Hydraulic Fracturing Stimulations and Oil Drilling Near California Schools and within School Districts Disproportionately Burdens Hispanic and Non-White Students.

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Executive Summary

In California, 352,724 students attend school within one mile of oil and gas well, including 217 wells known to be stimulated using hydraulic fracturing, acidizing and gravel-packing.

Currently, California state law does not limit how close industry may place unconventional oil wells next to sensitive land uses like schools, hospitals, or residential housing. California state law and corresponding regulations do not limit where industry may drill. The regulations do not require industrial operators or state officials to give notice to students, parents, teachers or school officials at schools near fracking or unconventional oil extraction. Further, California regulations do not require state officials to consider a proposed well's physical proximity to sensitive land uses like schools in their permit review process. Additionally, community residents, students, and school officials are not provided an opportunity to participate in the process of siting, approving or denying wells in their area.

In this analysis, California schools and school districts were mapped to explore the spatial distribution of oil and gas wells and the relationship to demographics in schools and school districts. For the analysis two separate oil and gas well categories were defined; "Active/New Wells," which includes all actively producing and newly permitted oil and gas wells, and "Stimulated Wells," which only includes oil and gas wells known to have been stimulated using hydraulic fracturing (fracking), acidizing, or gravel-packing. The results show that Hispanic and non-white students predominantly attend schools with more oil and gas drilling and stimulation.

Key Findings:

- There are 485 active/new oil and gas wells within 1 mile of a school and 177 active/new oil and gas wells within 0.5 miles of a school
- There are 352,784 students who attend school within 1 mile of an oil or gas well, and 121,903 student who attend school within 0.5 miles of an oil or gas well.
- There are 78 stimulated wells drilled within 1 mile of a school and 14 stimulated wells drilled within 0.5 miles of a school.
- There are 61,612 students who attend school within 1 mile of a stimulated oil or gas well, and 12,362 students who attend school within 0.5 miles of a stimulated oil or gas well.
- School Districts with greater Hispanic and non-white student enrollment are more likely to contain more oil and gas drilling and stimulation.
- Schools campuses with greater Hispanic and non-white student enrollment are more likely to be closer to more oil and gas drilling and stimulation.
- Students attending school within 1 mile of oil and gas wells are predominantly non-white (79.6%), and 60.3% are Hispanic.
- The top 11 school districts with the highest well counts are located the San Joaquin Valley with 10 districts in Kern County and the other just north of Kern in Fresno County.
- The two districts with the highest well counts are in Kern County; Taft Union High School District, host to 33,155 oil and gas wells, and Kern Union High School District, host to 19,800 oil and gas wells.
- Of the schools with the most wells within a 1 mile radius, 8/10 are located in Los Angeles County.

Introduction

In California, there are approximately 82,000 new and active oil and gas wells as well as at least 3,014 stimulated wells. These wells are predominantly located in Southern California, including Kern, Los Angeles and Ventura counties. A growing number of scientific studies have identified public health threats resulting from oil and gas development, including hydraulic fracturing. Recent research in Pennsylvania shows increased incidences of skin rashes and respiratory problems for residents living closer (within 2/3 of a mile) to hydraulic fracturing operations[i]. Studies by the U.S. Agency for Toxic Substances and Disease Registry have found elevated levels of carcinogens near hydraulic fracturing operations; researchers in Colorado found an increased risk of health issues resulting from degraded air quality for those living within 0.5 miles of a gas well; and researchers in Manitoba linked increased cancer rates and illness to development of the Athabasca Oil Sands.[ii,iii,iv]Another study in Colorado found an increased incidence of birth defects for mothers living within 0.5 miles of an oil or gas well, including congenital heart defects.[v] A recent study by the Natural Resources Defense Council found that 5.4 million Californians live within a mile of an active or new oil or gas well and 92% of these Californians are people of color.[vi]

Children are the most vulnerable to these impacts. The same amount of contaminants entering a child's body as opposed to an adult body, will result in a higher internal dose, and are therefore more acutely toxic. Children respire at a higher rate than adults and their metabolic rates are higher thus they consume more food in proportion to body size. Ambient pollution will therefore result in an increased exposure in children. A child's hormonal and neural pathways are susceptible to chemical interactions. Children's exposure patterns are also much different from adults, as they are much closer to the physical ground, and during the fall, spring and winter they spend much of their time at a central shared location, the school campus.[vii]

Note from Madeline Stano, Legal Counsel at the Center for Race, Poverty and the Environment:

Currently, California state law does not limit how close industry may place unconventional oil wells next to sensitive land uses like schools, hospitals, or residential housing. California state law and corresponding regulations do not at all limit where industry may drill and merely require notification that drilling will occur to parties nearby. However, this notification requirement only extends to landowners and tenants of properties neighboring wells. The regulations do not require industrial operators or state officials to give notice to students, parents, teachers or school officials at schools near fracking or unconventional oil extraction. California regulations do not even require state officials to consider a proposed well's physical proximity to sensitive land uses like schools in their permit review process. Additionally, community residents, students, and school officials are not provided an opportunity to participate in the process of siting, approving or denying wells in their area.

The majority of states around the country do require setback distances for unconventional oil and gas extraction. Fracking occurs in 32 states, and only 11 of them including California[1] do not require setback limits or protections for sensitive land uses. California is the third largest oil producing state in the country with the majority of our current production from conventional extraction. The first and second largest oil producing states, Texas and North Dakota, both require setback limits for unconventional extraction. Similarly, other heavy oil producing states in the Gulf Coast like Louisiana and Alabama also have setback requirements stricter than California.

Yet, specific protections to protect the health of children attending schools from industrial activities do not exist for the oil and gas industry in California. A recent report released by the research organization Shale Test, showed elevated concentrations of carcinogens and air toxics at playgrounds located near oil and gas wells in Northern Texas.[viii] In California's San Joaquin Valley, where much of the oil and gas activity has been occurring and is expanding, Hispanic students have been shown to bear disparate exposures to pesticides, the health effects of which include neural and respiratory disorders, birth defects, and death.[ix] Coincidentally, the San Joaquin Valley is also host to over 82% of California's active oil and gas wells. In areas with similar scales of oil and gas development, the U.S. Environmental Protection Agency, the Utah Department of Environmental Quality, The City of Dish, TX, and most recently the organization ShaleTest– among others -- have identified elevated levels of air pollutants including ozone, VOC's such as BTEX, diesel particulate matter, and other air toxics in ambient air as a result of oil and gas well development, stimulation, and during production.[x,xi,xii]

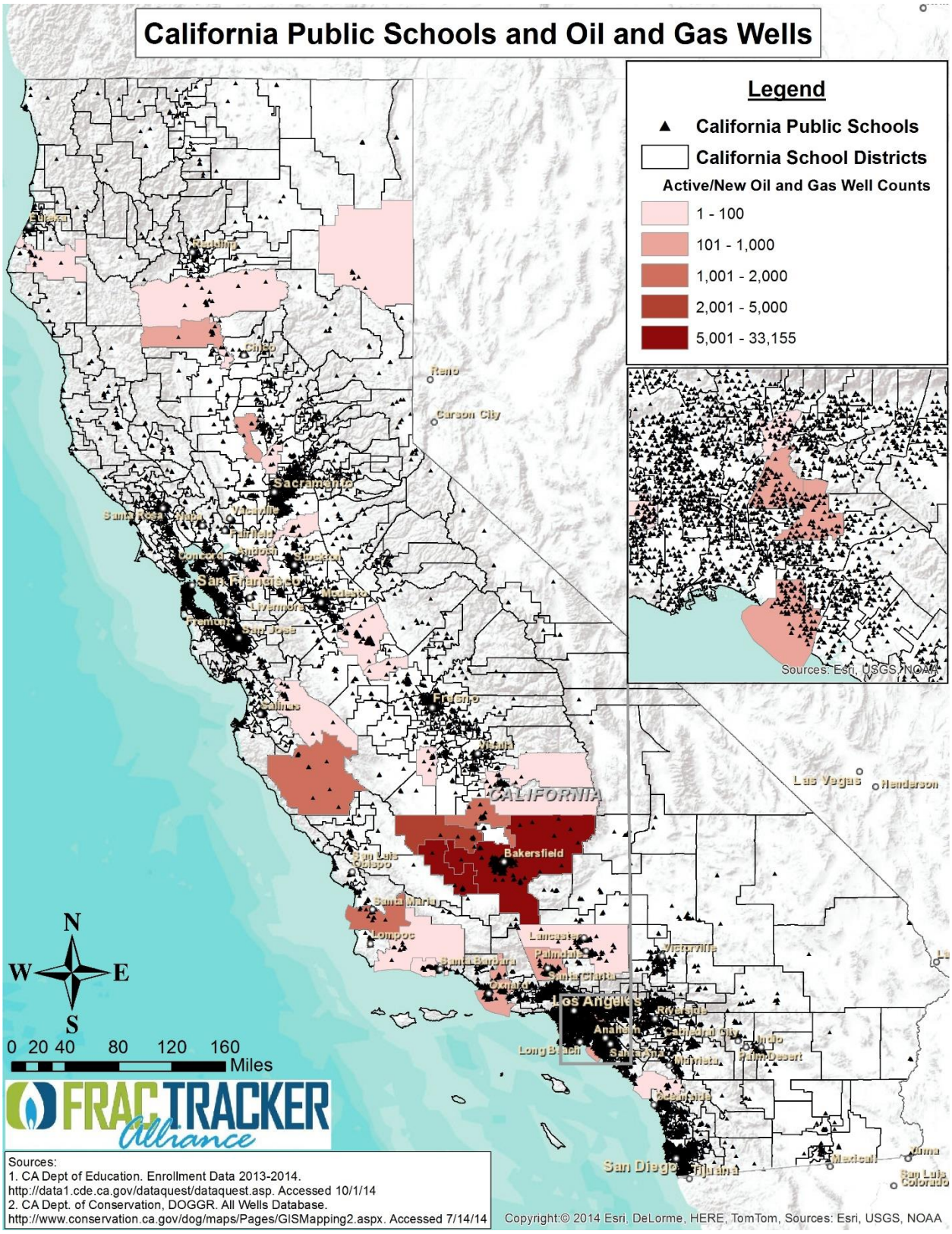

Figure 1. The Locations of schools in California are mapped with counts of active/new oil and gas wells in school districts.

To begin the discussion of disparate impacts resulting from oil and gas resource development in California, schools and school districts with oil and gas wells were mapped to explore the spatial distribution of wells in relation to demographics in schools and school districts. For the analysis two separate oil and gas well categories were defined; "Active/New Wells," which includes all actively producing and newly permitted oil and gas wells, and "Stimulated Wells," which only include oil and gas wells known to have been stimulated using hydraulic fracturing (fracking), acidizing, or gravel-packing.

The data was tested to see if there are correlations between increasing numbers of oil and gas wells with increasing Hispanic and non-white school enrollment. Results of the statistical tests showed that the number of active/new oil and gas wells within school districts and near schools increases with the percentage of non-white or Hispanic students enrolled in the school. Similar significant correlations also exist when the data is limited to just the wells that have been stimulated. Figure 1 shows the counts of oil and gas wells within school district boundaries, as well as the locations of schools in the state.

Methods

The analyses used ArcGIS Version 10.2, using the projection NAD83 California Teale Albers (Meters). For the well site data used in the analysis, the Active/New Wells dataset was taken from the California Department of Conservation Division of Oil Gas and Geothermal Resources "All Wells" dataset. The dataset was limited to include only oil and gas wells reporting production figures in 2014 and wells marked as "New". The dataset of stimulated wells is a compilation of the DOGGR "All Wells" dataset, the DOGGR SB4 stimulation notices, FracFocus.org data, and the South Coast Air Quality Management District's reports.[xiii,xiv,xv]

For the school districts analysis, enrollment demographics data was downloaded from the California Department of Education website and school district boundaries from the US Census Tiger/Line website for elementary, secondary, and unified school districts.[xvixvii] Using the school names, the enrollment demographics were manually added to the corresponding polygon according to a GEOID field from the census shapefiles. Quality control techniques identified enrollment demographics for districts that did not match the schools listed in the GIS files, and was therefore eliminated from the analysis. The stimulated wells and oil and gas wells shapefiles were joined to the school district shapefiles to get counts of stimulated and unstimulated oil and gas wells within the boundaries.

For the schools analysis, the dataset of schools from the CA.gov Geoportal was downloaded, cleaned and the locations verified.[xviii] Then 2013/2014 enrollment demographic profiles of each school was joined to the shapefile. Schools marked as "0" for total enrollment were removed. Using ArcGIS Ver. 10.2, buffers with diameters of 1609.34m (1 mile) and 804.67 (0.5 miles) were generated and the counts of active/new oil and gas wells and stimulated (hydraulically fractured, acidized, and gravel packed) wells within those boundaries were calculated. Data was explored using IBM SPSS Statistics V22. Well counts within the buffers were not normally distributed. Scatter plots were produced showing the number of wells falling within school districts/ the number of wells within a certain radius of school districts compared with non-white and Hispanic enrollment demographics for schools and the school districts.

Results

In California, 352,724 students attend school within 1 mile of oil and gas wells. These students are predominantly non-white (79.6%), and 60.3% are Hispanic. For the schools with wells with a 0.5 mile radius, the proportions stay relatively the same; 77.8% non-white and 59.4% Hispanic. Furthermore the trend in the data shows that as the number of Hispanic and non-white students in a school or district increases, the number of drilled and stimulated oil and gas wells increase, both in the district and near the schools.

The Spearman's rho test for correlations showed a significant correlation between *increasing percentages of non-white students* enrolled in California schools and districts **statewide**, and five variables that included:

1. Increasing numbers of active/new oil and gas wells within the school district ($r=.169$, $p<.001$, $N=947$)
2. Increasing numbers of active/new stimulated oil and gas wells within the school district ($r=.123$, $p<.001$, $N=947$)
3. Increasing number of active/new oil and gas wells within a 1 mile proximity of the school ($r=.086$, $p<.001$, $N=8390$)
4. Increasing number of active/new stimulated wells within a 1 mile proximity of the school ($r=.048$, $p<.001$, $N=8390$)
5. Increasing number of active/new oil and gas wells within a 0.5 mile proximity of the school ($r=.048$, $p<.001$, $N=8390$)
6. Increasing number of active/new stimulated wells within a 0.5 mile proximity of the school ($r=.039$, $p<.001$, $N=8390$)

The Spearman's rho test for correlations also showed a significant correlation between *increasing percentages of Hispanic students* enrolled in California schools and districts **statewide**, and the four variables:

1. Increasing numbers of active/new oil and gas wells within the school district ($r=.243$, $p<.001$, $N=947$)
2. Increasing numbers of active/new stimulated oil and gas wells within the school district ($r=.153$, $p<.001$, $N=947$)
3. Increasing number of active/new oil and gas wells within a 1 mile proximity of the school ($r=.067$, $p<.001$, $N=8390$)
4. Increasing number of active/new oil and gas wells within a 0.5 mile proximity of the school ($r=.036$, $p<.001$, $N=8390$)

Discussion

Exploring the data using visual tools, like maps, and statistical tests gives insight into the spatial patterns of stimulation events and other oil and gas wells. The tools show exactly where wells are located, where schools are in relation, and who makes up those communities who are host to the oil and gas activity. The analysis show that there are 485 active/new wells, 78 stimulated, within one mile of a school; and there are 177 active/new wells, 14 stimulated, within 0.5 miles of a school. See the distribution of well counts in school districts in Figure 2.

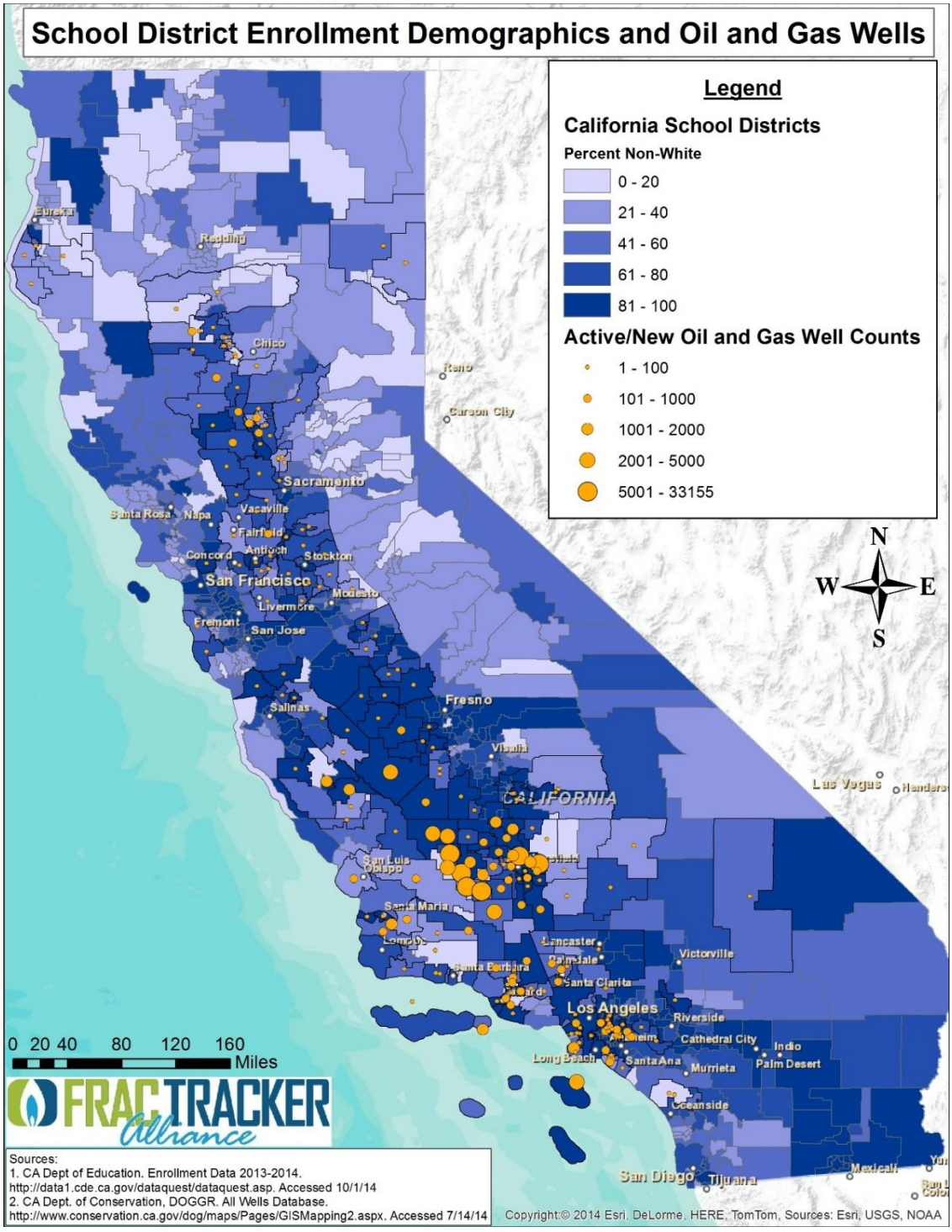

Figure 2. Non-white enrollment percentages of school districts are displayed in shades of blue overlaid with markers identifying relative counts of stimulated and/or non-stimulated oil and gas wells. The highest counts of wells are hosted in school districts located in the Central (San Joaquin) Valley and along California's south coast. Geologically, these areas sit above the Monterey Shale – the 50 million year sedimentary basin producing California's oil reserves.

Using GIS techniques the counts of wells located in school districts and within chosen distances from schools were generated. This information is valuable as it tells us which schools may be the most impacted by environmental degradation of air and water resources due to extraction activity. Table 1, below, lists the 50 school districts in California with the most oil and gas wells.

- The top eleven school districts with the highest well counts are located the San Joaquin Valley with 10 districts in Kern County and the other just north of Fresno County.
- The top 5 ranked school districts had the most variability in well counts, with the 1st (Taft Union High School District) having almost 40% more wells than the school that ranked 2nd (Kern Union High School District).
- The largest difference in consecutive ranks of well counts was a 48% decrease from rank 5 to rank 6 (Belridge Elementary District with 10,405 wells and Taft City Elementary District with 5,369 wells).
- The 13 school districts with the most *stimulated* wells are also among these 50, and only 12/50 differ when ranking *stimulation* counts in school districts.

Table 2 is similar to Table 1, but instead of using the school districts as boundaries the table displays the number of stimulated and non-stimulated wells within distances of 0.5 and 1 mile radii. In Table 2, the school rankings change drastically. Kern County hosts, Highland Elementary, the school with the most wells within a 1 mile radius. Of the remaining ranks, 8/10 are located in Los Angeles County, where wells in urban oil fields are densely concentrated near schools.

Furthermore, all of the highest ranking well and stimulations counts within the smaller radius (0.5 mile) are located in the Greater LA Basin/Southern California where the oil fields are located in urban areas. This trend is consistent with the findings of Tiwari (2012) in Denton, TX, which found greater numbers of wells in rural areas, but higher density concentrations of wells at close proximity to human activity in urban areas. The only exception is Sequoia Elementary in Shafter, CA. Sequoia is the only school located within 0.5 miles of 3 separate hydraulically fractured/stimulated wells, while the other 13 schools in the state located within 0.5 miles of at least 1 stimulated well are in Southern California. Over 800 students attend Sequoia Elementary and 86% of the students are Hispanic. The image below (Figure 4) shows just how close the oil and gas stimulations and extraction activity can be to schools.

Statistical tests for correlations showed that as the percentage of non-white and Hispanic students increased, so did the number of active/new wells as well as the number of stimulated wells drilled within each school district. The number of active/new wells drilled within a 0.5 mile radius and within a 1 mile radius also increased. Additionally, as the percentage of non-white students increased, so did the number of stimulated oil and gas wells within a 0.5 mile radius and within a 1 mile radius. The relationships with non-white enrollment demographics are visualized in the scatter plots shown below (Figure 3). It should be noted that this test does not prove causation as there are most likely more factors that relate significantly to both variables (well counts and enrollment), and the tests do not indicate whether the enrollment demographics are affecting the number of wells or vice versa.

Highest Well Counts in School Districts with Enrollment Demographics							
Rank	School District	County	Active Wells	Stimulated Wells	Population	Percent Hispanic	Percent Non-white
1	Taft Union High School District	Kern	33155	1947	1045	40.86	47.08
2	Kern Union High School District	Kern	19800	342	37100	62.84	75.13
3	Standard Elementary School District	Kern	12583	3	2947	23.58	28.81
4	Midway Elementary School District	Kern	10910	24	108	14.81	15.74
5	Belridge Elementary School District	Kern	10405	1621	38	73.68	73.68
6	Taft City Elementary School District	Kern	5369	109	2024	50.99	54.90
7	McKittrick Elementary School District	Kern	4511	74	70	4.29	11.43
8	Wasco Union High School District	Kern	4454	259	1730	91.68	94.45
9	Lost Hills Union Elementary School District	Kern	4286	221	568	98.77	100.00
10	Coalinga-Huron Joint Unified School District	Fresno	3377	2	4355	84.34	88.36
11	Maricopa Unified School District	Kern	2649	5	2455	28.47	43.79
12	Long Beach Unified School District	Los Angeles	2015	74	81155	54.95	83.83
13	Elk Hills Elementary School District	Kern	1960	119	199	10.05	12.56
14	Santa Maria Joint Union High School District	Santa Barbara	1676	1	7720	81.68	87.26
15	Buttonwillow Union Elementary School District	Kern	1658	276	338	93.49	95.27
16	Bakersfield City Elementary School District	Kern	1431	17	29684	78.20	89.88
17	King City Joint Union High School District	Monterey	1196	1	2595	91.75	94.07
18	Ventura Unified School District	Ventura	1191	23	17430	49.11	58.07
19	Beardsley Elementary School District	Kern	1188	0	1778	34.76	40.89
20	San Ardo Union Elementary School District	Monterey	1103	1	113	92.04	92.04
21	Los Angeles Unified School District	Los Angeles	1062	20	653826	73.50	89.62
22	Delano Union Elementary School District	Kern	1060	11	7685	87.55	98.77
23	Delano Joint Union High School District	Kern	1060	11	4238	84.87	97.97
24	McFarland Unified School District	Kern	967	0	3370	98.19	99.08
25	Blochman Union Elementary School District	Santa Barbara	851	0	929	22.39	30.79
26	Edison Elementary School District	Kern	850	0	1108	81.32	86.28
27	Orcutt Union Elementary School District	Santa Barbara	750	1	5145	43.89	53.97
28	Fillmore Unified School District	Ventura	745	311	3825	90.17	91.66
29	Brea-Olinda Unified School District	Orange	627	17	5973	35.14	61.91
30	William S. Hart Union High School District	Los Angeles	619	5	25640	34.72	54.23
31	Huntington Beach Union High School District	Orange	441	3	16431	25.73	58.15
32	Huntington Beach City Elementary School District	Orange	428	3	7002	19.31	38.72
33	Santa Paula Union High School District	Ventura	406	23	5503	94.98	95.75
34	General Shafter Elementary School District	Kern	403	2	146	84.93	86.30
35	River Delta Joint Unified School District	Sacramento	400	0	2299	50.76	57.60
36	Sutter Union High School District	Sutter	394	13	708	18.93	27.12
37	Newhall Elementary School District	Los Angeles	366	0	6831	46.58	65.50
38	Reef-Sunset Unified School District	Kings	352	6	2638	96.97	98.67
39	Oxnard Union High School District	Ventura	350	6	16876	74.09	84.42
40	Cuyama Joint Unified School District	Santa Barbara	285	0	246	76.42	78.86
41	San Luis Coastal Unified School District	San Luis Obispo	281	0	7509	27.29	38.62
42	Panama-Buena Vista Union Elementary School District	Kern	269	1	17484	53.59	74.44
43	Culver City Unified School District	Los Angeles	252	4	6691	39.93	74.13
44	Whittier Union High School District	Los Angeles	240	0	13263	87.13	90.62
45	Ojai Unified School District	Ventura	237	67	2751	35.15	41.33
46	Lamont Elementary School District	Kern	230	0	2933	97.75	98.26
47	Castaic Union Elementary School District	Los Angeles	230	5	2651	39.31	53.19
48	Pierce Joint Unified School District	Colusa	211	1	1393	72.65	76.74
49	Arvin Union Elementary School District	Kern	208	0	3152	96.03	97.21
50	Fruitvale Elementary School District	Kern	203	0	3313	35.10	46.75

Table 1. Shown are the top 50 CA school districts ranked by the count of active/new oil and gas wells. The number of stimulated wells as well as the Hispanic and non-white enrollment percentages are also listed.

Schools Ranked by Counts of Stimulated and Non-Stimulated Oil and Gas Wells at 0.5 and 1 Mile Distances							
Schools Ranked by Number of Oil and Gas Well Counts within 1 Mile							
				Wells in Buffer Radius		Stimulations in Buffer Radius	
Rank	School	District	County	1 mile	0.5 Mile	1 Mile	0.5 Mile
1	Highland Elementary	Standard	Kern	507	24	1	0
2	Signal Hill Elementary	Long Beach Unified	Los Angeles	328	115	2	2
3	Alvarado (Juan Bautista) Elementary	Long Beach Unified	Los Angeles	289	64	2	0
4	Midway Elementary	Midway	Kern	256	45	2	0
5	Butler (Mary)	Long Beach Unified	Los Angeles	254	5	2	0
6	Chavez (Cesar) Elementary	Long Beach Unified	Los Angeles	244	56	4	1
7	ICEF Vista Middle Academy	Los Angeles Unified	Los Angeles	239	78	5	2
8	ICEF Inglewood Elementary Charter Academy	Inglewood Unified	Los Angeles	239	78	5	2
9	ICEF Inglewood Middle Charter Academy	Inglewood Unified	Los Angeles	239	78	5	2
10	Windsor Hills Math Science	Los Angeles Unified	Los Angeles	233	114	5	2
Schools Ranked by Number of Oil and Gas Well Counts within 0.5 Miles							
Rank	School	District	County	1 mile	0.5 Mile	1 Mile	0.5 Mile
1	Signal Hill Elementary	Long Beach Unified	Los Angeles	328	115	2	2
2	Windsor Hills Math Science	Los Angeles Unified	Los Angeles	233	114	5	2
3	Brea-Olinda High	Brea-Olinda Unified	Orange	214	97	13	2
4	ICEF Vista Middle Academy	Los Angeles Unified	Los Angeles	239	78	5	2
5	ICEF Inglewood Elementary Charter Academy	Inglewood Unified	Los Angeles	239	78	5	2
6	ICEF Inglewood Middle Charter Academy	Inglewood Unified	Los Angeles	239	78	5	2
7	Golden Valley High	William S. Hart Union	Los Angeles	187	72	0	0
8	Alvarado (Juan Bautista) Elementary	Long Beach Unified	Los Angeles	289	64	2	0
9	Edison Elementary	Long Beach Unified	Los Angeles	133	57	1	1
10	Chavez (Cesar) Elementary	Long Beach Unified	Los Angeles	244	56	4	1
Schools Ranked by Number of Stimulated (Oil and Gas) Well Counts within 1 Mile							
Rank	School	District	County	1 mile	0.5 Mile	1 Mile	0.5 Mile
1	Brea-Olinda High	Brea-Olinda Unified	Orange	214	97	13	2
2	Ladera Palma Elementary	La Habra City	Orange	73	25	11	0
3	Mariposa Elementary	Brea-Olinda Unified	Orange	201	30	9	0
4	Sequoia Elementary	Richland Union	Kern	35	8	9	3
5	Lost Hills Elementary	Lost Hills Union	Kern	176	1	8	0
6	Summit Elementary	Ojai Unified	Ventura	87	23	8	0
7	Wilmington Middle	Los Angeles Unified	Los Angeles	102	35	7	2
8	Normont Elementary	Los Angeles Unified	Los Angeles	113	28	6	0
9	Brea Country Hills Elementary	Brea-Olinda Unified	Orange	105	4	6	0
10	Two Hundred Thirty-Second Place	Los Angeles Unified	Los Angeles	56	1	6	0
Schools Ranked by Number of Stimulated (Oil and Gas) Wells within 0.5 Miles							
Rank	School	District	County	1 mile	0.5 Mile	1 Mile	0.5 Mile
1	Sequoia Elementary	Richland Union	Kern	35	8	9	3
2	Brea-Olinda High	Brea-Olinda Unified	Orange	214	97	13	2
3	Wilmington Middle	Los Angeles Unified	Los Angeles	102	35	7	2
4	ICEF Vista Middle Academy	Los Angeles Unified	Los Angeles	239	78	5	2
5	ICEF Inglewood Elementary Charter Academy	Inglewood Unified	Los Angeles	239	78	5	2
6	ICEF Inglewood Middle Charter Academy	Inglewood Unified	Los Angeles	239	78	5	2
7	Windsor Hills Math Science	Los Angeles Unified	Los Angeles	233	114	5	2
8	President Avenue Elementary	Los Angeles Unified	Los Angeles	94	37	5	2
9	Signal Hill Elementary	Long Beach Unified	Los Angeles	328	115	2	2
10	Chavez (Cesar) Elementary	Long Beach Unified	Los Angeles	244	56	4	1

Table 2. Shown are the highest ranking CA schools for the number of wells and stimulations within a 0.5 and 1 mile radius. The table is divided into four sections of rankings that show both stimulated and non-stimulated well counts at each distance. The highlighted columns are ranked by well counts. .

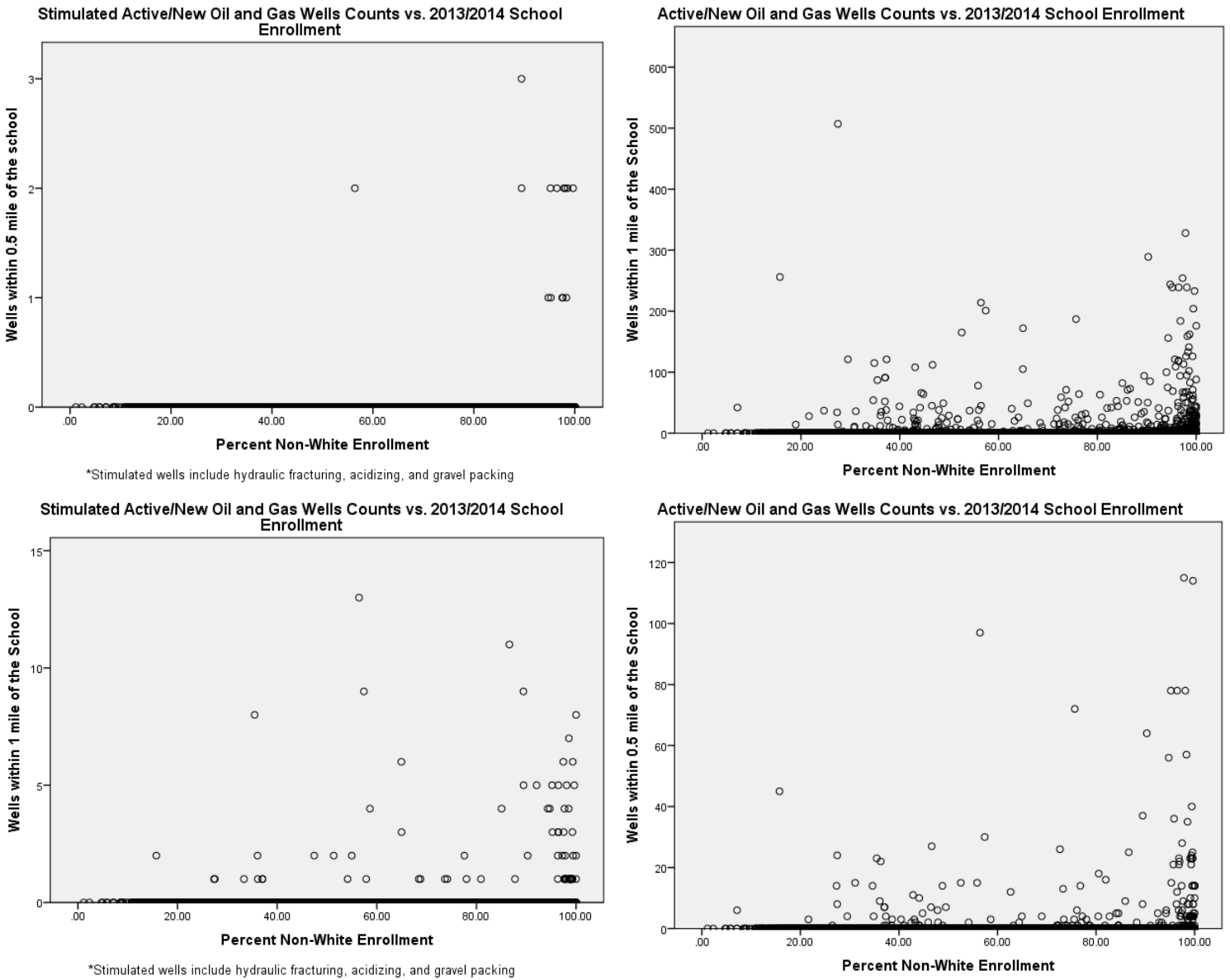

Figure 3. Scatterplots show the number of stimulated and non-stimulated (active/new oil and gas) wells within 0.5 and 1 mile radii of schools plotted against the non-white enrollment demographics of said school. The top row shows counts of non-stimulated wells at the two distances, while the bottom two graphs shows the same for stimulated wells.

Figure 4. This playground is located on the campus of Sequoia Elementary School, located at 500 Fresno Ave. Shafter, CA 93263. In the background, less than ,1200 feet from the school is an oil well (API 403043765) that was hydraulically fractured. (Photo taken by Brooke Anderson)

Conclusion

From the data visualizations and these analyses, there is an apparent disparity in development of oil and gas resources near schools with predominantly non-white enrollment demographics. These results warrant further exploration that includes more variables including other indicators of socio-economic status as well as additional data, including the use of school footprint GIS data instead of points for buffer analyses. Another important piece to consider is the sample size/area since there are many areas in California without recoverable oil, as well as differences between urban and rural communities considering the results of Tiwari (2012).[xix] Research at the FracTracker Alliance is continuing to develop and expand upon these relationships with more robust analyses.

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