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# CHEMICALS USED IN NATURAL GAS OPERATIONS:

# WASHINGTON

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## *INTRODUCTION*

The following summaries are based on the possible health effects of the products and chemicals used in operations to produce natural gas in Washington. They provide a profile of the possible health hazards for those living and working in regions where natural gas activity is taking place. The names of the products and chemicals and their known or suspected health effects were entered in an EXCEL spreadsheet for easy sorting and searching. The health effects associated with the chemicals were listed under one or more of the 14 categories used in government toxicological literature.

TEDX compiled a list containing the names of 69 products containing 88 chemicals as of February 2009. Information about the products and the chemicals they contain came from Material Data Safety Sheets (MSDSs) and information disclosed prior to drilling operations. The quantity and quality of information varied between these data sources. TEDX makes no claim that the list of products and chemicals in this analysis is complete.

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## *PRODUCT SUMMARY*

### Material Safety Data Sheets (MSDSs)

MSDSs are designed to inform those who handle, ship, and use the products about their physical and chemical characteristics, and their direct and/or immediate health effects, in order to prevent injury while working with the products. The sheets are also designed to inform emergency response crews in case of accidents or spills. The total reported composition of a product on an MSDS can be less than 0.1% up to 100%. MSDSs are not submitted to the Occupational Safety and Health Administration (OSHA) for review. The product manufacturers determine what is revealed on their MSDSs.

The health information on MSDSs most often warns of possible harm to the skin and eyes, gastrointestinal and respiratory tracts, followed by the nervous system and brain. Many MSDSs do not address the outcome of long term, intermittent or chronic exposures, or adverse health effects that may not be expressed until years after the exposure.

TEDX has obtained full MSDSs for 65 of the 69 products proposed to be used in Washington. Three of the MSDSs listed "no hazardous ingredients" as the composition of the product. Ten MSDSs listed at least one ingredient, but no CAS numbers[1], and one of these MSDSs provided no percent of composition. Of the 52

[1] CAS =Chemical Abstracts Service, provided by the American Chemical Society. This unique number is used to identify a specific substance. A single substance can have many different names, but only one CAS number. A substance may be a single chemical, an isomer of a chemical, a mixture of isomers, polymer, biological sequences, or a mixture of related chemicals.

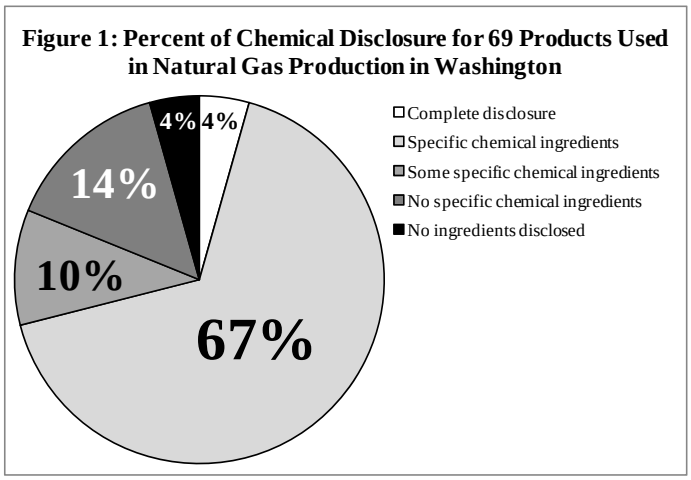
MSDSs that listed at least one ingredient with a CAS number, 13 provided information on less than 50% of the total composition. Three MSDSs disclosed over 95% of the product ingredients and all the CAS numbers.

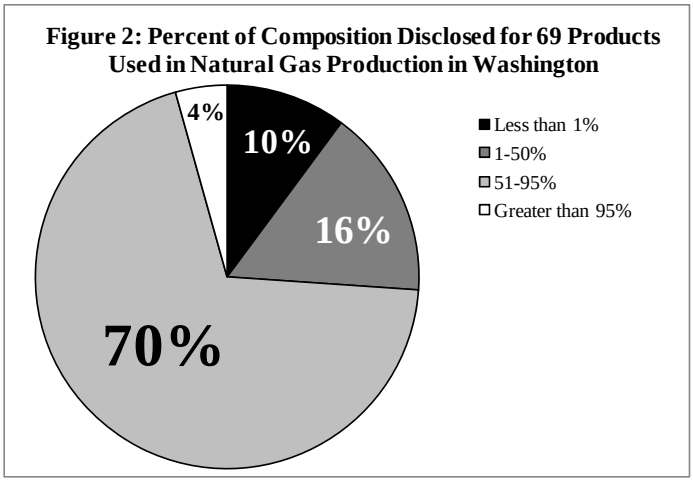
**Other Sources of Information**

Data on the remaining four products on the TEDX list came from information released prior to drilling operations. All of the products disclosed chemical ingredients with CAS numbers, but three of the products included no percent of composition. One product reported 60 to 100% of the contents.

**Evaluation of the information available about the 69 products**

Forty-six products (67%) list specific chemical ingredients (Figure 1). Seven (10%) of the products contain a combination of chemicals with and without CAS numbers, and 10 (14%) contain chemicals with only general or non-specific names. No information for three (4%) of the products was provided. The remaining three (4%) products disclose all of the ingredients.



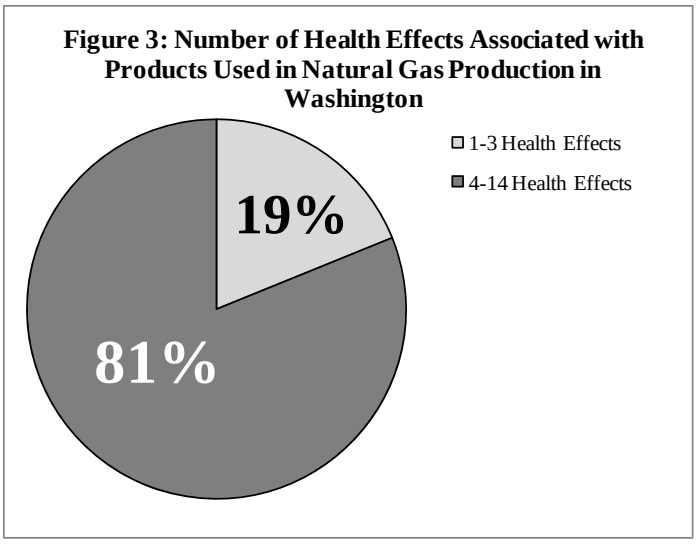



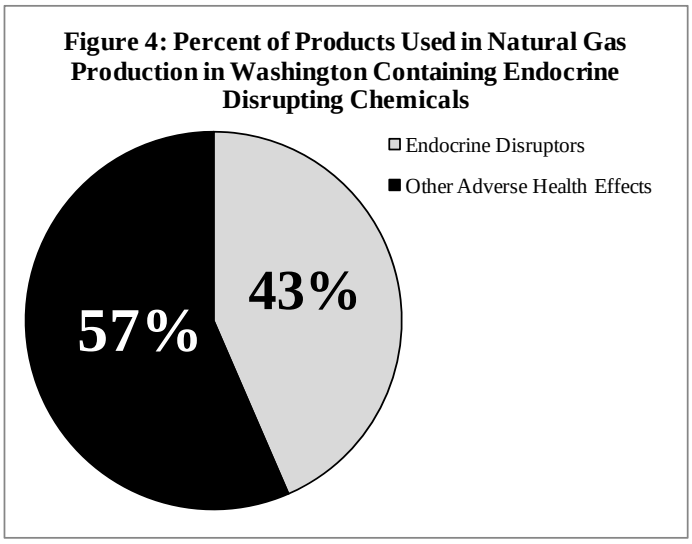

Less than 1% of the total composition is known for 7 (10%) of the 69 products in our spreadsheet (Figure 2). Less than 50% of the composition is known for 11 (16%) of the products, and between 51% and 95% of the composition is known for 48 (70%) of the products. Three (4%) of the products have information about more than 95% of their full composition.

**Evaluation of the health effects associated with the 69 products**

The health effects of those products with an MSDS that did not list specific ingredients (13 products) were determined by the information contained in the Hazards Identification (Section 6), Toxicological Information (Section 11) and Ecological Information (Section 12) portions of the MSDS. Because of the limitations inherent in some of the data sources, the health effects of the products and chemicals in the following summary will not be comprehensive.

All of the products had health effects associated with them. Nineteen percent had one to three health effects, and 81% had between four and 14 health effects (Figure 3). Forty-three percent of the products contained one or more chemicals considered to be endocrine disruptors (Figure 4), chemicals that interfere with development and function.




## *CHEMICAL SUMMARY*

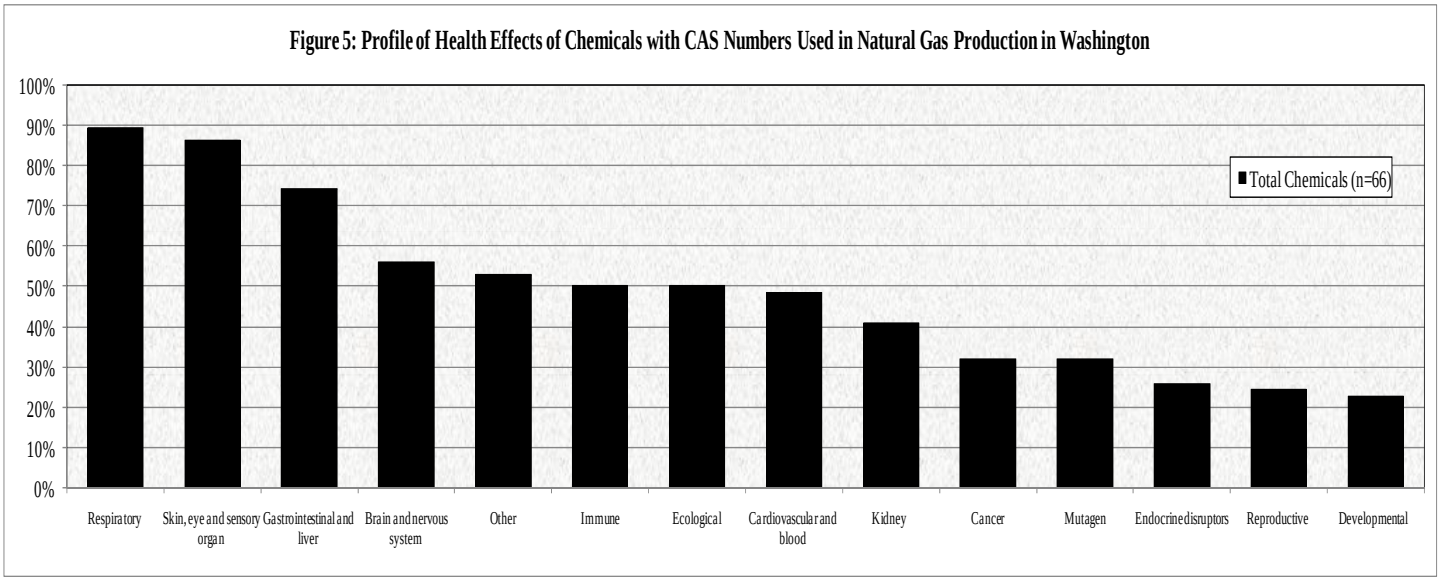
**Evaluation of the information available about the 88 chemicals**

Products may contain more than one chemical, and a given chemical may occur in more than one product. In the 69 products identified above, there were a total of 88 chemicals. Specific chemical names and CAS numbers could not be determined for 22 (25%) of the 88 chemicals on TEDX's list. The names provided for the chemicals were too general (e.g. alcohol, polymer, etc.), or they were listed as "proprietary," "mixtures," or as containing no hazardous substances or ingredients.

It was impossible to link 13 of the chemicals without CAS numbers to any health category aside from the health data reported on an MSDS. The limitations of MSDS data for possible health effects are noted above. For the remaining nine, no information could be found.

**Summary of the health effects associated with the 66 chemicals with CAS numbers**

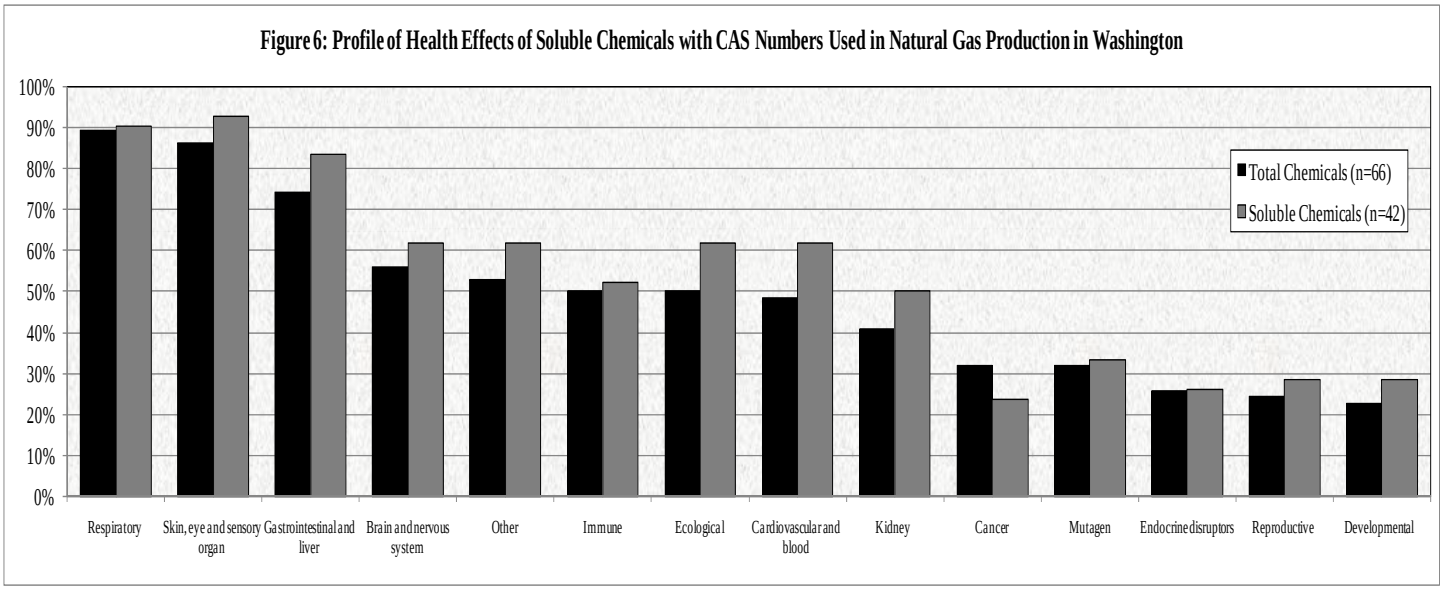
Figure 5 shows the percentages of the 66 chemicals with CAS numbers associated with the general health categories used in government reports. Chemicals are often included in more than one category.




When all of the chemicals with CAS numbers are combined, over 85% are associated with respiratory or skin, eye or sensory organ effects. Seventy-four percent can harm the gastrointestinal tract or liver. The brain and

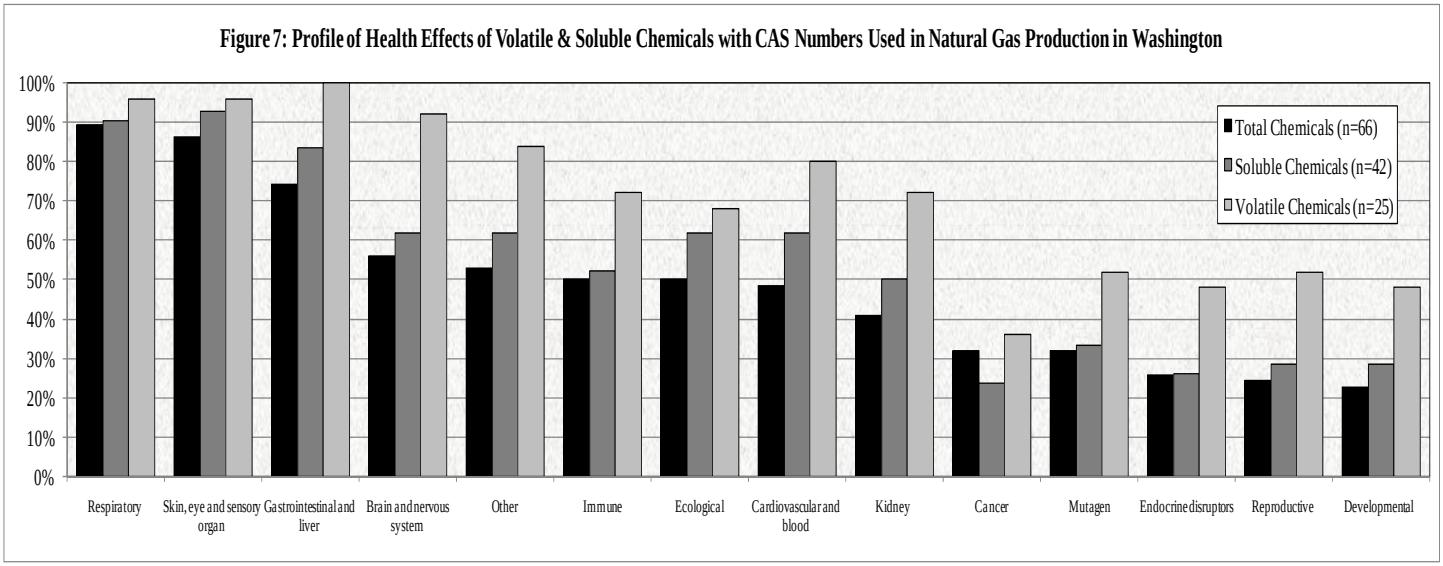
nervous system can be harmed by 56% of the chemicals, and 50% can have ecological effects (harm to aquatic species, birds, amphibians or invertebrates) or immune effects. Over 50% of the chemicals have health effects in the 'Other' category. The 'Other' category includes such effects as changes in weight or effects on teeth or bones, for example, but the most often cited effect in this category is the ability of the chemical to cause death.

The health effects on the left side of the figure are those effects that are more likely to appear immediately or soon after exposure. These effects include symptoms such as burning eyes, rashes, coughs, nausea, vomiting and diarrhea. The health effects on the right side of the figure are long term and would tend to appear months or years later, such as some cancers, the results of organ damage, harm to the reproductive system, or developmental effects as the result of prenatal exposure, all of which were associated with over 20% of the chemicals in this analysis.




Forty-two (over 60%) of the chemicals with CAS numbers are water soluble. When examined alone (Figure 6), they produce a similar profile of health effects as all the chemicals combined, but with higher percentages in every category except Cancer. Notably, more than 95% of these chemicals can harm the skin, eyes or sensory organs, and 100% can harm the gastrointestinal tract or liver.

Approximately 38% of the chemicals with CAS numbers are volatile (Figure 7), in other words, they can become airborne. Over 95% of these chemicals can harm the eyes, skin, sensory organs, or respiratory tract, and all of them are associated with gastrointestinal tract or liver effects. Compared with the soluble chemicals, far more of these chemicals (92%) can cause harm to the brain and nervous system. Eighty percent of the chemicals can harm the cardiovascular system and blood, and 72% can harm the kidneys and immune system. Overall, the volatile chemicals produce a different profile with higher percentages than the water soluble chemicals. Because they can readily become airborne and can be inhaled as well as swallowed, and they can reach the skin, the potential for exposure to these chemicals is greater.




## *COMMENTS*

The health effects summary for the chemicals used in Washington is not a weighted analysis. Each chemical is included only once in the summary whether it is in only one product, or in many. Some of the most prevalent chemicals are among those associated with the most health categories. Two of these are crystalline silica and methanol.

Crystalline silica is reported in 12 products on this list, ranging from less than 1% to 100% of the total composition of the product. Silica poses hazard as a respirable dust that lodges permanently in the lungs, and can cause silicosis, emphysema, obstructive airway diseases, and lymph node fibrosis. It poses a long-term, delayed health hazard similar to asbestos that can turn rapidly into a malignant lung cancer. Silica is reported in both drilling and fracturing products and could become airborne as fines or dust, along with other toxic compounds, when deposited in pits or used to create berms around the pad.

Methanol is reported in 6 products on this list. Both volatile and soluble, methanol is readily absorbed by inhalation, ingestion and dermal exposure. Methanol is associated with all of the health categories except cancer and less than an ounce can be fatal. Some of the most prominent consequences of exposure are damage to the eyes (blindness), the nervous system, the liver and kidney. It also causes birth defects.

Three products on the Washington list are biocides. These products are extremely toxic, with good reason. Bacterial activity in well casings, pipes and joints can be highly corrosive, costly and dangerous. Bacteria can also alter the chemical structure of polymers and make them useless. Nonetheless, when these products return to the surface, either through deliberate retrieval processes or accidentally, they pose a significant danger to workers and those living near the pad and evaporation ponds. Biocides can also sterilize the soil and inhibit normal bacterial and plant growth for many years.

## *FOR FURTHER CONSIDERATION*

Prior to use, these products must be shipped and stored before being transported to the well site. They pose a hazard on highways, roads and rail systems, as well as to communities near the storage facilities.

Fracturing, frac'ing, and stimulation are terms used to describe a process commonly used to facilitate the release of the gas and to improve production. In this process up to a million gallons or more of fluid under extremely high pressure are injected underground to open up fractures in the strata being mined. The gas industry claims that 70% of the material it injects underground is retrieved, but have provided no actual studies to confirm their

estimate. At some locations, because of regional differences in geology and technology, 100% of the injected fracturing fluids may remain underground.

In addition to fracturing fluids, underground water, produced water that comes off the gas, drilling muds and cuttings of rock and debris from the well bore may be deposited into pits on the well pad. Evaporation allows toxic, volatile chemicals to be released into the air, and it concentrates the non-volatile chemicals in the pits. Technology is available to re-inject the recovered fluids on site, pipe it to a central re-injection well, or to use a closed loop system where the liquids are reused and not allowed to evaporate on site.

After development ceases on a pad and the wells go into production, the residues in the pits are often bulldozed over. It is impossible to predict how long the buried chemicals will remain in place. Highly persistent and mobile chemicals could migrate from these pits into underground water resources, or gradually surface over time. When the fluids evaporate from open pits, their condensed residuals are taken off-site and re-injected in the ground, or "land farmed" where they are incorporated into the soil through disking. Here, toxic metals and silica fines could continually build up in the disked soils and be mobilized on dust particles.

For the life of a gas well in most regions, water is stripped from the gas before it enters the delivery pipeline by an evaporation unit. These evaporation units are connected to condensate water tanks near the well heads where this contaminated water is stored. In some instances the condensate water is re-injected on site or piped to a central re-injection well. In other instances, water levels are monitored in the condensate tanks and the water trucked to large open-pit, waste facilities where the water and volatile chemicals escape into the air. This activity will continue until the well stops producing gas, which could be as long as 20 to 25 years.

Cumulative exposure impacts are not addressed in this analysis; however, the accompanying EXCEL spreadsheet provides a hint of the combinations and permutations of mixtures possible and the possible aggregate exposure. Each drilling and fracturing event is custom-designed depending on the geology, depth and resources available. The chemicals and products used, and the amounts or volumes used, can differ from well to well. In addition, the fluids or vehicles that make up the balance of the full composition of a product frequently are not provided, and nowhere are there data accounting for the fluids that make up the million gallons of fluid used. Complete records for each well must be kept for a realistic picture of what is being introduced into watersheds, air, and soil. This information should include the exact location of the well (state, county, township, section, latitude, longitude, etc.), the complete formulation of every product used at each stage of development and production, the weight and or volume of each product used, the composition of the fluids comprising the total volume injected underground, the depths at which material/mixtures were injected, the amount and composition of the recovered liquids, and their disposal method and location. The hazard posed by natural gas operations to our health and the environment requires full disclosure of this information.