



Petitioners,

v.

LEIGH M. CHAPMAN, in her official capacity as the Acting Secretary of the Commonwealth of Pennsylvania; JESSICA MATHIS, in her official capacity as Director for the Pennsylvania Bureau of Election Services and Notaries,

Respondents.

**GOVERNOR WOLF'S RESPONSIVE BRIEF IN SUPPORT OF  
PROPOSED 17-DISTRICT CONGRESSIONAL REDISTRICTING PLAN**

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Intervenor-Respondent Tom Wolf, Governor of the Commonwealth of Pennsylvania, submits this Responsive Brief in support of his Proposed 17-District Congressional Redistricting Plan (the “Plan”).

Applying the Pennsylvania Constitution’s Free and Equal Elections Clause, *see* Pa. Const. art. I, § 5, Governor Wolf’s Plan is one of only a small handful of the submitted proposed redistricting plans that make good on the “mandate[e] that the power of [each] vote in the selection of representatives be equalized to the greatest degree possible with all other Pennsylvania citizens.” *League of Women Voters v. Commonwealth*, 178 A.3d 737, 817 (Pa. 2018) (*League of Women Voters D*). Using the *League of Women Voters* neutral criteria to narrow the field, the Governor’s Plan is in the top tier of proposed redistricting plans. And when narrowing the field further by the maps’ political fairness, to ensure that they do not unfairly dilute the power of a particular group’s vote for a congressional representative, the Governor’s Plan stands out as the one the Court should adopt.

Republican Legislative Intervenors, apparently understanding that their proposal falls short, attempt to tip the scales of review in their favor. They argue that their plan, HB 2146, should receive “special consideration” because it passed both chambers of the General Assembly. Earlier today, however, Governor Wolf vetoed HB 2146, as he had previously indicated he would, because HB 2146 does not deliver on the Pennsylvania Constitution’s guarantee of free and equal

elections, and *not* as the Republican Legislative Intervenors crassly suggest, “as a partisan political ploy.” (House GOP Br. at 12.) The Republican Legislative Intervenors contend that Governor Wolf’s veto has no bearing on how the Court should view HB 2146. That is wrong as a matter of law.

**I. Comparing the Submitted Congressional Districting Plans, Governor Wolf’s Plan Is Least Likely to Unfairly Dilute the Power of any Particular Group’s Vote.**

As the Supreme Court held in *League of Women Voters v. Commonwealth*, 178 A.3d 737 (Pa. 2018) (*League of Women Voters I*), the Free and Equal Elections Clause “governs all aspects of the electoral process,” including reapportionment, and “provides the people of this Commonwealth an equally effective power to select the representative of his or her choice, and bars the dilution of the people’s power to do so.” *Id.* at 814. To ensure compliance with the Free and Equal Elections Clause, a court reviewing a redistricting plan must proceed in two steps: first, it must determine whether the plan comports with the *League of Women Voters I* “neutral ‘floor’ criteria,” *id.* at 817; and second, it must also ensure that the plan does not “nevertheless operate to unfairly dilute the power of a particular group’s vote for a congressional representative[,]” such as by entrenching partisan advantage. *Id.*<sup>1</sup>

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<sup>1</sup> In *League of Women Voters I*, the Court recognized that “advances in map drawing technology and analytical software can potentially allow mapmakers, in the future, to engineer congressional districting maps, which, although minimally comporting with these neutral ‘floor’ criteria, nevertheless operate to unfairly dilute the power of a particular group’s vote for a

Here, because the Court is reviewing many plans, the scope of the Court’s inquiry is different than the one undertaken in *League of Women Voters I*: the Court is not considering whether to invalidate an enacted plan; it is choosing among many proposed plans in the absence of a lawfully enacted map. Accordingly, as in *Mellow v. Mitchell*, 607 A.2d 204 (Pa. 1992), the inquiry is more appropriately framed as: “Which of the [13] plans timely offered to this [C]ourt comes closest to the constitutional standards in all pertinent respects?” *See id.* at 218.<sup>2</sup> As a result, this case goes beyond simply asking whether each plan satisfies the requirements of steps one and two of the *League of Women Voters I* analysis. Instead, the Court is tasked with determining which plans, after satisfying the neutral criteria “floor” at step one, are the least likely to cause systemic vote dilution at step two, *i.e.*, which plans best realize the goal of fundamental fairness and avoid entrenching partisan advantage.

Based on the analysis of Governor Wolf’s redistricting expert, Dr. Moon Duchin, several of the proposed maps, including the Governor’s Plan, establish themselves as viable candidates at step one. But at the second step, Dr. Duchin

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congressional representative.” 178 A.3d at 817. To ensure that is not the case here, particularly given the limited factual record about the development of each proposed district map, the Court must look beyond the “floor” criteria to ensure that the plan adopted by the Court does not “unfairly dilute the power of a particular group’s vote for a congressional representative.” *Id.*

<sup>2</sup> The question presented in *Mellow* was included in Judge Craig’s “Findings, Recommended Decision and Form Order,” which the Supreme Court adopted. *Mellow v. Mitchell*, 607 A.2d 204, 211 (Pa. 1992).



concluded the Governor’s Plan best achieves partisan fairness and promotes accountability and responsiveness to voters, so as best to guarantee no unfair dilution of “the power of a particular group’s vote.” *League of Women Voters I*, 178 A.3d at 817.

**A. *League of Women Voters I* Step One: Adherence to Neutral Criteria**

At step one, Dr. Duchin quantified the proposed redistricting plans’ faithfulness to the *League of Women Voters I* “neutral criteria” of compactness, contiguity, population deviation, and keeping together political subdivisions. *Id.* at 816-17. For population deviation and contiguity, there was relatively little differentiation among the plans. Exhibit A, Duchin Rebuttal Report at 2. And for minimizing split political subdivisions, all of the plans performed well, meaning that the differences among the plans are not disqualifying. *Id.* Compactness, however, demonstrates the wide gap between all of the at-issue proposals. As shown below, Dr. Duchin determined that two tiers of plans separated themselves overall:

Neutral Criteria – Tier One  
Governor Wolf’s Plan  
Amici Voters of the Commonwealth of PA Plan  
Intervenor-Petitioner Reschenthaler et al. Plan 1  
Amicus Draw the Lines PA Plan

Neutral Criteria – Tier Two  
Amici Ali et al. Plan  
Intervenor-Petitioner Reschenthaler et al. Plan 2

*Id.* Governor Wolf’s Plan is among the best plans, when judging based on the neutral criteria.

**B. *League of Women Voters I Step Two: Ensuring No Unfair Vote Dilution by Achieving Partisan Fairness***

At step two, Dr. Duchin quantified the proposed redistricting plans’ political fairness, to ensure that each plan does not pose a risk of unfairly diluting the power of a particular group’s vote. Dr. Duchin compared the plans using four measures of partisan fairness, each of which was discussed in her expert report and Governor Wolf’s Brief in support of his Plan: (1) total efficiency gap; (2) Eguia metric; (3) mean-median score; (4) partisan bias score. Ex. A, Rebuttal Report at 2-3.

Comparing all four metrics, Dr. Duchin determined that, of the twelve plans aside from the Governor’s, the Governor’s Plan dominates 10 and is in a “trade-off position” with two others (the Carter Petitioners’ plan and House Democratic Caucus plan). No plan dominates the Governor’s plan, however. Thus, from this “Pareto frontier” perspective, the Governor’s plan is the strongest in the field.

	total efficiency gap	total Eguia metric	total mean-median	total partisan bias
GovPlan	0.1007	-0.0486	-0.0077	-0.1176
CitizensPlan	-0.1678	-0.3427	-0.1042	-0.6471
HB-2146	-0.8336	-0.9898	-0.2927	-1.2353
Carter	-0.0058	-0.1663	-0.113	-0.5294
Gressman/GMS	0.1394	-0.0486	-0.0385	-0.2353
HouseDemCaucus	0.1814	0.0102	-0.0071	0.1765
SenateDemCaucus1	-0.2601	-0.4015	-0.1382	-0.7059
SenateDemCaucus2	0.1221	-0.0486	0.0106	0.1176
Resenthaler1	-1.1024	-1.2251	-0.2524	-1.1176
Resenthaler2 2	-1.1042	-1.2251	-0.2534	-1.0588
CitizenVoters	-0.4074	-0.5192	-0.1847	-0.6471
VotersOfPA	-0.5686	-0.6957	-0.2734	-0.8824
KhalifAli	-0.3166	-0.4604	-0.1209	-0.4706

Ex. A, Duchin Rebuttal Report at 3.

In sum, of the proposed plans that were among the top tiers at step one of the *League of Women Voters I* analysis, only the Governor’s Plan performed highly at step two, measuring for partisan fairness. As a result, the Governor’s Plan, and the Governor’s Plan alone, not only comports with the neutral criteria, but also delivers on the “mandate[e] that the power of [each] vote in the selection of representatives be equalized to the greatest degree possible with all other Pennsylvania citizens.” *League of Women Voters I*, 178 A.3d at 817.

## II. HB 2146 Is Not Entitled to Any Special Weight

Relying primarily on two 50-year-old district court decisions, *Donnelly v. Meskill*, 345 F. Supp. 962, 965 (D. Conn. 1972), and *Skolnick v. State Electoral Bd. of Ill.*, 336 F. Supp. 839 (N.D. Ill. 1971), the Republican Legislative Intervenor asserts that HB 2146, is entitled to “special weight” or “special consideration” because the General Assembly passed the bill. (See House GOP Br.

at 9-12; Senate GOP Br. at 10-12.) But the overwhelming weight of authority shows that the opposite is true: vetoed reapportionment plans receive no deference.

As a threshold issue, state supreme courts and the U.S. Supreme Court have flatly rejected the Republican Legislative Intervenors' position, which should end the inquiry. Just months ago, in November 2021, the Wisconsin Supreme Court disagreed with the Republican Legislative Intervenors' argument that vetoed reapportionment plans get special weight or consideration: "The Legislature suggested we start with their proposed maps. But those maps, if not enacted into law, are mere proposals deserving no special weight." *Johnson v. Wisconsin Elections Comm.*, 967 N.W.2d 469, 495 fn.15 (Wis. 2021) (Grassl Bradley, J.). Other state supreme courts are in accord. *See, e.g., Hartung v. Bradbury*, 33 P.3d 972, 979 (Or. 2001) (rejecting argument that Oregon Secretary of State, who as matter of statute conducts reapportionment after impasse between legislature and governor, "should have deferred to the Legislative Assembly's plan of reapportionment, even though the Governor vetoed that plan"); *Wilson v. Eu*, 823 P.2d 545, 576 (Cal. 1992) (rejecting argument that "special deference be given to the various plans passed by the Legislature but vetoed by the Governor"). Most importantly, the U.S. Supreme Court has similarly stated that a legislature's vetoed proffered reapportionment plan does not warrant anything more than "thoughtful consideration[.]" *Sixty-Seventh Minnesota State Sen. v. Beens*, 406 U.S. 187, 197

(1972) (distinguishing between “the *State’s* policy” on districting, on the one hand, and the legislature’s vetoed reapportionment plan, on the other hand, which “represented *only* the legislature’s proffered current policy.” (emphasis added)); accord *O’Sullivan v. Brier*, 540 F. Supp. 1200, 1202 (D. Kan. 1982) (“[W]e are not required to defer to any plan that has not survived the full legislative process to become law.” (citing *Beens*, 406 U.S. at 197)).

That should put the issue to rest. Moreover, and tellingly, the only cases the Republican Legislative Intervenors cite to espouse their “special weight” argument are *Donnelly* and *Skolnick*. Each is fifty-years-old; no Pennsylvania court has cited to either district court decision; and the facts of both cases are easily distinguishable. In *Carstens v. Lamm*, 543 F. Supp. 68 (D. Colo. 1982), which factored heavily in Judge Craig’s Findings, Recommended Decision and Form of Order in *Mellow*, see 607 A.2d at 208 fn.1; see also *id.* at 215, 219, the court refused to follow *Donnelly* for reasons that are equally applicable here:

[In *Donnelly*, the court] concluded ‘if time permitted extended hearings before the court or extended consideration by a court-appointed master, a better plan might be devised, weighing all possible factors.’ In the instant case, the Court has solicited extensive submissions from the parties and does not face the same severe time constraints which confronted the *Donnelly* court. Thus, we do not feel that the holding in ... *Donnelly* compels us to give priority to [a legislature’s vetoed plan], particularly if a better plan is available.

*Carstens*, 543 F. Supp. at 78.<sup>3</sup> As in *Carstens*, this Court has solicited extensive submissions from many parties and amici and is set to hold a two-day hearing. There is no reason or need to defer to HB 2146, particularly in light of the overwhelming weight of authority stating that any such deference would be error.

Likewise, *Skolnick* is off-point given its facts. In *Skolnick*, the court reviewed a reapportionment plan that received “the over-whelming approval of one house of the legislature” *but was never brought to a vote* in the other house of the legislature. 336 F. Supp. at 846. As a result, the court cautioned that it “would be unwise to attempt to guess the fate of the map in the upper house.” *Id.* Here, there is no need for the Court to guess the fate of HB 2146. Governor Wolf vetoed it, meaning it is not a law and does not have the “substantial bipartisan support” attributed to the plan in *Skolnick. Id.*

Likely because the weight of authority is against them, the Republican Legislative Intervenors also suggest that the Court should treat HB 2146 as a valid exercise of the Commonwealth’s legislative power and therefore the plan should be entitled to special consideration or deference. The Republican Legislative Intervenors argue that because the Elections Clause of the U.S. Constitution

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<sup>3</sup> In *Mellow*, the Supreme Court recognized that “Judge Craig relied on earlier cases, to wit ... *Carstens v. Lamm*, 543 F. Supp. 68 (1982)[.]” 607 A.2d at 208 fn.1; *see also id.* at 215, 219. Although *Mellow* did not explicitly cite the portions of *Carstens* distinguishing *Donnelly*, the Court’s reliance on *Carstens* in *Mellow* nonetheless suggests that Judge Craig agreed with the methodology used to decide *Carstens*.

provides that “[t]he Times, Places and Manner of holding Elections for Senators and Representatives, shall be prescribed in each State by the *Legislature* thereof[.]” U.S. Const. art. I, § 4 (emphasis added), a legislative enactment of the General Assembly “reflects state policies and the people’s preferences[.]” (House GOP Br. at 11; *see also* Senate GOP br. at 10.) Operating under the misapprehension that the General Assembly can wield the legislative power absent action by the Governor, they posit that “[t]his Court should adopt the House Plan regardless of whether it is ultimately vetoed by the Governor.” (*Id.* at 12.)

The Republican Legislative Intervenors’ argument relies on a fundamentally incorrect statement of law: that “Pennsylvania’s legislative power (and therefore its power to engage in congressional redistricting) is vested *exclusively* in the General Assembly.” (Senate GOP Br. at 11 (citing Pa. Const. art. II, § 1) (emphasis added)). As this Court and the Pennsylvania Supreme Court have explicitly stated, the Governor’s power to approve or veto bills is a quintessentially legislative power: ““The Governor’s powers include his power to veto legislation to the extent that this power is vested in him by Sections 15 and 16 of Article IV. The Governor’s exercise of his veto power is unique in that it is essentially a limited *legislative power*[.]” *Brouillette v. Wolf*, 213 A.3d 341, 362 (Pa. Commw. Ct. 2019) (en banc) (quoting *Jubelirer v. Rendell*, 953 A.2d 514, 529 (Pa. 2008)

(emphasis added)). Redistricting legislation, like all legislation, is “subject to veto by the Governor.” *League of Women Voters I*, 178 A.3d at 742.

Thus, in circumstances such as this, where a governor has the authority under the state constitution to veto election-related legislation, the U.S. Supreme Court has concluded that under the Elections Clause, “legislative action in districting the state for congressional elections shall be subject to the veto power of the Governor as in other cases of the exercise of the lawmaking power.” *Smiley v. Holm*, 285 U.S. 355, 373 (1932). Accordingly, HB 2146 “cannot be sustained by virtue of any authority conferred by the Federal Constitution upon the Legislature ... to create congressional districts independently of the participation of the Governor as required by the state Constitution with respect to the enactment of laws.” *Id.* The Governor has vetoed HB 2146, and so HB 2146 has no legal status under the Elections Clause.

In sum, as a matter of law, HB 2146 is not, entitled to any degree of deference.<sup>4</sup>

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<sup>4</sup> To the extent the Court agrees with the House Republican Intervenors that HB 2146 is entitled to some degree of deference, the Governor’s Plan – submitted by a coequal branch of government with an equal role in approval of congressional reapportionment plans – should be entitled to the same deference.



### III. Conclusion

“It is a core principle of our republican form of government ‘that the voters should choose their representatives, not the other way around.’” *League of Women Voters I*, 178 A.3d at 740-41 (citation omitted). To make good on that guarantee, the Court should adopt Governor’s Wolf Plan.

Respectfully submitted,

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Dated: January 26, 2022

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## **CERTIFICATION REGARDING PUBLIC ACCESS POLICY**

I certify that this filing complies with the provisions of the Public Access Policy of the Unified Judicial System of Pennsylvania: Case Records of the Appellate and Trial Courts that require filing confidential information and documents differently than non-confidential information and documents.

Dated: January 26, 2022

*/s/ Robert A. Wiygul*  
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# **EXHIBIT A**

# Response Report on Congressional Districting Plans in Pennsylvania

Moon Duchin  
Professor of Mathematics, Tufts University  
Senior Fellow, Tisch College of Civic Life

January 26, 2022

## 1 Assignment and qualifications

I am a Professor of Mathematics and a Senior Fellow in the Jonathan M. Tisch College of Civic Life at Tufts University. At Tisch College, I am the principal investigator of an interdisciplinary research lab focused on geometric and computational aspects of redistricting. I was recently awarded a major grant from the National Science Foundation to study *Network Science of Census Data*. My areas of research and teaching include the structure of census data, the design and implementation of randomized algorithms for generating districting plans, and the analysis of partisan fairness and of redistricting more broadly.

I have previously submitted a report in this case, and this report is in response to the filings of January 24, 2022.

## 2 Overview of plans

In my previous report, I compared three 17-district plans:

- HB-2146– derived from a plan by Amanda Holt, modified and then passed by the House of Representatives on Jan 12, 2022 and now by the Senate on Jan 24, 2022;
- CitizensPlan– derived from citizen-submitted contest entries in the Draw the Lines PA competition; and
- GovPlan– developed by the Governor’s office, derived from submissions to a public portal.

To these I will add ten other plans that were submitted to the Commonwealth Court on January 24, 2022.

- Carter– plan by Carter petitioner group, developed by Dr. Jonathan Rodden using a least-change principle;
- Gressman/GMS– plan by Gressman petitioner group, developed through mathematical optimization techniques;
- HouseDemCaucus– plan by House Democratic Caucus;
- SenateDemCaucus1– first plan by Senate Democratic Caucus;
- SenateDemCaucus2– second plan by Senate Democratic Caucus;
- Reschenthaler1– first plan by Congressman Reschenthaler et al.;

- Reschenthaler2– second plan by Congressman Reschenthaler et al.;
- CitizenVoters– plan by "Citizen Voters" amici;
- VotersOfPA– plan by "Voters of the Commonwealth of Pennsylvania" amici;
- KhalifAli– plan by Khalif Ali et al. on behalf of the Public Interest Law Center.

### 3 An excellence standard for traditional criteria

Redistricting is not a literal optimization problem; if one plan splits an additional county with respect to another, it need not be disqualified, because plans are made in view of many legitimate, competing, and sometimes qualitative goals.<sup>1</sup> Even if we desired to seek literal optimization, there is no standard or universal way to optimize several factors at once. And even if we wanted to prioritize, say, compactness, we are still left with dozens of different compactness metrics and a question of how to aggregate them over a 17-district plan. The quantitative metrics describing traditional redistricting principles are helpful but not dispositive in our search for the best and fairest plan available.

Rather, the traditional/neutral principles serve as "a 'floor' of protection," in the words of the LWV decision. This means that if we can identify a level that constitutes *excellent* alignment with traditional principles, we should treat this as a threshold after which we may legitimately consider other aspects of a plan in coming to an ultimate selection.

#### 3.1 Plans meeting the excellence standard for traditional criteria

All 13 plans are contiguous, and all 13 plans are closely population-balanced for either Census PL population or prisoner-adjusted population. This means that the neutral criteria most relevant for distinguishing the plans are **compactness** and **respect for counties and municipalities**.

I have based my review of six compactness metrics: five contour-based metrics named by the Court in 2018 and one discrete metric.

Table 1: Comparison of compactness and splitting metrics.

name	mean Polsby	mean Schwartz	mean Reock	mean ConvHull	mean PopPoly	cut edges	split counties	county pieces	split munis	muni pieces
GovPlan	0.3808	1.6534	0.4313	0.8257	0.7834	5185	16	35	18	37
CitizensPlan	0.3785	1.6625	0.4512	0.8120	0.7725	5237	14	30	16	33
HB-2146	0.3212	1.8197	0.4087	0.7987	0.7524	5907	15	33	16	34
Carter	0.3214	1.8103	0.4499	0.7922	0.7416	5926	14	31	20	41
Gressman/GMS	0.3478	1.7351	0.4261	0.8176	0.7582	5582	15	32	16	33
HouseDemCaucus	0.2787	1.9693	0.4286	0.7717	0.7205	6853	16	34	18	37
SenateDemCaucus1	0.3147	1.8144	0.4137	0.7918	0.7519	6047	17	36	19	39
SenateDemCaucus2	0.3346	1.7478	0.4146	0.8153	0.7601	5505	16	34	16	33
Reschenthaler1	0.3629	1.6859	0.4347	0.8238	0.7737	5090	13	29	16	33
Reschenthaler2	0.3524	1.7127	0.4231	0.8161	0.7658	5237	13	29	16	33
CitizenVoters	0.3490	1.7133	0.4412	0.8082	0.7575	5173	14	31	16	33
VotersOfPA	0.3965	1.6069	0.4697	0.8209	0.7681	5052	15	31	18	37
KhalifAli	0.3523	1.7204	0.4448	0.8111	0.7456	5266	16	35	18	37

By far the two most compact plans, considering these metrics overall, are VotersOfPA and GovPlan. The next two, some ways behind the leaders, are Reschenthaler1 and CitizensPlan.

When it comes to splits, I judge all of the plans to be excellent, with the possible exception of Carter and SenateDemCaucus1. All eleven others have 13-16 county splits and 16-18 municipality splits, which may be close to optimal for reasonable 17-district plans in Pennsylvania (though it is computationally intractable to prove this rigorously).

<sup>1</sup>Optimization techniques may, of course, still be highly helpful for finding valuable examples of plans.

Therefore I judge that plans that meet a high excellence standard for traditional criteria are

- GovPlan
- VotersOfPA
- Reschenthaler1
- CitizensPlan

The next tier of plans meeting an excellence standard for traditional criteria are

- KhalifAli
- Reschenthaler2

## **4 Partisan fairness does not require loosening neutral criteria**

### **4.1 Using election data**

To understand partisan fairness in the context of the range of electoral conditions in Pennsylvania, it is crucial to observe a range of voting behavior in the state. This is why creating a "voting index" or "election blend" is highly inadvisable. To illustrate this, consider for example a state like Massachusetts, in which Senate and Presidential elections are strongly Democratic (with something like a 2-to-1 ratio) and Governor elections are sometimes strongly Republican (approaching a 2-to-1 ratio in the other direction). If you simply averaged these, you would produce an index that looks "purple," with many precincts evenly split between a Democratic and Republican preference—a pattern that never actually occurs in the state.

This means that there are two options for a responsible modeler: either show observed elections serially, one at a time and not averaged, so that the local effects of incumbency and office and national climate can be considered in assessing the pattern, or study how and whether the Congressional voting patterns do in fact resemble a statewide average, and how they differ. Of the expert reports assessing partisan fairness, I have taken the former approach, along with Daryl DeFord, and Jonathan Rodden has taken the latter approach.

Michael Barber's report does neither, basing the bulk of his analysis on a blend of elections and even applying a swing to the election mix rather than regarding the actual observed elections serially.<sup>2</sup>

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<sup>2</sup>A corollary of this blending approach, especially under the time constraints of a compressed court schedule, is that the accuracy of his results is harder to audit. But in at least one case he is clearly in error. Dr. Barber reports that CD 16 (Erie) in HB-2146 is a swing district—that is, it is sometimes won by the Democrat and sometimes by the Republican across the 11 elections in his principal dataset. This is false—this district went for the Republican in 11 out of 11 elections. Even in the Governor's race of 2018, in which the Democratic candidate achieved nearly 59% share statewide, this district had more votes for the Republican. Since this is one of only a few cases in which there was enough information to audit Dr. Barber's report for accuracy, I assume there are many similar errors in the handling of electoral data.

## 4.2 Overview of partisan performance by election

Table 2: Partisan outcomes (number of D seats) by election.

Plan	GOV14	AG16	AUD16	PRES16	SEN16	TRES16	GOV18	SEN18	AG20	AUD20	PRES20	TRES20
GovPlan	10	10	8	9	6	10	11	11	10	8	9	9
CitizensPlan	10	10	7	8	6	10	11	10	10	7	9	8
HB-2146	9	7	7	7	5	10	10	10	10	5	8	7
Carter	10	10	8	8	6	10	11	11	10	7	9	9
Gressman/GMS	10	10	8	8	9	10	11	10	10	8	9	8
HouseDemCaucus	10	10	8	8	6	10	11	11	11	8	10	9
SenateDemCaucus1	10	9	8	7	7	9	11	11	10	7	9	7
SenateDemCaucus2	10	10	8	9	7	10	11	10	10	8	9	9
Resenthaler1	9	6	7	7	5	8	10	9	9	6	8	7
Resenthaler2	9	6	7	7	5	8	10	9	9	6	8	7
CitizenVoters	9	9	8	8	5	10	11	10	10	7	8	8
VotersOfPA	9	8	8	8	5	10	11	9	10	6	8	8
KhalifAli	9	8	9	7	7	10	11	11	10	6	9	7

## 4.3 Plans dominating the field under partisan fairness metrics

Table 3: Comparison of all plans under four metrics of fairness in the economics and political science literature.

	total efficiency gap	total Eguia metric	total mean-median	total partisan bias
GovPlan	0.1007	-0.0486	-0.0077	-0.1176
CitizensPlan	-0.1678	-0.3427	-0.1042	-0.6471
HB-2146	-0.8336	-0.9898	-0.2927	-1.2353
Carter	-0.0058	-0.1663	-0.113	-0.5294
Gressman/GMS	0.1394	-0.0486	-0.0385	-0.2353
HouseDemCaucus	0.1814	0.0102	-0.0071	0.1765
SenateDemCaucus1	-0.2601	-0.4015	-0.1382	-0.7059
SenateDemCaucus2	0.1221	-0.0486	0.0106	0.1176
Resenthaler1	-1.1024	-1.2251	-0.2524	-1.1176
Resenthaler2 2	-1.1042	-1.2251	-0.2534	-1.0588
CitizenVoters	-0.4074	-0.5192	-0.1847	-0.6471
VotersOfPA	-0.5686	-0.6957	-0.2734	-0.8824
KhalifAli	-0.3166	-0.4604	-0.1209	-0.4706
ensemble mean	-0.6755	-0.8451	-0.2872	-1.1437

In the study of optimizing multiple objectives, we say that one data point **dominates** another if it is equal or better in every metric. A data point that is not dominated by any other is on the *Pareto frontier* of the dataset.

Of the twelve other plans, the Governor's Plan dominates 10 and is in a trade-off position with the other two (Carter and HouseDemCaucus). No plan dominates the Governor's plan. From this "Pareto frontier" perspective, the Governor's plan is the strongest in the field.<sup>3</sup>

<sup>3</sup>Of these four metrics, three have been subjected to much more scrutiny in the peer-reviewed literature, with Eguia's metric being newer and less tested. If you throw out the Eguia metric and restrict to the three better-established ones, the list of dominating plans is unchanged.

## 5 Conclusion

Most of the plans before the court are very good on the traditional districting principles and would be well over the line to be considered for adoption under normal circumstances. Even if a standard of *excellence* is imposed on the neutral criteria, I find four plans (GovPlan, VotersOfPA, Reschenthaler1, and CitizensPlan) to be in the top tier, followed by two more (KhalifAli, Reschenthaler2). Many of the others, I emphasize, are also very strong.

But among those that meet the quality standards for the neutral criteria, we are not required to choose by a beauty contest of numerical optimization. Instead, we should rightly consider factors like whether community input was meaningfully incorporated into the plan design and whether the ultimate effect of the plan will be one of treating the political parties fairly and even-handedly.

In partisan terms, a multi-optimization framework applied to traditional scores of partisan fairness would identify three plans—GovPlan, Carter, and HouseDemCaucus—as dominating the field.

Therefore it is my conclusion that the Governor’s plan is an excellent choice (though not the only reasonable choice) as the best plan before the Court.