

September 1, 2020

Dear Bryan,

Thank you for participating in the pilot study, “Human exposure to chemicals associated with unconventional oil and gas operations in Pennsylvania.”

Last summer I collected air, water, and urine samples from five Southwestern Pennsylvania households, including yours. Three households were within two miles of fracking wells, and two were at least five miles away from the nearest fracking well.

This report will inform you of the laboratory results for the urine, water, and air samples I collected for your family. These samples were analyzed at the University of Missouri for chemicals commonly emitted from fracking sites and their breakdown products.

Please keep these results confidential.

You may share this information with a physician or counselor, but please don't share it beyond your immediate family or discuss it online or on social media until after we have published our findings in *Environmental Health News*.

Think of this report as a starting point in our exploration of these lab results. I wanted to get you the information I have now as quickly as possible, but I'm still in the process of working with statisticians and epidemiologists to further analyze these results. I will provide you with more information and insights about our findings as I have them moving forward.

In the meantime, if you have questions or would like clarification about anything contained in this report, please don't hesitate to email, call, or text me.

Important notes about these results:

- These test results list health effects that have been linked to exposure to these chemicals in animal studies, human studies, or both.
- **Having these chemicals in your body or environment does not necessarily mean you will experience these health effects.**
- Because so many factors contribute to overall health—including genetics and many different types of environmental exposures—our findings in this study will not enable us to directly relate the levels of chemicals in your body or environment to any individual health conditions.

Important notes about the urine results:

- There are two separate sets of urine sample results for each family member: One that looks at metabolites, or breakdown products of chemicals your body has processed and excreted, and one that looks at parent compounds themselves.
- **The metabolite results provide us with the most insight about what chemicals you've been exposed to.**
- Your metabolite results were compared to the median and the 95th percentile measured in the general U.S. population obtained from the National Health and Nutrition Examination Survey (NHANES) conducted by the U.S. Centers for Disease Control and Prevention. The median is the middle number in a data set; the 95th percentile is the level that 95% of numbers in a data set fall below.
- These tests reflect the exposure to chemicals you had over the previous few days. If your test results are higher than the median or 95th percentile seen in the U.S. population, it means that you had higher than average exposure to these chemicals.
- There are several possible reasons for higher-than-average results, including activities that aren't related to exposures from

gas wells. For example, it's not uncommon to see slight elevations of these chemicals in urine samples in people that have recently been in contact with gasoline, paint, varnish, shellac, rust preventives, pesticides, or cigarette smoke.

- Since NHANES data isn't available for 4 of the 11 metabolites we tested for, your results have also been compared against the median level seen among all participants in our study for reference.
- The levels of parent compounds are included here too, but it's difficult to find data to compare them against—most scientific studies focus on metabolites since they offer a more accurate indication of exposure. Your levels of the parent compounds are also compared to the median level seen in our study for reference.
- **While an elevated level of a parent compound *does* indicate a high level of recent exposure, a low level in a parent compound *does not necessarily* indicate a lower level of exposure.** This is because the parent compound wouldn't show up if it's already been broken down by the body.

Important notes about the air and water results:

- The results of the wearable air monitor samples we collected were compared to recommendations for the maximum amount of chemicals that should be in the air to avoid health impacts where they exist.
- **Most of these standards were developed for short-term workplace exposures that occur in workers who handle these chemicals, so they may not accurately reflect the risk associated with ongoing, low-dose exposure.**
- The results of the water samples I took from your home were compared to state and federal regulations for safety where they exist. They were also compared to the median level seen in our study for reference.

- Unfortunately, for many of the chemicals we tested for, safety standards don't yet exist for how much exposure through air or water is safe. More research—like this study—is needed to determine whether exposure to these chemicals is widespread enough to warrant new safety standards.

Moving forward:

Physicians and nurses at the Environmental Health Project of Southwestern Pennsylvania are available to consult with you about these test results. Here is their contact information:

Dr. Ned Ketyer
eketyer@environmentalhealthproject.org
724-255-7440

Sarah Rankin
srankin@environmentalhealthproject.org
724-260-5504

If you would like to speak with a qualified counselor who can help you process your response to these findings, please let me know—I will be happy to help connect you with one.

Thank you again for your participation in the study.

Sincerely,



Kristina Marusic
Reporter for Environmental Health News
kmarusic@ehn.org
(c) 412-519-4618

Urine Testing Results - Metabolites: Bryan Latkanich

All measurements are creatinine-adjusted parts per million (ppm)

Metabolite	Parent Chemical (s)	Potential Health Effects*	Metabolite levels in your urine			Median for U.S. Population	95th percentile for U.S. Population	Median for Our Study
			7/24/19	8/5/19	8/19/19			
Hippuric acid	Toluene, Cinnamaldehyde	Nervous system, kidney, or liver problems; skin irritation; increased cancer risk	304,048	104,885	226,938	18,000	360,000	170,783
2-hydroxy-N-methylsuccinimide	N-Methyl-2-pyrrolidone (NMP)	Skin, eye, and respiratory irritation; kidney, liver, and nervous system problems; reproductive harm in pregnant individuals	410,674	381,153	322,324	N/A	N/A	250,594
Mandelic acid	Ethylbenzene, Styrene	Liver, kidney, or circulatory system problems; increased cancer risk	1,492	3,096	1,229	124	408	2,315
4-Methylhippuric acid	Xylene	Headache, dizziness, drowsiness, nausea, tiredness, nervous system damage; eye, skin, and lung irritation; increased cancer risk	442	167	317	210	1500	230
2-Methylhippuric acid	Xylene	Headache, dizziness, drowsiness, nausea, tiredness, nervous system damage; eye, skin, and lung irritation; increased cancer risk	165	194	224	40	276	106
3-Methylhippuric Acid	Xylene	Headache, dizziness, drowsiness, nausea, tiredness, nervous system damage; eye, skin, and lung irritation; increased cancer risk	85	193	135	210	1500	96
Alpha-Naphthyl Glucuronide	Naphthalene	Skin and eye irritation; nausea, vomiting, abdominal cramps, diarrhea; nervous system problems, kidney problems, jaundice, anemia	191	297	362	N/A	N/A	264
Beta-Naphthyl Sulphate	Naphthalene	Skin and eye irritation; nausea, vomiting, abdominal cramps, diarrhea; nervous system problems, kidney problems, jaundice, anemia	46	43	71	N/A	N/A	61
Phenylglyoxylic Acid	Ethylbenzene, Styrene	Liver, kidney, or circulatory system problems; increased cancer risk	940	1,971	1,488	210	520	741
Trans, Trans-Muconic Acid	Benzene	Anemia; decrease in blood platelets; increased risk of cancer	354	1,052	797	77	470	436
2-Pyrrolidone	N-Methyl-2-pyrrolidone (NMP)	Skin, eye, and respiratory irritation; kidney, liver, and nervous system problems; birth defects in pregnant individuals	5,040	6,884	6,941	N/A	N/A	4,239

Median = The middle number in the data set
95th percentile = 95% of levels fall below this number

How to Read Your Results	
	Exceeds 95th percentile for the general U.S. population
	Exceeds median for the general U.S. population
	No U.S. population data available
	Below median and 95th percentile for the general U.S. population

* This list includes findings from both human and animal studies. Having this chemical in your air, water, or body does not necessarily mean that you will experience these health effects.

Sources: Agency for Toxic Substances and Disease Registry (ATSDR): <https://www.atsdr.cdc.gov/>
New Jersey Department of Health Hazardous Substances Fact Sheets: <https://www.nj.gov/health/workplacehealthandsafety/right-to-know/hazardous-substances/toxicology-data-network/>
Toxicology Data Network: <https://toxnet.nlm.nih.gov/index.html>

U.S. Centers for Disease Control and Prevention, National Institutes of Health, World Health Organization, Agency for Toxic Substances and Disease Registry, European Chemicals Agency
New Jersey Department of Health, Chemwatch, Sigma-Aldrich, the Human Metabolome Database, Thermo Fisher Scientific

Urine Testing Results - Parent Compounds: Bryan Latkanich

All measurements are creatinine-adjusted parts per million (ppm)

Compound	Potential Health Effects*	Levels in your urine			Median for Our study
		7/23/19	8/6/19	8/19/19	
1,2,3-Trimethylbenzene	Skin and eye irritation, liver and respiratory damage, anemia, increased cancer risk	—	—	—	0.32
1,2,4,5-Tetramethylbenzene	Nervous system problems; respiratory irritation	—	—	—	—
1,2,4-Trimethylbenzene	Skin and eye irritation, liver and respiratory damage, anemia, increased cancer risk	—	—	—	1.07
1,3,5-Trimethylbenzene	Skin and eye irritation, liver and respiratory damage, anemia, increased cancer risk	—	—	—	—
1-Methylnaphthalene	Skin irritation	—	—	—	—
2-Ethylhexanol-1	Irritation of nose, throat, and lungs; dizziness, nausea, headache, nervous system problems	—	—	47.36	14.83
2-Heptanone	Irritation to the skin, eyes, and, respiratory system; headaches, vomiting, and nausea.	—	—	—	14.25
2-Methylnaphthalene	Skin irritation	—	—	—	1.92
2-Pentanone	Digestive tract irritation	62.75	218.52	11.00	182.26
4-Heptanone	Irritation of eyes and skin, central nervous system depression, dizziness, drowsiness, decreased breath, liver damage	10.11	—	—	42.53
4-isothiocyanato-1-butene	Skin, eye, and respiratory irritation or damage; difficulty breathing, kidney, urinary tract, and bladder problems, reproductive harm in pregnant individuals	—	—	—	—
Allyl isothiocyanate	Skin, eye, and respiratory irritation; difficulty breathing	—	—	—	51.13
Alpha-Pinene	Headache; nausea; vomiting; central nervous system issues; skin, eye, and respiratory irritation; kidney damage	—	—	—	—
Benzene	Anemia; decrease in blood platelets; increased cancer risk	1.36	2.41	1.83	0.72
Butylcyclohexane	Respiratory irritation; central nervous system problems; drowsiness and dizziness; lung damage	—	—	—	—
Carvone	Skin irritation	—	—	—	80.26
Cumene	Eye, skin, gastrointestinal and respiratory irritation; tiredness, irritability; kidney, urinary tract, and bladder problems; reproductive harm in pregnant individuals; increased cancer risk	—	—	—	—
Decane	Irritation of nose, throat, and lungs; dizziness	6.22	—	12.67	4.54
D-Limonene	Eye, skin, and gastrointestinal irritation	—	—	—	1.13
Dodecane	Skin and respiratory irritation	—	—	—	2.73
Ethylbenzene	Eye and skin irritation; liver or kidney problems; reproductive harm in pregnant individuals; increased cancer risk	—	—	—	0.49
Ethylcyclohexane	Skin, eye, and respiratory irritation; dizziness and drowsiness; central nervous system problems	—	—	—	2.86
Heptane	Nervous system problems	3.83	9.77	24.30	3.86
M/P-Diethylbenzene	Irritation of skin, nose, and throat; headache, nausea, vomiting, dizziness; liver and kidney damage	—	—	—	—
M/P-Ethyltoluene	Eye, skin, and respiratory irritation	—	—	—	—
M/P-Xylene	Nervous system damage; increased cancer risk	—	—	—	0.33
Methyl Salicylate	Eye, skin, and respiratory irritation; central nervous system and gastrointestinal problems; liver and kidney damage	—	—	—	3.71
Methylcyclohexane	Skin and eye irritation; dizziness or drowsiness	—	—	—	0.73
Naphthalene	Damage to blood cells, increased cancer risk	—	2.84	—	1.77
Nonane	Skin irritation, dizziness, liver damage	—	—	—	0.66
N-Propylbenzene	Skin and eye irritation, headache, nausea, vomiting	—	—	—	—
Octane	Irritation of nose, throat, and lungs; headache, dizziness	2.18	—	6.30	2.35
O-Diethylbenzene	Respiratory, skin, and eye irritation	—	—	—	—
O-Xylene	Nervous system damage; increased cancer risk	—	—	—	1.19
Pentadecane	Skin and eye irritation	—	—	—	10.04
Styrene	Liver, kidney, or circulatory system problems; increased cancer risk	—	—	—	—
Tetradecane	Nausea, vomiting and diarrhea; central nervous system problems	—	—	—	1.47
Toluene	Nervous system, kidney, or liver problems; increased cancer risk	2.38	5.41	4.72	1.65
Tridecane	Skin irritation, headache	—	—	—	—
Undecane	Skin and eye irritation	14.68	46.90	57.60	19.42

How to Read Your Results	
—	Exceeds Median for Our Study
—	Chemical not detected

* This list includes findings from both human and animal studies. Having this chemical in your air, water, or body does not necessarily mean that you will experience these health effects.

Sources: Agency for Toxic Substances and Disease Registry (ATSDR): <https://www.atsdr.cdc.gov/> New Jersey Department of Health Hazardous Substances Fact Sheets: https://www.nj.gov/health/workplacehealthandsafety/right-to-know/hazardous-substances/Toxicology_Data_Network_https://toxnet.nlm.nih.gov/index.html





U.S. Centers for Disease Control and Prevention, National Institutes of Health, World Health Organization, Agency for Toxic Substances and Disease Registry, European Chemicals Agency New Jersey Department of Health, Chemwatch, Sigma-Aldrich, the Human Metabolome Database, Thermo Fisher Scientific

Urine Testing Results - Metabolites: Ryan Latkanich

All measurements are creatinine-adjusted parts per million (ppm)

Metabolite	Parent Chemical (s)	Potential Health Effects*	Metabolite levels in your urine			Median for U.S. Population	95th percentile for U.S. Population	Median for Our Study
			7/24/19	8/5/19	8/19/19			
Hippuric acid	Toluene, Cinnamaldehyde	Nervous system, kidney, or liver problems; skin irritation; increased cancer risk	1,646,215	85,062	327,594	18,000	360,000	170,783
2-hydroxy-N-methylsuccinimide	N-Methyl-2-pyrrolidone (NMP)	Skin, eye, and respiratory irritation; kidney, liver, and nervous system problems; reproductive harm in pregnant individuals	526,248	453,510	257,164	N/A	N/A	250,594
Mandelic acid	Ethylbenzene, Styrene	Liver, kidney, or circulatory system problems; increased cancer risk	5,193	2,272	3,891	124	408	2,315
4-Methylhippuric acid	Xylene	Headache, dizziness, drowsiness, nausea, tiredness, nervous system damage; eye, skin, and lung irritation; increased cancer risk	2,723	148	727	210	1500	230
2-Methylhippuric acid	Xylene	Headache, dizziness, drowsiness, nausea, tiredness, nervous system damage; eye, skin, and lung irritation; increased cancer risk	178	81	544	40	276	106
3-Methylhippuric Acid	Xylene	Headache, dizziness, drowsiness, nausea, tiredness, nervous system damage; eye, skin, and lung irritation; increased cancer risk	304	78	272	210	1500	96
Alpha-Naphthyl Glucuronide	Naphthalene	Skin and eye irritation; nausea, vomiting, abdominal cramps, diarrhea; nervous system problems, kidney problems, jaundice, anemia	1,928	249	266	N/A	N/A	264
Beta-Naphthyl Sulphate	Naphthalene	Skin and eye irritation; nausea, vomiting, abdominal cramps, diarrhea; nervous system problems, kidney problems, jaundice, anemia	58	21	45	N/A	N/A	61
Phenylglyoxylic Acid	Ethylbenzene, Styrene	Liver, kidney, or circulatory system problems; increased cancer risk	1,826	956	3,266	210	520	741
Trans, Trans-Muconic Acid	Benzene	Anemia; decrease in blood platelets; increased risk of cancer	1,129	264	2,112	77	470	436
2-Pyrrolidone	N-Methyl-2-pyrrolidone (NMP)	Skin, eye, and respiratory irritation; kidney, liver, and nervous system problems; birth defects in pregnant individuals	9,633	5,009	6,736	N/A	N/A	4,239

Median = The middle number in the data set
95th percentile = 95% of levels fall below this number

How to Read Your Results	
	Exceeds 95th percentile for the general U.S. population
	Exceeds median for the general U.S. population
	No U.S. population data available
	Below median and 95th percentile for the general U.S. population

* This list includes findings from both human and animal studies. Having this chemical in your air, water, or body does not necessarily mean that you will experience these health effects.

Sources: Agency for Toxic Substances and Disease Registry (ATSDR): <https://www.atsdr.cdc.gov/>
New Jersey Department of Health Hazardous Substances Fact Sheets: <https://www.nj.gov/health/workplacehealthandsafety/right-to-know/hazardous-substances/toxicology-data-network/>
Toxicology Data Network: <https://toxnet.nlm.nih.gov/index.html>

U.S. Centers for Disease Control and Prevention, National Institutes of Health, World Health Organization, Agency for Toxic Substances and Disease Registry, European Chemicals Agency
New Jersey Department of Health, Chemwatch, Sigma-Aldrich, the Human Metabolome Database, Thermo Fisher Scientific

Urine Testing Results - Parent Compounds: Ryan Latkanich

All measurements are creatinine-adjusted parts per million (ppm)

Compound	Potential Health Effects*	Levels in your urine			Median for Our study
		7/23/19	8/6/19	8/19/19	
1,2,3-Trimethylbenzene	Skin and eye irritation, liver and respiratory damage, anemia, increased cancer risk	—	—	—	0.32
1,2,4,5-Tetramethylbenzene	Nervous system problems; respiratory irritation	—	—	—	—
1,2,4-Trimethylbenzene	Skin and eye irritation, liver and respiratory damage, anemia, increased cancer risk	—	—	—	1.07
1,3,5-Trimethylbenzene	Skin and eye irritation, liver and respiratory damage, anemia, increased cancer risk	—	—	—	—
1-Methylnaphthalene	Skin irritation	—	—	—	—
2-Ethylhexanol-1	Irritation of nose, throat, and lungs; dizziness, nausea, headache, nervous system problems	—	10.24	—	14.83
2-Heptanone	Irritation to the skin, eyes, and, respiratory system; headaches, vomiting, and nausea.	—	—	—	14.25
2-Methylnaphthalene	Skin irritation	—	—	—	1.92
2-Pentanone	Digestive tract irritation	109.53	74.56	—	182.26
4-Heptanone	Irritation of eyes and skin, central nervous system depression, dizziness, drowsiness, decreased breath, liver damage	65.50	—	20.62	42.53
4-isothiocyanato-1-butene	Skin, eye, and respiratory irritation or damage; difficulty breathing, kidney, urinary tract, and bladder problems, reproductive harm in pregnant individuals	—	—	—	—
Allyl isothiocyanate	Skin, eye, and respiratory irritation; difficulty breathing	53.14	—	—	51.13
Alpha-Pinene	Headache; nausea; vomiting; central nervous system issues; skin, eye, and respiratory irritation; kidney damage	—	—	—	—
Benzene	Anemia; decrease in blood platelets; increased cancer risk	—	0.93	1.84	0.72
Butylcyclohexane	Respiratory irritation; central nervous system problems; drowsiness and dizziness; lung damage	—	—	—	—
Carvone	Skin irritation	—	—	—	80.26
Cumene	Eye, skin, gastrointestinal and respiratory irritation; tiredness, irritability; kidney, urinary tract, and bladder problems; reproductive harm in pregnant individuals; increased cancer risk	—	—	—	—
Decane	Irritation of nose, throat, and lungs; dizziness	29.90	—	6.31	4.54
D-Limonene	Eye, skin, and gastrointestinal irritation	—	—	—	1.13
Dodecane	Skin and respiratory irritation	—	—	—	2.73
Ethylbenzene	Eye and skin irritation; liver or kidney problems; reproductive harm in pregnant individuals; increased cancer risk	—	—	—	0.49
Ethylcyclohexane	Skin, eye, and respiratory irritation; dizziness and drowsiness; central nervous system problems	—	—	11.22	2.86
Heptane	Nervous system problems	7.65	3.23	24.00	3.86
M/P-Diethylbenzene	Irritation of skin, nose, and throat; headache, nausea, vomiting, dizziness; liver and kidney damage	—	—	—	—
M/P-Ethyltoluene	Eye, skin, and respiratory irritation	—	—	—	—
M/P-Xylene	Nervous system damage; increased cancer risk	—	—	—	0.33
Methyl Salicylate	Eye, skin, and respiratory irritation; central nervous system and gastrointestinal problems; liver and kidney damage	—	—	—	3.71
Methylcyclohexane	Skin and eye irritation; dizziness or drowsiness	—	—	—	0.73
Naphthalene	Damage to blood cells, increased cancer risk	2.03	1.12	—	1.77
Nonane	Skin irritation, dizziness, liver damage	—	—	—	0.66
N-Propylbenzene	Skin and eye irritation, headache, nausea, vomiting	—	—	—	—
Octane	Irritation of nose, throat, and lungs; headache, dizziness	2.82	—	—	2.35
O-Diethylbenzene	Respiratory, skin, and eye irritation	—	—	—	—
O-Xylene	Nervous system damage; increased cancer risk	—	—	—	1.19
Pentadecane	Skin and eye irritation	—	—	—	10.04
Styrene	Liver, kidney, or circulatory system problems; increased cancer risk	—	—	—	—
Tetradecane	Nausea, vomiting and diarrhea; central nervous system problems	—	—	—	1.47
Toluene	Nervous system, kidney, or liver problems; increased cancer risk	3.54	1.48	8.50	1.65
Tridecane	Skin irritation, headache	—	—	—	—
Undecane	Skin and eye irritation	69.15	12.33	58.72	19.42

How to Read Your Results	
—	Exceeds Median for Our Study
—	Chemical not detected

* This list includes findings from both human and animal studies. Having this chemical in your air, water, or body does not necessarily mean that you will experience these health effects.

Sources: Agency for Toxic Substances and Disease Registry (ATSDR): https://www.atsdr.cdc.gov/New_Jersey_Department_of_Health_Hazardous_Substances_Fact_Sheets:

https://www.nj.gov/health/workplacehealthandsafety/right-to-know/hazardous-substances/Toxicology_Data_Network_https://toxnet.nlm.nih.gov/index.html

U.S. Centers for Disease Control and Prevention, National Institutes of Health, World Health Organization, Agency for Toxic Substances and Disease Registry, European Chemicals Agency

New Jersey Department of Health, Chemwatch, Sigma-Aldrich, the Human Metabolome Database, Thermo Fisher Scientific

Air Testing Results: Bryan Latkanich

Measurements are in micrograms per cubic meter (µg/m³)

Chemical	Potential Health Effects*	Level in your air		Median for Our Study
		July 23, 2019	August 5, 2019	
1,2,3-Trimethylbenzene	Dizziness; headaches; tiredness; blood clotting issues; lung irritation; eye and skin irritation; increased cancer risk	0.071	0.236	0.79
1,2,4,5-Tetramethylbenzene	Nervous system problems; respiratory irritation	0.022	0.136	0.26
1,2,4-Trimethylbenzene	Respiratory, nervous, and blood system problems; increased cancer risk	0.234	0.661	1.98
1,3,5-Trimethylbenzene	Nervous system damage; increased cancer risk	0.062	0.139	0.51
1-Dodecanol	Skin, eye, and respiratory irritation	0.186	0.175	1.22
1-Methylnaphthalene	Skin irritation	0.016	0.022	0.13
2 Ethyl 1 Hexanol	Respiratory irritation; nervous system damage; liver and kidney problems	0.504	0.607	3.81
2-Heptanone	Skin and eye irritation; respiratory and nervous system problems	0.026	0.039	0.3
2-Methylnaphthalene	Skin irritation	0.029	0.045	0.27
4-Heptanone	Eye and skin irritation; central nervous system damage; liver problems	0.012	—	0.11
Alpha-Pinene	Headache; nausea; vomiting; central nervous system issues; skin, eye, and respiratory irritation; kidney damage	0.026	0.031	0.74
Benzaldehyde	Eye, skin, and respiratory irritation; dizziness	0.768	1.192	3.4
Benzene	Anemia; decrease in blood platelets; increased cancer risk	0.635	0.698	1.01
Butylcyclohexane	Respiratory irritation; central nervous system problems; drowsiness and dizziness; lung damage	0.043	0.031	0.18
Cumene	Headache; dizziness and drowsiness; central nervous system problems; eye and skin irritation; kidney and liver damage; increased cancer risk	0.026	0.041	0.14
Decanal	Eye and skin irritation; respiratory problems; gastrointestinal problems	8.744	6.555	3.74
Decane	Irritation of nose, throat, and lungs; dizziness	0.099	0.194	1.95
D-Limonene	Skin irritation	0.136	0.098	5.51
Dodecane	Skin and respiratory irritation	0.112	0.335	1.24
Ethylbenzene	Liver or kidneys problems; increased cancer risk	0.283	0.403	1.11
Ethylcyclohexane	Skin, eye, and respiratory irritation; dizziness and drowsiness; central nervous system problems	0.088	0.069	0.25
Heptanal	Skin, eye, and respiratory irritation	0.652	0.841	1.55
Hexanal	Headache; respiratory, eye, and skin irritation	0.899	0.828	2.01
M/P-Diethylbenzene	Irritation of skin, nose, and throat; headache, nausea, vomiting, dizziness; liver and kidney damage	0.041	0.127	0.42
M/P-Ethyltoluene	Eye, skin, and respiratory irritation	0.435	0.779	2.26
m/p-Xylene	Nervous system damage; increased cancer risk	0.45	0.946	1.88
Methyl salicylate	Eye, skin, and respiratory irritation; central nervous system and gastrointestinal problems; liver and kidney damage	0.162	0.204	0.4
Naphthalene	Neurological damage, liver damage, eye damage; increased cancer risk	0.2	0.11	0.53
N-Nonane	Skin irritation, dizziness, liver damage	0.389	0.422	1.3
N-Octanal	Headache, nausea, dizziness, eye and skin irritation, pulmonary tract irritation, central nervous system problems	1.438	1.834	2.81
N-Propylbenzene	Skin and eye irritation, headache, nausea, vomiting	0.056	0.128	0.36
Octane	Respiratory, skin, and eye irritation; dizziness and headache	1.355	—	2.54
O-Diethylbenzene	Respiratory, skin, and eye irritation	0.123	0.59	1.22
O-Xylene	Nervous system damage; increased cancer risk	0.331	0.589	1.43
Pentadecane	Skin and eye irritation	0.179	0.166	0.94
Styrene	Liver, kidney, or circulatory system problems; increased cancer risk	0.029	0.021	0.58
Tetradecane	Nausea, vomiting and diarrhea; central nervous system problems	0.15	0.269	1.54
Toluene	Nervous system, kidney, or liver problems; increased cancer risk	1.856	4.539	16.21
Tridecane	Skin irritation, headache	0.139	0.321	0.6
Undecane	Skin and eye irritation	0.21	0.28	1.3

How to Read Your Results

	Exceeds a level estimated to cause non-cancer health effects over a lifetime
	Exceeds a level of exposure estimated to increase cancer risk by more than 1 in a million
	No state or federal exposure limits available
	Below available exposure limits
	Chemical not found in your air sample

Recommended Exposure Limits

Compounds	RIC, µg/m ³	IUR ×10 ⁻⁶ (µg/m ³)-1	References
1,2,3-Trimethylbenzene	60		EPA
1,2,4-Trimethylbenzene	60		EPA
1,3,5-Trimethylbenzene	60		EPA
Benzene	30	29	EPA, OEHHA
Cumene	400		EPA
Ethylbenzene	1,000	2.5	EPA, OEHHA
Xylenes	10		EPA
Naphthalene	3	34	EPA, OEHHA
Styrene	1,000		EPA
Toluene	5,000		EPA

RIC = Reference Concentration; an estimate of a level of continuous inhalation exposure likely to be without an appreciable risk of harmful non-cancer effects over a lifetime

IUR = Inhalation Unit Risk; an estimate of the level of inhalation exposure that's likely to increase lifetime cancer risk by more than 1 in a million

EPA = U.S. Environmental Protection Agency
OEHHA = California Office of Environmental Health Hazard Assessment

* This list includes findings from both human and animal studies. Having this chemical in your air, water, or body does not necessarily mean that you will experience these health effects.

Sources: EPA. 2009. Risk Assessment Guidance for Superfund (RAGS); Part F. 2009. https://www.epa.gov/sites/production/files/2015-09/documents/partf_200901_final.pdf Integrated Risk Information System (IRIS) Assessments <https://cfpub.epa.gov/ncea/iris/search/index.cfm>. Assessed July 4th 2018 The Office of Environmental Health Hazard Assessment (OEHHA). Toxicity criteria on chemicals evaluation U.S. Centers for Disease Control and Prevention, National Institutes of Health, World Health Organization, Agency for Toxic Substances and Disease Registry, European Chemicals Agency New Jersey Department of Health, Chemwatch, Sigma-Aldrich, the Human Metabolome Database, Thermo Fisher Scientific

Air Testing Results: Ryan Latkanich

Measurements are in micrograms per cubic meter (µg/m³)

Chemical	Potential Health Effects*	Level in your air		Median for Our Study
		July 23, 2019	August 5, 2019	
1,2,3-Trimethylbenzene	Dizziness; headaches; tiredness; blood clotting issues; lung irritation; eye and skin irritation; increased cancer risk	0.313	0.216	0.79
1,2,4,5-Tetramethylbenzene	Nervous system problems; respiratory irritation	0.096	0.262	0.26
1,2,4-Trimethylbenzene	Respiratory, nervous, and blood system problems; increased cancer risk	1.011	0.488	1.98
1,3,5-Trimethylbenzene	Nervous system damage; increased cancer risk	0.306	—	0.51
1-Dodecanol	Skin, eye, and respiratory irritation	2.864	17.632	1.22
1-Methylnaphthalene	Skin irritation	0.066	0.059	0.13
2 Ethyl 1 Hexanol	Respiratory irritation; nervous system damage; liver and kidney problems	4.499	10.095	3.81
2-Heptanone	Skin and eye irritation; respiratory and nervous system problems	0.183	—	0.3
2-Methylnaphthalene	Skin irritation	0.141	0.062	0.27
4-Heptanone	Eye and skin irritation; central nervous system damage; liver problems	0.118	—	0.11
Alpha-Pinene	Headache; nausea; vomiting; central nervous system issues; skin, eye, and respiratory irritation; kidney damage	0.148	—	0.74
Benzaldehyde	Eye, skin, and respiratory irritation; dizziness	6.064	31.89	3.4
Benzene	Anemia; decrease in blood platelets; increased cancer risk	0.748	4.079	1.01
Butylcyclohexane	Respiratory irritation; central nervous system problems; drowsiness and dizziness; lung damage	—	—	0.18
Cumene	Headache; dizziness and drowsiness; central nervous system problems; eye and skin irritation; kidney and liver damage; increased cancer risk	0.078	—	0.14
Decanal	Eye and skin irritation; respiratory problems; gastrointestinal problems	20.046	24.697	3.74
Decane	Irritation of nose, throat, and lungs; dizziness	0.403	—	1.95
D-Limonene	Skin irritation	1.272	4.056	5.51
Dodecane	Skin and respiratory irritation	1.566	—	1.24
Ethylbenzene	Liver or kidneys problems; increased cancer risk	0.455	0.324	1.11
Ethylcyclohexane	Skin, eye, and respiratory irritation; dizziness and drowsiness; central nervous system problems	—	—	0.25
Heptanal	Skin, eye, and respiratory irritation	0.372	—	1.55
Hexanal	Headache; respiratory, eye, and skin irritation	1.253	—	2.01
M/P-Diethylbenzene	Irritation of skin, nose, and throat; headache, nausea, vomiting, dizziness; liver and kidney damage	0.196	—	0.42
M/P-Ethyltoluene	Eye, skin, and respiratory irritation	2.37	9.475	2.26
m/p-Xylene	Nervous system damage; increased cancer risk	1.348	0.491	1.88
Methyl salicylate	Eye, skin, and respiratory irritation; central nervous system and gastrointestinal problems; liver and kidney damage	0.503	0.473	0.4
Naphthalene	Neurological damage, liver damage, eye damage; increased cancer risk	0.392	0.323	0.53
N-Nonane	Skin irritation, dizziness, liver damage	0.487	—	1.3
N-Octanal	Headache, nausea, dizziness, eye and skin irritation, pulmonary tract irritation, central nervous system problems	3.176	—	2.81
N-Propylbenzene	Skin and eye irritation, headache, nausea, vomiting	0.245	0.112	0.36
Octane	Respiratory, skin, and eye irritation; dizziness and headache	—	—	2.54
O-Diethylbenzene	Respiratory, skin, and eye irritation	0.419	1.224	1.22
O-Xylene	Nervous system damage; increased cancer risk	0.976	0.291	1.43
Pentadecane	Skin and eye irritation	0.433	0.471	0.94
Styrene	Liver, kidney, or circulatory system problems; increased cancer risk	0.333	0.74	0.58
Tetradecane	Nausea, vomiting and diarrhea; central nervous system problems	0.533	0.765	1.54
Toluene	Nervous system, kidney, or liver problems; increased cancer risk	5.575	21.183	16.21
Tridecane	Skin irritation, headache	0.423	0.828	0.6
Undecane	Skin and eye irritation	0.5	0.49	1.3

How to Read Your Results

	Exceeds a level estimated to cause non-cancer health effects over a lifetime
	Exceeds a level of exposure estimated to increase cancer risk by more than 1 in a million
	No state or federal exposure limits available
	Below available exposure limits
	Chemical not found in your air sample

Recommended Exposure Limits

Compounds	RIC, µg/m ³	IUR ×10 ⁻⁶ (µg/m ³)-1	References
1,2,3-Trimethylbenzene	60		EPA
1,2,4-Trimethylbenzene	60		EPA
1,3,5-Trimethylbenzene	60		EPA
Benzene	30	29	EPA, OEHHA
Cumene	400		EPA
Ethylbenzene	1,000	2.5	EPA, OEHHA
Xylenes	10		EPA
Naphthalene	3	34	EPA, OEHHA
Styrene	1,000		EPA
Toluene	5,000		EPA

RIC = Reference Concentration; an estimate of a level of continuous inhalation exposure likely to be without an appreciable risk of harmful non-cancer effects over a lifetime

IUR = Inhalation Unit Risk; an estimate of the level of inhalation exposure that's likely to increase lifetime cancer risk by more than 1 in a million

EPA = U.S. Environmental Protection Agency

OEHHA = California Office of Environmental Health Hazard Assessment

* This list includes findings from both human and animal studies. Having this chemical in your air, water, or body does not necessarily mean that you will experience these health effects.

Sources: EPA, 2009. Risk Assessment Guidance for Superfund (RAGS); Part F, 2009.

https://www.epa.gov/sites/production/files/2015-09/documents/partf_200901_final.pdf Integrated Risk Information System (IRIS) Assessments

<https://cfpub.epa.gov/ncea/iris/search/index.cfm>. Assessed July 4th 2018 The Office of Environmental Health Hazard Assessment (OEHA), Toxicity criteria on chemicals evaluation

U.S. Centers for Disease Control and Prevention, National Institutes of Health, World Health Organization, Agency for Toxic Substances and Disease Registry, European Chemicals Agency New Jersey Department of Health, Chemwatch, Sigma-Aldrich, the Human Metabolome Database, Thermo Fisher Scientific

Water Testing Results for the Latkanich Household

All samples were collected on 7/1/19

Measurements are in parts per billion (ppb)

Chemical	Potential Health Effects*	Your Kitchen Tap	Your Bathtub	Your Outdoor Hose	Median for Our study
Benzene	Anemia; decrease in blood platelets; increased risk of cancer	—	—	—	2.28
2-pentanone	Digestive tract irritation	—	—	—	.
Heptane	Nervous system problems	—	—	5.89	9.36
Methyl Cyclohexane	Irritation of nose, throat, and digestive tract; lung damage	—	—	—	—
Toluene	Nervous system, kidney, or liver problems	—	—	—	23.6
Octane	Irritation of nose, throat, and lungs; headache, dizziness	—	—	—	1.94
Ethyl Cyclohexane	Headache, dizziness, tiredness, nausea, vomiting	—	—	—	1.16
Ethylbenzene	Liver or kidneys problems	—	—	—	1.11
M-xylene	Nervous system damage	—	—	—	0.52
P-xylene	Nervous system damage	—	—	—	0.52
4-heptanone	Irritation of eyes and skin, central nervous system depression, dizziness, drowsiness, decreased breath, liver damage	—	—	—	—
Allyl-isothiocyanate	Irritation of eyes, throat, nose, and skin	—	—	—	—
2-heptanone	Irritation to the skin, eyes, and, respiratory system; headaches, vomiting, and nausea.	—	—	—	—
Styrene	Liver, kidney, or circulatory system problems	—	—	—	—
O-xylene	Nervous system damage	—	1.16	—	1.16
N-nonane	Skin irritation, dizziness, liver damage	—	—	—	4.06
Cumene	Nervous system and kidney problems	—	—	—	—
Propylbenzene	Irritation of eyes nose, throat, and skin; headache, nausea, dizziness, drowsiness	—	—	—	—
M-ethyltoluene	Unknown	—	—	—	—
P-ethyltoluene	Unknown	—	—	—	—
1,3,5-trimethylbenzene	Skin and eye irritation, liver and respiratory damage, anemia	—	—	—	0.97
4-isothiocyanate-1-butene	Unknown	—	—	—	—
1,2,4-trimethylbenzene	Respiratory, nervous, and blood system problems	—	—	—	—
N-decane	Irritation of nose, throat, and lungs; dizziness	—	—	—	—
2-ethylhexanol-1	Irritation of nose, throat, and lungs; dizziness, nausea, headache, nervous system problems	—	—	—	1.47
1,2,3-trimethylbenzene	Nervous system damage	—	—	—	1.12
D-limonene	Eye, skin, and gastrointestinal irritation	—	—	—	1.98
Butyl Cyclohexane	Unknown	1.12	—	1.18	1.13
Diethylbenzenes	Irritation of skin, nose, and throat; headache, nausea, vomiting, dizziness; liver and kidney damage	—	—	—	—
Diethylbenzene Isomer	Unknown	—	—	—	—
N-undecane	Skin and eye irritation	—	1.16	1.18	2.34
1,2,4,5-tetramethylbenzen	Unknown	—	—	1.18	1.09
N-dodecane	Nausea, vomiting, dizziness, weakness, central nervous system and respiratory damage	2.25	3.48	2.36	3.37
Naphthalene	Damage to blood cells, increased cancer risk	4.5	6.96	4.71	5.83
Carvone	Skin irritation	—	—	—	—
Tridecane	Skin irritation, headache	2.25	3.48	2.355	3.21
2-methylnaphthalene	Skin irritation	4.5	9.29	5.888	5.97
1-methylnaphthalene	Skin irritation	2.25	3.48	2.355	3.41
Tetradecane	Nausea, vomiting and diarrhea; central nervous system problems	3.37	4.64	3.533	4.4
Pentadecane	Skin and eye irritation	4.5	5.8	4.711	5.62

How to Read Your Results	
	The level in your water is below all standards
	The level in your water is above at least one standard
	No applicable standard has been set for this chemical
	Chemical not found

Recommended Drinking Water Limits (ppb)

Compound	EPA Standard	PA Standard	WHO Guideline
Benzene	5	5	10
Toluene	1000	1000	700
Ethylbenzene	700	700	300
Xylenes	10,000 total	10,000 total	500 total
Styrene	100	100	20

* This list includes findings from both human and animal studies. Having this chemical in your air, water, or body does not necessarily mean that you will experience these health effects.

Sources:

National Primary Drinking Water Regulations: <https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations>
 Pennsylvania Department of Environmental Protection: <https://quantumlabs.net/wp-content/uploads/2013/09/DEP-Standards-April-2006.pdf>
 World Health Organization Drinking Water Guidelines: <https://apps.who.int/iris/bitstream/handle/10665/254637/9789241549950-eng.pdf;jsessionid=372CE996160860EC2217C873AB018BD0?sequence=1>
 Agency for Toxic Substances and Disease Registry (ATSDR): <https://www.atsdr.cdc.gov/>
 New Jersey Department of Health Hazardous Substances Fact Sheets: <https://www.nj.gov/health/workplacehealthandsafety/right-to-know/hazardous-substances/>
 Toxicology Data Network: <https://toxnet.nlm.nih.gov/index.html>

Summary of Your Family's Results

I collected a total of three water samples from different locations in your home (all on the same date): The kitchen tap, the bathtub, and the outdoor hose valve.

Both of you wore an active sampling air monitor for periods of 6-8 hours on two separate dates for a total of four air samples.

We collected a total of six urine samples from you and Ryan over three visits, with the first two visits on the same days as the air sample collection.

Urine test results

All six of your urine samples exceeded the U.S. 95th percentile for Mandelic acid, a metabolite for Ethylbenzene and Styrene, and for Phenylglyoxylic acid, a metabolite of Ethylbenzene and Styrene. Four of the six samples exceeded the U.S. 95th percentile for trans, trans-muconic acid, a metabolite for Benzene.

All six of your samples exceeded the U.S. median for Hippuric acid (a metabolite for Toluene and Cinnamaldehyde), Mandelic acid (a metabolite for Ethylbenzene and Styrene), 2-Methylhippuric acid (a metabolite for Xylene), Phenylglyoxylic acid (a metabolite for Ethylbenzene and Styrene), and Trans, trans-Muconic acid (a metabolite for Benzene).

On July 24, 2019 Ryan had a level of hippuric acid in his urine more than 91 times as high as the U.S. median and nearly five times as high as the U.S. 95th percentile. Hippuric acid is a metabolite for Toluene and

Cinnamaldehyde. This was the highest level of hippuric acid detected in anyone in our study.

The same urine sample from Ryan showed a level of mandelic acid nearly 42 times as high as the U.S. median and nearly 13 times as high as the U.S. 95th percentile. Mandelic acid is a metabolite for Ethylbenzene and Styrene. This was the highest level of mandelic acid detected in anyone in our study.

The same day (July 24), Bryan's urine sample had a level of mandelic acid nearly 25 times as high as the U.S. median and nearly eight times as high as the 95th percentile.

On August 19, 2019 Ryan's urine sample showed a level of mandelic acid more than 31 times as high as the U.S. median and nearly 10 times as high as the U.S. 95th percentile; Bryan's was nearly 10 times as high as the U.S. median and three times as high as the U.S. percentile.

The same day (August 19), Ryan had a level of 2-Methylhippuric acid, a metabolite of Xylene, at a level nearly 14 times as high as the U.S. median, nearly five times as high as the median we detected in families in non-fracking regions, and nearly twice as high as the U.S. 95th percentile. At 544 ug/g, Ryan had the highest level of this compound detected in anyone in our study. Bryan's level of the same compound that day was nearly 6 times as high as the U.S. median and nearly as high as the U.S. 95th percentile.

Ryan also had the second-highest level of Phenylglyoxylic acid in his urine of anyone in the study on August 19, 2019. Phenylglyoxylic acid is a metabolite of Ethylbenzene and Styrene. At 3,266 ug/g, Ryan's level of this compound was nearly 16 times as high as the U.S. median and more than six times higher than the U.S. 95th percentile.

The same day (August 19) Ryan had a level of trans, transmuconic acid, a metabolite for benzene, that has nearly 32 times as high as the U.S. median and more than five times as high as the U.S. 95th percentile. On July 24, his level of this compound was nearly 15 times as high as the U.S. median and more than twice as high as the U.S. 95th percentile. On August 5th, Bryan had a level of the same compound that was nearly 14 times as high as the U.S. median and more than twice as high as the U.S. 95th percentile.

Air monitoring results

Regulatory limits exist for just 10 of the 39 chemicals we looked for in your air monitoring samples.

Your air monitoring did not exceed regulatory limits for any of those 10 chemicals.

We can also make some comparisons with other households in the study, but keep in mind that we collected 39 samples from five households, making this a very small sample size.

Ryan's air monitor recorded the highest levels of Benzaldehyde, m/p-Ethyltoluene, and 1-Dodecanol seen in our study on August 5, 2019.

Bryan's air monitor recorded the highest level of 4-Heptanone seen in our study on July 24, 2019.

Water test results

Regulatory limits exist for just five of the 40 chemicals we looked for in your water samples. **Your water samples did not exceed regulatory limits for any of those five chemicals.**

We can also make some comparisons with other households in the study, but keep in mind that we collected 19 samples from five households, making this a very small sample size.

Levels of the following chemicals exceeded the median levels detected in our study: Butyl Cyclohexane (outside sample), N-dodecane (bathtub sample), Naphthalene (bathtub sample), Tridecane (bathtub sample), 2-methylnaphthalene (bathtub sample), 1-methylnaphthalene (bathtub sample), tetradecane (bathtub sample), and pentadecane (bathtub sample).

The levels of all other chemicals detected were either at or below the median levels seen in our study.