

# Health GIS – Infectious Disease Response Planning

Este Geraghty, Chief Medical Officer

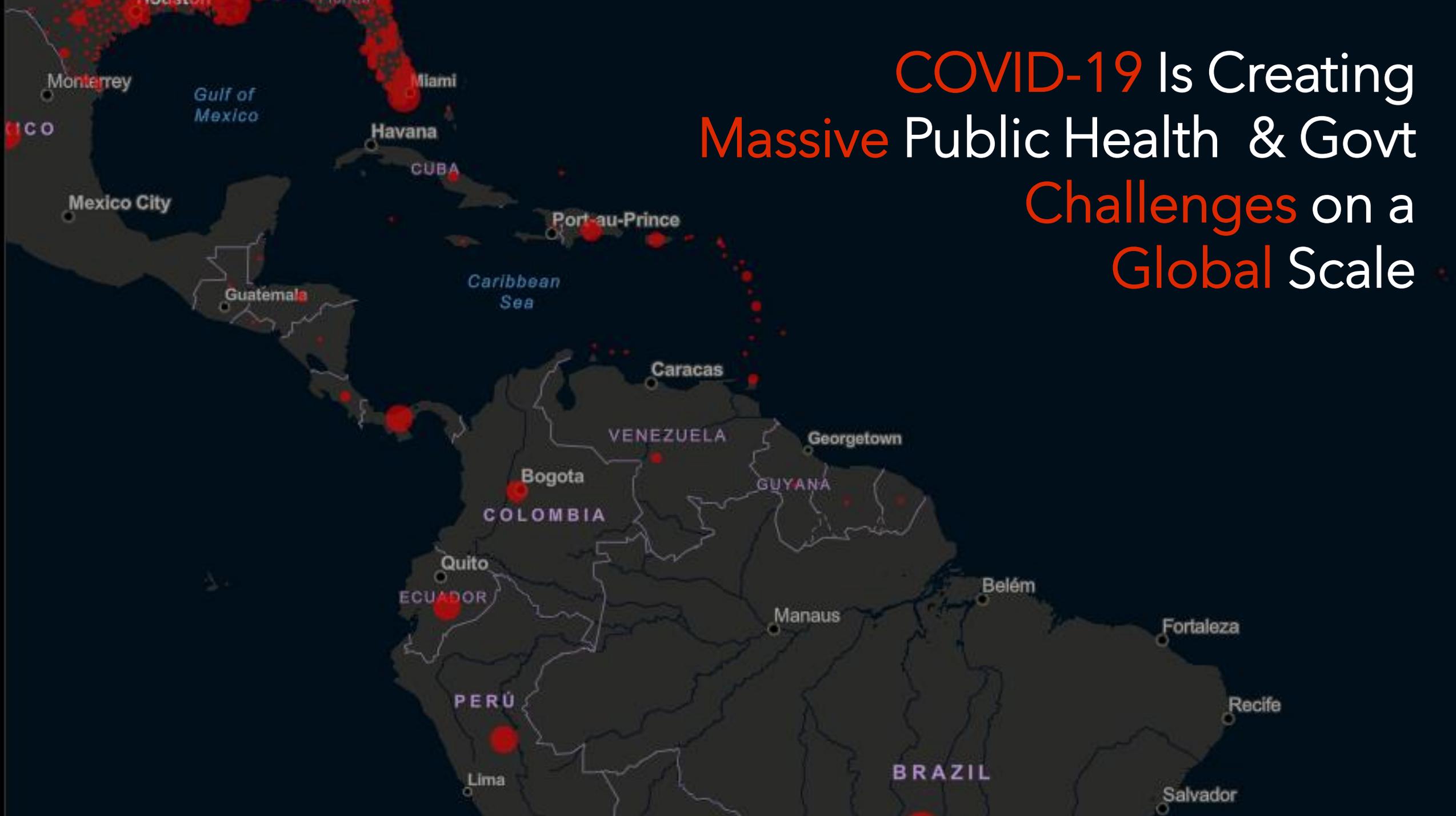
UN GGIM  
April 8, 2020

50 Years  
Strong and Growing

**THE  
SCIENCE  
OF  
WHERE**

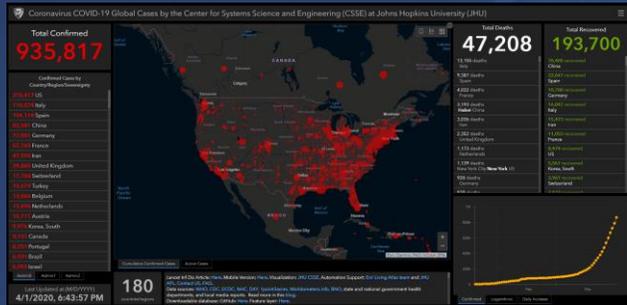


# COVID-19 Is Creating Massive Public Health & Govt Challenges on a Global Scale



# An Enterprise System For Pandemic Response

## Johns Hopkins University



## FEMA

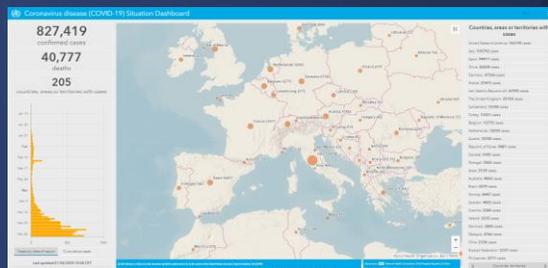


## State of Florida



## Connecticut

## WHO



Apps

Portal

Visualization and Analytic Services

## US Military



Case Data

Movement Data

Facilities

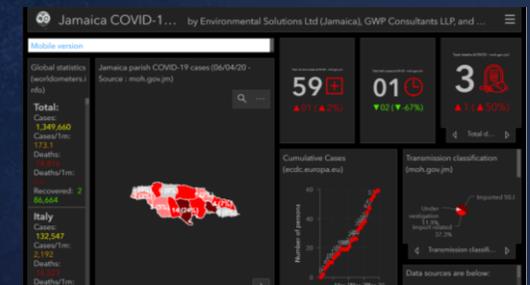
Population, Demographics & Basemaps

Organizing Content and Applications

... Providing Mapping and Analysis

... Enabling Sharing and Better Decision Making

## Jamaica



# GIS

## A Complete System for Understanding and Responding to Pandemics



*Integrating All the Data, Activities and Missions . . .  
. . . Empowering Collaborative Action*

# GIS

Provides A Framework . . .  
. . . And Process

Observing

Understanding

Responding



. . . Data Driven & Science Based

# GIS

Provides A Framework . . .  
. . . And Process

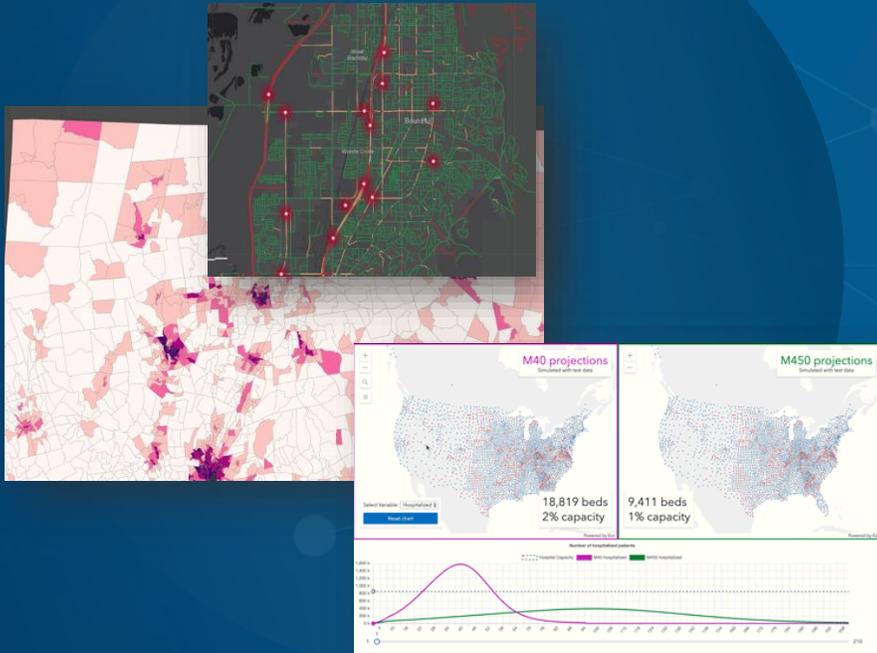
**COVID – 19**  
*Response*



*. . . Data Driven & Science Based*

# Modeling & Spatial Analysis

## Prediction



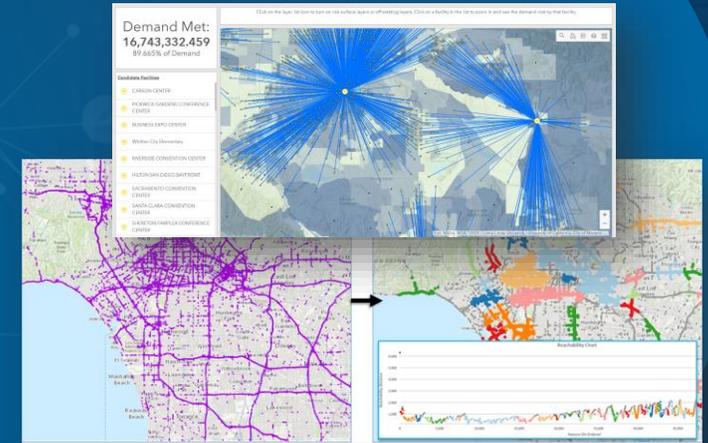
Predicting Geospatial Events/Phenomena

## Pattern Detection



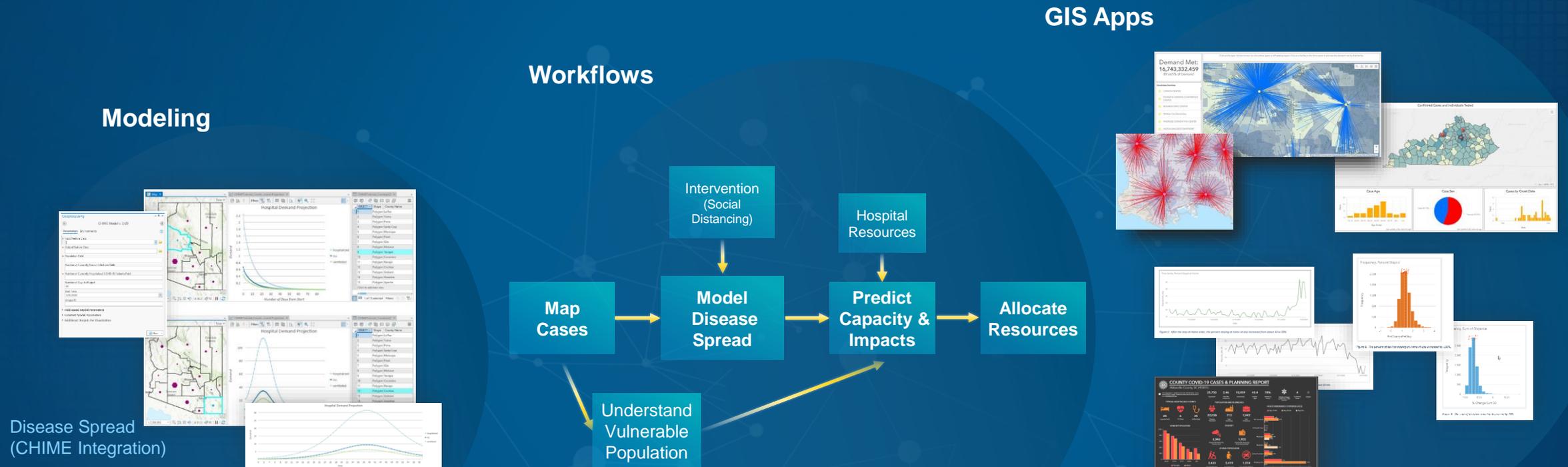
Finding Statistically Significant Clusters & Patterns

## Site Selection and Resource Allocation



Helping Understand, Predict and Make Decisions . . .  
. . . at Many Scales

# Tools and Methods for Pandemic Analysis, Modeling & Visualization



Helping Understand, Predict and Make Decisions . . .  
. . . at Many Scales

**Where do you start?**

# Understanding the Impacts of COVID-19: Five Steps

**Step 1**

Map the Cases

**Step 2**

Map the Spread

**Step 3**

Map Vulnerable  
Populations

**Step 4**

Map Your Capacity

**Step 5**

Communicate with  
Maps



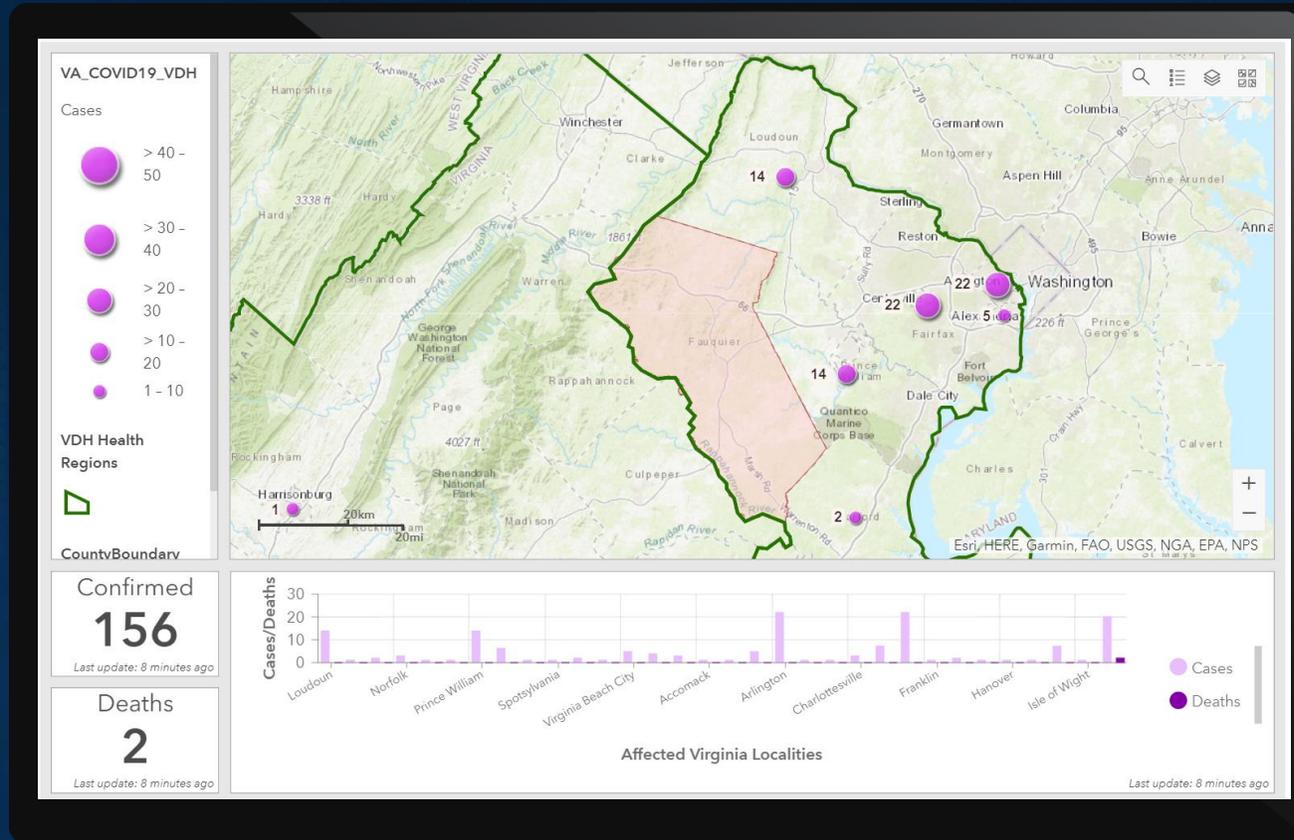
Step 1

Step 2

Step 3

Step 4

Step 5



Fauquier County, VA



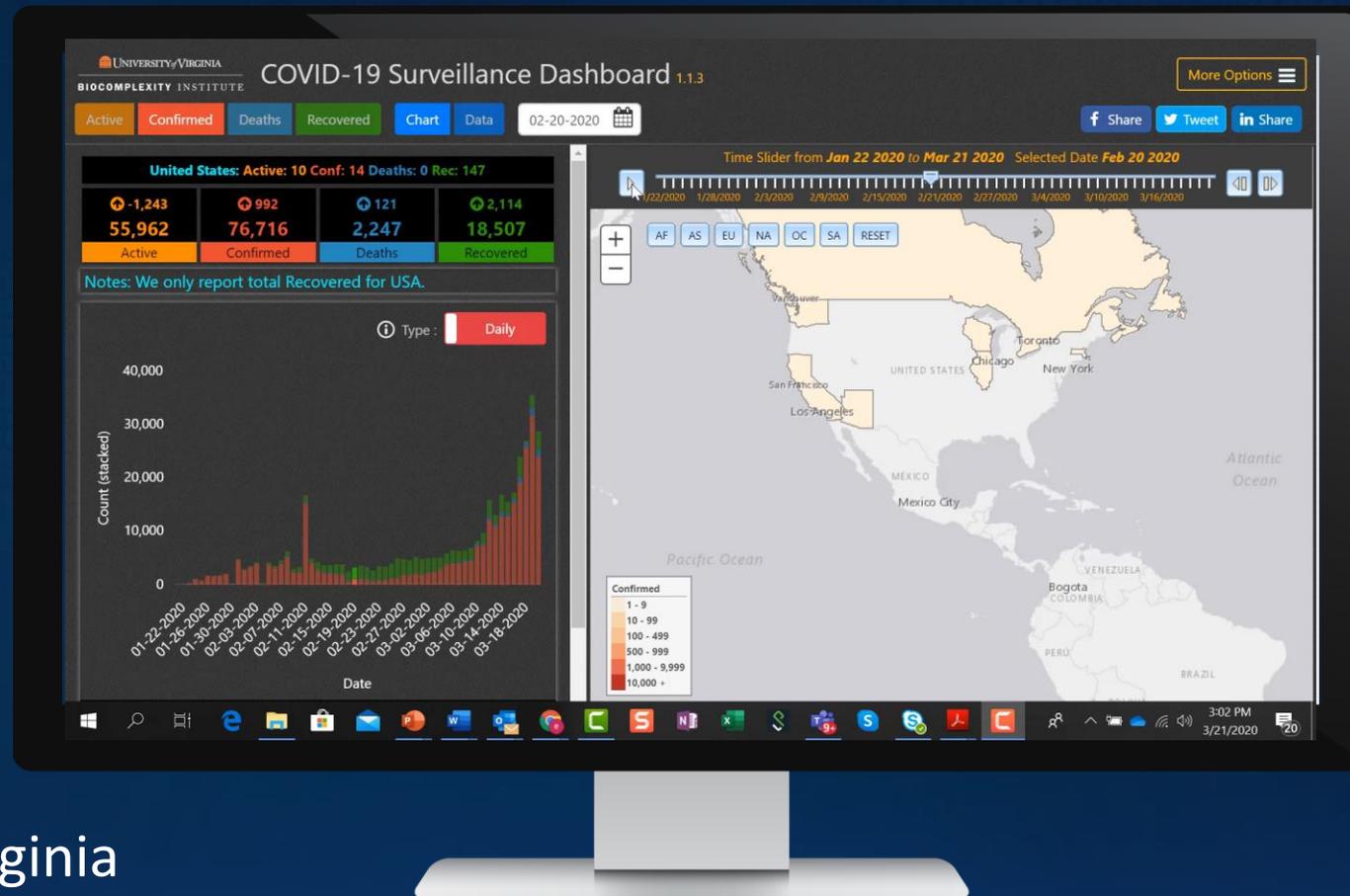
Step 1

Step 2

Step 3

Step 4

Step 5



University of Virginia  
Biocomplexity Institute



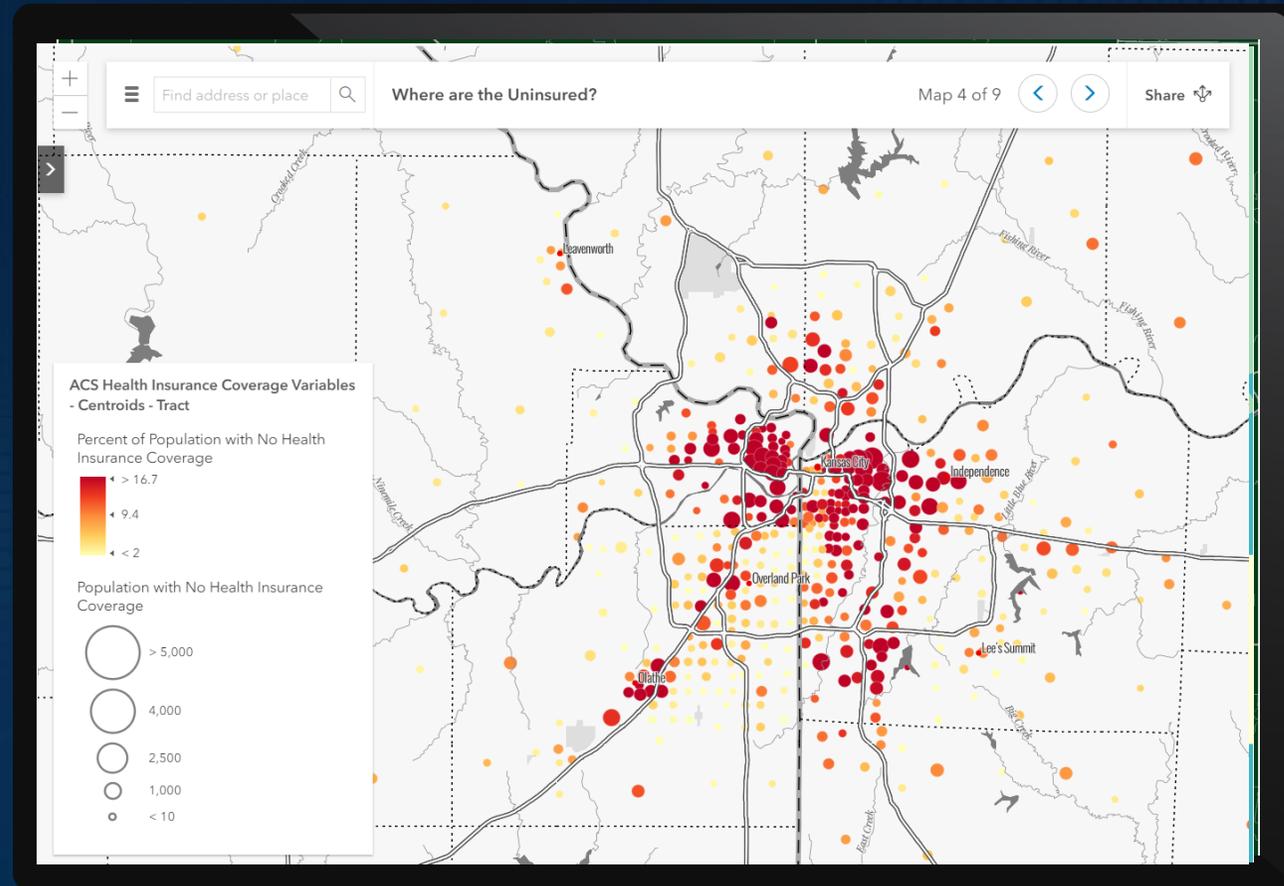
Step 1

Step 2

Step 3

Step 4

Step 5



Esri policy maps viewer

Step 1

Step 2

Step 3

Step 4

Step 5



# COVID-19 PLANNING: Morbidity and Mortality Estimates

New York City, NY

**20%  
Infection Rate**

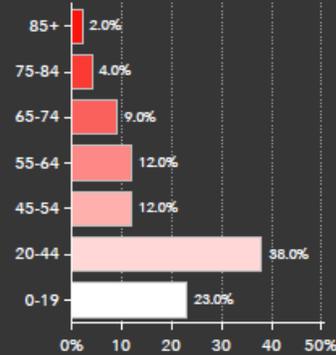


Geography: Place

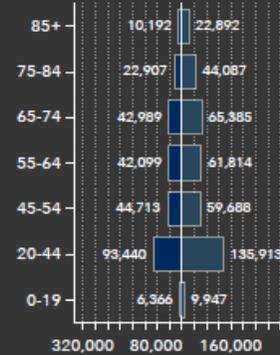
**8,627,852**   **3,266,735**   **2.59**   **37.0**   **\$62,062**   **22,435**   **1,328**   **19,032**

Population   Households   Avg Size Household   Median Age   Median Household Income   Licensed Beds   ICU Beds   Staffed Beds

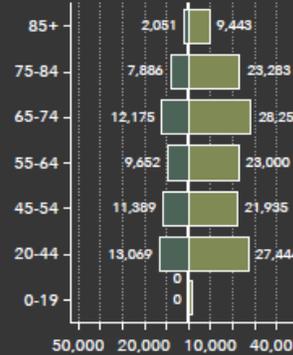
Total Population



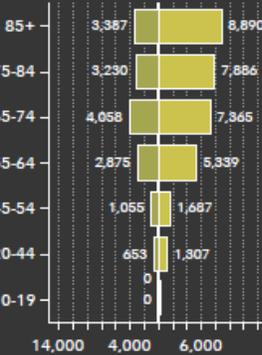
Hospitalization



ICU Admissions



Case-Fatality



## Estimated Rates: Feb 12 - Mar 16

Ages	Hospitalized		ICU Admissions		Case-Fatality	
	Low	High	Low	High	Low	High
0-19	1.6%	2.5%	0%	0%	0%	0%
20-44	14.3%	20.8%	2.0%	4.2%	0.1%	0.2%
45-54	21.2%	28.3%	5.4%	10.4%	0.5%	0.8%
55-64	20.5%	30.1%	4.7%	11.2%	1.4%	2.6%
65-74	28.6%	43.5%	8.1%	18.8%	2.7%	4.9%
75-84	30.5%	58.7%	10.5%	31.0%	4.3%	10.5%
85+	31.3%	70.3%	6.3%	29.0%	10.4%	27.3%

## Estimated Cases: Infection Rate 20%

Ages	Population	Potentially Infected	Hospitalization		ICU Admissions		Case-Fatality	
			Low	High	Low	High	Low	High
0-19	1,989,462	397,892	6,366	9,947	0	0	0	0
20-44	3,267,129	653,426	93,440	135,913	13,069	27,444	653	1,307
45-54	1,054,560	210,912	44,713	59,688	11,389	21,935	1,055	1,687
55-64	1,026,805	205,361	42,099	61,814	9,652	23,000	2,875	5,339
65-74	751,551	150,310	42,989	65,385	12,175	28,258	4,058	7,365
75-84	375,528	75,106	22,907	44,087	7,886	23,283	3,230	7,886
85+	162,816	32,563	10,192	22,892	2,051	9,443	3,387	8,890
<b>Total</b>	<b>8,627,851</b>	<b>1,725,570</b>	<b>262,707</b>	<b>399,726</b>	<b>56,222</b>	<b>133,364</b>	<b>15,258</b>	<b>32,475</b>

Totals may not exactly match due to rounding

Source: Est. forecasts for 2019, 2013-2017 American Community Survey (ACS), Hospital Beds from Definitive Healthcare - Version 1.6

Source: CDC estimates for hospitalization, intensive care unit (ICU) admission, and case-fatality percentages for reported COVID-19 cases reported Feb 12 - Mar 16, 2020, by age group. Click here for more information on the report by the CDC dated March 18, 2020

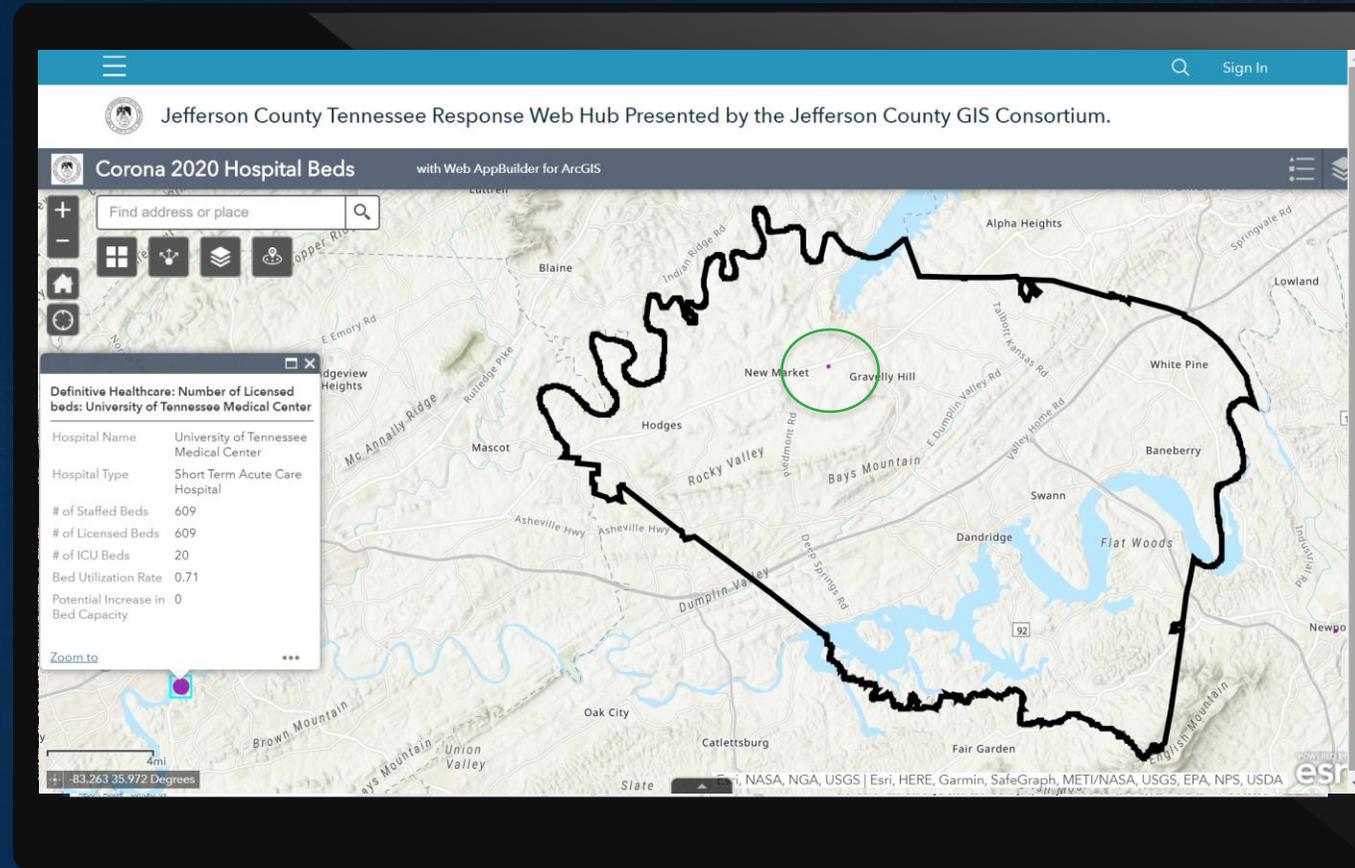
Step 1

Step 2

Step 3

Step 4

Step 5



Definitive Healthcare  
US Hospital Bed Data

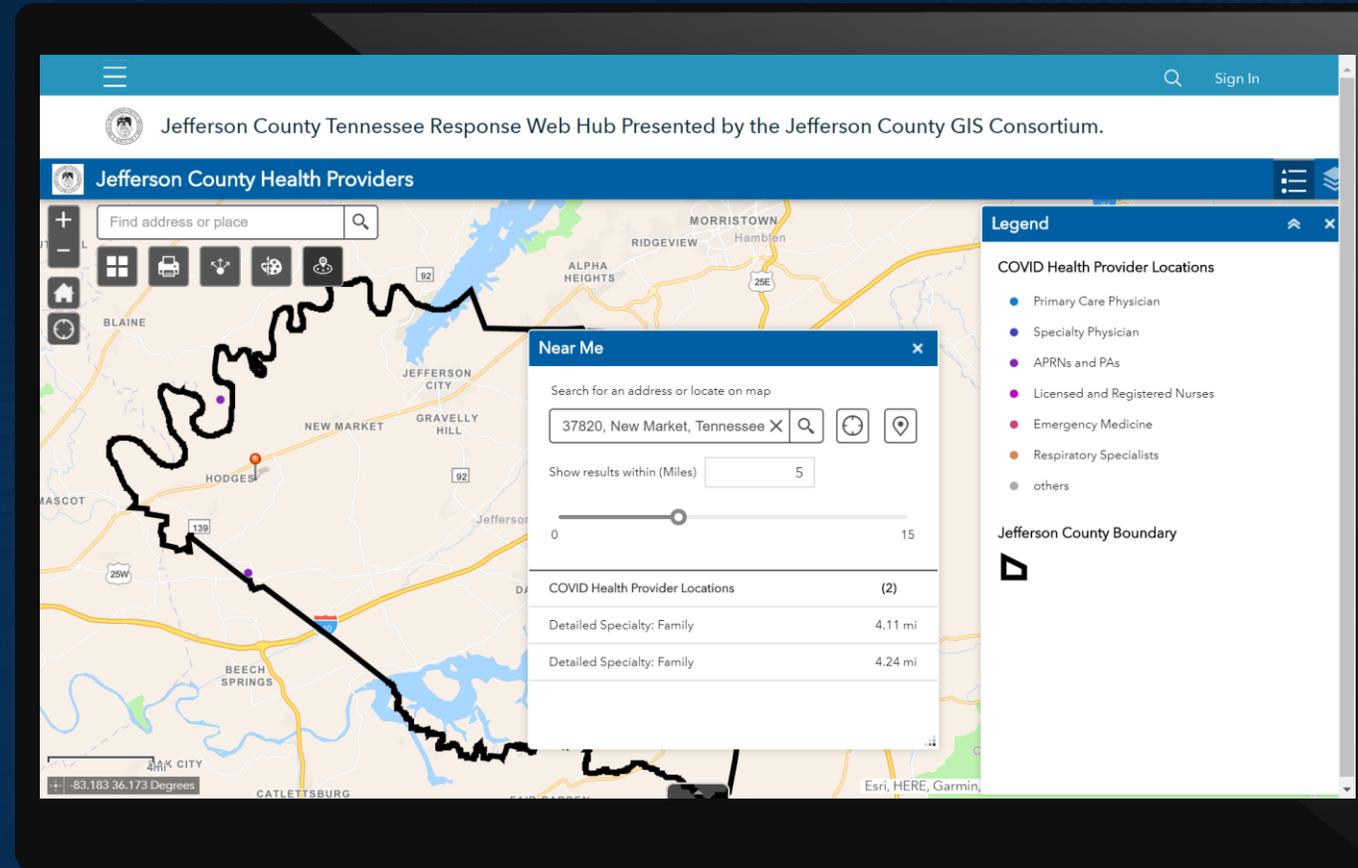
Step 1

Step 2

Step 3

Step 4

Step 5



National Provider Identifier (NPI) data



# Step 1

# Step 2

# Step 3

# Step 4

# Step 5

## Communicating Businesses Impacted to Citizens

## School Closures and Event Cancellations

**Valley County COVID-19 Business Changes**

**Total Responses: 93**

- Open Business: 38
- Closed Business: 19
- Altered Operations: 36

**Valley County Idaho**

**Total Responses: 80**

- Open Business: 34
- Closed Business: 16
- Altered Operations: 30

**AZ COVID19**

**44 Total Cases**

- Maricopa County: 22 Cases
- Pinal County: 10 Cases
- Pima County: 7 Cases
- Navajo County: 3 Cases
- Cocconino County: 1 Case

**Schools Closed: 2,308**

**Events Canceled: 398**

**Government Facility Closed: 0**

### Valley County Idaho

### State of Arizona

## Business Resilience

## County Impact Planning

**Tallahassee | Leon County Open For Takeout**

Restaurants Near Me:

- Open for Take-Out (180)
- FRESH FOOD COMPANY (0.91 mi)
- A TOZ L'OLIVE (0.71 mi)
- JIMMY JOHN'S GOURMET SANDWICHES (0.22 mi)
- BURGER KING (0.23 mi)
- MR. ROBERTO PIZZA (0.24 mi)

### Leon County Florida

### Delaware County Pennsylvania

**CORONAVIRUS (COVID-19) IMPACT PLANNING REPORT**

Boulder County, CO

Population	333,887	132,940	2.43	36.9	\$84,419	\$482,059	150	89	44
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**KEY INDICATORS: IMPACT PLANNING**

Population: 102,099 | Median Age: 31.6 | Median Household Income: \$54,218

### Boulder County Colorado

**Missouri COVID-19 Impact Planning Report Viewer**

Population: 102,099 | Median Age: 31.6 | Median Household Income: \$54,218

**KEY INDICATORS: IMPACT PLANNING**

Population: 102,099 | Median Age: 31.6 | Median Household Income: \$54,218

### Boone County Missouri



# Step 1

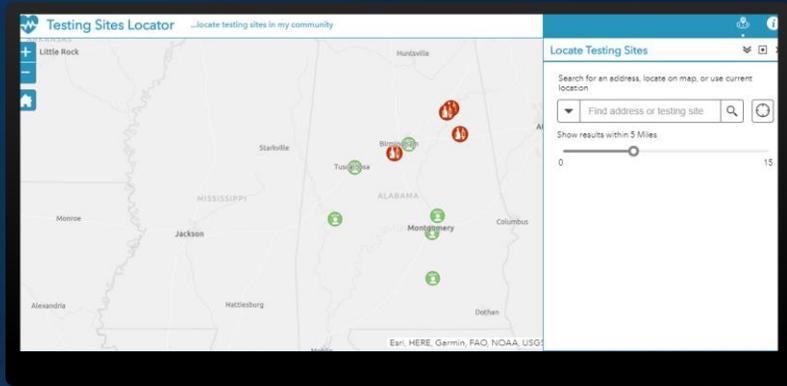
# Step 2

# Step 3

# Step 4

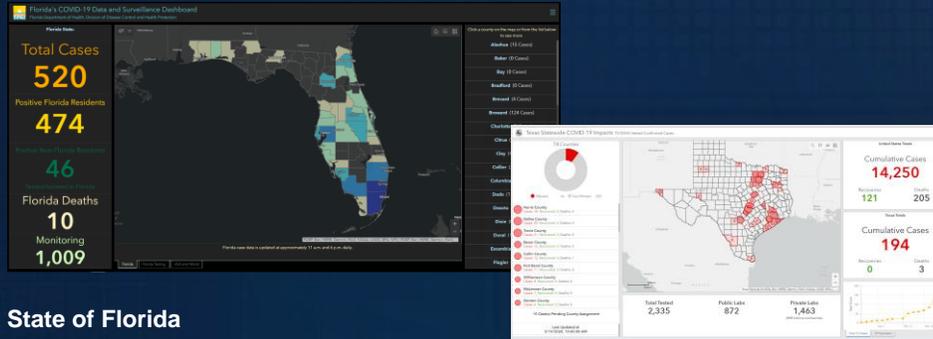
# Step 5

## Testing Site Locator



State of Alabama

## Monitoring Confirmed Cases



State of Florida

State of Texas



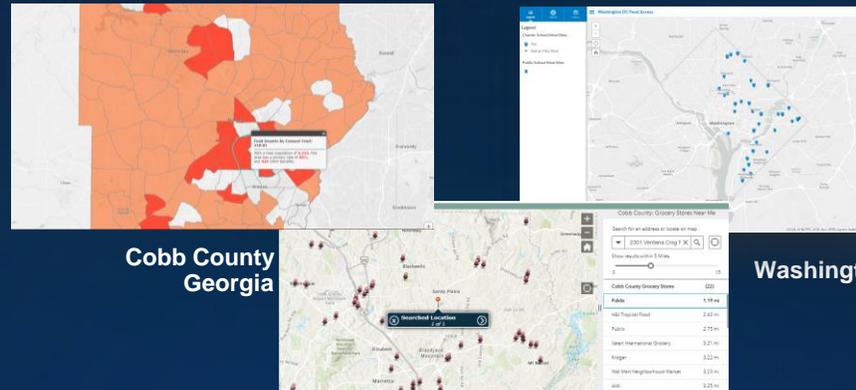
Durham County North Carolina

## Airports Impact



State of Oklahoma

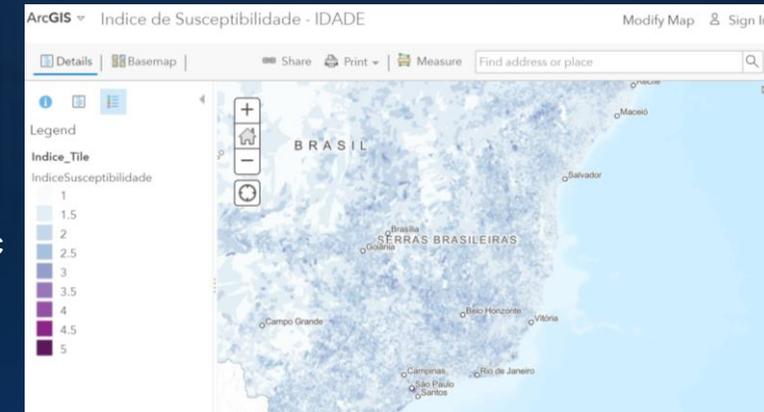
## Food Assistance Information



Cobb County Georgia

Washington DC

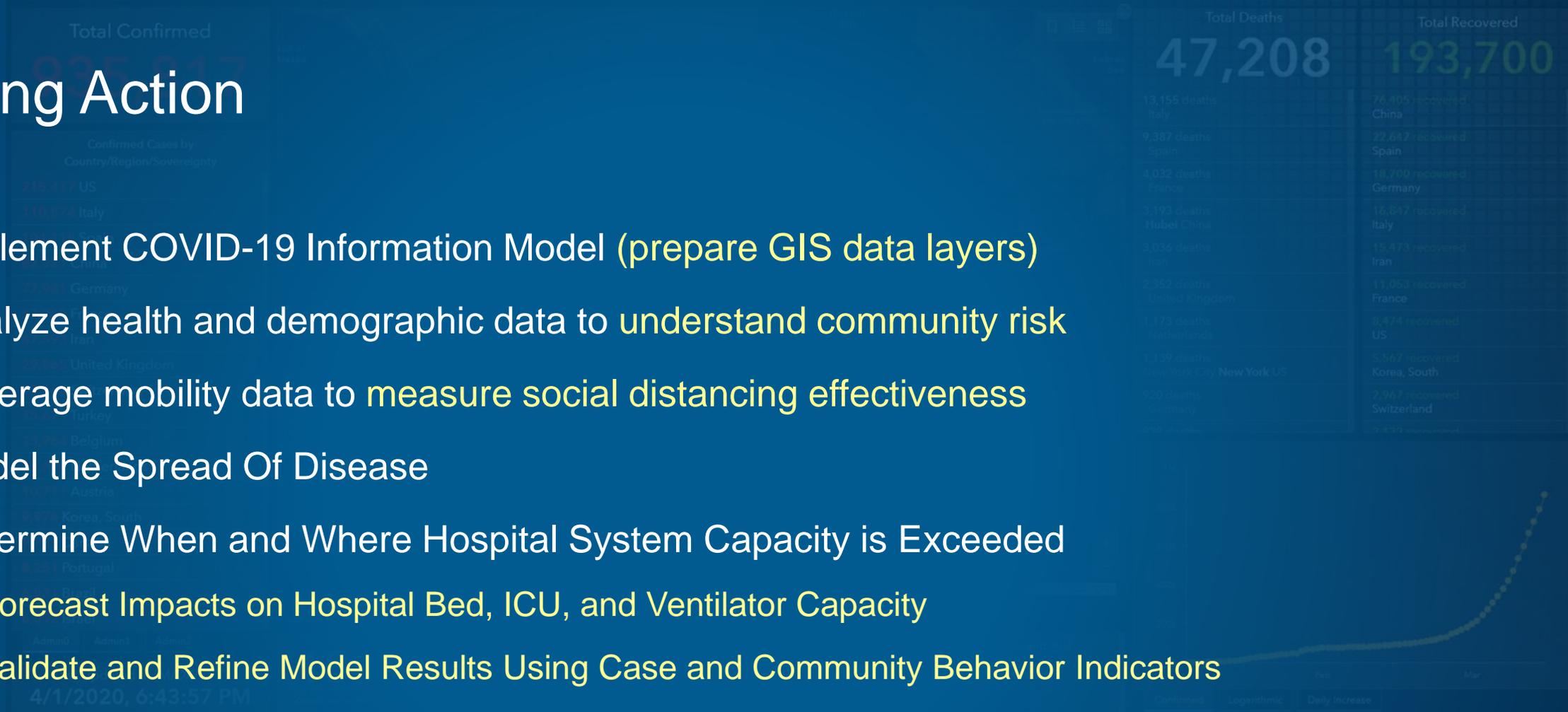
## Vulnerabilities



Brazil

# Taking Action

- Implement COVID-19 Information Model (prepare GIS data layers)
- Analyze health and demographic data to understand community risk
- Leverage mobility data to measure social distancing effectiveness
- Model the Spread Of Disease
- Determine When and Where Hospital System Capacity is Exceeded
  - Forecast Impacts on Hospital Bed, ICU, and Ventilator Capacity
  - Validate and Refine Model Results Using Case and Community Behavior Indicators
- Perform location analytics to
  - Identify optimal testing and treatment sites
  - Allocate resources (beds, equipment, personnel, ...)

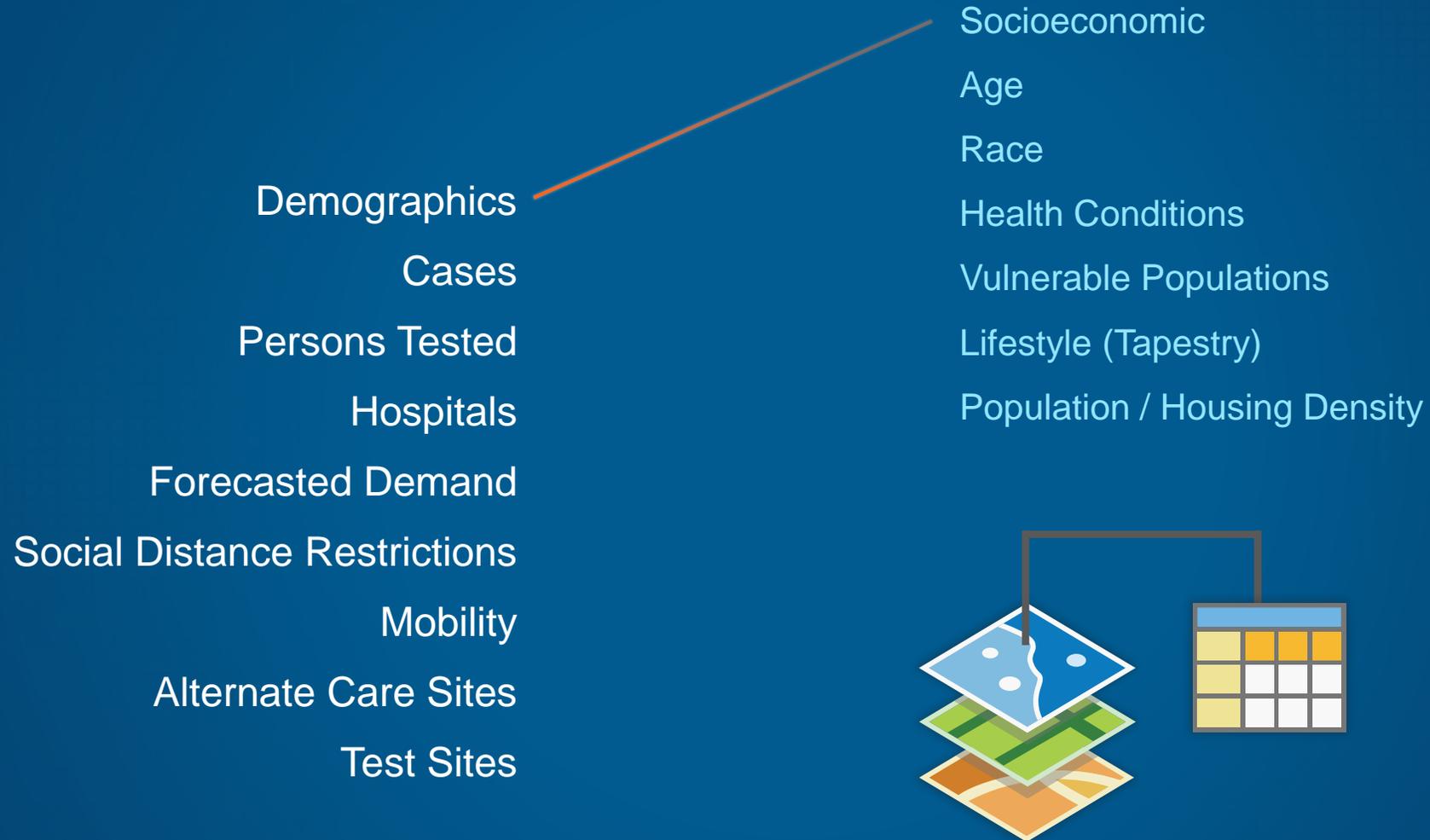


# Information Model for COVID-19 Response

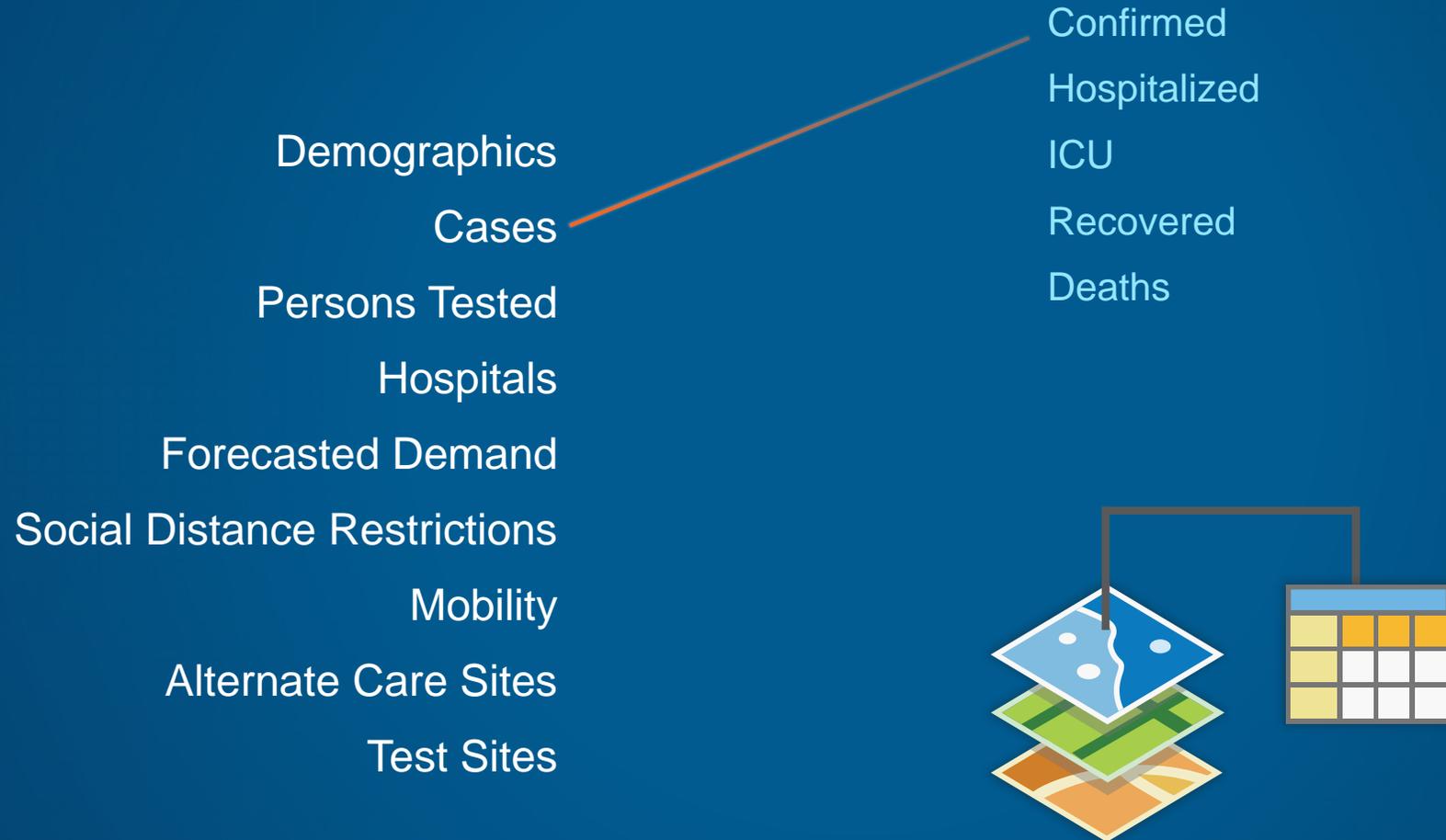
Demographics  
Cases  
Persons Tested  
Hospitals  
Forecasted Demand  
Social Distance Restrictions  
Mobility  
Alternate Care Sites  
Test Sites



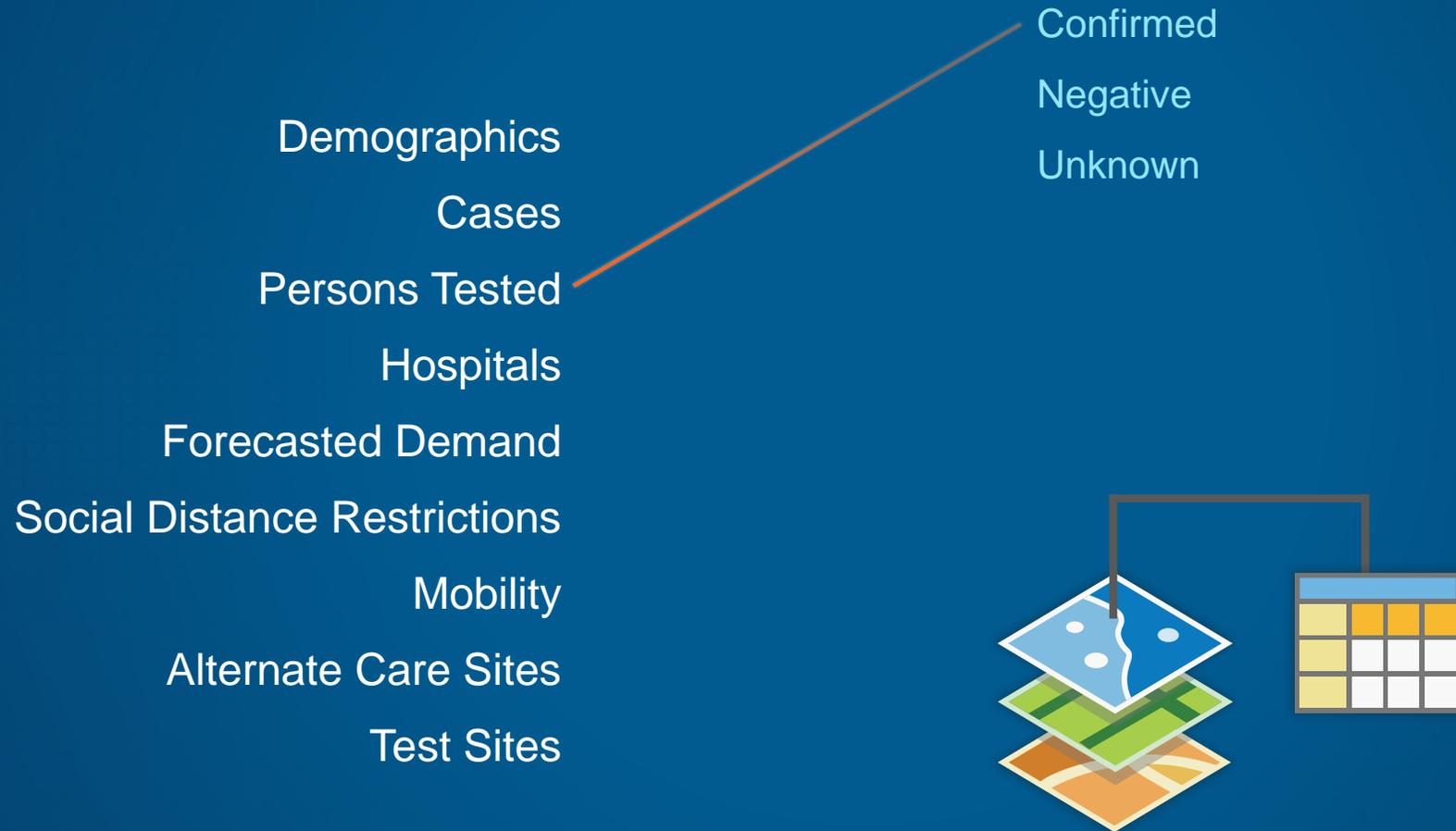
# Information Model for COVID-19 Response



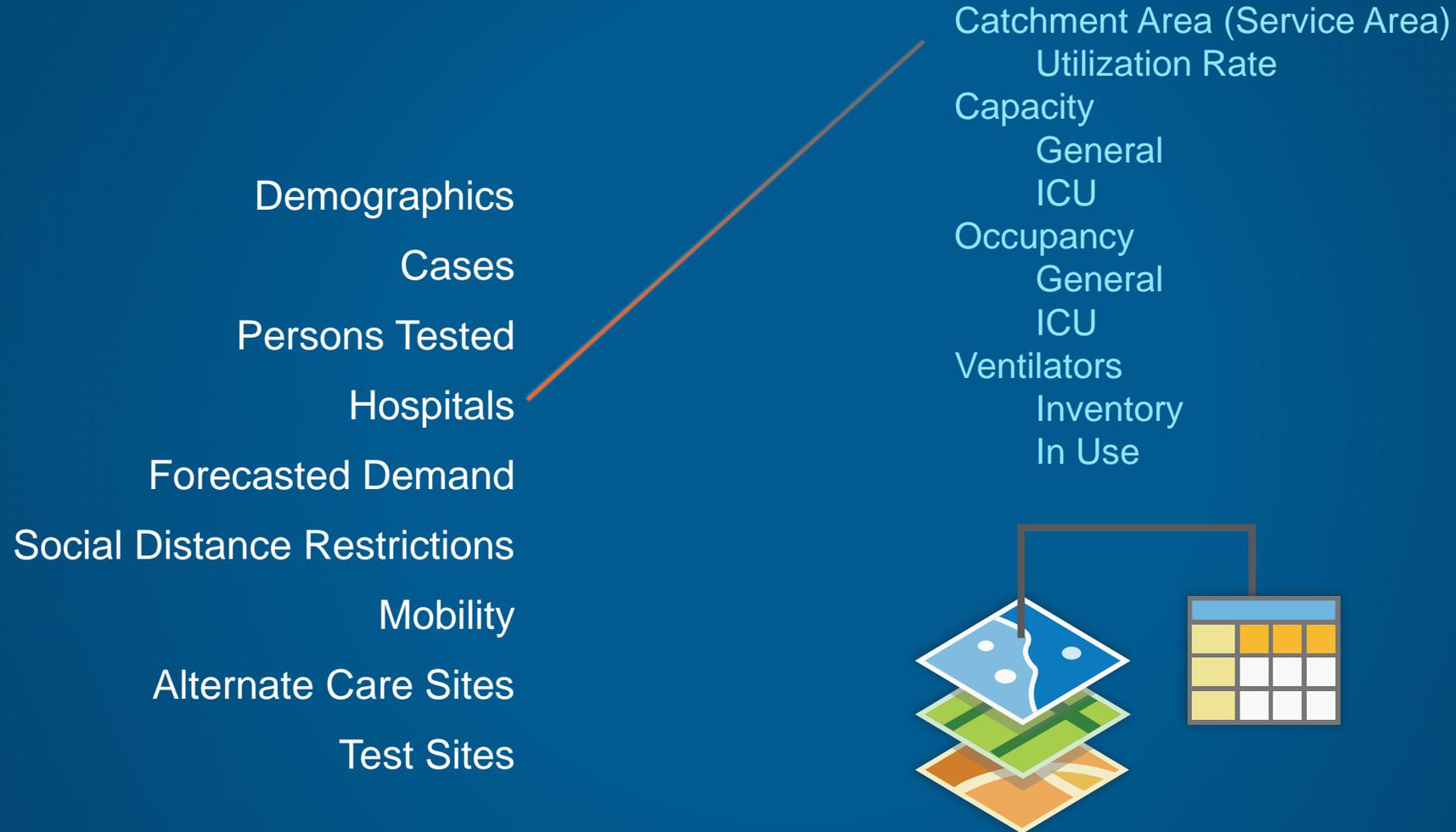
# Information Model for COVID-19 Response



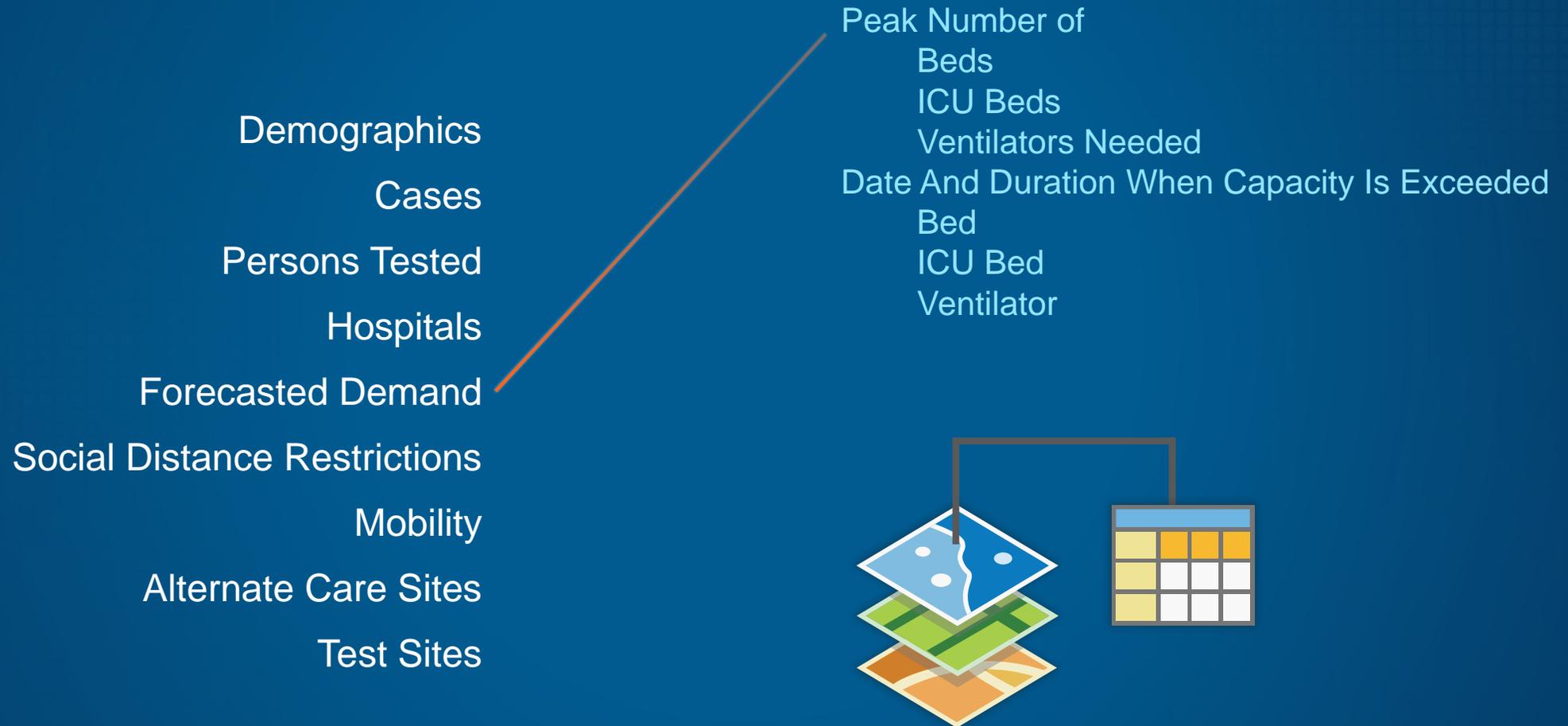
# Information Model for COVID-19 Response



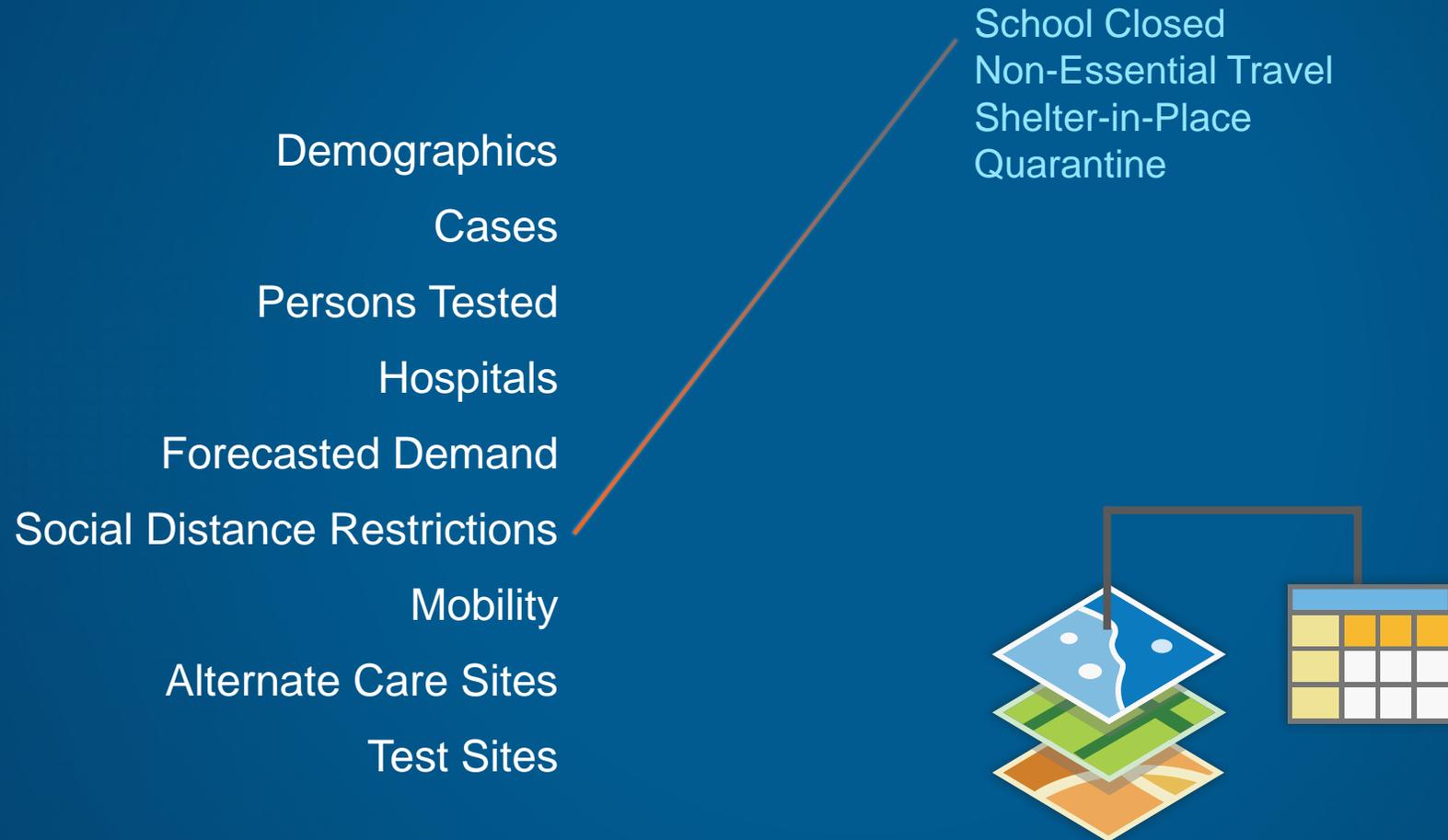
# Information Model for COVID-19 Response



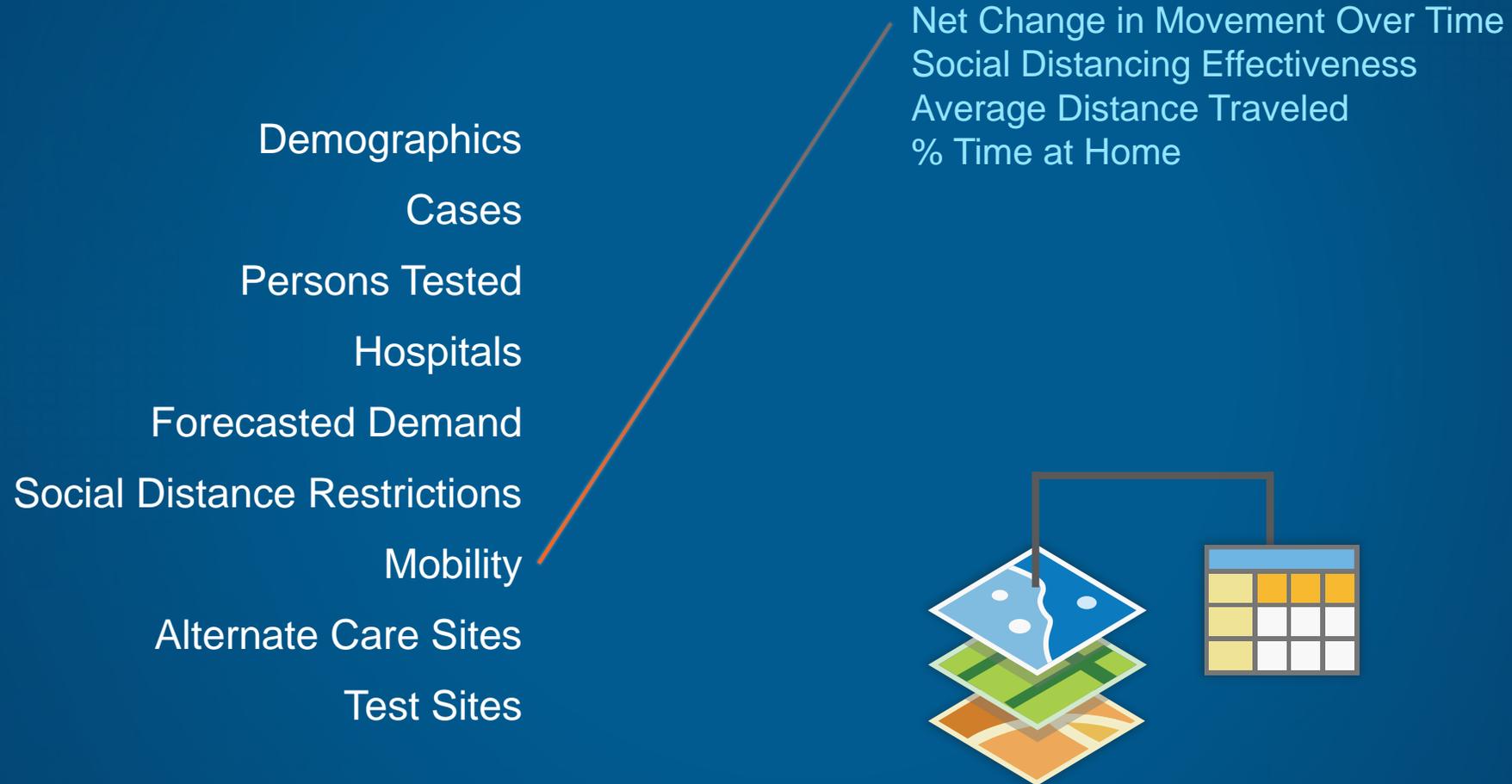
# Information Model for COVID-19 Response



# Information Model for COVID-19 Response



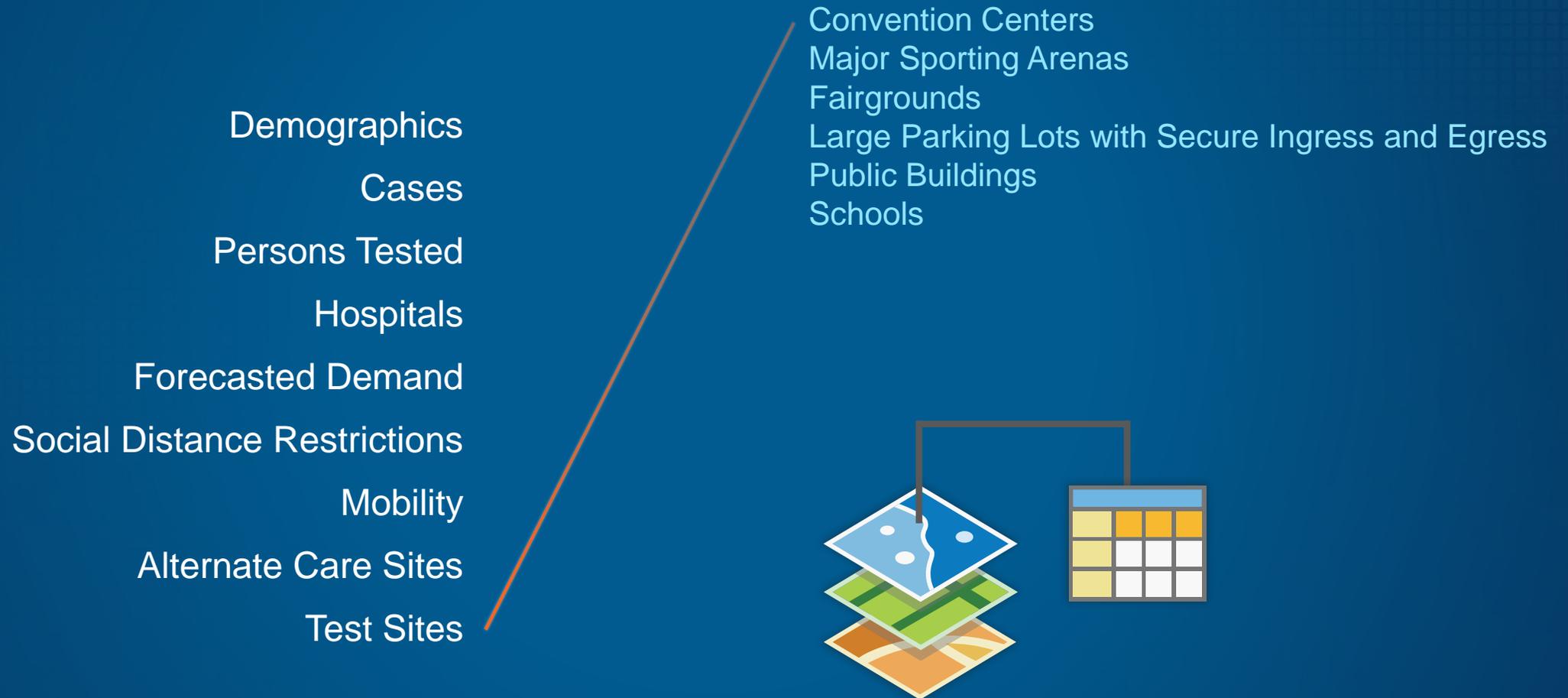
# Information Model for COVID-19 Response



# Information Model for COVID-19 Response



# Information Model for COVID-19 Response



# Site Selection



Testing Sites



Treatment Sites



Food Distribution Sites

# A Two-Step Approach

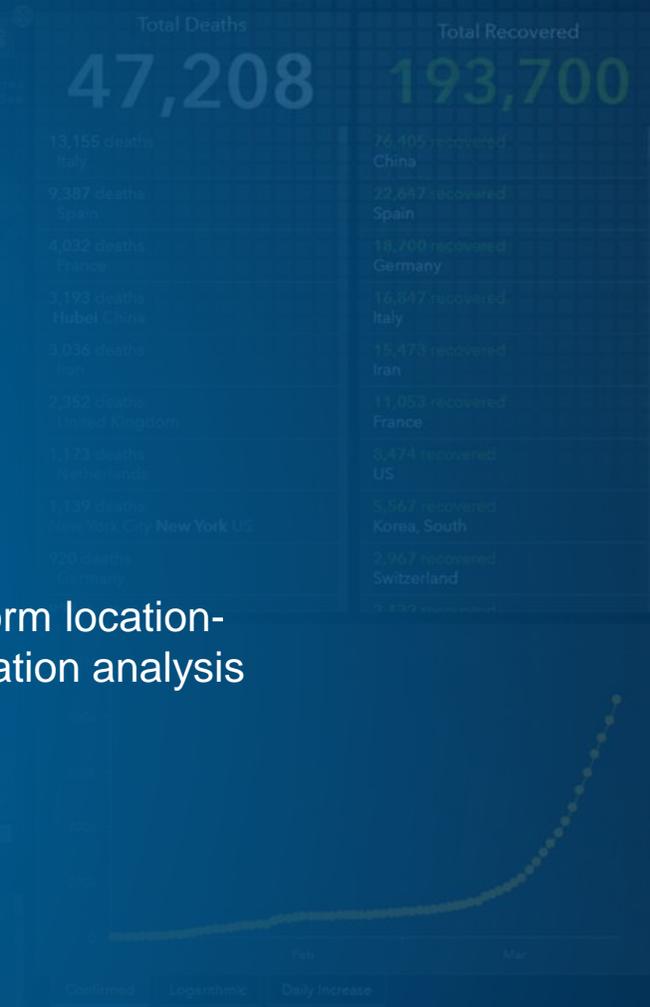
1. Calculate Population Demand

Confirmed Cases by Country/Region/Sovereignty
215,417 US
118,374 Italy
104,118 Spain
82,281 China
72,081 Germany
60,068 France
47,003 Iran
29,000 United Kingdom
19,000 Switzerland
18,000 Turkey
17,000 Russia
8,000 Korea, South
4,700 Canada
3,200 Portugal
2,000 Brazil
1,000 Israel

Last Updated at (M/D/YYYY)  
4/1/2020, 6:43:57 PM



2. Perform location-allocation analysis



# Population Demand (learn how [here](#))

## Transmission Risk



Population density



Housing density



Group living

e.g. prisons, immigrant interment camps, refugee housing



Spatial Interaction Index



People commuting on public transit

## Socioeconomic Risk



Households below poverty level



Households where English is not the primary language



Households without health insurance



Education level



High risk jobs

e.g. health care workers, flight attendants, cashiers/service workers

## Susceptibility Risk



Population density



Seniors (65+)

as a proportion of general population



Chronic/comorbid conditions

Asthma/respiratory disease prevalence as a proportion of general population

Diabetes prevalence (or projected diabetes drug purchases as proxy)

Heart disease prevalence (or projected salt restricted diet and cholesterol drug purchases as proxy)



Immunocompromising conditions e.g. cancer, HIV

## Exposure Risk



Relative case distance field

(Relative Case Distance Index field is the summed distance from each constituency centroid to the closest 10% of all COVID-19 case)



Latest case rate (by age group)

published by an authoritative epidemiological agency

## Insufficient Resource Risk



Healthcare resource index



Staffed beds per 1000 people



Bed space availability per 1000 people



ICU beds per 1000 people



ICU bed space availability per 1000 people



Ventilators per 1000 people



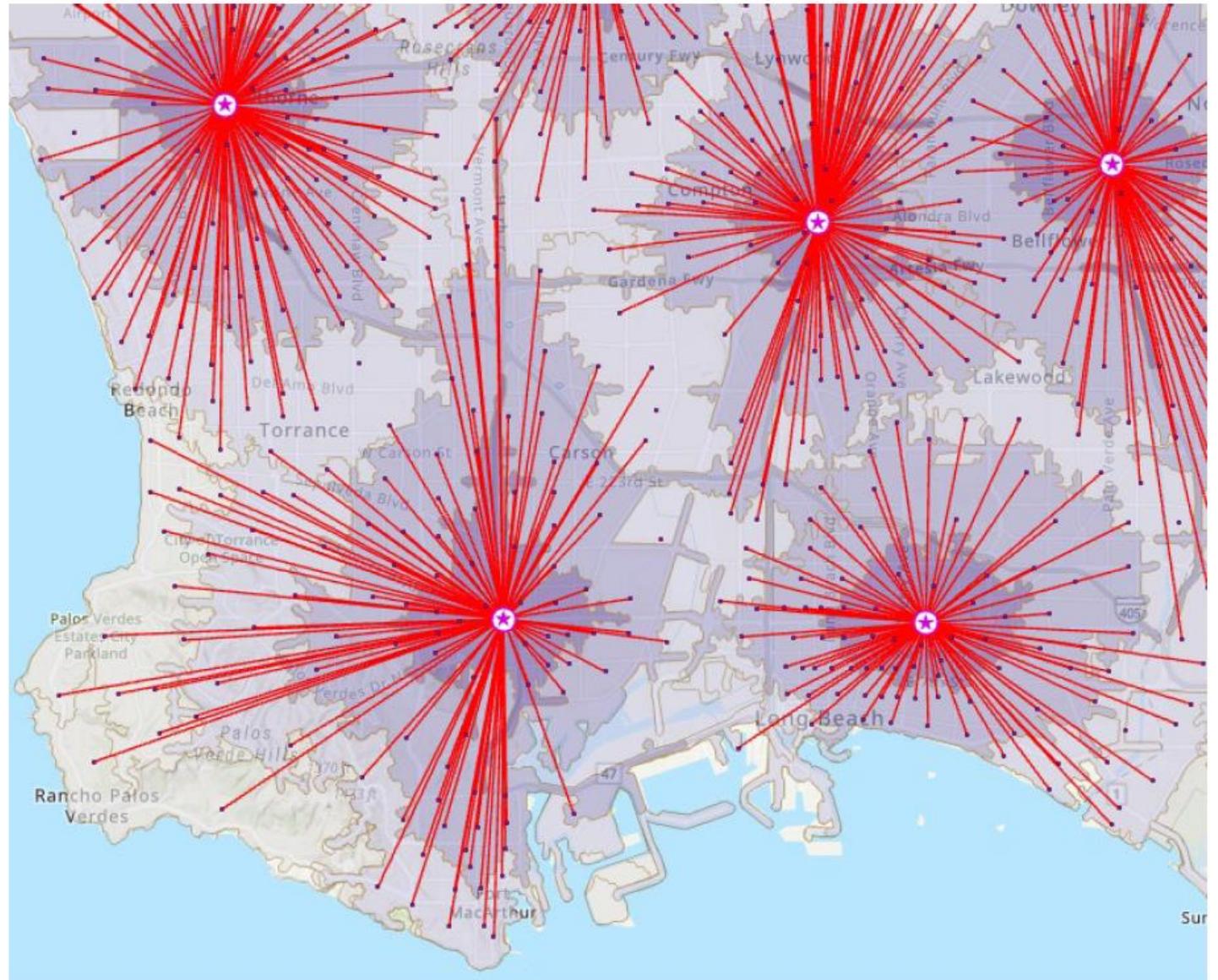
Medical staff per 1000 people



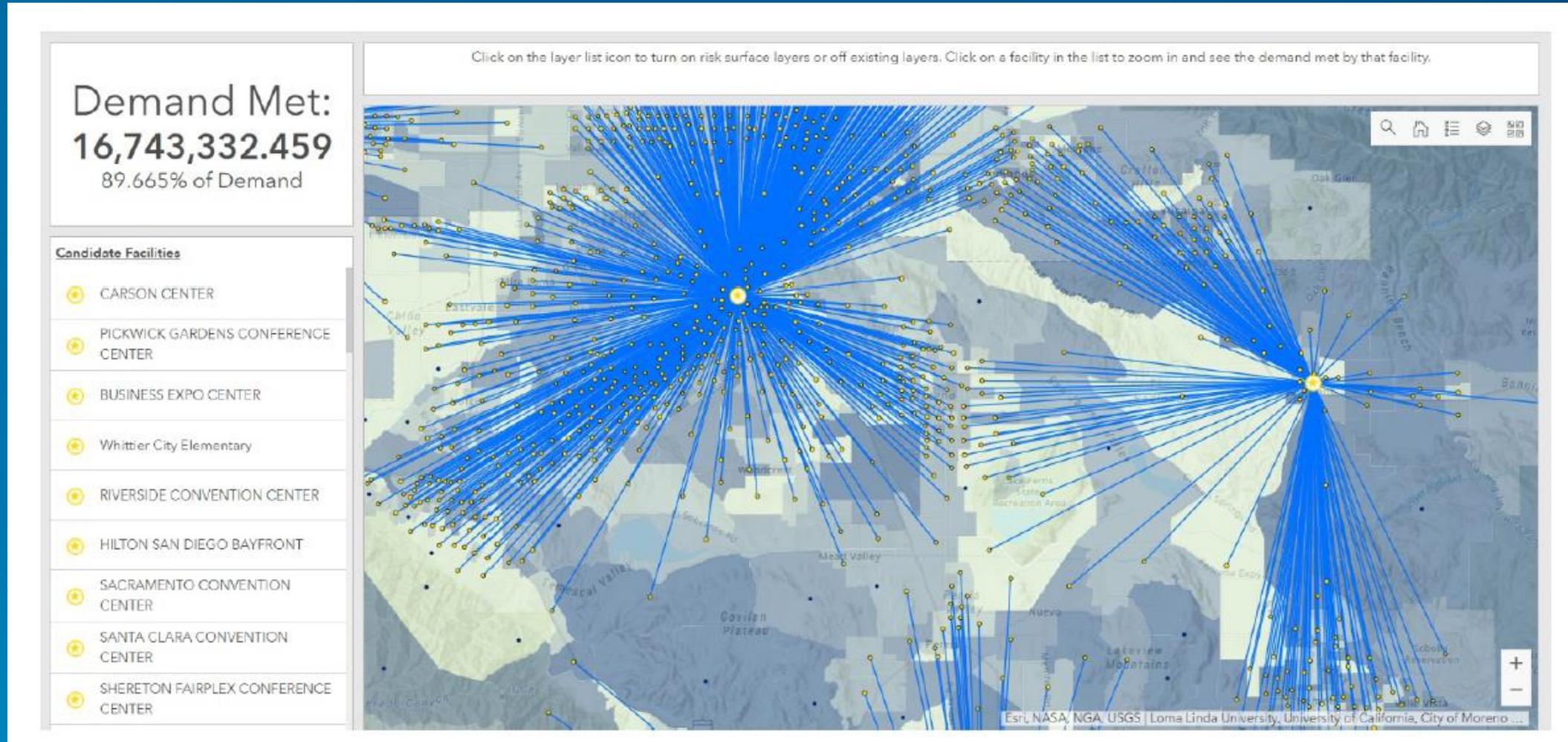
Surgical masks/gloves/gowns/face shields/eye gear per 1000 people

# Location-Allocation

(learn how [here](#))



# Evaluate your outcomes



# Realizing a GIS for Pandemic Response

Requires More Than Technology

- A Strong Champion
  - Understanding The Mission
  - Leadership Involvement
- Clear Strategy
  - Understanding of Benefits
  - Cost, IT, Vision, Risk Management
  - Realistic Timelines
- Ongoing Governance
- Good People - GIS Professionals



... and a Culture of Collaboration and Continuous Innovation





April 7th Webinar: [What's Working in the COVID-19 Response Using GIS?](#)

# COVID-19 GIS Hub

Get maps, datasets, applications, and more for coronavirus disease 2019 (COVID-19).

Check back often—these resources will be updated with new information as it becomes available.

[Request GIS assistance](#)

<https://coronavirus-resources.esri.com>



esri

THE  
SCIENCE  
OF  
WHERE

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