UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF VIRGINIA
Lynchburg Division

LEAGUE OF WOMEN VOTERS OF VIRGINIA, et al.,	)	
	)	
Plaintiffs,	)	
	)	
v.	)	**Case No. 6:20-cv-00024**
	)	
VIRGINIA STATE BOARD OF ELECTIONS, et al.,	)	
	)	
	)	
Defendants.	)	

DECLARATION OF BRYAN LEWIS,
RESEARCH ASSOCIATE PROFESSOR, UNIVERSITY OF VIRGINIA

1. I currently work as a Research Associate Professor in the Network Systems Science and Advanced Computing Division of the Biocomplexity Institute at the University of Virginia. In that role, my research focuses on the transmission dynamics of infectious diseases within specific populations through both analysis and simulation. I have worked as a Research Associate Professor at the University of Virginia since September 2018. Prior to that, I worked as a Research Assistant Professor and a Research Scientist at Virginia Tech. I also worked as an epidemiologist at the California Department of Public Health for approximately four years.

2. I hold a BS degree in computational biology from Carnegie Mellon University, an MPH degree in infectious diseases from University of California – Berkeley, and a PhD degree in genetics, bioinformatics, and computational biology from Virginia Tech. I have published numerous articles regarding public health data, modeling, and simulation.

3. Throughout my career as a computational epidemiologist, I have more than 15 years of experience crafting, analyzing, and interpreting the results of models in the context of

real-world public health threats. I have been heavily involved in a series of projects supporting public officials by forecasting the spread of infectious disease as well as evaluating responses to those diseases. Those projects have involved diseases such as ebola, pandemic influenza, and cholera (among others).

4. On April 13, 2020, I participated in a public presentation entitled "Estimation of COVID-19 Impact in Virginia" hosted by Dr. Daniel Cary, Secretary of Health and Human Resources for the Commonwealth of Virginia. The presentation summarized the results of research conducted by the Biocomplexity Institute regarding the impact of COVID-19 mitigations in Virginia. I personally conducted that research along with the COVID-19 team at the Institute. The objective of this research was to make current data available to the Commonwealth of Virginia, not to advocate for or against specific policy decisions. A copy of the slides that I presented during that presentation is attached here as an Exhibit.

5. Although data limitations and other factors make it impossible to project future cases with precision, we can confidently draw the following conclusions from our research.

6. Current social distancing efforts have paused the growth of the epidemic in Virginia. Anonymized mobility data shows Virginians greatly reduced activities since the Governor declared a state of emergency on March 12, 2020. Virginia Department of Health data shows a corresponding reduction in the growth rate of COVID-19 cases around that same time. The weekly average growth rate by date of onset went down from 0.3 the week before March 15 to 0.03 the week after March 15. There was an equivalent reduction in the reproductive number, a measure of the transmission rate, from 2.2 before March 15 to 1.1 after March 15.

7. As a result of these reductions, for all regions in Virginia, social distancing postpones the time when hospital surge capacity is exceeded by 1 to 2.5 months.

8. Lifting social distancing restrictions too soon can lead quickly to a second wave of infections. This is because a reduction in social distancing measures would result in more opportunities for transmission thus leading to an increase in the growth rate of COVID-19 cases.

9. According to the current version of the model the data is currently tracking ("Pause Jun10") — which assumes that current mitigation strategies and their observed effects continue until June 10 — daily confirmed cases are projected to grow at a much slower rate as compared to a scenario where no mitigation measures are in place ("Unmitigated") or a scenario where current measures are reduced or are less effective ("Slow Jun10").

10. If current restrictions were lifted on April 30, infection rates would begin to climb earlier than if the restrictions remained in place until June 10.

In accordance with 28 U.S.C. 1746, I declare under penalty of perjury that the foregoing is true and correct.

Executed on: Apr. 30, 2020

Dr. Bryan Lewis
Research Associate Professor
Biocomplexity Institute
University of Virginia

Lewis Declaration Exhibit

Network Systems
Science & Advanced
Computing

Biocomplexity Institute
& Initiative

University of Virginia

Estimation of COVID-19 Impact in Virginia

April 13, 2020

(data current to April 11, 2020)

Biocomplexity Institute Technical report: TR-2020-048

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biocomplexity.virginia.edu

Who We Are

- Biocomplexity Institute at the University of Virginia
- Over 20 years of crafting and analyzing infectious disease models
  - Pandemic response and support for Influenza, Ebola, Zika, others
- COVID-19 researchers on today's panel

Bryan Lewis
Research Associate Professor

Chris Barrett
Executive Director

Madhav Marathe
Division Director

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Overview

- **Goal**: Understand impact of COVID-19 mitigations in Virginia
- **Approach:**
  - Calibrate explanatory mechanistic model to observed cases
  - Project infections through the end of summer
  - Consider a range of possible mitigation effects in "what-if" scenarios
- **Outcomes:**
  - Ill, Confirmed, Hospitalized, ICU, Ventilated, Death
  - Geographic spread over time, case counts, healthcare burdens

Key Takeaways

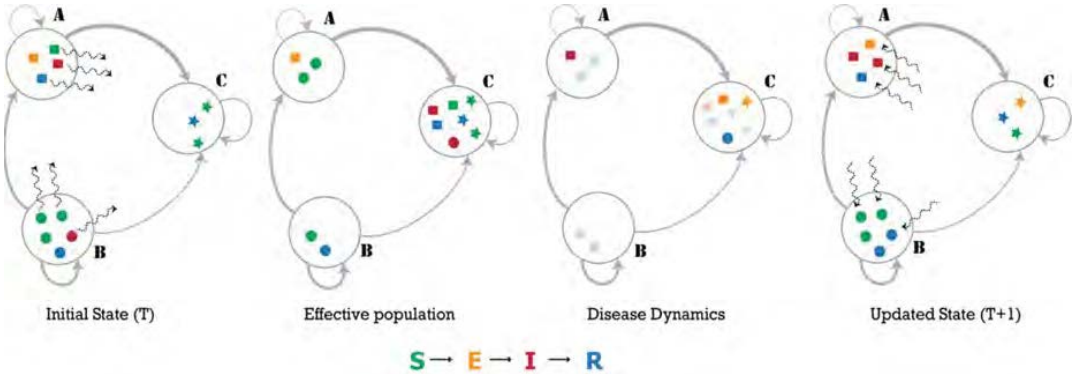
Projecting future cases precisely is impossible and unnecessary.
Even without precise projections, we can confidently draw conclusions:

- Current social distancing efforts have paused the growth of the epidemic.
- Under current conditions, Virginia *as a whole* will have sufficient medical resources for at least the next couple months.
- Lifting social distancing restrictions too soon can lead quickly to a second wave.
- Further modeling could elucidate the effectiveness of test-trace-isolate policies.
- The situation is changing rapidly. Models will be updated regularly.

Model Configuration and Data Analysis

Simulation Engine – PatchSim

- Metapopulation model
  - Represents each county's population and its interactions in a single patch
  - 133 patches for Virginia
- Extended SEIR disease representation
  - Includes asymptomatic infections and treatments
- Mitigations affect both disease dynamics and population interactions
- Runs fast on high-performance computers
  - Ideal for calibration and optimization



Venkatramanan, Srinivasan, et al. "Optimizing spatial allocation of seasonal influenza vaccine under temporal constraints." *PLoS Computational Biology* 15.9 (2019): e1007111.

Model Configuration

- **Transmission:** These parameters are calibrated to the observed case counts
  - **Reproductive number:** 2.1 - 2.3
  - **Infectious period** (time of infectiousness before full isolation): 3.3 to 5 days
- **Initial infections:** Start infections from confirmed cases by county
  - Timing and location based on onset of illness from VDH data
  - Assume 15% detection rate, so one confirmed case becomes ~7 initial infections
- **Mitigations:** Duration and intensity of mitigations into the future are unknowable, thus explored through 5 scenarios

Mitigation Scenarios

- **Consider 5 possible futures**
  - Two levels of intensity with two durations and one with no effect
- **Start of social distancing:** March 15th, as measured from VDH data
- **Duration:** Lift on April 30th or lift on June 10th
- **Intensity of mitigation:**

  Slowing growth vs. Pausing growth
  - **Slowing –** Social distancing slows the growth, but doesn't fully stop it
  - **Pausing –** Social distancing pauses growth, keeping new cases steady
  - Pausing scenarios track the data better

Duration (lift date)	Intensity	Short Name	Description
Apr 30th	Slowing	Slow - Apr30	Slowing intensity, lift April 30th
June 10th	Slowing	Slow - Jun10	Slowing intensity, lift June 10th
Apr 30th	Pausing	Pause – Apr30	Pausing intensity, lift April 30th
June 10th	Pausing	Pause – Jun10	Pausing intensity, lift June 10th
None	Unmitigated	Unmitigated	No effect of social distancing

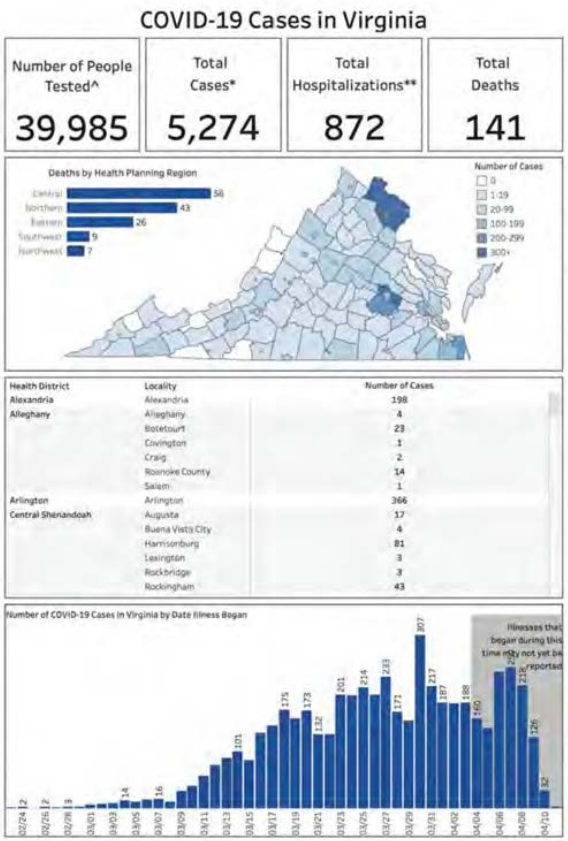
Full Parameters

Parameter	Estimated Values	Description [Source]
Transmissibility (R0)	2.2 [2.1 – 2.3]	Reproductive number *
Incubation period	5 days	Time from infection to Infectious *
Infectious period	3.3 - 5 days	Duration of infectiousness *
Proportion asymptomatic	50%	Proportion of infections that don't exhibit symptoms *
Proportion hospitalized	5.5% (~20% of confirmed)	Symptomatic Infections becoming Hospitalized *
Proportion in ICU	20%	Hospitalized patients that require ICU *
Proportion ventilated	70%	Proportion of ICU requiring ventilation *
Onset to hospitalization	5 days	Time from symptoms to hospitalization *
Hospitalization to ventilation	3 days	Time from hospitalization to ventilation *
Duration hospitalized	10 days	Time spent in the hospital
Duration ventilated	14 days	Time spent on a ventilator †
Infection detection rate	15%	One confirmed case becomes ~7 initial infections #

* CDC COVID-19 Modeling Team. "Best Guess" scenario. Planning Parameters for COVID-19 Outbreak Scenarios. Version: 2020-03-31.
† Up-to-date. COVID-19 Critical Care Issues. https://www.uptodate.com/contents/coronavirus-disease-2019-covid-19-critical-care-issues?source=related_link
# Li et al., *Science* 16 Mar 2020:eabb3221 https://science.sciencemag.org/content/early/2020/03/24/science.abb3221

Calibration Approach

- **Data:**
  - County level case counts by date of onset (from VDH)
  - Confirmed cases for model fitting
- **Model:** PatchSim initialized with disease parameter ranges from literature
- **Calibration:** fit model to observed data
  - Search transmissibility and duration of infectiousness
  - Markov Chain Monte Carlo (MCMC) particle filtering finds best fits while capturing uncertainty in parameter estimates
- **Project** future cases and outcomes using the trained particles



Accessed 1pm April 12, 2020

https://public.tableau.com/views/VirginiaCOVID-19Dashboard/VirginiaCOVID-19Dashboard

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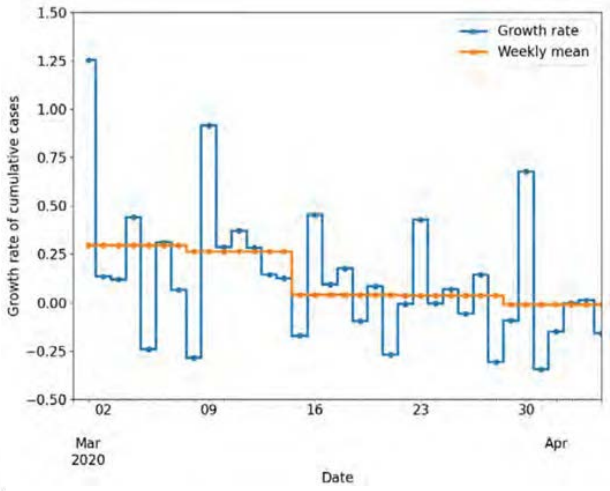
Impact of Interventions

Estimating Effects of Social Distancing

- **Anonymized mobility data shows Virginia greatly reduced activities**
  - Google: -44% retail & recreation, -18% grocery stores, -39% workplaces
  - Cuebiq: 50% reduction of average person's movement compared to Jan / Feb
- **VDH data shows reductions in growth rate starting in mid-March**
  - Weekly average growth rate by date of onset
    - Week before March 15 = 0.3
    - Week after March 15 = 0.03
  - Equivalent reproductive number change
    - 2.2 before March 15th
    - 1.1 after March 15th



Google. COVID-19 community mobility reports. https://www.google.com/covid19/mobility/
Cuebiq: COVID-19 Mobility insights. https://www.cuebiq.com/visitation-insights-covid19/

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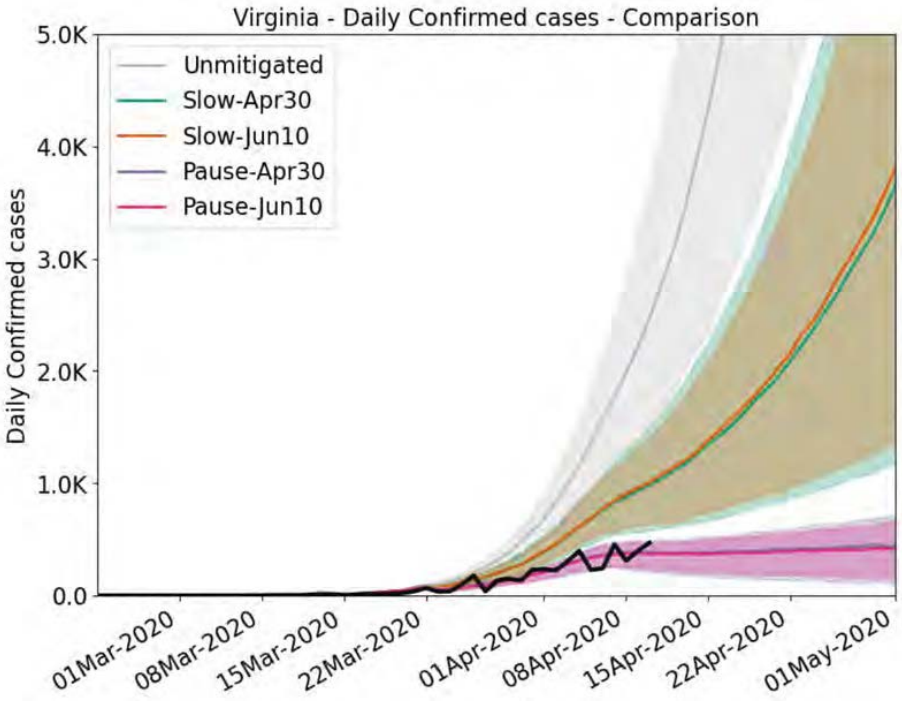
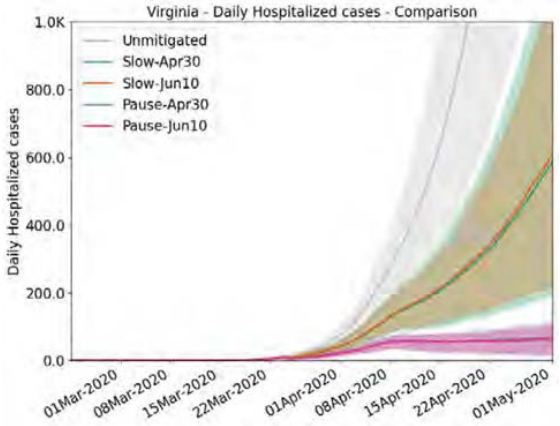
Virginia-wide results

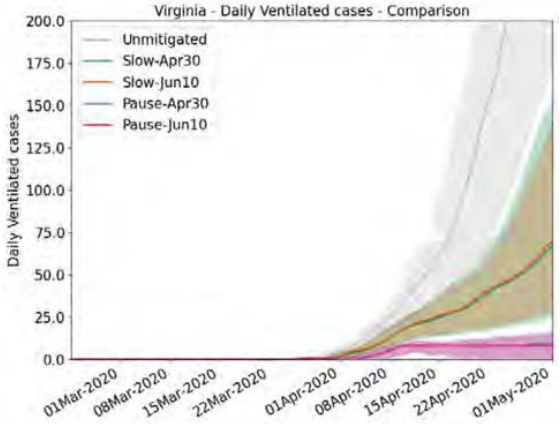
Confirmed cases



Hospitalizations



Ventilations



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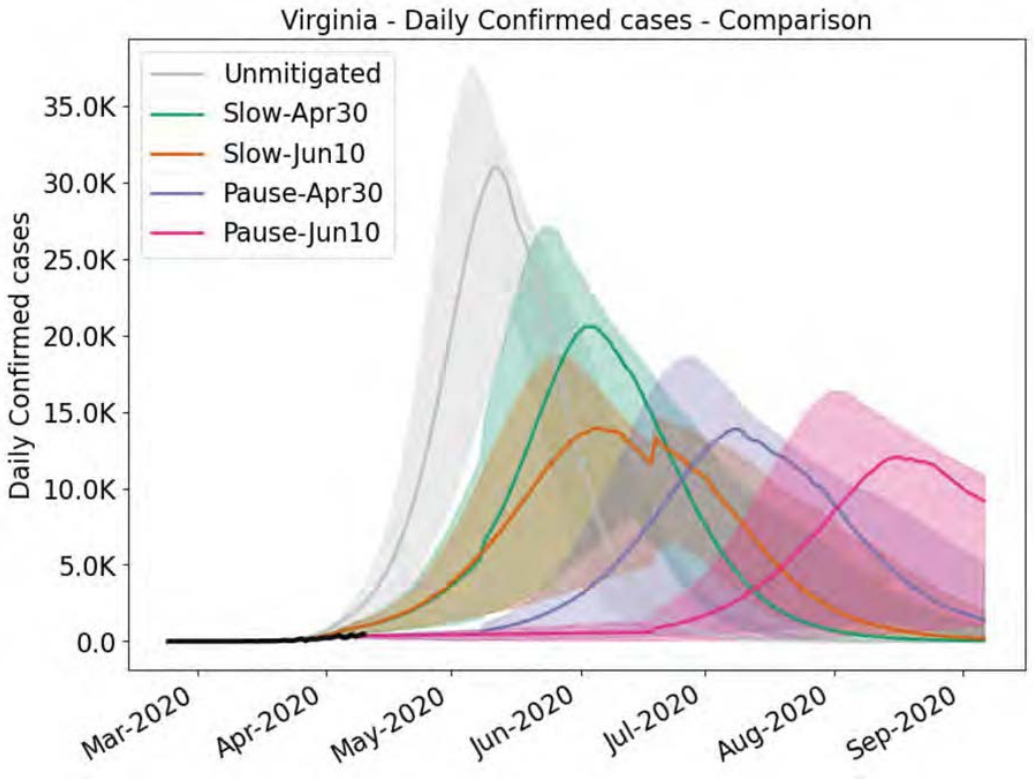
Course of Action Analysis

Confirmed Cases – Many Possible Futures



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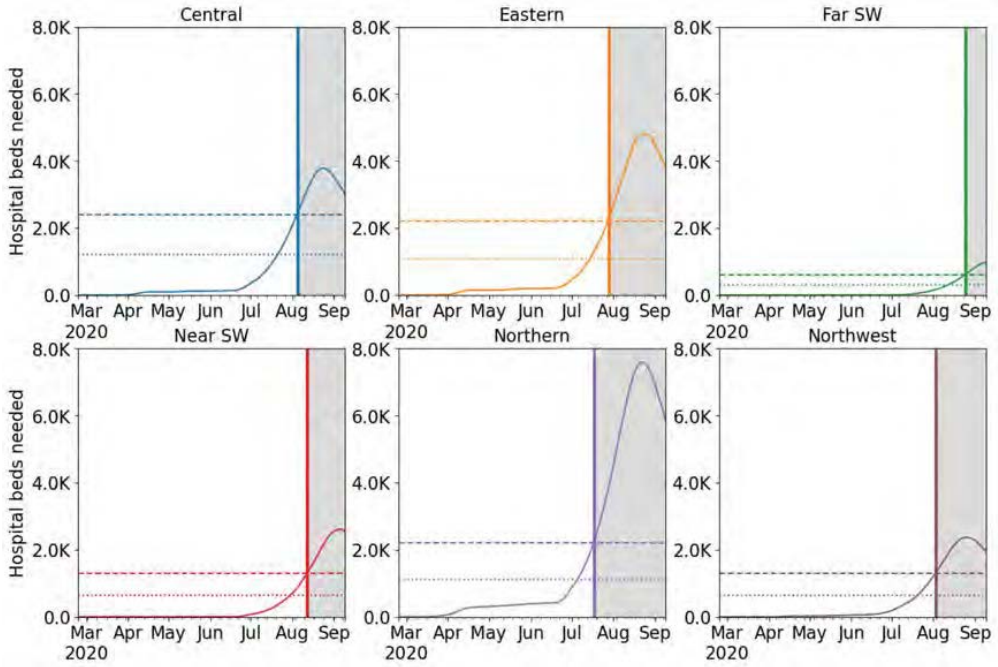
Weekly New Confirmed Cases

Week ending	Unmitigated	Slow Jun10	Pause Jun10
4/12/20	11,846	5,518	2,469
4/19/20	25,712	8,502	2,599
4/26/20	53,562	13,076	2,742
5/3/20	101,876	19,881	2,944
5/10/20	164,527	29,567	3,151
5/17/20	200,184	42,312	3,345
5/24/20	182,818	57,679	3,558
5/31/20	136,652	73,380	3,770
6/7/20	84,016	85,874	3,962
6/14/20	46,350	89,390	4,144
6/21/20	23,363	85,226	4,470
6/28/20	11,366	91,648	7,850

Hospital Demand and Capacity by Region

Capacities by Region – Pause June 10



Assumes average length of stay of 10 days

COVID-19 capacity ranges from 80% (dots) to 120% (dash) of total beds

Date ranges when regions are estimated to exceed surge capacity

Scenario	Date Ranges
Slow – Apr30	Early May – Early June
Slow – Jun10	Early May – Mid June
Pause – Apr30	Mid June – Late July
Pause – Jun10	Mid July – Late August
Unmitigated	Late April – Mid May

Social Distancing postpones the time when capacity is exceeded 1 to 2.5 months

Timing estimates can be used for planning to augment existing capacities if needed

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Ongoing Efforts and Improvements

- Incorporate age structure into transmission dynamics and stratify outcomes by age in these projections
- Incorporate Virginia-specific outcomes and durations which will better tailor these analyses to our Commonwealth
- Assess evidence for the role of seasonality, and incorporate if warranted
- Analyze Test-Trace-Isolate mitigations
- Connect forecast demand to VDH dashboard

Key Takeaways

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Even without precise projections, we can confidently draw conclusions:

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- The situation changes rapidly. Models will be updated regularly.

References

Venkatramanan, S., et al. "Optimizing spatial allocation of seasonal influenza vaccine under temporal constraints." *PLoS computational biology* 15.9 (2019): e1007111.

Arindam Fadikar, Dave Higdon, Jiangzhuo Chen, Bryan Lewis, Srinivasan Venkatramanan, and Madhav Marathe. Calibrating a stochastic, agent-based model using quantile-based emulation. SIAM/ASA Journal on Uncertainty Quantification, 6(4):1685–1706, 2018.

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Cuebiq: COVID-19 Mobility insights. https://www.cuebiq.com/visitation-insights-covid19/

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	)	
Defendants.	)	

DECLARATION OF EVAN FEINMAN

1. I am over the age of 18, competent to offer testimony, and have personal knowledge of the facts in this Declaration.

2. I have served as the Governor's Chief Broadband Advisor since July of 2018.

3. In this position I developed a plan to realize Governor Northam's goal of universal broadband coverage prior to 2028, and oversee the inter-agency efforts to implement that plan.

4. The Commonwealth's Broadband Effort, "Commonwealth Connect" is an inter-agency team consisting of staff from the Governor's office, the Center for Innovative Technology, the Department of Housing and Community Development, and the Tobacco Region Revitalization Commission, with ad-hoc assistance from many additional executive agencies. The Commonwealth Connect team partners with Virginia's communities, utilities, and telecommunications providers to develop local and regional universal coverage plans, and to direct appropriated funds in support of those plans.

5. In order to fulfill the mission to extend broadband service to unserved areas, we researched both the flaws in the current federal reporting requirements and worked with federal, state, local, and provider data to determine good estimates for the nature and extent of broadband coverage as well as estimates of the numbers of citizens without access.

6. As a result of this work, we now know that there are hundreds of thousands of Virginians without residential access to broadband, and that many thousands of Virginians lack residential access to cellular service sufficient to engage in simultaneous video exchanges, such as FaceTime, Google Chat, to name a few.

7. Many of the unserved communities in which we work also contain a disproportionally high concentration of low-income Virginians. Many of these Virginian do not own, and lack the resources to own, the devices and subscriptions necessary to engage in video chatting even if their home could receive service.

Pursuant to 28 USC § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Executed on: April 30, 2020

Evan Feinman
Office of Governor Northam