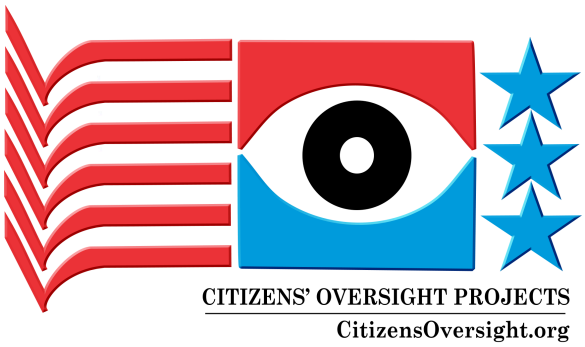

AuditEngine

Ballot Image Audits of:

Burlington and Sussex Counties (2024) New Jersey

Raymond Lutz
Executive Director and Lead Developer,
Citizens' Oversight Projects

V1.2 2025-09-02 (REF: M2036)

Citizens' Oversight Projects

a 501(c)(3) nonprofit and nonpartisan organization
http://citizensoversight.org

Abstract

AuditEngine serves as a ballot-image auditing (BIA) platform designed to independently tabulate ballot images derived from voting systems, and compare that result with the official Cast Vote Records.

The subject of this document is an audit of the November 2024 election results for Burlington and Sussex Counties, NJ. Over 99% of votes were confirmed in both counties, with only a small number of disagreements insufficient to affect any election outcomes.

The audit checked every ballot, not a sample, by interpreting the ballot images using independent image recognition software. These are the original images created when the ballots were first scanned in the election office and could not be affected by any attacks or errors which might have affected ballots in storage later. Although there were no cryptographic controls on these images that would detect alterations, we had no reason to suspect such alterations, particularly since New Jersey was not a critical swing state in the Presidential contest.

The audit first compares complete ballots between the voting system and the results from AuditEngine. If all contests match and have no irregularities (write-ins, overvotes, or ambiguous evaluations), they are classified as "nonvariant". Otherwise, each contest on each ballot (a "ballot-contest") is considered separately.

Burlington had 231,573 ballots, containing 1,916,200 ballot-contests, including 618 classified as disagreed (0.032%). Sussex had 85,228 ballots, containing 684,803 ballot-contests, including 96 classified as disagreed (0.014%). Most disagreed classifications were due to differences in how overvotes were reported, due to bad images, or just hard to read marks.

In addition to verifying results, the audit process confirmed the accuracy of election programming, highlighted the value of consistent ballot formatting, and demonstrated how ballot image auditing can enhance election transparency and integrity. This report provides a detailed account of findings and includes recommendations for future audits and election administration improvements.

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Introduction

AuditEngine creates an independent tabulation of all ballots

AuditEngine is a cloud-based platform that performs an independent tabulation of votes by analyzing ballot images originally scanned by certified election system scanners. It then compares the independently derived results with the official results provided in the form of Cast Vote Records (CVRs). For an overview of AuditEngine's methodology, see "Auditing Elections Using Ballot Images and AuditEngine -- General Background"[1].

Not a sampling methodology, 0% risk limit

Unlike traditional audits that typically sample only a subset of ballots, or ballot viewer applications that provide a user interface to look at any ballot and compare manually, AuditEngine examines every ballot image and uses image analysis to determine voter intent and create an independent complete tabulation. This comprehensive approach enables detection of discrepancies or anomalies that may go unnoticed in partial audits. It has a 0% risk limit compared with other "risk limiting" audits that audit only a few contests and allow additional risk due to sampling errors. For BMD ballots that use barcodes, AuditEngine performs OCR on the summary text and does not rely on barcodes.

However, it is important to note the inherent limitations of this approach. AuditEngine cannot detect ballots that were never scanned, nor can it identify instances where fraudulent ballots may have been inserted to create matching images and CVRs.

On the other hand, ballot images may be more reliable than paper as ballots are scanned immediately and thereby thwart changing ballots that may be stored for a lengthy period of time.

Detractors of ballot image audits must still admit that discrepancies found by AuditEngine must be taken seriously and investigated, as they reflect

---

[1] https://docs.google.com/document/d/18A1K8mXXHnhisLqBQigx0ibboz39FAh9hOSykcR-jT4/edit?usp=sharing

inconsistencies that cannot be dismissed without explanation. Further, we find that the configuration of AuditEngine parallels what must be done by the voting system and will frequently detect configuration errors long before the audit is completed.

Track Record

In nearly every audit conducted using AuditEngine, we have identified findings that range from minor anomalies to significant errors. These discoveries underscore the value of conducting independent, image-based audits. Audits conducted during the 2020 General Election in Florida (Volusia, Collier, and St. Lucie Counties), Georgia (Fulton and Bartow Counties), and Wisconsin (Dane County), and more recently in New Jersey and Maryland revealed additional ballots left in the system, thumb drives accidentally imported, and differences between the QRCode and ballot summary. These results from other jurisdictions are available at: https://AuditEngine.org.

Definitions: Variant and Disagreed Contests

Before explaining the results in more detail, it is necessary to introduce some concepts that are specific to our comparison methods.

A core capability of AuditEngine is its ability to perform a detailed comparison between its independent tabulation of ballot images with the official results published in the Cast Vote Record (CVR). AuditEngine operates as a general-purpose auditing tool that treats every ballot-contest independently, and it is capable of identifying a wide range of discrepancies.

To compare AuditEngine results with the CVR, we apply a multi-stage filtering process. The fundamental unit of comparison is the ballot-contest, defined as a single contest on one ballot. Each ballot-contest is evaluated to determine the vote selection, presence of overvotes or undervotes, and whether the mark was ambiguous. The filtering steps are as follows:

Agreed Regular, or "Nonvariants"

The first filter identifies all ballot-contests where AuditEngine and the voting system agree, with no irregularities (write-ins, overvotes, or ambiguous, i.e. "gray-eval" markings). These contests are categorized as *Agreed Regular, or*

simply "Nonvariants". In both Burlington and Sussex, about 99% of contests fell into this category—slightly higher than we have typically found of about 95%. This may reflect a relatively low number of write-in votes.

Contest Variants

After removing all agreed-regular contests what remains are Contest Variants. They include **agreed and irregular contests** (agreed but with write-ins, overvotes, ambiguous marks), as well as "**disagreed**," those contests that did not match between AuditEngine and the CVR, including both regular and irregular classifications.

Those marked as disagreed often involve unusual marks, poor image quality, or markings that fall outside conventional interpretation zones. AuditEngine often performs better than the voting system in resolving such markings, but there are cases where neither system can interpret the voter's intent with confidence.

Gray-Eval

AuditEngine is normally configured to attempt to use a set of heuristics and machine learning algorithms that recognize voter intent regarding overvotes. These heuristics are not perfect, but will generally recognize light hesitation marks or partial marks when paired with obvious unambiguous marks. In all such cases, the contests will also be marked as "gray-eval" to indicate that the evaluation of the vote required the use of heuristics, and should be further reviewed in close contests.

Unprocessed Ballots

Some ballots cannot be processed due to severe image defects or alignment issues. These may include:

- Torn ballots with dark wedges at the fold.
- Smudges or obstructed barcodes.
- Misfeeds that result in distorted or curved images.

By handling unprocessable ballots separately, we maintain a high standard of accuracy while enabling meaningful review of edge cases. We can't include

these in the total of ballot-contests because we may not know how many contests are included in these unprocessed ballots, as the source of that information is the CVR which (by rule) AuditEngine cannot accept as trusted.

High-Level Results in Burlington and Sussex

Based on the definitions described above, this audit has the following numbers:

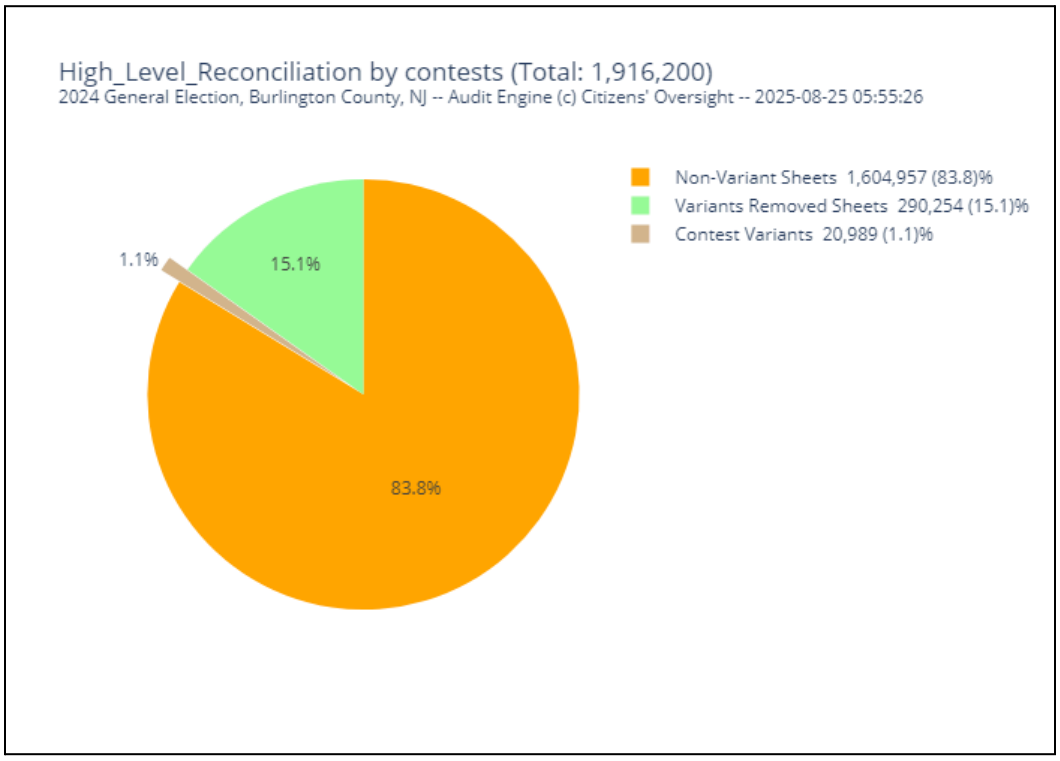
Attribute	Burlington	Sussex
Total Ballot Sheets	231,573	85,228
Total Ballot-Contests	1,916,200	664,731
Non-variant Contests	1,892,511 (98.9%)	658,265 (99.0%)
Contest Variants	20,989 (1.1%)	6,466 (1%)
Agreed Irregular:		
Write-ins	11,910	5,891
Overvotes	3,647	104
Gray-Flagged	4,814	425
True Disagreed	618 (0.032%)	46 (0.007%)
Unprocessed Ballots	30 (0.013%)	34 (0.039%)

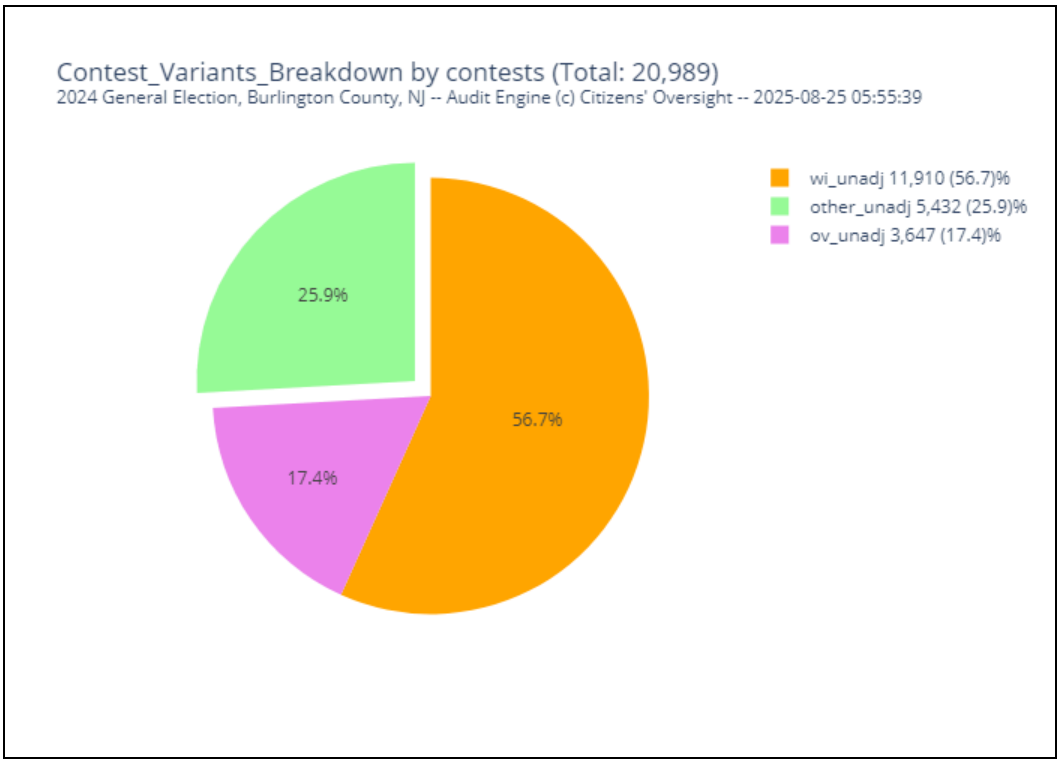
IN BURLINGTON: Overvotes are shown in the official CVRs as undervotes for all candidates rather than as a single overvote. AuditEngine properly indicates an overvote as an overvote rather than undervotes. To avoid a plethora of contests that appear to be disagreements, AuditEngine was configured to regard these as “agreed overvotes”. Generally, undervotes are NOT regarded as a variant, as it is common for voters to not vote on every contest and to vote for the full complement of allowed selections.

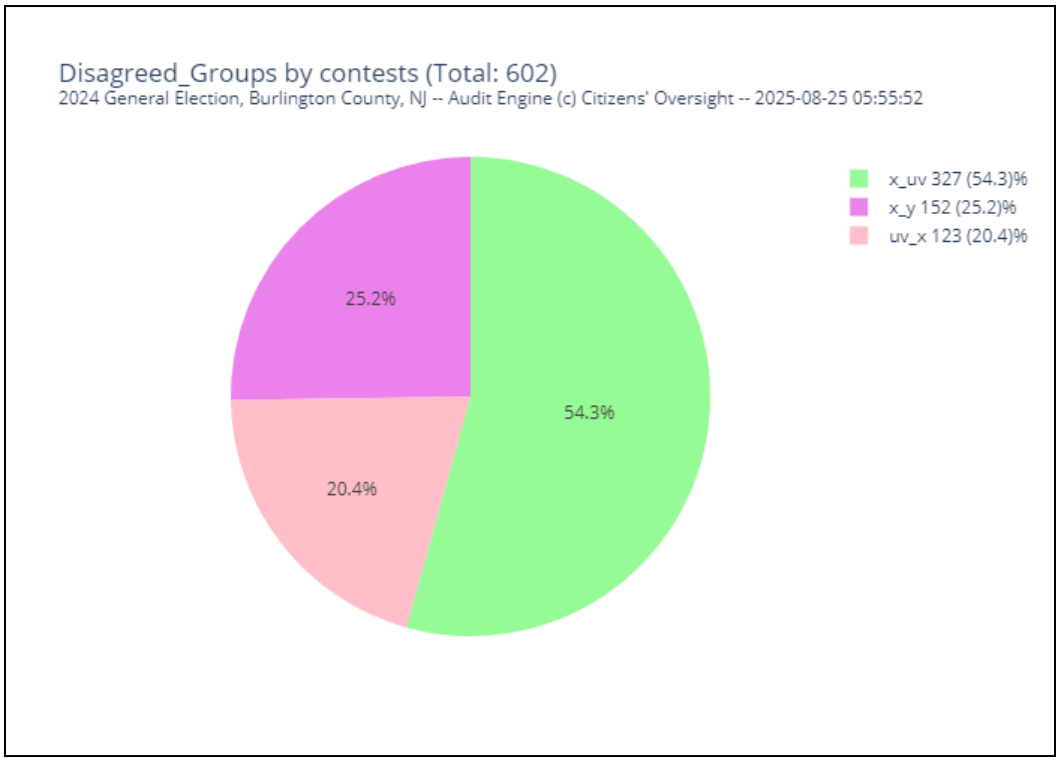
Comparison Visual Breakdowns

In each case, each subsequent pie chart is a breakdown of a slice of the previous pie.

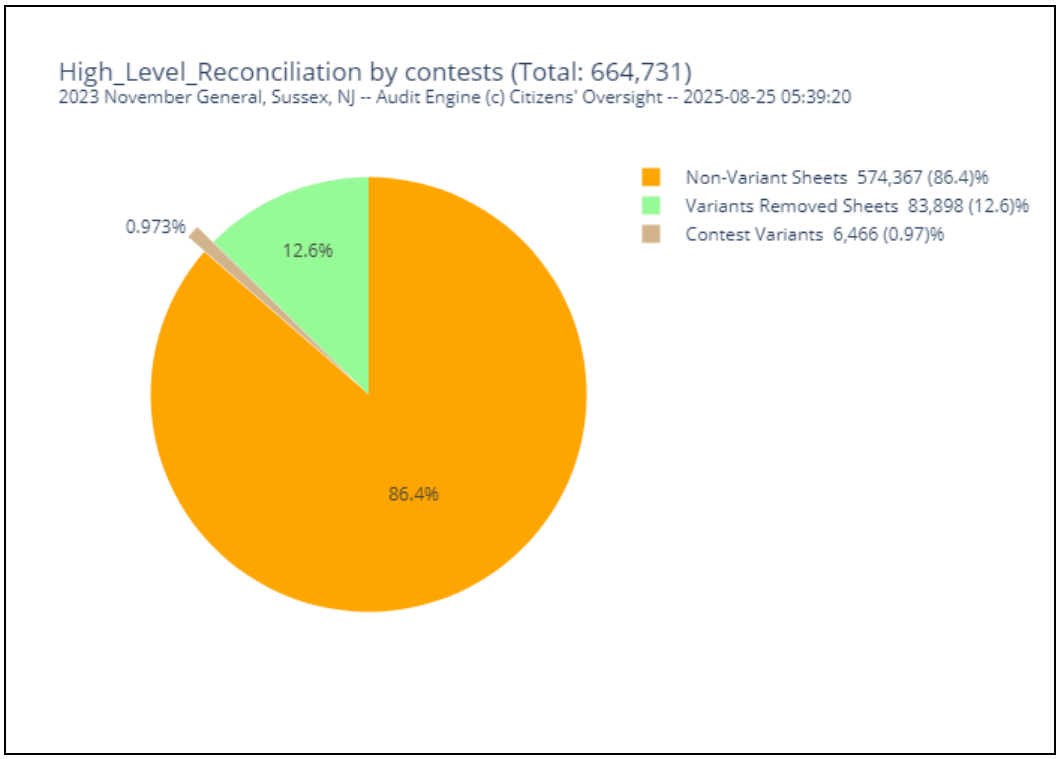
Burlington

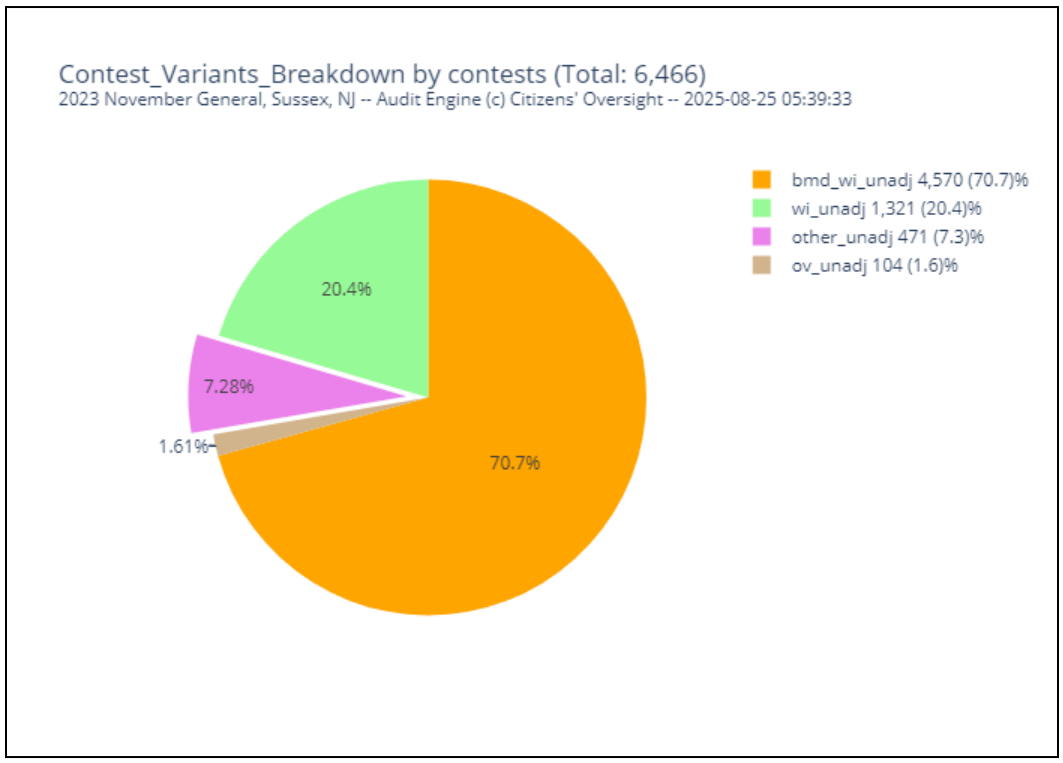


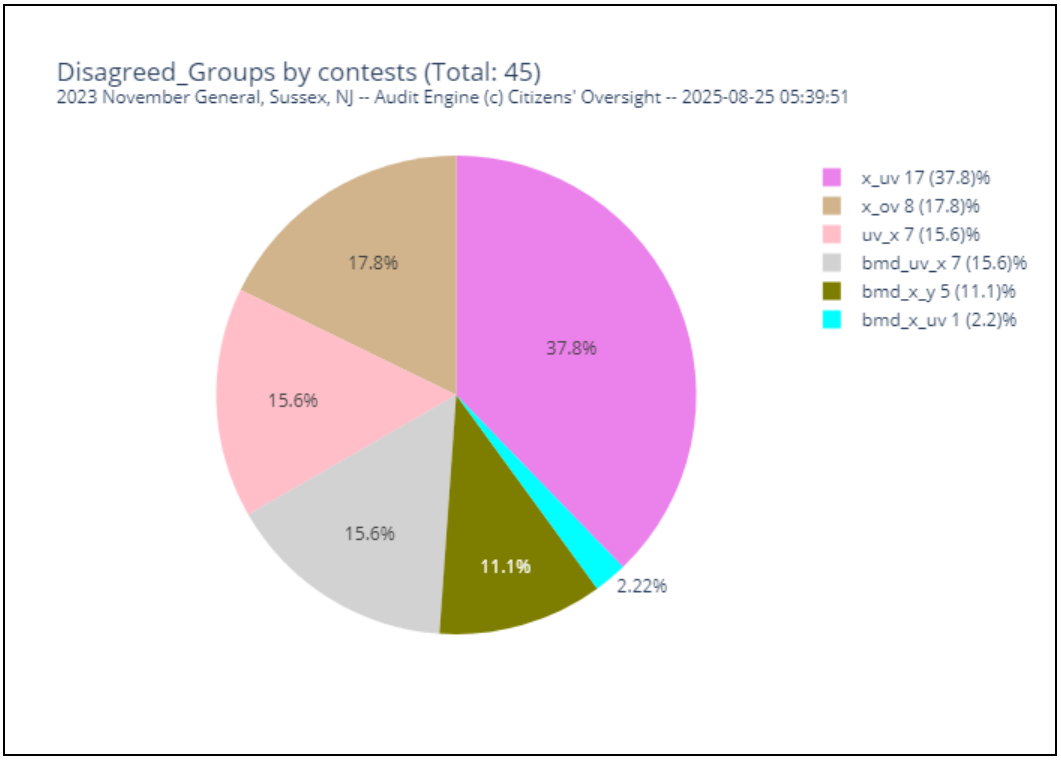

Contest_Variants_Breakdown by contests (Total: 20,989)
2024 General Election, Burlington County, NJ -- Audit Engine (c) Citizens' Oversight -- 2025-08-25 05:55:39
wi_unadj 11,910 (56.7)%
other_unadj 5,432 (25.9)%
ov_unadj 3,647 (17.4)%
25.9%
56.7%
17.4%


Disagreed_Groups by contests (Total: 602)
2024 General Election, Burlington County, NJ -- Audit Engine (c) Citizens' Oversight -- 2025-08-25 05:55:52
x_uv 327 (54.3)%
x_y 152 (25.2)%
uv_x 123 (20.4)%
25.2%
54.3%
20.4%

Sussex


High_Level_Reconciliation by contests (Total: 664,731)
2023 November General, Sussex, NJ -- Audit Engine (c) Citizens' Oversight -- 2025-08-25 05:39:20
Non-Variant Sheets 574,367 (86.4)%
Variants Removed Sheets 83,898 (12.6)%
Contest Variants 6,466 (0.97)%
0.973%
12.6%
86.4%


Contest_Variants_Breakdown by contests (Total: 6,466)
2023 November General, Sussex, NJ -- Audit Engine (c) Citizens' Oversight -- 2025-08-25 05:39:33
bmd_wi_unadj 4,570 (70.7)%
wi_unadj 1,321 (20.4)%
other_unadj 471 (7.3)%
ov_unadj 104 (1.6)%
20.4%
7.28%
1.61%
70.7%



Common Observations

We can compare and contrast the two counties and their results. This is the complete list of attributes for comparison. Subsequently, we will consider each group and explain each of the attributes that are of interest.

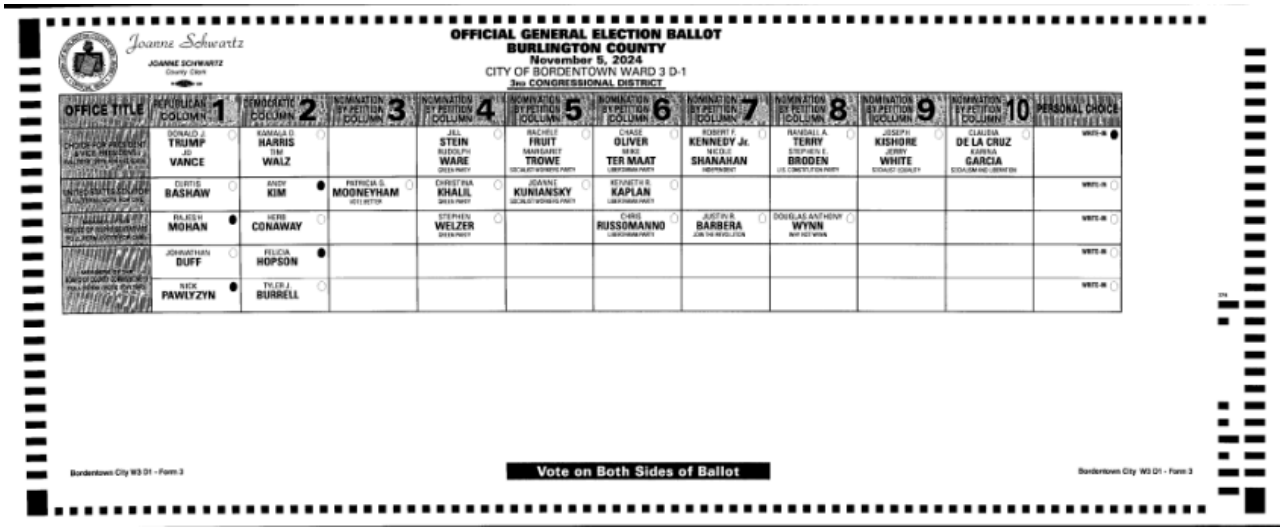
Election system and ballot layout

Attribute	Burlington	Sussex
Election System Vendor	Dominion	ES&S
Barcoded BMDs?	No — hand-marked layout only	Yes — ExpressVote summary cards
HMB Layout	Landscape grid	Portrait with three vertical columns
Oval location	Right side of candidate name	Left side of candidate name

Transitioning away from paperless DRE systems was a critical improvement for both counties following the 2020 election. However, the systems now in use are quite different and present distinct characteristics that impact auditability and usability.

Burlington:

Here is an example of the ballot layout, on the front and back. The actual dimensions of the ballot were 8.5" x 17".



OFFICIAL GENERAL ELECTION BALLOT
BURLINGTON COUNTY
November 5, 2024
CITY OF BORDENTOWN WARD 3 D-1
3rd CONGRESSIONAL DISTRICT

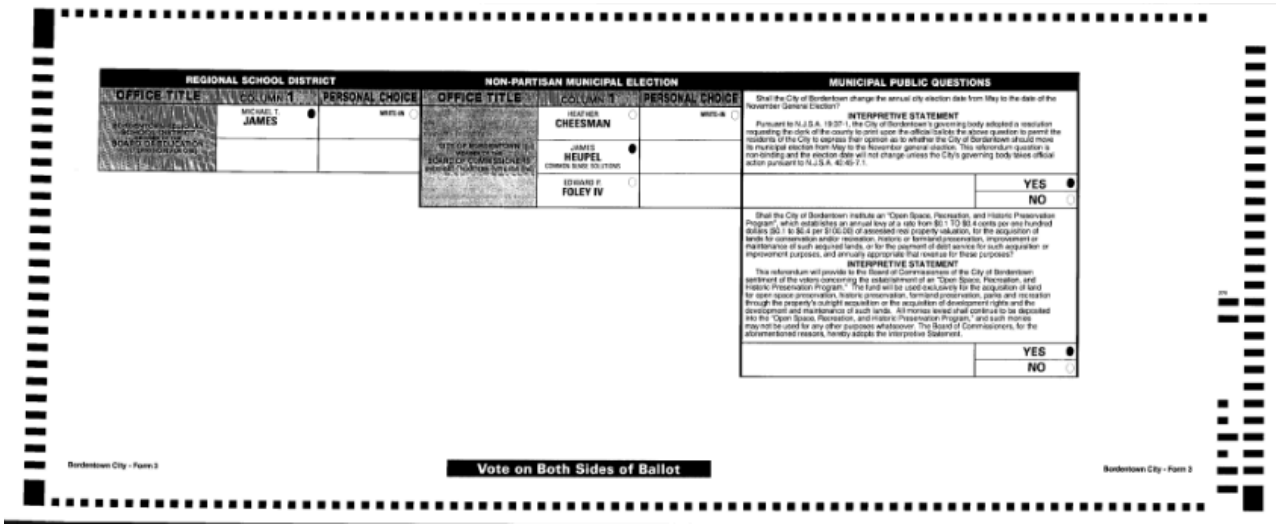
Joanne Schwartz
JOANNE SCHWARTZ
County Clerk

OFFICE TITLE	REPUBLICAN COLUMN 1	DEMOCRATIC COLUMN 2	NOMINATION BY PETITION COLUMN 3	NOMINATION BY PETITION COLUMN 4	NOMINATION BY PETITION COLUMN 5	NOMINATION BY PETITION COLUMN 6	NOMINATION BY PETITION COLUMN 7	NOMINATION BY PETITION COLUMN 8	NOMINATION BY PETITION COLUMN 9	NOMINATION BY PETITION COLUMN 10	PERSONAL CHOICE
VOTE FOR PRESIDENT & VICE PRESIDENT	DONALD J. TRUMP / JD VANCE	KAMALA D. HARRIS / TIM WALZ		JILL STEIN / RUDOLPH WARE	RACHELE FRUIT / MARGARET TROWE	CHASE OLIVER / MIKE TER MAAT	ROBERT F. KENNEDY Jr. / NICOLE SHANAHAN	RANDALL A. TERRY / STEPHEN E. BRODEN	JOSEPH KISHORE / JERRY WHITE	CLAUDIA DE LA CRUZ / KARINA GARCIA	WRITE-IN
UNITED STATES SENATOR	CURTIS BASHAW	ANDY KIM	PATRICIA D. MOONEYHAM	CHRISTINA KHALIL	JOANNE KUNIANSKY	KENNETH R. KAPLAN					WRITE-IN
MEMBER OF THE HOUSE OF REPRESENTATIVES	RAJESH MOHAN	HERB CONAWAY		STEPHEN WELZER		CHRIS RUSSOMANNO	JUSTIN R. BARBERA	DOUGLAS ANTHONY WYNN			WRITE-IN
BURLINGTON COUNTY FREEHOLDER	JONATHAN DUFF	FELICIA HOPSON									WRITE-IN
BURLINGTON COUNTY FREEHOLDER	NICK PAWLYZYN	TYLER J. BURRELL									WRITE-IN

Bordentown City W3 D1 - Form 3

Vote on Both Sides of Ballot

Bordentown City W3 D1 - Form 3



REGIONAL SCHOOL DISTRICT			NON-PARTISAN MUNICIPAL ELECTION			MUNICIPAL PUBLIC QUESTIONS
OFFICE TITLE	COLUMN 1	PERSONAL CHOICE	OFFICE TITLE	COLUMN 1	PERSONAL CHOICE	
BORDENTOWN REGIONAL SCHOOL DISTRICT BOARD OF EDUCATION	MICHAEL T. JAMES	WRITE-IN	CITY OF BORDENTOWN COMMON BOARD SOLUTIONS	HEATHER CHEESMAN	WRITE-IN	Shall the City of Bordentown change the annual city election date from May to the date of the November General Election? INTERPRETIVE STATEMENT Pursuant to N.J.S.A. 19:37-1, the City of Bordentown's governing body adopted a resolution requesting the clerk of the county to print upon the official ballots the above question to permit the residents of the City to express their opinion as to whether the City of Bordentown should move its municipal election from May to the November general election. This referendum question is non-binding and the election date will not change unless the City's governing body takes official action pursuant to N.J.S.A. 40:49-7.1.
				JAMES HEUPEL		YES / NO
				EDWARD F. FOLEY IV		Shall the City of Bordentown institute an "Open Space, Recreation, and Historic Preservation Program", which establishes an annual levy of a rate from $0.1 TO $0.4 cents per one hundred dollars ($0.1 to $0.4 per $100.00) of assessed real property valuation, for the acquisition of lands for conservation and/or recreation, historic or farmland preservation, improvement or maintenance of such acquired lands, or for the payment of debt service for such acquisition or improvement purposes, and annually appropriate that revenue for these purposes? INTERPRETIVE STATEMENT This referendum will provide to the Board of Commissioners of the City of Bordentown sentiment of the voters concerning the establishment of an "Open Space, Recreation, and Historic Preservation Program." The fund will be used exclusively for the acquisition of land for open space preservation, historic preservation, farmland preservation, parks and recreation through the property's outright acquisition or the acquisition of development rights and the development and maintenance of such lands. All monies levied shall continue to be deposited into the "Open Space, Recreation, and Historic Preservation Program," and such monies may not be used for any other purposes whatsoever. The Board of Commissioners, for the aforementioned reasons, hereby adopts the interpretive Statement.
						YES / NO

Bordentown City - Form 3

Vote on Both Sides of Ballot

Bordentown City - Form 3

Comments:

1. The ballots are laid out in a landscape orientation, with ovals to the right of each candidate name.

2. Party affiliations form columns, while contests occupy rows—an uncommon grid-style format influenced by the previous DRE layout (Sequoia AVC Advantage).

3. **Barcodes are present on both sides**, which greatly aids in image orientation. The barcode is a proprietary graphic, not an industry-standard format, and typically appears at the bottom when the landscape ballot (as shown in the image above) is rotated 90° clockwise.

4. The ballot is flipped to the back along the long-edge, meaning that the barcode and top of each side are along the same edges.

5. **Soak-Through Hazard:** Special care must be taken in the design and printing of the ballot to offset front and back ovals, preventing bleed-through or soak-through errors if ovals are aligned back-to-back.

6. **Ovals to the right:** The use of ovals on the right of the ballot option name is contrary to conventional checklist design, where checkboxes typically appear on the left. This may be confusing for some voters, although it does not impair AuditEngine's ability to correctly process and audit the ballots.

   In some instances, the name may be left-justified while the oval is right-justified, making the oval closer to the next option to the right. Standardizing this makes it easier for assistive readers to make sense of the ballot.

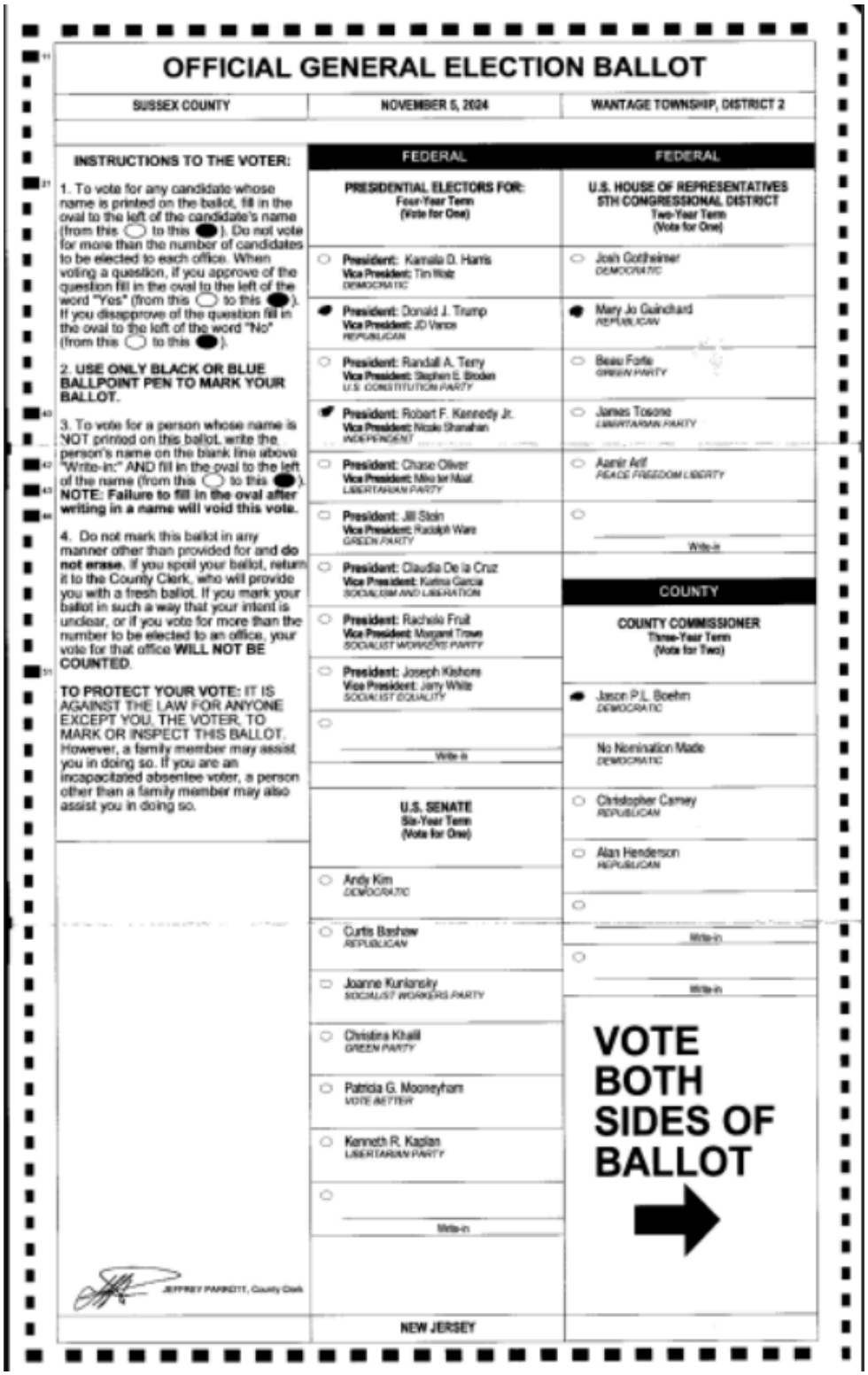
7. **Consider Portrait Orientation with Columns:** We recommend that the county consider transitioning to a standard vertical column layout, which is more common and user-friendly.

8. **No vote-encoding barcodes:** This system does not use barcodes to encode votes. Even when voters use a touch-screen interface for accessibility, the resulting ballot follows the same hand-marked-style layout, preserving full voter verifiability, and supportive of the recent

Executive Order which intends to ban such barcodes.

9. **Write-ins are machine-written with in-person voting.** When voters use the touch screen to enter write-ins, the names are rendered in a handwriting-like font that is generally readable and can be parsed reliably. AuditEngine is capable of processing these entries with minimal configuration changes.

Sussex:



OFFICIAL GENERAL ELECTION BALLOT

SUSSEX COUNTY | NOVEMBER 5, 2024 | WANTAGE TOWNSHIP, DISTRICT 2

INSTRUCTIONS TO THE VOTER:

1. To vote for any candidate whose name is printed on the ballot, fill in the oval to the left of the candidate's name (from this ○ to this ●). Do not vote for more than the number of candidates to be elected to each office. When voting a question, if you approve of the question fill in the oval to the left of the word "Yes" (from this ○ to this ●). If you disapprove of the question fill in the oval to the left of the word "No" (from this ○ to this ●).

2. **USE ONLY BLACK OR BLUE BALLPOINT PEN TO MARK YOUR BALLOT.**

3. To vote for a person whose name is NOT printed on this ballot, write the person's name on the blank line above "Write-in:" AND fill in the oval to the left of the name (from this ○ to this ●). **NOTE: Failure to fill in the oval after writing in a name will void this vote.**

4. Do not mark this ballot in any manner other than provided for and **do not erase.** If you spoil your ballot, return it to the County Clerk, who will provide you with a fresh ballot. If you mark your ballot in such a way that your intent is unclear, or if you vote for more than the number to be elected to an office, your vote for that office **WILL NOT BE COUNTED.**

TO PROTECT YOUR VOTE: IT IS AGAINST THE LAW FOR ANYONE EXCEPT YOU, THE VOTER, TO MARK OR INSPECT THIS BALLOT. However, a family member may assist you in doing so. If you are an incapacitated absentee voter, a person other than a family member may also assist you in doing so.

JEFFREY PARKETT, County Clerk

FEDERAL

PRESIDENTIAL ELECTORS FOR:
Four-Year Term
(Vote for One)

- ○ **President:** Kamala D. Harris / **Vice President:** Tim Walz — DEMOCRATIC
- ● **President:** Donald J. Trump / **Vice President:** JD Vance — REPUBLICAN
- ○ **President:** Randall A. Terry / **Vice President:** Stephen E. Broden — U.S. CONSTITUTION PARTY
- ● **President:** Robert F. Kennedy Jr. / **Vice President:** Nicole Shanahan — INDEPENDENT
- ○ **President:** Chase Oliver / **Vice President:** Mike ter Maat — LIBERTARIAN PARTY
- ○ **President:** Jill Stein / **Vice President:** Rudolph Ware — GREEN PARTY
- ○ **President:** Claudia De la Cruz / **Vice President:** Karina Garcia — SOCIALISM AND LIBERATION
- ○ **President:** Rachele Fruit / **Vice President:** Margaret Trowe — SOCIALIST WORKERS PARTY
- ○ **President:** Joseph Kishore / **Vice President:** Jerry White — SOCIALIST EQUALITY
- ○ Write-in

U.S. SENATE
Six-Year Term
(Vote for One)

- ○ Andy Kim — DEMOCRATIC
- ○ Curtis Bashaw — REPUBLICAN
- ○ Joanne Kuniansky — SOCIALIST WORKERS PARTY
- ○ Christina Khalil — GREEN PARTY
- ○ Patricia G. Mooneyham — VOTE BETTER
- ○ Kenneth R. Kaplan — LIBERTARIAN PARTY
- ○ Write-in

NEW JERSEY

FEDERAL

U.S. HOUSE OF REPRESENTATIVES
5TH CONGRESSIONAL DISTRICT
Two-Year Term
(Vote for One)

- ○ Josh Gottheimer — DEMOCRATIC
- ● Mary Jo Guinchard — REPUBLICAN
- ○ Beau Forte — GREEN PARTY
- ○ James Tosone — LIBERTARIAN PARTY
- ○ Aamir Arif — PEACE FREEDOM LIBERTY
- ○ Write-in

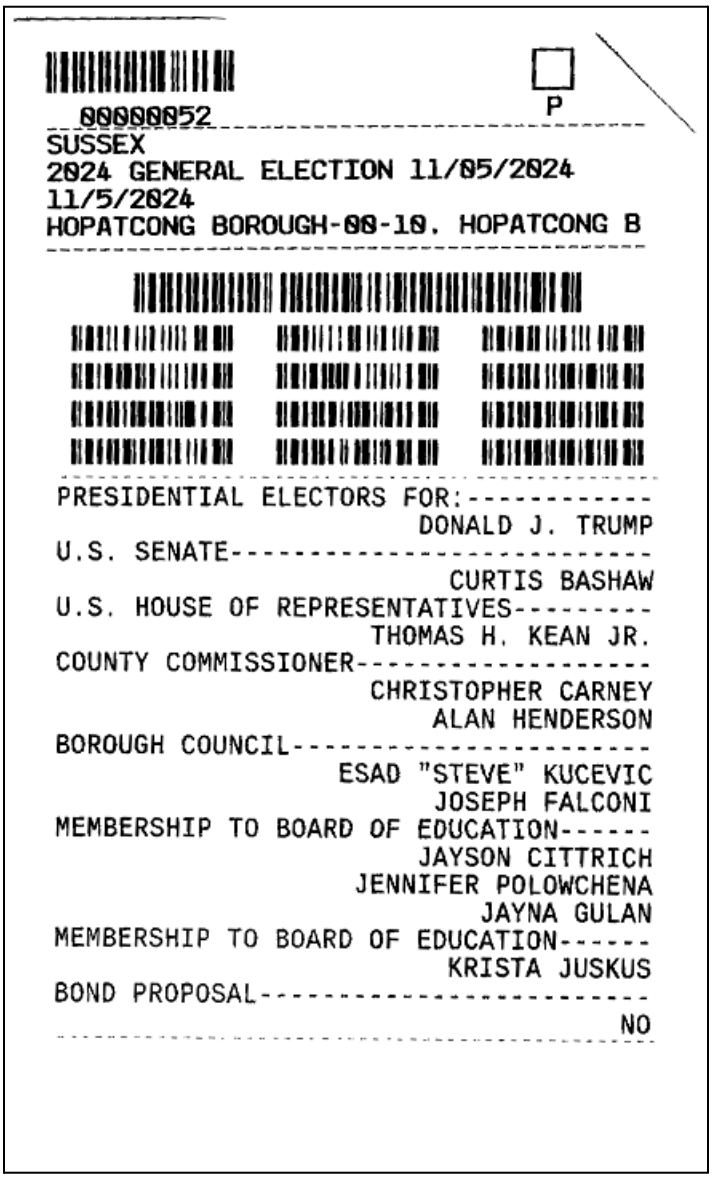
COUNTY

COUNTY COMMISSIONER
Three-Year Term
(Vote for Two)

- ● Jason P.L. Boehm — DEMOCRATIC
- No Nomination Made — DEMOCRATIC
- ○ Christopher Carney — REPUBLICAN
- ○ Alan Henderson — REPUBLICAN
- ○ Write-in
- ○ Write-in

VOTE BOTH SIDES OF BALLOT

The BMD (barcoded) ballot summary is from a ES&S ExpressVote touchscreen device.



00000052

P

SUSSEX
2024 GENERAL ELECTION 11/05/2024
11/5/2024
HOPATCONG BOROUGH-00-10. HOPATCONG B

PRESIDENTIAL ELECTORS FOR:
DONALD J. TRUMP
U.S. SENATE
CURTIS BASHAW
U.S. HOUSE OF REPRESENTATIVES
THOMAS H. KEAN JR.
COUNTY COMMISSIONER
CHRISTOPHER CARNEY
ALAN HENDERSON
BOROUGH COUNCIL
ESAD "STEVE" KUCEVIC
JOSEPH FALCONI
MEMBERSHIP TO BOARD OF EDUCATION
JAYSON CITTRICH
JENNIFER POLOWCHENA
JAYNA GULAN
MEMBERSHIP TO BOARD OF EDUCATION
KRISTA JUSKUS
BOND PROPOSAL
NO

Comments:

- **POSITIVE: Standard Layout**

  Sussex uses a **three-column portrait layout** with **ovals positioned to the left** of the candidate or option name. This format is more consistent with standard ballot designs across the country and mirrors the layout of paper checklists, which most voters find intuitive.

- **NEGATIVE: Limited Orientation Cues**
  Unlike Burlington's ballots, ES&S ballots lack reliable rotation hints on the back. The barcode is embedded within the left-side timing marks, but it is not present on both sides of the ballot. As a result, determining the correct orientation for the back side requires inspection of the printed content within the timing frame, which complicates automated processing.

- **GOOD TRY BUT: Fiducial Mark Ambiguity:**

  The darkened corner fiducial mark is an unreliable orientation indicator. A folded or damaged corner can appear visually identical, making it unsuitable for resolving front/back orientation ambiguities.

- **POSITIVE: Header Placement:**

  The consistent placement of the county name and election date at the top of the ballot helps support both image orientation and quality control. These elements can be automatically checked to detect ballots from the wrong jurisdiction or election.

  > ***Example:*** In this election, we identified one ballot from the 2024 Republican Primary mistakenly included in the general election ballot pool. While it was included in the overall scanned ballot count, no votes were tallied from it, and it was properly excluded from the audit results.

- **NEGATIVE: BMD Text Line Limitations**

  The ES&S ExpressVote system restricts BMD summary cards to 38 characters per line. As a result, contest names are frequently truncated (e.g., "HOPATCHOG BOROUGH COUNCIL" becomes simply "BOROUGH COUNCIL" like every other BOROUGH COUNCIL). While this reduces visual clutter, it increases the risk of misinterpretation or configuration mismatches, particularly in jurisdictions with overlapping contest names. (The newer release of these machines uses 54 characters per line, although in trade, they are smaller and harder to read).

Turnout and Counts

Attribute	Burlington	Sussex
Population (Recent)	464,269	146,132
Registered Voters (RV)	372,410 (80.2%)	120,644 (82.5%)
Reported ballots cast	231,573	85,228
Turnout of RV	62.18%	70.64%
Turnout of Population	49.88%	58.32%

Analysis:

The registration rates in both Burlington (80.2%) and Sussex (82.5%) counties are relatively high when measured against their total populations, including non-citizens and those under age 18. According to the U.S. Census Bureau, approximately 22% of the U.S. population is under the age of 18, making them ineligible to register. When comparing eligible populations, the national average for registration among the citizen voting-age population (CVAP) was 73.6% in 2024.

In terms of voter turnout:

- **Burlington**'s turnout among registered voters was 62.18%, slightly below both the national turnout of 63.7% and the New Jersey statewide rate of 67%.

- **Sussex County**, by contrast, reported a 70.64% turnout—notably higher than both state and national averages.

When turnout is calculated as a percentage of total population, Sussex also outperformed Burlington (58.32% vs. 49.88%), reflecting both stronger participation and a higher registration rate relative to its size.

Data Counts

Attribute	Burlington	Sussex
Images (sheets)	231,555	85,228

CVR records	231,555	85,228
Missing Ballot Images	18	0
Barcode Ballots	0	73,707
Barcode Ballots %	0%	86.4%
Image archives (zip)	6	29
CVR type	CSV w/writein columns	XLSX

Burlington County is a significantly larger jurisdiction, with approximately **2.7 times more voters** and ballots cast than Sussex County. However, both audits required **three rounds** of data submissions before the complete dataset was available and validated.

Burlington

Three rounds were required to get the complete data set.

- **March 19, 2025**: Audit project initiated.
- **March 25**: First round of ballot images received.
- **April 13**: First ZIP file was found to be corrupted, with trailing data beyond the normal payload. Only 113,456 unique ballot images were usable out of 231,573 ballots cast, resulting in more than half of the images missing.
- **May 16**: A new set of image archives was received, resolving most of the issues. However, approximately 643 ballots from Williamsboro were still unaccounted for.
- **July 12**: An additional set of 15 ZIP archives was submitted. After processing, it was determined that only one archive was previously missing. With this final addition, the image set was considered complete, and the 643 missing ballots were recovered.

- **Additional ballot styles** were introduced with the new data, requiring updates to the style map.

- **Final discrepancy**: The CVR record count differs from the image count by 18 ballots. The cause of this mismatch remains unknown but is considered non-material and does not affect any outcomes.

Sussex County – Data Timeline and Issues

- **June 1, 2025**: Initial CVR and ballot images uploaded to AuditEngine.

- **June 3**: The original CVR file contained only the presidential contest. Additionally, one image folder appeared to be a stray ZIP file but was later found to be duplicated in `Andover Twp.zip`.

- **June 23**: A **replacement CVR** was provided containing all contests.

- **June 28**: It was determined that **3,800 ballot images** from the Newton area were missing.

- **June 30**: A set of six ZIP archives labeled “Sussex Newton” was uploaded. This resolved the missing image issue.

- **July 1**: Sussex election was mapped and validated using the **TargetMapper** application.

- Analysis revealed that 86.4% of all ballots (73,707) were BMD-generated ballot summary cards with barcodes, confirming that the majority of in-person voters used ExpressVote devices.

Precincts, Styles, Contests

Attribute	Burlington	Sussex
Precincts	409	20
Average Ballots cast per precinct	566	4,261
Styles Defined	775	194
Contests	121	67
Unique Contest Patterns	43	26
Small Styles	5*	Not avail.

Analysis:

1. **High Ballot Style Count (Both Counties):**

   Burlington defined 775 different types of paper ballots (styles) most differing only in the precinct number printed on the ballot, while Sussex had 194. However, Burlington only had 43 unique groups of contests across all ballots, indicating that many styles are functionally redundant.

   - Recommendation: Counties should periodically review and consolidate ballot styles to minimize complexity, reduce configuration burden, and enhance voter privacy[2], particularly for styles with very low usage.

2. **Federal-Only Ballots (Sussex):**

   Federal-only ballots were identified based on a bit field in the barcode, which was not initially documented in the configuration. These required us to regenerate templates and refine the mapping logic. We numbered the styles to 1000 and above to these ballots which are

[2] When the public can find which voters use a style with very few ballots, they may figure out which ballot came from each person https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4926979

further split by precinct. But as federal only ballots, only the federal contests are on them, and thus the ballot content (style) will be the same for each congressional district, for all precincts. If these are categorized by precinct, it will result in a large number of styles with fewer than 10 ballots, and thus there is a danger of revealing the voter of specific ballots and piercing ballot anonymity.

    - **Recommendation:** We advise against this method of handling federal-only ballots, as it leads to artificial style inflation and the creation of styles with very few ballots, increasing the risk of voter re-identification. Instead, it is better to group all such voters to the same style ballot per congressional district.

3. The **Small Styles Report** is marked for enhancement and further testing and was not fully available for this audit. The goal of this report is to highlight those styles with fewer than 10 ballots, and thus there is a privacy risk.

Repeated or Improper Ballots

AuditEngine routinely verifies ballot integrity by checking for repeated images and ballots from the wrong jurisdiction or election. When possible, we also extract and validate the county name and election date printed on each ballot—typically found in the header area just inside the timing marks.

In this audit:

- **Repeated ballot images** can be identified by comparing both the `ballot_id` values and the digital hash of the image content. This process reliably detects duplicate uploads, such as those previously found in Monmouth County (2022). **No repeated ballots were detected in either county.**

- **Jurisdiction and election date checks** were performed in Sussex County, where the ballot design includes a consistently placed header showing the county name and date. This greatly aids validation. One improper ballot was detected.

- In Burlington County, similar checks were not easily feasible due to the absence of a reliably positioned, machine-readable county/date header.

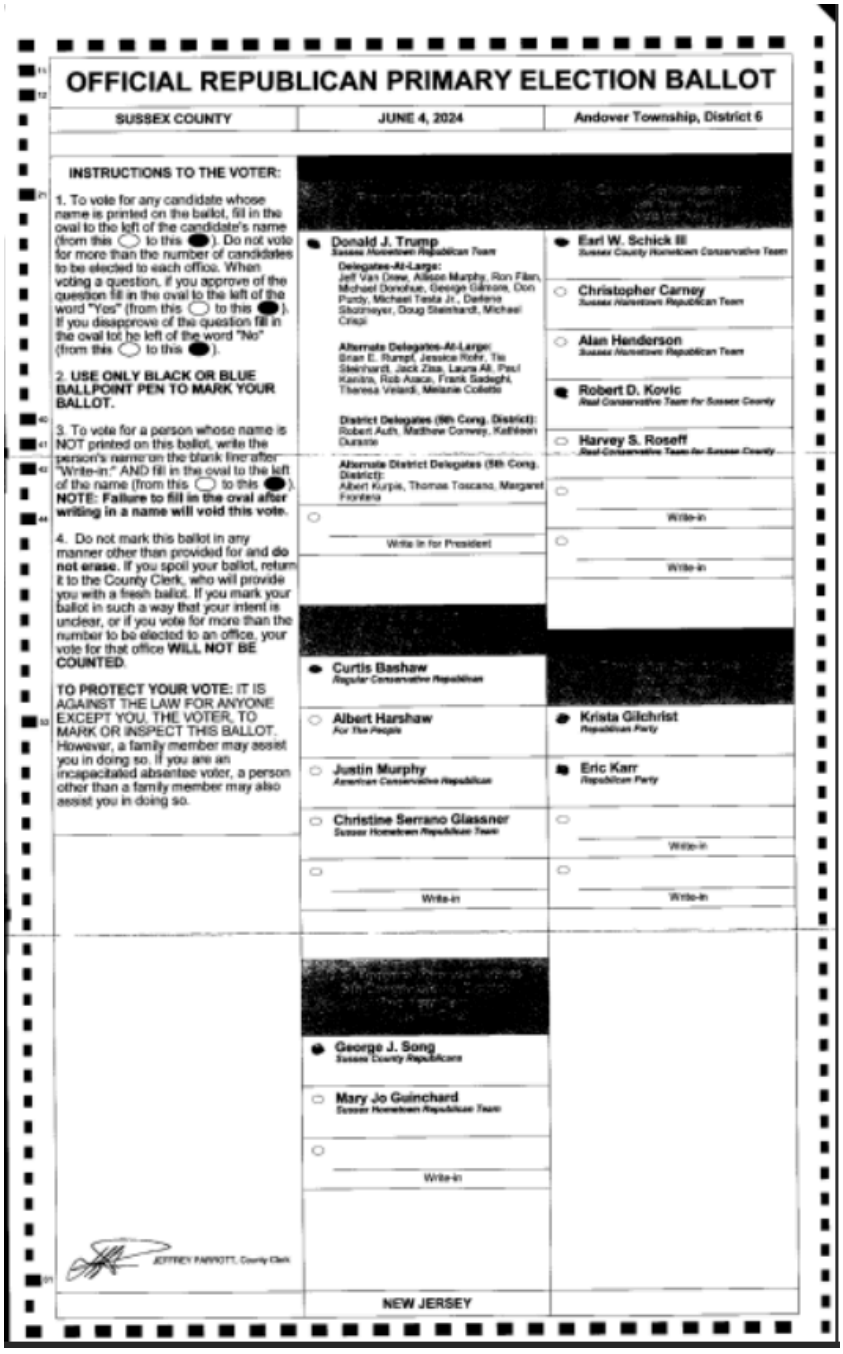
Attribute	Burlington	Sussex
Repeated Images	0	0
Ballots from other Counties	not specifically checked	specifically checked, 0 found
Ballots from other elections	not specifically checked	specifically checked, 1 found (June 4, 2024)

Stray Ballot in Sussex County

One ballot from Sussex County was identified as originating from the June 4, 2024 Republican Primary. It **was** included in the total image count and number of ballots cast, but **no votes were included in the CVR** and so it did not improperly affect the outcome. No votes were counted from this ballot.

Similarly, the audit also did not capture any votes from this ballot.

However, we must observe that this was likely not due to any positive controls that would exclude votes from this ballot, but rather that it just so happened that there were no dark spots under the ovals.



OFFICIAL REPUBLICAN PRIMARY ELECTION BALLOT

SUSSEX COUNTY | JUNE 4, 2024 | Andover Township, District 6

INSTRUCTIONS TO THE VOTER:

1. To vote for any candidate whose name is printed on the ballot, fill in the oval to the left of the candidate's name (from this ◯ to this ●). Do not vote for more than the number of candidates to be elected to each office. When voting a question, if you approve of the question fill in the oval to the left of the word "Yes" (from this ◯ to this ●). If you disapprove of the question fill in the oval to the left of the word "No" (from this ◯ to this ●).

2. USE ONLY BLACK OR BLUE BALLPOINT PEN TO MARK YOUR BALLOT.

3. To vote for a person whose name is NOT printed on this ballot, write the person's name on the blank line after "Write-in." AND fill in the oval to the left of the name (from this ◯ to this ●). NOTE: Failure to fill in the oval after writing in a name will void this vote.

4. Do not mark this ballot in any manner other than provided for and do not erase. If you spoil your ballot, return it to the County Clerk, who will provide you with a fresh ballot. If you mark your ballot in such a way that your intent is unclear, or if you vote for more than the number to be elected to an office, your vote for that office WILL NOT BE COUNTED.

TO PROTECT YOUR VOTE: IT IS AGAINST THE LAW FOR ANYONE EXCEPT YOU, THE VOTER, TO MARK OR INSPECT THIS BALLOT. However, a family member may assist you in doing so. If you are an incapacitated absentee voter, a person other than a family member may also assist you in doing so.

[redacted]

● Donald J. Trump
Sussex Hometown Republican Team
Delegates-At-Large:
Jeff Van Drew, Allison Murphy, Ron Filer, Michael Donohue, George Gilmore, Don Purdy, Michael Testa Jr., Darlene Shoinmeyer, Doug Steinhardt, Michael Crispi
Alternate Delegates-At-Large:
Brian E. Rumpf, Jessica Rohr, Tia Steinhardt, Jack Zisa, Laura Ali, Paul Kanaris, Rob Asaca, Frank Sadeghi, Theresa Velardi, Melanie Colletto
District Delegates (5th Cong. District):
Robert Auth, Matthew Conway, Kathleen Durante
Alternate District Delegates (5th Cong. District):
Albert Kurpis, Thomas Toscano, Margaret Fronlera

○ Write In for President

[redacted]

● Curtis Bashaw
Regular Conservative Republican

○ Albert Harshaw
For The People

○ Justin Murphy
American Conservative Republican

○ Christine Serrano Glassner
Sussex Hometown Republican Team

○ Write-in

[redacted]

● George J. Song
Sussex County Republicans

○ Mary Jo Guinchard
Sussex Hometown Republican Team

○ Write-in

● Earl W. Schick III
Sussex County Hometown Conservative Team

○ Christopher Carney
Sussex Hometown Republican Team

○ Alan Henderson
Sussex Hometown Republican Team

● Robert D. Kovic
Real Conservative Team for Sussex County

○ Harvey S. Roseff
Real Conservative Team for Sussex County

○ Write-in

○ Write-in

[redacted]

● Krista Gilchrist
Republican Party

● Eric Karr
Republican Party

○ Write-in

○ Write-in

JEFFREY PARROTT, County Clerk

NEW JERSEY

Contest Discrepancies

While the filtering process described above provides a strong overall picture of election quality based on ballot-contests, it is essential to examine individual complete contests more closely.

A ballot-contest discrepancy count -- such as the 96 or 618 disagreements we have here -- may appear insignificant in the context of millions of ballot-contests, but in a small local contest with limited turnout, even a handful of discrepancies can be impactful. In other words, it depends on how those discrepancies are distributed across the contests. If they are all found in just a few contests, what looks like a small discrepancy may be significant.

To support this analysis, all contests are summarized in the **Contest Discrepancy Report (see "Automated Reports", below)**, which provides detailed metrics on agreement, disagreement, write-ins, overvotes, and ambiguous marks for each contest.

By way of example for this narrative report, we focus on a subset of contests that are most sensitive to discrepancies, either due to close margins, small voter populations, or high rates of non-standard markings. These contests are the most likely to be influenced by interpretation differences and should be given particular attention in post-election review. In the overall Contest Discrepancy Report, these are highlighted if they are close in terms of their relationship to the margin of victory.

To assess the potential impact of discrepancies on individual contests, we compare the number of **disagreed ballot-contests** to the **margin of victory**. If the number of disagreements is **less than the margin**, it is mathematically impossible for the result to be reversed—even if all disagreements favored the losing candidate.

In practice, disagreements are typically split between candidates or stem from ambiguous marks, write-ins, or overvotes. For this reason, a contest generally does not become a concern unless the number of disagreements approaches or exceeds twice the margin of victory, which could indicate the possibility of a swing under extreme assumptions.

BURLINGTON

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However, in practice, disagreements are typically split between candidates or stem from ambiguous marks, write-ins, or overvotes. For this reason, a contest generally does not become a concern unless the number of disagreements approaches or exceeds twice the margin, which could indicate the possibility of a swing under extreme assumptions.

Here are the contest with the highest number of disagreed cases or variants. All contests can be reviewed in the Discrepancy 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%
Chesterfield Township - Township Committee (Vote For=1)	3,494	3,479	1	10	0	2	11	15	23.91%	32.61%	46	1.38%
Maple Shade Township - Township Council (Vote For=3)	8,448	7,963	3	441	0	40	342	485	16.72%	23.70%	2,046	9.12%
North Hanover Township - Township Committee (Vote For=2)	2,754	2,634	0	5	0	1	116	120	29.67%	30.69%	391	7.70%
Riverton Borough - Borough Council (Vote For=2)	1,503	1,487	2	6	0	6	8	16	11.76%	23.53%	68	2.37%
Cinnaminson Township Board of Education (Vote For=3)	9,006	8,728	108	120	0	45	100	278	81.30%	226.02%	123	0.62%
Hainesport Township Board of Education (Vote For=3)	3,229	2,821	57	344	0	5	217	408	61.82%	116.24%	351	5.45%
Medford Lakes Borough Board of Education (Vote For=2)	2,513	2,466	19	23	0	4	13	47	43.33%	156.67%	30	0.83%
Moorestown Township Board of Education (Vote For=3)	12,460	12,111	70	239	0	36	158	349	72.48%	160.09%	218	0.80%
Riverton Borough Board of Education (Vote For=3)	1,503	1,003	2	492	0	6	292	500	27.89%	47.76%	1,047	49.11%
Shamong - Lenape Regional School District Board of Education (Vote For=1)	3,934	3,842	54	28	0	4	29	92	72.50%	230.00%	40	1.27%
Tabernacle Township Board of Education (Vote For=3)	4,406	4,266	49	66	0	21	36	140	11.15%	43.34%	323	3.65%

Let's look at a few examples that will also explain a few of the other aspects mentioned.

One contest in Burlington merits closer attention:

Cinnaminson Township Board of Education

- **Margin of Victory**: 123 votes
- **Disagreed Ballot-Contests**: 100
- **Disagreements as % of Margin**: ~81%
- **Total Variants (including overvotes, write-ins, etc.)**: ~226% of margin

Although the number of outright disagreements is less than the margin, the total number of **contest variants**—including ambiguous and exceptional cases—exceeds twice the margin. For this reason, we recommend **additional review of this contest**, including, if deemed appropriate, adjudication of all variants using AdjudiTally, especially if any concerns were raised during canvass or public review.

Summary of the contest:

Parameter/Option	CVR	Diff	Audit
num_ballots	9,006	0	9,006
tot_votes	19,844	36	19,880
writeins	0	132	132
overvotes	0	111	111
undervotes	7,174	-369	6,805
margin	123	2	125
margin_pct	0.62%	0.010	0.63%
winners	Donna M. Iacone Laura Fitzwater Jennifer Falconiero		Donna M. Iacone Laura Fitzwater Jennifer Falconiero
Donna M. Iacone	4,635	4	4,639
Laura Fitzwater	4,410	2	4,412
Jennifer Falconiero	3,757	2	3,759
Daniel T. Evans III	3,634	0	3,634
Edyta Poplawski	3,302	2	3,304

In Burlington, since write-ins and overvotes are frequently going to be reported as undervotes, the 132 write-ins and 111 overvotes will partially balance out the -369 difference in undervotes. This contest is a "vote-for 3" type, and there are 5 contestants. In some cases, AuditEngine found that some votes would likely be evaluated as votes rather than overvotes (i.e. undervotes).

And, if you are wondering why these don't easily add up, you will have to remember that an overvote is counted as 1 for the entire contest while if you count these as undervotes, there are then 3 undervotes for each overvote. Thus, if all overvotes were legitimately recognized as an overvote and converted to undervotes, we would have 333 undervotes for those 111 overvotes, and then 132 write-ins that might or might not be considered a vote or not, and so that is enough to cover the -369 votes.

Let's take a couple of specific cases:

Ballot 50000_00100_000011:

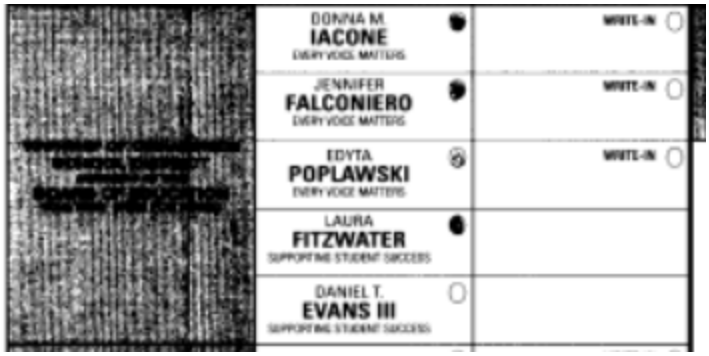
In this case, we are considering a hand-marked ballot format not marked by a BMD device, and so the user may have ambiguous marks.

The voting system reported this as **undervoted**, but in reality, this was evaluated by the voting system to be an **overvote**. There is no way for the voting system to signal that it was an overvote through the CVR.

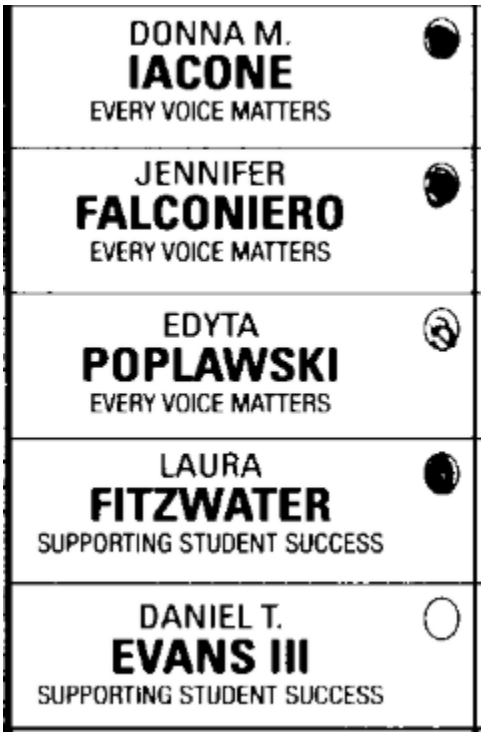
AuditEngine determined that there was a large difference between that fourth mark and the others, and so it evaluated this as three votes, while also marking it as "gray" so it could be reviewed in detail.

In reality, anything like this would be up to the election board to determine, particularly if the contest were extremely close.

Property	Value
ballot_id	50000_00100_000011
style	58
precinct	58
hexstyle	
chunk_name	
is_bmd	0
sheet_agreed	0
num_contests	1
no_cvr	0
blank	0
contest	Cinnaminson Township Board of Education (Vote For=3)
audit==cvr_orig	0
contests_mismatch	0
audit_gray_eval	1
vote_for	3



Property	PMV	Audit	CVR
tot_votes		3	0
overvotes		0	0
undervotes		0	3
num_ballots		1	1
writeins		0	0
Donna M. Iacone	603	1	0
Jennifer Falconiero	645	1	0
Edyta Poplawski	375	0	0
Laura Fitzwater	643	1	0
Daniel T. Evans III	173	0	0
writein_0	175		
writein_1	157		
writein_2	163		

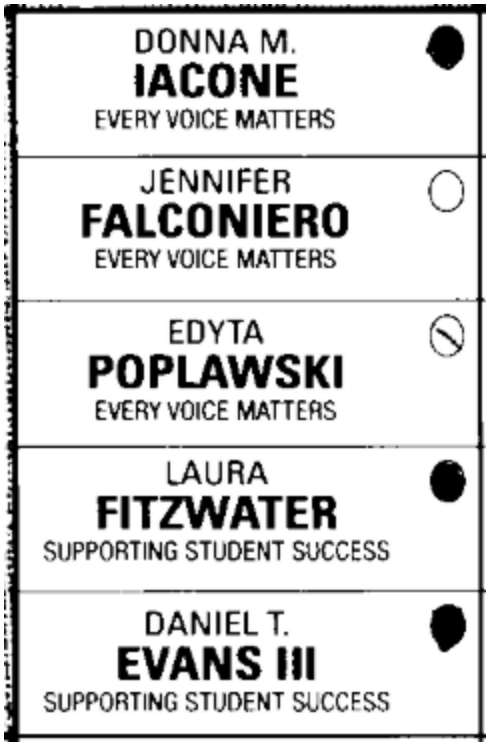


Ballot 50003_00068_000027:

Let's look at one more like this. In this case, it is even more obvious that it should not be evaluated as an overvote. AuditEngine uses a variety of heuristics to help to decide how overvotes should be evaluated, based on whether the mark is light, small, or very large. In the case of very large overvotes, these are sometimes logically regarded as scratch-outs. These heuristics require fine tuning to get them to be reliable, and so in all cases, such decisions are also flagged as gray, so they can be reviewed in extremely close contests.

Property	Value
ballot_id	50003_00068_000027
style	52
precinct	52
hexstyle	
chunk_name	
is_bmd	0
sheet_agreed	0
num_contests	1
no_cvr	0
blank	0
contest	Cinnaminson Township Board of Education (Vote For=3)
audit==cvr_orig	0
contests_mismatch	0
audit_gray_eval	1
vote_for	3

Property	PMV	Audit	CVR
tot_votes		3	0
overvotes		0	0
undervotes		0	3
num_ballots		1	1
writeins		0	0
Donna M. Iacone	713	1	0
Jennifer Falconiero	176	0	0
Edyta Poplawski	238	0	0
Laura Fitzwater	662	1	0
Daniel T. Evans III	722	1	0
writein_0	181		
writein_1	159		
writein_2	161		



SUSSEX

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%
BOROUGH COUNCIL Branchville Borough	488	480	0	2	0	0	0	8	0.00%	44.44%	18	2.40%
MEMBERSHIP TO BOE - Fredon Twp	2,145	2,091	2	8	0	13	2	54	0.47%	12.71%	425	13.96%
MEMBERSHIP TO BOE - Green Twp 3 YR	2,259	2,213	0	10	0	4	1	46	1.96%	90.20%	51	1.20%
Bond Proposal Hopatcong Borough	8,098	7,843	0	0	0	250	5	255	0.18%	9.23%	2,763	36.56%
MEMBERSHIP TO BOE - Montague Twp	2,038	2,002	0	4	0	1	0	36	0.00%	46.75%	77	2.81%
MEMBERSHIP TO BOE - Sussex-Wantage Rgnl - Wantage Twp 3 YR	6,491	6,314	0	41	0	6	1	177	0.32%	57.10%	310	2.55%
CANNABIS QUESTION REFERENDUM Stanhope Borough	2,043	1,963	0	0	0	77	3	80	1.52%	40.40%	198	10.25%

Sussex has no contests that are of any concern of being overturned by any errors, with the contest "**MEMBERSHIP TO BOE - Green Twp 3 YR**" having the highed Disagreed% of margin of 1.96%, as the margin of victory is only 51 votes and there was only 1 vote of concern in the comparison. But when reviewed, it was caused by ambiguous rotation due to a corner folded over which appeared to be the fiducial mark. Yes, that was an error by AuditEngine, but it is one that we would be able to resolve and avoid in any future audits, by

avoiding the use of the fiducial mark (dark corner) and instead using the county name and date, as they are placed in reliable locations.

The CVR provides somewhat of an intermediate resolution for write-ins, particularly for BMD ballots. Those ballots use a touch screen interface and allow the voter to key-in their vote, so there is no doubt that it is a write-in and what the name is. But the name is only captured as a digital image while AuditEngine does convert it (quite reliably) using OCR. However, it will take another round of review to resolve whether those write-in candidates are qualified. For our purposes, we stopped at the point of resolving whether write-ins exist and did not attempt to resolve them against a qualified list (as we did not have that list).

But this points out a useful feature of AuditEngine because it does provide all converted write-in names in the data file "wins.csv", which has one record per ballot (if write-ins are detected) and the converted name for each write-in opportunity.

For hand-marked paper ballots completed by hand, the names are much harder to convert and automated recognition is not reliable, and the ballot images must be reviewed, or at least the snip of the write-in area.

The summary for this contest. Notice there is only one ballot which is disagreed, but the margin is tight, being only 51 votes.

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%
MEMBERSHIP TO BOE - Green Twp 3 YR	2,261	2,256	0	0	0	4	1	5	1.96%	9.80%	51	1.20%

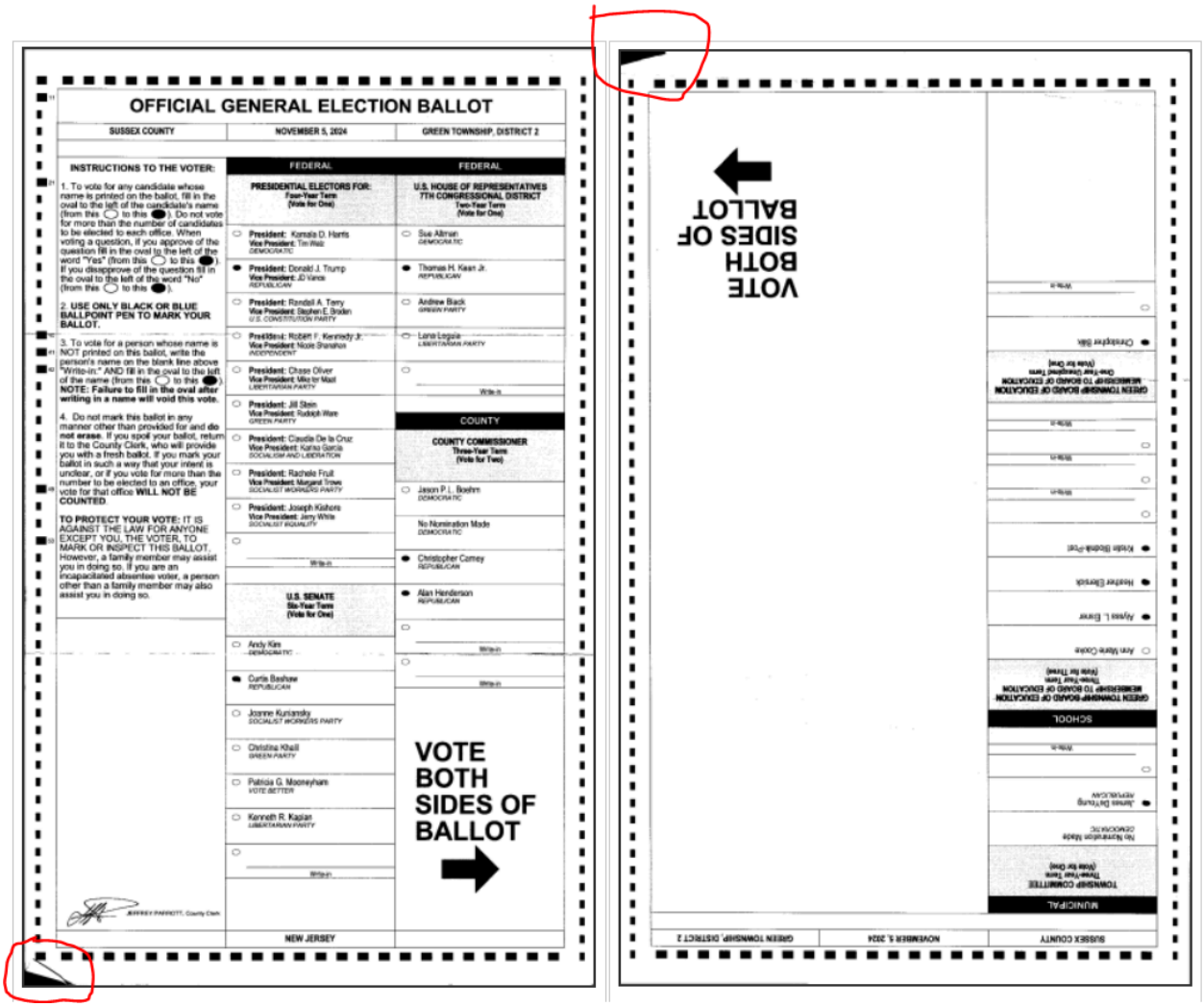
And here is the detailed summary for this one ballot of concern. We have identified the reason for the discrepancy, and it was due to a confusion about the rotation of the back, and there were three votes missing as a result.

In the future, we can avoid the use of the corner for orientation and improve the accuracy of the AuditEngine result.

Needless to say, there is no concern that any errors in the processing of these images can overturn this or any other contest in Sussex.

Parameter/Option	CVR	Diff	Audit
num_ballots	2,259	0	2,259
tot_votes	4,331	-3	4,328
writeins	79	-1	78
overvotes	0	0	0
undervotes	2,446	3	2,449
margin	51	-1	50
margin_pct	1.18%	-0.020	1.16%
winners	Ann Marie Cooke Heather Ellersick Alyssa L. Eisner		Ann Marie Cooke Heather Ellersick Alyssa L. Eisner
Ann Marie Cooke	1,245	0	1,245
Heather Ellersick	1,028	-1	1,027
Alyssa L. Eisner	1,015	-1	1,014
Kristin Blodnik-Post	964	0	964

The image of the ballot shows the folded corner which was misinterpreted as the fiducial mark.



Context of these Audits

Both counties -- Burlington and Sussex Counties, New Jersey -- recently transitioned away from legacy paperless voting systems to new systems that produce voter-verifiable paper records. In this election, Burlington used hand-marked *formatted* ballots from Dominion touch-screen ballot marking devices (BMDs) -- with no votes encoded as barcodes -- and then scanned by Dominion equipment. These are still processed as if they are hand-marked ballots.

Sussex used ES&S ExpressVote ballot marking devices alongside DS200 scanners, and hand-marked ballots for mail and absentee voters.

AuditEngine independently processed and reviewed all ballot images, comparing the results with the official Cast Vote Records (CVRs). Agreement exceeded 99% in both counties, with only a small number of disagreements—none large enough to affect any election outcomes. The audit also revealed areas for process improvement, including excessive ballot style complexity in Burlington and continued reliance on barcode-based BMDs in Sussex.

In addition to verifying results, the audit process confirmed the accuracy of ballot configuration mappings, highlighted the value of consistent ballot formatting, and demonstrated how ballot image auditing can enhance election transparency and integrity. This report provides a detailed account of findings and includes recommendations for future audits and election administration improvements.

Audits of NJ Counties in 2022

In 2022, we conducted audits of three counties in New Jersey, Burlington, Mercer, and Monmouth[3]. At the time, Burlington County still relied on an outdated Direct-Recording Electronic (DRE) system for in-person voting[4], while using hand-marked ballots for mail and absentee voting. Because DRE systems do not produce auditable records, we were only able to audit the hand-marked ballots. Furthermore, the absence of Cast Vote Records (CVRs) meant that our analysis for Burlington could only compare aggregate results for the mail/absentee ballots.

Despite these limitations, the 2022 audits proved valuable. In Monmouth County, we uncovered a significant error in which six USB drives were inadvertently counted twice. Since the duplicated ballot images were identical, we were able to identify and remove the duplicates. After correction, our audit results matched the official hand-counted tallies, leading to a revision of one contest's reported outcome. Additional issues were also identified in Mercer County.

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[3] https://copswiki.org/Common/M2009 -- Ballot Image Audits of: Burlington, Mercer and Monmouth Counties (2022) New Jersey

[4] The Sequoia AVC Advantage DRE system with no paper trail. https://verifiedvoting.org/election-system/sequoia-dominion-avc-advantage/

We encourage readers to review the 2022 audit report for a detailed account of these findings and their implications.

Burlington County 2024

For the 2024 General Election, Burlington County used the Dominion ImageCast X touch-screen system configured to produce ballots laid out the same as hand-marked ballots, rather than small ballot summary sheets with votes encoded in barcodes or QR codes, used in some counties. As a result, ballots cast by mail and those cast in person were visually identical, which greatly simplifies auditing and improves transparency.

Although in-person ballots in Burlington County are now produced using ballot marking devices, they are still classified as hand-marked ballots for the purposes of the audit.

We commend Burlington County for this implementation. It enhances voter verifiability and aligns with the recent Presidential Executive Order prohibiting the use of barcode- or QR-encoded vote records.

The ballots used in Burlington followed a grid-based layout: each contest appeared as a row, with columns corresponding to party affiliations. While this design mirrors the interface used in the legacy Sequoia AVC Advantage DRE—providing consistency for voters familiar with that system—we do not recommend this format for ongoing use. As we will discuss later in this report, there are several technical drawbacks to this layout. Nevertheless, AuditEngine was able to accommodate the format with only minor configuration adjustments.

Unlike the legacy Sequoia AVC Advantage DRE -- which recorded votes electronically without creating paper records -- systems that generate and scan paper ballots introduce new maintenance requirements. Proper handling and upkeep of paper-path components are critical. Specifically, paper feed rollers should normally be replaced after each election to ensure reliable scanning and to minimize skew, warping, or feed errors.

Figure 1. Sequoia AVC Advantage DRE used for election-day voting in Burlington County, NJ in 2022. These produce no auditable records.

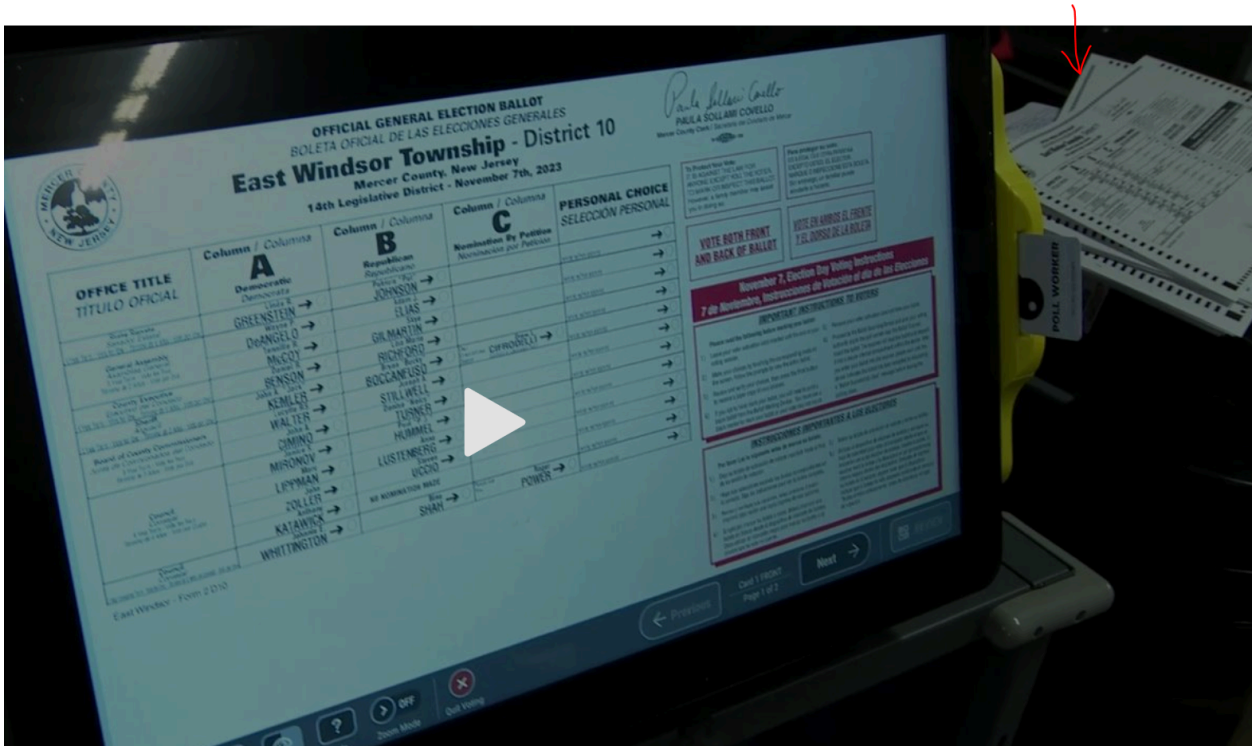

Figure 2: New BMD voting system purchased by Mercer County with full-face ballots printed for easy voter verification (no barcodes). This is the same type used by Burlington.

Burlington CVR

The Cast Vote Record (CVR) format used by Burlington County in the 2024 General Election—and also in the 2024 Primary, which we had the opportunity to audit—is notably different from other Dominion CVR formats we have encountered. Instead of using the JSON-based structure often provided by Dominion systems, Burlington's CVR was delivered as a CSV (character-separated value) file. This is not too uncommon itself, but the way write-ins are handled in the file are a departure from norms.

In this CSV format, the first few columns contain metadata describing each ballot (e.g., precinct, tabulator ID, and ballot style). The remaining columns represent contests and their associated options (e.g., candidate names or Yes/No choices). These columns are organized using a two-row header: the first row specifies the contest name (repeated across all options within the contest), and the second row specifies the option for each corresponding column.

For each ballot row, the cells corresponding to a contest are either:

- **Blank**: indicating that the contest was not present on the ballot;
- **0**: indicating the option was present but either not selected or too many candidates were selected in this contest, so none was counted;
- **1**: indicating a vote for that option.

Some contests also include an additional column for write-ins, which is marked with a 1 if a write-in was recorded, or 0 otherwise. However, no detail is included about the actual write-in name or intent.

We learned from requests for information that the write-ins were not automatically captured by the voting system, but rather were read by bi-partisan teams who read the write-in names from each ballot that had write-ins. This was facilitated by an out-stacking feature where any ballot with write-ins is segregated into a different output bin, so it is not necessary to search for those ballots with write-ins.

Metadata Fields

The metadata columns at the beginning of the CVR are:

Field Name	Meaning
CvrNumber	The record number in the table.
TabulatorNum	First field of the ballot_id, related to which tabulator was used.
BatchId	Second field of the ballot_id, the batch number processed by that tabulator.
RecordId	Third field of the ballot_id, the individual ballot within the batch.
ImprintedId	One representation of the ballot_id, which suppresses leading zeroes in the three preceding fields.
CountingGroup	"Mail-In", "Early Voting", "Election Day", or "Provisional"
PrecinctPortion	The name or number of the precinct.

BallotType	This can be the style of the ballot (which contests are on it) and it may or may not include language, party or precinct, which also may alter the type designation.

Write-in Expansion and Column Bloat

In the **Presidential contest**, for example, the CVR includes all qualified candidates such as:

> Donald J. Trump and JD Vance, REP,
> Kamala D. Harris and Tim Walz, DEM,
> Jill Stein and Rudolph Ware, GRE,
> ...and others.

After these standard options and a single "Write-in" column, the CVR includes **326 additional columns** containing literal write-in text strings entered by voters. These entries include names like:

> *Cornel West and Melina Abdullah, Dean Phillips, Nikki Haley, Sean Combs Free Diddy, Condoleezza Rice Liz Cheney, None of the above, Mickey Mouse*, and so on.

These names appear in arbitrary order -- likely based on first appearance -- without being cross-checked against any qualified write-in candidate list. NJ does not require that write-in candidates register in advance[5], but presidential candidates must comply with state rules to appear on the ballot. Many are duplicates with spelling variations, and many are not legally valid. This "raw" representation is clearly an intermediate step, allowing election officials to later determine which write-ins are legitimate.

The fact that the CVR winds up having many columns is discussed in the Appendix as it is not critical to the results of the election.

Overvote and Write-in Ambiguity

The Burlington CVR format introduces significant ambiguity in how overvotes and write-ins are represented.

[5] https://www.eac.gov/sites/default/files/2023-09/Write_In_Voting_Designed_Report_508.pdf page 7

Overvotes

When an overvote is detected by the voting system—meaning the voter selected more options than allowed in a contest—it is not recorded as a vote for any of the selected candidates. Instead, the CVR marks the contest as an undervote, with no indication that an overvote occurred or which candidates were involved. This design choice supports the goal of enabling simple column-wise summing of candidate vote totals, but it obscures valuable information.

In particular, it prevents detection of a known form of election manipulation: marking additional ovals on a legitimate ballot to intentionally invalidate a vote for a targeted candidate. If the CVR reported which candidates were part of the overvote, it could reveal patterns suggestive of fraud. Unfortunately, this format suppresses such evidence by collapsing all overvotes into silent undervotes. (But even the "Common Data Format CVR format drafted under the auspices of NIST also has this problem, in that an overvote is a lossy indication. It does not provide the ballot options involved in the overvote.)

Write-ins

Write-ins suffer from a different but related ambiguity. The CVR includes a column for each unique write-in name observed, regardless of whether the name corresponds to a qualified write-in candidate. As a result, write-ins such as "Mickey Mouse" or blank entries are still counted and summed in the CVR.

Several edge cases highlight the limitations:

- If the **write-in oval is filled but no name is written**, the vote may be recorded either as a blank write-in or simply as an undervote.

- If a voter marks the oval for a listed candidate and **also writes in the same candidate's name**, the CVR may treat the result as an overvote and record it as an undervote—even though voter intent is clear.

- Write-ins for unqualified candidates are still counted in the CVR totals, even though they have no legal standing.

AuditEngine's Interpretation

Unlike the CVR, AuditEngine separately identifies overvotes and write-ins by directly analyzing the ballot images. This allows for a more nuanced and accurate interpretation of voter intent. However, because the CVR omits or misrepresents these cases, AuditEngine's results may differ—sometimes significantly.

When we consider comparing the audit results with the results from the voting system, since the voting system does not report overvotes, there is an option to allow the option to match if AuditEngine says it is an overvote while the voting says it is N undervotes, where N is the "Vote For" number. These should still be regarded as overvotes that match rather than undervotes that match.

When these discrepancies arise, our adjudication tool, **AdjudiTally**, can assist in the review of any ballots flagged as "variants"—those where AuditEngine's interpretation deviates from the official CVR. In routine audits, these cases are reviewed primarily for completeness. In close contests, however, they may be critical. If the number of variants is smaller than the margin of victory, their resolution cannot change the outcome. But if the number of unresolved variants exceeds the margin, further investigation is warranted.

Sussex County

In 2020, Sussex County used the **ES&S iVotronic** Direct Recording Electronic (DRE) system for in-person voting. In subsequent elections, the county upgraded to the **ES&S ExpressVote** ballot marking device (BMD) for in-person voting and used **DS200 scanners** to tabulate the printed summary cards. These summary cards encode votes in barcodes, while displaying a human-readable summary of selections. Meanwhile, mail and absentee voters continued to use traditional hand-marked paper ballots.

The hand-marked ballots used in Sussex County followed a conventional **three-column vertical layout**, commonly seen in other jurisdictions and well-supported by our processing system.

Sussex used this system in the 2022 General Election but we did not have the opportunity to audit it. For the 2024 General Election, however, we were able

to audit Sussex County's election, which included a substantial number of BMD-generated ballots with barcode-encoded votes.

It is important to emphasize that AuditEngine can accurately extract and interpret the voter-verifiable text from these BMD summary cards. Although we strongly recommend the use of either:

- **Full-face BMD ballots** with clearly visible ovals for each contest and selection, or
- **Purely hand-marked ballots**, which are inherently voter-verified,

The ES&S CVR used by Sussex County

The Cast Vote Record (CVR) format used by Sussex County follows the standard **ES&S XLSX format**, which differs significantly from the Dominion CSV structure described earlier. One key distinction is that the number of columns in the ES&S CVR corresponds to the number of **voting opportunities**, not the number of candidates. For example:

- A **"Vote for 1"** contest will have one column.
- A **"Vote for 3"** contest will have three columns.

Rather than using 0, 1, or blank values, each cell contains either:

- The name of the selected candidate or option (e.g., `"Alice Jones"`),
- The word `"overvote"` if the selection exceeds the allowed number, or
- `"undervote"` if no selection was made.

In the case of overvotes, "**overvote**" is repeated across all cells for the contest. While this clearly signals an overvote, it does not indicate which candidates were marked—similar to the limitations discussed in the Dominion CVR. However, unlike Dominion's format, which silently treats overvotes as undervotes, the ES&S format at least explicitly marks them as overvotes, which improves transparency in overvote detection.

Notably, the **ExpressVote BMD** system used in Sussex does not encode write-in names into the barcode; instead, it relies on the physical ballot image to capture the write-in text. AuditEngine is designed to handle this: for BMD-generated write-ins, we use Optical Character Recognition (OCR) to

extract the text automatically, converting the graphical write-in into searchable text where possible.

For hand-marked ballots, write-ins are often less legible and may require manual review. AuditEngine flags these cases for adjudication in AdjudiTally, where human reviewers can assess the write-in entries to determine voter intent.

Status of this Audit

The main aspects of this audit and the report are complete. There are some aspects of the automated reports, specifically regarding unprocessed ballots and missing images and CVR records which are accounted for now separately and are not properly reported in the overall reconciliation.

Also, it was our plan to demonstrate the adjudication module but it was undergoing enhancement and not yet available for use.

We are working to improve our reporting so it is more concise and useful for counties and any person wishing to check on their own contest results. The AjudiTally app allows review of any contest including any contest variants, and entry of corrections when human eye review is utilized.

Although the results of our audit will not change in any significant way, we are looking to improve our automated reports and may modify them in the near future. These reports are intended to both provide a complete audit trail for anyone who wishes to check on the results of AuditEngine as well as reports that are suitable for the public and interested parties.

Automated Reports

Burlington County

Burlington 2024 Master Report Index
https://us-east-1-audit-engine-jobs.s3.amazonaws.com/US/NJ/US_NJ_Burlington_20241105/reports/Final_Report.html

Burlington 2024 Discrepancy Report:
https://us-east-1-audit-engine-jobs.s3.amazonaws.com/US/NJ/US_NJ_Burlington_20241105/reports/Discrepancy_Report.html

Sussex

Burlington 2024 Master Report Index
https://us-east-1-audit-engine-jobs.s3.amazonaws.com/US/NJ/US_NJ_Sussex_20241105/reports/Final_Report.html

Burlington 2024 Discrepancy Report:
https://us-east-1-audit-engine-jobs.s3.amazonaws.com/US/NJ/US_NJ_Sussex_20241105/reports/Discrepancy_Report.html

Summary and conclusion

The 2024 General Election audits for Burlington and Sussex Counties demonstrate meaningful progress in the adoption of verifiable election systems and provide a valuable opportunity to assess the accuracy and transparency of vote tabulation using ballot image auditing.

We appreciate the cooperation of the counties and also local activists that were instrumental in getting the data and helping to process the audit, particularly with regard to mapping, which is a manual process.

Both counties have transitioned away from paperless DRE systems, replacing them with systems that generate voter-verifiable paper records. Burlington uses hand-marked paper ballots scanned by Dominion systems, while Sussex uses a hybrid system with ES&S ExpressVote ballot marking devices and DS200 scanners. These two models represent significantly different approaches, each with distinct advantages and limitations in terms of auditability, layout complexity, and write-in handling.

AuditEngine successfully processed and independently tabulated every ballot image, validating results against the official Cast Vote Records, with the exception of about 30 images in each case that were corrupted due to tears or other image issues. The data from both counties was largely complete, though both required multiple rounds of submissions to ensure all images

and CVRs were present and correctly formatted. Discrepancies between the AuditEngine results and the official records were minimal, with agreement rates exceeding 99% in both counties in the first filtering round. This is a strong indicator of election integrity, particularly given the scale of the data sets. Subsequent filtering boiled this down to just a very few discrepancies that would require additional review, if there were any contests that had any possibility of being overturned.

In this case, there was no chance that any contest could be overturned, even if all the variants were resolved in favor of the highest loser in the contest.

While the overall results align with official outcomes, our analysis identified areas for improvement:

- **Burlington County** has an unusually large number of precincts and ballot styles, which increases data complexity and may impact both efficiency and voter privacy. Some federal-only ballot styles included fewer than ten ballots and should be reconsidered.

- **Sussex County's** heavy reliance on BMD ballot summary cards (86.4% of ballots) raises concerns about voter verifiability, though AuditEngine was able to reliably extract the voter-verifiable text from those cards, there is now a trend to move away from barcodes and QR Codes.

- One ballot from a different election was found among Sussex County's general election ballots but was not tabulated, however it may have been improperly tabulated had there been ovals in exactly the same place between the two elections.

- In Burlington, the Cinnaminson Township Board of Education contest had a high number of variants relative to the margin of victory and could be reviewed further, although no outcome-changing discrepancies were found.

This audit illustrates that comprehensive image-based auditing can play a key role in election verification—detecting rare anomalies, validating system behavior, and identifying opportunities to improve ballot design and election configuration.

We recommend that both counties continue their commitment to ballot-level transparency and consider simplifying precinct and style structures where possible. Additionally, greater standardization in ballot formatting—especially with regard to orientation and write-in handling—will help streamline future audits and enhance voter confidence.

Appendix

Election Configuration Validation

[This may be moved to another document with ACRE]

An important side benefit of conducting a ballot image audit is the validation of the configuration and target mapping used by the voting system -- that is, the positional information that links each oval on a ballot to a specific contest and candidate. Unlike voting systems, which rely on their own internal configuration for this mapping, AuditEngine builds its target map independently.

This independent target mapping can be generated in two ways:

- By **parsing ballot style master PDFs**, if provided by the election office.
- Or, as in this audit, by **manually placing targets** based on templates generated from ballot images or images from the Logic and Accuracy Test (LAT) deck.

In both cases, there are two types of hand validation using red-lined proofs.

In the "cooperative workflow," AuditEngine can process these files in advance of the election to **generate and validate the independent target map before ballots are cast**. If misconfigurations exist, they are typically discovered during this early phase—long before votes are tabulated.

For example, during an audit in **DeKalb County, Georgia**, we discovered an issue that had gone undetected in pre-election testing. A candidate who had withdrawn was still listed on hand-marked ballots. Both hand-marked and

BMD ballots allowed votes for this candidate, and the printed summaries correctly reflected the voter's selection. However, the problem emerged with scanner interpretation: the scanner's interpretation of the bit field no longer matched the updated candidate list. The ballot summary and even the QR code appeared valid—but the scanner misinterpreted the selection. This case highlights a fundamental weakness in using QR codes to encode votes: voter verification is limited to what's printed, not to how the machine interprets it. Here, no matter how much the voter might review what was printed would not reveal that the scanner had been programmed to interpret the QR Code differently.

These types of configuration issues are rarely caught using traditional LAT test decks. LATs typically include only a small number of test ballots, and they often **do not include all combinations** of contest selections needed to uncover mapping errors, such as swapped ovals or omitted candidates.

AuditEngine offers a better solution through a **mini-audit using a test deck that meets ACRE (All Contests Reviewed and Evaluated) criteria**. This deck is designed to ensure that every contest and every target position is explicitly tested—including combinations where each pair of ovals differs by a vote. With this method, far fewer ballots are needed than in a full LAT because AuditEngine compares the scanner-generated CVR with the known expected result directly—making it a much more efficient and precise method of testing configuration integrity.

This pre-election workflow not only improves confidence in the accuracy of the system but also positions counties to detect and resolve issues **before votes are cast**, rather than after tabulation. Given interest from both Burlington and Sussex Counties in more robust validation methods, we see this as a promising area for future collaboration.

Also, after conducting this mini-audit prior to the election using test ballots, it readies AuditEngine to audit the live ballots quickly after the election, with a target of 24 hours to run the audit and produce automated results.