COUNTY OF LOS ANGELES
Public Health

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April 23, 2019

Community Advisory Panel
Baldwin Hills Community Standards District
c/o County of Los Angeles Department of Regional Planning
320 W. Temple Street
Los Angeles, CA 90012

Dear Mr. McNeill and members of the Community Advisory Panel (CAP):

Thank you for your letter of April 4, 2019 sharing your concerns and recommendations regarding the next Health Assessment and Environmental Justice study for the Baldwin Hills Community. Please find below our responses to the points raised in your letter.

1. Provide a Clear Timeline and Definite Start Date for Phase 2; at a minimum officially complete Phase 1 and a timeline for the other Phases prior to June 30th.

We have appreciated the community's participation and patience as we work through these challenges. The Department of Public Health (DPH) is identifying funds for the health assessment. Once those funds are in place, DPH will establish a clearer timeline for Phase 2. We anticipate providing that timeline before June 30th. As we plan ahead, the Phase 3 timeline and scope will be dependent on the work and findings by the Steering Committee in Phase 2.

2. Provide an Update on the Process for Updating the Litigants.

We acknowledge and share the CAP's concern about concurrence from the litigants with the Health Assessment Plan. DPH is preparing a letter to update the litigants on the collaborative work done as part of Phase 1, and the plan to assemble a steering committee and develop a study design driven by community input from the CAP in coordination with The California Air Resources Board Study of Neighborhood Air near Petroleum Sources (CARB SNAPS). The letter will inform the litigants of DPH's primary goal to design the Health Assessment according to the needs and preferences of this community, and to leverage this unique opportunity to align chronologically with the CARB SNAPS study, which we anticipate will provide a wealth of useful data.

3. Provide the Community with Information Collected Thus Far and Updates on the Process.

Please find the requested documents attached for posting on the Baldwin Hills CSD webpage. We will be happy to work with the CAP to provide other updates for posting as appropriate.

Please feel free to contact me with any questions you may have.

Sincerely,

Cyrus Rangan MD FAAP FACMT

Cyrus Rangan, M.D., F.A.A.P., F.A.C.M.T.
Director, Toxicology and Environmental Assessment Branch
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cc: Supervisor Mark Ridley-Thomas, Second District
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Encl.

STUDYING THE POTENTIAL HEALTH EFFECTS OF LIVING NEAR OIL AND GAS DEVELOPMENT
EXAMPLES OF RESEARCH METHODOLOGIES FROM THE LITERATURE

Purpose: To provide examples of methods used to research this topic in the past five years to gain a sense of different approaches and their strengths and limitations.

Citation	1st author affiliation; source of funding	Purpose of the study	Methods	Findings	Some strengths and limitations of the approach*
1. Fryzek J, Pastula S, Jiang X, et al., 2013.[1]	EpidStat Institute (Ann Arbor, MI) America's Natural Gas Alliance grant	Evaluate whether childhood cancer incidence is associated with counties with hydraulic fracturing (Pennsylvania).	Retrospective study comparing cancer incidence in children by county before and after oil and gas drilling began. **Exposure measure** was based on number of oil and gas wells drilled by county and year from 1990-2009. **Outcome measure** was childhood cancers, leukemias, and CHS tumors from 1990-2009. Calculated standardized incidence ratios (SIRs) to compare the observed number of cancers with the number expected.	No evidence of increased incidence of cancer (i.e., SIRs were similar before and after drilling) in counties with drilling.	<u>Strengths</u> Used publicly available, valid data. <u>Limitations</u> Ecological study at county level. Level of analysis – childhood cancer rates by <u>county</u> – is large enough / sufficiently insensitive to obscure possible correlations. Study did not take into account lag time between exposure and development of cancer. Relatively few wells were being fracked by the time the study ended. Did not provide the number of fracked wells used in analysis. No individual-level information on exposure to hydraulic fracturing. Did not include any relevant covariates.
2. Steinzor N, Subra W, Sumi L, 2013.[2]	Earthworks' Oil & Gas Accountability Project Colcom Foundation	Investigate extent / types of health symptoms experienced by people living in "gas patches;" provide air and water quality testing; identify connections between health and proximity to gas facilities (Pennsylvania).	Cross-sectional Health Survey using some snowball sampling across counties of interest; environmental testing at homes among a subset of participants (24-hour air sampling and water). Rural and suburban residential communities. **Exposure measure** was based on self-reported proximity to three types of facilities (compressor and pipeline stations; gas-producing wells; impoundment or waste pits). Also assessed types and frequencies of odors via surveys.	Health symptoms reported by individuals living in homes where testing occurred matched the known health effects of chemicals detected in that home at an overall rate of 68%.	<u>Strengths</u> Study linked test results to surveys, which adds validity to symptom reports, particularly when symptoms match the chemicals found. Article does not claim to explore or establish causality. <u>Limitations</u> Findings based on self-report, including distance from facilities, which is likely very unreliable. Small sample size. Only sampled air for 24 hours – not clear how time frame relates to symptom reports. No frame of reference for how good a match 68% is.

Citation	1st author affiliation; source of funding	Purpose of the study	Methods	Findings	Some strengths and limitations of the approach*
			Outcome measure = checklist of health symptoms grouped into categories.		Study design does not allow inference about cause and effect.
3. McKenzie LM, Guo R, Witter RZ et al., 2014.[3]	CO School of PH CO School of PH: in-kind from CDPHE	Examine associations between maternal residential proximity to natural gas development (NGD) and birth outcomes (rural Colorado, 1996-2009). Limited analysis to rural areas and towns with <50K.	Retrospective cohort study of 124,842 births between 1996 and 2009 in rural CO. **Exposure measure** incorporated residential distance from wells and number of wells; created a 4- level variable. **Outcome measures** were heart and neural defects, oral cleft, preterm birth and low birth weight.	Compared to category with smallest number of wells per sq mile, odds of CHD for category with highest number of wells = 1.3 (95% CI 1.2, 1.5). Similar outcome for neural tube defects but marginal significance (95% CI includes 0 but p=.01 for trend). Other outcomes not related or in protective direction.	<u>Strengths</u> Exposure metric was weighted by well distance for every well within 10 miles of maternal residence; included 4 exposure groups. Outcome measure derived from hospital records and other valid sources. Covariates included maternal age, education, tobacco use, ethnicity, alcohol use, parity, infant sex, gestational age, elevation. <u>Limitations</u> Covariates were very limited and did not include income/SES or other environmental variables. Indirect exposure measurement. Assumes mother lived at same residence through entire pregnancy.
4. Jemielita T, Gertpon GL, Neidell M, et al., 2015.[4]	U Pennsylvania School of Medicine NIEHS	Examine association between wells and healthcare use by zip code from 2007 to 2011 in three counties. (Pennsylvania). Note: Total population across 3 counties = 157,311.	Ecological study (observational, correlational) comparing active wells and inpatient prevalence rates **Exposure measure**: Number of active wells in zip code at the time of hospitalization. Also looked at wells per square kilometer. **Outcome measure**: Inpatient counts for 25 different medical categories.	The number of wells in a zip code and the density of wells per k^2 was positively associated with the cardiology hospitalizations. The density of wells per k^2 was positively associated with neurology hospitalizations. Dermatology and neonatal hospitalizations were also positively associated with wells, but these associations did not achieve statistical significance after Bonferroni correction.	<u>Strengths</u> Exposure metric included well density. Outcome data derived from hospital records. Dose-response relationship identified. Analysis took number of new wells each year into account. Corrected for multiple comparisons. <u>Limitations</u> Ecological study at zip code level, may not accurately reflect exposure. Specific confounders not evaluated – unable to rule out potentially associated 3rd variables. Study found decreasing rates of hospitalizations for two other outcomes which were unexplained, suggesting that not all variables responsible for changes in prevalence rates were controlled.

Citation	1st author affiliation; source of funding	Purpose of the study	Methods	Findings	Some strengths and limitations of the approach*
5. Rabinowitz PM, Slizovskiy IB, Lamers V, et al., 2015[5]	Yale U School of Medicine Heinz Endowments, Schmidt Family Foundation, Clancil Foundation, Jan Stolwijk Fellowship fund, Yale CTSA, NIH	Examine the relationship between household proximity to natural gas wells and reported health symptoms (Washington County, Pennsylvania). Included focus on ground water. Avoided urban areas.	Cross-sectional, random-sample interviewer-administered survey. **Exposure measure** was distance from nearest active gas well (<1 km, 1-2 km, >2 km); incorporated age of well. **Outcome measures** were dermal, upper respiratory, lower respiratory, gastrointestinal, neurological, dermal, and cardiovascular symptoms.	Respondents who lived closer to wells (<1 km, 1-2 km) reported more symptoms than did those living >2 km from the nearest well. Those living <1 km from the nearest well had higher odds of reporting dermal symptoms (OR=4.13, 95% CI 1.38, 12.3) and upper respiratory symptoms (OR 3.10, 95% CI 1.45, 6.65) compared with those living >2 km from the nearest well.	<u>Strengths</u> Adjusts for main confounders. Random selection of households; decent response rate (71%). Adjusted for environmental awareness (bias) and results held. <u>Limitations</u> Due to exploratory nature of the study, did not correct for multiple comparisons. Indirect exposure measurement. Outcome measure based on self-report. Awareness bias – people aware of the oil and gas activity were more likely to report health symptoms. Differential participation rate by proximity to oil and gas activity may have introduced bias. Difficult to rule out a different reason for the findings.
6. Stacy SL, Brink LL, Larkin JC, et al., 2015.[6]	University of Pittsburg Graduate SP Heinz Endowments	Investigate the association of proximity to unconventional gas drilling (UGD) and perinatal outcomes in three counties (Pennsylvania).	Retrospective cohort study of 15,451 live births in Southwest Pennsylvania from 2007-2010. **Exposure measure** incorporated residential distance from wells and number of wells. Created a 4-level variable based on quartiles. **Outcome measures** were birth weight, size for gestational weight.	Infants in highest exposure quartile had lower birth weight than those in the first quartile. There appeared to be a dose-response increase in babies being small for gestational age across exposure quartiles, but the only difference that was significant was between the first and fourth quartiles.	<u>Strengths</u> Replicated exposure metric from McKenzie 2014 study: Exposure metric was weighted by well distance for every well within 10 miles of maternal residence; included 4 exposure groups. Outcome measure derived from hospital records and other valid sources. Adjusted for a variety of potential confounders. <u>Limitations</u> Indirect exposure measurement. Assumes mother lived at same residence through entire pregnancy. There may be other confounders that were not controlled, including rural, suburban, or urban setting.

Citation	1st author affiliation; source of funding	Purpose of the study	Methods	Findings	Some strengths and limitations of the approach*
					20% of birth certificate records did not have a geocodable address and were excluded from analysis. Did not have exact birth date; exposure measure used new and existing wells during the birth year. Cannot rule out an alternative explanation for the findings.
7. Casey JA, Savitz DA, Rasmussen SG, et al., 2016. [7]	Johns Hopkins SPH National Institute of Environmental Health Sciences (NIEHS), Degestein Foundation, RWJ Foundation, National Science Foundation (NSF)	Examine associations between birth outcomes and natural gas production activities (Pennsylvania).	Retrospective cohort study using electronic health record data on 9382 mothers linked to 10946 neonates in the Geisinger Health System 2009-2013 delivered at 2 hospitals in central and northeast PA. **Exposure measure** incorporated well phase, location, total depth, daily gas production, residential distance from wells, dates and durations of well-pad development, drilling and fracking, and production volume during pregnancy. **Outcome measures** were birth weight, preterm birth, Apgar score, size for gestational age.	Mothers with higher exposure scores (those who lived nearer to more active wells and drilling activity) were more likely to give birth pre-term and to have a high-risk pregnancy.	<u>Strengths</u> Exposure measure stronger than others because it incorporated a variety of production variables. Outcome measure derived from valid sources. Adjusted for a variety of relevant, potential confounders, including environmental factors (e.g., distance to nearest major road). Dose-response evidence for preterm birth. <u>Limitations</u> Indirect exposure measurement. Assumes 2013 addresses same as during pregnancy (including those going back to 2009); however, 2010 addresses were correlated (~85%) with 2013 addresses.
8. Rasmussen SG, Ogburn EL, McCormack M, et al., 2016.[8]	Johns Hopkins SPH	Evaluate associations between UNGD and asthma exacerbations (Pennsylvania).	Nested case-control study comparing patients with asthma with and without exacerbations from 2005 through 2012. **Cases (outcome)** were patients with asthma aged 5 to 90 years (n = 35 508) identified in electronic health records; those with exacerbations were frequency matched on age, sex, and year of event to those without.	Compared to very low activity on 4 different activity metrics (pad, spud, stimulation, production) higher activity on the measures was associated with increased odds of all 3 different levels of asthma exacerbation.	<u>Strengths</u> Large sample size from a representative population. Outcome measure based on health plan data. Stronger exposure measure because it incorporates different measures of oil field activity. Adjusted for a variety of relevant, potential confounders, including environmental factors (e.g., distance to nearest major road).

Citation	1st author affiliation; source of funding	Purpose of the study	Methods	Findings	Some strengths and limitations of the approach*
	NIEHS, RWJ Foundation, Degenstein Foundation, NSF		**Exposure measure** incorporated 4 phases (pad prep, drilling, stimulation, and production), residential distance, well characteristics, and dates and durations of phases on the day before each patient's index date (for cases, date of event or medication order; for controls, contact date).		<u>Limitations</u> Indirect exposure measure. Only used most recent patient address. Only patients at one health care provider.
9. Currie J, Greenstone M, Meckel K, 2017.[9]	Princeton University	Evaluate the potential health impacts of fracking on newborn health, 2004-2013 (Pennsylvania; excludes Philadelphia).	Retrospective study using birth records and well data from the state of Pennsylvania. **Exposure measure** was based on distance of wells, number of wells in different distance categories, and "spud" date to compare before and after onset of well activity. **Outcome measures** were low birth weight (yes/no) and an infant health index that combined several different health indicators.	For mothers living within 1 km of one or more active wells, there was a 25% increase in the probability of low birth weight, and significant declines in average birth weight and the index of infant health. There were also reductions in infant health for mothers living within 1 to 3 km of a fracking site, but the estimates are reduced. No evidence for health effects beyond 3 km.	<u>Strengths</u> Large sample size from a representative population. Stronger exposure measure because it incorporates distance, number of proximate wells, and well activity. Adjusted for many relevant confounders. Reliable data from official sources.
	John D. and Catherine T. MacArthur Foundation; Environmental Protection Agency grant #EPA G2009-STAR-B1				<u>Limitations</u> Indirect exposure measurement. Did not control for income or other environmental variables.
10. McKenzie LM, Allshouse WB, Byers TE, et al., 2017.[10]	CO School of PH	Explore whether residential proximity to oil and gas development was associated with risk	Registry-based case control design **Cases (outcome)** were children and youth ages 0-24 diagnosed with acute lymphocytic leukemia (ALL) or non-Hodgkins lymphoma (NHL) between	Cases aged 0-24 were more than twice as likely as controls to live in areas with active oil and gas wells within 16.1 km of their residence during the latency period after	<u>Strengths</u> Used case-control design with objective outcome measure based on institutional data. Accounted for latency period between exposure and onset of cancer.

Citation	1st author affiliation; source of funding	Purpose of the study	Methods	Findings	Some strengths and limitations of the approach*
		for hematologic cancers (rural Colorado).	2001-2013 in rural areas and towns with <50K population. Controls were children and youth of the same age diagnosed with non-hematologic cancers. All cases and controls were identified through the Colorado Central Cancer Registry. **Exposure measure** used inverse distance weighted well count to estimate well density for active wells (based on spud date in year of diagnosis and up to 10 years prior), compared to geocoded residential address	adjusting for age, race, gender, income, and elevation (no association for children aged 0-4). No association between density of oil and gas development and NHL.	Analyses controlled for a variety of relevant potential confounders.
	National Science Foundation; in-kind from CO DPH; cancer data=CDC Cooperative Agreement				<u>Limitations</u> Used an indirect measure of exposure. Controls were children and youth with other cancers, not healthy controls. Significant missing data on some variables. Used patient address at time of diagnosis which doesn't account for time at address. Not able to control for maternal smoking during pregnancy.
11. Tustin AW, Hirsch AG, Rasmussen SG, et al., 2017[11]	Johns Hopkins SPH	Examine associations between unconventional natural gas development (UNGD) activity and symptoms in a cross-sectional study (Pennsylvania).	Cross-sectional study using self-administered questionnaire; case-control analysis. **Cases (outcome)** were those who reported chronic rhinosinusitis, migraine, or higher levels of fatigue. **Exposure measure** incorporated well phase, location, total depth, daily gas production, residential distance.	No associations when outcome examined individually; positive association for 2 or more outcomes. Comparing highest to lowest quartile of UNGD activity: no single symptom differed significantly, but: Odds of people in highest quartile reporting both chronic rhinosinusitis and fatigue compared to people in lowest quartile = 1.88 (95% CI 1.08, 3.25); Odds of reporting migraine and fatigue were 1.95 (95% CI 1.18, 3.21); Odds of reporting all three 1.84 (95% CI1.08, 3.14).	<u>Strengths</u> Stronger exposure measure – based on well phase / activity, depth, production, and distance from respondent. Adjusted for some confounders; some of these were based on hospital records and institutional data. Conducted sensitivity (specificity?) analyses that supported major findings; looked at proximity to major roadway. Because analysis was secondary, respondents did not know study was about gas development.
	NIH, RWJ Foundation, Degenstein Foundation, NSF				<u>Limitations</u> 33% participation rate. Cross-sectional study. Non-matched controls; control group excluded participants with milder symptoms (?). Indirect exposure measurement. Outcome measure based on self-report. Some evidence of selection bias (participants had poorer health than non-responders).

Citation	1st author affiliation; source of funding	Purpose of the study	Methods	Findings	Some strengths and limitations of the approach*
12. Weinberger B, Greiner LH, Walleigh, et al., 2017.[12]	Southwest Pennsylvania Environmental Health Project (EHP) Heinz Endowments	Describe the symptoms reported in a sample of Pennsylvania residents who lived in close proximity to unconventional gas wells in 3 counties (Pennsylvania).	Retrospective review of 135 health assessment records of individuals who lived in the Marcellus Shale region of the U.S. **Exposure measure**: Based on number of wells within 1 km of residence and spud dates of wells. **Outcome measure**: Health data collected by the EHP as a service for residents concerned about health impacts of UOGD who sought evaluation by a health care provider. Symptoms had to occur after spud date and if another plausible cause for the symptom existed in the record (e.g., smoking) the symptom was excluded. included	Although all 51 clients reported one or more symptoms, symptoms reported by 19 participants (37%) did not qualify for inclusion. Thus, 32 participants (63% reported symptoms deemed plausibly related to UOGD. Most commonly reported symptoms were sleep disruption (43%), headache (41%), throat irritation (39%), stress anxiety (37%), cough (33%), shortness of breath and sinus problems (both 29%), fatigue and nausea (both 24%), wheezing and itchy eyes (both 22%).	<u>Strengths</u> Health data were collected by health care provider and included critical review for plausibility and timing of exposure. Exposure measure obtained from valid source. <u>Limitations</u> Used convenience sample, main purpose of which was to report symptoms due to UOGD exposure. Small sample size. No comparison group. Symptoms were self-reported (possible recall bias for onset date). Indirect exposure measurement. Not possible to rule out other causes for symptoms.
13. Whitworth KW, Marshall AK, Symanski E, 2017.[13]	UTHealth SPH, San Antonio NIEHS, NIOSH, CDC	Assess association between maternal residential proximity to unconventional gas development (UGD) activity and perinatal outcomes, considering timing of UGD activity relative to pregnancy. Also examined the characterization of proximity to UGD activity according to several distance criteria (urban Texas).	Retrospective birth cohort study of 158,894 singleton births or fetal deaths between 11/30/2010 – 11/29/2012 in 24-county Barnett Shale area of North Texas. **Exposure measure** was based on number and distance of active wells (based on SPUD or related date) within ½, 2, and 10 mile radii (split into tertiles) of maternal residential address during 1/1/2010-11/29/2012. **Outcome measures** included fetal death, small size for gestational age, pre-term birth, and birth weight.	Adjusted odds of preterm birth were significantly higher for women in the 3rd tertile of UGD activity within each buffer zone (ORs 1.14, 1.14, 1.15 for ½, 2, and 10 mile radii, respectively, all p's <0.05). Adjusted odds of fetal death were significantly higher in the 2nd tertile of UGD activity for the 2-mile buffer zone and the 3rd tertile of UGD activity for the 10-mile buffer (ORs 1.56 and 1.34, respectively, both p's <0.05).	<u>Strengths</u> Large sample size from a representative population. Used reliable sources of data for both exposure and outcome measures. Analysis controlled for a variety of confounders. <u>Limitations</u> Findings for fetal death are difficult to interpret because they are not internally consistent. Indirect exposure measurement. Used patient address at time of birth or fetal death which doesn't account for time at address.

Citation	1st author affiliation; source of funding	Purpose of the study	Methods	Findings	Some strengths and limitations of the approach*
14. Elliott EG, MA X, Leaderer, et al., 2018[14]	Yale University School of Public Health Yale Institute of Biospheric Studies; Jan A.J. Stolwijk Fellowship	Explore association between residential proximity to UO&G wells and drinking water contaminants, health symptoms (Belmont County, Ohio).	Interviewer-administered survey with 66 residents, geocoded distance from wells, and residential water testing. **Exposure measure**s included proximity to oil and gas wells, and chemicals found in residential drinking water. Proximity incorporated residential distance from wells and number of wells. **Health outcomes** included those with short latency: respiratory, dermal, neurologic, gastrointestinal, and general symptoms.	Levels of chemicals generally did not reach US EPA enforceable max contaminant levels; however, some chemicals detected are known or possible carcinogens with no established safe level of exposure. All homes had at least one VOC or GRO (gasoline range organics) above detection limits. Residential proximity of UO&G wells was associated with higher levels of drinking water contaminants. Residential proximity of UO&G wells was associated with higher levels of general symptoms (stress, fatigue), but not other health outcomes.	<u>Strengths</u> Water samples and chemical analysis are objective measures; analysis allowed for detection of chemicals at very low levels. <u>Limitations</u> Small sample size (N=66). Study design cannot conclude that oil and gas activities are the cause of water contaminants. By design the study sample was biased, so results cannot be generalized to other populations. Indirect measure of exposure; did not compare water contamination levels to health outcomes. Not clear if setting is rural, suburban, or urban. Contaminants found in water could be due to some other source than UO&G.
15. Shamasunder B, Collier-Oxandale A, Blickley J, et al., 2018[15]	Occidental College Schmidt Family Foundation, NSF	Examine association between oil production activities and self-reported asthma in 2 south LA neighborhoods. Also pilot tested low-cost sensors. (Los Angeles / urban)	Community-based participatory study using interviewer-administered survey of randomly selected residents (+snowball sample) living within a 1500 ft. radius of two drill sites (Jefferson and Allenco) located in densely populated neighborhoods. Comparisons were made to rates in SPA 6 and County-wide. Compared methane levels across at Jefferson and a control site. **Exposure measure**: All respondents were considered exposed based on living within the designated radius. **Outcome measures:** self-reported physician-diagnosed asthma and asthma hospitalizations.	Self-reported asthma rates were higher in both Jefferson and Allenco neighborhoods than SPA 6; and higher in Jefferson than LA County. No significant differences were found in hospitalizations. Methane readings were mostly similar between Jefferson and the control site, except for periods of elevated methane at Jefferson site lasting 10 minutes to 3 hours, indicating an emission source.	<u>Strengths</u> Survey used validated questions and comparison groups from ongoing state-wide study. Used community-based participatory research (CBPR). Used low-cost sensors to test for methane emissions. <u>Limitations</u> Outcome measure based on self-report. Indirect exposure measurement. Only controlled for demographics. Awareness bias (different patterns of response from people who knew oil facility was there compared to people who did not).

Citation	1st author affiliation; source of funding	Purpose of the study	Methods	Findings	Some strengths and limitations of the approach*
16. Willis MD, Jusko TA, Halterman JS, et al., 2018.[16]	Oregon State University School of Biological and Population Health Sciences NIH Office of the Director	Quantify the association between UNGD and pediatric asthma hospitalizations by zip code in natural gas producing counties (Pennsylvania).	Retrospective analysis of pediatric hospitalizations from 2003 through 2014 by zip code. **Exposure measure** used three different metrics based on existing wells, newly drilled wells, and counts of wells ever drilled. Also used a database of chemicals emitted, as reported by operators (in tons per year; also calculated by zip code). **Outcome measure:** Pediatric asthma hospitalizations from a state database by year and quarter for 3 age groups between 2-18 years. Excluded counties qualified as urban due to differences in urban vs. rural air quality.	Children residing in a zip code with newly spudded wells were 1.25 times as likely to experience an asthma-related hospitalization compared to children living in a county with no newly spudded wells. Children residing in a zip code with any current or previous drilling activity were 1.19 times as likely to experience an asthma-related hospitalization compared to children living in a county with no drilling activity. Compared to children residing in zip codes with the lowest tertile of number of wells ever drilled in their zip code, children residing in zip codes with the highest tertile of wells ever drilled were 1.39 times as likely to experience an asthma-related hospitalization. The findings above were strongest for children aged 2-6. Overall, there were consistent increased risks of pediatric asthma hospitalizations across most models when comparing lowest to highest quintiles of emissions.	<u>Strengths</u> Controlled for other respiratory hazards from mobile and stationary sources (no other study did this). Objective measure of emissions and hospitalizations. Used difference-in-differences analysis which takes time trends into account. <u>Limitations</u> Although the exposure measure is stronger than many other studies, it is still an indirect measure at zip code level, and it its validity is unknown.

*Not an exhaustive list of all strengths and weaknesses. Strengths and limitations based <u>partially</u> on report from Colorado Department of Public Health & Environment, 2017: Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado.

[1] Fryzek J, Pastula S, Jiang X, Garabrant DH, 2013. Childhood cancer incidence in Pennsylvania counties in relation to living in counties with hydraulic fracturing sites. Journal of Occupational and Environmental Medicine, 55; 796-801.

[2] Steinzor N, Subra W, Sumi L, 2013. Investigating links between shale gas development and health impacts through a community survey project in Pennsylvania. New Solutions, 23: 55-83.

[3] McKenzie LM, Guo R, Witter RZ et al., 2014. Birth outcomes and maternal residential proximity to natural gas development in rural Colorado. Environmental Health Perspectives, 122: 412-7

[4] Jemielita T, Gerton GL, Neidell M, et al., 2015. Unconventional gas and oil drilling is associated with increased hospital utilization rates. PLoS One 10: e0131093. doi:10.1371/journal.pone.0131093.

[5] Rabinowitz PM, Slizovskiy IB, Lamers V., et al., 2015. Environmental Health Perspectives, 123:21-26.

[6] Stacy SL, Brink LL, Larkin JC, et al., 2015. Perinatal outcomes and unconventional natural gas operations in southwest Pennsylvania. PLoS One 10: e0126425. doi:10.1371/journal.pone.0126425.

[7] Casey JA, Savitz DA, Rasmussen SG, et al., 2016. Unconventional natural gas development and birth outcomes in Pennsylvania, USA. Epidemiology, 27:163-172.

[8] Rasmussen SG, Ogburn EL, McCormack M, et al., 2016. Association between unconventional natural gas development in the Marcellus shale and asthma exacerbations. JAMA Internal Medicine, 176; 1334-1343.

[9] Currie J, Greenstone M, Meckel K, 2017. Hydraulic fracturing and infant health: New evidence from Pennsylvania. Science Advances 3: e1603021. DOI: 10.1126/sciadv. 1603021.

[10] McKenzie LM, Allshouse WB, Byers TE, et al., 2017. Childhood hematologic cancer and residential proximity to oil and gas development. PLoS ONE 12: e0170423. doi:10.137/journal.pone.0170423.

[11] Tustin AW, Hirsch AG, Rasmussen SG, et al., 2016. Associations between unconventional natural gas development and nasal and sinus, migraine headache and fatigue symptoms in Pennsylvania. Environmental Health Perspectives, 125:189-197.

[12] Weinberger B, Greiner LH, Walleigh L, Brown D, 2017. Health symptoms in residents living near shale gas activity: A retrospective record review from the Environmental Health Project. Preventive Medicine Reports, 8: 12-115.

[13] Whitworth KW, Marshall AK, Symanski E, 2017. Maternal residential proximity to unconventional gas development and perinatal outcomes among a diverse urban population in Texas. PLoS ONE 12: e0180966. doi:10.1371/journal.pone.0180966.

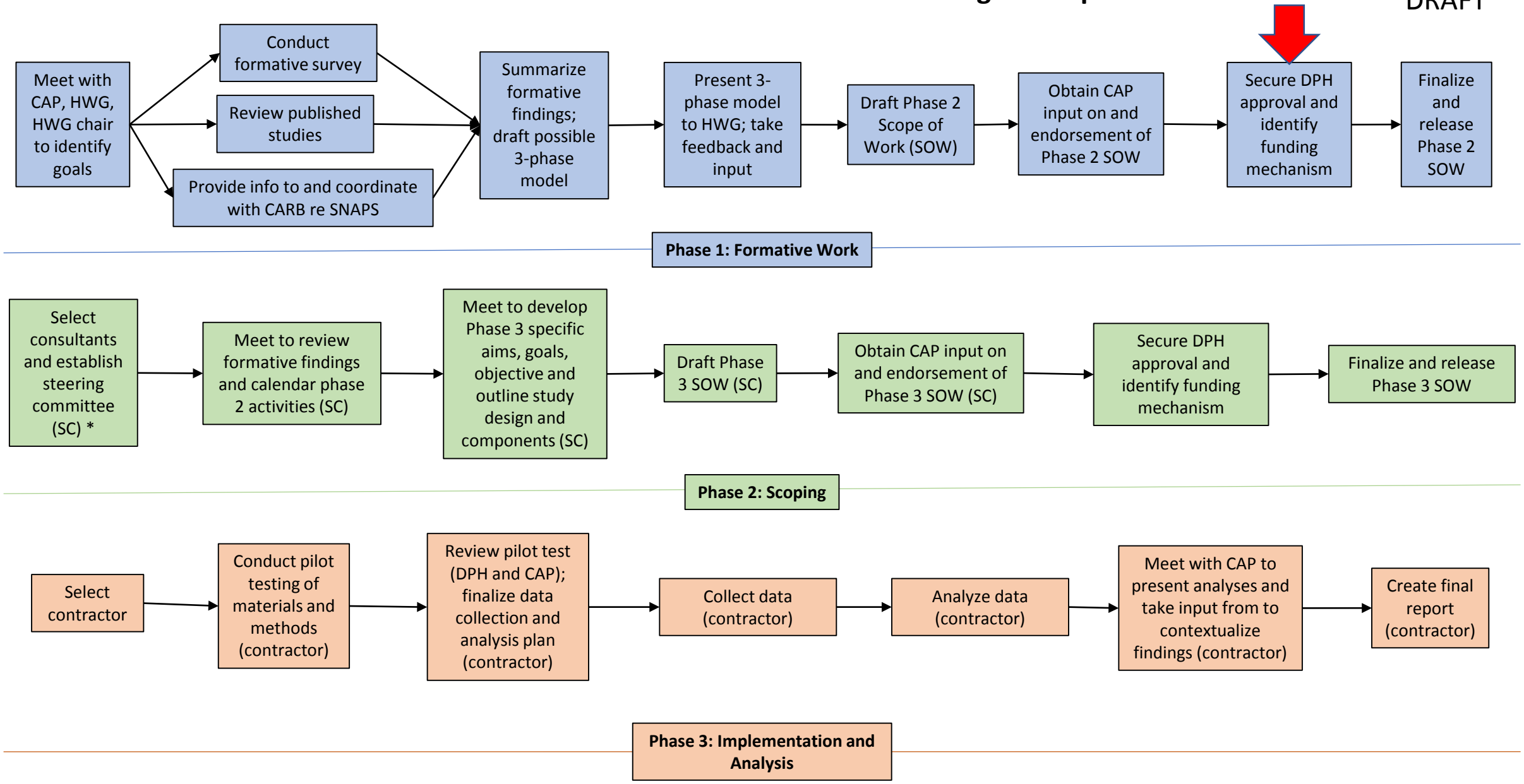
[14] Elliott EG, MA X, Leaderer BP, et al., 2018. A community-based evaluation of proximity to unconventional oil and gas wells, drinking water contaminants, and health symptoms in Ohio. Environmental Research, 167: 550-557.

[15] Shamasunder B, Collier-Oxandale A, Blickley J, Sadd J, Chan M, Navarro S, Hannigan M, Wong NJ. Community-based health and exposure study around urban oil developments in south Los Angeles. International Journal of Environmental Research and Public Health, 15, 138; doi:10.3390/ijerph15010138.

[16] Willis MD, Jusko TA, Halterman JS, et al., 2018. Unconventional natural gas development and pediatric asthma hospitalizations in Pennsylvania. Environmental Research, 166: 402-408.

Baldwin Hills CAP Assessment: Draft overview diagram of process

DRAFT



*Steering committee to consist of up to 3 academic experts; CAP health working group members; DPH staff; CARB representative.

1/18/19