Statement of the problem: A water tank has the form of a toilet paper roll with inner radius \( r = 6 \text{m} \) (where \( m \) =meters), a height \( h = 5 \text{m} \) and a total capacity of \( 140\pi m^3 \).

Answer the following questions:

1. What is the area of the tank exposed to the wind?

2. Can you design a tank with the same volume but less area exposed to the wind?

The answer to the first question is not hard. The volume of the tank is the difference between the volume of the big cylinder and the small cylinder and so it is equal to

\[
V = \pi h (R^2 - 36),
\]

where \( R \) is the outer radius of the tank. Solving for \( R \) we get \( R = 8 \text{m} \). The area exposed to the wind is actually the projection of the surface of the tank (its shadow), that is,

\[
A = 2Rh = 80 m^2.
\]

The answer to the second question depends on many different factors and it involves also the particular characteristics of the designer. We’ve got a few good answers that I list below in no particular order. Thank you very much to Joe, Karen and Lindsay for sharing your work with everybody and for helping me putting this summary together. Sebastian

Solution by Joe from Section 01:

Joe decided to let the inner radius of the tank constant, increase the height of the tank and reduce the outer radius preserving the volume. This has the advantage that we still have a tube inside the tank from which we can access the pipes and pumps installed there (and to clean the tank). The fact that this increase in height reducing the outer radius decreases the total area exposed to the wind is very interesting. It follows from the fact that the volume is a function of the square of the outer radius while the area exposed to the wind is a linear function of the outer radius. See the above equations.

Solution by Karen from Section 03:

Karen decided to try a spherical tank as she saw it on Hwy 5 north on her way out of Stockton from campus. She is actually not sure that it is, in fact a water tank. She found the volume of the tank given, then set this volume equal to the volume of the sphere, finding the radius of the new spherical tank. She then found the surface area of this tank and compared the amount of surface area of the spherical tank exposed to the wind to the cylindrical tank surface area exposed to the wind. She found that the area of the spherical tank exposed was indeed less than the area of the cylindrical tank exposed.
This was a great idea because the sphere is the solid object with least total area for a given volume. It does not take into account the access to the tank, pipes and pump but this can be solved in many different ways and so it is not a problem at all.

**Solution by Lindsay from Section 03:**

Lindsay decided to reduce the inner radius to 2 meters while keeping the height constant. In this way we obtain a reduction in the outer radius and therefore a reduction in the area exposed to the wind. Also, a great solution that takes into account the access to the tank and pipes.