

## How many bath bombs would it take to turn Lake Windermere pink?

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### Abstract

This paper explores the hypothetical scenario of using bath bombs to turn Lake Windermere pink and calculates the number of bath bombs required. The environmental impacts of this hypothetical scenario are also discussed by focusing on the effects of some of the ingredients of Lush's 'Think Pink' bath bomb.

**Keywords:** Chemistry; Biology; Cosmetics; Environment; Environmental Pollution; Bath Bombs; Lake Windermere

### Introduction

Bath bombs are a novel cosmetic product, designed to be a single use, comprised mainly of sodium carbonate and citric acid alongside various other ingredients, depending on the type of bath bomb [1]. They are added to a bath before the user bathes, where the user will undergo a multisensory experience. Depending on the type of bath bomb, the user may experience a strong aroma, or witness a colour change of the water. Typically, bath bombs as the name suggests are only used for domestic baths, however, this paper aims to explore a hypothetical scenario in which they are added to Lake Windermere. We will firstly calculate the number of bath bombs needed to turn Lake Windermere pink and then we shall discuss the environmental impacts of this hypothetical scenario.

### Lake Windermere

Located in the Lake District, Lake Windermere is England's largest lake being a staggering 10.5 miles long [2]. Figure 1 shows a map of the major lakes in the Lake District, where it is noticeably visible that Lake Windermere is the largest. Renowned for its natural beauty, it's a popular tourist destination; however, it acts as much more than a scenic spot. Lake Windermere is a vital ecological system made up of interactions between biotic and abiotic factors. Within the lake, several processes such as nutrient cycling, trophic interactions, primary production, and species diversity all play important roles in shaping

the dynamics of the ecosystem [3]. Later on in this paper we shall discuss these processes in more detail and evaluate the potential risks that the addition of bath bombs will cause to the lake's ecosystem.

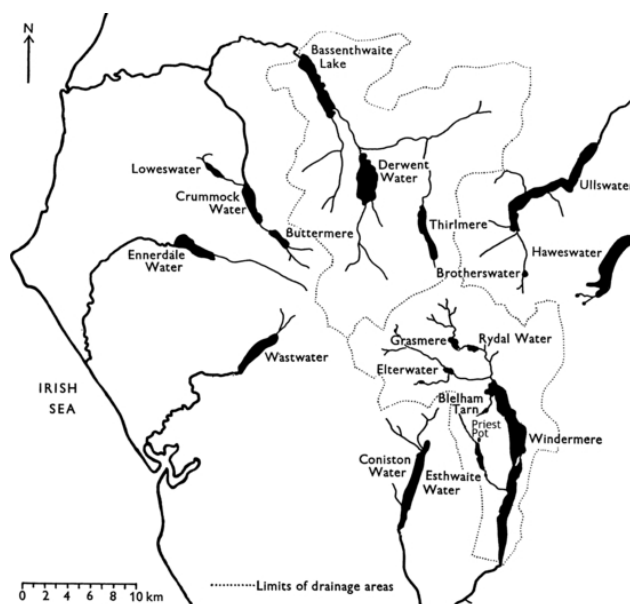


Figure 1 – Map of the major lakes in the Lake District. The watersheds for Lake Windermere and Bassenthwaite Lake are shown in dotted lines [3].

### Calculating the Number of Bath Bombs needed for the Pink Transition

In order to calculate the number of bath bombs needed in order to turn Lake Windermere pink we must firstly make some assumptions. Our first assumption is that the volume of the lake remains

constant with no inflow or outflow. Our second assumption is that the bath bombs will be universally distributed throughout the lake to create an even distribution of colour.

The bath bomb we will use in this study is a product from the popular cosmetics company Lush, called 'Think Pink', with figure 2 showing the pink colour the bath bomb turns the water to.



Figure 2 – Picture illustrating the pink colour the bath bomb 'Think Pink' turns the water to [4].

The average domestic bath in a UK household can hold 300 litres of water [5], so we can assume that 1 bath bomb per every 300 litres will achieve this pink colour. The total volume of Lake Windermere is 0.315 km<sup>3</sup> [6], which we shall convert into litres.

$$1 \text{ km}^3 = 1 \times 10^{12} \text{ L}$$
$$0.315 \text{ km}^3 = 3.15 \times 10^{11} \text{ L}$$

From this, we know the total volume of Lake Windermere is 3.15×10<sup>11</sup> litres. As 1 bath bomb is equal to 300 litres, we can divide the total volume by 300 to determine how many bath bombs are required to turn the lake pink.

$$(3.15 \times 10^{11}) \div 300 = 1,050,000,000$$

This shows us that in order to achieve the same pink colour figure 2 displays in Lake Windermere, a grand total of 1.05 billion bath bombs are needed!

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## Environmental Impacts of Turning Lake Windermere Pink

As mentioned previously, Lake Windermere is a complex ecological system that supports a diverse variety of life and functions within a delicately balanced environment. The addition of this quantity of bath bombs will have detrimental effects upon the lake's ecosystem. The 'Think Pink' bath bomb contains Limonene [7], which can be highly toxic to aquatic life in high quantities. Due to its volatility, the Limonene will evaporate from the lake, where it will be released into the atmosphere. If there are any hydroxyl radicals present in the atmosphere, the Limonene will react with them to produce several products, with one product being the toxic formaldehyde [8]. As well as this, the synthetic colourings (Colour 45410:1, Colour 45410:2, Colour 15850:1, Colour 17200, Colour 14700, and Colour 77491 [7]) may contain heavy metals which do not degrade in the water, meaning that it could build up in the aquatic living tissue and disrupt the food chain [9]. This would have an effect on the species diversity part of the ecosystem as it may lead to certain species becoming extinct in the lake.

## Conclusion

To conclude, we have successfully calculated that in order to turn Lake Windermere pink we would require 1.05 billion 'Think Pink' bath bombs. Although considered environmentally safe in low quantities, the ingredients of the bath bomb can be extremely toxic to the environment in such large quantities which we would require. This means that if we ever did turn Lake Windermere pink there would be a detrimental effect upon the ecosystem. Not only this, but the production of this scale of bath bombs would negatively impact the environment due to additional pollution as well as energy consumption. Therefore, although the idea of turning Lake Windermere pink seems harmless, it would be extremely toxic to the environment.

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