STATE OF NORTH CAROLINA
COUNTY OF WAKE

IN THE GENERAL COURT OF JUSTICE
SUPERIOR COURT DIVISION
Case No. 18 CVS 014001

COMMON CAUSE, *et al.*

Plaintiffs,

v.

DAVID R. LEWIS, *et al.*

Defendants.

Expert Rebuttal Report of Douglas Johnson, Ph.D.

Pursuant to the North Carolina Rules of Civil Procedure and the Case Management Orders of the Court in the above-captioned matter, I, Douglas Johnson, provide the following written report:

1. I am over 18 years of age and I have personal knowledge of the facts stated herein. My qualifications are stated in my original report, to which I add the following paragraph:

Expertise with Maptitude Software

2. Since I started working at NDC in 2011, I have drawn thousands of districting and redistricting plans using Maptitude for Redistricting software. I provided expert testimony on the software and its functionality in *Leach v. Arizona Independent Redistricting Commission*, in Maricopa County Superior Court, Case No. CV2012-007344. I have built hundreds of statewide and local demographic databases using this software. And I have used Maptitude for Redistricting to perform demographic analysis and to plot public opinion survey results for numerous projects. On average, I have probably spent two to three hours using the software each workday for the last eighteen years. Given the intensity of my daily use of the software; my nearly two decades of experience using the software; and the number of districting projects my firm has handled due to the impact of the California Voting Rights Act, the odds are high that I have drawn more districting and redistricting maps using Maptitude for Redistricting than anyone else in the country. The number of maps that I have drawn, analyzed, and presented using the software is certainly well over one thousand. I frequently talk with the Caliper customer support team and the programmers on the company's staff about the software's functionality, bugs, bug fixes, and new features for new releases of the software. I have spoken at a more than a dozen local, state and national government conferences on redistricting, and many of those discussions included discussion of the Maptitude software and its functions and advantages. I have trained newly hired students at the Rose Institute of State and Local Government at Claremont McKenna College on the use of Maptitude for Redistricting software almost every year for the last 17 years. I have led numerous community engagement sessions where, on behalf of our local government clients, we trained local residents on the use of the very similar "Maptitude Online Redistricting" program. And I have demonstrated the use of GIS software in general, and usually Maptitude for Redistricting in particular, on CNN, Fox News, Good Morning

America, and various Public Television News programs in southern California.

Task Description

3. For this supplemental report, I was asked to review and comment on Dr. Chen's June 7th rebuttal report. I have done so in as much detail as possible in the limited time available. I may continue to analyze that report and may further refine, revise or expand my analysis.

Summary of Opinions

4. Dr. Chen's percentages of population matches between the 2017 Adopted map and the maps allegedly from Dr. Hofeller's computer files are inflated and ignore the fact that any mapmaker has no discretion over how to draw districts covering most of the state's territory and much of its population.
5. The true measures of how many people are moved between the two House maps and between the two Senate maps prove that the differences in the Adopted maps are significant and widespread. The scale of population that differs between the Hofeller and the Adopted maps is similar to the scale of differences between the Hofeller and Covington maps, and between the Hofeller and Common Cause maps. In the House, Dr. Chen's method of measuring the differences concludes the Hofeller map is a closer match with the Common Cause map than with the Adopted map.
6. The Maptitude backup files allegedly from Dr. Hofeller's computer files reflect what was in each Redistricting Plan at the time it was last closed – they do not tell us what was on the screen as the plans were being drawn.
7. The way Maptitude encourages creating new maps by copying old maps and then erasing the specific district lines of the old map means the data, formulas, and color ranges all could have been carried into these maps from plans drawn weeks, months or even years earlier.

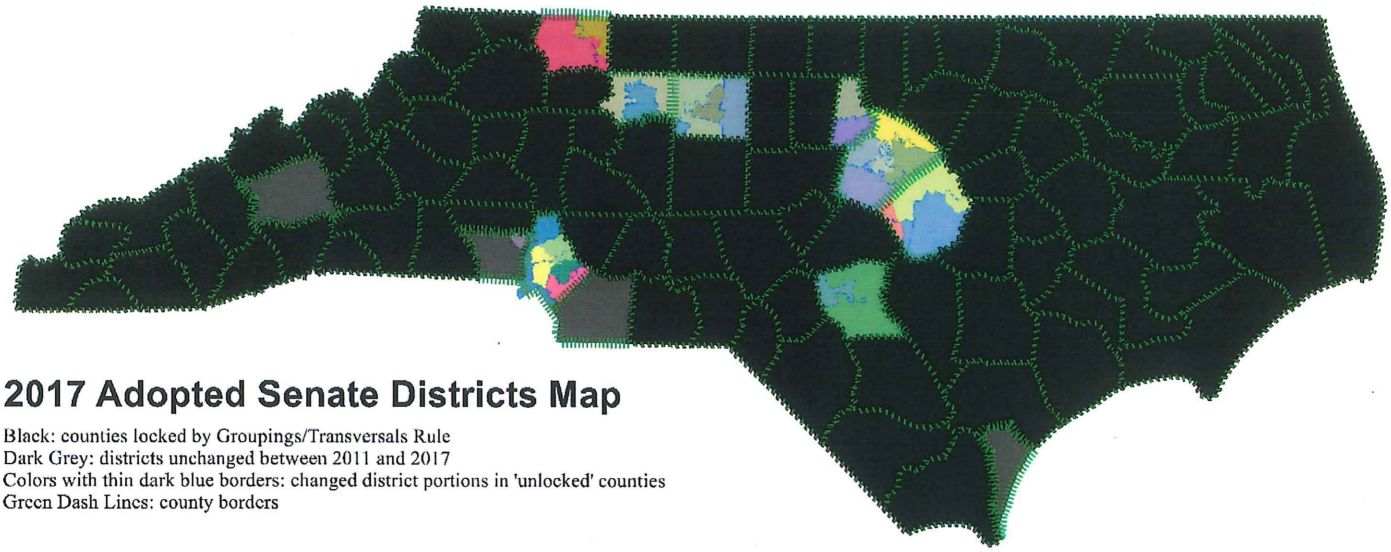
Chen's 'district match' percentages are inflated

8. The district by district percentages listed by Dr. Chen on page 2 of his rebuttal report incorrectly claim that Dr. Hofeller made 90 percent or more of the decisions about population assignments on his computer. Dr. Chen incorrectly indicates Dr. Hofeller simply transferred those assignments to the state computer and made minor final adjustments. The

reality is that the County Groupings and Traversal rules of the North Carolina Constitution, not Dr. Hofeller, made 54.5% of the population assignments in the 2017 Adopted Senate map, and 22.1% in the 2017 Adopted House map. No mapmaker, of any party, has any discretion over where those residents are assigned. Another 800,000 residents (8.8% of the state's population), reside in counties that are not locked in by the County Groupings and Traversal rules but live in Senate districts that were unchanged from the 2011 map to the 2017 adopted map. And 2.3 million residents (24.4% of the state's population) reside in House districts that in the 2017 Adopted House map are unchanged from their 2011 versions even though they are not locked by the County Groupings and Traversal rules.

9. Thus, the total share of state population locked into Senate districts and outside of any mapmaker's discretion is 63.3%. The mapmaker's only discretion over where the lines go is for the remaining 36.7% of the state's population, shown by the colored (not black or grey) districts below. The green dashed lines are county borders; the black areas are counties that fall under the Groupings and Traversal rule; the dark grey areas are the 2017 districts where the entire district was kept identical to its 2011 version; and the other colors are the parts of Senate Districts that are in divided counties and that change from their 2011 shapes:

Rebuttal Map 1

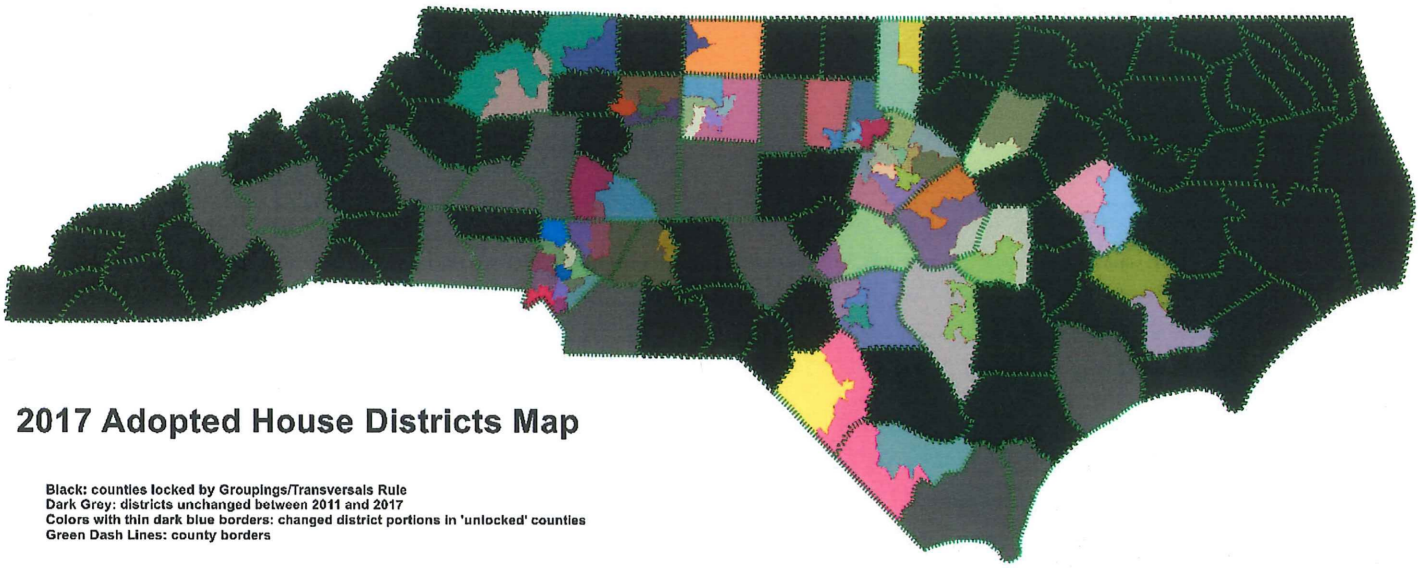


2017 Adopted Senate Districts Map

Black: counties locked by Groupings/Transversals Rule
Dark Grey: districts unchanged between 2011 and 2017
Colors with thin dark blue borders: changed district portions in 'unlocked' counties
Green Dash Lines: county borders

10. For the House, even with the smaller districts that mean fewer whole-county locked districts, mapmakers have discretion over only half (53.5%) of the state's population for the same reasons:

Rebuttal Map 2



2017 Adopted House Districts Map

Black: counties locked by Groupings/Transversals Rule
Dark Grey: districts unchanged between 2011 and 2017
Colors with thin dark blue borders: changed district portions in 'unlocked' counties
Green Dash Lines: county borders

11. Just under half (46.5%) of the state's population is locked into 2017 districts either because of the Grouping and Traversal rules or because they are in districts unchanged from 2011.

Senate Similarity Index Results

12. Where the district numbers change among competing map proposals, analyzing the similarities between a district in one map and a district in a later map requires some way to deal with those changing district numbers. In 2002, Professors Gary Cox and Johnathan Katz came up with the "similarity index" to do just that. The similarity index tells us that 19% of the population that Dr. Hofeller had the option to move (excluding those locked in by the County Groupings and Traversal rules, and by the unchanged 2011 – 2017 districts), were moved between the Senate map allegedly on Dr. Hofeller's home computer and the 2017 Adopted Map. In other words, one in five residents who could be in another district are in another district when we compare these two maps. Eighty-one percent of the population

that legally could be moved stayed in the same district (not the 95.6% figure cited by Dr. Chen on page 2 of his report).

13. For comparison, 59% of the discretionary population stays in the same district between the Hofeller map and the Common Cause Plaintiffs' Senate map, as do 56% between the Hofeller map and the Covington Plaintiffs' map. This means over half of the population subject to map-maker discretion was assigned to the same districts in the Hofeller Senate map and the Covington and Common Cause Senate maps. Yet no one is alleging Dr. Hofeller secretly drew the Covington or Common Cause maps. I disagree that the difference between 81% (one in five residents moved) and 59% (two in five residents moved) proves that one map was predetermined while the other map is independent.

14. I realize that is a lot of numbers. This may be a useful alternative way to look at it: when compared to the Senate map allegedly from Dr. Hofeller's computer, the adopted map changed the district assignments of one in five residents whose district assignments were open to change. The Covington map changed the district assignment of two in five, and Common Cause changed the assignments of slightly more than two in five. Dr. Chen's allegation appears to be that changing two in five does not indicate a secret and improper relationship between the maps, but one in five does. That appears to be an arbitrary dividing line. It is incorrect to say that a map where the average district changes the district assignment of one in five residents (of those who can be reassigned) is substantively identical to the alternative map, especially if one claims the remedy is an alternative map that changes the district assignment of only two in five residents (of those eligible to move).

Dr. Chen's 'Population Moved' Totals Appear Incorrect, Inflated and Overly Simplified

15. Instead of using an established methodology for measuring similarity ratios across plans, Dr. Chen's artificially inflated percentages simply calculate a percentage of the statewide population found in the same district in the Hofeller map and the 2017 map. Dr. Chen's 95.6% figure is artificially inflated because it ignores the fact that mapmakers have no discretion in the district assignments of much of the state's population. Dr. Chen writes that "in a June 24, 2017 draft Senate map, Dr. Hofeller had already finished assigning 95.6% of

North Carolina's census blocks (containing 97.6% of the state's population) into their final districts. First, his math is slightly off, and the actual figure is 95.7% of the state's population, not 97.6%. More importantly, that 95.7% is actually the sum of three categories of population, over two of which the mapmaker has no control:

16. Population Locked into Districts by the Groupings and Traversal rules:
    a. 5,197,864 people, or 54.5% of the state's population;
17. Population Unchanged from 2011 Districts:
    a. 839,312 people, or 8.8% (for a cumulative total of 63.3%);
18. Population in the same district in the Hofeller map and the 2017 map:
    a. 3,085,195, or 32.4% of the state's population (for a cumulative total of 95.7% of the state's population).
19. While Dr. Chen claims "the final Senate Bill 691 map affected only . . . 2.4% of the state's population", the fact is that, when compared to the Hofeller map, the districts in the 2017 Adopted Senate map moved an average of 19% of the residents who were eligible to be moved. Dr. Chen's counts as mapmaker-driven-decisions those residents who in fact were locked in by the Grouping and Traversal requirements and those residents in unchanged 2011 districts. The result of this mistake is to artificially inflate the percentages reported. Districts in substantively identical maps would move only a percentage or two of population, and even that only for population balancing – moving an average 19% of those residents who can be moved in each district represents a large and significant map revision.
20. For comparison, using Dr. Chen's approach: the 2017 map actually keeps 95.7% of the state's population in the same district as in the Hofeller map; the Covington plaintiffs' map keeps 88.0% in the same district as in the Hofeller map; and Common Cause keeps 89.2%. Dr. Chen's assertion that the 95.7% similarity proves an excessive and thus illegal dependency on the earlier map seems dubious when the corresponding similarity percentages for the alternative maps proposed by various plaintiffs in related cases are only slightly lower at 88.0% and 89.2%.

House Similarity Index Results

21. I found similar results when looking at the various House plans:

    a. Similarity Index for Hofeller versus 2017 Adopted House Map: 64%

    b. Similarity Index for Hofeller versus Covington House Map: 40%

    c. Similarity Index for Hofeller versus Common Cause House Map: 53%

22. Dr. Chen also artificially inflates the "unchanged" percentage in his report when he writes "Subsequent changes made after Dr. Hofeller's June 28 draft map and prior to the final House Bill 927 map affected only . . . 11.8% of the state's population". Again he is attributing to the mapmaker decisions that were dictated by law and by the decision to keep numerous districts unchanged from the 2011 map. Using, simply for comparison, Dr. Chen's (flawed) analytic approach, the actual percentage of population in one district in the Hofeller map and in another in the 2017 Adopted House map is 25.5%. Following this methodology, one gets the following "unchanged population" percentages when comparing the Hofeller map with the following maps:

    a. Unchanged Population for Hofeller versus 2017 Adopted House Map: 74.5%

    b. Unchanged Population for Hofeller versus Covington: 67.4%

    c. Unchanged Population Percentage for Hofeller versus Common Cause: 82.1%

23. You read that correctly: a larger percentage of the state's population in the Common Cause map match their assignments in the Hofeller map than match their assignments in the 2017 Adopted House map.

Similarity Conclusions

24. Dr. Chen's groupings charts (starting on page 4) also artificially inflate the population similarities between the Hofeller districts and the 2017 Adopted maps. The numbers are again artificially inflated by counting residents whose assignment is dictated by the Traversal Rule or locked-in by the unchanged 2011 to 2017 districts.

25. For example, to cite a district found on page 32 of Dr. Chen's report, the Traversal Rule dictates that all of the territory of Davie County must be united in a single district. So Dr. Hofeller and the Legislature had no discretion to assign it to any other district, despite the implications in Dr. Chen's report. Dr. Chen never mentions the Traversal Rule, so I am

unaware of whether he ignored it in his report by choice, or whether he did not know about that part of the state constitution's requirements for redistricting.

26. An even clearer analytical mistake is Dr. Chen's analysis of the Duplin/Onslow County Group on pages 12 and 13. Dr. Chen highlights that 100% of all three districts in this grouping match in the Hofeller and Adopted House maps – but fails to mention that the mapmaker had zero discretion in any district in this grouping. The County Traversal rule dictated that Duplin County be kept whole in one district, while districts 14 and 15 are locked in as unchanged from the 2011 map, leaving the mapmaker no options and dictating that district 4 cover the portion of Onslow County shown in the adopted map.

Dr. Chen's cluster by cluster analysis ignore the Traversal Rule

27. The math on pages 4 through 38 of Dr. Chen's report is similarly inflated like the figures on page 2 of his report. Also, the titles on the grouping by grouping maps are misleading – the ".shp" files and the resulting images labeled as "Hofeller" were created by Blake Esselstyn, not Dr. Hofeller, as Dr. Chen acknowledges in a completely separate footnote on page 2.

28. The screenshots attributed to Dr. Hofeller and Maptitude were not made in Maptitude (by Dr. Hofeller nor by anyone else).

29. Each time a redistricting plan is closed in Maptitude, the program creates a backup file and includes in it a ".bmp" ("bit-map") file that captures the image currently in the map window. But that .bmp file captures only the specific window with the map in it – not the top or side menus, dataviews, or any other screen elements. Maptitude does not have a "screenshot" function in it. (I did a word search on the Maptitude for Redistricting help system to confirm this, and a search for "screenshot" or "screen shot" did not find those words anywhere in the system. And I have not yet found any ".jpg" or ".png" screen shots in Dr. Hofeller's files (those are the two file formats screen shots are most typically stored in when they are created and saved). We know from the "Licensed to FrontWater geo" wording at the top of the screenshots that they were created by Blake Esselstyn, not Dr. Hofeller.

Maptitude Backup File Dates indicate the last time they were closed, not when they were modified

30. Dr. Chen repeatedly references the "Modified" dates on the Maptitude files allegedly from Dr. Hofeller's computer and cites those dates as indicating when those maps were drawn. This is an incorrect inference. Every time a Maptitude Plan file is opened and closed, Maptitude creates a backup file with a "Modified" date matching the time it is created. This occurs even when no changes were made in the plan. So a plan with a backup file "last modified" date could very well have been last worked on months or even years earlier, if a user then accidentally or intentionally opened it simply to look at it rather than to modify it.

Maptitude Carries Dataviews and Formula Fields forward from one plan to another

31. Maptitude can have literally hundreds of system and data settings for a given map. Rather than set those map by map, users either create a plan template or simply copy an old map when starting work on a new map. If a new map is made by copying and then modifying an old map (which is the way I create two-thirds or more of the maps I make for NDC), the formula fields and dataview sort settings are also carried over. So it is entirely possible that the formula fields and sort-by-field settings cited by Dr. Chen in pages 39 through 51 were set up weeks or months prior to the June and August "last modified" dates cited by Dr. Chen, and their presence simply shows that at some time those fields and views were set up – not that they were set up or used after the state's adoption of criteria for the 2017 redistricting. There are a myriad of reasons why these fields and views may have been set up at various earlier dates in the process, and the information cited by Dr. Chen gives us no indication of when or why Dr. Hofeller might have actually reviewed and/or used that data.

Maptitude Backup Files Show What Was On Screen When a Map is Closed – Not What Was On Screen When the Map was Drawn

32. The map, dataview, layers and other settings in a Maptitude Redistricting Plan backup file are stored at the time a Redistricting Plan is closed, not while an operator is working on the Plan. There is no "backup now" or other mid-project function that creates a backup file while an operator is in the software. That functionality only creates the ".zip" backup file of a Plan when the Plan is closed.

33. In short, all of the screen shots labeled or cited as "Hofeller" were in fact made by Blake

Esselstyn. The backup files used by Mr. Esselstyn to make the pictures in Dr. Chen's report use data and maps that were (according to the plaintiffs) in Dr. Hofeller's personal computers or backup drives when he closed each Redistricting Plan file. To emphasize that key point: these backup files tell us what was in the system at the time the Plan was closed, not at the time the Plan was originally drawn or modified. We have no indications that Dr. Hofeller used those color-coded maps at the time he was drawing the plans allegedly on his laptop, or whether those were just settings and data carried over from older plans drawn weeks, months or even years earlier.

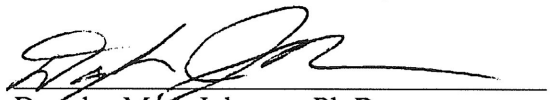
34. And even if all of those facts about the data in the backup files are ignored, Dr. Chen artificially inflated how closely the maps allegedly on Dr. Hofeller's personal files matched the 2017 Adopted House and Senate maps. In reality, the difference is one of degrees, rather than major jumps, between how closely the maps in those personal files match the Adopted maps compared to how closely the Covington and Common Cause plaintiff maps match those Adopted maps. As I have previously noted, North Carolina's County Groupings and Traversal rules are a significant limitation on the discretion of mapmakers. Those rules, along with avoiding changing 2011 districts that do not need to be changed, dictated the district assignment of just slightly under half of the state's population in House maps and nearly two-thirds of the state's population in Senate maps.

A final caveat

35. In the time available, I was able to calculate the population "locked in" to their district assignments because they are in districts that did not change from 2011 to 2017 and/or because they are in counties that cannot be split due to the Groupings and Traversal rule. But House District 4 in Onslow County illustrates another group of people "locked in" who are not captured by my math. These residents are "locked in" not because the district and county where they live is directly covered by any of these rules, but because every other district in the county is "locked" – indirectly "locking" these residents in as well. If my calculations included these additional "locked in" residents, the resulting reductions in the total statewide "population eligible to move" would increase the evidence in support of my opinions.

CERTIFICATION

I certify that the statements and opinions provided in this report are true and accurate to the best of my knowledge, information, and belief.



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