Colorado Local Public Health Agency Contact Tracing Workforce and Technical Capacity: Final Report
(June 10th, 2020)

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Summary and Key Findings *(Findings reflect data collected through 05/13/2020)*

- Based on the information collected from 45 of Colorado's 53 local public health agencies (LPHA), there are approximately 128 FTEs currently conducting COVID-19 case investigation and contact tracing in Colorado, not including those working for the Colorado Department of Public Health and Environment. The distribution of these FTEs by rurality is:
  - o Urban counties: 53% (74.5 workers)
  - o Rural counties: 33% (37 workers)
  - o Frontier counties: 14% (16 workers)
- Based on experience in different jurisdictions and expert projections of contact tracing workforce needs and considering Colorado's population size, the current gap in the contact tracing workforce in CO is between 557 to 4,894 in comparison with projections from these external sources. While there is a wide range of estimates of need and an unrealistic upper bound, there is a clear indication of a substantial unmet need for CO.
  Note: Contact tracing workforce includes unit supervisors, case investigators, contact tracers and resource coordinators.

Contact Tracing Workforce Gap in Colorado Based on Experience in Other Locations

Location	Contact Tracers/100,000 population	Projected Number of Contact Tracers Needed in CO	Gap in Contact Tracing Workforce in CO
New York City	11.9	685	557
Massachusetts	14.5	835	707
San Francisco	17	979	851
Metro Denver	19	1,094	966
California	50.6	2,914	2,786
NACCHO	30	1,728	1,600
New York State	32.8-87.2	1,889-5,022	1,761-4,894

Note: Current contact tracing workforce obtained from the "CO Local Public Health Agency Contact Tracing Workforce and Technical Capacity Survey". 45 out of 53 LPHAs responded for a response rate of 85%. These 45 LPHAs reported a total of 128 FTE contact tracers.

- 96% of LPHAs indicated a need for additional funding to support their local contact tracing efforts.
- Some LPHAs have identified additional workers who can be trained and become contact tracers. These workers include a mix of LPHA and other government workers who can be temporarily redeployed, as well as other types of community workers and volunteers.

Worker Type	Number of Workers Potentially Available *(total)*
Other Government Workers	161
Volunteers	128
LPHA Staff	91.5
Temporary Paid Workers	48
Community Health Workers	26
Other	0
TOTAL	454.5

Note: "Other" category included nursing students, retired healthcare workers, and CSPH volunteers.

- We identified 4 key positions for the contact tracing team "unit": unit supervisor, contact tracer/case investigator, COVID navigator and data analyst/programmer. Of these positions, contact tracer/case investigators are the most needed. COVID navigators are the second most needed positions, with unit supervisors and data analyst/programmer being third and fourth respectively.
- Currently, 64% of LPHAs indicated they're following a COVID-19 contact tracing protocol, while the other LPHAs are either not currently conducting COVID-19 contact tracing (1 LPHA) or are not using a COVID-19 specific protocol (15 LPHAs).
- LPHAs are using a variety of electronic platforms and software to collect and store data from contact tracing interviews.
    - Excel spreadsheet: 21 LPHAs
    - Google applications: 9 LPHAs
    - CO Electronic Disease Reporting System (CEDRS): 4 LPHAs
    - LabOnline, Trello or ESRI: 3 LPHAs
    - Paper/None: 8 LPHAs

Findings reported here reflect data collected through 05/13/2020 for most LPHAs. Two LPHAs completed the survey on 05/27/2020 and 05/29/2020, respectively. It is possible that the number of contact tracing FTEs has changed since data was collected.

Initial Recommendations

- Based on current guidance and experience elsewhere, the state (including CDPHE and the LPHAs) will need additional contact tracers (and case investigators) with the range projected to be between 1,000 and 1,600 personnel.
- This initial estimate is based on the Metro Denver Partnership for Health contact tracing workforce needs estimate and that of the National Association of County and City Health Officials (NACCHO), both likely to be directly relevant to the context in Colorado.
- These estimates for contact tracing workforce needs provide initial guidance but will need to be adjusted as the pandemic evolves, the workforce grows, and CO experience is gained.
- To the extent possible, data should drive contact tracing workforce allocation decisions.
  In alignment with recommendations by various groups, some of the most critical factors to consider are:
    - Daily rate of COVID-19 cases at the county-level (or past 7-day rate)
    - Daily rate of COVID-19 testing for the county (or past 7-day rate)
    - Number of contacts per case
    - Contact tracer productivity (average number of contacts handled per contact tracer)
    - County-level contact tracing workforce (total FTE)
    - Number of newly trained contact tracing workers
    - County-level demographics and socio-economic factors
    - Aggregated, county-level human mobility data as an indicator of future burden
- The eight-hour daily case load at the county level will need to be continually monitored so that adjustments can be made to the methodology and information used for allocating contact tracers. Factors that can affect the daily case load include the following.

- o Average number of contacts per case: there can be variation across counties in the average number of contacts per case due to changes in human mobility as social distancing measures relax.
  - o Average number of cases that a contact tracer can complete in an 8-hour day: the time a contact tracer spends with a given person is likely to vary based on the person's social and economic needs; these factors vary by county.
- To the extent possible, there should be one COVID-19 contact tracing protocol developed for all LPHAs to follow (e.g., all LPHAs use the same COVID-19 case investigation and tracing questionnaire; uniform data entry practices; and decision on whether to test all contacts of index case).
- To the extent possible, the data bases used to manage the contact tracing data should be harmonized/uniform so that data can be integrated across counties and with CDPHE. This is a potentially costly and time-consuming undertaking that would require additional funding. There needs to be discussion and planning for the possibility of enhancing data bases
- Regularly collect data to carefully track workforce needs, for example by administering short surveys or other modalities (e.g., monthly for months 1-6, bi-monthly for months 7-12, and quarterly thereafter). Data to be collected includes:
  - o Contact tracer workforce productivity (investigators, tracers and resource coordinators)
  - o 8-hour daily case load (investigators, tracers and resource coordinators)
  - o Number of contacts per case
  - o Positivity rate among contacts of index case
  - o Proportion of detected cases traced
  - o Time between case identification and case isolation
  - o Proportion of contacts quarantined
  - o Experience during contact tracing calls (qualitative)
  - o Other human resource indicators of the contact tracing workforce

Future Steps for Continued Tracking of Contact Tracing Capacity

- Create county-level profiles that highlight key characteristics of LPHA contact tracing workforce and technical capacity for that county, as well as other county-level factors that are likely to be critical in workforce allocation decisions.
- Continue to refine recommendations for workforce allocation.
- Follow up with the LPHAs (8) that haven't completed the survey to collect their data.
- Monitor state's progress in helping LPHAs meet their contact tracing workforce and technical capacity gaps overtime (e.g., through surveys administered at set intervals).

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Introduction: Local Public Health Agency Contact Tracing Workforce and Technical Capacity in Colorado

Case identification and contact tracing are critical components in a comprehensive approach to contain and eventually suppress of COVID-19, especially after the State of Colorado (CO) transitioned from Level 1 (Stay at Home) to Level 2 (Safer at Home) on April 27th, 2020 and continues with additional measures to re-open Colorado.

Contact tracing needs to be incorporated into a broad program for epidemic control. Other key components in a comprehensive containment and suppression approach include: increasing the skilled epidemiology workforce, COVID-19 surge investigation support, training support, technical assistance, uniform surveillance data systems, data analytics, testing supplies, test processing and other public health infrastructure components.

During the Safer at Home phase everyone is still encouraged to stay at home as much as possible, to wear face coverings/masks in public, to continue to practice good hygiene (wash hands frequently and avoid touching the face), while critical businesses are allowed to open and non-critical business begin to operate with restrictions. During the Safer at Home phase, Coloradans should be prepared for state and local public health orders to be extended, amended, or changed as needed to protect public health as the epidemic evolves. Because of the changing course of the epidemic, counties and the state may implement measures that move between the different levels depending on the success of the control measures in place.

Controlling COVID-19 during the next phase of the epidemic in the state and counties across CO will require local public health agencies (LPHA) and the state to carry out the contact tracing strategy below along with other measures:
- Identify nearly all cases of COVID-19;
- Encourage voluntary isolation of infected individuals at home or in other dedicated isolation facilities;
- Alert and trace the contacts of each case;
- Encourage voluntary quarantine of exposed contacts in their homes (or other dedicated facilities) for 14 days after their last exposure to the case

To meet these objectives for contact tracing, sufficient capacity will be needed at the state and local levels. Consequently, the Colorado School of Public Health (CSPH) collaborated with the CO Association of Local Public Health Officials (CALPHO), the CO Department of Public Health & Environment (CDPHE) and members of the Colorado Community Tracing Collaborative to develop and administer the "CO Local Public Health Agency Contact Tracing Workforce and Technical Capacity Survey". It was developed to assess the current capacity of CO LPHAs specific to COVID-19 contact tracing activities and to facilitate a data-informed approach to workforce planning and allocation as the pandemic evolves. The data collected may also provide valuable input for the CSPH COVID-19 Modeling Group as it incorporates case identification, isolation and contact tracing into disease models.

The survey was launched on April 29th, 2020 and while LPHAs can still complete the survey, this report is based on data collected through May 31st, 2020. Once the final version of the survey was approved by all collaborators, we created an online form to be completed by LPHAs by accessing a link which was e-mailed to the public health director distribution list maintained by CALPHO. As of May 11th, we had received completed surveys from 30 LPHAs. We followed up directly with the LPHAs that had not yet completed the survey and another 15 LPHAs completed the survey by 05/13/2020. Two LPHAs completed the survey

on 05/27/2020 and 05/29/2020 respectively. It is possible that contact tracing workforce capacity has changed since the data were collected.

The report is divided in four sections. Section I presents the findings from the survey grouped by the five key areas listed below:

a) Current COVID-19 contact tracing staffing levels
   i. Active COVID-19 contact tracing workforce
   ii. LPHA redeployment of existing workers and volunteer recruitment for contact tracing
   iii. LPHA's ability to fund additional contact tracers
   iv. Continuation of contact tracing for other diseases
b) Current COVID-19 contact tracing processes
   i. Contact tracing effort prioritization (e.g., long-term care facilities and healthcare workers)
   ii. Protocols followed for contact tracing (e.g., number of times contact tracer follows up with a case and interview questionnaire)
c) COVID-19 contact tracing workforce needs (e.g., case investigator and contact tracer)
d) COVID-19 contact tracing resource needs (training, funding and other technical assistance)
e) Technological capacity for contact tracing (e.g., platforms/software used to collect information and electronic symptom tracking platforms)

Section II includes a discussion of key findings from the survey in the context of other estimates for contact tracing workforce needs. Section III includes initial recommendations for contact tracing workforce allocation, which integrate factors that may influence estimates of workforce needs, such as the number of COVID-19 cases, testing, population demographics and frequency of comorbidities. Finally, Section IV includes a brief presentation of future steps for the Colorado Community Tracing Collaborative such as the creation of county-level profiles that combine the survey data on contact tracing workforce and other county-level data.

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Section I. Survey Findings

A) Description of Survey Responders

The findings are based on completed surveys by 45 LPHAs (out of 53 total LPHAs in CO), for a response rate of 85%. The jurisdictions of these LPHAs cover 54 counties and a total population of 4,728,168 (Table 1). Based on the 2019 Census estimate of total CO population of 5,758,736; the sample represents approximately 82% of the CO population. The largest counties not currently represented in the sample are Jefferson and Weld, which together include 893,739 residents.

Table 1. Description of the Sample

Number of LPHAs Represented	Number of Counties Represented	Urban – Rural – Frontier County Designation	Total Population
45	54	**14 Urban counties**: 26%	4,083,390
		20 Rural counties: 37%	517,838
		20 Frontier counties: 37%	126,940

Note: Urban/Rural/Frontier designation was based on Colorado Rural Health Center information (http://coruralhealth.wpengine.netdna-cdn.com/wp-content/uploads/2013/10/2018-map.pdf).

B) Current COVID-19 contact tracing staffing levels

i. Active COVID-19 contact tracing workforce

Only three (7%) LPHAs indicated that they're not currently conducting COVID-19 contact tracing. Of the LPHAs conducing contact tracing, the range of full-time equivalents (FTE) dedicated to COVID-19 is 0.1 to 20 FTEs, with an average of approximately 2.2 FTEs. Overall, in CO there are 138.5 FTEs dedicated to COVID-19 contact tracing. Figure 1 presents a color-coded map based on the number of FTEs (i.e., darkest green represents the county with the largest number of FTEs and lightest yellow the county with the lowest number of FTEs).

Figure 2 displays the county distribution of COVID-19 cases over the past seven days from 05/16/2020 to 05/22/2020, while Figure 3 displays the county distribution of COVID-19 testing rate per 100,000 population.

As part of the analysis, we ran simple bivariate regressions to understand if and how the supply of contact tracers relates to county-level characteristics such as population size, COVID-19 case rate and count, COVID-19 mortality rate, and COVID-19 testing rate. For the most part, bivariate analyses did not show a significant correlation between the number of contact tracers and county characteristics.

Figure 1. Number of Contact Tracing FTEs by County

Note: For LPHAs that cover multiple counties, we divided the total FTE entered in the survey by the number of counties under the jurisdiction of the LPHA to avoid double counting.

Counties that do not show FTE information (gray) are missing data because their corresponding LPHA has not completed the survey (Conejos, Crowley, Gilpin, Hinsdale, Jackson, Jefferson, Mineral, Otero, Summit, and Weld).

Darker green represents counties with the largest number of FTEs and lighter yellow counties with the lowest number of FTEs.
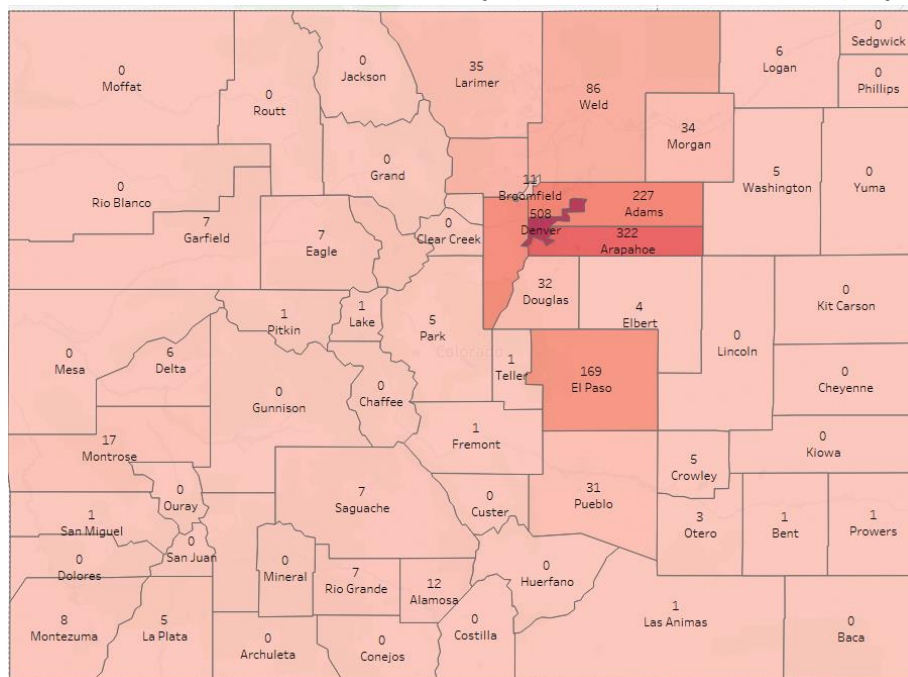
Figure 2. Number of COVID-19 Cases in the Past 7 Days (05/16/2020 to 05/22/2020); **by County**

Note: COVID-19 case data updated as of 05/22/2020. Darker red represents counties with the highest number of COVID-19 cases in the past 7 days (05/16 to 05/22/2020) and lighter red are counties with the lowest number of COVID-19 cases in the past 7 days (05/16 to 05/22/2020). Boulder county had 63 COVID-19 cases over past 7 days.

Figure 3. COVID-19 Testing Rate per 100,000 population; by County
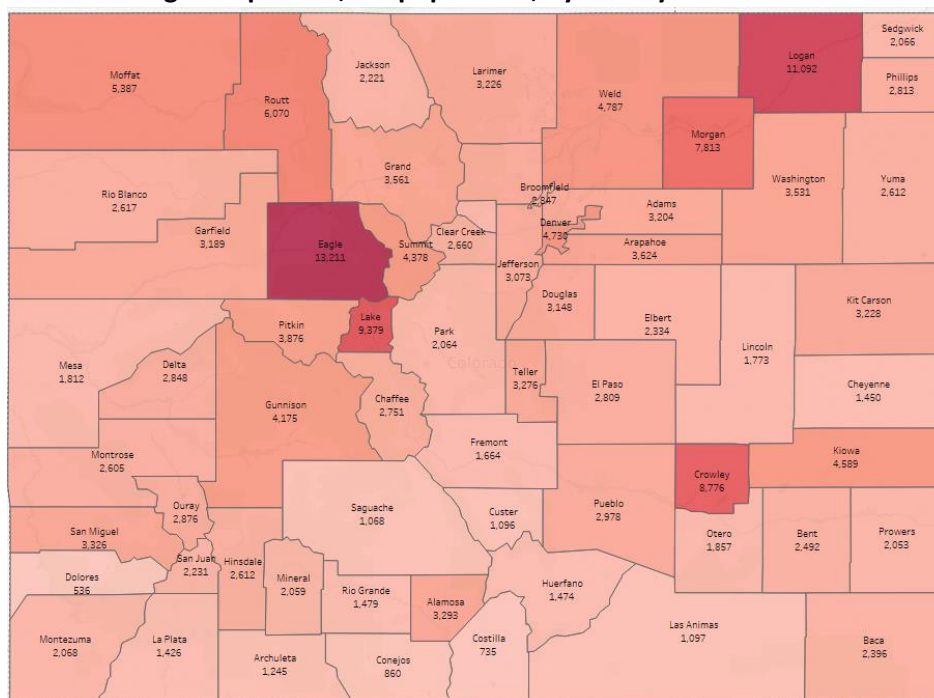
Note: COVID-19 testing data updated as of 05/22/2020. Darker red represents counties with the highest COVID-19 testing rates and lighter red are counties with the lowest COVID-19 testing rates. Boulder county has a rate of 2,987 COVID-19 tests per 100,000.

ii. LPHA redeployment of existing workers and volunteer recruitment for contact tracing

The survey asked two questions to understand whether LPHAs could potentially train and redeploy some of its own employees or outside workers to focus on COVID-19 contact tracing (Table 2). In total, LPHAs indicated the potential to train 519.5 FTEs (i.e., LPHA workers and other outside professionals).

Table 2. Redeployment of LPHA and Non-LPHA Workers for Contact Tracing

Worker Type	Number of Workers Potentially Available *(total and range)*
Other Government Workers	161
Volunteers	128
LPHA Staff	91.5
Temporary Paid Workers	48
Community Health Workers	26
Other	0
TOTAL	454.5

Note: "Other" category included nursing students, retired healthcare workers, and CSPH volunteers.

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Figure 4. Workforce Redeployment: Number of Potential LPHA and Non-LPHA Workers by County
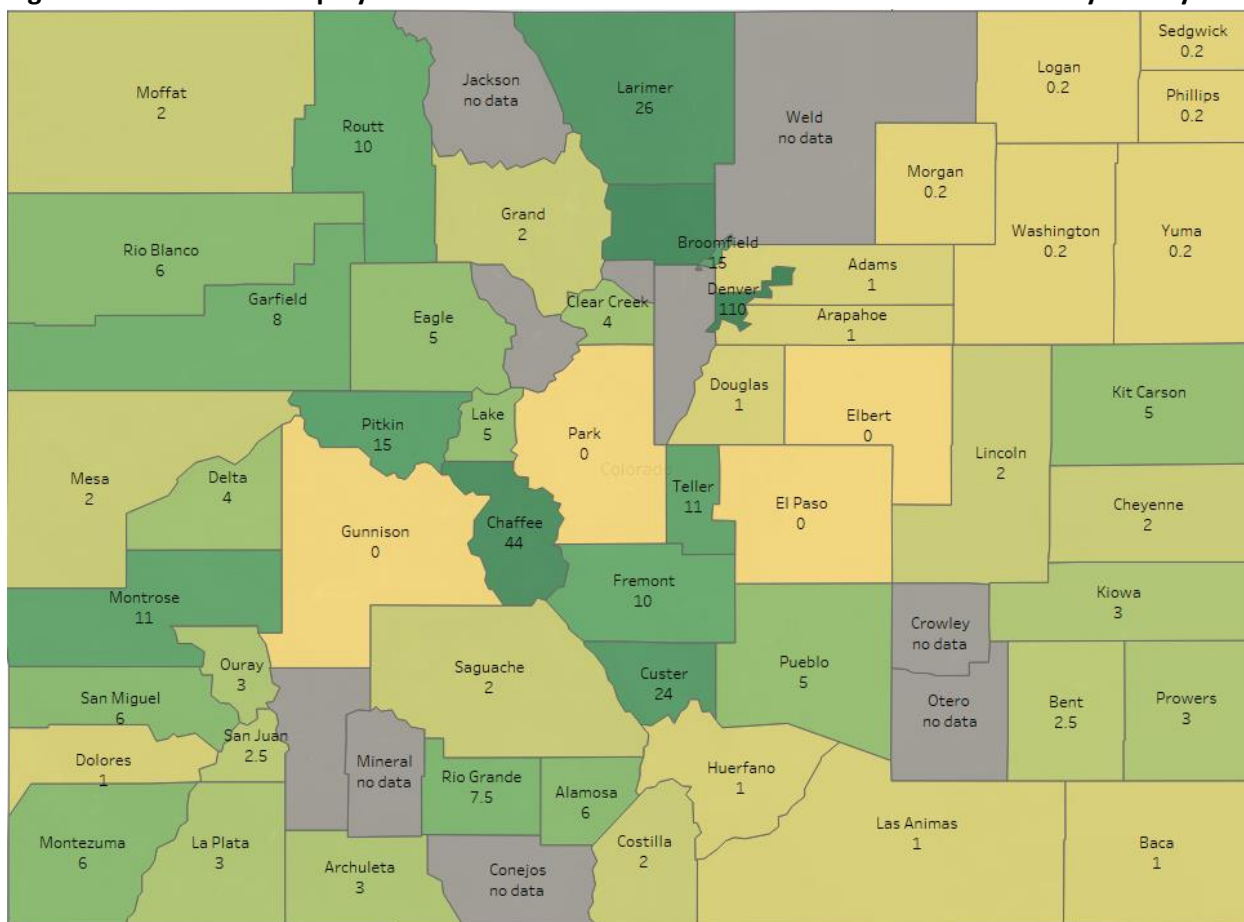
Note: The number of FTE is a sum of all categories of workers. For LPHAs that cover multiple counties, we divided the total FTE entered in the survey by the number of counties under the jurisdiction of the LPHA to avoid double counting.

Counties that do not show FTE information (gray) are missing data because their corresponding LPHA has not completed the survey (Conejos, Crowley, Gilpin, Hinsdale, Jackson, Jefferson, Mineral, Otero, Summit, and Weld).

Darker green represents counties with the largest number of FTEs and lighter yellow counties with the lowest number of FTEs.

iii. LPHA's ability to fund additional contact tracers and Continuation of contact tracing for other diseases

Four LPHAs (9%) indicated they have funding available to hire additional temporary COVID-19 contact tracing workers. In total, they can hire approximately 6.5 FTEs

About 49%, or 22 LPHAs, indicated that they're still conducting contact tracing for infections other than COVID-19.

C) Current COVID-19 contact tracing processes

i. Contact tracing effort prioritization

LPHAs were asked whether they're prioritizing specific sites (e.g., long-term care facility) or populations (e.g., homeless). More specifically, the question was:

> "Please indicate the sites and priority populations on which your LPHA is currently focusing its COVID-19 contact tracing activities."

Table 3. Contact Tracing Priority Sites and Populations

Site/Population	Priority *(% of LPHAs)*
People over 65	73%
People with co-morbidities (for example, diabetes, heart disease or cancer)	73%
Other Essential Workers (public transportation drivers and law enforcement)	73%
Healthcare Workers	71%
Long Term Care Facilities	62%
People from other vulnerable populations (e.g., African American and Hispanic)	62%
Homeless	42%
Other	49%

Note: "Other" category includes corrections facilities, child care facilities, food production workers, large employer outbreaks, self-referrals from website set up by LPHA, all symptomatic (with no confirmed positive test).

ii. Protocols followed for contact tracing

Twenty-nine LPHAs (64%) indicated they're following a protocol to guide their COVID-19 contact tracing activities, while 31 LPHAs (69%) are using an interview questionnaire specifically developed for COVID-19 contact tracing. The questionnaire is one component of a protocol for COVID-19 contact tracing. Many LPHAs across the US have been adapting their COVID-19 contact tracing interview guides to improve efficiency in data collection and minimize fatigue by both interviewee and interviewer.

D) COVID-19 contact tracing workforce needs

Forty-two LPHAs (93%) indicated a need for additional FTE for COVID-19 contact tracing activities. Some LPHAs indicated they don't currently need additional FTEs, but recognized that need could change as the pandemic evolves. Based on their best estimate of current need, LPHAs estimated they need an additional 538 FTE contact tracing workers.

LPHAs were asked to estimate how many FTEs they needed for each of four main categories of workers (Table 4). The categories were:

a) ***Contact Tracing and Case Investigation Group Supervisor:*** These positions ensure that "contact tracing" staff is consistently collecting accurate information; meeting targets; and provide consultation for more complex cases.

b) ***Contact Tracer/Case Investigator:*** These positions may do some combination of the following: calling people with COVID-19, providing isolation guidance, identifying and collecting contact

details of people with COVID-19, providing voluntary quarantine guidance for contacts, and connecting contacts with various services (including social support structures, testing, clinical care, etc.).

c) **Data Analyst/Programmer:** These positions process entered contact tracing data to determine how many new contacts need to be added to the contact tracing list: contacts who have not yet been contacted, and contacts who need to be contacted/re-contacted.

d) **COVID Navigator:** COVID Navigators conduct a virtual needs check and connect at-risk COVID-19 positive patients and people in voluntary quarantine to community resources.

Table 4. Contact Tracing Full-Time Equivalent Needed

Category	FTE Needed (total and range)
Contact Tracer/Case Investigator	392 (0-120)
COVID Navigator	83.15 (0-40)
Contact Tracing and Case Investigation Group Supervisor	54.75 (0-20)
Data Analyst/Programmer	43.3 (0-9)
Total	**573.2**

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Figure 5. Additional Contact Tracing Full-Time Equivalents Needed
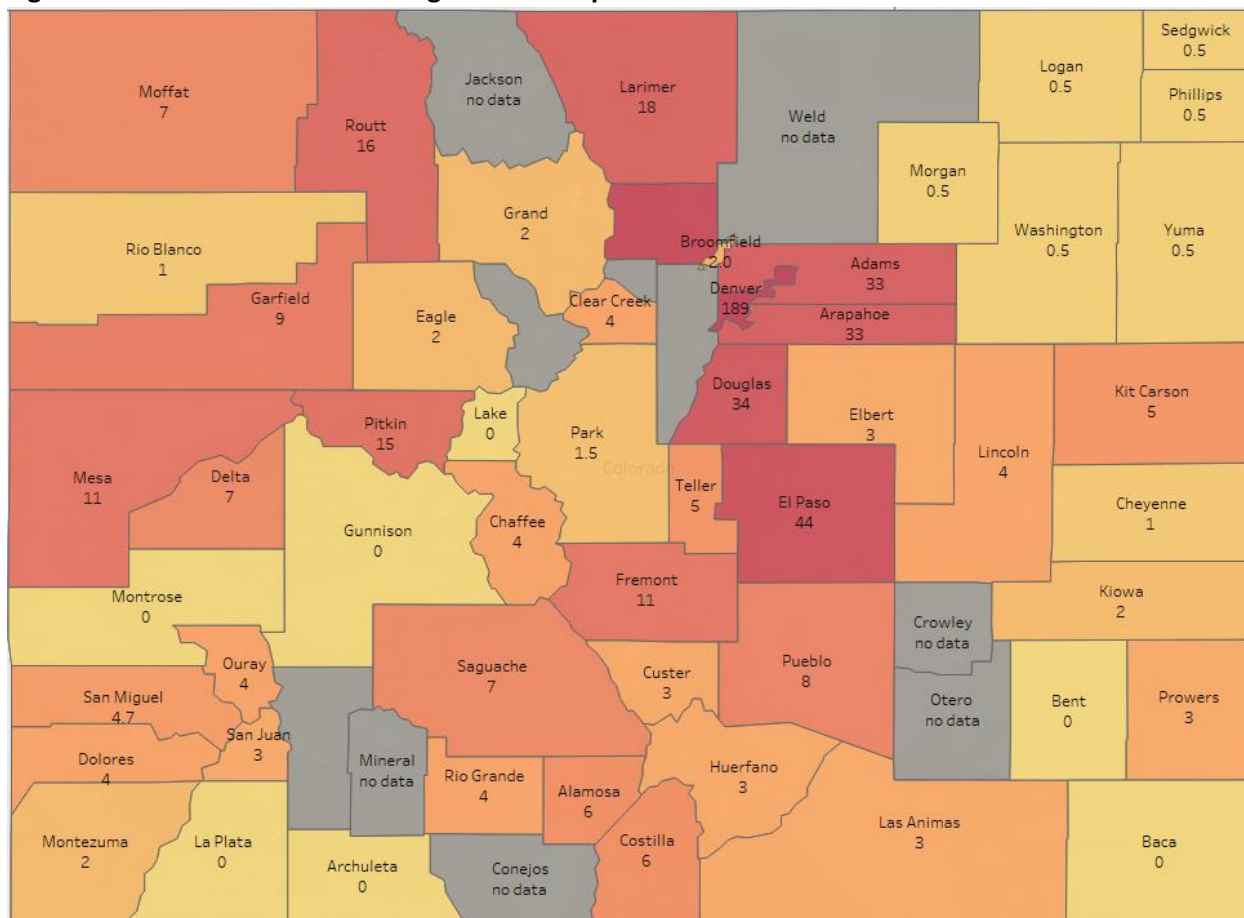
Note: The number of FTE is a sum of all categories of workers. For LPHAs that cover multiple counties, we divided the total FTE entered in the survey by the number of counties under the jurisdiction of the LPHA to avoid double counting.

Counties that do not show FTE information (gray) are missing data because their corresponding LPHA has not completed the survey (Conejos, Crowley, Gilpin, Hinsdale, Jackson, Jefferson, Mineral, Otero, Summit, and Weld).

Darker maroon represents counties with the largest number of FTEs and lighter yellow counties with the lowest number of FTEs.

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E) COVID-19 contact tracing resource needs

Table 5 provides information on needs other than workforce indicated by LPHAs. Twenty-five LPHAs (56%) indicated they need both additional funding and COVID-19 contact tracing training

Table 5. LPHA COVID-19 Contact Tracing Resource Needs

Category	Need *(% of LPHAs)*
Funding	91%
Training	62%
Other	71%

Note: "Other" category included: electronic system for contact tracing, symptom tracker, coordinator for additional staff, data entry and analytics, bi-lingual contact tracers, guidance on tracing asymptomatic cases and resource allocation for vulnerable populations.

F) Technological capacity for contact tracing

Approximately 27% of LPHAs (12 LPHAs) are supplementing live-person COVID-19 contact tracing with an electronic platform that collects self-reported symptoms. The platforms they indicated using include google-based solutions, FormStack, Data Studio, Mosio and the state's symptom tracker.

The vast majority (93% or 42 LPHAs) of LPHAs are using an electronic platform or application to enter and store information collected during contact tracing interviews (Table 6).

Table 6. Electronic Platform or Software Used for Contact Tracing

Platform/Application	Percentage of LPHAs Using Platform/Application *(total)*
Excel	47% (21)
Google	20% (9)
Paper	11% (5)
CEDRS	9% (4)
LabOnline	2% (1)
Trello	2% (1)
ESRI	2% (1)
None	7% (3)

**Section II: Colorado Contact Tracing Capacity in the Context of Workforce Need Estimates**

A) Colorado Local Public Health System Structure: Background

Colorado has a decentralized public health system wherein each of its 64 counties are required to either operate a local public health agency (LPHA) or participate in a district public health agency.

The Colorado Public Health Act of 2008, C.R.S. 25-1-501 et seq. was designed to improve the performance of the public health system statewide. The Act required each county to establish and maintain a county public health agency or to participate in a district public health agency. Any two or more contiguous counties may establish a district public health agency. Currently, there are 53 LPHAs with some representing multiple counties (Figure 6). These LPHAs provide a set of Core Public Health Services and additional services customized to their community needs and resources.

The Act also required LPHAs to establish local boards of health to provide administrative, policy, and financial oversight to their local health departments. Local public health agencies serving populations of 100,000 or more are required to have an independent board of health made up of at least five health experts and community members. LPHAs serving smaller populations can be governed by either an independent board of health, or at minimum, by a board of health comprised of the three county commissioners within a county.

Figure 6. Colorado LPHA Jurisdictions
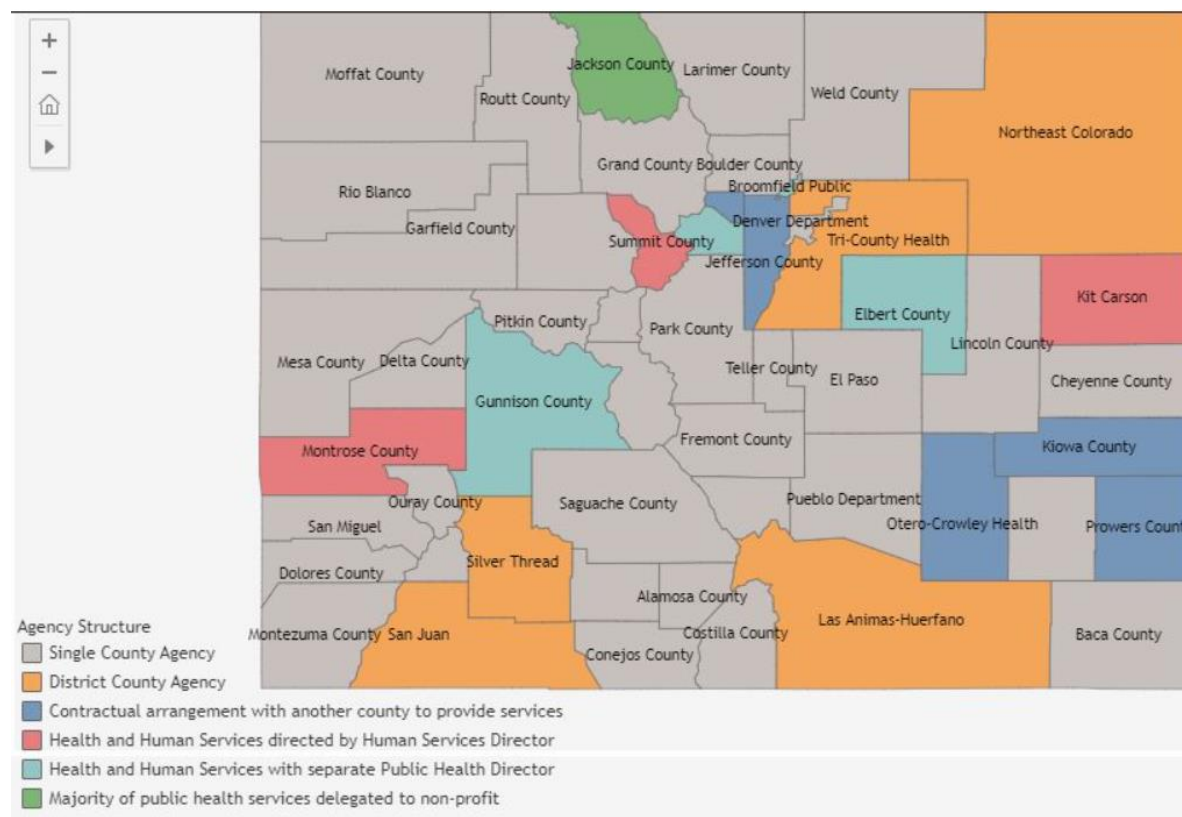
Courtesy of the Colorado Department of Public Health and Environment

B) From Societal Social Distancing to Reopening Colorado's Economy and Schools: The Role of Sustained Coronavirus Contact Tracing in the Suppression and Post-Suppression Phases

According to the guidance provided in several reports, it's become clear that long-term management of the SARS-CoV-2 (COVID-19) pandemic will heavily rely on two traditional public health methods: case identification and contact tracing. For the long-term, we will be able to resume life pre-COVID-19 with broad COVID-19 surveillance, availability of therapeutics to prevent serious illness in the most vulnerable, and a safe and effective vaccine. Achieving a sufficiently high level of immunity to achieve herd immunity is a less likely scenario.

The contact tracing workforce capacity required for meticulous contact tracing has been estimated by several institutions including the Johns Hopkins Center for Health Security, the American Enterprise Institute, the Association of State and Territorial Health Officials (ASTHO), the National Association of County & City Health Officials (NACCHO), and George Washington University. The workforce estimates range from 100,000 to 300,000 for the entire US and were based on what is currently in place in other countries, states and cities.

The per capita estimates are helpful but fail to account for regional outbreaks and case variability, as well as the current contact tracing workforce in place and efficiencies within a LPHA. Importantly, as testing capacity increases so will the number of COVID-19 positive cases, and workforce estimates will need to be scaled accordingly. For instance, it's possible that a county with a population of less than 100,000 may experience an epidemic cluster that would necessitate a larger number of contact tracers than the one that would be allocated to that county under current estimates. In fact, CO counties such as Eagle and Summit with relatively small population sizes (Eagle: 55,127; Summit: 31,011) would experience a shortage of contact tracing workforce if allocation was solely based on a straightforward per capita estimate. These counties documented a relatively high number of positive COVID-19 cases early on, likely due to seasonal ski visitors and proximity to the I-70 corridor. Despite the variability in estimates, the consensus is that CO, as with most US states, does not have the capacity for implementing case identification and contact tracing at the level required to safely ease social distancing measures.

A CO-based estimate was recently provided by the Metro Denver Partnership for Health (MDPH; Containment Action Plan for Responding to COVID-19; May 2020). The report estimated a need for 600 contact tracers in the metro Denver area which covers seven counties and a population of 3,231,918 (Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, and Jefferson). This translates into approximately 19 contact tracers per 100,000. This is relatively comparable to estimates from other US locations; however, it is more conservative than the national- and state-level estimates.

The MDPH estimate was largely based on NACCHO's estimate and assumed full scale case investigation including daily contact with cases and identification and notification of contacts. The estimate also assumes limited technology support for conducting case investigation and tracing. Finally, these estimates do not include the human resources and administrative support workforce needed.

Additional factors to consider in estimating needs for contact tracing capacity account for technology and the special needs of vulnerable populations. Technology may assist in the identification of new contacts; however, it may also overestimate the number of contacts for an individual case. One example of technology being used to reduce the effort required for direct contact follow-up is offered by the San Francisco Department of Public Health, which is utilizing text messaging to follow up with contacts for

daily symptom checks. There is also a collaborative effort by Apple and Google to utilize Bluetooth technology to identify contacts. Overall, the consequences of technology on workload for contact tracing remain unknown.

The special needs of vulnerable populations also have implications for contact tracing workforce needs. Some population characteristics may translate may result in more time with a given case or contact which in turn may have implications for the number of contact tracers needed. Some examples include demographics (e.g., population over 65, percentage of immigrants), socio-economic factors (e.g., percent of population in poverty), co-morbidities, percent of population who do not speak English, and many other factors. A county with a large number of immigrants who do not speak English as a first language may have very specific contact tracing workforce needs related to interpreting services as well as fears that immigrants may in providing their information to "government" workers. To better reach and serve vulnerable populations, Massachusetts created the position of "care resource coordinators" who help connect individuals to the resources they need to self-isolate/voluntarily quarantine for 14 days.

C) Meeting Contact Tracing Workforce Needs in Colorado

Based on the survey, Colorado LPHAs currently have 128 FTE contact tracers spread throughout 54 counties. Table 7 provides information on the current gap in contact tracing workforce capacity based on existing national and local estimates, as well as experience in other states. The gap reported in the last column takes into account the current FTE contact tracing workforce in CO. These numbers do not reflect the recruitment of 50 part-time contact tracers by CDPHE or any contact tracers that have been hired since the LPHAs completed the survey.

Table 7. Contact Tracing Deficits Based on Existing Estimates

Location	Contact Tracers/100,000 population	Projected Number of Contact Tracers Needed in CO	Gap in Contact Tracing Workforce in CO
Other Country Estimates and Experience			
New Zealand	3.9	225	97
Wuhan, China	81.1	4,670	4,542
Iceland	13.7	789	661
US Estimates and Experience			
New York City	11.9	685	557
Massachusetts	14.5	835	707
San Francisco	17	979	851
Metro Denver	19	1,094	966
California	50.6	2,914	2,786
NACCHO	30	1,728	1,600
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Note: Current contact tracing workforce obtained from the "CO Local Public Health Agency Contact Tracing Workforce and Technical Capacity Survey". 45 out of 53 LPHAs responded for a response rate of 85%. These 45 LPHAs reported a total of 128 FTE contact tracers.

It is likely that some LPHAs have temporarily stopped some essential public health services in order to respond to the emerging local COVID-19 epidemics in their jurisdictions. This is important to consider when examining the workforce gaps on Table 7. That is, it's possible that many of the 128 FTEs currently working on COVID-19 contact tracing will need to eventually resume their original roles so as to maintain all public health functions. This means that the deficits are likely to be larger than the ones presented here.

For instance, one LPHA director wrote:

> "Currently contact tracing is being completed by Director and Regional Epi, because we are a small county it is doable but everything else "Public Health" has been put on the back burner because director can't do it all."

As presented in Section I, 87% of LPHAs indicated a need for contact tracing FTEs. These contact tracing workforce needs reflect the estimates by individual LPHA directors. Many of the survey respondents expressed the uncertainty of their estimates due to the changing nature of the COVID-19 epidemic, as well as their unique circumstances (e.g., being a resort county which may experience population surges during the summer and/or winter). For example, one LPHA director wrote:

> "As a rural resort our county's population can increase 2.5 times in the summer. This might mean we will need more people but it's is difficult to assess how much activity and people will come this summer, winter, and next summer."

Other LPHA directors wrote:

> "This is all dependent on the 2nd wave of COVID and a surge in cases."

> "If we max out our capacity, then we will [need] assistance. It is hard to project at this point which type of help we will need."

> "This will depend on how case load develops; funding and epi staffing are biggest gaps on our radar at this time."

> "We are currently doing okay given our current caseload. If there are multiple outbreaks at the same time or additional language needs that overwhelm our current employee's capacity, we could use some assistance."

Finally, one LPHA director directly acknowledged the potential for underestimating contact tracing workforce needs based on personal opinion:

> "We would like these decisions to be data driven and not based on self-reported needs from LPHA."

D) Redeployment of Workers and Recruitment of Volunteers

As presented in Section I, LPHAs indicated the potential to train and redeploy a total of 454.5 FTEs for contact tracing in their communities. Redeploying the existing workforce has the benefit of experienced workers; however, some of these workers (e.g., LPHA staff and other government workers) will eventually need to return to their primary positions. Retention may also be a challenge when working with volunteers.

One LPHA director explained:

> "Stable FTEs [is a priority]. The 11 persons identified are current government employees that are underused at this time. As we lift the public health orders, these staff will have to rotate off the team to go back to their full-time job. While I can't expect every position to be stable for the entire event, I need the supervisor positions to be stable or I will be in training mode for the next 12-18 months as the only full-time employee on the team right now."

CO has some promising sources of temporary workers and volunteers. One of them is a group of CSPH students who have volunteered for contact tracing activities. Other potential sources for volunteers include the CO Medical Society, AmeriCorps and school nurses.

All these additional workers will require training and equipment to conduct contact tracing. On the positive side, many of the potential workers identified by LPHAs are local residents who may be more effective in creating rapport and effectively performing comprehensive contact tracing (e.g., local residents may be more open to sharing their information if they know the contact tracer lives is a "local"). On the down side, the upfront investment needed to train additional workers that may not be able to make a long-term commitment of up to a year or 18 months could be prohibitive from a human resource (e.g., staff needed to train and onboard new contact tracers) and funding perspective.

E) Limitations of current report

The key limitation of this current report is that it does not represent all 53 LPHAs in CO (8 LPHAs did not complete the survey). The initial recommendations in this report do not account for the current contact tracing workforce in these 8 LPHAs.

Other limitations include the reliance of our estimates and recommendations on the experience and estimates from other countries and states that are potentially different from CO. However, the current recommendations are a starting point and give some lower and upper bounds on the current contact tracing workforce gap in CO.

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Section III: Factors to Consider in Contact Tracing Workforce Allocation

In this Section, we make initial suggestions for important factors to consider when making contact tracing workforce allocation decisions. These suggestions are based on the findings from Sections I and II combined with anecdotal information on contact tracing workforce capacity augmentation and planning in other countries, states, and counties.

Here is a list of factors to consider when making contact tracing workforce allocation decisions:

- Daily rate of COVID-19 cases at the county-level
- Daily rate of COVID-19 testing for the county
- Number of contacts per case
- Contact tracer productivity (average number of contacts handled per contact tracer)
- County-level contact tracing workforce (total FTE)
- Number of newly trained contact tracing workers
- County-level demographics and socio-economic factors
- Aggregated, county-level human mobility data as an indicator of future burden (e.g., this can be measured by time spent away from home; more below on the relevance of this indicator)

Among the most important factors to consider is the number of new COVID-19 cases. For instance, in South Korea, most of the planning is focused on a simple count of COVID-19 cases and reliance of modeling projections is not as critical for contact tracing purposes. One key difference between South Korea and virtually all US states is that the former acted early on in the pandemic such that their number of COVID-19 cases was more manageable from a contact tracing perspective. In Massachusetts, for example, the number of existing positive COVID-19 cases was already high when it launched its Community Tracing Collaborative in partnership with Partners in Health. Some of MA's initial work focused on existing cases that still presented a potential risk for exposure in the in the community (e.g., a person who tested positive less than 14 days prior to contact tracing interview).

The number of exposed contacts per COVID-19 positive case is also a key factor to consider. We expect that as social distancing measures are relaxed, the number of people exposed to COVID-19 will increase. Experts have estimated that the number of contacts are 10 with social distancing and 19 without social distancing. Also, the number of contacts may be less than five in places with stricter stay-at-home orders.

During the "Stay at Home" order in CO the CSPH COVID-19 Modeling Group found that human mobility (measured by time spent away from home) decreased considerably across CO counties and was lowest in early April. However, it has been increasing steadily since mid-April. This may translate in exposure to COVID-19 by residents who have not been previously exposed, especially through asymptomatic individuals. The implication is that more individuals will need to be traced, contacted and voluntarily quarantined; adding to the burden on the contact tracing workforce. Using aggregated, county-level human mobility data can help better understand the potential impact of relaxing social distancing on exposure to COVID-19, and consequently it can help forecast contact tracing surge capacity.

The number of cases and their respective contacts that a single contact tracer can complete in one eight-hour day is another important factor. Table 8 presents some estimates of daily case load based on an 8-hour day. We suggest that CO base its own estimates of daily case load on actual experience as contact

tracing efforts are rolled out more widely. This should be done early in the process so that CO-specific 8-hour daily case load can be used in allocation decisions.

Table 8. Eight-Hour Daily Case Load

| Source of Estimate	Index Case Interview	Initial Contact Notifications	Contact Follow-ups
European Centers for Disease Control	3	8	48
Washington State	7	21	N/A
George Washington University Contact Tracing Workforce Estimator	6	12	32

Source: https://www.gwhwi.org/uploads/4/3/3/5/43358451/contact_tracing_brief_05.05.20.pdf

One way to integrate factors encompassed under "demographics and socio-economic" characteristics in workforce allocation decision is to use the Centers for Disease Control & Prevention (CDC) Social Vulnerability Index (SVI).

The CDC SVI was created by the Agency for Toxic Substances and Disease Registry's (ATSDR) Geospatial Research, Analysis & Services Program (GRASP) "to help public health officials and emergency response planners identify and map the communities that are most likely to need support before, during, and after a hazardous event". SVI indicates the relative vulnerability of every U.S. Census tract and county. SVI ranks the counties on 15 social factors and further groups them into four related themes (Figure 7). Each county receives a ranking for each variable and for each of the four themes, as well as an overall ranking. County rankings are based on percentiles. Percentile ranking values range from 0 to 1, with higher values indicating greater vulnerability.

For our analysis of CO counties, we used the state-specific database, in which counties are ranked only against other counties in the specified state. Figure 8 presents a color-coded map of CO counties which highlights the ranking of CDC's SVI.

Figure 7. Variables Used for CDC Social Vulnerability Index (4 Categories and 15 Variables)
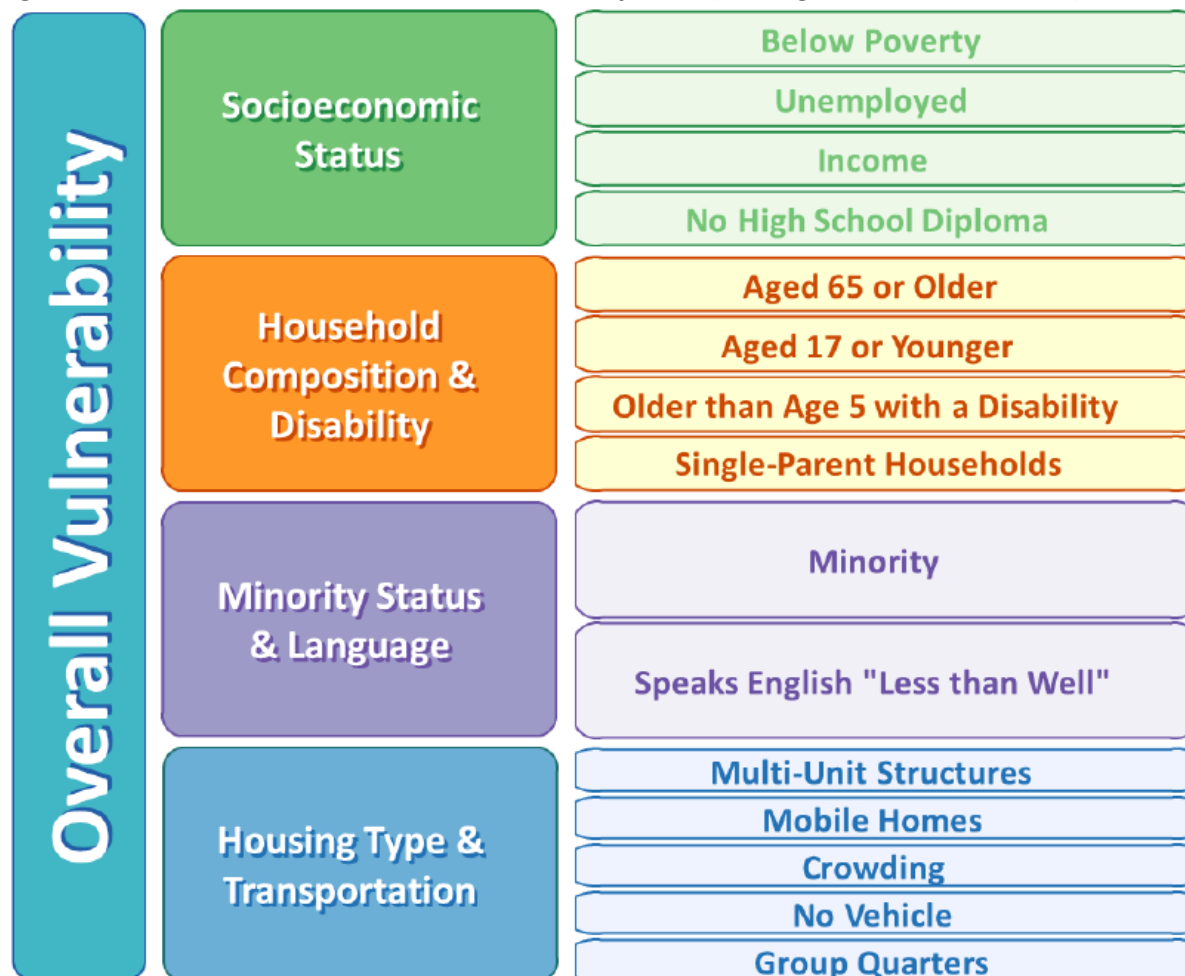
Source: Centers for Disease Control & Prevention.
https://svi.cdc.gov/Documents/Data/2018_SVI_Data/SVI2018Documentation.pdf

As shown in Tables 9a and 9b, currently many of the counties ranking highest based on the CDC SVI also have a small number of contact tracers. Of special concern is the fact that many of the top 30 counties (in terms of SVI ranking) also have a relatively high number of COVID-19 cases over the past seven days since 05/22/2020. This is one example of using a data driven approach to understand the different levels of contact tracing workforce capacity in the context of other important county characteristics that may influence contact tracing efforts. For instance, a central component of effective contact tracing is case isolation/voluntary quarantine for 14 days. In counties with high levels of vulnerability, its residents may need to be connected to community and state resources (e.g., shelter, food and medication) so they are able to successfully complete the 14-day voluntary quarantine. This means that the role of the "COVID Navigator" will be especially important in those counties. This also means that each case might take a longer time to investigate, contact trace and connect to resources; which has implications for the number of cases that can be completed in an 8-hour day. There are other ways to use each group of SVI variables to provide more insight into workforce allocation decisions. For instance, the "Minority Status &

Language" can be used to understand the need for interpretation services or a bilingual contact tracing workforce.

Language spoken at home, more specifically whether a person speaks English or not, also needs to be taken into account. Language information is included in the CDC SVI but this could be a stand-alone factor to consider in contact tracing workforce needs. For cases in which the interviewee does not speak English, the contact tracer will need to use interpreter services which may translate into longer interview times and impact 8-hour daily case load. Also, it is important to prioritize the recruitment of bilingual contact tracers whenever possible. Finally, there will likely be a need for in-person contact tracing for populations that cannot be reached by phone (e.g., homeless). These contact tracers will need additional training to perform their duties.

Figure 8. CDC Social Vulnerability Ranking by Colorado County
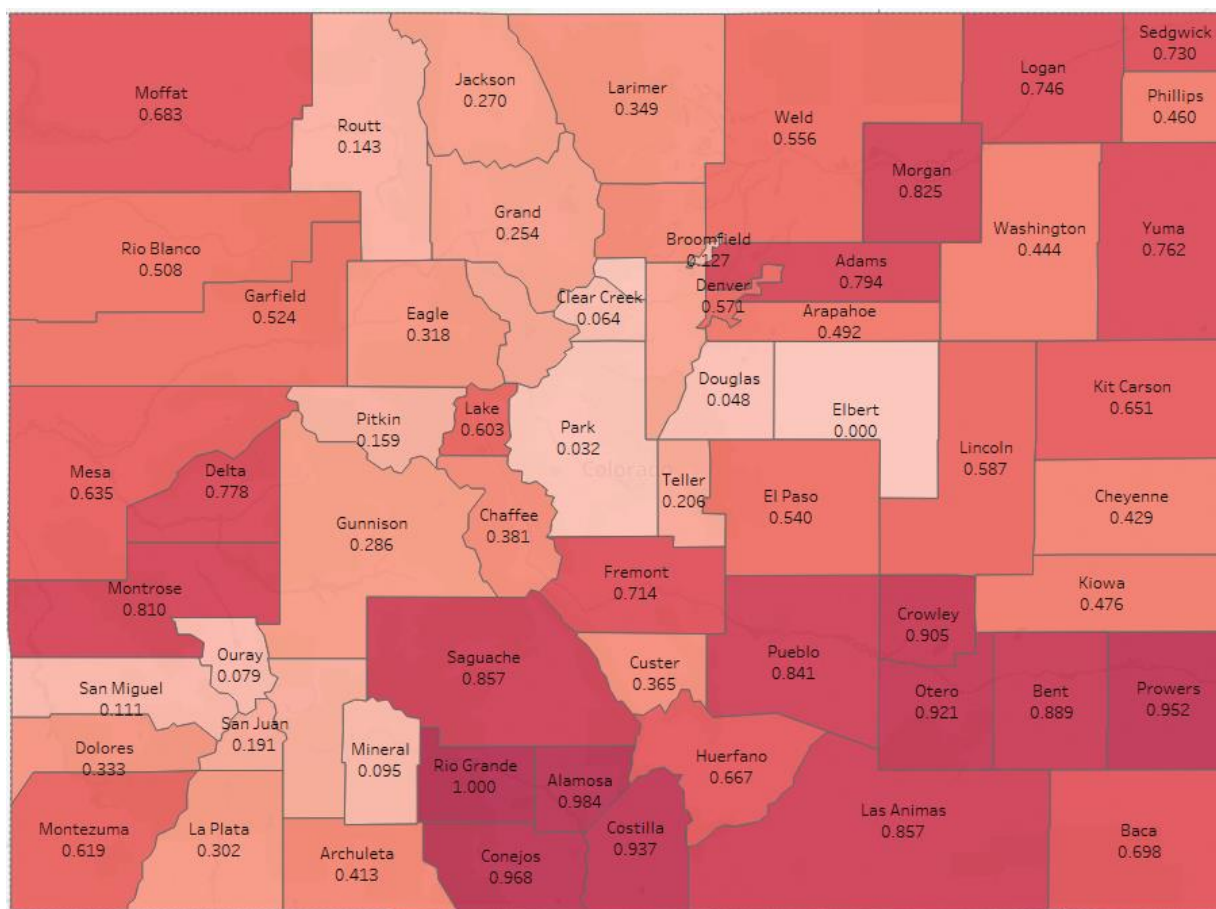
Note: Colorado counties were ranked within Colorado to enable mapping and analysis of relative vulnerability in an individual state. County rankings are based on percentiles. Percentile ranking values range from 0 to 1, with higher values indicating greater vulnerability. Darker red represents counties with the greatest social vulnerability and lighter red counties with the lowest social vulnerability.

Table 9a. Top 30 Counties for CDC Social Vulnerability Index (Greater Vulnerability)

County	COVID-19 Contact Tracing FTE	Overall SV Rank	COVID-19 Past 7 Days Case Count
Rio Grande	1	1.000	7
Alamosa	3	0.984	12
Conejos	No data	0.968	0
Prowers	2	0.952	1
Costilla	1	0.937	0
Otero	No data	0.921	3
Crowley	No data	0.905	5
Bent	0	0.889	1
Las Animas	1	0.857	1
Saguache	1	0.857	7
Pueblo	7	0.841	31
Morgan	1	0.825	34
Montrose	2	0.810	17
Adams	5	0.794	227
Delta	3	0.778	6
Yuma	1	0.762	0
Logan	1	0.746	6
Sedgwick	1	0.730	0
Fremont	4	0.714	1
Baca	1	0.698	0
Moffat	1	0.683	0
Huerfano	1	0.667	0
Kit Carson	2	0.651	0
Mesa	3	0.635	0
Montezuma	2	0.619	8
Lake	1	0.603	1
Lincoln	1	0.587	0
Denver	5.5	0.571	508
Weld	No data	0.556	86
El Paso	4	0.540	169

Note: Colorado counties were ranked based on CDC Social Vulnerability Index (SVI). County rankings are based on percentiles. Percentile ranking values range from 0 to 1, with higher values indicating greater vulnerability. Number of COVID-19 cases in the past 7 days from 05/16/2020 to 05/22/2020. COVID-19 case data updated as of 05/22/2020. For LPHAs that cover multiple counties, we divided the total FTE entered in the survey by the number of counties under the jurisdiction of the LPHA to avoid double counting.

Table 9b. Bottom 35 Counties for CDC Social Vulnerability Index (Lower Vulnerability)

County	COVID-19 Contact Tracing FTE	Overall SV Rank	COVID-19 Past 7 Days Case Count
Garfield	5	0.524	7
Rio Blanco	1	0.508	0
Arapahoe	5	0.492	322
Kiowa	0	0.476	0
Phillips	1	0.460	0
Washington	1	0.444	5
Cheyenne	1	0.429	0
Archuleta	0.5	0.413	0
Boulder	20	0.397	63
Chaffee	1	0.381	0
Custer	1	0.365	0
Larimer	10	0.349	35
Dolores	0	0.333	0
Eagle	4	0.318	7
La Plata	3	0.302	5
Gunnison	1	0.286	0
Jackson	No data	0.270	0
Grand	1	0.254	0
Jefferson	No data	0.238	199
Summit	No data	0.222	15
Teller	3	0.206	1
San Juan	1	0.191	0
Hinsdale	No data	0.175	0
Pitkin	4	0.159	1
Routt	0	0.143	0
Broomfield	5	0.127	11
San Miguel	3	0.111	1
Mineral	No data	0.095	0
Ouray	1	0.079	0
Clear Creek	1	0.064	0
Douglas	5	0.048	32
Park	1	0.032	5
Gilpin	No data	0.016	0
Elbert	0	0.000	4

Note: Colorado counties were ranked based on CDC Social Vulnerability Index (SVI). County rankings are based on percentiles. Percentile ranking values range from 0 to 1, with higher values indicating greater vulnerability. Number of COVID-19 cases in the past 7 days from 05/16/2020 to 05/22/2020. COVID-19 case data updated as of 05/22/2020. For LPHAs that cover multiple counties, we divided the total FTE entered in the survey by the number of counties under the jurisdiction of the LPHA to avoid double counting.

Section IV: Future Steps: Creating County-Level Profiles

This is the first report on the current capacity for contact tracing efforts in Colorado. In a future series of reports, we will create county-level profiles that will highlight key characteristics of LPHA contact tracing workforce and technical capacity, as well as other county-level factors that are likely to be critical in workforce allocation decisions. We will continue to refine our initial recommendations for a workforce allocation methodology.

We will follow up with the LPHAs (8) that haven't completed the survey to collect their data. Finally, we will monitor the state's progress in helping LPHAs meet their contact tracing workforce and technical capacity gaps overtime (e.g., through surveys administered at set intervals).

APPENDIX

CO Local Public Health Agency Contact Tracing Workforce and Technical Capacity Survey (attach instrument to report)

The survey was launched on April 29th, 2020 and while LPHAs can still complete the survey, this report is based on data collected through May 31st, 2020. Once the final version of the survey was approved by all collaborators, we created an online form to be completed by LPHAs by accessing a link which was e-mailed to the public health director distribution list maintained by CALPHO. As of May 11th, we had received completed surveys from 30 LPHAs. We followed up directly with the LPHAs that had not yet completed the survey and another 15 LPHAs completed the survey by 05/13/2020. Two LPHAs completed the survey on 05/27/202 and 05/29/2020 respectively. It is possible that contact tracing workforce capacity has changed since data was collected.

Appendix Tables 1a and 1b contextualize the current COVID-19 contact tracing FTE workforce in relation to COVID-19 case rates and case counts by county (COVID-19 case data updated as of 05/22/2020). Each table is sorted based on the number of COVID-19 cases over the past 7 days (highest to lowest rates). Many counties that have a high number of COVID-19 cases over the past 7 days have a lower number of FTEs for contact tracing.

Appendix Table 1a. Top 30 Counties for Number of COVID-19 Cases in the Past 7 Days

County	COVID-19 Past 7 Days Case Count	COVID-19 Case Rate (per 100,000)	COVID-19 Contact Tracing FTE
Denver	508	704	5.5
Arapahoe	322	610	5
Adams	227	548	5
Jefferson	199	345	No data
El Paso	169	204	4
Weld	86	753	No data
Boulder	63	276	20
Larimer	35	148	10
Morgan	34	2,073	1
Douglas	32	195	5
Pueblo	31	139	7
Montrose	17	360	2
Summit	15	636	No data
Alamosa	12	315	3
Broomfield	11	317	5
Montezuma	8	134	2
Eagle	7	1,052	4
Saguache	7	336	1
Garfield	7	201	5
Rio Grande	7	134	1
Logan	6	2,247	1
Delta	6	197	3
Crowley	5	751	No data
Washington	5	317	1
La Plata	5	129	3
Park	5	113	1
Elbert	4	183	0
Otero	3	76	No data
Lake	1	348	1
Pitkin	1	319	4

Note: Top 30 counties according to number of COVID-19 cases in the past 7 days from 05/16/2020 to 05/22/2020. Caution should be used when interpreting rates in counties with small populations. County rates per 100,000 are calculated using 2018 population estimates from the Demography Section, Colorado Division of Local Government. COVID-19 case data updated as of 05/22/2020. For LPHAs that cover multiple counties, we divided the total FTE entered in the survey by the number of counties under the jurisdiction of the LPHA to avoid double counting.

Appendix Table 1b. Bottom 35 Counties for Number of COVID-19 Cases in the Past 7 Days

County	COVID-19 Past 7 Days Case Count	COVID-19 Case Rate (per 100,000)	COVID-19 Contact Tracing FTE
San Miguel	1	281	3
Teller	1	128	3
Prowers	1	91	2
Fremont	1	54	4
Las Animas	1	35	1
Bent	1	34	0
Gunnison	0	1,031	1
Hinsdale	0	373	No data
Kit Carson	0	363	2
Chaffee	0	345	1
Baca	0	338	1
Cheyenne	0	269	1
Mineral	0	257	No data
Phillips	0	234	1
Routt	0	230	0
Clear Creek	0	166	1
Ouray	0	146	1
San Juan	0	131	1
Yuma	0	120	1
Costilla	0	79	1
Archuleta	0	58	0.5
Lincoln	0	54	1
Gilpin	0	49	No data
Moffat	0	46	1
Huerfano	0	44	1
Custer	0	41	1
Mesa	0	33	3
Grand	0	32	1
Rio Blanco	0	16	1
Conejos	0	12	No data
Dolores	0	0	0
Jackson	0	0	No data
Kiowa	0	0	0
Sedgwick	0	0	1

Note: Bottom 35 counties according to number of COVID-19 cases in the past 7 days from 05/16/2020 to 05/22/2020. Caution should be used when interpreting rates in counties with small populations. County rates per 100,000 are calculated using 2018 population estimates from the Demography Section, Colorado Division of Local Government. COVID-19 case data updated as of 05/22/2020. For LPHAs that cover multiple counties, we divided the

total FTE entered in the survey by the number of counties under the jurisdiction of the LPHA to avoid double counting.

Appendix Tables 2a and 2b contextualize the current COVID-19 contact tracing FTE workforce in relation to COVID-19 testing rates by county (COVID-19 testing data updated as of 05/22/2020). Each table is sorted based on COVID-19 testing rate per 100,000 (highest to lowest rates).

Appendix Table 2a. Top 30 Counties for COVID-19 Testing Rate per 100,000

County	COVID-19 Testing Rate	COVID-19 Contact Tracing FTE
Eagle	13,211	4
Logan	11,092	1
Lake	9,379	1
Crowley	8,776	No data
Morgan	7,813	1
Routt	6,070	0
Moffat	5,387	1
Weld	4,787	No data
Denver	4,730	5.5
Kiowa	4,589	0
Summit	4,378	No data
Gunnison	4,175	1
Pitkin	3,876	4
Arapahoe	3,624	5
Grand	3,561	1
Washington	3,531	1
San Miguel	3,326	3
Alamosa	3,293	3
Teller	3,276	3
Kit Carson	3,228	2
Larimer	3,226	10
Adams	3,204	5
Garfield	3,189	5
Douglas	3,148	5
Jefferson	3,073	No data
Boulder	2,987	20
Pueblo	2,978	7
Ouray	2,876	1
Delta	2,848	3
Broomfield	2,847	5

Note: Top 30 counties according to COVID-19 testing rate. Caution should be used when interpreting rates in counties with small populations. County rates per 100,000 are calculated using 2018 population estimates from the Demography Section, Colorado Division of Local Government. COVID-19 testing data updated as of 05/22/2020. For

LPHAs that cover multiple counties, we divided the total FTE entered in the survey by the number of counties under the jurisdiction of the LPHA to avoid double counting.

Appendix Table 2b. Bottom 35 Counties for COVID-19 Testing Rate

County	COVID-19 Testing Rate	COVID-19 Contact Tracing FTE
Phillips	2,813	1
El Paso	2,809	4
Chaffee	2,751	1
Clear Creek	2,660	1
Rio Blanco	2,617	1
Yuma	2,612	1
Hinsdale	2,612	No data
Montrose	2,605	2
Bent	2,492	0
Baca	2,396	1
Elbert	2,334	0
San Juan	2,231	1
Jackson	2,221	No data
Montezuma	2,068	2
Sedgwick	2,066	1
Park	2,064	1
Mineral	2,059	No data
Prowers	2,053	2
Gilpin	1,952	No data
Otero	1,857	No data
Mesa	1,812	3
Lincoln	1,773	1
Fremont	1,664	4
Rio Grande	1,479	1
Huerfano	1,474	1
Cheyenne	1,450	1
La Plata	1,426	3
Archuleta	1,245	0.5
Las Animas	1,097	1
Custer	1,096	1
Saguache	1,068	1
Conejos	860	No data
Costilla	735	1
Dolores	536	0

Note: Bottom 35 counties according to COVID-19 testing rate. Caution should be used when interpreting rates in counties with small populations. County rates per 100,000 are calculated using 2018 population estimates from the Demography Section, Colorado Division of Local Government. COVID-19 testing data updated as of 05/22/2020. For

LPHAs that cover multiple counties, we divided the total FTE entered in the survey by the number of counties under the jurisdiction of the LPHA to avoid double counting.

Appendix Table 3. Contact Tracing Workforce in Different Locations

Location	Population Size	Number of Contact Tracers	Contact Tracers/100,000 population
Wuhan, China	11.1 million	9,000	81.1
Iceland	364,134	50	13.7
New Zealand	4.9 million	190	3.9
New York State	19.5 million	6,400-17,000	32.8-87.2
New York City	8.4 million	1,000	11.9
California	39.5 million	20,000	50.6
San Francisco	883,305	150	17
Massachusetts	6.9 million	1,000	14.5
NACCHO	N/A	98,460 (for all US)	30
Metro Denver	3,231,918	600	19

Appendix Table 4. Contact Tracing Workforce Needs in Colorado Based on Experience in Other Locations

Location	Contact Tracers/100,000 population	Number of Contact Tracers	Projected Number of Contact Tracers Needed in CO
Wuhan, China	81.1	9,000	4,670
Iceland	13.7	50	789
New Zealand	3.9	190	225
New York State	32.8-87.2	6,400-17,000	1,889-5,022
New York City	11.9	1,000	685
California	50.6	20,000	2,914
San Francisco	17	150	979
Massachusetts	14.5	1,000	835
NACCHO	30	98,460 (for all US)	1,728
Metro Denver	19	600	1,094

Note: Population size of Colorado based on July 1, 2019 Census estimate of 5,758,736