

Case study

Distribution of Preferences (DoP) in a Local Government Proportional Representation Election



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Section 1: Overview

The Joint Standing Committee on Electoral Matters (JSCEM), in its report of November 2017 to the Parliament of New South Wales, made the following recommendations:

- Recommendation 1: That the Government removes the random sampling of ballots when transferring preferences when a candidate receives more than a required quota to be elected.
- Recommendation 2: That the Government introduce the weighted inclusive Gregory method to conduct future local government elections.

A full copy of the JSCEM report can be found on the Parliament of New South Wales website: parliament.nsw.gov.au

The weighted inclusive Gregory method (WIGM) is used to count the ballot papers where there are 2 or more councillor vacancies to be filled.

This document provides an example of how to conduct a proportional representation distribution of preferences using WIGM.

In a proportional counting system, a candidate is elected if they receive votes equal to or exceeding the quota. In some circumstances candidates may be elected without receiving a quota of votes where the number of vacancies remaining to be filled at the completion of the count equals the number of candidates remaining in the count. Further detail on these scenarios can be found at the end of this document.

The quota is determined by first dividing the aggregate number of formal first preferences by one more than the number of candidates to be elected. The quotient (disregarding the fraction) is increased by 1 to give the quota.

For example, if there are 316 formal first preference votes and 3 councillors to be elected, the quota would be 80 (ie $316 / 4 = 79$ (disregarding any fraction) + 1 = 80).

After the Count of First Preferences is complete, each candidate who has reached quota is elected.

Where an elected candidate has a surplus of ballot papers over the quota, this surplus is transferred to the **continuing candidates** (ie those not yet elected or excluded). If multiple candidates are elected at the same count, each candidate's surplus is transferred (one at a time) to the continuing candidates, from the highest surplus to the lowest.

To transfer a surplus, all the ballot papers received by the elected candidate are sorted to their next preferred continuing candidate. Each ballot paper is then worth a portion of that surplus. This portion is called the Transfer Value. *For example, if the quota was 80 and an elected candidate had 100 ballot papers, their surplus would be 20 votes. Each ballot paper would be worth 0.2 of a vote. A continuing candidate receiving 10 of these ballot papers would therefore receive 2 of the 20 surplus votes.*

After each transfer of ballot papers (and their associated votes), if any more candidates have reached quota, they are elected and added to the queue of surpluses to be transferred. This transfer of surpluses continues (one at a time) until all have been transferred.

Then, if vacancies remain, the candidate with the lowest number of votes is excluded. All the ballot papers received by this candidate, including those received from surplus transfers, are sorted to the continuing candidates according to their next available preference.

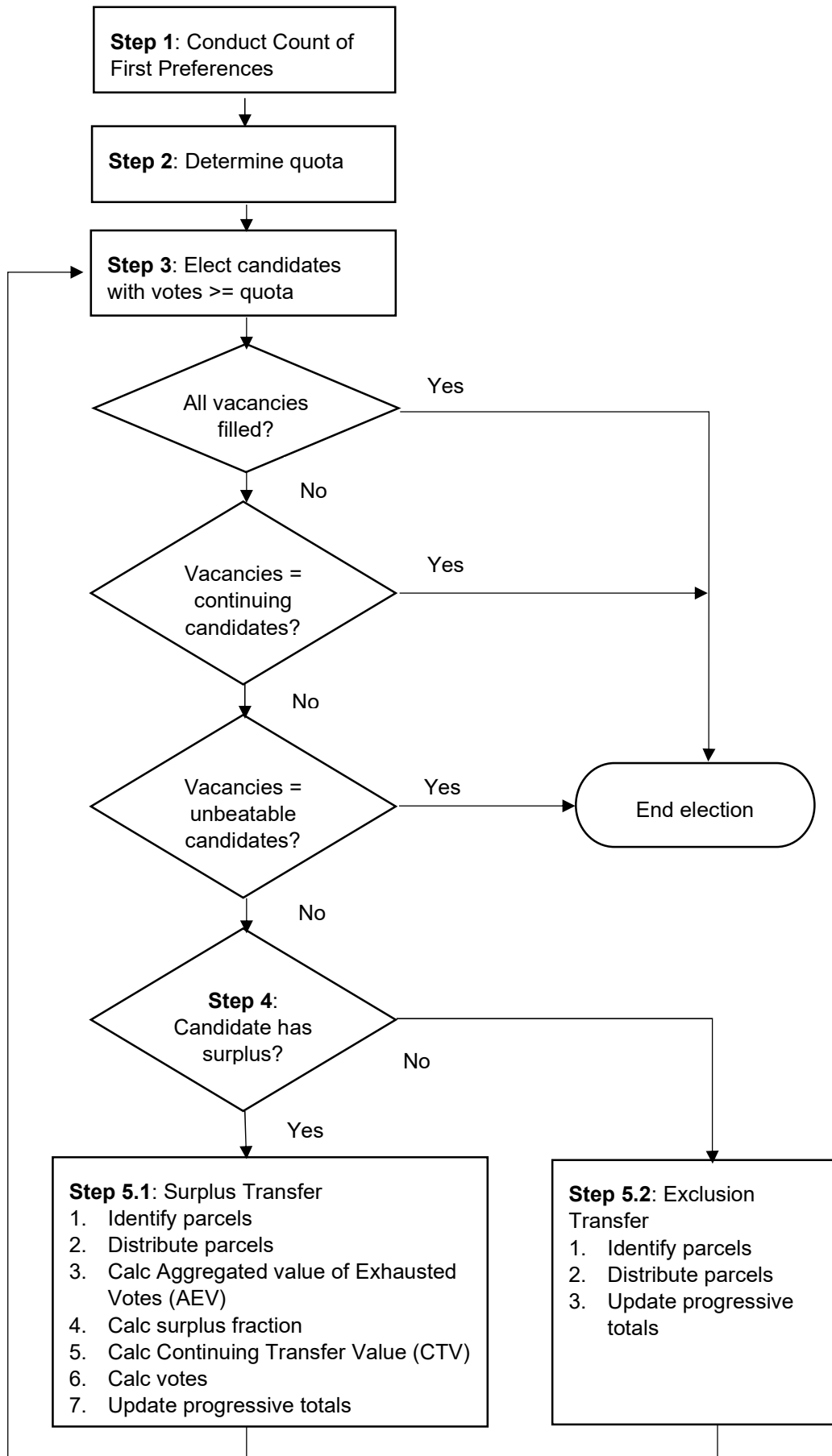
This process continues with candidates being:

- elected when their votes equal or exceed quota, with their surplus distributed as above, or
- excluded, with their ballot papers distributed as above

until either:

- no vacancies remain to be filled, or
- the number of continuing candidates equals the number of remaining vacancies, or
- all remaining vacancies can be filled by candidates whose total votes cannot be overtaken by the continuing candidates in the count.

In these circumstances, the elected candidates are elected despite not reaching the quota.



Section 2: Conduct Count of First Preferences

The first step is to perform the Count of First Preferences. This is the allocation of all **formal** first preference votes to each candidate. **Informal** ballot papers are set aside and not referenced during the count.

Note

The Count of First Preferences is conducted in accordance with Clause 5 of Schedule 5 of the *NSW Local Government (General) Regulation 2005*.

In our example election, there are 316 formal first preference votes, and these were distributed amongst the candidates per the table below (70 ballot papers had number 1 for Amy, 55 had number 1 for Bob, ...)

Figure 1

Description	Amy	Bob	Chris	Dave	Eve	Exhausted	Total	Result
First Preferences	70	55	30	120	41	0	316	

Section 3: Determine quota

To be elected, a candidate must receive votes equal to or exceeding the quota. The quota is determined by dividing the aggregate number of formal first preferences by one more than the number of candidates to be elected. The quotient (disregarding the fraction) is increased by 1.

$$\text{Quota} = \frac{\text{Total First Preferences}}{(\text{Number of Vacancies} + 1)} + 1$$

In our example election, there are three candidates to be elected. As there are 316 formal votes, the quota is 80:

$$\text{Quota} = \frac{316}{(3 + 1)} + 1 = 80$$

Section 4: Determine elected candidates

Each candidate that has votes \geq quota is elected.

In our example election, Dave had 120 votes after the Count of First Preferences. As Dave has votes equal or greater than the quota of 80, he is elected. The election continues as 2 vacancies remain to be filled.

Figure 2

Description	Amy	Bob	Chris	Dave	Eve	Exhausted	Total	Result
First Preferences	70	55	30	120	41	0	316	DAVE Elected (1)

Section 5: Count 2 - surplus transfer (Dave)

Note

Surplus transfers for candidates elected at the Count of First Preferences are conducted in accordance with Clause 6 of Schedule 5 of the *NSW Local Government (General) Regulation 2005*.

In our example election, Dave's surplus of 40 votes is to be transferred.

5.1 Identify parcels to be distributed

We first identify each parcel of ballot papers that this elected candidate has received in previous transfers.

Example: Dave has only received one parcel of ballot papers so far, being the 120 votes from the Count of First Preferences.

5.2 Distribute parcels

Ballot papers in each parcel will be distributed to the continuing candidates according to the next valid preference on each ballot paper or, if there is no valid preference, to the exhausted pile.

Example: Of Dave's 120 ballot papers, 50 ballot papers have the next highest preference (ie 2) for Amy, 40 ballot papers have number 2 for Bob, and 10 ballot papers have 2 for Chris. No ballot papers had the number 2 for Eve. 20 ballot papers had no number 2 or two number 2's and therefore exhausted.

Figure 3

Description	Ballot Papers B/F (BP)	Amy	Bob	Chris	Dave	Eve	Exhausted	Total
From Count of First Preferences	120	50	40	10		0	20	120

5.3 Calculate Transfer Value

The ballot papers received by each continuing candidate are multiplied by the Transfer Value to ascertain the value of each parcel of ballot papers they have received.

The Transfer Value is determined by the following formula:

$$\text{Surplus} \div \text{first preferences recorded by the elected candidate (excluding any exhausted ballot papers)}$$

The Transfer Value is equal to the resulting fraction or (if the fraction exceeds 1) to 1.

In the example above the Transfer Value is: $40 \div 100 = 0.40$.

** The quota is 80 and Dave has 120 first preference ballot papers, therefore the surplus is 40 ballot papers.*

*** Dave has 120 first preference ballot papers, of which 20 exhausted during the distribution of his 2nd preferences, resulting in 100 ballot papers.*

5.4 Calculate votes

Processing one parcel at a time, we determine the value of the votes each continuing candidate receives from each parcel of ballot papers.

Example:

Multiplying Amy's 50 ballot papers by the Transfer Value of 0.40 means Amy receives 20 votes.

Multiplying Bob's 40 ballot papers by the Transfer Value of 0.40 means Bob receives 16 votes.

Multiplying Chris' 10 ballot papers by the Transfer Value of 0.40 means Chris receives 4 votes.

The total of 40 votes being transferred to continuing candidates equals Dave's surplus, which is being transferred to all the continuing candidates.

Figure 4

Description	Amy		Bob		Chris		Dave		Eve		Total	
	BPs	Cand. Votes	BPs	Cand. Votes	BPs	Cand. Votes	BPs	Cand. Votes	BPs	Cand. Votes	BPs	Cand. Votes
From Count of First Preferences	50	20	40	16	10	4			0	0	120	40

50 ballot papers X 0.40 (Transfer Value) = 20 votes

5.5 Update progressive totals

The 80 votes which are equal to the quota remain with the elected candidate until the end of the election.

The votes received by each continuing candidate are added to their progressive total.

Figure 5

Description	Amy		Bob		Chris		Dave		Eve	
	BP's	Cand. Votes	BP's	Cand. Votes	BP's	Cand. Votes	BP's	Cand. Votes	BP's	Cand. Votes
First Preferences	70	70	55	55	30	30	120	120	41	41
From Count of First Preferences	50	20	40	16	10	4			0	0
Progressive Totals	120	90	95	71	40	34	0	80	41	41

Progressive totals for continuing candidates

Elected candidate retains votes equal to the quota

Example: Amy received 70 votes in the Count of First Preferences plus 20 more from Dave's surplus transfer making a progressive total of 90 votes. As this equals or exceeds quota, Amy is elected. There is still one vacancy remaining, so we now conduct a surplus transfer of Amy's surplus 10 votes to the continuing candidates (Bob, Dave, and Eve).



Section 6: Count 3 - surplus transfer (Amy)

Note

Surplus transfers for candidates elected other than at the Count of First Preferences are conducted in accordance with Clause 7 of Schedule 5 of the *NSW Local Government (General) Regulation 2005*.

In our example election, Amy is the next candidate to have their surplus transferred - she is the only remaining candidate who has a quota.

6.1 Identify parcels to be distributed

Example: Amy has received two parcels so far, being:

- 70 ballot papers (representing 70 votes) from the Count of First Preferences (this will be referred to as parcel 3.1)
- 50 ballot papers (representing 20 votes) from Dave's surplus transfer (parcel 3.2)

6.2 Distribute parcels

The ballot papers in each parcel are distributed to the continuing candidates according to the next available preference. The distribution in our example election is shown in Figure 6 below.

Figure 6

Count	Description	Amy	Bob	Chris	Dave	Eve	Exhausted	Total
3.1	From Count of First Preferences		40	20		0	10	70
3.2	From Dave's Surplus Transfer		20	30		0	0	50
3	Total		60	50		0	10	120

6.3 Calculate Aggregate Value of Exhausted Votes (AEV)

For each parcel of ballot papers being distributed, the Value of Exhausted Votes requires calculation. This is the number of exhausted ballot papers in that parcel multiplied by the parcel's Transfer Value. (For parcels that come from the Count of First Preferences, the Transfer Value is 1.)

The Aggregate Value of Exhausted Votes (AEV) is the sum of each parcel's Value of Exhausted Votes.

Example: The Value of Exhausted Votes for parcel 3.1 is 10 (=10 exhausted ballot papers multiplied by the parcel's Transfer Value of 1).

There is zero exhausted votes from the distribution of Parcel 3.2.

Therefore the AEV is 10.

6.4 Calculate Surplus Fraction

The Surplus Fraction for this surplus transfer is calculated using the formula:

$$\text{Surplus Fraction} = \frac{\text{Surplus}}{(\text{Number of votes received by the elected candidate} - \text{AEV})}$$

Example:

Amy's surplus is 10, being the number of votes for the elected candidate (90) minus the Quota (80).

The AEV is 10 (per the previous step).

Therefore Surplus Fraction = 10 ÷ (90 – 10) = 0.125

6.5 Calculate Continued Transfer Values (CTVs)

The Continued Transfer Value (CTV) represents the vote value of each ballot paper in that parcel.

For each parcel, the CTV is calculated according to the following formula:

$$\text{CTV} = \text{Surplus Fraction} \times \text{Original Transfer Value.}$$

The original Transfer Value for each parcel will either be:

- 1 (if the parcel came from the Count of First Preferences, *as parcel 3.1 does*), or
- the Continued Transfer Value (CTV) that was used when this parcel was created (*parcel 3.2 was created in count 2 with a CTV of 0.40*)

Each parcel's original Transfer Value is multiplied by this count's Surplus Fraction to generate a new CTV for that parcel.

Example: The total votes transferred should equal the surplus votes. In this case, 10.

Figure 7

Count	Description	Ballot Papers B/F (BP)	Transfer Value B/F (TV)	Continued Transfer Value (CTV)	Votes To Be Transferred
3.1	From Count of First Preferences	70	1.00	0.125	7.50
3.2	From Dave's Surplus Transfer	50	0.40	0.050	2.50

The number of ballot papers in each parcel is multiplied by the parcel's CTV to obtain the votes to be transferred.

The Transfer Value of each parcel is multiplied by this count's Surplus Fraction (0.125) to obtain the CTV

6.6 Calculate votes

The number of votes each continuing candidate receives from each parcel is now determined.

If multiplying the number of ballot papers by the CTV results in a non-integer number (ie includes a fraction), the number of votes received equals the integer portion (ie the whole number), and the fraction is disregarded.

Figure 8

Count	Description	Continued Transfer Value (CTV)	Bob			Chris			Eve			Total			
			BPs	Cand. Votes	DF	BPs	Cand. Votes	DF	BPs	Cand. Votes	DF	BPs	Cand. Votes	DF	Votes
3.1	From Count of First Preferences	0.125	40	5	0.00	20	2	0.50	0	0	0.00	70	7	0.50	7.50
3.2	From Dave's Surplus Transfer	0.050	20	1	0.00	30	1	0.50	0	0	0.00	50	2	0.50	2.50
3	Total		60	6	0.00	50	3	1.00	0	0	0.00	120	9	1.00	10.00

Chris' 20 ballot papers are multiplied by that parcel's CTV of 0.125, generating 2 votes and a Disregarded Fraction of 0.5 vote.

At the end of this Transfer, 9 votes remain with candidates. The Disregarded Fractions add up to 1.

6.7 Update progressive totals

The votes received by each continuing candidate are added to their progressive total.

Figure 9

Count	Description	Bob			Chris			Eve			Total			
		BPs	Cand. Votes	DF	BPs	Cand. Votes	DF	BPs	Cand. Votes	DF	BPs	Cand. Votes	DF	Votes
2	Prev Progressive Totals	95	71		40	34		41	41		316	316		
3.1	From Count of First Preferences	40	5	0.00	20	2	0.50	0	0	0.00	70	7	0.50	7.50
3.2	From Dave's Surplus Transfer	20	1	0.00	30	1	0.50	0	0	0.00	50	2	0.50	2.50
3	Total	60	6	0.00	50	3	1.00	0	0	0.00	120	9	1.00	10.00
3	Progressive Totals	155	77		90	37		41	41		316	315		

No candidate has reached quota, therefore we conduct an exclusion transfer of the candidate with the fewest votes, Chris.



Section 7: Count 4 - exclusion transfer (Chris)

In an exclusion transfer, each parcel of ballot papers that's been received by the excluded candidate are distributed to the continuing candidates using the parcel's current Continued Transfer Value (CTV).

Note

Exclusion transfers are conducted in accordance with Clause 9 of Schedule 5 of the *NSW Local Government (General) Regulation 2005*.

7.1 Identify parcels to be distributed

Each parcel of ballot papers that this excluded candidate has received in previous transfers is identified.

Example: Chris has received 4 parcels so far:

- 30 ballot papers from the Count of First Preferences
- 10 ballot papers from Dave's Surplus Transfer
- 20 ballot papers from parcel 3.1 in Amy's Surplus Transfer
- 30 ballot papers from parcel 3.2 in Amy's Surplus Transfer

7.2 Distribute parcels

Within each parcel, each ballot paper is distributed to the continuing candidate with the highest preference, or set aside as exhausted if there is none.

Upon the completion of distribution of a parcel, the total ballot papers received by each candidate is multiplied by the parcel's Transfer Value to determine how many votes that candidate receives. A candidate only receives the integer value, and any fraction is disregarded.

Example: Of Chris's 37 votes, 13 are distributed to Bob, and 14 to Eve. The remaining 11 votes were lost due to disregarded fractions and ballot papers being exhausted.

Figure 10

Count	Description	Continued Transfer Value (CTV)	Bob			Eve			Exhausted		Total			
			BPs	Cand. Votes	DF	BPs	Cand. Votes	DF	BPs	DF	BPs	Cand. Votes	DF	Votes
4.1	From Count of First Preferences	1.000	12	12	0.00	11	11	0.00	7	7.00	30	23	7.00	30.00
4.2	From Dave's Surplus Transfer	0.400	4	1	0.60	6	2	0.40	0	0.00	10	3	1.00	4.00
4.3.1	From Amy's Surplus Transfer	0.125	6	0	0.75	8	1	0.00	6	0.75	20	1	1.50	2.50
4.3.2	From Amy's Surplus Transfer	0.050	15	0	0.75	5	0	0.25	10	0.50	30	0	1.50	1.50
4	Total		37	13	2.10	30	14	0.65	23	8.25	90	27	11.00	38.00

Disregarded exhausted votes and disregarded exhausted fractions are added together to simplify the reporting.

7.3 Update progressive totals

The votes received by each candidate are added to their progressive total.

Figure 11

Count	Description	Bob		Eve	
		BPs	Cand. Votes	BPs	Cand. Votes
3	Prev Progressive Totals	155	77	41	41
4	Total	37	13	30	14
4	Progressive Totals	192	90	71	55

Example: With 90 votes, Bob has reached the quota of 80 and is elected, filling the last vacancy and concluding the election.



Section 8: Appendix A - Conclusion of election

An election will conclude when, after the completion of a transfer, any of the following conditions are met.

Vacancies Filled

If all vacancies have been filled, the election ends.

Vacancies = Remaining Candidates

If the number of continuing candidates (ie candidates who haven't been elected or excluded) = number of remaining vacancies, all continuing candidates are elected.

Single Unbeatable Candidate

If only one vacancy remains, and the votes of one continuing candidate exceeds the sum of:

- the total votes of all continuing candidates, and
- the total surpluses yet to be transferred

then that candidate will be elected, and the election ends.

Example: Amy has 40 votes, Bob 20 votes, Chris 10 votes, and there is a surplus of 7 votes yet to be transferred. There are only 37 votes remaining between Bob, Chris, and the surplus. Neither Bob nor Chris can reach Amy's current total of 40 votes. Amy is elected, and the election ends.

Multiple Unbeatable Candidates

If more than one vacancy remains and the candidates are sorted in order of votes from highest to lowest, if the last candidate who would be elected using this order has votes that exceed the sum of:

- the total votes of all candidates who would not be elected, and
the total surpluses yet to be transferred

then the candidates who would be elected are elected in this order such that all remaining vacancies are filled, and the election ends.

Example: There are two vacancies remaining. Amy has 40 votes, Bob 30 votes, Chris 10 votes, Dave 5 votes, and there is an outstanding surplus of 7 votes from a just-elected candidate. After sorting the candidates in vote order, Amy would be elected first and Bob second. Even if one candidate received all remaining 22 votes, they couldn't match Bob's 30 votes. Therefore both Amy and Bob are elected, and the election ends.

Final Candidates Tied

If only one vacancy and two continuing candidates remain, and all surpluses have been transferred, and the continuing candidates had an equal number of votes, the tied candidate with the least votes at the end of the last transfer in which the tied candidates had an unequal number of votes is excluded, or by random draw if the tie can't be broken. The non-excluded candidate is elected into the last vacancy, and the election ends.

