

12.0 TECHNOLOGY AND CONTROLS (04/16/21)

This section provides a summary of the literature on effectiveness of selected non-pharmaceutical interventions (NPIs) for control of transmission of the novel coronavirus SARS-CoV-2. The summary is intended to support Camp personnel who are responsible for managing the COVID-19 programs in day, overnight, and family camp settings. NPIs should be layered upon one another and used at the same time with several layers of safeguards working together to reduce potential transmission. No one NPI is sufficient.

The NPIs addressed in this summary are relevant and applicable to multiple camp settings and should be considered each as part of a multilayer control strategy. These NPIs are also described in COVID-19 guidance from cognizant authorities including the Centers for Disease Control and Prevention (CDC), Association of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), or American Industrial Hygiene Association (AIHA).¹

This summary begins with background information that is intended to orient camp management and staff to the pathways of SARS-CoV-2 transmission recognized at this time and the conceptual model for a *hierarchy of controls* that is generally accepted and commonly used in environmental and occupational health management. Next, summarized in Table 12.1, is a description of the expected effectiveness of the NPIs by drawing upon the relevant scientific literature and the professional judgement of EH&E scientists and engineers. The summary information is intentionally brief to enhance its utility for Camp personnel and to facilitate updates as information and knowledge about transmission of the virus continues to grow.

ROUTES OF TRANSMISSION

SARS-CoV-2 is the coronavirus that causes COVID-19 disease. SARS-CoV-2 is transmitted from person-to-person when respiratory droplets that contain the virus are expelled by a contagious person while breathing, vocalizing, coughing, or sneezing and subsequently taken up through the mouth, nose, or eyes of a previously non-infected person. Three possible pathways of transmission are recognized.

Close contact transmission refers to exchange of respiratory droplets, whether large or small, when people are very near to each other. Close contact is commonly defined as within 6 feet. Strong evidence exists for transmission when people are in close contact.

Fomite transmission refers to transfer of the coronavirus from an infected person to a surface and subsequently to a previously uninfected person. Transmission by this route is thought to occur less often than by close contact, and few cases of fomite transmission have been reported.²

¹ [CDC Considerations for Institutions of Higher Education](#); [ASHRAE Position Document on Infectious Aerosols](#); [ASHRAE Emerging Issue Brief on Pandemic COVID-19 and Airborne Transmission](#); [AIHA Reopening: Guidance for Institutions of Higher Education](#).

² <https://www.cdc.gov/media/releases/2020/s0522-cdc-updates-covid-transmission.html>

Long range transmission refers to exchange of small, microscopic respiratory droplets that can occur when people are more than 6 feet apart from each other. Some reports of spread between people in crowded, indoor settings are consistent with long range transmission, but could also be explained by undocumented close contact. Long range transmission is thought to occur less often than by close contact.

HIERARCHY OF CONTROLS

Transmission of SARS-CoV-2 and health impacts of COVID-19 can be mitigated by proper use of NPIs. The classic hierarchy of controls for management of environmental and occupational health illustrated in Figure 12.1 provides a framework for NPIs. Five layers of control comprise the hierarchy: 1) elimination, 2) substitution, 3) engineering, 4) administrative, and 5) personal protective equipment. The labels to the right of the pyramid provide examples of NPIs for SARS-CoV-2 by layer in the hierarchy.

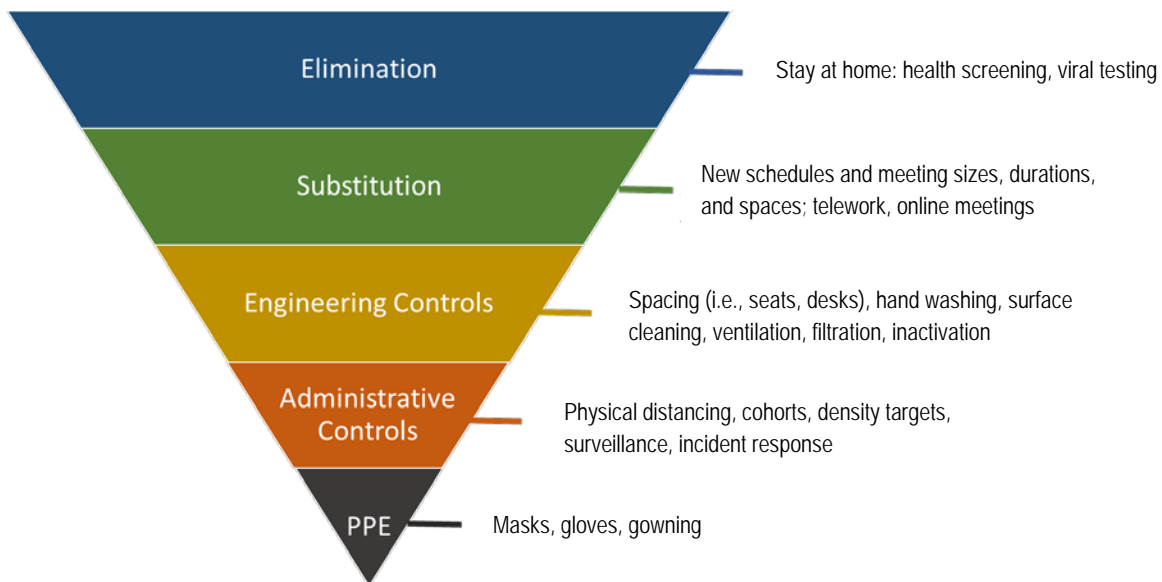


Figure 12.1 Classic Hierarchy of Controls for Environmental and Occupational Health with Examples of its Application to Control of the Novel Coronavirus SARS-CoV-2

Selected NPIs for control of coronavirus transmission applicable to a variety of camp settings including day, overnight, and family camp and their potential effectiveness are presented in Table 12.1, including: testing for the virus, screening for COVID-19 symptoms, use of face masks, cleaning and disinfection, ventilation, air filtration, air cleaning, and safety culture as well as other controls. Potential effectiveness reflects the relative magnitude of expected reduction on transmission rate or reproduction rate of SARS-CoV-2, if implemented widely and appropriately. In addition, the quality factor reflects the quantity and quality of relevant and applicable information and data available for each NPI. The potential effectiveness of each NPI has been developed by drawing upon the relevant scientific literature and the professional judgement of EH&E scientists and engineers. NPIs should be layered upon one another and used at the same time with several layers of safeguards working together to reduce potential transmission.

Table 12.1 Selected Non-Pharmaceutical Interventions for Control of Coronavirus Transmission and Their Potential Effectiveness Applicable to Day, Overnight, and Family Camp Settings			
Control Measure	Description	Potential Effectiveness ^a	Quality Factor ^b
Viral Testing and Symptom Screening			
Surveillance viral testing (molecular), 1-2 times per week	Once or twice-weekly surveillance of SARS-CoV-2 RNA for campers and camp staff can identify many cases while infectious. A turnaround time for test results of 1 day or less will allow cases to be isolated quickly and contacts to be minimized. Identification of close contacts and quarantining within 48 hours will reduce chance of transmission further. Modeling studies indicate that together these controls have the potential to reduce transmission by 50 – 80%. Surveillance with a test that can detect very low levels of the virus will likely identify non-infectious carriers of the virus as well, which could strain resources for contact tracing and quarantine.	High ^c	High
Prescreening and pre-camp behaviors	During the two weeks prior to reporting to camp all campers and staff should take steps to keep themselves and others around them healthy. Prescreening testing carried out within 7 days (or preferably 72 hours) prior to arrival at camp.	High ^c	Medium
Daily survey of COVID-like symptoms	Daily surveys of symptoms and temperature taking can identify people for follow-up who may be carrying SARS-CoV-2, but surveys will not control transmission before symptom onset or by cases that never exhibit symptoms. Approximately 40% of cases are thought to never develop symptoms.	Medium	High
Face Coverings			
Face coverings	Universal face covering use, especially indoors, is reported to reduce risk of transmission by up to 80%.	High	High
Eye protection	Safety glasses and goggles can block exposure to airborne SARS-CoV-2 and prevent the wearer from transferring SARS-CoV-2 to their eyes by touch.	Medium ^d	Medium
Face shields	Face shields can block ballistic transport of larger airborne respiratory droplets, but the open sides and bottom allow exit and entry of particles of the size reported to contain SARS-CoV-2.	Medium ^d	Low
Administrative Controls			
Outdoor activities	Provides greater space for physical distancing and substantially dilutes respiratory emissions; sunlight is reported to inactivate SARS-CoV-2.	High	High
Safety Culture	The ideas and beliefs that all members of the camp community (parents, staff, and campers) share about safety and health. Includes plans to build basic attitudes and habits of good behavior and a culture of compliance so that safety is a valued and key part of the camp operation.	High	High
Physical distance	Every three feet of physical distance is reported to lower the probability of transmission by one-half in the absence of other controls.	High	Medium
Decrease density	Fewer people per space than normal can reduce the probability that an infectious case is present in the space.	Medium	High
Cohorts	Restricting inter-person interactions to small groups can mitigate transmission by limiting the number of close contacts and facilitating contact tracing but this control alone will not directly impact risk of transmission among members of a cohort. In camp settings, cohorting may reduce the number of individuals that need to isolate/quarantine following close contact with an infected person.	High	Medium
Decrease loud vocalization indoors (i.e., singing)	Fewer loud vocalizations can reduce production of respiratory droplets and may lower emissions of SARS-CoV-2 from an infected person if present. Emissions of respiratory droplets during loud vocalizations are reported to be 3-fold greater than during normal speech and breathing.	Medium	Low
Avoid the 3 Cs	Modify start, stop, and transition times; food service schedules and modes of delivery; and other activities to avoid: 1) closed-off spaces with little ventilation, 2) crowded spaces with many people, and 3) close conversations.	Medium	Medium

Table 12.1 Continued			
Control Measure	Description	Potential Effectiveness ^a	Quality Factor ^b
Engineering Controls			
Ventilation	Delivery of outdoor air into occupied spaces per building code or better can lower room-average concentrations of respirable-size airborne particles and SARS-CoV-2, if present, and may reduce the risk of long-range transmission. Effectiveness likely constrained by HVAC system, operable windows and both hot/humid and cold outdoor air. Naturally ventilated and open-air camp buildings with multiple operable and screened doors and windows may provide adequate ventilation.	Medium	High
Cleaning and Disinfecting	According to CDC, droplets can land on surfaces and objects and be transferred by touch. A person may get COVID-19 by touching the surface or object that has the virus on it and then touching their own mouth, nose, or eyes. Spread from touching surfaces is not thought to be the main way the virus spreads. According to CDC, cleaning and disinfection is an important control for reducing the risk of exposure to COVID-19. The virus that causes COVID-19 can be killed with certain products, and EPA has compiled a list of disinfectant products that can be used against SARS-CoV-2.	Medium	High
Central filtration	Recirculation of indoor air through a mechanical ventilation system equipped with a high efficiency filter (e.g., MERV 13) can lower room-average concentrations of respirable-size airborne particles and SARS-CoV-2, if present, and may reduce risk of long-range transmission. Effectiveness likely constrained by HVAC system.	Medium	High
Portable air cleaners (HEPA)	Recirculation of indoor air through an in-room high efficiency filter (e.g., HEPA) can lower room-average concentrations of respirable-size airborne particles and SARS-CoV-2, if present, and may reduce risk of long-range transmission. Use may be impacted by noise levels and space availability. This NPI may be particularly useful in closed and poorly ventilated spaces.	Medium	High
Upper-room ultraviolet germicidal irradiation	Irradiation of indoor air with high-energy ultraviolet light can inactivate airborne SARS-CoV-2, if present, and may reduce risk of long-range transmission. Effectiveness may be limited in spaces with high ceilings.	Medium	High
Barriers or sneeze guards	A plexiglass or similar physical barrier between people may reduce exchange of respiratory droplets by capture or dilution.	Medium	Low
Directional airflow	Manage supply and exhaust air to minimize circulation of indoor air between zones; may control airborne transport of respiratory emissions and SARS-CoV-2 if present.	Low	Low
<p>Notes</p> <p>^a Reflects relative magnitude of expected effect on transmission rate or reproduction rate of SARS-CoV-2 transmission if implemented widely and appropriately.</p> <p>^b Reflects quantity and quality of relevant and applicable information and data.</p> <p>^c See Section 13.0 of the Field Guide for details on application in both day and overnight camp settings.</p> <p>^d Typically most applicable to staff and medical teams involved with close contact care as part of an overall personal protective equipment plan.</p>			

NPI EFFECTIVENESS IN CAMPS

Research on the effectiveness of NPIs on the prevention and mitigation of SARS-CoV-2 transmission among children and adolescents in camp settings was conducted during the 2020 summer camp season at four Maine overnight camps that had implemented a multilayered prevention and mitigation strategy (Blaisdell 2020). The four camps were reported to have

implemented several NPIs, including prearrival quarantine, pre- and post-arrival testing and symptom screening, cohorting, use of face coverings, physical distancing, enhanced hygiene measures, cleaning and disinfecting, and maximal outdoor programming.

Discussion from the research team stated that “Diligent use of multiple NPIs was successful in preventing and mitigating SARS-CoV-2 transmission in four Maine overnight camps. Although no single intervention can prevent SARS-CoV-2 transmission, a multilayered use of NPIs allowed camps to prevent transmission and quickly identify campers or staff members with SARS-CoV-2 infection to successfully mitigate spread.” In addition, the research team stated that the camps did not rely on testing as a sole NPI and that they incorporated a series of control strategies. The NPIs and control strategies listed in the research publication are similar to those outlined in Table 12.1 and provided throughout the Field Guide.

TRACKING INDICATORS

Camps should be prepared to make operational shifts based on a variety of community and on-camp conditions and performance indicators throughout the COVID-19 pandemic. These indicators will help Camps evaluate factors related to disease transmission in their region and at their Camp as well as the effectiveness of their COVID-19 NPIs. The example criteria suggested here are based upon review of research findings presented in the scientific literature, both preprints and peer-reviewed studies. NPIs should be layered upon one another and used at the same time with several layers of safeguards working together to reduce potential transmission. No one NPI is sufficient.

The Field Guide offers suggested metrics that may be tracked for determining ongoing risk and to facilitate decision making. The following Table 12.2 provides suggested metrics and example thresholds for overnight camp programs and Table 12.3 provides example metrics for day camp programs. These thresholds will differ between Camps based on factors such as size of the Camp, health services support, and specializations. Note that orders or requirements from state or local health authorities regarding models or criteria for operation would take precedence.

While these recommendations may help guide Camps in decision making, they have important limitations and may need to be adjusted based on changes in pandemic dynamics, additional infectious disease, or other local, regional or national factors. It is also important to note that every Camp is different. Camps should determine if and how to implement these metrics while adjusting them to meet their unique needs and circumstances and those of the local jurisdiction. Implementation should also be informed by what is feasible, practical and acceptable, which will be different for each Camp.

Table 12.2 Example Risk Metrics for Overnight Camp – Operational Decision Making During the COVID-19 Pandemic¹

Metric	Continue Operations	Improve Operations	Initiate Immediate Improvement or Consider Shutdown of Operations
Local Indicators ²			
Daily new cases	Decreasing or <10 new cases/100,000 people	10-25 new cases/100,000 people	>25 new cases/100,000 people
Percent positive tests	<5%	<5% and increasing trend	>5%
7-day moving average of new cases	Decline or remain steady	Increasing trend for 2 weeks	Increasing trend for more than 2 weeks
3-day moving average of new hospital admissions	Decline or remain steady	Increasing trend for 2 weeks	Increasing trend for more than 2 weeks
State/local requirements	No state/local order	State/local order to modify operations	State/local order to stop operations
Camp Indicators for Camp with Diagnostic Testing			
Number of new cases within 48 hours (must notify and work with local health officials) ³	0-2 positive cases identified with likely cohort/group ties. Close contacts quarantined.	≤3 cases in a single cohort/group. Cohort is tested and quarantined.	>3 cases in three or more different cohorts/groups. Consider shutdown for at least 14 days. Additional testing of all campers and staff.
Cases epidemiologically linked to at least one other case, weekly	>80% High confidence in containment	≤80%–50% Moderate confidence in containment	<50% Low confidence in containment
Percent positive tests	<5%	<5% and increasing trend	>5%
Diagnostic test turnaround time	≤1 day	2 days	>2 days
Time from diagnostic test specimen collection to isolation/quarantine	>80% within 48 hours	70%–80% within 48 hours	<70% within 48 hours
Camp Indicators for Camp with No Internal Diagnostic Testing but with Reported Testing Results			
Number of new cases within 48 hours (Camp notified by local health officials or by staff or parents/guardians) ³	0-2 positive cases reported to Camp with likely cohort/group ties. Close contacts quarantined.	≤3 cases in a single cohort/group reported to Camp. Cohort is tested and quarantined.	>3 cases reported to Camp in three or more different cohorts/groups. Consider shutdown for at least 14 days.
Cases epidemiologically linked to at least one other case, weekly	>80% High confidence in containment	≤80%–50% Moderate confidence in containment	<50% Low confidence in containment
Camp Indicators, Other Non-Pharmaceutical Interventions			
Face covering compliance	Almost Always	Sometimes	Infrequent/Never
Physical distancing compliance	Almost Always	Sometimes	Infrequent/Never
Daily symptom screening compliance	Almost Always	Sometimes	Infrequent/Never
Cohort Maintenance	Almost Always	Sometimes	Infrequent/Never
Outdoor Activities and Programming	Almost Always	Sometimes	Infrequent/Never
Hygiene stockpile (soap, hand sanitizer, and cleaning/disinfection products)	>4-week supply	2–4-week supply	<2-week supply
Critical health center PPE	>4-week supply	2–4-week supply	<2-week supply
Availability of isolation spaces	>75%	75%–50%	<50%
Critical staff levels (may include health services, counselors, dining and janitorial)	Normal	Moderate (Some absenteeism)	Low (Significant absenteeism)

Table 12.2 Continued

< less than
> greater than
≤ less than or equal to
PPE personal protective equipment

- ¹ Factors that may be tracked and considered in decision making for Camp operation status. Values may vary depending on camp size, type, and specialization. Non-Pharmaceutical Interventions (NPIs) should be layered upon one another and used at the same time with several layers of safeguards working together to reduce potential transmission. No one NPI is sufficient.
- ² Local indicators are related to SARS-CoV-2 transmission within the surrounding community to determine the possible risk of introduction and transmission of SARS-CoV-2 within the camp. These example metrics may need to be adjusted based on individual camp characteristics. For example, an overnight camp with a tight "bubble" may not need to weigh the health status of the surrounding community as heavily as an overnight camp with a high number of staff members that commute into and out of camp on a daily basis. Research [findings](#) show rates of COVID-19 cases for campers and staff were relatively low – even in areas with high community COVID-19 rates – and further demonstrate the importance of strict face covering and targeted physical distancing measures to reduce SARS-CoV-2 infection in campers and staff.
- ³ Camps with large populations and corresponding support services and facilities may be able to manage a larger number of cases.

Table 12.3 Example Risk Metrics for Day Camp – Operational Decision Making During the COVID-19 Pandemic¹

Metric	Continue Operations	Improve Operations	Initiate Immediate Improvement or Consider Shutdown of Operations
Local Indicators ²			
Daily new cases	Decreasing or <10 new cases/100,000 people	10-25 new cases/100,000 people	>25 new cases/100,000 people
Percent positive tests	<5%	<5% and increasing trend	>5%
7-day moving average of new cases	Decline or remain steady	Increasing trend for 2 weeks	Increasing trend for more than 2 weeks
3-day moving average of new hospital admissions	Decline or remain steady	Increasing trend for 2 weeks	Increasing trend for more than 2 weeks
State/local requirements	No state/local order	State/local order to modify operations	State/local order to stop operations
Camp Indicators for Camp with Diagnostic Testing			
Number of new cases within 48 hours (must notify and work with local health officials)	0-2 positive cases identified with likely cohort/group ties. Close contacts quarantined.	≤3 cases in a single cohort/group. Cohort is tested and quarantined.	>3 cases in three or more different cohorts/groups. Consider shutdown for at least 14 days. Additional testing of all campers and staff.
Cases epidemiologically linked to at least one other case, weekly	>80% High confidence in containment	≤80%–50% Moderate confidence in containment	<50% Low confidence in containment
Percent positive tests	<5%	<5% and increasing trend	>5%
Diagnostic test turnaround time	≤1 day	2 days	>2 days
Time from diagnostic test specimen collection to isolation/quarantine	>80% within 48 hours	70%–80% within 48 hours	<70% within 48 hours
Camp Indicators for Camp with No Internal Diagnostic Testing but with Reported Testing Results			
Number of new cases within 48 hours (Camp notified by local health officials or by staff or parents/guardians)	0-2 positive cases reported to Camp with likely cohort/group ties. Close contacts quarantined.	≤3 cases in a single cohort/group reported to Camp. Cohort is tested and quarantined.	>3 cases reported to Camp in three or more different cohorts/groups. Consider shutdown for at least 14 days.
Cases epidemiologically linked to at least one other case, weekly	>80% High confidence in containment	≤80%–50% Moderate confidence in containment	<50% Low confidence in containment
Camp Indicators, Other Non-Pharmaceutical Interventions			
Face covering compliance	Almost Always	Sometimes	Infrequent/Never
Physical distancing compliance	Almost Always	Sometimes	Infrequent/Never
Daily symptom screening compliance	Almost Always	Sometimes	Infrequent/Never
Cohort Maintenance	Almost Always	Sometimes	Infrequent/Never
Pick-up and Drop-off protocol compliance	Almost Always	Sometimes	Infrequent/Never
Timely Pick-up of Symptomatic Campers	Almost Always	Sometimes	Infrequent/Never
Outdoor Activities and Programing	Almost Always	Sometimes	Infrequent/Never
Availability of temporary and dedicated isolation spaces	Yes – dedicated room, tent, or building	Limited availability of dedicated space	No availability of dedicated space
Hygiene stockpile (soap, hand sanitizer, and cleaning/disinfection products)	>4-week supply	2–4-week supply	<2-week supply

Table 12.3 Continued

Camp Indicators, Other Non-Pharmaceutical Interventions (continued)			
Critical health center PPE	>4-week supply	2–4-week supply	<2-week supply
Critical staff levels (may include health services, counselor, dining and janitorial)	Normal	Moderate (Some absenteeism)	Low (Significant absenteeism)

< less than
 > greater than
 ≤ less than or equal to
 PPE personal protective equipment

¹ Factors that may be tracked and considered in decision making for Camp operation status. Values may vary depending on camp size, type, and specialization. Non-Pharmaceutical Interventions (NPIs) should be layered upon one another and used at the same time with several layers of safeguards working together to reduce potential transmission. No one NPI is sufficient.

² Local indicators are related to SARS-CoV-2 transmission within the surrounding community to determine the possible risk of introduction and transmission of SARS-CoV-2 within the camp. Research [findings](#) show rates of COVID-19 cases for campers and staff were relatively low – even in areas with high community COVID-19 rates – and further demonstrate the importance of strict face covering and targeted physical distancing measures to reduce SARS-CoV-2 infection in campers and staff.

KEY REFERENCES

- Surveillance viral testing (Kucharski et al., 2020; Larremore et al., 2020; Paltiel et al., 2020)
- Symptom screening (Burke et al., 2020; Menni et al., 2020; Richardson et al., 2020)
- Face masks (Chu et al., 2020; Hendrix et al., 2020; Leung et al., 2020; National Academies of Sciences, 2020; Prather et al., 2020; Wang et al., 2020)
- Eye protection (Chu et al., 2020)
- Face shields (Chu et al., 2020)
- Ventilation (Correia et al., 2020; Evans, 2020; Manassypov, 2020; Pantelic and Tham, 2013)
- Central filtration (Brown et al., 2014; Manassypov, 2020)
- Upper room UVGI (Nardell et al., 2008; Nardell and Nathavitharana, 2020; Walker and Ko, 2007)
- Meet outdoors (Nishiura et al., 2020; Qian et al., 2020)
- Physical distance (Chu et al., 2020; Courtemanche et al., 2020; Kucharski et al., 2020; MacIntyre, 2020)
- Cohorts (Benzell et al., 2020; Block et al., 2020; Leng et al., 2020; Marcus et al., 2020; Miller et al., 2020)
- Vocalization (Ai and Melikov, 2018; Asadi et al., 2020; Milton et al., 2013)
- Avoid 3 Cs. (Bromage, 2020; Fineberg, 2020; Leclerc et al., 2020)
- Overnight Camps (Blaisdell, 2020).
- Safety Culture (Cooper, 2000)

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LIMITATIONS

EH&E's advice, recommendations, guidance and work product is intended to augment and supplement all existing local, state and federal , laws, by-laws, regulations, and ordinances that may apply to the Client's work, workforce and places of work, such as, without limitation, all employment laws, and all U.S. Occupational Safety and Health Administration (OSHA), U.S. Environmental Protection Agency (EPA) and Americans with Disabilities Act (ADA) laws and regulations; therefore, where EH&E's advice, recommendations, guidance, and work product may overlap or touch upon existing laws and regulations, such advice and recommendations should be construed and interpreted in a manner that further defines existing duties and obligations, and assists in the implementation of policies and procedures to discharge those duties and obligations, and should not be construed or interpreted in a manner that lessens or diminishes existing duties and obligations.