Errors in the 2016 NSW LG elections

We found two different types of error in the count for the 2016 NSW LG elections, that resulted in incorrect distribution of preferences in four observed instances. Our guess is that they did not change who was elected in any contest, but we cannot be sure, and there is some reason for doubt.

We pointed out these two errors and three of the instances (we found the fourth later) to the NSW Electoral Commission (NSWEC) a couple of days after the election results were posted, but have not yet had a response from them. In the prior LG election we pointed out a different error to them that they acknowledged it was an error and probably – but not certainly – meant the wrong person was elected.

Error 1: 3 Way ties for elimination

When a candidate must be chosen for exclusion, and there is a tie for the lowest candidate, then the tie is broken via a countback. From the published spec (Functional Requirements Specification for the Vote Count v 3.2), section 1.4.26:

> If the Election is a Local Government Election and there are 2 or more Candidates with equal lowest current Progressive Totals, then the Count process must be reviewed to go back and determine the previous Count at which the Progressive Totals for these 2 or more Candidates were last unequal and Exclude the Candidate with the lowest Progressive Total at that point. If the 2 or more Candidates have had equal Progressive Totals at all preceding Counts (including Count 1), then a draw must be conducted to determine the Candidate to be Excluded.

This is somewhat ambiguous in the case of 3 or more way ties. Consider the case of Hawkesbury. There is a 3 way tie at count 37, on 21 votes. Countbacks show:

Count	VIGOUROUX Tara	SMITH Fiona	MERCER Sidonie
36	21	21	21
35	20	21	21
34	20	21	21
33	20	21	21
32	20	21	21
31	20	21	21
30	20	21	21
29	20	21	21
28	20	21	17

…

On count 36, they are all equal. On count 35 they are unequal, and indeed there is a unique lowest, `VIGOUROUX Tara`, and it would seem very reasonable to exclude `VIGOUROUX Tara`. One could however interpret as having to go back until all three are unequal, that is step 28. Then the lowest is `MERCER Sidonie`. In the official results, it is `VIGOUROUX Tara` who is excluded (as seems reasonable), so this is evidence that the official interpretation is to not require all unequal, just a clear loser. The same choice is made in other equivalent places (e.g. count 12 of Albury, 4 way tie).

Similarly, at count 12 there is a 3 way tie. This time there is never a count when all are unequal. However, there is still an obvious loser in the countback, `GINNINGS Margaret`, who is indeed eliminated:

```
3 way tie at count 12 on 4 votes. GINNINGS Margaret was excluded.
Count              LUGTON Jen        GINNINGS Margaret CRAWFORD Edward
```

11	4	4	4
10	4	4	4
9	4	4	4
8	4	4	4
7	4	3	4
6	4	3	4
5	4	3	4
4	4	3	4
3	4	3	4
2	4	3	4
1	3	3	4

This interpretation is confirmed in an unpublished (as far as we know) addendum to the specification version 3.2 that we have been sent (personal communication).

However, this is contradicted in counts 9 and 20 Hawkesbury.

In count 9, `MIDDLEBROOK Shaun` is excluded rather than the more reasonable `CARTER Michelle`.

Count	BLACK Peter	CARTER Michelle	MIDDLEBROOK Shaun
8	3	3	3
7	3	3	3
6	3	3	3
5	3	3	3
4	3	3	3
3	3	3	3
2	3	2	3
1	3	2	3

Similarly, in count 20, `JAY Graeme` was excluded instead of `THOMAS John`.

Count	REARDON Roger	THOMAS John	JAY Graeme
19	9	9	9
18	9	9	9
17	9	9	9
16	9	9	9
15	9	9	9
14	9	9	9
13	9	9	9
12	9	9	9
11	9	8	9
10	9	8	9
9	9	8	9
8	9	8	9
7	9	8	9
6	9	8	9
5	9	8	9
4	9	8	9
3	9	8	9
2	9	6	9
1	9	5	9

Also in Cambelltown, count 17, `RIAD Youssef` was excluded instead of `SIMMONS Carla`.

Count	RIAD Youssef	FANOUS Anthony	SIMMONS Carla
16	3	3	3
15	3	3	3
14	3	3	2
13	3	3	2

12	3	3	2
11	3	3	2
10	3	3	2
9	3	3	2
8	3	3	2
7	3	3	2
6	3	3	2
5	3	3	2
4	3	3	2
3	3	3	2
2	3	3	2
1	3	3	2

These three exclusions directly contradict both the expected behaviour demonstrated in other rounds, and the (unpublished as far as we know) specification we were sent.

The thing these three implausible results have in common is that while there is a clear loser (which is needed), it is not possible to distinguish amongst the others (not that you need to).

Does it matter?

The wrong order of exclusion can clearly directly cause the election to change. It can also indirectly cause the results to change in not-obvious ways, as if the effect it has is to cause a random draw, then this will take numbers from the pseudo random number generator, changing the results of future draws.

This probable bug happened to not make a difference in this case, as Cambelltown's results are the same when run a million times without this putative bug. Hawkesbury is similar, although it may change the order of election. Not having access to the source code we cannot confirm that the bug is restricted to these two contests.

Error 2: Rounding of votes to be transferred during excess distribution

When distributing the excess from an elected candidate, only a portion (defined by a transfer value) of the votes get transferred. This is done by distributing the appropriate papers to each candidate based on the next continuing preference, and then taking a portion of these. Usually, this portion will not be an integer. Rounding is done by a set of rounding rules defined in section 1.4.17.1 of the spec. A fixed number will be rounded up, ordered by largest fractional value (as makes sense). In case of ties, preference goes to the largest integer value, then highest values in a countback, then a random draw.

In Bland Shire Council, count 2, the transfer value is exactly 0.2. Four candidates end up with a fractional value of 0.6; three of those 4 need to be chosen. The integers are:

```
MONAGHAN Brian 9

GRELLMAN Peter 7

BAKER Bruce 5

THOMAS Muzz 3
```

It is unambiguous that the first three should be rounded up, and the last rounded down. But instead, BAKER Bruce is the candidate who was rounded down, and THOMAS Muzz was rounded up.

There is some rounding that the spec requires to fixed number of decimal digits. However, this does not affect the outcome as decimal rounding does not affect multiples of 0.2. Of course careless use of a combination of decimal rounding and binary arithmetic could cause this problem, but it is also likely to cause many other problems which don't seem to exist. We do not understand the cause of this bug (not having access to the source code), but will point out that this is the only example of a rounding determined by the integers where the transfer value is perfectly representable in base ten but not in base two.

Does it matter?

In principle a rounding error could make a difference in a close fight – many of the contests are decided by a couple of votes. However in the specific case of Bland Shire, the same candidates are elected in a million runs (although it may affect order of election).

The more serious effect is what this could have on random number generation (in case the bug causes a random draw, which is somewhat unlikely to cause the observed outcome, but other possibilities are also somewhat problematic). This could have a large knock on effect. In particular, a very similar situation arises in count 3 of Yass Valley Council. In this particular case the NSWEC rounding appears correct, but an undetectable (from the outside) effect on random number generation is likely to change the result of the election, as our million runs show BUTLER Greg should be elected roughly 56% of the time (but wasn't in the official count) while TURNER Kim should be elected roughly 36% of the time (and was in the official count). Not having access to the source code we cannot confirm that this result was not affected by this bug.