iVote Issues

Assessment of potential impacts on the 2021 NSW local government elections

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1. Introduction

In December 2021 New South Wales (NSW) ran the largest-ever Internet voting run in the world (as far as we know),[1] receiving more than 650,000 votes over the Internet via a system called iVote, representing approximately 10% of votes in NSW local government elections. Like prior runs of iVote, the system suffered significant downtime during the election period and an analysis of its source code raised serious questions about its security.

On December 23, the NSW Electoral Commission (NSWEC) released a report which attempts to quantify how these problems affected election outcomes. They also published extensive and detailed data about the election. They concluded that six local government elections were potentially affected by iVote's problems, but that the remainder of results should be trusted.

In this report we conduct an alternative analysis based on NSWEC data, examining which NSW local government election results could have been altered by small changes in votes. Our main findings are as follows.

- In 25 contests, the election outcome based only on paper ballots is different from the outcome that incorporates iVote ballots. This does not mean that the official results are wrong, but it does mean that iVotes affected outcomes.

- In most contests, including both mayoral and councillor contests, the number of vote-changes sufficient to alter the election outcome is less than the number of votes received from iVote.

- In 39 contests, the election outcome can be changed by adding fewer votes than the number that NSWEC acknowledges were excluded by iVote's known performance issue. This includes the 6 contests that the NSWEC acknowledges were affected, plus 33 others.

This analysis is preliminary and we welcome comments, corrections, or suggestions for improvement. All our code is available at https://github.com/AndrewConway/ConcreteSTV.

1.1. Why the NSWEC's analysis is not convincing

The NSWEC analysis[2] attempts to assess which of the 2021 Local Government contests were affected by iVote's downtime. Their methodology consists of simulating missing iVotes by

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[1]Estonia runs a larger *fraction* of their votes over the Internet, but fewer by absolute number.
[2]https://elections.nsw.gov.au/NSWEC/media/NSWEC/LGE21/iVote-Assessment-Methodology.pdf

randomly resampling them from existing iVotes. This is repeated 1000 times, and if no alternative outcomes appear, the results are accepted. This makes three significant assumptions, which are not supported by evidence.

1. It assumes all iVote results are accurate, hence disregarding possible security issues or bugs. The report does not provide any statistics about voter-verification attempts, nor any account of whether any other attempt to verify the iVote votes was made. Since the iVote protocol does not provide end-to-end verifiability, it does not seem possible at this stage to derive evidence supporting the apparent iVotes.

2. Its count of the number of potential additional iVotes includes only those who successfully registered but were not sent a voting credential, thus omitting

   - people who were unable to register,
   - people who received a voting credential but were unable to vote, and
   - people who heard about the technical problems and did not try to vote.

3. It assumes missing iVotes are distributed the same as existing iVotes, thus assuming no difference introduced by demographic differences between early and later voters, differences of opinion caused by recent news, or biases introduced by the downtime itself.[3]

In combination, these assumptions may cause a significant underestimate of the impact of iVote's performance and security issues.

iVote has a long history of issues affecting performance,[4] security [HT15], and cryptographic verification [HLPT20]. A report commissioned by NSWEC for the 2021 local government elections found that the codebase was so complex that the auditors could not tell whether the hardcoded passwords they found were in executable parts of the code [HS21]. They also noted that the NSWEC does not compile their own code, instead trusting the vendor to supply an executable version that matches the audited code. iVote does not provide any meaningful way for scrutineers or others to verify that its outputs accurately reflect voters' intentions, so complete trust in the accuracy of iVotes is not justified by evidence.

There are also some evident calculation errors in the NSWEC analysis. For example, in Round 9 of the Albury council count,[5] C STAR was eliminated with 6 votes, but Esther HEATHER also had 6 votes and was not eliminated. Albury is listed in the NSWEC report as having a "Min vote difference during count" of 1 (p.18, Row 7, Col 5). It should be zero. We are not certain how much these calculation errors affected the analysis. If the source code for the NSWEC analysis is made openly available, we would be happy to help correct it.

We have, however, replicated the simulations described in the NSWEC report, adding the same number of votes that NSWEC acknowledges to be missing, and obtained broadly similar results. Hence the analysis is probably mostly correct *if* its assumptions are accepted. We ran one million simulations for each contest and discovered some low-frequency alternative outcomes that were not detected in NSWEC's thousand samples.

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[3]The authors are aware of at least one family that was intending to use iVote, but decided to go to a polling place when the performance issue made iVote inaccessible. This behaviour change might have been much easier for some voters than others. For example, those who were genuinely very distant from the nearest polling place, or genuinely living with a physical disability, might not have been as easily able to vote in person. Such a difference might have meant that the omitted iVotes were quite different from the iVotes that would have been received if it had not gone down.

[4]https://www.smh.com.au/nsw-election-2019/this-is-ridiculous-nsw-voters-struggle-to-lodge-early-vote-after-ivc html

[5]https://vtr.elections.nsw.gov.au/LG2101/albury/councillor/report/dop-cnt-009

Example 1. *In Blue Mountains Ward 3, an alternate outcome appeared 903 times out of one million samples, despite having occurred 0 times in the NSWEC's thousand samples: Kingsley LIU replaced Daniel MYLES (the official winner). The other elected councillors were unchanged.*

The complete list of alternate outcomes and with non-zero occurrences per million is listed in Appendix A.

1.2. This report: Data-only analysis of election differences

In this report, we do not attempt to guess anything about the missing votes or the size of any iVote security or accuracy issues. We simply analyse the existing data and ask how many dropped or altered votes could have changed the election results.

We thank the NSWEC for the detailed election data and distribution-of-preferences transcripts that are freely available online. This gives us, and other interested members of the public, the opportunity to examine and check the results. Some other electoral commissions fail to make any useful election data available, and most do not share informal votes. We appreciate the opportunity to use real election data to make our own examination and share the results with others.

Section 2 examines the differences between the paper votes and the iVote votes, identifying those contests in which the paper-only outcomes differ from those that include iVotes. Section 3 computes the exact margins for each mayoral contest. Section 4 finds examples in which a small number of vote changes can change the overall election outcome—this quantifies the size of iVote security issues or software errors that could make a difference to the outcome. In almost all contests, this is fewer than the number of votes received over iVote. Section 5 does a similar analysis, but only for adding votes—this quantifies the number of excluded votes that could have altered the outcome. In 39 contests, the number of required additions is less than the number NSWEC acknowledges that they excluded. In many other contests, the number is only slightly more.

2. Comparing paper-only and paper-plus-iVote results

In prior runs of iVote, which all occured during state elections, it was argued that iVote's security was not important because "on the current scale of internet voting it is unlikely that people will want to intervene to try to alter the election result," and "it is highly likely that intervention that changed results would be detected. Psephologists, political parties, pollsters and other experts would most likely query and question outcomes that are inconsistent with expectations." [Wil18] Whether this was true previously,[6] it is certainly not true for the 2021 local government elections—the iVote results were sufficiently numerous, and in many cases sufficiently different from the paper-only returns, to alter election outcomes. We are not aware of any psephologists who have been able to compare these outcomes to any detailed predictions about the outcome of each mayoral race or precise composition of each multi-member council.

Example 2. *In the City of Sydney, more than 33% of votes were received via iVote. If we count only the paper votes (including both postal and attendance), the elected councillors are Jess SCULLY, Shauna JARRETT, Linda SCOTT, Sylvie ELLSMORE, Robert KOK, Emelda DAVIS, William CHAN, Yvonne WELDON and Damien MINTON. Including the iVotes alters the outcome, substituting Lyndon GANNON for Damien MINTON. The Mayor of Sydney and the other councillors are unchanged.*

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[6]This claim deserves skepticism even for prior iVote runs, because 5% of votes is enough to alter a close Legislative Assembly contest or a crossbench Legislative Council seat, which are hard to predict.

Contest	Official winner (iVotes included)	Paper-only winner
City of Blue Mountains - Ward 2	HOARE Brent	VAN DER KLEY Chris
Burwood	HULL David	YANG Alex
Byron	HUNTER Alan	CLARKE Bruce
Coonamble	DEANS Barbara	SMITH Steven (Jay Jay)
Dubbo Regional - Wellington Ward	GOUGH Jess	JONES Anne
Hilltops	FITZGERALD Patrick	HORTON John
Inner West - Marrickville - Midjuburi (Lillypilly) Ward	TSARDOULIAS Zoi	MACRI Victor
Kempsey	FREEMAN Joshua	SAUL Dean
Kiama	LARKINS Stuart	GEORGE Tanya
Lane Cove - East Ward	ROENFELDT David	VISSEL Frances
City of Maitland Mayoral	PENFOLD Philip	BAKER Loretta
Moree Plains	COCHRANE Mekayla	RITCHIE Stephen
Muswellbrook	BOWDITCH Mark	OGG Malcolm
Nambucca Valley	WILSON John	HALL David
Narrabri	BOEHM Rohan	STAINES Cameron
North Sydney - Cammeraygal Ward	LAMB Georgia	BAUER Hugo
Parkes	WEBER Daniel	SNYMAN Erik
City of Parramatta - Rosehill Ward	NOACK Paul	STRANO Franceska
City of Randwick - West Ward	VEITCH Philipa	STAVRINOS Harry
City of Shellharbour - Ward A	EDWARDS Maree	BITSCHKAT Shane
Singleton	McNAMARA Tony	JOHNSTONE Sarah
Snowy Valleys	IVILL Michael	DALE Kenneth
City of Sydney	GANNON Lyndon	MINTON Damien
Walgett	KEIR Jane	TAYLOR Michael
Yass Valley	REID Mike	GINN Bill

Table 1: Contests in which the paper-only outcome differs from the outcome when iVotes are included. In multi-winner contests, the other winners stay the same and are omitted from the table.

Example 3. *In the city of Maitland, the Mayor elected when we count only paper ballots is Loretta BAKER. Including the iVotes changes the outcome, electing Philip PENFOLD instead.*

Table 1 lists all contests for which the paper-only results were different from the official results, which included both paper and iVote votes.

These differences do not prove that there were software bugs or security problems that affected the iVote results, because there are possible legitimate reasons for the differences. For example, iVote voters may have voted earlier, or may have come from different demographics, than those who voted on paper. It does, however, mean that any possible iVote security and verification issues definitely do matter, because iVote votes changed election outcomes.

These differences are probably the main reason that the NSWEC's simulations produced a result different from the official result substantially more than half the time in Kempsey, out of only two possible results. It would otherwise be surprising to sample from the same distribution and get the other result 61% of the time—it happens because the iVote returns are distributed differently from the paper ones.

The fraction of votes accepted through iVote varied by location, from less than 5% in some

rural electorates to more than 33% in Sydney. On average, it was much higher than in the 2019 state election. Complete statistics, including iVote rates and overall turnout, are given in Appendix B.

3. Calculating the exact margin for single-winner contests

In NSW, many Mayors are elected directly using a single-winner preferential (Instant Runoff) electoral system similar to that used in Australian lower-house parliamentary seats.

This section reports on the exact margins of all single-winner contests—this is the number of votes that would need to change in order to alter the outcome. To put it another way, this is the number of (iVote or other) votes that would need to have been altered by a software bug or security problem to divert the result from the correct one.

The calculations were conducted by Michelle Blom using her code at https://github.com/michelleblom/margin-irv, which implements the algorithms described in [BTST16].

In most cases, the true margin is the last-round margin, i.e. half the difference between the winner and the runner-up in the last stage of the count, when all but two candidates have been excluded. For example, if Alice and Bob are the only two candidates remaining after all others have been eliminated, and Alice wins with A votes while Bob loses with B votes, then we could make Bob win (or tie) by taking $\lceil (A - B)/2 \rceil$ of Alice's votes and changing them into votes for Bob.[7] To put it the other way, if a software bug or security problem had inappropriately changed $\lceil (A - B)/2 \rceil$ of Bob's votes into votes for Alice, this election outcome would be wrong.

However, the true margin is not always the last-round margin, and the candidate who remains in the count second-longest is not always the alternative candidate closest to winning. Sometimes a small change earlier in the count can alter the elimination order and result in a different outcome.

Example 4. *In Hunter's Hill, Richard QUINN was excluded at Count 3, with 2,153 votes.[8] If 109 votes are removed from Ross WILLIAMS and added to QUINN, WILLIAMS is excluded in Count 3 instead, then QUINN defeats Zac MILES (the official winner) in the last step.[9]*

In NSW Local Government Elections 2021, the Mayoral contests in Broken Hill, Coffs Harbour and Lismore also had a true margin smaller than the last-round margin, because early elimination steps affected the final result. For all the rest, the true margin was the last-round margin. The smallest margins were:

Hunter's Hill	109
Kempsey	194
Orange	244
Port Stephens	284

For 2/3 of mayoral contests, the margin was smaller than the number of votes accepted from iVote. The full results are given in Appendix C.

This is a much more useful value than the least-difference used in the NSWEC report, because it is both a *working example* and a *lower bound*: when we say that the margin for Kempsey Mayor 194 is votes, this means that altering 194 votes suffices for changing the outcome, and also that there is no change of less than 194 votes that changes the outcome.

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[7] $\lceil \cdot \rceil$ represents rounding up to the nearest whole number.

[8] https://vtr.elections.nsw.gov.au/LG2101/hunters-hill/mayoral/report/mayoral-dop

[9] This assumes that the tie is broken in QUINN's favour—otherwise, one more vote would be required.

4. Altering votes to change outcomes in multi-winner contests

Ideally we would also calculate exact margins for the multi-winner council elections. This would answer the question, "What is the smallest alteration or misrecording of votes that could have altered the outcome?" Unfortunately, however, there is no known efficient algorithm for answering this question—the problem is probably intractable in practice.

We have therefore implemented some simple heuristics that look for small alterations that change the outcome. These are exact working examples—if a solution is found, it definitely produces a different set of winners. However, unlike the IRV margins calculated in Section 3, the search is not exhaustive and does not produce a lower bound: there might be even smaller vote changes that alter the outcome, which our algorithm did not find.

The heuristics in this section and the next are available at https://github.com/AndrewConway/ConcreteSTV. The main idea is to change which candidate is excluded or seated at each count, then check whether that change induces a different election outcome. The main steps are:

1. at each count where a candidate E is excluded, for each continuing candidate C,

   a) calculate n, the number of votes that must be moved from C to E so that C's tally will be smaller than E's and hence E will not be excluded,

   b) try to find n appropriate votes from among existing iVotes,

   c) change them from votes that count for C to votes that count for E,

   d) check whether this changes the election outcome,

   e) if so, check whether changing a smaller number of them also changes the outcome;

2. do the same for each count at which some candidate C is seated, moving votes from the candidate who got a seat to the highest candidate who did not.

We found many contests in which small vote changes could alter the election outcome. In most contests, the number of votes received through iVote was much more than the number of changes sufficient to change the winners.

Example 5. *In the council election for Walgett, altering two votes can change the election outcome. Changing two (below-the-line) votes that mention Jane KEIR to list Anna WITT instead causes Jo COLEMAN, rather than KEIR, to be elected. The rest of the elected council remains the same. The specific changes are:*

	1st preference	2nd	3rd	
Vote Change 1: from	*TRINDALL Garry*	*KEIR Jane*	*TURNBULL Robbie*	*...*
to	*TRINDALL Garry*	*WITT Anna*	*TURNBULL Robbie*	*...*
Vote Change 2: from	*TRINDALL Garry*	*KEIR Jane*	*COLEMAN Jo*	*...*
to	*TRINDALL Garry*	*WITT Anna*	*COLEMAN Jo*	*...*

This can also be expressed in reverse: it means that if two iVotes were misrecorded or altered in the opposite way, the election outcome would be wrong. There are probably many other related ways to produce the same effect.

In addition to 6 contests acknowledged by NSWEC to have been problematic, many others were very close, including 17 for which the election outcome could be changed by altering 10 or fewer votes. These are listed in Table 2.

The contests with very small margins tend to have small populations, but some larger cities require a very small number of changes as a fraction of the overall votes. The smallest margins as a fraction of the total number of votes are in Table 3—there were 13 contests that could be altered by changing fewer than 0.2% (but more than 10) of the votes, of which only one (Paramatta - Rosehill Ward) was already acknowledged as problematic.

Contest	Total votes	Added votes to change outcome	Vote changes to change outcome
City of Blue Mountains - Ward 3	12567	19	10
Bogan	1467	17	7
Byron	17735	16	8
Carrathool - Ward A	694	7	4
Coolamon	2576	8	5
Coonamble	2096	5	3
Forbes	5628	27	8
Gilgandra	2492	20	10
Lockhart - B Ward	615	20	9
Muswellbrook	8756	16	9
Nambucca Valley	12043	12	6
Parkes	8027	12	6
Snowy Valleys	8310	27	8
Walgett	2507	11	2
Warren - D Ward	335	6	3
Weddin	2380	15	7
City of Willoughby - Naremburn Ward	8633	19	9

Table 2: Contests with the closest margins found by our algorithm. The last column is the number of iVote changes that can alter the outcome. The second-last column is the number of added votes that can alter the outcome, which is usually (but not always) close to double.

Contest	Total votes	Added votes to change outcome	Vote changes to change outcome	Vote changes as % of total
City of Albury	28378	34	17	0.06%
Armidale Regional	15223	46	25	0.16%
Bathurst Regional	24704	85	45	0.18%
City of Blue Mountains - Ward 2	12493	25	13	0.10%
City of Campbelltown	89337	240	120	0.13%
Goulburn Mulwaree	17394	89	28	0.16%
Hilltops	11021	21	11	0.10%
Inner West - Marrickville - Midjuburi (Lillypilly) Ward	20347	48	32	0.16%
City of Orange	23740	70	35	0.15%
City of Parramatta - Rosehill Ward	22283	20	13	0.06%
City of Shoalhaven - Ward 1	21724	99	39	0.18%
Snowy Monaro Regional	11746	40	20	0.17%
Tamworth Regional	35318	70	34	0.10%

Table 3: Councils with closest margins as a fraction of the total votes, excluding those with vote changes less than 11, which are in Table 2.

Another 9 council outcomes can be altered by 11–20 vote changes: Dubbo Regional - Wellington Ward, Junee, Oberon, Temora, Uralla - Ward B, Walcha - B & D Wards, Warren - A & B Wards.

Appendix D contains the complete list of the smallest vote changes we found that could alter the election outcome. In almost every case, there were sufficiently many iVotes that a carefully-chosen change could alter the outcome. Our companion website at https://andrewconway.github.io/ConcreteSTV/NSWLGE2021/ gives further details on each case, including the alternate winners. Note that we will continue to improve the heuristics after this paper is produced, so the numbers may improve.

5. Adding votes to change outcomes in multi-winner contests

It is extremely difficult to quantify the number of iVote votes that might have been misrecorded or altered—the system generally does not provide any evidence either way. However, it is broadly agreed that in the 2021 NSW LGE at least some voters were unable to vote due to iVote's performance issue. In this section we therefore consider only missing votes. We repeat the analysis of Section 4, but generate different election outcomes only by *adding* votes, without changing any. The heuristic is otherwise the same as that of Section 4 and is implemented as an option in the same code.

These results answer the question "Could the omission of a certain number of votes have altered the outcome?" This was the question most relevant in the 2013 West Australian Senate counting problem, in which a ballot box went missing—it sufficed to show that it had contained enough votes that its omission may have altered the outcome. This also seems to be the right question for analysing only the omissions caused by iVote's performance issue, assuming that the votes received from iVote were accurate.

Example 6. *In the city of Albury council, NSWEC acknowledges missing at least **142** votes as a consequence of iVote's performance issue.*

*If **34** votes are added for Henk VAN DE VEN, the outcome changes: in Count 48 (where VAN DE VEN would be excluded[10]), David THURLEY is excluded instead.[11] Then in the next count, Ross HAMILTON wins a seat instead of David THURLEY. The other elected councillors are unchanged.*

This means that if the omitted votes contained 34 more votes for VAN DE VEN than THURLEY, and otherwise did not alter the distribution of preferences, the announced outcome would be wrong.

There are at least 39 contests in which the outcome can be changed by adding fewer votes than the NSWEC acknowledges missing. Of these, 6 contests were already identified by NSWEC as possibly inaccurate. The other 33 are shown in Table 4. Appendix D contains the complete list of the smallest number of added votes that can change each election outcome. Our companion website at https://andrewconway.github.io/ConcreteSTV/NSWLGE2021/ gives further details on each case, including the alternate winners.

As in Section 4, these results are working examples but not lower bounds: if we find a solution, it certainly suffices to change the outcome, but we may have missed smaller sets of added votes that also change the outcome. More sophisticated heuristics such as [BCST20] (https://github.com/michelleblom/STV-manipulator) would probably get better results.

These results are, therefore, probably an underestimate of the number of contests that could have been affected by iVote's performance issue. This is partly because our heuristic search may have missed some smaller solutions, and partly because NSWEC's estimate of the votes they missed may be conservative.

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[10] https://vtr.elections.nsw.gov.au/LG2101/albury/councillor/report/dop-cnt-048

[11] This assumes the tie is resolved in favour of VAN DE VEN. If it were not, one more vote would be needed.

Electorate	Votes	Added votes to change outcome	Votes NSWEC acknowledges excluding
City of Albury	28378	34	142
Armidale Regional	15223	46	71
Bathurst Regional	24704	85	137
Bayside - Ward 2	17168	109	245
City of Blue Mountains - Ward 2	12493	25	73
City of Blue Mountains - Ward 3	12567	19	94
City of Broken Hill	10395	26	38
Byron	17735	16	127
Cabonne	7836	42	57
City of Campbelltown	89337	240	764
Clarence Valley	30661	139	143
Coolamon	2576	8	19
Coonamble	2096	5	10
Forbes	5628	27	37
Goulburn Mulwaree	17394	89	93
City of Griffith	12556	60	73
Hilltops	11021	21	45
Inner West - Marrickville - Midjuburi (Lillypilly) Ward	20347	48	242
Muswellbrook	8756	16	69
Nambucca Valley	12043	12	35
North Sydney - Cammeraygal Ward	19088	182	251
Northern Beaches - Curl Curl Ward	29742	270	305
City of Orange	23740	70	172
Parkes	8027	12	41
City of Randwick - West Ward	13609	92	140
City of Shellharbour - Ward B	10527	69	86
City of Shoalhaven - Ward 1	21724	99	145
Snowy Monaro Regional	11746	40	45
City of Sydney	117362	1044	2003
Tamworth Regional	35318	70	194
Walgett	2507	11	23
Weddin	2380	15	23
City of Willoughby - Naremburn Ward	8633	19	43

Table 4: Contests in which the added votes sufficient to change the outcome are fewer than the number NSWEC acknowledges missing due to iVote's performance issue. The last column is the number of missing votes acknowledged by NSWEC. The second-last is the number of votes that can alter the outcome if added. The 6 contests already identified by NSWEC as problematic are omitted from the table.

6. Some notes on the counting legislation

The NSW Local Government (General) Regulation, which specifies the local government counting algorithm, was recently updated to remove randomness in surplus distributions. This is a significant improvement. However, there are some important ambiguities in the new legislation, which need to be resolved before they cause ambiguities in an election result. See

for detailed discussion.

7. Discussion and Conclusion

The NSWEC has engaged with technology more extensively than any other electoral commission in Australia. Some of this is beneficial, such as their extensive publication of election data, allowing independent studies like this one. Some choices, however, put the foundations of democracy at risk. Use of iVote should be discontinued because it does not securely convey votes, and leaves the state without a rigorous way of assessing how much its problems affected the integrity of the election. The same situation could easily recur if the LGE—or the 2023 state election—is simply rerun with the same unreliable, insecure and unverifiable technology.

Apart from the 6 contests identified as at risk by NSWEC, there are another 33 in which it is possible to change the outcome by adding fewer votes than the NSWEC acknowledges to be missing due to iVote's performance issue. In the 2013 West Australian Senate ballot problem, the same fact was sufficient to justify re-running the election.

Many other outcomes are highly dependent on the integrity of the iVotes. In 25 contests (of which only 5 are acknowledged as problematic by NSWEC), the official outcome is different from the outcome when only paper ballots are tallied. This does not prove the iVotes are wrong, but it does prove that the integrity of the outcome is dependent on the accuracy of the iVote ballots, which cannot be verified. In most of the remaining contests, there are sufficient iVotes that a targeted manipulation or unlucky software error could have altered the outcome.

The tiny margins in Sections 4 and 5 indicate the importance of the assumptions behind the official NSWEC analysis of the impact of the iVote performance issue—the decision to retain the apparent outcome in all but six contests depends very strongly on their assumptions that the iVotes are accurate, and that the votes they are missing are the same as the votes they already have. If those assumptions are not accepted, there is a possibility that many of the announced election outcomes do not accurately represent the choice of the people.

8. Acknowledgements

References

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A. Replication of NSWEC analysis: frequency of alternate outcomes from one million simulations

The following table shows the results of replicating the NSWEC analysis, running one million iterations of the randomised vote sampling (rather than the 1000 simulations conducted by NSWEC).

Electorate	Votes added	NSWEC differences per 1000	Outcome change	Different outcomes per million
City of Blue Mountains - Ward 2	73	0	Remove: HOARE Brent Add: BROMILOW Joanne	6
City of Blue Mountains - Ward 3	94	0	Remove: MYLES Daniel Add: LIU Kingsley	903
Byron	127	0	Remove: HUNTER Alan Add: CLARKE Bruce	19
Coonamble	10	0	Remove: DEANS Barbara Add: SMITH Steven (Jay Jay)	92
Forbes	37	0	Remove: HERBERT Michele Add: HENDERSON Emma	1
Hay	6	7	Remove: PORTER Paul Add: PERRY John	5,129
Kempsey	34	610	Remove: PATTERSON Anthony Add: BAXTER Mark	605,541
Kiama	57	3	Remove: LARKINS Stuart Add: GEORGE Tanya	2,864
Nambucca Valley	35	0	Remove: WILSON John Add: HALL David	1
Parkes	41	0	Remove: WEBER Daniel Add: SNYMAN Erik	1
City of Parramatta - Rosehill Ward	119	1	Remove: NOACK Paul Add: STRANO Franceska	1,434
City of Shellharbour - Ward A	54	70	Remove: EDWARDS Maree Add: BITSCHKAT Shane	63,023
Singleton	55	432	Remove: SCOTT Val Add: JOHNSTONE Sarah	431,354
Walgett	23	0	Remove: KEIR Jane Add: COLEMAN Jo	66
City of Willoughby - Naremburn Ward	43	0	Remove: GRECO Anna Add: SETHI Ashish	802

B. iVote statistics by contest, including differences between iVote and paper outcomes

Voting statistics for LGE 2021, including the total number of formal votes and the fraction that came from iVote. Contests in which the paper-only winner differs from the official winner (when iVotes are included) are marked with an asterisk—see Table 1 for details.

Electorate	formal votes	formal iVotes (% total votes)	enrolment	informal	turnout
City of Albury	28378	2827 (10.0%)	37657	1745	80.0%
Armidale Regional	15223	1555 (10.2%)	19214	913	84.0%
Ballina - A	7947	763 (9.6%)	10782	933	82.4%
Ballina - B	9087	1212 (13.3%)	11528	747	85.3%
Ballina - C	8237	1099 (13.3%)	10520	837	86.3%
Ballina Mayoral	26913	3132 (11.6%)	32830	940	84.8%
Bathurst Regional	24704	2904 (11.8%)	30855	1939	86.3%
Bayside - 1	17379	3026 (17.4%)	22305	1070	82.7%
Bayside - 2	17168	3877 (22.6%)	22666	1064	80.4%
Bayside - 3	15212	2865 (18.8%)	19734	1202	83.2%
Bayside - 4	16519	2975 (18.0%)	20702	1239	85.8%
Bayside - 5	14990	2542 (17.0%)	19423	1398	84.4%
Bega Valley	21435	1413 (6.6%)	26696	2026	87.9%
Bellingen	8270	722 (8.7%)	10286	352	83.8%
Bellingen Mayoral	8374	724 (8.6%)	10286	235	83.7%
Berrigan	4720	301 (6.4%)	6170	249	80.5%
City of Blacktown - 1	44012	11624 (26.4%)	54105	2857	86.6%
City of Blacktown - 2	34854	7529 (21.6%)	43503	2211	85.2%
City of Blacktown - 3	33681	6679 (19.8%)	43145	2398	83.6%
City of Blacktown - 4	35351	7549 (21.4%)	44668	2447	84.6%
City of Blacktown - 5	36254	8048 (22.2%)	49982	2949	78.4%
Bland	3211	495 (15.4%)	4140	131	80.7%
Blayney	4560	385 (8.4%)	5453	224	87.7%
City of Blue Mountains - 1	11435	1261 (11.0%)	14448	501	82.6%
⋆City of Blue Mountains - 2	12493	1506 (12.1%)	14664	474	88.4%
City of Blue Mountains - 3	12567	1632 (13.0%)	14697	425	88.4%
City of Blue Mountains - 4	12338	1537 (12.5%)	14266	384	89.2%
Bogan	1467	185 (12.6%)	1920	38	78.4%
Brewarrina	550	55 (10.0%)	891	17	63.6%
City of Broken Hill	10395	954 (9.2%)	13344	732	83.4%
City of Broken Hill Mayoral	10812	972 (9.0%)	13344	272	83.1%
⋆Burwood	17250	3256 (18.9%)	21010	1030	87.0%
Burwood Mayoral	17797	3270 (18.4%)	21010	435	86.8%
⋆Byron	17735	1887 (10.6%)	25414	1021	73.8%
Byron Mayoral	18165	1908 (10.5%)	25414	567	73.7%
Cabonne	7836	1569 (20.0%)	10062	618	84.0%
Camden - Central	20735	4695 (22.6%)	25241	1159	86.7%
Camden - North	22975	5865 (25.5%)	28314	1366	86.0%
Camden - South	18016	3717 (20.6%)	22335	1012	85.2%
City of Campbelltown	89337	14657 (16.4%)	112968	6011	84.4%
Canada Bay	47472	9772 (20.6%)	58191	2312	85.6%

Electorate	formal votes	formal iVotes (% total votes)	enrolment	informal	turnout
Canada Bay Mayoral	48542	9815 (20.2%)	58191	1140	85.4%
Canterbury-Bankstown - Bankstown	34062	7339 (21.5%)	45049	2378	80.9%
Canterbury-Bankstown - Bass Hill	33153	6998 (21.1%)	44439	2547	80.3%
Canterbury-Bankstown - Canterbury	37276	7998 (21.5%)	46536	2310	85.1%
Canterbury-Bankstown - Revesby	38446	6972 (18.1%)	46981	2080	86.3%
Canterbury-Bankstown - Roselands	33553	6833 (20.4%)	44961	2724	80.7%
Carrathool - A	694	74 (10.7%)	905	15	78.3%
City of Cessnock - A	9176	1652 (18.0%)	11831	713	83.6%
City of Cessnock - B	7893	1338 (17.0%)	10181	495	82.4%
City of Cessnock - C	9552	1783 (18.7%)	12132	547	83.2%
City of Cessnock - D	8997	1806 (20.1%)	11264	519	84.5%
City of Cessnock Mayoral	36497	6615 (18.1%)	45408	1447	83.6%
Clarence Valley	30661	3813 (12.4%)	38544	2358	85.7%
City of Coffs Harbour	43587	5135 (11.8%)	56687	3410	82.9%
City of Coffs Harbour Mayoral	45155	5202 (11.5%)	56687	1774	82.8%
Coolamon	2576	261 (10.1%)	3239	97	82.5%
⋆Coonamble	2096	373 (17.8%)	2732	51	78.6%
Cootamundra-Gundagai Regional	6922	659 (9.5%)	8603	310	84.1%
Cowra	7764	583 (7.5%)	9697	480	85.0%
Cumberland - Granville	19325	3966 (20.5%)	26038	1447	79.8%
Cumberland - Greystanes	20779	3905 (18.8%)	25915	1357	85.4%
Cumberland - Regents Park	19749	4429 (22.4%)	24763	1267	84.9%
Cumberland - South Granville	17397	3292 (18.9%)	24820	1500	76.1%
Cumberland - Wentworthville	20211	4675 (23.1%)	25595	1134	83.4%
Dubbo Regional - Dubbo Central	5320	713 (13.4%)	6864	232	80.9%
Dubbo Regional - Dubbo East	5231	786 (15.0%)	6827	294	80.9%
Dubbo Regional - Dubbo North	6291	1015 (16.1%)	8203	337	80.8%
Dubbo Regional - Dubbo South	6876	1174 (17.1%)	8389	324	85.8%
⋆Dubbo Regional - Wellington	5524	598 (10.8%)	6856	212	83.7%
Dungog - A	1987	228 (11.5%)	2377	91	87.4%
Dungog - B	2107	413 (19.6%)	2538	94	86.7%
Dungog - C	2041	341 (16.7%)	2517	115	85.7%
Edward River	4559	270 (5.9%)	6335	245	75.8%
Eurobodalla	24875	2645 (10.6%)	32006	1780	83.3%
Eurobodalla Mayoral	25526	2664 (10.4%)	32006	1078	83.1%
Federation	7402	589 (8.0%)	9896	475	79.6%
Forbes	5628	729 (13.0%)	6975	170	83.1%
Georges River - Blakehurst	16142	3101 (19.2%)	19302	795	87.7%
Georges River - Hurstville	14773	3183 (21.5%)	18409	1039	85.9%
Georges River - Kogarah Bay	15797	3209 (20.3%)	19964	1029	84.3%
Georges River - Mortdale	14452	2856 (19.8%)	17718	880	86.5%
Georges River - Peakhurst	16286	2977 (18.3%)	19508	713	87.1%
Gilgandra	2492	270 (10.8%)	3166	60	80.6%
Glen Innes Severn Shire	5496	331 (6.0%)	6260	161	90.4%
Goulburn Mulwaree	17394	2632 (15.1%)	21530	1519	87.8%
Greater Hume Shire - North	2048	147 (7.2%)	2718	84	78.4%
Greater Hume Shire - West	1989	176 (8.8%)	2464	102	84.9%

Electorate	formal votes	formal iVotes (% total votes)	enrolment	informal	turnout
City of Griffith	12556	1624 (12.9%)	16797	2250	88.1%
City of Griffith Mayoral	14179	1642 (11.6%)	16797	625	88.1%
Gunnedah	7164	907 (12.7%)	9055	309	82.5%
Gwydir	2940	457 (15.5%)	3771	133	81.5%
City of Hawkesbury	39488	6483 (16.4%)	48349	2135	86.1%
Hay	1747	177 (10.1%)	2146	47	83.6%
⋆Hilltops	11021	1274 (11.6%)	14321	788	82.5%
Hornsby - A	28734	4595 (16.0%)	33622	1111	88.8%
Hornsby - B	28273	5767 (20.4%)	33623	817	86.5%
Hornsby - C	28064	5329 (19.0%)	32204	804	89.6%
Hornsby Mayoral	85656	15723 (18.4%)	99449	2136	88.3%
Hunter's Hill - North	4172	753 (18.0%)	5079	193	85.9%
Hunter's Hill - South	4062	591 (14.5%)	4835	121	86.5%
Hunter's Hill Mayoral	8356	1350 (16.2%)	9914	216	86.5%
Inner West - Ashfield - Djarrawunang (Magpie)	21310	3657 (17.2%)	26526	904	83.7%
Inner West - Balmain - Baludarri (Leather Jacket)	21240	2997 (14.1%)	26851	555	81.2%
Inner West - Leichhardt - Gulgadya (Grass Tree)	20783	3271 (15.7%)	26069	900	83.2%
⋆Inner West - Marrickville - Midjuburi (Lillypilly)	20347	3642 (17.9%)	26219	731	80.4%
Inner West - Stanmore - Damun (Port Jackson Fig)	20355	3993 (19.6%)	26697	705	78.9%
Inverell	9887	1104 (11.2%)	12871	705	82.3%
Junee	3262	400 (12.3%)	3997	138	85.1%
⋆Kempsey	16204	1743 (10.8%)	22744	2289	81.3%
Kempsey Mayoral	17585	1764 (10.0%)	22744	886	81.2%
⋆Kiama	15016	1986 (13.2%)	18000	628	86.9%
Ku-ring-gai - Comenarra	13804	2344 (17.0%)	16617	770	87.7%
Ku-ring-gai - Gordon	13720	2689 (19.6%)	16936	883	86.2%
Ku-ring-gai - Roseville	13785	2597 (18.8%)	16477	560	87.1%
Ku-ring-gai - St Ives	13940	2405 (17.3%)	16504	781	89.2%
Ku-ring-gai - Wahroonga	13513	2023 (15.0%)	16235	671	87.4%
Kyogle - B	1753	136 (7.8%)	2197	90	83.9%
Kyogle - C	1666	225 (13.5%)	2240	82	78.0%
Lachlan - E	649	50 (7.7%)	916	12	72.2%
City of Lake Macquarie - East	41593	6080 (14.6%)	51525	2311	85.2%
City of Lake Macquarie - North	42316	7803 (18.4%)	52005	2147	85.5%
City of Lake Macquarie - West	44643	6433 (14.4%)	57668	2665	82.0%
City of Lake Macquarie Mayoral	130336	20390 (15.6%)	161198	5265	84.1%
Lane Cove - Central	7259	1064 (14.7%)	8477	178	87.7%
⋆Lane Cove - East	6974	1312 (18.8%)	8534	242	84.6%
Lane Cove - West	7362	1383 (18.8%)	8927	259	85.4%
Leeton	6105	598 (9.8%)	7698	249	82.5%
City of Lismore	25948	3729 (14.4%)	31531	1140	85.9%
City of Lismore Mayoral	26474	3750 (14.2%)	31531	570	85.8%

Electorate	formal votes	formal iVotes (% total votes)	enrolment	informal	turnout
City of Lithgow	13061	1380 (10.6%)	15856	636	86.4%
City of Liverpool - North	51345	10787 (21.0%)	69329	5519	82.0%
City of Liverpool - South	58279	13118 (22.5%)	75370	5311	84.4%
City of Liverpool Mayoral	115177	24136 (21.0%)	144699	5479	83.4%
Liverpool Plains	4460	581 (13.0%)	5707	256	82.6%
Lockhart - A	599	54 (9.0%)	756	27	82.8%
Lockhart - B	615	74 (12.0%)	773	33	83.8%
City of Maitland - Central	13083	2088 (16.0%)	16066	696	85.8%
City of Maitland - East	12397	2264 (18.3%)	15186	751	86.6%
City of Maitland - North	14761	3042 (20.6%)	17619	822	88.4%
City of Maitland - West	12720	2063 (16.2%)	15730	739	85.6%
⋆City of Maitland Mayoral	54181	9535 (17.6%)	64601	1875	86.8%
Mid-Coast	61696	6360 (10.3%)	76170	3706	85.9%
Mid-Western Regional	15023	1548 (10.3%)	18618	842	85.2%
⋆Moree Plains	5789	1113 (19.2%)	8274	289	73.5%
Mosman	16197	2429 (15.0%)	20620	788	82.4%
Mosman Mayoral	16425	2442 (14.9%)	20620	501	82.1%
Murrumbidgee - Jerilderie	686	96 (14.0%)	895	18	78.7%
Murrumbidgee - Murrumbidgee East	698	151 (21.6%)	898	15	79.4%
Murrumbidgee - Murrumbidgee	649	60 (9.2%)	871	23	77.2%
⋆Muswellbrook	8756	1653 (18.9%)	11654	756	81.6%
⋆Nambucca Valley	12043	1192 (9.9%)	15961	783	80.4%
Nambucca Valley Mayoral	12482	1212 (9.7%)	15961	334	80.3%
⋆Narrabri	7042	1010 (14.3%)	9235	345	80.0%
Narrandera	3398	351 (10.3%)	4291	144	82.5%
City of Newcastle - 1	23428	3702 (15.8%)	30757	907	79.1%
City of Newcastle - 2	26089	4050 (15.5%)	32193	916	83.9%
City of Newcastle - 3	24468	3851 (15.7%)	30791	1094	83.0%
City of Newcastle - 4	24317	4096 (16.8%)	30327	1659	85.7%
City of Newcastle Mayoral	100275	15794 (15.8%)	124068	2768	83.1%
⋆North Sydney - Cammeraygal	19088	3748 (19.6%)	24932	818	79.8%
North Sydney - St Leonards	18541	3857 (20.8%)	23620	746	81.7%
Northern Beaches - Curl Curl	29742	5292 (17.8%)	37692	1039	81.7%
Northern Beaches - Frenchs Forest	30625	5295 (17.3%)	36083	971	87.6%
Northern Beaches - Manly	28981	4623 (16.0%)	36299	766	81.9%
Northern Beaches - Narrabeen	30124	4918 (16.3%)	36759	1189	85.2%
Northern Beaches - Pittwater	29642	3998 (13.5%)	36645	969	83.5%
Oberon	3215	290 (9.0%)	3989	153	84.4%
City of Orange	23740	4023 (16.9%)	30109	1684	84.4%
City of Orange Mayoral	24355	4044 (16.6%)	30109	1054	84.4%
⋆Parkes	8027	932 (11.6%)	10528	797	83.8%
City of Parramatta - Dundas	22076	5625 (25.5%)	28011	1327	83.5%
City of Parramatta - Epping	23461	4848 (20.7%)	27940	1108	87.9%
City of Parramatta - North Rocks	22525	5070 (22.5%)	26822	949	87.5%
City of Parramatta - Parramatta	20440	4461 (21.8%)	26649	1141	81.0%
⋆City of Parramatta - Rosehill	22283	5603 (25.1%)	29677	1022	78.5%
Port Macquarie-Hastings	52517	6212 (11.8%)	66483	4402	85.6%

Electorate	formal votes	formal iVotes (% total votes)	enrolment	informal	turnout
Port Macquarie-Hastings Mayoral	54499	6267 (11.5%)	66483	2328	85.5%
Port Stephens - Central	16289	3100 (19.0%)	20221	1286	86.9%
Port Stephens - East	14813	1790 (12.1%)	18248	669	84.8%
Port Stephens - West	15425	2678 (17.4%)	19170	1088	86.1%
Port Stephens Mayoral	47807	7619 (15.9%)	57639	1721	85.9%
Queanbeyan-Palerang Regional	33813	3484 (10.3%)	43470	1684	81.7%
City of Randwick - Central	13840	2488 (18.0%)	17947	547	80.2%
City of Randwick - East	12801	2360 (18.4%)	16993	419	77.8%
City of Randwick - North	13121	2231 (17.0%)	17217	382	78.4%
City of Randwick - South	14468	2018 (13.9%)	18302	644	82.6%
⋆City of Randwick - West	13609	2373 (17.4%)	17642	534	80.2%
Richmond Valley	13229	1345 (10.2%)	16469	845	85.5%
Richmond Valley Mayoral	13405	1346 (10.0%)	16469	659	85.4%
City of Ryde - Central	21826	4706 (21.6%)	26661	975	85.5%
City of Ryde - East	22323	4489 (20.1%)	26513	918	87.7%
City of Ryde - West	20370	3898 (19.1%)	24398	897	87.2%
⋆City of Shellharbour - A	13138	2746 (20.9%)	15661	640	88.0%
City of Shellharbour - B	10527	1916 (18.2%)	13415	699	83.7%
City of Shellharbour - C	10617	1644 (15.5%)	13288	506	83.7%
City of Shellharbour Mayoral	46273	8468 (18.3%)	55825	1486	85.6%
City of Shoalhaven - 1	21724	2579 (11.9%)	28239	1584	82.5%
City of Shoalhaven - 2	21863	2738 (12.5%)	28320	1527	82.6%
City of Shoalhaven - 3	22029	2344 (10.6%)	27670	1452	84.9%
City of Shoalhaven Mayoral	67030	7704 (11.5%)	84229	3100	83.3%
⋆Singleton	12745	2386 (18.7%)	17080	1596	84.0%
Singleton Mayoral	13755	2449 (17.8%)	17080	582	83.9%
Snowy Monaro Regional	11746	792 (6.7%)	14527	640	85.3%
⋆Snowy Valleys	8310	608 (7.3%)	10045	495	87.7%
Strathfield	19500	4336 (22.2%)	24254	1097	84.9%
Sutherland Shire - A	28011	4415 (15.8%)	34085	1192	85.7%
Sutherland Shire - B	28585	4963 (17.4%)	33966	1139	87.5%
Sutherland Shire - C	27880	4916 (17.6%)	33864	1223	85.9%
Sutherland Shire - D	28543	4625 (16.2%)	33048	1163	89.9%
Sutherland Shire - E	28313	4341 (15.3%)	32438	1163	90.9%
⋆City of Sydney	117362	39217 (33.4%)	175053	3378	69.0%
City of Sydney Mayoral	118511	39371 (33.2%)	175053	1675	68.7%
Tamworth Regional	35318	4130 (11.7%)	44550	2956	85.9%
Temora	4046	353 (8.7%)	4606	87	89.7%
Tenterfield - D	747	27 (3.6%)	969	28	80.0%
The Hills Shire - Central	26375	6783 (25.7%)	30885	978	88.6%
The Hills Shire - East	24594	5559 (22.6%)	29400	1130	87.5%
The Hills Shire - North	27025	6954 (25.7%)	32462	1447	87.7%
The Hills Shire - West	25507	6253 (24.5%)	29949	1220	89.2%
The Hills Shire Mayoral	105384	25645 (24.3%)	122696	3015	88.3%
Tweed	50020	3947 (7.9%)	66406	3380	80.4%
Upper Hunter Shire	8300	1195 (14.4%)	10279	515	85.8%
Upper Lachlan Shire	5219	645 (12.4%)	6386	272	86.0%

Electorate	formal votes	formal iVotes (% total votes)	enrolment	informal	turnout
Uralla - A	1837	194 (10.6%)	2203	111	88.4%
Uralla - B	1818	198 (10.9%)	2323	144	84.5%
Uralla Mayoral	3781	395 (10.4%)	4526	125	86.3%
City of Wagga Wagga	35885	3935 (11.0%)	46257	2634	83.3%
Walcha - B	488	120 (24.6%)	582	11	85.7%
Walcha - D	467	46 (9.9%)	600	37	84.0%
⋆Walgett	2507	415 (16.6%)	3638	79	71.1%
Warren - A	332	63 (19.0%)	490	8	69.4%
Warren - B	347	75 (21.6%)	496	4	70.8%
Warren - D	335	25 (7.5%)	490	5	69.4%
Warrumbungle Shire	5530	1111 (20.1%)	6900	191	82.9%
Waverley - Bondi	7152	1259 (17.6%)	11519	240	64.2%
Waverley - Hunter	8114	1587 (19.6%)	10704	301	78.6%
Waverley - Lawson	8770	1360 (15.5%)	11759	254	76.7%
Waverley - Waverley	8052	1210 (15.0%)	11201	201	73.7%
Weddin	2380	324 (13.6%)	2798	66	87.4%
Wentworth	3318	325 (9.8%)	4332	108	79.1%
City of Willoughby - Middle Harbour	9385	1599 (17.0%)	11616	598	85.9%
City of Willoughby - Naremburn	8633	1705 (19.7%)	10949	589	84.2%
City of Willoughby - Sailors Bay	9502	1531 (16.1%)	11719	677	86.9%
City of Willoughby - West	9425	1939 (20.6%)	11902	654	84.7%
City of Willoughby Mayoral	37942	6823 (18.0%)	46186	1511	85.4%
Wollondilly - East	15133	2335 (15.4%)	18513	1509	89.9%
Wollondilly - North	14655	2610 (17.8%)	18297	1659	89.2%
Wollondilly Mayoral	31355	5001 (15.9%)	36810	1650	89.7%
City of Wollongong - 1	42730	6303 (14.8%)	52640	2190	85.3%
City of Wollongong - 2	41073	7683 (18.7%)	51632	2016	83.5%
City of Wollongong - 3	40706	6530 (16.0%)	50641	2898	86.1%
City of Wollongong Mayoral	127240	20614 (16.2%)	154913	4500	85.0%
Woollahra - Bellevue Hill	5519	1091 (19.8%)	7713	187	74.0%
Woollahra - Cooper	5892	1039 (17.6%)	7884	212	77.4%
Woollahra - Double Bay	5716	1123 (19.6%)	8013	165	73.4%
Woollahra - Paddington	5834	1164 (20.0%)	8254	120	72.1%
Woollahra - Vaucluse	5997	1170 (19.5%)	8007	199	77.4%
⋆Yass Valley	9452	1753 (18.5%)	12489	592	80.4%

C. Exact margins for all single-winner (mayoral) contests

Contest	Margin
Ballina Mayoral	1847
Bellingen Mayoral	1256
Burwood Mayoral	3522
Byron Mayoral	530
CanadaBay Mayoral	2982
City of Broken Hill Mayoral	1650
City of Cessnock Mayoral	2822
City of Coffs Harbour Mayoral LB	1338
City of Griffith Mayoral	1803
City of Lake Macquarie Mayoral	20945
City of Lismore Mayoral	4518
City of Liverpool Mayoral	1268
City of Maitland Mayoral	576
City of Newcastle Mayoral	8479
City of Orange Mayoral	244
City of Shellharbour Mayoral	1298
City of Shoalhaven Mayoral	807
City of Sydney Mayoral	16070
City of Willoughby Mayoral	1266
City of Wollongong Mayoral	1333
Eurobodalla Mayoral	553
Hornsby Mayoral	6237
Hunters Hill Mayoral	109
Kempsey Mayoral	194
Mosman Mayoral	1826
Nambucca Valley Mayoral	2281
Port Macquarie-Hastings Mayoral	9553
Port Stephens Mayoral	284
Richmond Valley Mayoral	2911
Singleton Mayoral	568
The Hills Shire Mayoral	14318
Uralla Mayoral	1160
Wollondilly Mayoral	643

D. Vote changes for altering multi-winner contests

This table shows, for each contest, the number of added votes and altered iVotes sufficient to change the outcome. A '-' indicates no solution was found.

Contest	Total votes	Added votes to change outcome	Vote changes to change outcome
City of Albury	28378	34	17
Armidale Regional	15223	46	25
Ballina - A Ward	7947	89	45
Ballina - B Ward	9087	172	88
Ballina - C Ward	8237	513	242
Ballina Mayoral	26913	3695	-
Bathurst Regional	24704	85	45
Bayside - Ward 1	17379	734	383
Bayside - Ward 2	17168	109	54
Bayside - Ward 3	15212	620	251
Bayside - Ward 4	16519	337	201
Bayside - Ward 5	14990	733	409
Bega Valley	21435	139	97
Bellingen	8270	151	92
Bellingen Mayoral	8374	2513	-
Berrigan	4720	54	25
City of Blacktown - Ward 1	44012	1854	1249
City of Blacktown - Ward 2	34854	2633	1762
City of Blacktown - Ward 3	33681	3607	-
City of Blacktown - Ward 4	35351	3095	1525
City of Blacktown - Ward 5	36254	2512	1242
Bland	3211	94	51
Blayney	4560	85	-
City of Blue Mountains - Ward 1	11435	558	-
City of Blue Mountains - Ward 2	12493	25	13
City of Blue Mountains - Ward 3	12567	19	10
City of Blue Mountains - Ward 4	12338	1291	-
Bogan	1467	17	7
Brewarrina	550	19	-
City of Broken Hill	10395	26	-
City of Broken Hill Mayoral	10812	3381	-
Burwood	17250	288	177
Burwood Mayoral	17797	7043	-
Byron	17735	16	8
Byron Mayoral	18165	1060	531
Cabonne	7836	42	22
Camden - Central Ward	20735	1387	-
Camden - North Ward	22975	2455	-
Camden - South Ward	18016	4457	-
City of Campbelltown	89337	240	120
Canada Bay	47472	788	473
Canada Bay Mayoral	48542	5963	2982
Canterbury-Bankstown - Bankstown Ward	34062	5878	-

Continued...

Contest	Total votes	Added votes to change outcome	Vote changes to change outcome
Canterbury-Bankstown - Bass Hill Ward	33153	2748	1799
Canterbury-Bankstown - Canterbury Ward	37276	1876	908
Canterbury-Bankstown - Revesby Ward	38446	1051	701
Canterbury-Bankstown - Roselands Ward	33553	4907	-
Carrathool - Ward A	694	7	4
City of Cessnock - A Ward	9176	1004	-
City of Cessnock - B Ward	7893	481	182
City of Cessnock - C Ward	9552	221	92
City of Cessnock - D Ward	8997	97	54
City of Cessnock Mayoral	36497	5645	2823
Clarence Valley	30661	139	69
City of Coffs Harbour	43587	1975	-
City of Coffs Harbour Mayoral	45155	5935	-
Coolamon	2576	8	5
Coonamble	2096	5	3
Cootamundra-Gundagai Regional	6922	131	67
Cowra	7764	165	-
Cumberland - Granville Ward	19325	1342	-
Cumberland - Greystanes Ward	20779	6090	-
Cumberland - Regents Park Ward	19749	1370	724
Cumberland - South Granville Ward	17397	5006	-
Cumberland - Wentworthville Ward	20211	851	432
Dubbo Regional - Dubbo Central Ward	5320	1208	-
Dubbo Regional - Dubbo East Ward	5231	337	169
Dubbo Regional - Dubbo North Ward	6291	421	213
Dubbo Regional - Dubbo South Ward	6876	1014	-
Dubbo Regional - Wellington Ward	5524	31	16
Dungog - A Ward	1987	370	-
Dungog - B Ward	2107	329	-
Dungog - C Ward	2041	116	55
Edward River	4559	108	-
Eurobodalla	24875	364	253
Eurobodalla Mayoral	25526	1107	554
Federation	7402	75	-
Forbes	5628	27	8
Georges River - Blakehurst Ward	16142	1594	-
Georges River - Hurstville Ward	14773	619	426
Georges River - Kogarah Bay Ward	15797	769	378
Georges River - Mortdale Ward	14452	2288	-
Georges River - Peakhurst Ward	16286	1665	-
Gilgandra	2492	20	10
Glen Innes Severn Shire	5496	47	23
Goulburn Mulwaree	17394	89	28
Greater Hume Shire - North Ward	2048	58	29
Greater Hume Shire - West Ward	1989	195	-
City of Griffith	12556	60	31

Continued...

Contest	Total votes	Added votes to change outcome	Vote changes to change outcome
City of Griffith Mayoral	14179	3607	-
Gunnedah	7164	120	66
Gwydir	2940	110	-
City of Hawkesbury	39488	607	246
Hay	1747	4	2
Hilltops	11021	21	11
Hornsby - Ward A	28734	1211	595
Hornsby - Ward B	28273	277	114
Hornsby - Ward C	28064	2613	-
Hornsby Mayoral	85656	12475	6238
Hunter's Hill - North Ward	4172	509	-
Hunter's Hill - South Ward	4062	340	-
Hunter's Hill Mayoral	8356	219	110
Inner West - Ashfield	21310	1139	419
- Djarrawunang (Magpie) Ward			-
Inner West - Balmain	21240	2313	-
- Baludarri (Leather Jacket) Ward			-
Inner West - Leichhardt	20783	296	226
- Gulgadya (Grass Tree) Ward			-
Inner West - Marrickville	20347	48	32
- Midjuburi (Lillypilly) Ward			-
Inner West - Stanmore	20355	2320	-
- Damun (Port Jackson Fig) Ward			-
Inverell	9887	247	-
Junee	3262	18	12
Kempsey	16204	1	1
Kempsey Mayoral	17585	387	194
Kiama	15016	10	5
Ku-ring-gai - Comenarra Ward	13804	1548	-
Ku-ring-gai - Gordon Ward	13720	419	220
Ku-ring-gai - Roseville Ward	13785	1099	472
Ku-ring-gai - St Ives Ward	13940	825	-
Ku-ring-gai - Wahroonga Ward	13513	319	160
Kyogle - B Ward	1753	114	-
Kyogle - C Ward	1666	209	-
Lachlan - E Ward	649	175	-
City of Lake Macquarie - East Ward	41593	3911	-
City of Lake Macquarie - North Ward	42316	1830	942
City of Lake Macquarie - West Ward	44643	1812	1126
City of Lake Macquarie Mayoral	130336	41890	-
Lane Cove - Central Ward	7259	1020	-
Lane Cove - East Ward	6974	127	59
Lane Cove - West Ward	7362	239	124
Leeton	6105	147	-
City of Lismore	25948	916	-
City of Lismore Mayoral	26474	9054	-

Continued...

Contest	Total votes	Added votes to change outcome	Vote changes to change outcome
City of Lithgow	13061	117	68
City of Liverpool - North Ward	51345	1668	818
City of Liverpool - South Ward	58279	1589	539
City of Liverpool Mayoral	115177	2537	1269
Liverpool Plains	4460	69	46
Lockhart - A Ward	599	33	-
Lockhart - B Ward	615	20	9
City of Maitland - Central Ward	13083	800	383
City of Maitland - East Ward	12397	1098	419
City of Maitland - North Ward	14761	528	241
City of Maitland - West Ward	12720	1786	-
City of Maitland Mayoral	54181	1152	576
Mid-Coast	61696	402	235
Mid-Western Regional	15023	267	-
Moree Plains	5789	46	22
Mosman	16197	766	-
Mosman Mayoral	16425	3651	-
Murrumbidgee - Jerilderie Ward	686	64	-
Murrumbidgee - Murrumbidgee East Ward	698	95	-
Murrumbidgee - Murrumbidgee Ward	649	55	-
Muswellbrook	8756	16	9
Nambucca Valley	12043	12	6
Nambucca Valley Mayoral	12482	4563	-
Narrabri	7042	82	90
Narrandera	3398	50	-
City of Newcastle - Ward 1	23428	2772	-
City of Newcastle - Ward 2	26089	964	484
City of Newcastle - Ward 3	24468	649	419
City of Newcastle - Ward 4	24317	1056	493
City of Newcastle Mayoral	100275	16957	8479
North Sydney - Cammeraygal Ward	19088	182	77
North Sydney - St Leonards Ward	18541	920	-
Northern Beaches - Curl Curl Ward	29742	270	137
Northern Beaches - Frenchs Forest Ward	30625	1521	1020
Northern Beaches - Manly Ward	28981	2681	-
Northern Beaches - Narrabeen Ward	30124	830	418
Northern Beaches - Pittwater Ward	29642	900	-
Oberon	3215	27	12
City of Orange	23740	70	35
City of Orange Mayoral	24355	487	244
Parkes	8027	12	6
City of Parramatta - Dundas Ward	22076	877	411
City of Parramatta - Epping Ward	23461	2289	1199
City of Parramatta - North Rocks Ward	22525	2160	1067
City of Parramatta - Parramatta Ward	20440	1294	-
City of Parramatta - Rosehill Ward	22283	20	13

Contest	Total votes	Added votes to change outcome	Vote changes to change outcome
Continued...			
Port Macquarie-Hastings	52517	1694	-
Port Macquarie-Hastings Mayoral	54499	19107	-
Port Stephens - Central Ward	16289	2529	-
Port Stephens - East Ward	14813	4016	-
Port Stephens - West Ward	15425	961	539
Port Stephens Mayoral	47807	568	284
Queanbeyan-Palerang Regional	33813	465	-
City of Randwick - Central Ward	13840	362	191
City of Randwick - East Ward	12801	2390	-
City of Randwick - North Ward	13121	2596	-
City of Randwick - South Ward	14468	831	-
City of Randwick - West Ward	13609	92	46
Richmond Valley	13229	145	115
Richmond Valley Mayoral	13405	5821	-
City of Ryde - Central Ward	21826	779	486
City of Ryde - East Ward	22323	368	237
City of Ryde - West Ward	20370	382	224
City of Shellharbour - Ward A	13138	6	2
City of Shellharbour - Ward B	10527	69	38
City of Shellharbour - Ward C	10617	2726	-
City of Shellharbour Mayoral	46273	2595	1298
City of Shoalhaven - Ward 1	21724	99	39
City of Shoalhaven - Ward 2	21863	473	189
City of Shoalhaven - Ward 3	22029	3790	-
City of Shoalhaven Mayoral	67030	1615	808
Singleton	12745	3	2
Singleton Mayoral	13755	1136	568
Snowy Monaro Regional	11746	40	20
Snowy Valleys	8310	27	8
Strathfield	19500	330	186
Sutherland Shire - A Ward	28011	464	232
Sutherland Shire - B Ward	28585	419	279
Sutherland Shire - C Ward	27880	376	247
Sutherland Shire - D Ward	28543	298	247
Sutherland Shire - E Ward	28313	2102	-
City of Sydney	117362	1044	590
City of Sydney Mayoral	118511	32141	16071
Tamworth Regional	35318	70	34
Temora	4046	29	15
Tenterfield - Ward D	747	41	-
The Hills Shire - Central Ward	26375	2020	1033
The Hills Shire - East Ward	24594	2830	-
The Hills Shire - North Ward	27025	2180	549
The Hills Shire - West Ward	25507	3692	-
The Hills Shire Mayoral	105384	28637	-
Tweed	50020	1351	-

Continued...

Contest	Total votes	Added votes to change outcome	Vote changes to change outcome
Upper Hunter Shire	8300	233	-
Upper Lachlan Shire	5219	104	51
Uralla - Ward A	1837	69	-
Uralla - Ward B	1818	22	20
Uralla Mayoral	3781	2321	-
City of Wagga Wagga	35885	643	-
Walcha - B Ward	488	36	19
Walcha - D Ward	467	34	19
Walgett	2507	11	2
Warren - A Ward	332	19	14
Warren - B Ward	347	26	13
Warren - D Ward	335	6	3
Warrumbungle Shire	5530	159	108
Waverley - Bondi Ward	7152	1405	-
Waverley - Hunter Ward	8114	1553	-
Waverley - Lawson Ward	8770	2208	-
Waverley - Waverley Ward	8052	1053	-
Weddin	2380	15	7
Wentworth	3318	50	26
City of Willoughby - Middle Harbour Ward	9385	238	121
City of Willoughby - Naremburn Ward	8633	19	9
City of Willoughby - Sailors Bay Ward	9502	441	-
City of Willoughby - West Ward	9425	393	204
City of Willoughby Mayoral	37942	2531	1266
Wollondilly - East Ward	15133	504	253
Wollondilly - North Ward	14655	353	174
Wollondilly Mayoral	31355	1285	643
City of Wollongong - Ward 1	42730	3406	-
City of Wollongong - Ward 2	41073	1904	1063
City of Wollongong - Ward 3	40706	2300	1099
City of Wollongong Mayoral	127240	2666	1333
Woollahra - Bellevue Hill Ward	5519	696	-
Woollahra - Cooper Ward	5892	218	86
Woollahra - Double Bay Ward	5716	748	-
Woollahra - Paddington Ward	5834	1739	-
Woollahra - Vaucluse Ward	5997	1573	-
Yass Valley	9452	93	47