

a district from one of the 1,000 simulated plans. PX 31 ¶ 35 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 127:2-128:10 (Chen). Each row compares one district from Ad Astra 2 to 1,000 computer-simulated districts based on Republican vote share. PX 31 ¶ 35 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 127:2-128:10 (Chen). The two percentages in parentheses in the right margin of the Figure report the percentage of these 1,000 simulated districts that are less Republican than, and more Republican than, Ad Astra 2's district. PX 31 ¶ 36 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 127:2-128:10 (Chen).

77. As the bottom row of Figure 5 illustrates, the least-Republican (and therefore most-Democratic) district in Ad Astra 2, CD 3, is more heavily Republican than 99.6% of the least-Republican districts (i.e., the most-Democratic districts) in the 1,000 computer-simulated plans. PX 31 ¶ 37 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 128:11-130:4 (Chen). In fact, 98.8% of the simulated plans contained a Democratic-favoring district—that is, a least-Republican district with a Republican vote share of under 50%. PX 31 ¶ 37 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 128:11-130:4 (Chen). Dr. Chen therefore concluded that CD 3 is an extreme partisan outlier. PX 31 ¶ 38 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 129:25-130:4 (Chen).

78. He explained that to achieve this extreme result, Ad Astra 2 cracks Democratic voters to eliminate the Democratic-favoring district that appears in virtually all of the simulated plans. PX 31 ¶ 38 (Chen Rep.). Dr. Chen therefore concluded that CD 3 is an extreme partisan outlier that is more favorable to Republicans

than 99.6% of simulated plans, using a standard 95% threshold for statistical significance. PX 31 ¶ 38 (Chen Rep.); Hr’g Tr. Day 1 Vol. 2 at 129:25-130:4 (Chen).

79. Dr. Chen reached a similar conclusion with respect to the second-most-Democratic district in Ad Astra 2, CD 2, shown in the second-to-last row of Figure 5. PX 31 ¶ 39 (Chen Rep.); Hr’g Tr. Day 1 Vol. 2 at 130:12-131:7 (Chen). Dr. Chen found that CD 2 has a higher Republican vote share (57.8%) than 96.3% of corresponding districts in the 1,000 computer-simulated plans. PX 31 ¶ 39 (Chen Rep.); Hr’g Tr. Day 1 Vol. 2 at 130:12-131:7 (Chen). Thus, almost all such districts in the computer-simulated plans would be less Republican than the enacted plan’s CD 2. PX 31 ¶ 39 (Chen Rep.); Hr’g Tr. Day 1 Vol. 2 at 130:12-131:7 (Chen).

80. Based on this analysis, and again using a standard 95% threshold for statistical significance, Dr. Chen concluded that CD 2 is an extreme partisan outlier that is more favorable to Republicans than the corresponding district in 96.3% of the simulated plans. PX 31 ¶ 39 (Chen Rep.); Hr’g Tr. Day 1 Vol. 2 at 131:1-7 (Chen).

81. Dr. Chen explained that since CDs 2 and 3 are more Republican than their simulated counterparts, some other district must be less Republican than its simulated counterparts. PX 31 ¶ 40 (Chen Rep.); Hr’g Tr. Day 1 Vol. 2 at 131:8-15 (Chen). Consistent with this hypothesis, Dr. Chen’s analysis—and the top row of Figure 5—showed that CD 1, the most Republican district in Ad Astra 2, exhibits a lower Republican vote share (64.8%) than 99.9% of the most-Republican

districts in the simulated plans, which reflected Republican vote shares of 68%-73%. PX 31 ¶ 41 (Chen Rep.); Hr’g Tr. Day 1 Vol. 2 at 131:17-132:6 (Chen). Dr. Chen explained that Ad Astra 2 achieves this result by moving heavily Democratic Lawrence into CD 1, causing CD 1 to have a Republican vote share significantly lower than 99.9% of the most-Republican districts in the simulated plans. PX 31 ¶ 41 (Chen Rep.); Hr’g Tr. Day 1 Vol. 2 at 131:17-132:6 (Chen). Dr. Chen testified that this move enabled CD 1 to remain safely Republican while simultaneously allowing CDs 2 and 3 to achieve higher Republican vote shares than nearly all of their simulated counterparts. PX 31 ¶ 41 (Chen Rep.). Dr. Chen described this maneuver as “classic . . . cracking.” Hr’g Tr. Day 1 Vol. 2 at 132:7-8 (Chen).

82. Based on this analysis, Dr. Chen concluded that CD 1 is also an extreme partisan outlier, again applying a standard 95% significance threshold. PX 31 ¶ 42 (Chen Rep.).

83. In total, Dr. Chen identified three of the four districts in Ad Astra 2 as extreme partisan outliers: CDs 2 and 3 exhibit higher Republican vote shares than nearly all their simulated counterparts, while CD 1 features a Republican vote share lower than 99.9% of its computer-simulated counterparts—but still sufficiently high to leave the district safely Republican. PX 31 ¶ 42 (Chen Rep.).

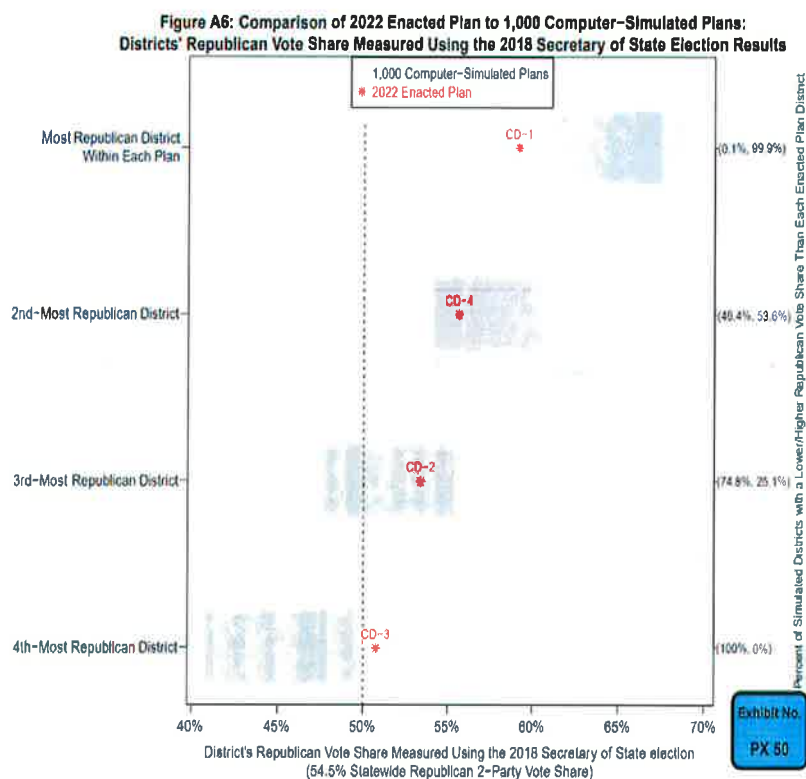
84. To examine whether the partisan compositions of Ad Astra 2’s districts remain outliers under a variety of electoral conditions, Dr. Chen repeated this analysis nine separate times, using the results of each of the

nine elections included in the 2016-2020 Statewide Election Composite. PX 31 ¶ 43 (Chen Rep.); Hr’g Tr. Day 1 Vol. 2 at 133:22-142:4 (Chen); *see* PX 45-53 (displaying results of separate analyses). Dr. Chen concluded that the same extreme partisan outlier patterns shown in Figure 5 in the 2016-2020 Statewide Election Composite are present when district partisanship is measured using any of the nine individual statewide elections,. PX 31 ¶ 43 (Chen Rep.); Hr’g Tr. Day 1 Vol. 2 at 141:2-142:4 (Chen); *see also* Hr’g Tr. Day 3 Vol. 2 at 65:14-66:1, 66:21-67:1 (Lockerbie) (agreeing that evidence that Ad Astra 2 is a partisan outlier under each individual election would “make [Dr. Chen’s] argument stronger” and support Dr. Chen’s conclusions).

85. For example, Dr. Chen repeated his analysis using the results of the 2018 Secretary of State election, rather than the 2016-2020 Statewide Election Composite, to measure district partisanship. Hr’g Tr. Day 1 Vol. 2 at 141:2-142:4 (Chen); *see* PX 50 (displaying results). The 2018 Secretary of State election resulted in a statewide Republican vote share of 54.5%, Hr’g Tr. Day 1 Vol. 2 at 134:18-21 (Chen); *see* PX 50, making the results slightly more favorable to the Democratic candidate than the overall composite, which features an average Republican vote share of 58.1%, PX 31 ¶ 44 (Chen Rep.).

86. Figure A6 in the appendix to Dr. Chen’s report, also admitted as Plaintiffs’ Exhibit 50, compares the partisan distribution of districts in Ad Astra 2 to the partisan distribution of districts in the 1,000 computer-

simulated plans, with partisanship measured using the results of the 2018 Secretary of State election:



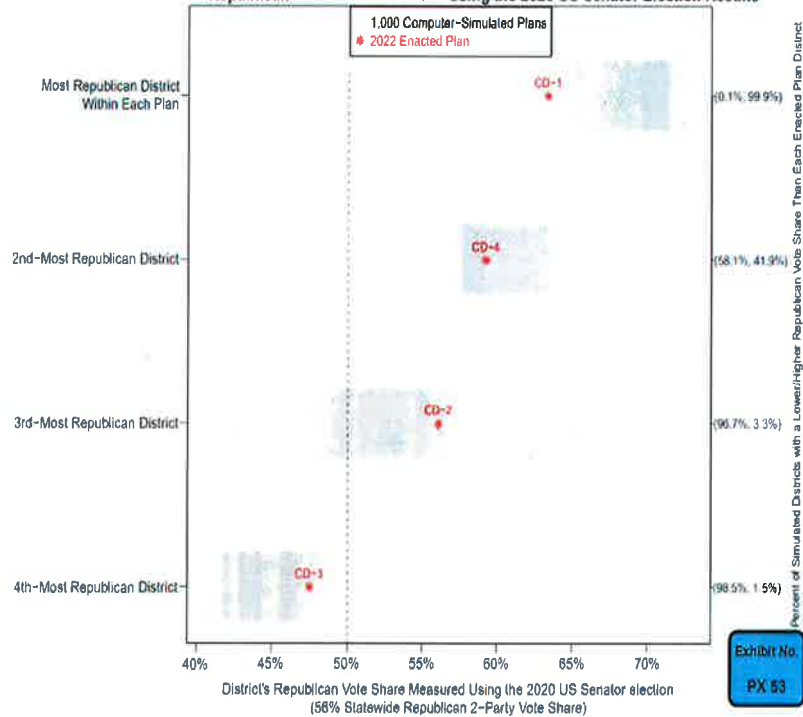
87. Even in this relatively Democratic-favoring electoral environment, all four of the enacted congressional districts favor Republicans. Hr'g Tr. Day 1 Vol. 2 at 134:22-135:7 (Chen). Dr. Chen explained that this result indicates that Ad Astra 2 is a durable plan, under which Republicans would be favored to win each district under a range of electoral conditions. Hr'g Tr. Day 1 Vol. 2 at 135:8-13 (Chen). Dr. Chen further explained that comparing the enacted districts'

partisan compositions to the partisan compositions of districts in the simulated plans showed that CDs 1, 2, and 3 in the enacted plan remain extreme partisan outliers when partisanship is calculated using the 2018 Secretary of State election rather than the multiyear composite. Hr’g Tr. Day 1 Vol. 2 at 135:14-136:17 (Chen). CD 3, for example, is more Republican-leaning than all of its simulated counterparts. Hr’g Tr. Day 1 Vol. 2 at 135:14-136:17 (Chen).

88. Dr. Chen further explained that the same patterns hold when partisanship is measured using the results of the 2020 U.S. Senate election. Hr’g Tr. Day 1 Vol. 2 at 136:18-140:17 (Chen); *see* PX 53 (displaying results).

89. Figure A9 in the appendix to Dr. Chen’s report, also admitted as Plaintiffs’ Exhibit 53, compares the partisan distribution of districts in Ad Astra 2 to the partisan distribution of districts in the 1,000 computer-simulated plans, with partisanship measured using the results of the 2020 U.S. Senate election:

**Figure A9: Comparison of 2022 Enacted Plan to 1,000 Computer-Simulated Plans:
Districts' Republican Vote Share Measured Using the 2020 US Senator Election Results**



90. Although under this relatively more Democratic-leaning electoral environment, in which the Republican won 56% of the vote, rather than 58.1% as under the composite, enacted CD 3 still exhibits a higher Republican vote share than the least-Republican district in 98.5% of the simulated plans. Hr'g Tr. Day 1 Vol. 2 at 137:1-24 (Chen). Moreover, CDs 1 and 2 display the same partisan-outlier pattern as under the original analysis. Hr'g Tr. Day 1 Vol. 2 at 137:25-138:9, 139:7-140:17 (Chen); PX 53. In particular, CD 2 remains safely Republican despite the fact that the third-least-Republican district is more competitive—or even Democratic-favoring—in 96.7% of the simulated

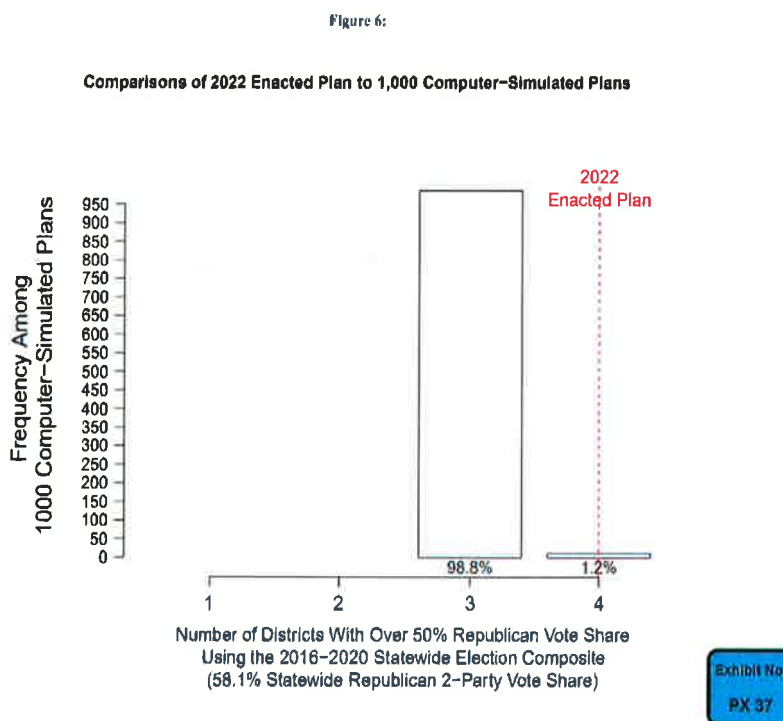
plans. Hr'g Tr. Day 1 Vol. 2 at 138:21-139:6 (Chen); PX 53. As Dr. Chen explained, no redistricting plan can guarantee that a party will win every seat in every electoral environment, but Ad Astra 2 makes each seat as invulnerable as possible for Republicans. Hr'g Tr. Day 1 Vol. 2 at 139:22-140:17 (Chen).

91. After examining Ad Astra 2 using both the 2016-2020 Statewide Election Composite and each of the nine elections contained in the composite individually, Dr. Chen did not find any electoral environment in which CD 3 was not an extreme partisan outlier. Hr'g Tr. Day 4 Vol. 1 at 119:11-15 (Chen).

92. Based on this analysis, Dr. Chen concluded that the same extreme partisan outlier patterns shown in Figure 5 are also present when district partisanship is measured using any of the nine individual statewide elections conducted from 2016 to 2020, rather than the 2016-2020 Statewide Election Composite. PX 31 ¶ 43 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 141:2-142:4 (Chen). Dr. Chen explained that this result shows that Ad Astra 2 is a durable gerrymander, in which CD 3, for example, is relatively more favorable for Republicans than its simulated counterparts would be across a range of electoral environments. Hr'g Tr. Day 1 Vol. 2 at 141:9-142:4 (Chen). In other words, Ad Astra 2 makes CD 3 as invulnerable as possible for Republicans. Hr'g Tr. Day 1 Vol. 2 at 141:9-142:4 (Chen).

93. Dr. Chen also analyzed the number of total Republican-favoring districts in Ad Astra 2, defined as districts having a Republican vote share of over 50%, as measured using the 2016-2020 Statewide Election

Composite. PX 31 ¶ 41 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 132:21-133:21 (Chen). Figure 6 in Dr. Chen's report, also admitted as Plaintiffs' Exhibit 37, displays the distribution of Republican-favoring seats under Ad Astra 2 and under the 1,000 computer-simulated plans:



94. All four districts in Ad Astra 2 favor Republicans, but only 1.2% of the simulated plans feature four Republican-favoring districts; 98.8% include at least one Democratic-favoring district. PX 31 ¶ 41 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 132:21-133:12 (Chen). Based on this analysis, Dr. Chen concluded that compared to the 1,000 simulated plans, Ad Astra 2 is an extreme pro-Republican statistical

outlier, using a standard 95% significance threshold. PX 45, ¶ 41 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 133:13-21 (Chen).

95. In sum, the Court credits Dr. Chen's district-level partisanship analysis of Ad Astra 2. The Court finds Dr. Chen's district-level analysis of Ad Astra 2 to be powerful evidence that Ad Astra 2 is an intentional, effective partisan gerrymander. Moreover, Dr. Chen's analysis of Ad Astra 2 under various electoral outcomes is persuasive evidence that the enacted congressional plan was designed specifically to provide Republicans with the most advantageous congressional map possible. The Court further finds that the number of Republican-leaning districts would be lower, and the partisan compositions of CDs 1, 2, and 3 would be different, under a map-drawing process that adhered to the Guidelines and to traditional redistricting principles but did not include partisan considerations. The Court finds this to be persuasive evidence that Ad Astra 2 was intentionally designed to give Republicans a partisan advantage.

Ad Astra 2 is an extreme partisan statistical outlier as measured by the efficiency gap.

96. Dr. Chen next evaluated Ad Astra 2's partisan bias at the statewide level using the efficiency gap. PX 31 ¶¶ 46-49 & fig.7 (Chen Rep.). As Dr. Chen explained—and as another one of Plaintiffs' experts, Dr. Christopher Warshaw, further documented, *see infra* FOF § II.C—the efficiency gap is a well-established measure of a redistricting plan's partisan bias. PX 31 ¶ 46 (Chen Rep.). The efficiency gap measures the degree to which more Democratic or Republican votes

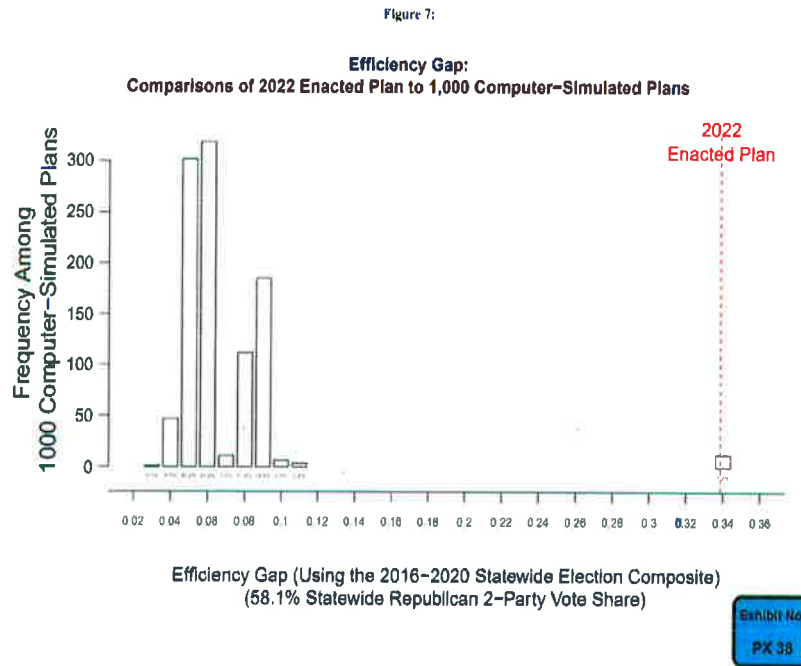
are cast inefficiently across an entire redistricting plan. PX 31 ¶¶ 46-47 (Chen Rep.). The efficiency gap is calculated using the total sum of surplus votes in districts a party won and lost votes in districts where that party lost. PX 31 ¶ 46 (Chen Rep.). In a district lost by a given party, all of the party's votes are considered lost votes; in a district won by a party, only the party's votes exceeding the 50% threshold necessary for victory are considered surplus votes. PX 31 ¶ 46 (Chen Rep.). A party's total inefficiently cast votes for an entire districting plan is the sum of its surplus votes in districts won by the party and its lost votes in districts lost by the party. PX 31 ¶ 46 (Chen Rep.). The efficiency gap is then calculated as total inefficiently cast Democratic votes minus total inefficiently cast Republican votes, divided by the total number of two-party votes cast statewide across all four congressional elections. PX 31 ¶ 46 (Chen Rep.). A positive efficiency gap indicates more inefficiently cast Democratic votes, while a negative efficiency gap indicates more inefficiently cast Republican votes.⁶ PX 31 ¶ 47 (Chen Rep.).

97. Measuring district partisanship using the 2016-2020 Statewide Election Composite, Dr. Chen found that Ad Astra 2 exhibits an efficiency gap of 33.9%, indicating that the plan results in far more inefficiently

⁶ The Court notes that another one of Plaintiffs' experts, Dr. Christopher Warshaw, used the opposite sign convention, with positive efficiency gaps indicating more inefficiently cast Republican votes. PX 105 at 5 (Warshaw Rep.). The choice of signs is a matter of convention and does not substantively affect the analysis.

cast Democratic votes than inefficiently cast Republican votes. PX 31 ¶ 49 (Chen Rep.). Dr. Chen compared Ad Astra 2's efficiency gap with the efficiency gaps of the computer-simulated plans and found that the enacted congressional plan's efficiency gap is larger than the efficiency gaps exhibited by 98.8% of the computer-simulated plans. PX 31 ¶ 49 (Chen Rep.). From this, Dr. Chen concluded that Ad Astra 2 creates an extreme pro-Republican partisan bias that cannot be explained by Kansas' political geography or by adherence to the Guidelines or traditional redistricting criteria. PX 31 ¶ 49 (Chen Rep.).

98. Figure 7 in Dr. Chen's report, also admitted as Plaintiffs' Exhibit 38, displays the distribution of efficiency gaps across the simulated maps and Ad Astra 2:



99. The Court credits Dr. Chen's analysis of Ad Astra 2's statewide partisan bias. The Court finds Dr. Chen's efficiency gap analysis to be persuasive evidence that Ad Astra 2 was designed to give Republicans a partisan advantage, and that the enacted plan exhibits extreme pro-Republican bias that cannot be explained by Kansas's political geography or by adherence to the Guidelines or traditional redistricting criteria. Nevertheless, the Court recognizes that the efficiency gap should be employed with caution in states with four districts. The Court nonetheless concludes that as explained below, *see infra* FOF § II.C, use of a multielection composite (as in Dr. Chen's analysis) allows the reliable use of the efficiency gap to measure partisan bias in Kansas, and further notes that the bulk of Dr. Chen's simulation analysis does not rely on the efficiency gap. The Court agrees with Dr. Chen's testimony, *see* Hr'g Tr. Day 4 Vol. 1 at 95:2-8 (Chen), that the evidence shows Ad Astra 2 is an extreme partisan outlier unexplainable by adherence to the Guidelines or other traditional districting criteria even without considering any evidence regarding the efficiency gap.

Ad Astra 2 is an extreme partisan statistical outlier at the municipal level.

100. In addition to the above district-level and statewide analyses, Dr. Chen also examined the extent to which partisan bias affected the map-drawing process around specific cities. PX 31 ¶¶ 53-58 & fig.8 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 142:5-146:13 (Chen). Dr. Chen found that Ad Astra 2's treatment of several cities exhibits extreme political bias when

compared to computer-simulated districts in the same regions. PX 31 ¶¶ 53-58 & fig.8 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 142:5-146:13 (Chen).

101. To analyze Ad Astra 2's treatment of Kansas's ten most populous cities, Dr. Chen first identified the district in Ad Astra 2 that contains most of each city's population and computed that district's partisanship using the 2016-2020 Statewide Election Composite. PX 31 ¶ 54 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 142:5-143:7 (Chen). Dr. Chen then repeated this process for each of the 1,000 computer-simulated redistricting plans, first determining which simulated district within each plan contained the majority of the city's population, then computing that district's partisanship. PX 31 ¶ 54 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 143:8-144:8 (Chen). Dr. Chen then plotted the partisanship of the districts containing the majority of each city's population under Ad Astra 2 and each of the simulated redistricting plans in Figure 8 of his report, also admitted as Plaintiffs' Exhibit 39:

**Figure 8: Comparison of Individual Districts' Republican Vote Shares
In the 2022 Plan and in 1,000 Computer-Simulated Plans**



Exhibit No.
PX 39

102. The top row of Figure 8 displays the partisanship of the district in each plan that contains the majority of Kansas City's population. PX 31 ¶ 55 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 142:5-144:8

(Chen). Under Ad Astra 2, the majority of Kansas City's population lives in CD 2, which has a Republican vote share of 57.8%. PX 31 ¶ 55 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 142:5-144:8 (Chen). This result is anomalous compared to the simulated plans' treatment of Kansas City: 99.1% of the simulated plans place the majority of Kansas City's population in a district with a lower Republican vote share, 97.6% place it into a district with a Republican vote share of under 55%, and 83.7% of simulated plans place the city into a Democratic-favoring district. PX 31 ¶ 55 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 143:17-144:8 (Chen).

103. Based on this analysis, Dr. Chen concluded that Ad Astra 2 is an extreme partisan outlier in its treatment of Kansas City. PX 31 ¶ 55 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 144:1-25 (Chen).

104. The second row of Figure 8 shows a similar pattern in Ad Astra 2's treatment of Topeka. Ad Astra 2 assigns the majority of Topeka's population to CD 2, which has a Republican vote share of 57.8%. PX 31 ¶ 56 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 145:3-14 (Chen). Again, this treatment is anomalous compared to the simulated plans' treatment of Topeka; 96.7% of the simulated maps assign the majority of Topeka's population to a district with a lower Republican vote share than Ad Astra 2's CD 2. PX 31 ¶ 56 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 145:3-14 (Chen).

105. Based on this analysis, Dr. Chen concluded that Ad Astra 2 is statistically anomalous in its treatment of Topeka and that Topeka's placement in a district with a Republican vote share of 57.8% cannot be explained by a map-drawing process that adhered to

traditional redistricting criteria. PX 31 ¶ 56 (Chen Rep.).

106. The sixth row of Figure 8 shows the same pattern in Ad Astra 2's treatment of Shawnee. Ad Astra 2 assigns the majority of Shawnee's population to CD 3, a Republican-favoring district with a Republican vote share of 50.6%. PX 31 ¶ 56 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 145:15-19 (Chen). But 96.5% of the simulated plans place the majority of Shawnee's population in districts with lower Republican vote shares than enacted CD 3, and 96.1% of simulated plans place Shawnee in a Democratic-favoring district. PX 31 ¶ 57 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 145:19-25 (Chen).

107. Based on this analysis, Dr. Chen concluded that Ad Astra 2 is statistically anomalous in its treatment of Shawnee and that Shawnee's placement in a Republican-favoring district cannot be explained by a map-drawing process that adhered to traditional redistricting criteria. PX 31 ¶ 56 (Chen Rep.).

108. Finally, the last row of Figure 8 displays the same pattern in Ad Astra 2's treatment of Lawrence. Ad Astra 2 assigns most of Lawrence to CD 1, which has a Republican vote share of 64.8%. PX 31 ¶ 58 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 146:1-7 (Chen). 99.7% of the simulated plans placed Lawrence in a more competitive district, and 36.2% of simulated plans place Lawrence in a Democratic-favoring district. PX 31 ¶ 57 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 146:7-13 (Chen).

109. Based on this analysis, Dr. Chen concluded that Ad Astra 2 is statistically anomalous in its treatment of Lawrence. PX 31 ¶ 58 (Chen Rep.). At trial, Dr. Chen testified that Ad Astra 2 is “a really, really extreme partisan outlier in how it treats Lawrence.” Hr’g Tr. Day 1 Vol. 2 at 146:5-7 (Chen); see PX 31 ¶ 57 (Chen Rep.). Dr. Chen further concluded that this anomalous treatment cannot be explained by a map-drawing process that adhered to traditional redistricting criteria. PX 31 ¶ 56 (Chen Rep.).

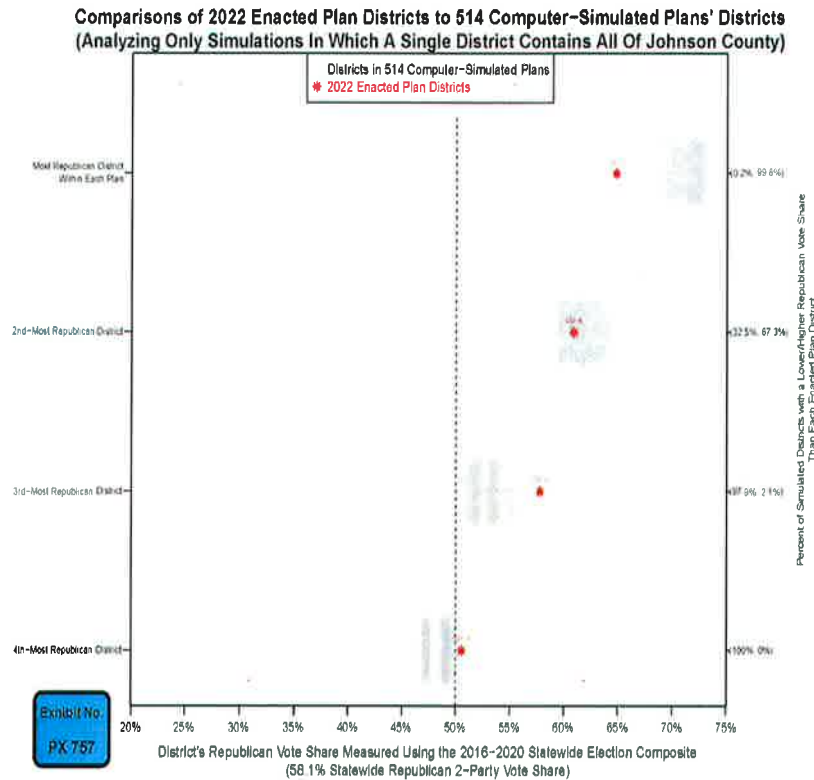
110. The Court credits Dr. Chen’s analysis of the partisan bias reflected in Ad Astra 2’s treatment of Kansas City, Topeka, Shawnee, and Lawrence. The Court finds that the partisan compositions of the enacted congressional districts containing these cities are extreme pro-Republican partisan outliers compared to the simulated districts produced using the Guidelines and traditional redistricting principles. The Court further finds that the partisan compositions of the districts containing these cities would be different under a map-drawing process that adhered to the Guidelines and to traditional redistricting principles. The Court finds this to be persuasive evidence that Ad Astra 2 was intentionally designed to give Republicans a partisan advantage.

Ad Astra 2 remains an extreme partisan outlier compared to simulated plans that preserve Johnson County in a single district.

111. Dr. Chen also examined whether Ad Astra 2 is a partisan outlier when compared specifically to the subset of the 1,000 simulated plans that keep Johnson County intact within a single congressional district.

Hr'g Tr. Day 4 Vol. 1 at 92:7-22 (Chen). Dr. Chen found that 514 of the 1,000 simulated plans do not divide Johnson County. Hr'g Tr. Day 4 Vol. 1 at 92:9-11 (Chen).

112. Plaintiffs' Exhibit 757 compares the partisan distribution of districts in Ad Astra 2 to the partisan distribution of districts in the 514 computer-simulated plans in which Johnson County falls within a single congressional district:



Hr'g Tr. Day 4 Vol. 1 at 92:5-22 (Chen).

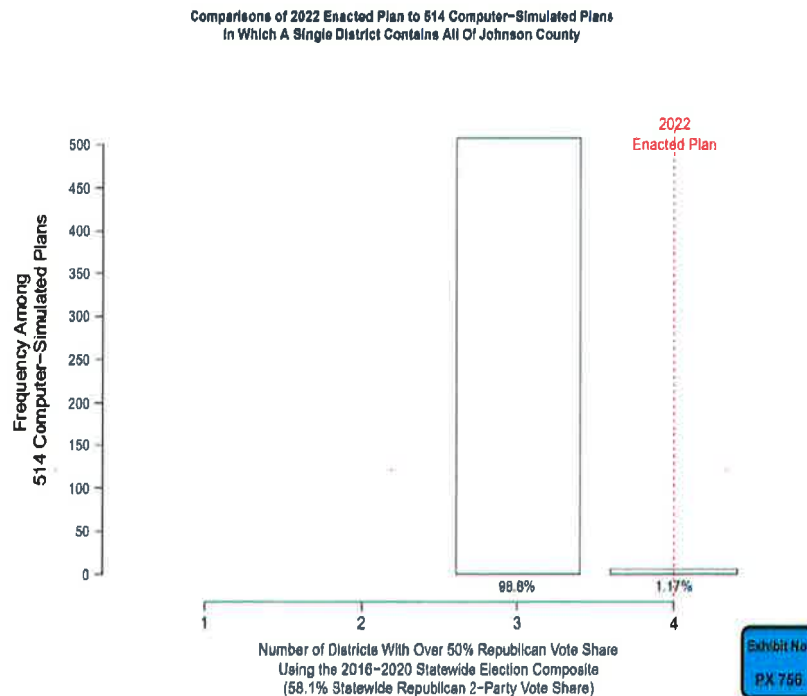
113. Dr. Chen concluded that this chart showed the same pattern as his earlier analysis comparing Ad Astra 2 to the full set of 1,000 simulated plans: even compared only to plans that keep Johnson County intact, the enacted plan remains “an extreme partisan outlier.” Hr’g Tr. Day 4 Vol. 1 at 99:15-25 (Chen).

114. Dr. Chen explained that CD 3 “is still an extreme partisan outlier” compared to the most Democratic districts in these 514 simulated plans. Hr’g Tr. Day 4 Vol. 1 at 93:17-22 (Chen). The most Democratic districts in the 514 simulated plans are almost all Democratic leaning or safely Democratic, with Republican vote shares primarily between 46% and 49%. Hr’g Tr. Day 4 Vol. 1 at 94:8-14 (Chen). Enacted CD 3, with a Republican vote share of 50.5%, is more favorable to Republicans than *every one* of the 514 simulated plans’ most Democratic districts. Hr’g Tr. Day 4 Vol. 1 at 94:16-95:1 (Chen).

115. Dr. Chen further testified that comparing enacted CD 1 to the simulated plans’ most-Republican districts also revealed the same patterns observed using the full set of 1,000 simulations: enacted CD 1 has a lower Republican vote share than 99.8% of the most-Republican districts in the 514 simulated plans that kept Johnson County whole. Hr’g Tr. Day 4 Vol. 1 at 95:9-96:8 (Chen). Indeed, the simulated plans’ most-Republican districts usually have Republican vote shares of roughly 70%, with some as high as 72% or 73%, while enacted CD 1 has a Republican vote share of only roughly 65%. Hr’g Tr. Day 4 Vol. 1 at 96:23-97:1, 97:15-18 (Chen). Dr. Chen concluded that enacted CD 1 “was intentionally drawn to intentionally

remove Republicans,” compared to a redistricting process that complied with traditional districting principles while seeking to keep Johnson County whole. Hr’g Tr. Day 4 Vol. 1 at 96:9-14 (Chen). Dr. Chen explained that removing Republican voters from CD 1—a safe Republican district, even after those voters’ removal—allowed “those Republican voters [to] . . . be used in other districts to increase the Republican vote share of closer districts” like CDs 2 and 3. Hr’g Tr. Day 4 Vol. 1 at 97:15-98:2 (Chen).

116. Plaintiffs’ Exhibit 756 displays the distribution of Republican-favoring seats under Ad Astra 2 and under the 514 computer-simulated plans that keep Johnson County whole within a single district:



Hr'g Tr. Day 4 Vol. 1 at 98:3-22 (Chen).

117. From this analysis, Dr. Chen concluded that Ad Astra 2 remains an extreme partisan outlier at both the district and statewide levels, compared to a redistricting process that follows traditional criteria *and* keeps Johnson County whole. Hr'g Tr. Day 4 Vol. 1 at 99:15-25 (Chen). Dr. Chen concluded that a hypothetical intent by the Legislature to keep Johnson County whole in a single district could not explain the partisan bias in the map. The Court credits Dr. Chen's analysis and conclusion and finds that a desire to keep Johnson County whole cannot explain Ad Astra 2's partisan bias. The Court finds these facts to be persuasive evidence that even if Republican lawmakers created the map from the starting point of keeping Johnson County whole, Ad Astra 2 was still intentionally designed to give Republicans a partisan advantage, and the desire to keep Johnson County whole does not explain the partisan bias inherent in the map. The Court concludes that the argument that Ad Astra 2 is the product of a desire to keep Johnson County whole is a post hoc rationalization.

Kansas's political geography does not explain Ad Astra 2's partisan bias.

118. Dr. Chen testified that Ad Astra 2's partisan bias cannot be explained by Kansas's political geography. PX 31 ¶ 70 (Chen Rep.); Hr'g Tr. Day 1 Vol. 2 at 118:19-23, 151:18-20 (Chen). Dr. Chen programmed a computer algorithm that drew simulated plans using Kansas's unique political geography. PX 31 ¶ 68 (Chen Rep.) As Dr. Chen, explained "the entire premise of conducting districting

simulations is to fully account for Kansas' unique political geography and its political subdivision boundaries and to analyze how the state's political geography affects electoral bias in congressional districting." PX 31 ¶ 68 (Chen Rep.). Thus, the simulation analysis allowed Dr. Chen to identify how much of the electoral bias in the enacted congressional plan is caused by Kansas's political geography and how much is caused by the map-drawer's intentional efforts to favor one political party over the other. PX 31 ¶ 69 (Chen Rep.). Dr. Chen concluded that the enacted congressional plan's partisan bias goes beyond any "natural" level of electoral bias caused by Kansas's political geography or the political composition of the state's voters. PX 31 ¶ 70 (Chen Rep.). The Court credits this analysis and adopts this conclusion. The Court further adopts Dr. Chen's conclusion that this extreme, additional level of partisan bias in the enacted congressional plan can be directly attributed to the map-drawer's intentional efforts to favor the Republican Party. PX 31 ¶ 70 (Chen Rep.).

119. Finally, as discussed in more detail below, *see infra* FOF § IV.A, the Court finds that Defendants offered no meaningful evidence to rebut Dr. Chen's analysis. The Court therefore credits Dr. Chen's analysis in its entirety and finds that it offers persuasive evidence that Ad Astra 2 was designed intentionally and effectively to maximize Republican advantage in Kansas's congressional delegation.

B. Evidence presented by Dr. Jonathan Rodden demonstrates that Ad Astra 2 is an intentional, effective partisan gerrymander.

120. Dr. Jonathan Rodden is a tenured professor of political science at Stanford University and the founder and director of the Stanford Spatial Social Science Lab—a center for research and teaching that focuses on the analysis of geo-spatial data in the social sciences. PX 1 at 3 (Rodden Rep.). His research focuses on political geography and redistricting. Hr’g Tr. Day 1 Vol. 2 at 10:14-18 (Rodden).

121. Dr. Rodden has served as an expert in numerous redistricting matters. PX 1 at 4 (Rodden Rep.); Hr’g Tr. Day 1 Vol. 2 at 11:17-12:14 (Rodden). This cycle, the Ohio Supreme Court credited Dr. Rodden’s analysis in *League of Women Voters of Ohio v. Ohio Redistricting Comm’n*, ___ N.E.3d ___, Nos. 2021-1193, 2021-1198, & 2021-1210, 2022 WL 110261 (Ohio Jan. 12, 2022), and *Adams v. DeWine*, ___ N.E.3d ___, Nos. 2021-1428 & 2021-1449, 2022 WL 129092 (Ohio Jan. 14, 2022), two redistricting cases challenging state legislative and congressional maps. PX 1 at 4 (Rodden Rep.); *see, e.g., League of Women Voters of Ohio*, 2022 WL 110261, at *23, *26; *Adams*, 2022 WL 129092, at *10, *12-13. Dr. Rodden drew the congressional plan that was chosen by the Pennsylvania Supreme Court for implementation after the political process in that state failed to produce a plan. *Carter v. Chapman*, No. 7 MM 2022, 2022 WL 549106 (Pa. Feb. 23, 2022); Hr’g Tr. Day 1 Vol. 2 at 12:8-14 (Rodden).

122. The Court accepts Dr. Rodden in this case as an expert in redistricting, political and racial geography, applied statistics, and geographic information systems.

123. For his analysis in this case, Dr. Rodden analyzed Kansas's political geography and applied traditional redistricting criteria, including those encompassed in the Guidelines, to examine Ad Astra 2's configuration. To do this, Dr. Rodden drew two illustrative congressional maps that adhered to traditional redistricting criteria and the Guidelines—a “least-change” map that prioritized the Guideline of core retention, PX 1 at 14-15 & fig.8 (Rodden Rep.); Hr’g Tr. Day 1 Vol. 2 at 23:3-24:10 (Rodden), and a “communities-of-interest” map that allowed for slightly lower core retention to better serve the Guidelines of compactness and respect for communities of interest, PX 1 at 14-16 & fig.9 (Rodden Rep.); Hr’g Tr. Day 1 Vol. 2 at 25:3-23 (Rodden).

124. In analyzing Kansas's political geography and traditional redistricting principles in the context of congressional redistricting, Dr. Rodden explained that it is “rather straightforward to abide by traditional redistricting criteria” and that it “is possible to draw plans that achieve . . . all of the goals that are laid out in [the Guidelines].” Hr’g Tr. Day 1 Vol. 2 at 15:14-16:4 (Rodden). For that reason, he found that the plan enacted by “the legislature seems to abide by a different logic. . . . [I]t’s not the kind of map that would emerge from the application of [the Guidelines].” Hr’g Tr. Day 1 Vol. 2 at 15:25-16:4 (Rodden). Specifically, Dr. Rodden explained that the geography of Kansas is

such that minimizing splits of political subdivisions like counties is straightforward and there is no tension between various Guidelines. Hr'g Tr. Day 1 Vol. 2 at 19:3-24 (Rodden). For example, he explained that "compactness and the preservation of communities of interest seem to go together . . . very nicely in this instance." Hr'g Tr. Day 1 Vol. 2 at 19:3-24 (Rodden).

125. Dr. Rodden compared Ad Astra 2 with the prior congressional plan and his illustrative plans on various traditional redistricting criteria contained in the Guidelines, including compactness, preservation of political subdivisions, and core retention. PX 1 at 17-26 (Rodden Rep.). Dr. Rodden's analysis and his illustrative plans demonstrate that adherence to the Guidelines or traditional redistricting criteria cannot explain the configuration of Ad Astra 2. PX 1 at 17-26 (Rodden Rep.); Hr'g Tr. Day 1 Vol. 2 at 28:23-29:4 (Rodden).

126. Of all of the maps Dr. Rodden analyzed, Ad Astra 2 had the lowest compactness scores using four different measures (Reock, Polsby-Popper, Convex Hull, and Schwartzberg), meaning that the prior plan and both of Dr. Rodden's illustrative plans contained more compact districts than Ad Astra 2. PX 1 at 18 tbl.1 (Rodden Rep.). Therefore, an effort to comply with the Guidelines and create compact districts cannot explain the configuration of Ad Astra 2. PX 1 at 18-19 & tbl.1 (Rodden Rep.); Hr'g Tr. Day 1 Vol. 2 at 29:11-30:14 (Rodden).

127. Ad Astra 2 also splits more political subdivisions than any of the comparison plans. It splits one additional county, 14-15 additional voting

tabulation districts, and 5 additional cities and towns, including Kansas City and Lawrence. PX 1 at 19 & tbl.2 (Rodden Rep.). Thus, an effort to comply with the Guidelines and preserve political subdivisions cannot explain the configuration of Ad Astra 2. PX 1 at 19 & tbl.2 (Rodden Rep.); Hr'g Tr. Day 1 Vol. 2 at 32:8-14 (Rodden).

128. Ad Astra 2 fares no better when it comes to core retention. By population, Ad Astra 2 preserves just 86% of the cores of former districts. PX 1 at 26 & tbl.3 (Rodden Rep.). By way of comparison, Dr. Rodden's least-change plan, which adhered to the Guidelines' requirement of core retention, retained 97% of the cores of former districts. PX 1 at 26 & tbl.3 (Rodden Rep.). Thus, to achieve population equality, it was necessary to move only 3% of Kansans between districts. Hr'g Tr. Day 1 Vol. 2 at 24:17-25:2 (Rodden). Moreover, Ad Astra 2 relocates more Black, Hispanic, and Native American Kansans than any of the comparator plans, meaning the changes in district boundaries were focused on areas with large minority populations. PX 1 at 26 & tbl.3 (Rodden Rep.); Hr'g Tr. Day 1 Vol. 2 at 36:18-37:13 (Rodden). As a result, population equality cannot explain the number of people moved among districts in Ad Astra 2.

129. Ad Astra 2 also splits multiple communities of interest in contravention of the Guidelines. PX 1 at 20 (Rodden Rep.); Hr'g Tr. Day 1 Vol. 2 at 32:15-33:18 (Rodden). Most of Lawrence is subsumed in the vast, rural CD 1—the “Big First”—resulting in only an arrow corridor connecting that portion of CD 2 in Ad Astra 2. Hr'g Tr. Day 1 Vol. 2 at 32:15-33:18 (Rodden). The

state's geographically proximate Native American communities are split between two congressional districts. Hr'g Tr. Day 1 Vol. 2 at 32:15-33:18 (Rodden); PX 1 at 20 (Rodden Rep.). Fort Riley—the town *and* the military installation—are split and also separated from Junction City. Hr'g Tr. Day 1 Vol. 2 at 32:15-33:18 (Rodden); PX 1 at 20 (Rodden Rep.). And perhaps most glaringly, Kansas City and Wyandotte County are split between districts, contravening multiple of the Guidelines. Hr'g Tr. Day 1 Vol. 2 at 26:12-27:9 (Rodden); PX 1 at 20 (Rodden Rep.).

130. Ad Astra 2 likewise divides geographically compact and proximate minority groups. PX 1 at 20-24 (Rodden Rep.); Hr'g Tr. Day 1 Vol. 2 at 33:19-35:9 (Rodden). For example, the split of Wyandotte County divides Black and Hispanic communities in the greater Kansas City metro area between CDs 2 and 3. PX 1 at 20-22 & figs. 11 & 12 (Rodden Rep.). Scooping Lawrence out of CD 2 extracts Black and Hispanic voters and submerges them in the vast, less diverse Big First. PX 1 at 20-22 & figs. 11 & 12 (Rodden Rep.). Native American Kansans are similarly dispersed, and one of the state's reservations is split from the other four, despite their geographic proximity. PX 1 at 23 & fig.13 (Rodden Rep.).

131. Dr. Rodden also conducted racial and partisan dislocation analyses. These analyses illuminate the impact the failure to adhere to traditional redistricting criteria and the Guidelines has in terms of both race and partisanship. Hr'g Tr. Day 1 Vol. 2 at 50:17-51:11 (Rodden).

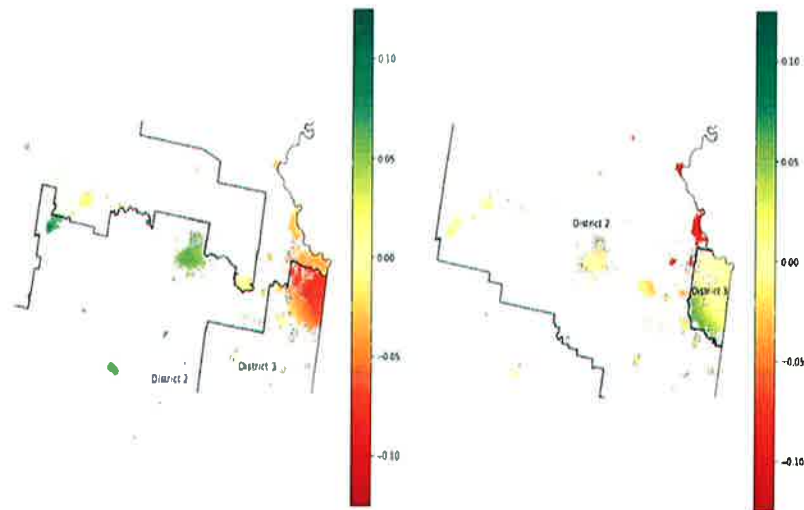
132. The racial dislocation analysis compares the racial composition of a *hypothetical* district or “neighborhood”—comprised of each individual Kansan and their nearest 734,469 neighbors, thus equaling the population of a Kansas congressional district—with the *actual* district in which each individual resides. PX 1 at 26 (Rodden Rep.); Hr’g Tr. Day 1 Vol. 2 at 37:20-39:22 (Rodden). It then asks, for each member of a racial minority group, how many members of that individual’s hypothetical neighborhood are also minorities. PX 1 at 26 (Rodden Rep.); Hr’g Tr. Day 1 Vol. 2 at 37:20-39:22 (Rodden). This captures the extent to which each individual lives in a neighborhood (at the scale relevant for drawing congressional districts) with other minorities. PX 1 at 26 (Rodden Rep.); Hr’g Tr. Day 1 Vol. 2 at 37:20-39:22 (Rodden). Next, for each member of a racial minority, it asks how many members of the district into which they have actually been drawn are also minorities. PX 1 at 26 (Rodden Rep.); Hr’g Tr. Day 1 Vol. 2 at 37:20-39:22 (Rodden). Thus, for each Kansan, the racial dislocation analysis measures the disparity between the minority population share of the assigned district and the share of the individual’s hypothetical neighborhood—which reveals whether the racial composition of the district matches that of the neighborhood. PX 1 at 26-27 (Rodden Rep.); Hr’g Tr. Day 1 Vol. 2 at 37:20-39:22 (Rodden). Gaps between the minority share of a neighborhood and the minority share of a district demonstrate that districts have not been drawn in a way that corresponds to communities of interest and the state’s natural racial geography, meaning the district was configured in a way that pairs together people from areas that have different

demographic compositions. PX 1 at 26-27 (Rodden Rep.); Hr’g Tr. Day 1 Vol. 2 at 37:20-39:22 (Rodden).

133. Ad Astra 2 has high levels of racial dislocation. Specifically, minority voters who live along the border of CDs 2 and 3 in Wyandotte and Johnson Counties experience high levels of racial dislocation. Hr’g Tr. Day 1 Vol. 2 at 40:17-41:13 (Rodden). Because the line drawn through Wyandotte County divides geographically proximate minority groups to the north and south, minority voters on either side of that line live in districts that have lower minority shares than would be expected if the districts were drawn according to the natural demographics of the area. Hr’g Tr. Day 1 Vol. 2 at 40:17-41:13 (Rodden). In fact, some of those voters live in a district that has a minority share that is *seven percentage points lower* than their neighborhood—a substantial disparity in a state that has a Black population of just about 6% and a Hispanic population about twice that. Hr’g Tr. Day 1 Vol. 2 at 41:4-42:1 (Rodden). By contrast, Dr. Rodden’s communities-of-interest map, as well as his least-change map and the prior congressional map, exhibit significantly lower levels of racial dislocation. Hr’g Tr. Day 1 Vol. 2 at 42:2-44:4 (Rodden).

134. These results are depicted in the figures below. The figure on the left, Plaintiffs’ Exhibit 20 (a zoomed-in version of Figure 16 in Dr. Rodden’s report), depicts racial dislocation levels for all minority groups in Ad Astra 2, while the figure on the right, Plaintiffs’ Exhibit 24 (a zoomed-in version of Figure 17 in Dr. Rodden’s report), shows racial dislocation levels in Dr. Rodden’s communities-of-interest map—which

preserves Wyandotte County in a single district—for the same groups. Red and orange shading, which features prominently in Ad Astra 2 in Wyandotte and Johnson Counties, indicates high levels of racial dislocation, meaning that minorities in those areas are placed in districts that have much lower proportions of minorities than their neighborhoods. Hr’g Tr. Day 1 Vol. 2 at 40:2-41:13 (Rodden). By comparison, the primarily yellow shading in the communities-of-interest map indicates low levels of racial dislocation, meaning the demographics of the neighborhood match the demographics of the districts. Hr’g Tr. Day 1 Vol. 2 at 42:7-25 (Rodden). The high levels of racial dislocation in Ad Astra 2 result from cracking minority voters between districts—that is, drawing noncompact districts that divide geographically proximate minority communities. Hr’g Tr. Day 1 Vol. 2 at 44:7-22 (Rodden).

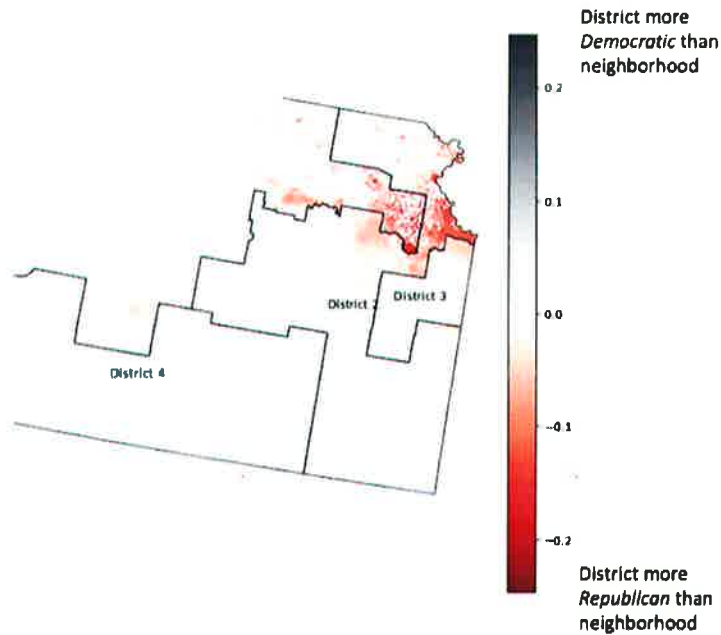


135. All told, Ad Astra 2 has more than double the level of racial dislocation of the previous congressional plan and Dr. Rodden's least-change map, and more than *triple* the level of Dr. Rodden's communities-of-interest map. PX 1 at 30 tbl.4 (Rodden Rep.); Hr'g Tr. Day 1 Vol. 2 at 45:5-46:16 (Rodden). The Third Congressional District, which encompasses half of Wyandotte County, has the highest levels of racial dislocation—nearly *four times higher* than the corresponding district in any of the comparison plans. PX 1 at 30 tbl.4 (Rodden Rep.). This is true for both the Black and Hispanic minority groups in CD 3. PX 1 at 30 tbl.4 (Rodden Rep.).

136. Dr. Rodden's partisan dislocation analysis reveal seven starker results. The partisan dislocation analysis proceeds in the same way as the racial dislocation analysis. Using official precinct-level election results, the analysis compares, for each individual Kansan, the partisanship of their nearest 735,000 neighbors and the partisanship of the district into which they were drawn. Hr'g Tr. Day 1 Vol. 2 at 47:24-48:22 (Rodden). Again, the difference between these two levels of partisanship signifies the degree to which someone has been assigned to a district that differs from their natural neighborhood. Hr'g Tr. Day 1 Vol. 2 at 47:24-48:22 (Rodden). The larger the difference, the greater the disparity between a voter's neighborhood and their district. Hr'g Tr. Day 1 Vol. 2 at 47:24-48:22 (Rodden). The analysis also asks which way this difference trends—more Republican or more Democratic. Hr'g Tr. Day 1 Vol. 2 at 47:24-48:22 (Rodden).

137. The results of this analysis are depicted in the figure below, PX 25 (a zoomed-in version of Figure 18 from Dr. Rodden's report), which focuses on Ad Astra 2 in the eastern part of the state. Red shading indicates that Kansans live in districts that are more Republican than the neighborhoods in which they reside, while gray represents voters who reside in districts that are more Democratic than their neighborhoods. The pattern is clear: Kansans across the northeast part of the state are consistently placed in districts that are far more Republican than their neighborhoods. Hr'g Tr. Day 1 Vol. 2 at 50:10-13 (Rodden).

Democratic vote share of district minus Democratic vote share
of nearest 734,496 neighbors



138. Specifically, light red shading in the southern part of Wyandotte County and the northern part of Johnson County indicates that voters in this region reside in a district that is five to six percentage points (or more) Republican than their neighborhoods. Hr’g Tr. Day 1 Vol. 2 at 49:3-20 (Rodden). Kansans who live on the north side of the line that slices Wyandotte County in two reside in an even more Republican district: one that is 10 to 12 percentage points more Republican than their neighborhoods. Hr’g Tr. Day 1 Vol. 2 at 49:21-50:3 (Rodden). And residents of Lawrence end up in a district that is over *20 percentage points* more Republican than their neighborhoods—exactly the effect that would be expected given that Ad Astra 2 scooped Democratic Lawrence out of Douglas County and paired it with a district that stretches across western Kansas to the Colorado border. Hr’g Tr. Day 1 Vol. 2 at 50:3-11 (Rodden).

139. Kansans in the northeastern part of the state are thus dispersed across CDs 1, 2, and 3 in a way that places almost all of them in districts that are five to 25 percentage points more Republican than the neighborhoods in which they reside. PX 1 at 32 fig.18 (Rodden Rep.). The unnaturally Republican nature of CDs 2 and 3 results directly from the contravention of traditional redistricting principles and the Guidelines. Hr’g Tr. Day 1 Vol. 2 at 50:17-51:11 (Rodden).

140. Dr. Rodden’s analysis shows that the configuration of Ad Astra 2 cannot be explained by Kansas’s political geography or compliance with the Guidelines. Ad Astra 2 contains districts that are noncompact and irregularly shaped, includes numerous

unnecessary political subdivisions splits, breaks up geographically compact communities of interests, and fails to preserve the cores of former districts. As a result, it yields four Republican districts and places Kansans across northeast Kansas—and especially in Wyandotte County, Johnson County, and Lawrence—in districts that are far more Republican than can be explained by any neutral map-drawing considerations.

141. Specifically, CD 3, which would have been comfortably Democratic in a configuration that adhered to the Guidelines and traditional redistricting principles, becomes a Republican-leaning district in Ad Astra 2. PX 1 at 33 & fig.19 (Rodden Rep.). Likewise, CD 2, which would have been competitive-but-Republican-leaning in a plan that respected the Guidelines and communities of interest, becomes a solidly Republican district under Ad Astra 2. PX 1 at 33 & fig.19 (Rodden Rep.)

142. The Court credits Dr. Rodden's testimony on the partisan consequences of Ad Astra 2 and concludes that it was enacted intentionally and effectively to diminish the electoral influence of Democratic voters in the state. During Dr. Rodden's live testimony, the Court carefully observed his demeanor, particularly as he was cross-examined for the first time about his work on this case. He consistently defended his work with careful and deliberate explanations of the bases for his opinions.

**C. Evidence presented by Dr. Chris
Warshaw demonstrates that Ad Astra 2
is an intentional, effective partisan
gerrymander.**

143. Plaintiffs' expert Dr. Christopher Warshaw, Ph.D., is a tenured Associate Professor of Political Science at George Washington University. PX 105 at 1 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 63:12-16 (Warshaw).

144. Dr. Warshaw's academic research focuses on American politics, with focuses on public opinion, representation, elections, polarization, redistricting, and partisan gerrymandering. PX 105 at 1 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 64:4-9 (Warshaw). Dr. Warshaw has written over twenty peer-reviewed papers on these topics, including multiple papers that focus specifically on elections or redistricting, and has a forthcoming book that includes an extensive analysis on the causes and consequences of partisan gerrymandering in state governments. PX 105 at 1 (Warshaw Rep.). Dr. Warshaw's work has appeared in leading peer-reviewed journals, such as the *American Political Science Review*, *Legislative Studies Quarterly*, and the *Election Law Journal*. PX 105 at 1 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 66:9-67:7, 67:17-68:9 (Warshaw). In particular, Dr. Warshaw has published two peer-reviewed articles on using the efficiency gap to quantify partisan bias in the redistricting process and examining its consequences for the political process. PX 105 at 1 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 67:25-68:9 (Warshaw).

145. Dr. Warshaw has presented expert reports or testimony using the efficiency gap in a number of partisan gerrymandering lawsuits, and his analysis has been consistently credited and relied upon by the courts in these cases. PX 105 at 2-3 (Warshaw Rep.); Hr’g Tr. Day 2 Vol. 1 at 70:12-21 (Warshaw); *see, e.g., Adams v. DeWine*, Nos. 2021-1428, 2021-1449, 2022 WL 129092, at *10-11, *14 (Ohio Jan. 14, 2022) (relying in part on Dr. Warshaw’s analysis in striking down congressional plan as partisan gerrymander); *League of Women Voters of Pa. v. Commonwealth*, 645 Pa. 1, 127, 178 A.3d 737 (2018) (citing Dr. Warshaw’s testimony as evidence of congressional map’s unconstitutional partisan gerrymandering); *Ohio A. Philip Randolph Inst. v. Householder*, 373 F. Supp. 3d 978, 1026 (S.D. Ohio) (“The Court qualified Dr. Warshaw as an expert in the fields of elections, partisan gerrymandering, polarization, and representation and found his testimony highly credible”), *vacated and remanded and other grounds*, 140 S. Ct. 101 (2019).

146. The Court accepts Dr. Warshaw in this case as an expert in American politics with specialties in political representation, elections, and polarization. During Dr. Warshaw’s live testimony, the Court carefully observed his demeanor, particularly as he was cross-examined for the first time about his work on this case. He consistently defended his work with careful and deliberate explanations of the bases for his opinions.

Dr. Warshaw employed reliable methodologies to analyze partisan bias.

147. To measure the partisanship of districts in Ad Astra 2, as well as the 2012 plan and other plans considered by the Legislature during this redistricting cycle, Dr. Warshaw used a composite of ten recent statewide elections for which precinct-level results were available: 2012 U.S. President, 2016 U.S. President, 2016 U.S. Senator, 2018 Governor, 2018 Attorney General, 2018 Insurance Commissioner, 2018 Secretary of State, 2018 Treasurer, 2020 U.S. President, and 2020 U.S. Senator.⁷ PX 105 at 10-11 & n.6 (Warshaw Rep.); Hr’g Tr. Day 2 Vol. 1 at 91:22-92:10 (Warshaw). To measure the partisanship of a district, Dr. Warshaw aggregated the precinct-level votes for each election to determine the vote share for each party within that district under a given election’s results, then averaged across the ten elections to determine the district’s average partisanship. PX 105 at 10-11 (Warshaw Rep.); Hr’g Tr. Day 2 Vol. 1 at 92:2-10 (Warshaw).

148. Dr. Warshaw explained that the use of statewide election results is appropriate—and standard practice—for evaluating the partisanship of new congressional districts for several reasons. At the most

⁷ Dr. Warshaw explained that he did not include any 2014 elections in his composite because precinct-level results were not available for those races. PX 105 at 3 n.2 (Warshaw Rep.); Hr’g Tr. Day 2 Vol. 1 at 73:10-11 (Warshaw). He further explained that including 2014, a Republican wave year, in his composite would have increased the plan’s pro-Republican bias, as measured using the composite. Hr’g Tr. Day 2 Vol. 1 at 153:10-154:13 (Warshaw).

basic level, there are no congressional-level election results available for a new district. Hr'g Tr. Day 2 Vol. 1 at 93:15-18 (Warshaw). Moreover, precinct-level results are not available for past congressional elections in Kansas, and using statewide elections avoids the need to impute results for uncontested congressional elections and ensures that partisanship estimates are not affected by idiosyncratic district features like incumbency or specific congressional candidates. Hr'g Tr. Day 2 Vol. 1 at 93:12-94:20 (Warshaw). As a result, Dr. Warshaw testified that he is not aware of any political science study that has analyzed a new congressional plan by analyzing past congressional elections. Hr'g Tr. Day 2 Vol. 1 at 93:19-25 (Warshaw); *see also supra* FOF § II.A (describing and approving Dr. Chen's similar use of a statewide composite to evaluate district partisanship). In any event, Dr. Warshaw explained that the statewide composite gives nearly identical results to observed congressional election results in determining the efficiency gap of the 2012 congressional plan, and that his research has shown that there is a strong correlation between efficiency gaps calculated using legislative elections and those calculated using statewide elections. Hr'g Tr. Day 2 Vol. 1 at 89:16-90:1, 155:22-56:9 (Warshaw).

149. The Court reaffirms its earlier finding that the use of statewide elections by Plaintiffs' experts to measure the partisanship of simulated and enacted districts is a reliable methodology. The Court further credits Dr. Warshaw's use of the ten elections comprising his statewide composite.

150. To evaluate the level of partisan bias exhibited by a given plan, Dr. Warshaw used the efficiency gap, a well-established, generally accepted metric of partisan fairness. PX 105 at 3 (Warshaw Rep.).

151. Dr. Warshaw explained that the efficiency gap measures the efficiency with which political parties are able to translate votes into legislative seats; improving this efficiency is the primary goal of redistricting, from a party's perspective. PX 105 at 4-5 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 64:18-25 (Warshaw). The efficiency gap captures the packing and cracking that underlie partisan gerrymandering. PX 105 at 6 (Warshaw Rep.).

152. The efficiency gap captures this idea by comparing the number of votes that each party casts inefficiently in a given election. PX 105 at 5 (Warshaw Rep.). In a congressional district in which a party's candidate loses, all votes for that party's candidate are inefficiently cast. PX 105 at 5 (Warshaw Rep.). In a district that a party wins, inefficiently cast votes are those beyond the 50% plus one needed to win. PX 105 at 5 (Warshaw Rep.).

153. The basic formula to calculate the efficiency gap is:

$$EG = \frac{W_R}{n} - \frac{W_D}{n}$$

PX 105 at 5 (Warshaw Rep.). In this formula, EG is the efficiency gap, W_R is the number of inefficiently cast Republican votes, W_D is the number of inefficiently cast Democratic votes, and n is the total number of votes cast in the state. PX 105 at 5 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 75:21-76:8 (Warshaw). This measure captures the extent to which one party's voters are packed and cracked to a greater extent than the other party's voters, and, because it is expressed as a percentage of the total votes cast, is comparable across time and states. PX 105 at 5 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 75:21-76:8 (Warshaw).

154. Table 1 of Dr. Warshaw's report, also admitted as Plaintiffs' Exhibit 117, gives a basic example of how to calculate the efficiency gap:

Table 1: Illustrative Example of Efficiency Gap

District	Democratic Votes	Republican Votes
1	75	25
2	40	60
3	40	60
Total	155 (52%)	145 (48%)
Inefficient	104	43

155. In this example, Democrats won a majority of the statewide vote, but only one of the three seats. PX 105 at 5 (Warshaw Rep.). Democrats won the first district with 75 of the 100 votes cast; this means the party inefficiently cast 24 votes beyond the 51 (50% +

1) needed to win the district. PX 105 at 5 (Warshaw Rep.). Democrats lost the second and third districts, so all 80 votes cast for the party across those two districts were inefficiently cast. PX 105 at 5 (Warshaw Rep.). Democrats thus inefficiently cast a total of 104 votes across the plan. PX 105 at 5 (Warshaw Rep.). Republicans inefficiently cast all their votes in the lost first district, but inefficiently cast only 9 votes in each of the second and third districts (60 votes is 9 more than the 51 necessary to win each district). PX 105 at 5 (Warshaw Rep.). Republicans thus inefficiently cast a total of only 43 votes across the plan. PX 105 at 5 (Warshaw Rep.). Applying the formula given above, the efficiency gap is $43/300 - 104/300 = -20\%$. PX 105 at 5 (Warshaw Rep.).

156. This simple formula for the efficiency gap does not account for the possibility that districts may have unequal populations or turnout levels. PX 105 at 5-6 (Warshaw Rep.). To account for this possibility, Dr. Warshaw used an alternative formula for the efficiency gap:

$$EG = S_D^{margin} - 2 * V_D^{margin}$$

PX 105 at 5-6 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 81:8-82:12 (Warshaw). In this formula, S_D^{margin} is the Democratic Party's seat margin (its seat share minus 0.5) and V_D^{margin} is the Democratic Party's vote margin, calculated by aggregating the raw vote for Democratic candidates across all districts, dividing by the total raw

vote cast, and subtracting 0.5. PX 105 at 5-6 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 81:15-82:7 (Warshaw).

157. Dr. Warshaw explained that he used the second version of the formula for his analysis in this case, as he does in all his academic work and expert reports. Hr'g Tr. Day 2 Vol. 1 at 82:13-15 (Warshaw). The second formula was first proposed in a peer-reviewed article by Eric McGhee. PX 105 at 6 (Warshaw Rep.); *see also* Hr'g Tr. Day 2 Vol. 1 at 82:8-15 (Warshaw).

158. Neither method for calculating the efficiency gap in any way implies that proportional representation is required. Hr'g Tr. Day 2 Vol. 1 at 76:9-11, 82:16-18 (Warshaw).

159. Dr. Warshaw explained that the efficiency gap has several theoretical and empirical properties that make it a good measure of partisan bias. At the theoretical level, the efficiency gap mathematically captures the packing and cracking that serve as the basic tools of partisan gerrymandering. PX 105 at 6 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 65:1-12, 82:22-83:5 (Warshaw). Moreover, empirical studies—including research conducted by Dr. Warshaw himself—have validated the efficiency gap's reliability as a measure of partisan bias: First, in states where multiple metrics for partisan bias are potentially available, the efficiency gap correlates strongly with those other metrics. Hr'g Tr. Day 2 Vol. 1 at 65:13-15, 83:6-17, 90:2-5 (Warshaw). Second, Dr. Warshaw's research shows that when party control of the redistricting process changes, the efficiency gap generally shifts in favor of the party taking power—as

one would expect. Hr’g Tr. Day 2 Vol. 1 at 65:16-66:4, 83:22-84:1, 90:6-11 (Warshaw). Third, Dr. Warshaw’s research has shown that bias in the redistricting process, as measured by the efficiency gap, empirically leads to bias in the composition of the relevant legislative body and affects eventual policy outcomes, again indicating that the measure correctly captures partisan bias. Hr’g Tr. Day 2 Vol. 1 at 89:1-15.

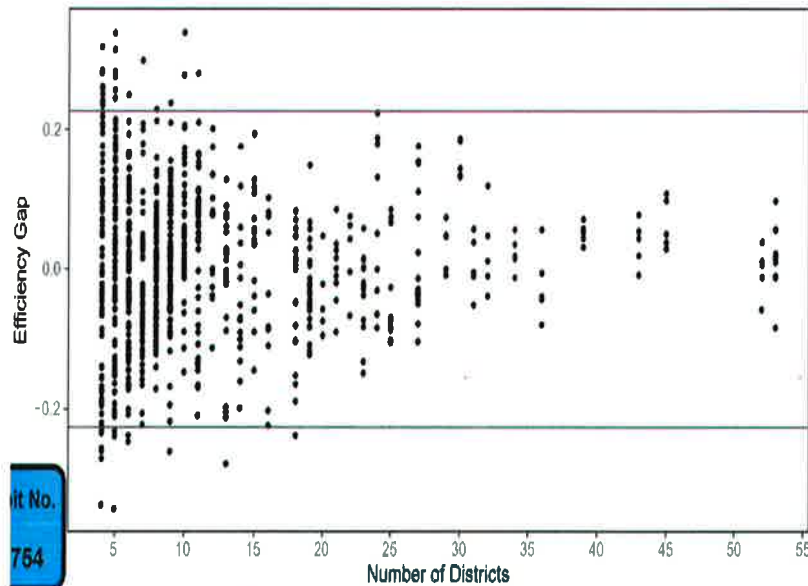
160. Consistent with these advantages, Dr. Warshaw affirmed that the academic literature involving the efficiency gap is “very robust” and that “the consensus of that literature is that . . . the efficiency gap performs very well” as a measure of partisan bias. Hr’g Tr. Day 2 Vol. 1 at 82:19-21, 211:5-14 (Warshaw). Dr. Warshaw also indicated that other social scientists can replicate his methodology and determine whether he made any errors. Hr’g Tr. Day 2 Vol. 1 at 90:21-91:2 (Warshaw).

161. Dr. Warshaw further testified that no court, to his knowledge, had ever ruled that the efficiency gap is not admissible. Hr’g Tr. Day 2 Vol. 1 at 91:3-10 (Warshaw); *see, e.g., Adams*, 2022 WL 129092, at *10-11, *14 (relying in part on Dr. Warshaw’s efficiency-gap analysis in striking down congressional plan as partisan gerrymander).

162. Dr. Warshaw explained that although the efficiency gap can be more volatile in states, like Kansas, with relatively small numbers of congressional seats, he accounted for this concern and checked the robustness of his analysis in several ways. PX 105 at 6 (Warshaw Rep.); Hr’g Tr. Day 2 Vol. 1 at 92:20-93:11, 108:10-13, 168:22-169:11 (Warshaw). First, to smooth

out any volatility in his efficiency-gap calculations, in calculating the efficiency gap for Ad Astra 2 and other proposed or historical Kansas plans, Dr. Warsaw averaged the results of the ten elections included in his statewide composite. PX 105 at 6 (Warsaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 92:20-93:11, 168:22-169:11 (Warsaw). Second, as discussed below, Dr. Warsaw confirmed that his conclusions about the extremity of Ad Astra 2's efficiency gap hold when comparing the plan only to maps from states with four to seven districts.

163. To further demonstrate that the efficiency gap is a reliable measure of partisan bias in Kansas, Dr. Warsaw plotted the historical distribution of efficiency gaps across the country in states with four or more congressional seats, separated by the number of districts per state, in Plaintiffs' Exhibit 754:



Hr'g Tr. Day 2 Vol. 1 at 115:13-116:17 (Warshaw).

164. Dr. Warshaw explained that Exhibit 754 shows that while small states exhibit somewhat more variability in the efficiency gap, the differences between states of different sizes are relatively modest. Hr'g Tr. Day 2 Vol. 1 at 115:22-116:1 (Warshaw). The horizontal lines across the chart mark efficiency gaps of $\pm 22.5\%$ —the level of efficiency gap exhibited by Ad Astra 2. Hr'g Tr. Day 2 Vol. 1 at 116:8-12 (Warshaw). The chart indicates that there are “very, very few elections” that exhibit an efficiency gap of that magnitude, regardless of state size, such that any concern about the variability of the efficiency gaps in small states “really d[id]n’t substantially change [Dr. Warshaw’s] conclusions at all.” Hr'g Tr. Day 2 Vol. 1 at 116:11-17 (Warshaw).

165. The Court finds that the efficiency gap, as applied by Dr. Warshaw, is a reliable methodology for measuring the partisan bias of Ad Astra 2. The Court therefore credits Dr. Warshaw’s analysis and his conclusions based on that methodology. The Court recognizes that the efficiency gap should be employed with caution in states with four districts, and Dr. Warshaw credibly explained how he employed such caution. The Court further notes that the efficiency gap analysis reinforces independent analysis of the partisan bias in the map conducted by other experts, including Dr. Chen’s simulation analysis.

Ad Astra 2 exhibits pro-Republican partisan bias at the district level.

166. Dr. Warshaw testified that Ad Astra 2 exhibits signs of partisan bias in its treatment of CD 3 and its construction of district lines in the area around Kansas City and Lawrence.

167. First, Dr. Warshaw measured the partisanship of Ad Astra's CD 3 using his ten-election composite. Dr. Warshaw concluded that the new CD 3 has a Democratic vote share of approximately 47%, compared to a vote share under the 2012 plan of slightly over 50%. PX 105 at 11 (Warshaw Rep.). Dr. Warshaw concluded that as a result, a Democratic candidate would likely win CD 3 only "during a strong Democratic wave year." PX 105 at 11 (Warshaw Rep.).

168. Dr. Warshaw also concluded that none of the other plans the Legislature considered in 2020 cut the Democratic vote share in CD 3 as significantly as the Ad Astra 2 plan. PX 105 at 12-13 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 104:16-105:24 (Warshaw). In fact, while Ad Astra 2 decreases the Democratic vote share in CD 3 to 46.9%, only one other plan shrank the Democratic vote share to under 50%. PX 105 at 13 (Warshaw Rep.).

169. Figure 7 in Dr. Warshaw's report, also admitted as Plaintiffs' Exhibit 112, compares the Democratic vote share in CD 3 under Ad Astra 2, the 2012 plan, and the other plans considered by the Legislature during the redistricting process:

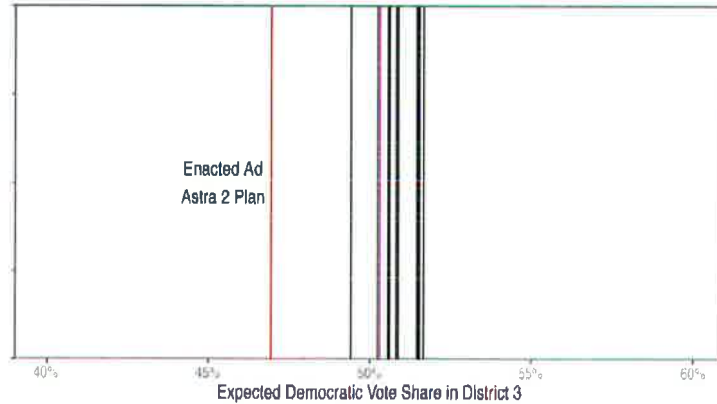


Figure 7: Comparison of Democratic vote share in district 3 in Ad Astra 2 plan (red), 2012-2020 plan (purple), and other potential plans in Kansas (black) based on composite of statewide elections.



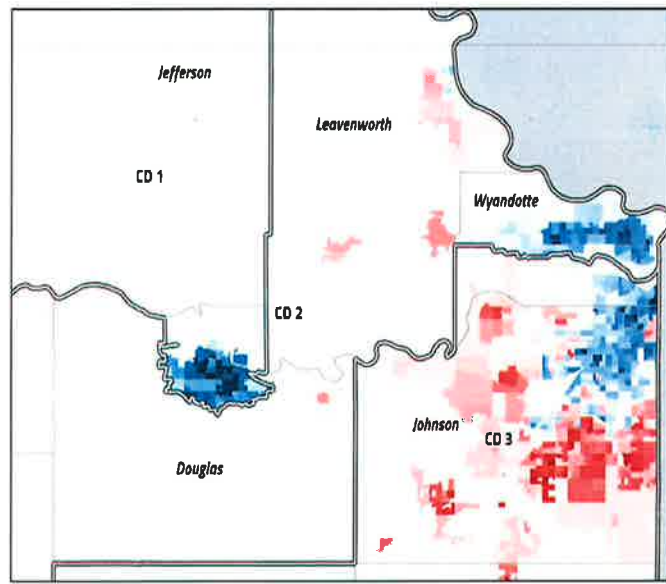
170. As Dr. Warshaw testified, the Figure shows that the Democratic vote share, based on the ten-election composite, is much lower in CD 3 compared to both the 2012 plan and the other plans considered by the Legislature. Hr’g Tr. Day 2 Vol. 1 at 104:16-105:1 (Warshaw).

171. Dr. Warshaw concluded that this difference in Democratic vote share “provides further evidence that the decrease in Democratic performance in [Ad Astra 2] appears to be intentional” and not a result of Kansas’s political geography. PX 105 at 14 (Warshaw Rep.).

172. Dr. Warshaw also analyzed the relationship between the district lines in Ad Astra 2 and the

distribution of Democratic and Republican votes across the state. Hr'g Tr. Day 2 Vol. 1 at 103:2-104:12 (Warshaw); see PX 105 at 7-10 (Warshaw Rep.).

173. Figure 4(b) in Dr. Warshaw's report, also admitted as part of Plaintiffs' Exhibit 109, displays the distribution of votes in the area around Kansas City and Lawrence and the district lines created by Ad Astra 2:



(b) Kansas City Area

Figure 4: Map of District 3 on the Enacted Ad Astra 2 plan. Blue areas are Democratic and red areas are Republican. The shading reflects the margin of votes per hectare.

174. The shading in the Figure reflects the vote margin per hectare, computed using Dr. Warshaw's ten-election composite; thus, areas with larger pro-Democratic vote margins appear in darker shades of blue, areas with larger pro-Republican vote margins appear in darker shades of red, and areas with lower voting populations or closer vote margins are more lightly shaded. PX 105 at 7-9 & fig.4 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 103:2-11 (Warshaw).

175. As Dr. Warshaw explained, this Figure illustrates how Ad Astra 2 cracks Democratic voters between districts. The plan first cracks Democratic voters in northern Wyandotte County (assigned to CD 2) from Democratic voters in Johnson County (assigned to CD 3), such that neither district contains a Democratic majority. Hr'g Tr. Day 2 Vol. 1 at 103:12-23 (Warshaw); *see* PX 105 at 9 (Warshaw Rep.). A more compact district in the Kansas City area would "clearly" have produced a majority-Democratic district. Hr'g Tr. Day 2 Vol. 1 at 103:20-23 (Warshaw).

176. Figure 4(b) also shows how Ad Astra 2 cracks heavily Democratic Lawrence out of CD 2 and into CD 1, which "was necessary in order to . . . ensure that District 2 continued to be a [R]epublican district," since Democratic voters in Lawrence could otherwise have combined with Democratic voters in northern Wyandotte County to produce "a much more closely contested district." Hr'g Tr. Day 2 Vol. 1 at 103:24-104:12 (Warshaw).

177. The Court credits Dr. Warshaw's analysis of the district-level partisan bias of Ad Astra 2. The Court finds that Ad Astra 2 results in a significantly higher

Republican vote share in CD 3 than existed under the 2012 plan or would result under other proposed plans. The Court finds that this increase in Republican vote share cannot be explained by Kansas's political geography. The Court finds that the district lines in the areas around Kansas City and Lawrence show clear signs of cracking Democratic voters between districts to prevent them from achieving majority status. The Court finds these facts to be persuasive evidence that Ad Astra 2 is an intentional, effective partisan gerrymander.

Ad Astra 2 is an extreme, intentional pro-Republican outlier at the statewide level.

178. Dr. Warshaw concluded that Ad Astra 2 exhibits “an extreme level of pro-Republican bias.” PX 105 at 3 (Warshaw Rep.); see Hr’g Tr. Day 2 Vol. 1 at 72:2-13, 116:18-117:6 (Warshaw).

179. Using his ten-election composite, Dr. Warshaw calculated that Ad Astra 2 exhibits an efficiency gap of -22.5%. PX 105 at 12 tbl.2 (Warshaw Rep.); Hr’g Tr. Day 2 Vol. 1 at 96:20-25 (Warshaw).⁸ This efficiency gap is equivalent to a reduction in Democratic representation of approximately one congressional seat per election, and is “much more extreme” than the efficiency gap exhibited by the 2012 plan (-15.6%). Hr’g Tr. Day 2 Vol. 1 at 97:1-16, 105:10-24 (Warshaw).

⁸ Dr. Chen and Dr. Warshaw reached different efficiency gap numbers because they used slightly different election composites. The Court finds that this difference does not affect the credibility or reliability of their results because each used a consistent approach across their respective analyses.

180. To place Ad Astra 2's partisan bias in context, Dr. Warshaw compared its efficiency gap to historical data on the efficiency gaps of congressional plans with four or more seats since 1972. PX 105 at 12 & tbl.2 (Warshaw Rep.); Hr'g Tr. Day 2 Vol. 1 at 97:17-98:25 (Warshaw). This historical data set includes efficiency gaps for 25 election cycles across 48 years, including about 10,000 individual elections. Hr'g Tr. Day 2 Vol. 1 at 98:2-4 (Warshaw).

181. Table 2 of Dr. Warshaw's report, also admitted as Plaintiffs' Exhibit 118, displays the result of this historical comparison:

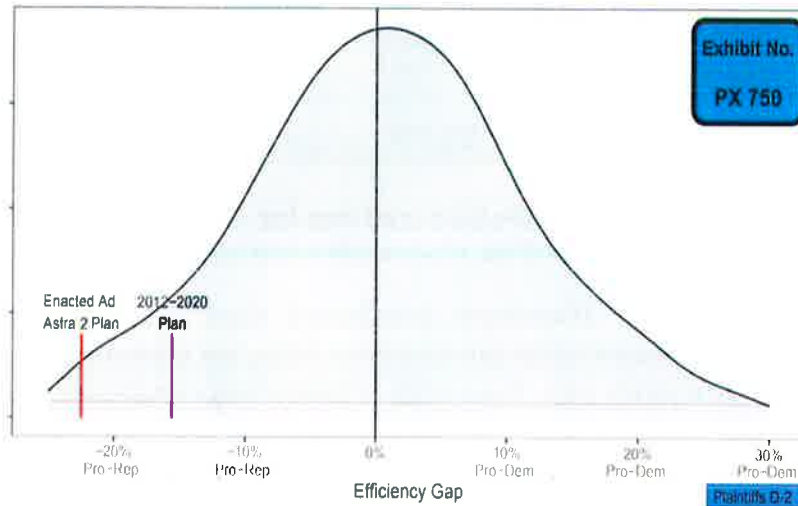
		2012-2020 Composite	
Metric	Value	> Biased than this % Elections	> Pro- Rep. than this % Elections
2012-2020 plan			
Democratic Vote Share	41%		
Democratic Seat Share	16%		
Efficiency Gap	-15.6%	83%	93%
Enacted Ad Astra 2 plan			
Democratic Vote Share	41%		

Democratic Seat Share	9%		
Efficiency Gap	-22.5%	95%	98%

Table 2: Composite bias metrics for Ad Astra 2 plan based on statewide elections

182. Dr. Warshaw concluded that Ad Astra 2 exhibits more extreme partisan bias, as measured by the efficiency gap, than 95% of historical congressional plans with four or more seats, and is more Republican-favoring than 98% of historical plans. PX 105 at 12 & tbl.2 (Warshaw Rep.); Hr’g Tr. Day 2 Vol. 1 at 98:18-25 (Warshaw).

183. Plaintiffs’ Exhibit 750 displays this information in graphical form: the chart compares the efficiency gap exhibited by Ad Astra 2 (marked in red) with the historical distribution of efficiency gaps in states with four or more congressional seats:



Hr’g Tr. Day 2 Vol. 1 at 101:4-15 (Warshaw).

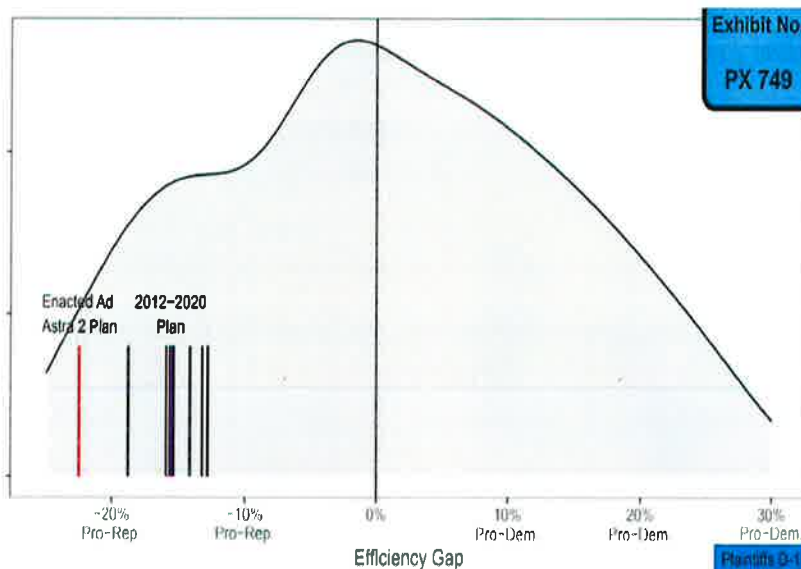
184. Dr. Warshaw explained that Exhibit 750 shows that the average congressional plan over the past fifty years has had an efficiency gap of about 0%, and most plans fall relatively close to 0%; two-thirds land between -10% and 10%, and only a small fraction exhibit efficiency gaps of over 20%. Hr’g Tr. Day 2 Vol. 1 at 101:17-102:10 (Warshaw). This data demonstrates the “historical extremity” of Ad Astra 2’s -22.5% efficiency gap. Hr’g Tr. Day 2 Vol. 1 at 102:5-10 (Warshaw).

185. Dr. Warshaw testified that this historical extremity is corroborated even by PlanScore, an online tool cited by Defendants whose methodology projects relatively elevated Democratic vote shares, *see* Hr’g Tr. Day 2 Vol. 1 at 160:16-161:3, 161:11-162:9 (Warshaw), which classifies Ad Astra 2 as exhibiting more extreme partisan bias than 98% of historical plans, Hr’g Tr. Day

2 Vol. 1 at 207:15-208:1 (Warshaw); *see* PX 746 at 4 (PlanScore evaluation of Ad Astra 2). PlanScore, too, thus marks Ad Astra 2 as “an extreme historical outlier [that] is more skewed than the vast, vast majority of plans in history.” Hr’g Tr. Day 2 Vol. 1 at 207:15-08:7 (Warshaw); *see* PX 746 at 4 (PlanScore evaluation of Ad Astra 2).

186. Dr. Warshaw also concluded that Ad Astra 2 remains an extreme historical partisan outlier even when compared only to plans in states with small numbers of congressional districts. Hr’g Tr. Day 2 Vol. 1 at 107:16-108:13, 184:19-185:2 (Warshaw).

187. Plaintiffs’ Exhibit 749 compares the efficiency gap of Ad Astra 2 (marked in red) to the historical distribution of efficiency gaps across states with four to seven congressional districts (displayed in gray):



Hr'g Tr. Day 2 Vol. 1 at 107:13-108:13 (Warshaw).

188. Dr. Warshaw testified that Ad Astra 2 exhibits more extreme partisan bias, as measured by the efficiency gap, than 90% to 91% of historical plans in states with 4 to 6 or 4 to 7 congressional seats. Hr'g Tr. Day 2 Vol. 1 at 184:19-185:2 (Warshaw). This figure shows that Ad Astra 2 remains “historically extreme” no matter what seat threshold applies. Hr'g Tr. Day 2 Vol. 1 at 108:7-13 (Warshaw).

189. Dr. Warshaw also concluded that Ad Astra 2's partisan bias, as measured by the efficiency gap, is “much more extreme” than the partisan bias of both the 2012 map and the other plans considered by the Legislature during the redistricting process. Hr'g Tr. Day 2 Vol. 1 at 105:14-24 (Warshaw); *see* PX 105 at 14-15 & fig.9 (Warshaw Rep.).

190. Figure 9 from Dr. Warshaw's report, also admitted as Plaintiffs' Exhibit 114, compares the efficiency gaps of Ad Astra 2 (in red), the 2012 plan (in purple), and other plans considered by the Legislature during the redistricting process (in black):