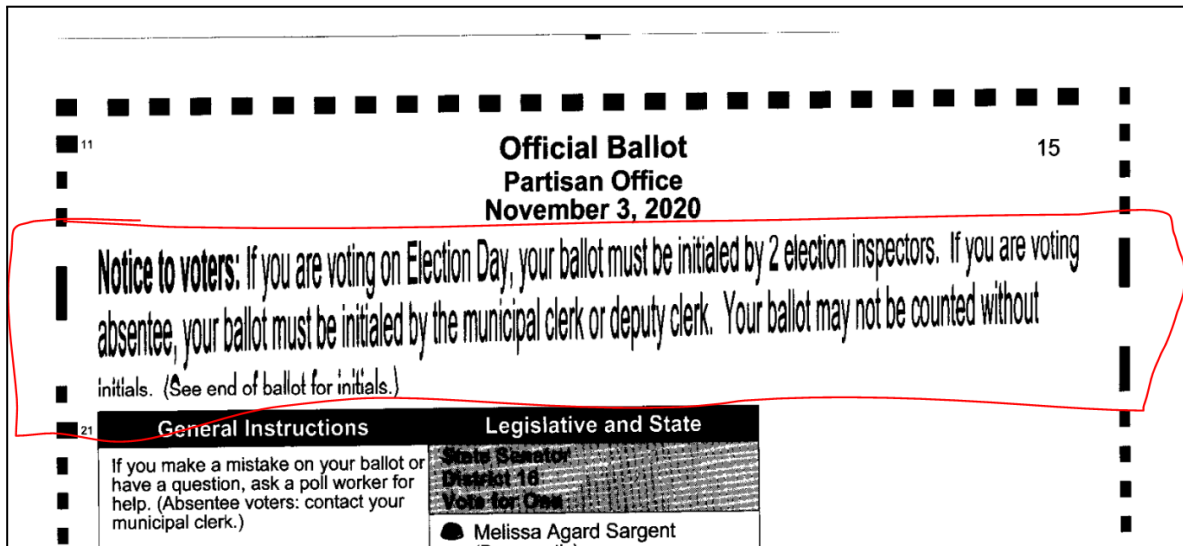
- 18. Agreed and Non-Variant Ballot Contests:** 2,929,015 non-variant ballot-contests, including 2,861,309 contests on 326,287 sheets that were "Fully Agreed" and 67,706 contests on 10,660 sheets that were "Partially Agreed".
- 19. Total Agreed Ballot-Contests:** AuditEngine processed 2,955,032 ballot-contests and 99.1% of these contests on 336,947 sheets had no variations and were fully agreed from both the Fully Agreed and Partially Agreed groups.
- 20. Contest Variants:** 26,017 ballot-contests on 10,660 sheets were classified as Contest Variants (0.88%). Contest Variants have either write-ins, overvotes, gray-flags, or are considered "disagreed".
- 21. Initial Consistency Screen:** The set of Contest Variants provides an initial consistency screen. If we had processed the entire election and if the tightest margin of victory was greater than twice the number of Contest Variants, then the outcome could be deemed as consistent, because even if all Contest Variants are fully reviewed and altered in favor of a losing candidate, it can not alter the outcome. This is a very conservative threshold because all Contest Variants are among all 33 contests.
- 22. Presidential Contest:** In WI, the statewide margin of victory in the Presidential contest was only 0.63% and 20,682 votes, which is less than twice the number of variants, $26,017 \times 2 = 52,034$. Therefore, it is necessary to break down the "Contest Variants", and also look at each contest in detail.
- 23. Other County Ballots:** AuditEngine did not detect ballots from other counties. We found that Dane County is not printed on the ballots and so this screen was not possible. We suggest that the county name is placed on all ballots in the same location to allow sorting into the correct county if ballots are dropped into the wrong box, and in the wrong envelope.
- 24. Unprocessed:** These are ballots that could not be processed at all, usually due to corruption of the image or other factors. In Dane County, 191 ballot sheets were encountered that could not be aligned and the vote extracted by AuditEngine and were classified as "Unprocessed".

These ballots can be reviewed at this link in the report:

https://us-east-1-audit-engine-jobs.s3.amazonaws.com/US/WI/US_WI_Dane_20201103/reports/Discrepancy_Report.html#unprocessed-ballots-report

These tend to be ballot images that are corrupted due to "stretched" images which

result from a pause as the ballot is scanned. A typical example is shown below. For these, we do not attempt to extract the vote and instead mark these as unprocessed. If the election is very close, then the vote from these ballots can be tallied by hand.

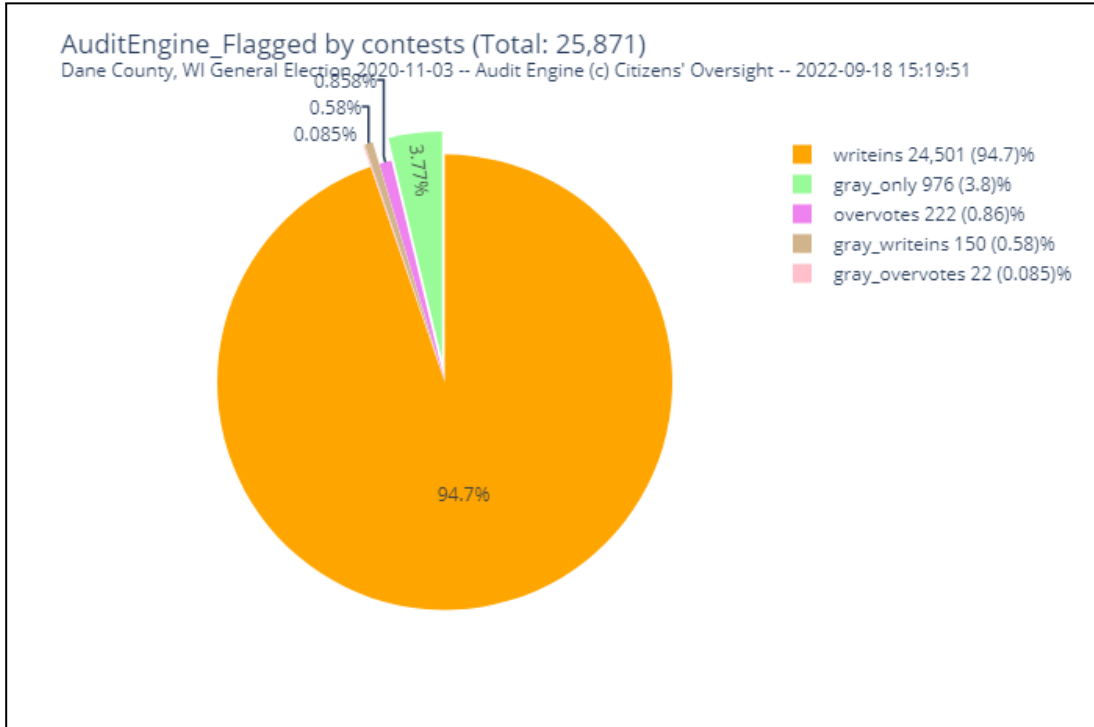


This represents a relatively high number of corrupted images compared with other jurisdictions.

4.2 Discrepancy Report -- AuditEngine Flags of Ambiguous Votes

25. If we had no cast vote records (CVRs or "CVR Files"), then we could not compare the AuditEngine tabulation on a ballot-by-ballot basis, but we can compare with aggregated totals. AuditEngine also provides "gray flags" when it uses heuristics or is unsure of ambiguous marks. To refine the results, we can take a look at the write-ins, overvotes, and contests flagged as "gray". These are shown in the following pie chart, without reference to the CVRs.

Of course here, we have the detailed CVR and we will use that instead, but this is shown here for demonstration of how the result could be used to identify ballots that need further review. These can then be reviewed using the AuditEngine Adjudicator App.



26. Total Flagged Contests: There were a total of 25,871 ballot-contests flagged for additional scrutiny, which is over the statewide margin of victory of 20,682 votes in the presidential contest, so it would need further scrutiny. Also, since there are 72 counties in WI the differences in all counties would need to be considered.

27. CVR was Available: Because the CVR is available, we need not depend only on the flags by AuditEngine. Thus, these are discussed here only to explain the capability. The category "ae_uncategorized" are the ballots that were discovered as variants by the CVR comparison. Thus, the "ae_uncategorized" group would not exist at all if we did not have the CVR, because these are determined by comparing with the CVR and will be a key focus in the sections below.

28. Across All Contests: We must be cognizant that these figures are across all contests, and there were 33 contests in the election. This would further dilute the effect of the contest variants. Also, each variant should be considered based on whether it would decrease or increase the margin of victory.

29. AuditEngine flagging detailed breakdown:

Non-Gray Write-ins: 21,902 contests (84.2%)
which are flagged because they involve write-ins. These are generally reviewed by the election department in detail, and so are generally not likely to find that these were misinterpreted by the time the canvass is completed.

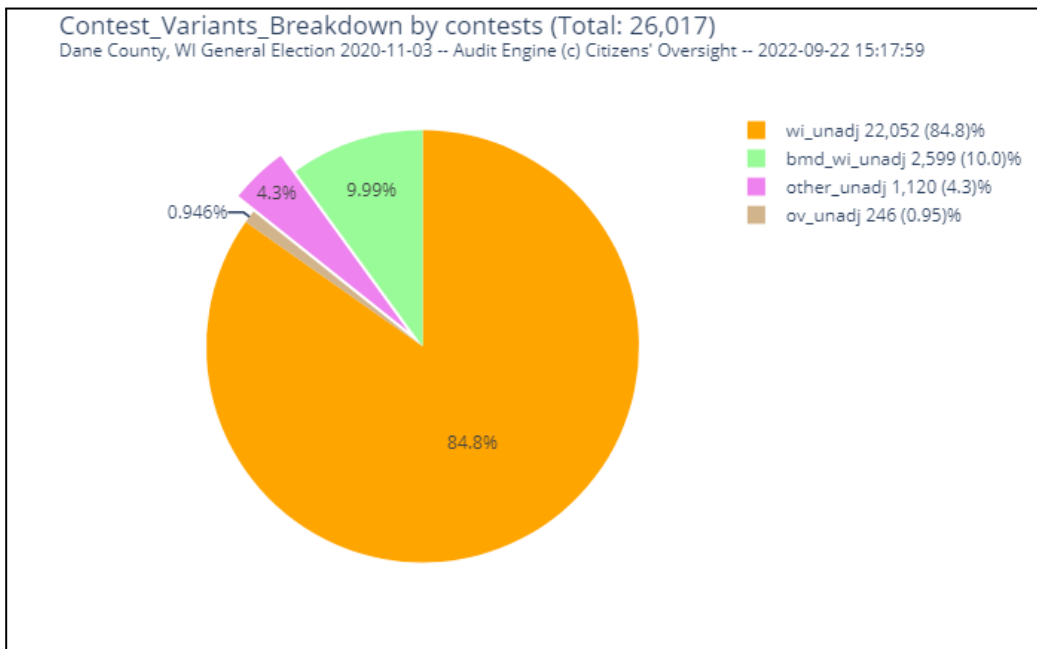
BMD Write-ins:	2,599 contests	(10.0%)
Gray Writeins:	150 contests	(0.58%)
Non-Gray Overvotes:	225 contests	(0.86%)
Gray Overvotes:	21 contests	(0.08%)
Other Gray:	974 contests	(3.70%)
Uncategorized:	146 contests	(0.06%)

These Uncategorized variant contests were not flagged by AuditEngine but were identified due to comparing AuditEngine with the CVR. Thus, these will be found in the "Normal Disagreed" group.

4.3 Discrepancy Report -- Contest Variant Breakdown

30. When the CVR is available, the Contest Variants can be further categorized and reviewed. This is the most powerful way to analyze an election, but since these are across all contests, the review will more appropriately inform considerations about the general quality of the canvass rather than reflecting on exact outcomes.

31. Contest Variants: 26,017 contests (0.88% of all contests) were either disagreed, write-ins, overvotes, or gray-flags pulled from the "Partially Agreed" sheets. Because the ES&S voting system does NOT include a "modified" record, and adjudication is not documented in the CVR, our analysis is limited in detail compared with audits we perform of the Dominion Voting System.



Of the Contest Variants further detailed, there were:

32. Write-Ins:

The most common form of variant are write-ins. All write-ins total 24,651 variant contests, 95% of all contest variants.

Write-ins have another wrinkle because although the write-in may be properly marked and a name written-in, it is usually not valid unless the name refers to an officially qualified write-in candidate. The voting system may indicate a write-in candidate was correctly indicated, but later, the list is reduced to only the qualified write-in candidates. However, this is a matter of state and local election statutes that may vary from place to place, and procedures used by election officials may vary as well.

Generally, at this stage, the write-ins are not often reduced, based on whether they are on the qualified write-ins list.

Sometimes, the write-ins are for one of the official candidates. In those cases, when reviewed, the vote is awarded to the official candidate. So for example, in this election, if the voter marked the oval for the write-in line and wrote "Biden", then that vote would be awarded to that candidate, even though the candidate is an "official" and not a "write-in" candidate.

All write-ins classifications are further reviewed in a detailed section later in this report.

33. Overvotes:

All overvotes total 246 contest variants, 0.94% of all contest variants. This is a surprisingly low number of overvotes.

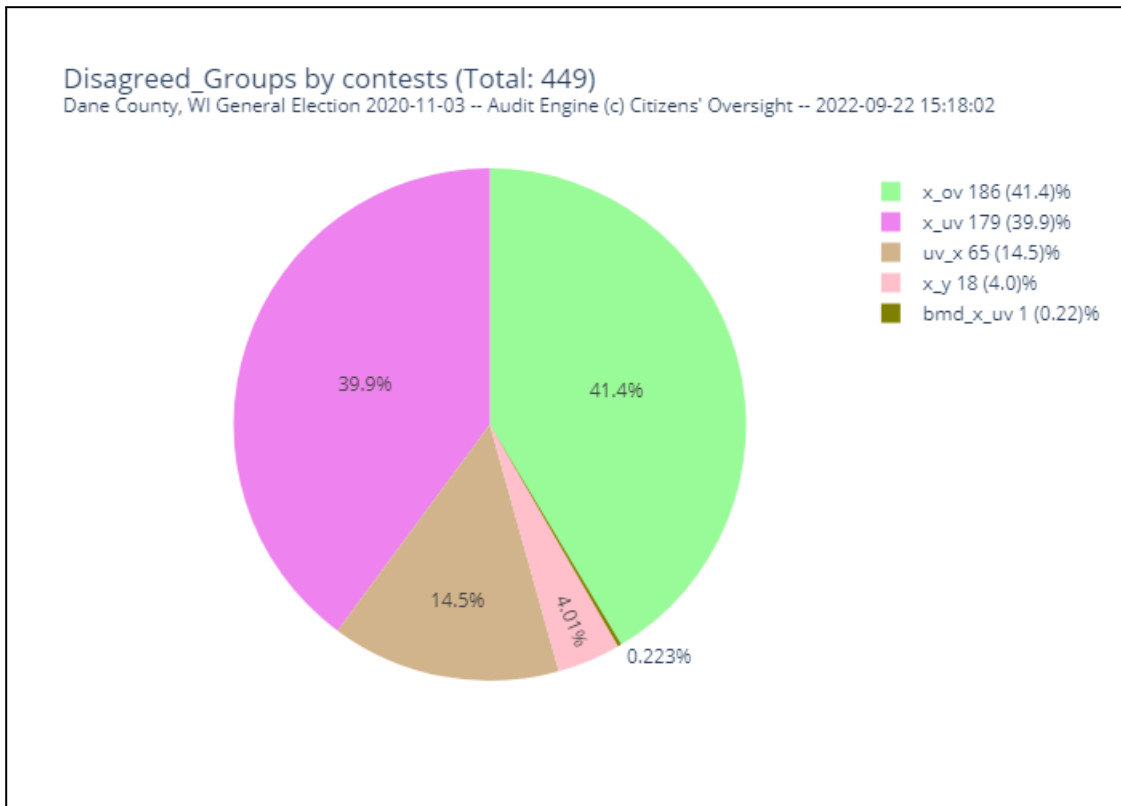
All Overvotes will be further detailed in a later section

34. Other Contest Variants - "Normal Discrepancies":

Other than Write-ins and Overvotes are "Normal Discrepancies". There were a total of 1,057 contest variants in this category, 4.1% of all contest variants. Included in this category are contests with true disagreements, but also contests where initially the voting system and AuditEngine disagreed, but after adjudication, the evaluation was in agreement.

4.4 Discrepancy Report -- Disagreements

35. Other than write-ins and overvotes, the final category includes the "Normal Disagreed" contests. There were 1,120 contests in the category "other_unadj" in the contest variant breakdown by contest. 449 were further analyzed. [We are looking into why this reduced number is involved here.]



36. Disagreed vote (x_y):

18 contests (4.0% of Contest Variants in the Normal Disagreed category). We find commonly that the original AuditEngine evaluation (x) is correct more than 90% of the time.

37. Disagreed Undervotes (uv_x).

65 Contests (14.5% of Contest Variants in the Normal Disagreed category). These were all definitely adjudicated and the change may be due to other voter marks to explain voter intent. Since undervotes are largely not adjudicated as there are so many, these are likely reviewed in close or critical contests.

38. Disagreed Votes as Undervotes (x_uv).

179 Contests (39.9% of Contest Variants in the Normal Disagreed category). This generally happens when the voter circles the target or marks it with a check or X that does not go into the oval. AuditEngine uses adaptive thresholding and a heuristic to allow light votes when there is an undervote, and uses a larger evaluation area. Therefore, these are generally evaluated correctly by AuditEngine.

39. Disagreed Overvotes as Votes (x_ov)

186 Contests (41.4% of Contest Variants in the Normal Disagreed category). This generally happens when ES&S has a hair-trigger on hesitation marks and calls them

an overvote, or if the voter crossed out one (very dark) while wanting the other (regular) mark. AuditEngine usually correctly evaluates these without further adjudication.

40. All other normal disagreed categories.

671 Contests. This category is missing from our detailed review and our team is currently reviewing the disposition of these contests. (This report will be updated when this is explained.)

4.5 Discrepancy Report -- Contest Discrepancy Report

41. The most effective report is the Contest Discrepancy Report because the disagreements can be related to the margin of victory in a specific contest.

This portion of the report is at this URL:

https://us-east-1-audit-engine-jobs.s3.amazonaws.com/US/WI/US_WI_Dane_20201103/reports/Discrepancy_Report.html#contest-discrepancy-report

Here is a clip of the top portion of this report.

Contest	Total	Agreed & NonVariant	Agreed Overvotes	Agreed Write-ins	No CVR	Gray Only	Disagreed	All Variants	Disagreed% of Margin	Variant% of Margin	Vote Margin	Margin%
President / Vice President	336,947	335,553	106	1,122	0	136	30	1,394	0.02%	0.78%	179,715	52.48%
Representative in Congress District 2	336,947	336,500	37	308	0	64	38	447	0.02%	0.26%	169,090	50.50%
State Senator District 14	2,627	2,625	1	1	0	0	0	2	0.00%	3.33%	60	2.37%
State Senator District 16	113,970	113,812	21	107	0	19	11	158	0.02%	0.30%	53,396	46.94%
State Senator District 26	117,727	115,831	0	1,863	0	20	13	1,896	0.01%	1.93%	98,447	96.33%
Representative to the Assembly District 37	10,690	10,676	4	3	0	5	2	14	0.14%	0.98%	1,433	13.79%
Representative to the Assembly District 38	7,299	7,289	1	3	0	4	2	10	0.17%	0.87%	1,145	15.97%
Representative to the Assembly District 42	2,627	2,623	1	3	0	0	0	4	0.00%	3.17%	126	4.96%

42. For any particular contest, we can focus on the "Disagreed% of Margin" or the "Variant% of Margin". The margin of victory in votes for the contest is between the last-winning candidate and the first-losing candidate. This is not the "pairwise" margin⁵, but the actual margin including all other candidates. For ease of reading, the closest 5 contests are highlighted in terms of the Disagreed% of Margin and Variant% of Margin, and also contests with margins of victory below 10% are highlighted. These contests are also detailed and can be accessed by the contest name link. (Other contests can be added to the report as needed.)

⁵ The pairwise margin considers only the two ballot options and not all the other options in that contest. So if there are three candidates, A, B, C with votes of 50,40,10, then the actual margin is 10% = 100 * (50 - 40)/100 but the pairwise margin is 100 * (50 - 40)/90 = 9%.

43. There were no contests with no listed options, and so there is no need to pull these from consideration. This sometimes happens, and then the Variant% of Margin will be about 100%.

44. Contests were individually considered. The 2 most discrepant contests had disagreements between 0.85% to 0.59% of the margin of victory:

- **Question 1 Wisconsin Heights School District**

- Margin of victory: 234 votes (5.93%)
- 2 votes "Disagreed" (0.85% of margin)
- 4 contest variants (1.71% of margin)

- **Question 1 T York Wd 1**

- Margin of victory: 169 votes (0.59%)
- 1 vote "Disagreed" (0.59% of margin)
- 1 contest variant (0.59% of margin)

4.6 Discrepancy Report -- Precinct Report

45. The Precinct Report provides a breakdown of the ballots in each precinct. These values are ballot counts, and are not specific to any particular contest. This report can sometimes highlight issues that may be specific to any particular precinct, but in our opinion is not as valuable as the Contest Discrepancy Report, but is included because some states have requirements for this report. This report highlights the highest 5 Disagreed% of Margin precincts.

46. Overall, there were 363 sheets with contests categorized as Normal Disagreed cases, and 10,660 cases of "All Variants."

Precinct Report													
Please note that the figures in this table are by ballot, rather than by contest, and the %Disagree is the number of cases among the ballots in the group rather than of a margin, since these cases are among all the contests in the precinct.													
To reduce the report size, precinct details are limited to those precincts that were highlighted or are included in the setting 'cmpcvr_report_include_precincts'.													
Precinct	Style	Total	Agreed & NonVariant	Agreed Overvotes	Agreed Write-Ins	Agreed Blank	No CVR	Gray Only	Disagreed	All Variants	Disagreed% of Total	Variant% of Total	Disagreed Examples
C Fitchburg Wd 14	[9, 29]	1,512	1,468	1	39	0	0	3	3	44	0.20%	2.91%	[260975, 261481, 262337]
C Fitchburg Wds 1-4	[7]	2,716	2,639	10	56	0	0	15	8	77	0.29%	2.84%	[249167, 248461, 249539, 249712, 250036, 250505, 250924, 251014]
C Fitchburg Wds 10-13	[6, 7]	2,633	2,559	5	62	0	0	10	3	74	0.11%	2.81%	[258914, 259900, 260067]
C Fitchburg Wds 15, 18-19	[7, 6]	3,824	3,720	0	95	0	0	7	7	104	0.18%	2.72%	[262650, 263733, 264708, 265800, 266200, 266478, 266718]
C Fitchburg Wds 16-17	[9, 29]	1,316	1,280	0	34	0	0	2	1	36	0.08%	2.74%	[266924]

4.7 Discrepancy Report -- Presidential Contest

47. To give the reader an understanding of the detail to which AuditEngine provides an ability to analyze the results, we will focus on the contest '*President of the United States*', since it is the most consequential contest and was quite close state-wide with an official statewide margin of 20,682 votes. However in Dane county, the margin was 179,715 votes with a margin of 52.5%, with Joe Biden receiving 258,209 votes (75.6%) and Donald Trump receiving 78,494 votes (23.0%). Thus, although this was a landslide victory for Biden in this county, on a statewide basis, this contest was still quite close, and any deviation of at least 20,682 votes might flip the election.

The analysis by AuditEngine shows that even if we consider all contest variants, they only account for less than 6.7% of the total margin needed to flip the contest with these results alone.

Dane County does not have the ability to adjudicate and provide adjudication records.

The official results of the Presidential Contest had 124 overvotes and 730 undervotes.

Undervotes on nonBMD ballots in critical contests may be of interest for additional review. These are not included in contest variants in this version of the Discrepancy Report but will be added as an option in the future as contest variants for critical contests.

Contest	Margin of Victory	Contest Variants (% of Margin)	Disagreed (% of Margin)
President of the United States		1,394	28
(County margin)	179,715	0.78%	0.02%
(Statewide Margin)	20,682	6.7%	0.13%

48. General approach for this document: Here, we will take a sample of a few of the cases in each category. The full Discrepancy Report for the contest "President of the United States' can be reviewed for more details. It provides ballot images for the first 10 cases in each category. Although they are categorized as variants, we do not routinely review agreed write-ins and agreed overvotes or agreed votes flagged as "gray", unless the contest is extremely close, because even if all the variants are ruled for the losing candidate, there is no way to overturn the election.

The cases we did review showed that the election office largely adjudicated the results quite well and there is no chance that the outcome could have been different, given that the ballot images are an accurate representation of eligible votes cast.

The notation is covered in the background document, but will be repeated here to refresh the memory:

[bmd_]AE_CVR_ADJ

We will see bmd_ if the contest variant applies specifically to BMD ballots, and left off if it is a nonBMD (hand marked) ballot.

AE is the AuditEngine evaluation, and will be either 'x', 'wi', 'ov' or 'uv' meaning a vote, a write-in, and overvote, or an undervote, respectively.

CVR is from the cast-vote record, and is the voting system evaluation. It has the same list of abbreviations except it might also have 'y' to mean a vote that differs from the vote 'x'.

ADJ is the adjudication, and if it differs from the CVR value, then we are sure that the contest was reviewed by election staff and changed, otherwise, we are not sure if it was reviewed. This will never be included in Dane County because ES&S does not provide these data in the CVR.


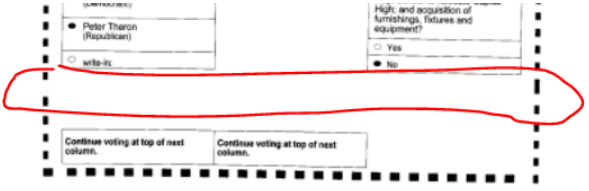
So for example, if the designation were **wi_uv** then it means that AuditEngine evaluated it as a write-in, the voting system evaluated it as an undervote.

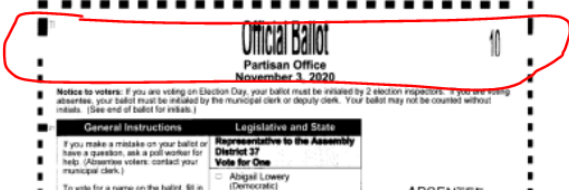
49. Normal Disagreed (Presidential Contest):

In this section, we will look at the normal disagreed cases for the Presidential contest. There were 30 cases:

Record Type	Sheets	Ballot Contests	Description
x_y	3	3	Disagreed contests with votes (No BMDs)
x_uv	10	10	Disagreed contests with CVR undervotes (No BMDs)
x_ov	7	7	Disagreed contests with CVR undervotes, (No BMDs)
uv_x	8	8	Unadjudicated disagreed undervotes with CVR votes. No BMDs

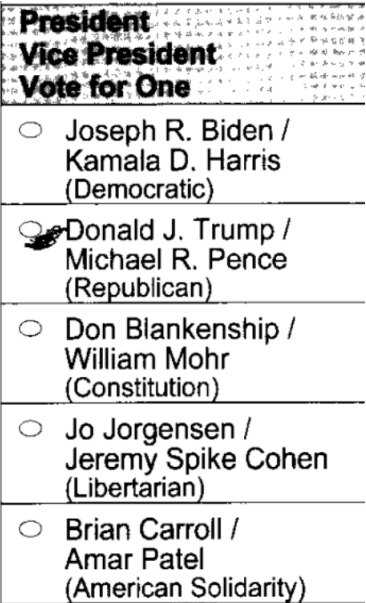
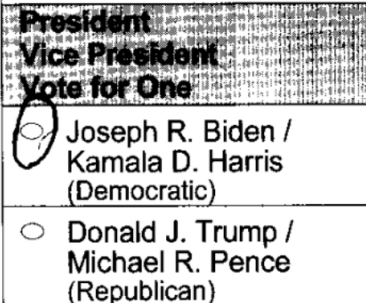
50. x_y: Disagreed contests with votes (3 cases)

ballot_id	Description	Image
188359	This ballot has a corrupted image, and should have been preferably marked as a ballot variant, and no attempt to extract the votes made. As a result on this ballot, AuditEngine misinterpreted a vote for Trump as a vote for Biden. Probably many other votes were incorrectly extracted. This was in precinct C Sun Prairie Wds 1-19, 26, and it may be that this voting machine should be serviced or retired.	
125762	Similar problem, this time stretched at the bottom. This was precinct C Madison Wd 106.	

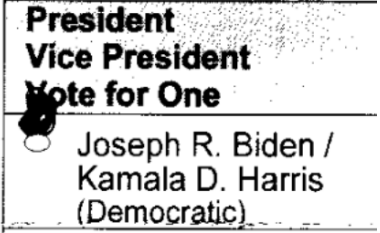
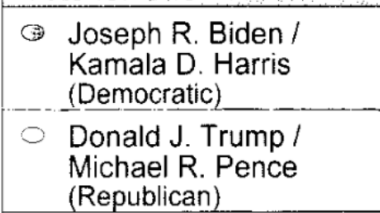
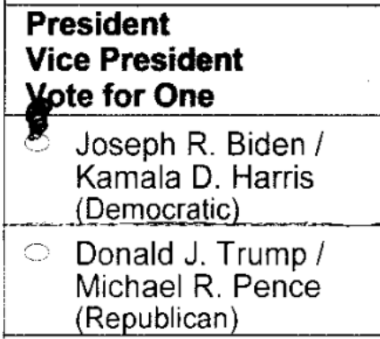
303670	Similar problem, stretched at the top. precinct: DeForest Wds 7-10, 12	
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51.x_uv: Disagreed contests with CVR undervotes (10 Cases)

All 10 cases were correctly evaluated by AuditEngine and some were also flagged as gray.

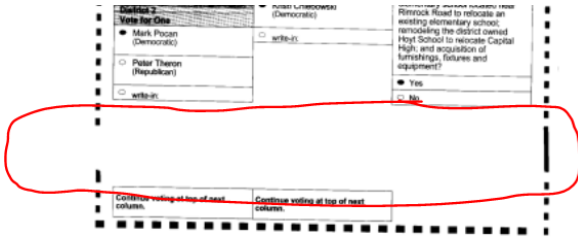
ballot_id	Description	Image
205794	<p>Here the mark was outside the oval, and sometimes people can't see and guide their hand to the target. On the other hand, this appears that it might be ruled a scratch out.</p> <p>The voting system evaluated this as an undervote while AuditEngine rated it as a vote for Trump. It was not flagged as gray.</p>	
185730	<p>Circled vote for Biden was evaluated as an undervote by the voting system and as a vote for Biden by AuditEngine. This is definitely the voter intent.</p> <p>This was marked as an ambiguous mark and flagged as gray.</p>	

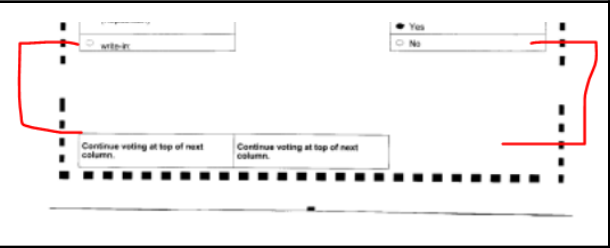


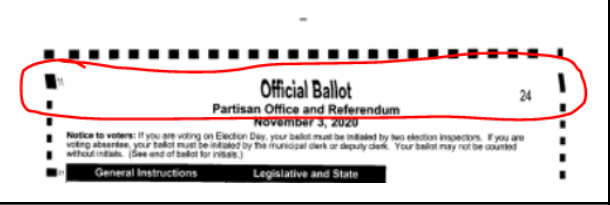
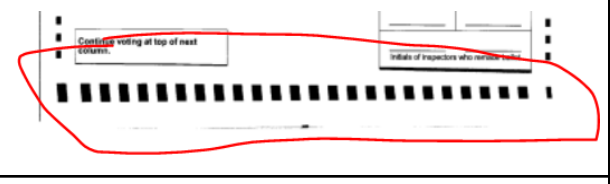
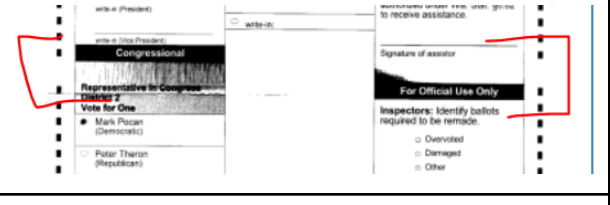

110365	<p>Vote for Biden was slightly outside the oval and regarded as an undervote by the voting system, while AuditEngine correctly evaluated it as a vote for Biden.</p> <p>This was marked as an ambiguous mark and flagged as gray.</p>	<p>President Vice President Vote for One</p> <p><input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic)</p> <hr/> <p><input type="radio"/> Donald J. Trump / Michael R. Pence (Republican)</p>
341507	<p>Vote for Biden was mostly outside the oval but was clearly voter intent. The voting system regarded this as an undervote while AuditEngine evaluated it as a vote for Biden.</p>	<p>President Vice President Vote for One</p> <p><input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic)</p> <hr/> <p><input type="radio"/> Donald J. Trump / Michael R. Pence</p>
341649	<p>Vote for Trump did not make it into the oval, but is clearly the voter intent. The voting system regarded this as an undervote but AuditEngine correctly evaluated this as a vote for Trump.</p>	<p><input type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic)</p> <hr/> <p><input checked="" type="radio"/> Donald J. Trump / Michael R. Pence (Republican)</p>
300567	<p>Vote for Trump did not make it into the oval, but is clearly the voter intent. The voting system regarded this as an undervote but AuditEngine correctly evaluated this as a vote for Trump.</p>	<p><input type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic) / (Dem</p> <hr/> <p><input checked="" type="radio"/> Donald J. Trump / Michael R. Pence (Republican) / (Repu</p>
287858	<p>Vote for Biden was slightly outside the oval and regarded as an undervote by the voting system, while AuditEngine correctly evaluated it as a vote for Biden.</p> <p>This was marked as an ambiguous mark and flagged as gray.</p>	<p>President Vice President Vote for One</p> <p><input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic)</p> <hr/> <p><input type="radio"/> Donald J. Trump /</p>

329657	Vote for Biden was slightly outside the oval and regarded as an undervote by the voting system, while AuditEngine correctly evaluated it as a vote for Biden. This one almost looks like the oval was forced to be blank. This was marked as an ambiguous mark and flagged as gray.	 <p>President Vice President Vote for One</p> <p><input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic)</p> <p><input type="radio"/> Donald J. Trump / Michael R. Pence (Republican)</p>
307364	This very light mark for Biden was regarded as an undervote by the voting system, but there were no other marks on the ballot, so this should be regarded not as a hesitation mark, but as a vote. AuditEngine correctly evaluated it as a definite vote for Biden.	 <p><input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic)</p> <p><input type="radio"/> Donald J. Trump / Michael R. Pence (Republican)</p>
222399	Vote for Biden was slightly outside the oval and regarded as an undervote by the voting system, while AuditEngine correctly evaluated it as a vote for Biden. This was marked as an ambiguous mark and flagged as gray.	 <p>President Vice President Vote for One</p> <p><input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic)</p> <p><input type="radio"/> Donald J. Trump / Michael R. Pence (Republican)</p>

52. Contest 'President / Vice President', group: 'uv_x' (8 Cases)

These may be improperly adjudicated by AuditEngine due stretching.

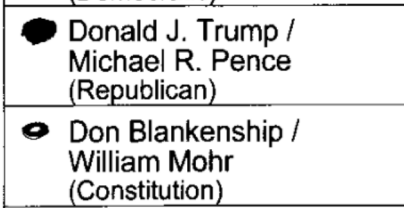
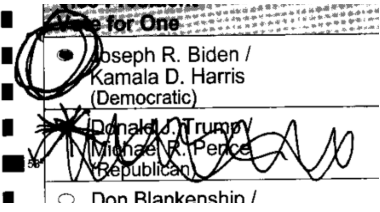
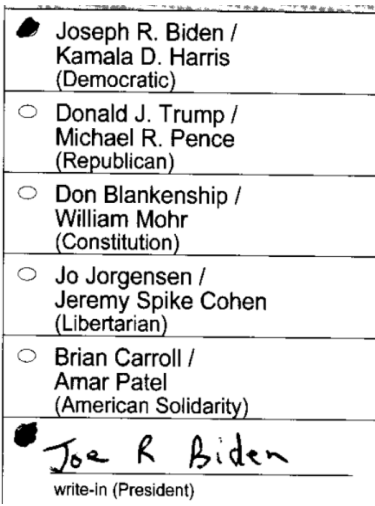
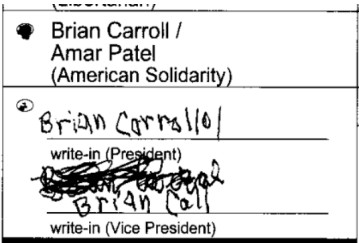
ballot_id	Description	Image
235884	Bottom of the ballot is severely stretched. In theory, because the "Active" portion of the ballot is unstretched, there is a chance that in the future we could still process this. But as these cases are getting more rare as the equipment improves, it has not been a focus of our work.	 <p>The image shows a ballot with a severely stretched bottom section. A red oval highlights the bottom portion of the ballot, which is distorted. The text 'Continue voting at top of next column.' is visible at the bottom of the ballot.</p>

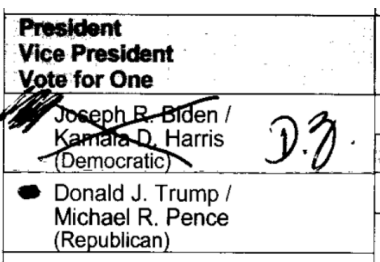
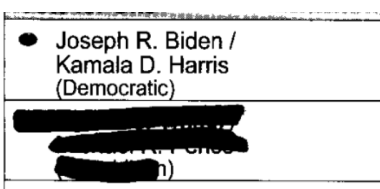
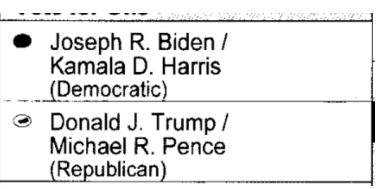
133399	Same issue.	
208315		
288063		
288329		
290332		
306122		
306718		

53. Contest 'President / Vice President', group: 'x_ov'

Disagreed contests with CVR undervotes (9 cases).

These are a bit more interesting, because here, AuditEngine will evaluate whether an overvote should be correctly attributed to one of the options. There are two important heuristics at play here, one to consider a regular mark as a vote if there is a very light additional mark, and the other is to eliminate a mark if it is very dark. The "dark overvote" heuristic will be improved so it will be limited to only those cases when there are two dark marks.

ballot_id	Description	Image
205958	This is a very typical case, where the voter started to vote for one option, darkened it somewhat, then indicated the other mark much more completely, which also matches the other marks on the ballot. This is the "light overvote" heuristic. AuditEngine evaluated this as a vote for Trump while the voting system rejected it as an overvote.	
167513	This one is a bit more complex, and it engages a heuristic that allows the smaller mark when the larger mark is very large, and seems to be a strike out. The heuristic usually works but is sometimes fooled. Here, AuditEngine correctly evaluated the vote for Biden while the voting system rejected it as an overvote.	
168285	This is a different case, and it was still correctly interpreted by AuditEngine, but it used the same heuristic as the prior example. The voting system does not provide any information regarding which options are selected when it trips into an overvote status. AuditEngine correctly awarded the vote for Biden.	
251559	This example was solved by the "light overvote" heuristic, and AuditEngine correctly ignored the write-in and attributed the vote to Brian Carroll.	

261481	The dark overvote heuristic was deployed in this case resulting in correctly attributing the vote for Trump.	 <p>President Vice President Vote for One</p> <p>Joseph R. Biden / Kamala D. Harris (Democratic) D.J.</p> <p>● Donald J. Trump / Michael R. Pence (Republican)</p>
135007	This is a correct evaluation by the dark-overvotes heuristic, awarding the vote correctly to Biden.	 <p>● Joseph R. Biden / Kamala D. Harris (Democratic)</p> <p>[REDACTED]</p> <p>[REDACTED]</p> <p>[REDACTED]</p>
329284	The light-overvote heuristic correctly interpreted this as a vote for Biden.	 <p>● Joseph R. Biden / Kamala D. Harris (Democratic)</p> <p>○ Donald J. Trump / Michael R. Pence (Republican)</p>

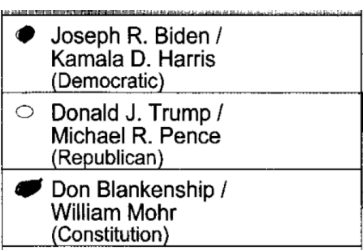
54. Contest 'President / Vice President', group: 'ov_ov'

Both AuditEngine and the voting system agreed that these were clear overvotes. There were 113 cases in this category.

Frequently, voters will overvote to make sure the ballot contest is not left blank so it could potentially be fraudulently changed to a candidate they don't want. On the other hand, these could be cases where the ballot was subjected to malicious tampering to cancel a vote the fraudster does not like. We will look at only a few of these in detail.

The other common case is when the voter fills in the write-in box. Unfortunately, the voting system CVR does not indicate anything about what was voted prior to considering the contest an overvote.

Ideally, all overvotes should be adjudicated by the election department in critical contests.

ballot_id	Description	Image
165012	Could be a canceling fraudulent change by adding Don Blankenship.	 <p>● Joseph R. Biden / Kamala D. Harris (Democratic)</p> <p>○ Donald J. Trump / Michael R. Pence (Republican)</p> <p>● Don Blankenship / William Mohr (Constitution)</p>

165617		<input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic) <input type="radio"/> Donald J. Trump / Michael R. Pence (Republican) <input type="radio"/> Don Blankenship / William Mohr (Constitution) <input type="radio"/> Jo Jorgensen / Jeremy Spike Cohen (Libertarian) <input type="radio"/> Brian Carroll / Amar Patel (American Solidarity) <input checked="" type="radio"/> <i>Joseph Biden</i> <small>write-in (President)</small> <input checked="" type="radio"/> <i>Kamala Harris</i> <small>write-in (Vice President)</small>
335589 225679	Legitimate overvote, voted equally for every option. "None of the above" perhaps.	<input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic) <input checked="" type="radio"/> Donald J. Trump / Michael R. Pence (Republican) <input checked="" type="radio"/> Don Blankenship / William Mohr (Constitution) <input checked="" type="radio"/> Jo Jorgensen / Jeremy Spike Cohen (Libertarian) <input checked="" type="radio"/> Brian Carroll / Amar Patel (American Solidarity)
336299	Biden + Jorgensen. Could be a canceling vote overwriting Biden.	
164218 226763	Trump + Brian Carroll could be a canceling vote overwriting Trump.	
165851	Trump + Jorgensen.	
165983	Biden + Trump	
166255	Crossed out Trump should be a vote for Biden.	<input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic) <input checked="" type="radio"/> Donald J. Trump / Michael R. Pence (Republican) <i>DS/RS</i>

55. Agreed Writeins (wi_wi). (1122 cases)

Write-ins are the largest portion of contest variants, normally about 80% of the contest variants. On BMD machines, write-ins are keyed-in directly and there is no difficulty in determining if the voter wanted to include a write-in. And then, those write-ins can also be easily reviewed to see if they match any qualified write-ins, because hand-writing does not need to be deciphered. For hand-marked ballots, we find that most jurisdictions only adjudicate to the point of saying "this is a write-in" but not to say "this is a write-in and there is a name written-in, and the name is included in the qualified write-in candidate list". Sometimes, we do see that the adjudication also went this extra step.

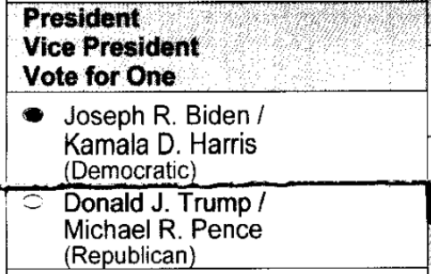
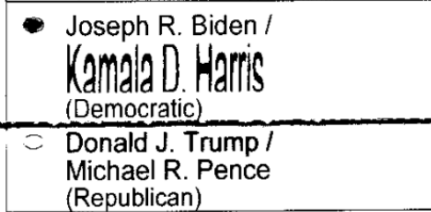
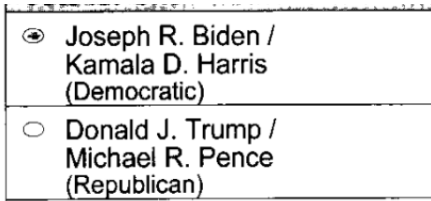
For both BMD and hand-marked ballots, if a listed candidate is written-in, it might affect the vote count between two listed candidates. But that situation is a fraction of the total number of write-ins -- maybe at most 10% -- so other than that, write-ins can largely be ignored when considering if the outcome might change.

The first 10 cases provide an idea:

Boris Johnson	
Jamie Dimon	
Jesse Ventura, Cynthia McCay	
William Jennings	
Howie Hawkins, Angela Walker	Hawkins may be a qualified write-in for the Green Party.
Paul Ryan, Nikki Hayly	
Howie Hawkins, Angela Walker	Hawkins may be a qualified write-in for the Green Party.
None, None	
Brock Pierce	
Brock Pierce	

56. Agreed and Gray Flagged (x_x_gry) (121 cases)

This is an interesting case where the vote was considered somewhat ambiguous by AuditEngine, but we still agreed with the voting system.

ballot_id	Description	Image
336119 183265 188557 235562 237415	Dark line caused by a crease was considered an ambiguous mark by AuditEngine.	 <p>President Vice President Vote for One</p> <p><input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic)</p> <p><input type="radio"/> Donald J. Trump / Michael R. Pence (Republican)</p>
336437	This example is similar to the first one, but also included some stretching of the ballot in the region of this contest.	 <p><input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic)</p> <p><input type="radio"/> Donald J. Trump / Michael R. Pence (Republican)</p>
205744 178584	Very light mark still correctly regarded as a vote for Biden. Other ballots with similar cases listed.	 <p><input checked="" type="radio"/> Joseph R. Biden / Kamala D. Harris (Democratic)</p> <p><input type="radio"/> Donald J. Trump / Michael R. Pence (Republican)</p>

5. General Evaluation

The issues we find in Dane County, WI are very far from being close to overturning the election, even when considering the closer, approximately 20,000 vote statewide margin in the presidential contest. We see no trends of variants indicating that the election could be questioned.

However, there are a number of comments which we feel are appropriate:

1. **The overall election processing by Dane County was "very good" with very few real issues.** 3,069 ballot images were repeated with the same ballot_id and were skipped in the archives, and not included in the official canvass. Images were not included in the archives for our review but there is no indication that these ballots are any less accurate than the ones included in our audit. But it would help if we could get all the images and corresponding CVR records in the future.
2. **Missing CVR or Images:** We hope that the counties will try to process all their ballots in the appropriate county, instead of sharing a precinct one way or the other, even

though that may seem convenient. It is not convenient when it comes to auditing the election.

3. The law that requires that the voter-id is written on the back should be repealed. Short of that, we recommend that instead a sequential number be placed on the ballots and that can be indexed to the voter-id using a second list which can be withheld.
4. **Corrupted Images:** We find that there is a relatively high number of stretched and corrupted ballots. This may mean that the voting equipment needs to be serviced or taken out of service in extreme cases. We note that in the cases we reviewed, the voting system was able to correctly interpret the ballots even though they were stretched, however we can't say for sure that this is always the case.

When scanners are stored for extended periods, the scanner rollers that are used to feed the sheets may get flat spots that could result in pauses during scanning and therefore cause "stretched" image corruption. Some counties say they replace the rollers for every election. At a minimum, the machines should be run for a period of time to round off any flat spots in the rollers.

In some cases, there were black streaks in the image through the left timing marks, which are used to encode the style. This could be some defect in the scanner array itself, or it could be some dirt on the glass window of the scanner. Workers should make sure the machines are carefully cleaned.

5. **AuditEngine parsed the human readable text on BMD ballots and found zero discrepancies.**

AuditEngine does not rely on barcodes on BMD ballots, but instead parses the human readable text of the ballot summary which describes the selections of the voter. We do this because the human readable text is voter verifiable while the barcodes are not easy at all to verify. AuditEngine then compares the readable text with the cast vote record on a ballot-by-ballot basis. We found zero discrepancies between the cast-vote records and the voter verifiable text summaries.

We believe this is an important feature of AuditEngine because it checks on the possibility that the text on the ballot says one thing while the barcode encodes something else.

6. **Verification Images.** We thank Peter Bernegger for providing hand-scanned images from four precincts for comparison. We have enhanced AuditEngine to be able to accept ballot images from another source, and compare those on an aggregated basis so as to verify that the images were not modified. The totals from these scans did roughly compare, but the images for three precincts were combined into one set,

making it hard to compare to the official totals of those precincts. This is still work in progress, and we will be updating this report when these verification images have been fully compared. However, we wanted to get the main reports done and available prior to completing this work.

- 7. No County Name on Ballots.** To check that all the ballots are from the correct county, it is helpful if the county name appears in the same place on all ballots. There was no county name on these ballots so our check for other counties was not included.

6. Conclusion

This case study is one of a set that shows the value of performing ballot image audits to check on the tabulation of elections from modern voting systems that utilize ballot images. We must caution the reader that finding consistency between the ballot images and the official reported results is not sufficient to fully audit an election, as there are still concerns regarding voter eligibility, chain of custody, whether the ballot images are a faithful representation of the ballots, and other factors.

We hope that election officials and the public see the value of such a review of ballot images to increase voter confidence in election results.

For further information, please visit <https://auditengine.org>. We appreciate funding by the public for these independent audits.

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How to Comment

Please send questions and comments about this report to support@citizenoversight.org

APPENDIX 1 -- Links to detailed reports

Auditing Elections Using Ballot Images and AuditEngine -- General Background:

 Auditing Elections Using Ballot Images and AuditEngine -- General Background

This Narrative Report:

[WI Dane 20201103 Narrative Report](#)

The following page provides links to the automated reports.

https://us-east-1-audit-engine-jobs.s3.amazonaws.com/US/WI/US_WI_Dane_20201103/reports/Final_Report.html