INVESTIGATION OF ENVIRONMENTAL EFFECTS OF GAS STATIONS

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The subject investigated in this thesis is "Investigation of Environmental Effects of Gas Stations". There are many occupational health and safety problems in all areas of working life. The fuel sector is one of the business lines where health and environmental risks are high. The increase in fuel consumption and, accordingly, the increase in the number of gas stations every year cause these risks to increase. For this reason, in this study, it is aimed to identify these risks created by gas stations and to determine solutions to reduce and prevent them.

Figure 1 : Schematic Figure of a Gas Station [4]

GAS STATIONS

Gas stations are registered and licensed places where petroleum products such as gasoline, diesel, kerosene, and mineral oils are retailed and where equipment parts can be easily obtained in case of vehicle breakdown.
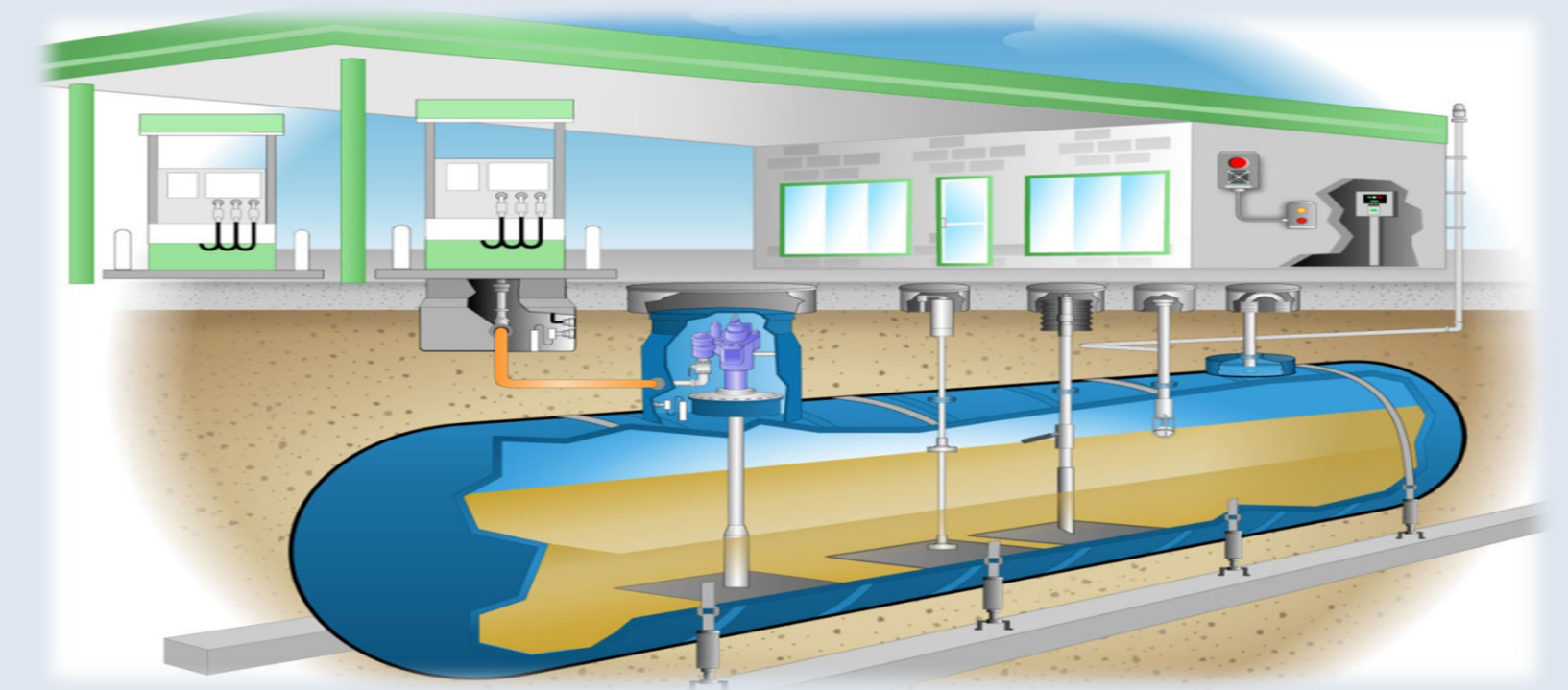
SOIL

Fuels in underground storage tanks can leak during pipeline corrosion or refilling and maintenance activities. Especially at gas stations where old or unsuitable equipment is used, there may be leaks from the pipelines that are not properly maintained and at the connection points of underground tanks. Petroleum and petroleum products leaking from gas stations first pollute the soil.

It is known to be difficult to plant and grow new plants in oil contaminated soils. In a study, the pH of the soils taken from different stations was measured and it was seen that the oil increased the soil pH to neutral. Since the optimum pH level for most plants is 6.0-6.5, values outside this range will negatively affect plant growth and crop productivity.

In addition to its damage to plants, it changes the physical properties of the soil, affects the biological activity and pollutes it due to the compounds in its structure.

Due to its negative effects, petroleum contaminated soils should be cleaned with certain methods, that is, they should be purified from these pollutants. **Chemical**, **physical**, **thermal** and **biological** methods are used for removing petroleum products from the soil and cleaning the soil.

Table 1 : Methods of treatment of soil from petroleum

Methods	Advantages	Disadvantages
Chemical	Effective and Fast	Hazardous
Physical	Safe and Fast	Costly and Complicated
Thermal	Effective	Costly and not Eco-friendly
Biological	Easy, Applicable and Eco-friendly	Slow

- Research shows that rhizoremediation, which uses cutting edge plants and microbes collaboratively, is the most effective method oil pollutants from the soil.

The most persistent and toxic of the petroleum-based pollutants in the soil is **PAH.** (Polycyclic Aromatic Hydrocarbon) Another advantage of biological treatment is that it is the most effective method to eliminate PAH.

In addition, as a result of the measurements made on the samples taken from the soils around the gas station, it was determined that concentration of the PAH remained below the maximum limit values, that is, there was no risk in terms of human health and the environment.

HUMAN HEALTH

Contamination of soil and groundwater by fuel storage facilities poses direct and indirect risks to human health. In direct contact, inhalation, ingestion, skin and eye contact may be pronounced; indirect contact involves ingestion of food and water contaminated with compounds found in fuels, which in most cases are carcinogenic [1].
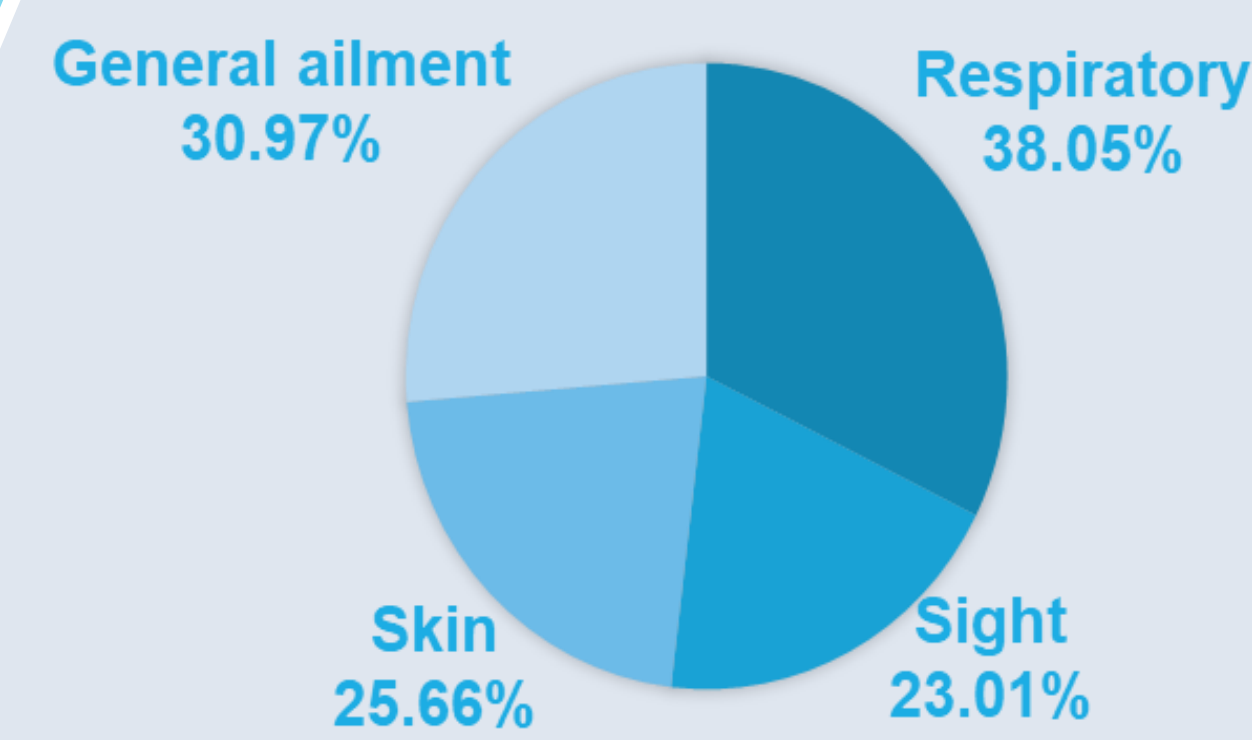
The percentage of health problems experienced by people working at gas stations and residing near them is shown in Figure 2. According to these data, respiratory problems have the highest percentage. In addition to respiratory problems, it is seen that vision and skin problems also have remarkable percentages. This shows that in addition to respiration, skin contact or exposure to the vapors of petroleum and derivative products cause health problems [2].

Figure 2 : Graph of health problems experienced by people working at gas stations and residing near them [2]

The schematic representation of the underground leakage event that occurred in a gas station is shown in Figure 3. Fluid leaking from the storage tank saturates the underlying soil with liquid, some of the fluid will evaporate from the soil to the air, but most will end up in groundwater. The fluid dissolved in the groundwater will contaminate the upper part of the groundwater because it is less dense.

Environmental Impacts of Gas Station

Every activity in gas station, involving flammable and explosive materials, including storage, supply and sale at a gas station, inevitably has level of danger. Activities at gas stations have the potential to pollute the environment. People and the vicinity of gas stations are exposed to pollutants. Therefore, it has a negative effect on **human health**.

Gas stations cause damage to the environment by polluting the **air**, **soil** and **groundwater**.

Air pollution occurs due to volatile chemicals that evaporate during the gas filling and discharge process or as a result of leaks. Benzene, toluene, ethylbenzene and xylene, which are the main representatives of VOCs, come at the beginning of these chemicals that cause air pollution.

Volatile chemicals that evaporate during the gas filling process pollute the air, while leakage of underground pipelines and tanks, as well as spills, pollute the soil. Pollution of groundwater occurs as a result of soil contamination. The petroleum leakage, which is absorbed in the soil and moves due to gravity, can also quickly pollute the groundwater due to the permeability of the soil.
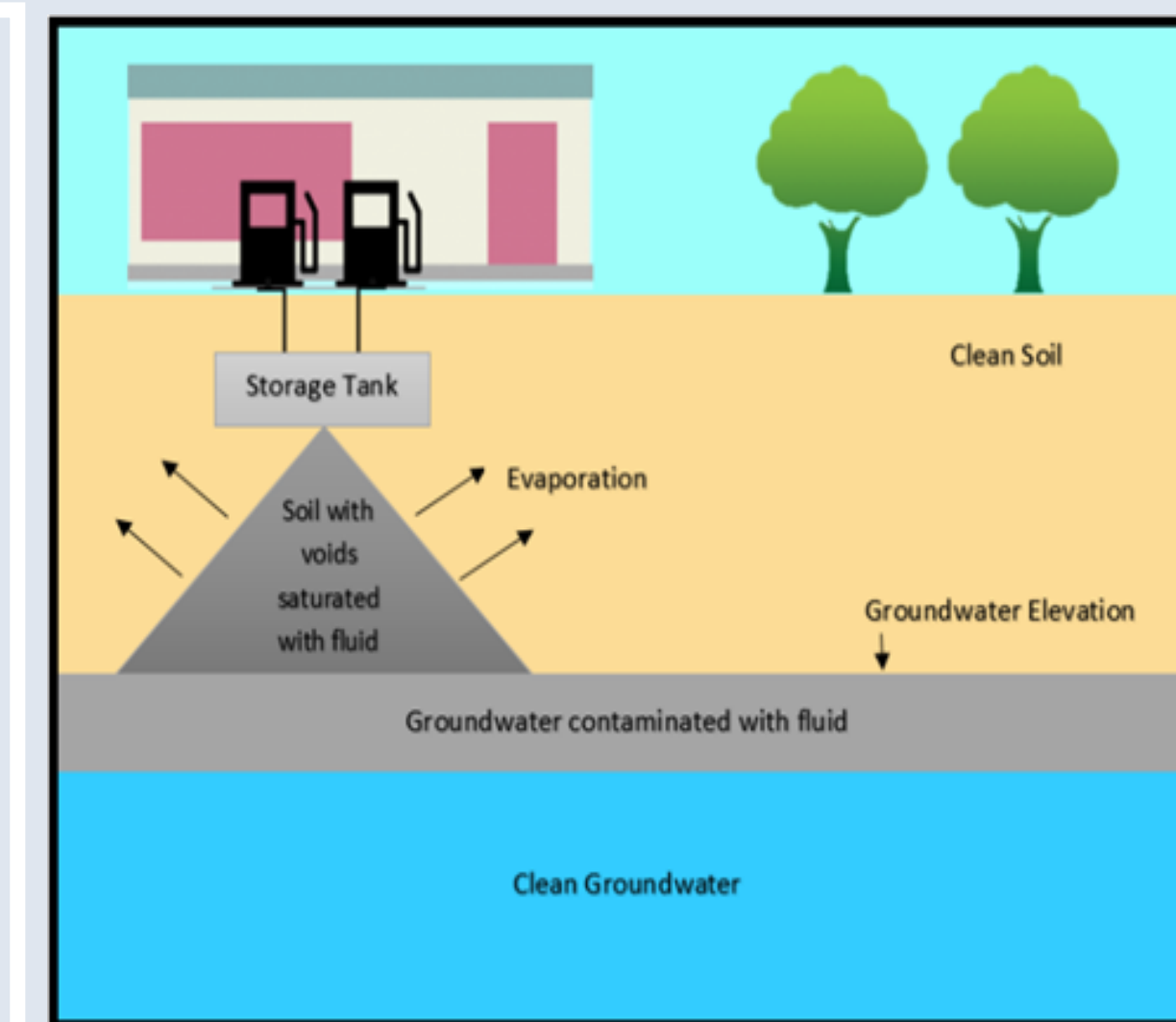

Figure 3 : The underground leakage event that occured in a gas station [5]

AIR

Various volatile organic compounds (VOCs) are found in the atmosphere of gas stations [3]. Although many compounds are originating from gas stations, the main compounds causing air pollution are; benzene, toluene, ethylbenzene, and xylene compounds. As a result of the researches, it has been seen that the most emitted pollutants from gas stations are VOCs. **BTEX** compounds are the main representatives of VOCs.
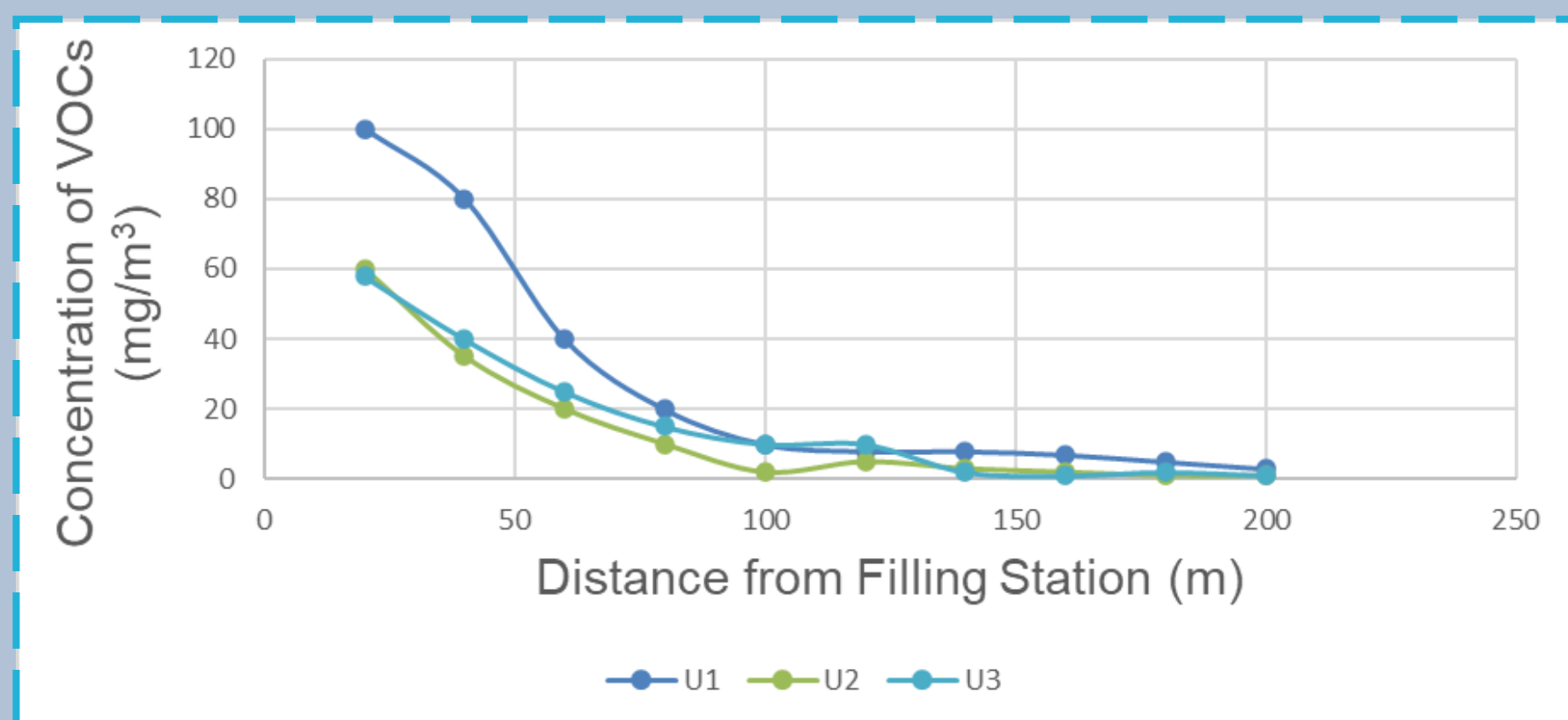

Figure 4 : Concentration of VOCs according to distance from fillling station. [6]

Figure 4 shows all VOC concentration measurements at three gas stations at different distances. According to this graph, building gas stations at a distance of **at least 80 m** from the settlements will be the safest distance for the people living in these settlements [3]. As a result of this, to be protected from air pollution caused by gas stations, it is sufficient to build the stations at a certain distance from the living areas.

It has been observed that the concentrations obtained by pollutant measurements made at gas stations are below the limit values of these pollutants. As a result, there is no great risk in terms of human health and air pollution.

GROUNDWATER

Oil or other fuel contamination leaking from underground storage tanks can move rapidly through the surrounding soil, rapidly contaminating large amounts of groundwater, and seep into nearby water bodies and surface waters such as lakes and rivers, damaging the ecological system.

Petroleum based pollutants from gas stations have adverse effects on groundwater. For this reason, it is necessary to clean the water with oil by certain methods, that is, to remove these pollutants.

Oil-contaminated water must be cleaned by certain methods, in other words, these pollutants must be removed.

Chemical Methods:
- Coagulation
- Electrochemical oxidation

Physical Methods:
- Flotation
- Membrane
- Adsorption

Biological Methods:
- Biological treatment
- Microaeration

A small leak of 1 drop per second from an underground storage tank causes 1500 liters of chemicals to escape underground per year.

Table 2 : Methods of Treatment of groundwater [7]

	Technology type	Treatment effect
Flotation	Flotation	Oil removal is more than 90%
	Peeling flotation	Oil removal is 81.4%
	Dissolved air flotation	Oil removal is more than 90%
Coagulation	CAX	Oil removal is more than 98%
	Aggregation zine silicate and anionic polyacrylamide	Oil removal is 99%
Biological treatment	Biological aerated filter reactor	Oil removal is 94%
Membrane separation	Microfiltration	Oil removal is 99%
	Dynamic membrane	Oil removal is 99%

In table 2, removal efficiencies of most applied remediation methods to oily wastewater are shown.

The most efficient methods used in oily water treatment are coagulation and membrane separation. Studies have shown that the coagulation method is more costly and causes secondary pollution, while membrane separation is less costly.

CONCLUSION

- Employees at the gas station must act carefully for their own health and the health of the people around the station, and to prevent environmental pollution.
- In order to prevent water and soil pollution, first of all, the equipment and storage tanks (anything that may cause leakage) at the gas station should be regularly maintained and renewed as necessary.
- In order to eliminate the risk of leakage, which causes the most pollution, tanks and pipelines should be manufactured as double-walled and they should be monitored with tank and pipe leak detectors.
- Since clayey soils are highly impermeable, such soils should be used by establishing fuel stations in areas with such soils or in places where fuel stations are located.
- In order to be protected from air pollution or to be affected at a minimum level, there should be a certain distance between fuel stations and living spaces.
- It has been understood that the concentrations of harmful substances released from gas stations are below the risk limit values in the studies examined. In addition, it has been determined that there are effective methods for removing these substances from water and soil.
- In order to prevent environmental pollution caused by fuel stations, first of all, the formation of oil pollution should be prevented. Therefore, measures to prevent and/or minimize accidents should be increased, and research should be continued to develop methods for cleaning oil-contaminated soils.

REFERENCES

[1] Freire, P. A. D. C., Trannin, I. C. D. B., & Simões, S. J. C. (2014). Bombeamento e tratamento da fase livre em Aquífero Litorâneo. Engenharia Sanitaria e Ambiental, 19(4), 461-470.
[2] Shinohara, N., Okazaki, Y., Mizukoshi, A., & Wakamatsu, S. (2019). Exposure to benzene, toluene, ethylbenzene, xylene, formaldehyde, and acetaldehyde in and around gas stations in Japan. Chemosphere, 222, 923-931.
[3] Okonkwo, U. C., Orji, I. N., & Onwuamaeze, I. (2014). Environmental impact assessment of petrol and gas filling stations on air quality in umuahia, Nigeria. Global Journal of Engineering Research, 13(1), 11-20.
[4] http://eia.met.gov.na/screening/763_eia_full_study_report_and_emp_1.pdf
[5] https://toracevre.com/akiskanlarin-yeralti-altinda-yayilimi-toprak-kirliligi/
[6] Okonkwo, U. C., Orji, I. N., & Onwuamaeze, I. (2014). Environmental impact assessment of petrol and gas filling stations on air quality in umuahia, Nigeria. Global Journal of Engineering Research, 13(1), 11-20.
[7] Yu, L., Han, M., & He, F. (2017). A review of treating oily wastewater. Arabian journal of chemistry, 10, S1913-S1922.