**Research Synopsis**

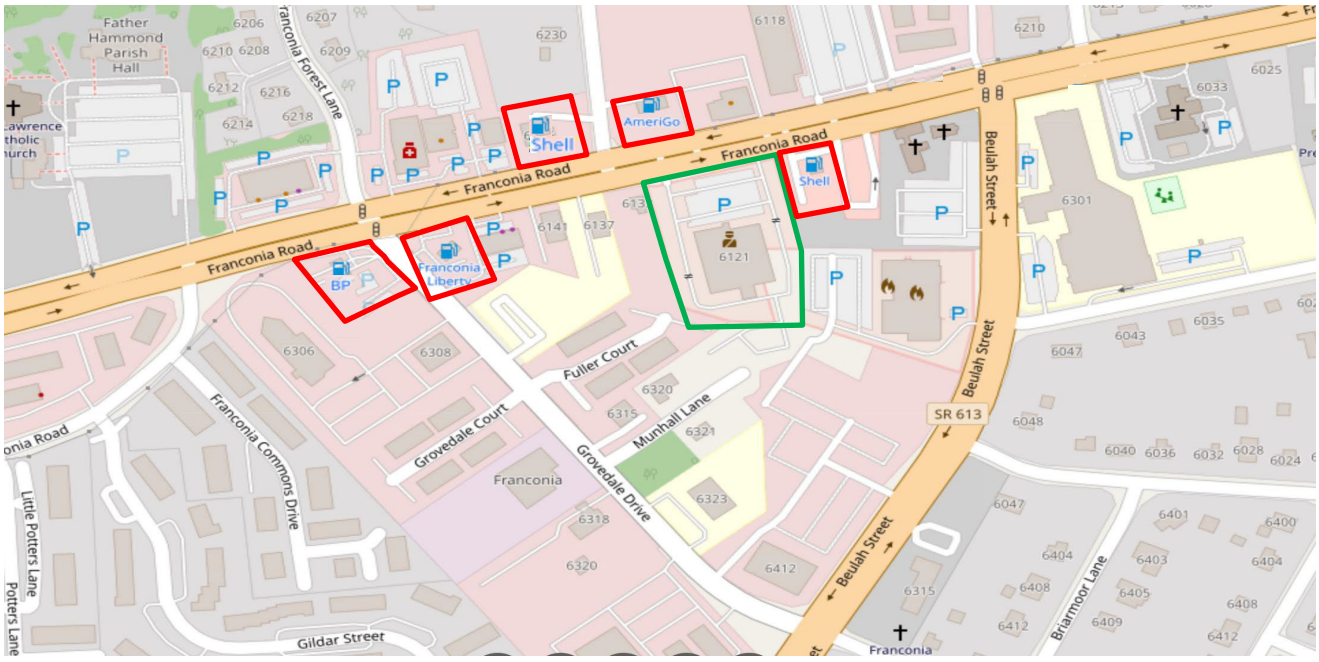
- The Franconia Governmental Center property is located next to or near 5 gasoline stations.
- Benzene is a known human carcinogen, and there are no safe levels of benzene exposure.
- Benzene exposure causes leukemia, specifically acute myeloid leukemia (AML).
- Montgomery County, MD requires a 500 ft setback from homes for gas stations selling 3.6+ million gallons of gasoline/year.
- Indoor air is also contaminated from outdoor sources like gasoline stations.
- **The CDC advises that people should not allow their families to PLAY near a gasoline station**. Presumably it is even riskier to LIVE near a gasoline station.
- Childhood leukemia is associated with residential proximity to gasoline stations.
- Research shows that vent pipes at gas stations released 10 times the amount of benzene previously assumed in the modeling California used when determining gas stations should be located at least 300 ft from sensitive locations like daycare and schools.
- Research also shows that clusters of gasoline stations have increased cancer risk compared to a single gasoline station due to cumulative emissions from individual gas stations.

**The Franconia Governmental Center property located at 6121 Franconia Rd is environmentally unsafe for residential use given its location next to or near a total of 5 gasoline/service stations**.

According to the CDC, gasoline stations are a major source of benzene exposure. Benzene (in gasoline) is a known human carcinogen. Numerous studies have established the link between even low-level exposure to benzene with increased cancers, particularly leukemia.

**Location:**

Franconia Governmental Center shown in green box; red boxes show 5 nearby gasoline stations.



Google Maps reveals the following about the Franconia Governmental Center property:

1. It is **next to** the Shell gasoline/service station located at 6117 Franconia Rd, which is obviously a distance of 0 ft.
2. It is **~100 ft** from the Franconia America gasoline/service station at 6134 Franconia Rd, across the street from the property.
3. It is **~150 ft** from another Shell gasoline/service station at 6136 Franconia Rd, which is caddy corner to the property.
4. It is **~415 ft** from the Liberty gasoline/service station located a few parcels away (same block) at 6149 Franconia Rd.
5. It is **just over 550 ft** away from a 5th gasoline/service station in the next block (a BP located at 6201 Franconia Rd).

**Benzene is a known human carcinogen:**

"The Environmental Protection Agency (EPA), the Department of Health and Human Services (DHHS), and the International Agency for Research on Cancer (IARC) have all classified benzene as a Group A carcinogen, which means that it is carcinogenic to humans." Benzene - Environmental Health (virginia.gov)[1]

**There is no safe level of exposure to benzene:**

The World Health Organization Guidelines for Indoor Air Quality include a specific section for benzene and includes extensive information regarding pathways of exposure, sources, health effects, health risk evaluation, etc. A causal relationship exists between benzene exposure and leukemia, particularly acute myeloid leukemia.

Interestingly, the WHO finds that "indoor concentrations of benzene are commonly higher than concentrations in outdoor air as a consequence of the entry of benzene from outdoor sources (such as heavy traffic, petrol stations or industrial sites)."
Benzene - WHO Guidelines for Indoor Air Quality: Selected Pollutants - NCBI Bookshelf (nih.gov)
Selected excepts (emphasis added):

> **Health relevance of indoor air exposures**
> **Indoor concentrations of benzene are commonly higher than concentrations in outdoor air (9) as a consequence of the entry of benzene from outdoor sources (such as heavy traffic, petrol stations or industrial sites)** and the presence of dominant benzene sources indoors. Indoor sources of benzene are mainly due to ETS, solvent use, building materials, attached garages and various human activities. On the other hand, in some regions unvented heating or cooking are the dominant sources indoors.
>
> Also, the relatively low rates of ventilation typically found in houses and offices prevent the rapid dispersal of airborne contaminants. In areas where cooking and

[1] https://www.vdh.virginia.gov/environmental-health/public-health-toxicology/benzene/

heating are provided by open fires in poorly ventilated housing, indoor levels of contaminants, including benzene, may reach high levels.[2]

**Nearby jurisdiction requires 500 ft gasoline station setback from residences:**

Montgomery County, MD previously required that a large filling station that could pump more than 3.6 million gallons per year had to be located at least 300 feet from the lot line of property used for a public or private school; any park or playground; a day care center; or any outdoor use categorized as a civic and institutional use or recreational and entertainment use.

In 2015, however, Montgomery County not only **increased the distance between large filling stations and sensitive land uses from the 300 feet to 500 feet, it also added dwelling units to the list of sensitive land uses from which a minimum distance would be required**.[3]

**Families should not live near gasoline stations:**

Selected excerpts from the CDC's Public Health Statement for Benzene[4] (emphasis added):

Benzene in the environment:

> "**Benzene levels in the air can be elevated by** emissions from burning coal and oil, benzene waste and storage operations, motor vehicle exhaust, and **evaporation from gasoline service stations**."

Benzene exposure:

> "Exposure of the general population to benzene mainly occurs through breathing air that contains benzene. **The major sources of benzene exposure are** tobacco smoke, **automobile service stations**, exhaust from motor vehicles, and industrial emissions." …
>
> "**People may be exposed to higher levels of benzene in air by living near** hazardous waste sites, petroleum refining operations, petrochemical manufacturing sites, or **gas stations**."

Benzene health effects:

> "**Benzene causes problems in the blood.** People who breathe benzene for long periods may experience harmful effects in the tissues that form blood cells, especially the bone marrow. These effects can disrupt normal blood production and cause a decrease in important blood components. A decrease in red blood cells can lead to anemia. Reduction in other components in the blood can cause excessive bleeding. Blood production may return to normal after exposure to benzene stops. Excessive exposure to benzene can be harmful to the immune

---

[2] https://www.ncbi.nlm.nih.gov/books/NBK138708/

[3] Montgomery Council extends restrictions on location of large gas stations (montgomerycountymd.gov)

[4] Benzene | Public Health Statement | ATSDR (cdc.gov)

system, increasing the chance for infection and perhaps lowering the body's defense against cancer.

**Long-term exposure to benzene can cause cancer of the blood-forming organs. This condition is called leukemia. Exposure to benzene has been associated with development of a particular type of leukemia called acute myeloid leukemia (AML). The Department of Health and Human Services has determined that benzene is a known carcinogen (can cause cancer). Both the International Agency for Cancer Research and the EPA have determined that benzene is carcinogenic to humans.**

**Exposure to benzene may be harmful to the reproductive organs.** Some women workers who breathed high levels of benzene for many months had irregular menstrual periods. When examined, these women showed a decrease in the size of their ovaries. However, exact exposure levels were unknown, and the studies of these women did not prove that benzene caused these effects. It is not known what effects exposure to benzene might have on the developing fetus in pregnant women or on fertility in men. **Studies with pregnant animals show that breathing benzene has harmful effects on the developing fetus. These effects include low birth weight, delayed bone formation, and bone marrow damage**."

Children:

"**Children can be affected by benzene exposure in the same ways as adults. Benzene can pass from the mother's blood to a fetus.** It is not known if children are more susceptible to benzene poisoning than adults."

**How can families reduce the risk of exposure to benzene?**

**"Gasoline** and cigarette smoke are two main sources of human exposure to benzene. **Benzene exposure can be reduced by limiting contact with these sources.**

Benzene is a major component of gasoline and used in many manufacturing processes. **Increased levels of benzene can be found at fueling stations**, and in air emissions from manufacturing plants and hazardous waste sites. **Living near gasoline fueling stations or hazardous waste sites may increase exposure to benzene. People are advised not to have their families play near fueling stations**, manufacturing plants, or hazardous waste sites."[5]

**NOTE: If the CDC advises that people should not allow their families to PLAY near gasoline stations, presumably it's even riskier to LIVE near a gasoline station.**

[5] https://wwwn.cdc.gov/TSP/PHS/PHS.aspx?phsid=37&toxid=14 For more details, see the Toxicological Profile for Benzene at https://wwwn.cdc.gov/TSP/ToxProfiles/ToxProfiles.aspx?id=40&tid=14

**Gas station setback distances due to benzene emissions:**
A 2019 study by scientists at Johns Hopkins and Columbia showed that people living and working near gas stations might be exposed to a far higher level of toxic fumes than previously thought. In California, based on cancer risk estimates, the state requires gas stations selling 3.6+ millions of gas/year to be located at least 300 feet from daycares, schools, and other sensitive uses.[6]

The authors discovered, however, that **vent pipes at gas stations released 10 times the amount of benzene than previously assumed in the modeling used to determine how far gas stations should be placed away from sensitive sites. In fact, sensitive land uses at a distance further than 300 feet from the fence line of the gas station would still represent a health concern despite compliance with the CARB guidelines**. Note that the study found that benzene emissions from underground gasoline storage tank vents were sufficiently high to constitute a health concern at a distance of up to **525 feet** (160 m). Vent Pipe Emissions from Storage Tanks at Gas Stations: Implications for Setback Distances - PMC (nih.gov)[7]
Selected excepts (working links included and emphasis added):

> In the US, approximately 143 billion gal (541 billion L) of gasoline were dispensed in 2016 at gas stations[1] resulting in release of unburned fuel to the environment in the form of vapor or liquid.[2] This is a public health concern, as unburned fuel chemicals such as benzene, toluene, ethyl-benzene, and xylenes (BTEX) are harmful to humans.[3] **Benzene is of special concern because it is causally associated with different types of cancer**.[4] Truck drivers delivering gasoline and workers dispensing fuel have among the highest exposures to fuel releases.[4] However, **people living near or working in retail at gas stations, and children in schools and on playgrounds can also be exposed, with distance to the gas stations significantly affecting exposure levels**.[5–8] A meta-analysis[9] of three case-control studies[10–12] suggests that **childhood leukemia is associated with residential proximity to gas stations.**
>
> Sources of unburned fuel releases at gas stations include leaks from storage tanks, accidental spills from the nozzles of gas dispensers,[13–15] fugitive vapor emissions through leaky pipes and fittings, vehicle tank vapor releases when refueling, and leaky hoses, all of which can contribute to subsurface and air pollution.[2] Routine fuel releases also occur through vent pipes of fuel storage tanks but are less noticeable because the pipes are typically tall, e.g., 4 m. These vent pipes are put in place to equilibrate pressures in the tanks and can be located as close as a few meters from residential buildings in dense urban settings (Figure 1).
>
> …

[6] ARB's Community Health: 2005-04-00 ARB's Air Quality and Landuse Handbook: A Community Health Perspective (aqmd.gov)
[7] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7059886/

**Regulations on setback distances for gas stations are based on lifetime cancer risk estimates. Several studies have assessed benzene cancer risk near gas stations.**[20–25] **Based on cancer risk estimations, the California Air Resources Board (CARB) recommended that schools, day cares, and other sensitive land uses should not be located within 300 ft (91 m) of a large gas station** (defined as a facility with an annual sales volume of 3.6 million gallons = 13.6 million L or greater).[26] This CARB recommendation has not been adopted by all US states, and within states setback distances can depend on local government. Notably, CARB regulations do not account for short term exposure limits and health effects. An important limitation of existing regulations is the use of average gasoline emission rates estimated in the 90's that do not consider excursions.

...

AERMOD air pollution modeling suggests that at GS-MW the 1-hour acute REL was exceeded at one grid point 160 m (525 ft) from the center of the gas station once in 20 days (Figure 5). **This distance is larger than the 300-ft (91 m) setback distance recommended by CARB for a large gasoline dispensing facility**.[26] Assuming the gas station's fence line is less than 225 ft (69 m) from its center (where the vent pipe was assumed to be located), **our study shows that sensitive land uses at a distance further than 300 feet from the fence line of the gas station would represent a health concern despite compliance with the CARB guidelines because of non-compliance with the acute REL** [27]

**Heightened risk from multiple gas stations (2021 study):**

Clusters of gas stations have increased cancer risk compared to a single station because of cumulative emissions from the individual gas stations. Cancer risk as a function of distance from gas station(s) and as a continuous function of total sales volume can be estimated from an equation the authors developed. For instance, the cancer risk at 40 m for four gas stations each dispensing 1 million gal/year is $9.84 \times 10^{-6}$ compared to $2.45 \times 10^{-6}$ for one gas station. From: Benzene emissions from gas station clusters: a new framework for estimating lifetime cancer risk - PMC (nih.gov) [8] Selected excepts (working links included and emphasis added):

During the operation of a gas station, unburned fuel is released from multiple sources, including spills, leaky pipes, leaky dispenser hoses, leaks in underground storage tanks, and underground storage tank venting [3–6]. All of these sources of exposures can contribute to negative health effects due to the toxicity of chemicals in unburned fuel.

Gasoline contains the BTEX group, consisting of benzene, toluene, ethylbenzene and xylenes, all of which are toxic [7–9]. Within the BTEX group, benzene is the sole chemical classified as a human carcinogen [10]; it is a causal agent of leukemia and is associated with non-Hodgkin's lymphoma and multiple myeloma [7, 11]. While the general population experiences low exposure to benzene at gas

[8] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8172828/

stations when dispensing gasoline, **at-risk populations include** those who are occupationally exposed, **people that live near gas stations**, and children in schools near stations [12–16]. **People living near gas stations can be exposed to chemicals from the stations even inside their homes**, as modeled by Hicklin et al. [17] in Malta and measured by Barros et al. [18] in Portugal. Additionally, **studies suggest that there may be a risk of childhood leukemia associated with living close to gas stations** [19–22]. Yet another study concluded that the lifetime cancer risk at and around selected gas stations in Iran exceeded values proposed by the US Environmental Protection Agency (EPA) [23].

As cancer risk due to toxic evaporative emissions from a gas station is a function of distance from the gas station [24, 25], regulations in the form of setback distances have been put in place to protect people. In the US, different states have different guidelines for setback distances, and even within states different counties may set their own guidelines. **Based on estimations of lifetime cancer risk, the California Air Resources Board (CARB) recommends that new sensitive land uses (such as schools and daycares) should not be sited within 300 ft (91 m) of a large gasoline dispensing facility, where large is defined as having a sales volume of at least 3.6 million gallons per year** [26, 27]. On the other hand, **a county council in the US state of Maryland approved a zoning amendment that requires gas stations that pump more than 3.6 million gallons of gas per year to be 500 ft.** from public and private schools, parks, playgrounds, recreational areas, **homes**, and environmentally sensitive areas [28].

**Particular effects of benzene in children:**

Findings from the currently available studies reveal that **benzene exposure is associated with abnormalities in hematologic, hepatic, respiratory, and pulmonary functions in children**. Children at various developmental stages have unique physical risk factors when exposed to environmental toxins including benzene due to their levels of mobility, oxygen consumption, hormonal production, and overall growth. In addition, the toxicodynamic processes that determine exposure, absorption, metabolism, excretion, and tissue vulnerability are all age related. Moreover, **children have a higher unit body weight exposure to benzene or other toxins than adults because of their heightened activity patterns and different ventilation tidal volumes and frequencies**. Furthermore, children are more susceptible to leukemogenesis because their hematopoietic cell populations are differentiating and undergoing maturation. **The incomplete metabolic systems, immature host defenses, high rates of infection by respiratory pathogens, and activity patterns make children more vulnerable to the toxic effects of benzene exposure**.

From: *Health Risks Associated With Benzene Exposure in Children: A Systematic Review* Mark A. D'Andrea, MD, FACRO and G. Kesava Reddy, PhD, MHA, 2018, evaluating and summarizing published studies on the adverse health effects of benzene exposure in children.

Health Risks Associated With Benzene Exposure in Children: A Systematic Review - PMC (nih.gov)[9] Note that 47 other studies are cited in References.

Clear association between residential proximity to gasoline stations and a higher risk of childhood leukemia. Steinmaus and Smith Respond to "Proximity to Gasoline Stations and Childhood Leukemia" - PMC (nih.gov)[10]

See also: Parental, In Utero, and Early-Life Exposure to Benzene and the Risk of Childhood Leukemia: A Meta-Analysis - PMC (nih.gov)[11]

**Gas station worker/cancer risk:**

Note study regarding increased risk of cancer for gasoline station workers (Franconia Govt Center located next to a gasoline station). "The cancer risk was increased from $1.35 \times 10^{-8}$ to $1.52 \times 10^{-4}$, and 70.67% of the workers had a lifetime cancer risk (>Inhalation Unit Risk (IUR): $2.2 \times 10^{-6}$). A significantly higher risk was found in fueling workers compared to cashiers, and in workers at gasoline stations in inner-city zones (suburban and urban), compared to rural zones." Risk Assessment on Benzene Exposure among Gasoline Station Workers - PMC (nih.gov)[12]

[9] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6100118/#:~:text=on%20pediatric%20populations.-,Findings%20from%20the%20currently%20available%20studies%20reveal%20that%20benzene%20exposure,and%20pulmonary%20functions%20in%20children

[10] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6267941/#kww133C1

[11] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4751231/

[12] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6678808/