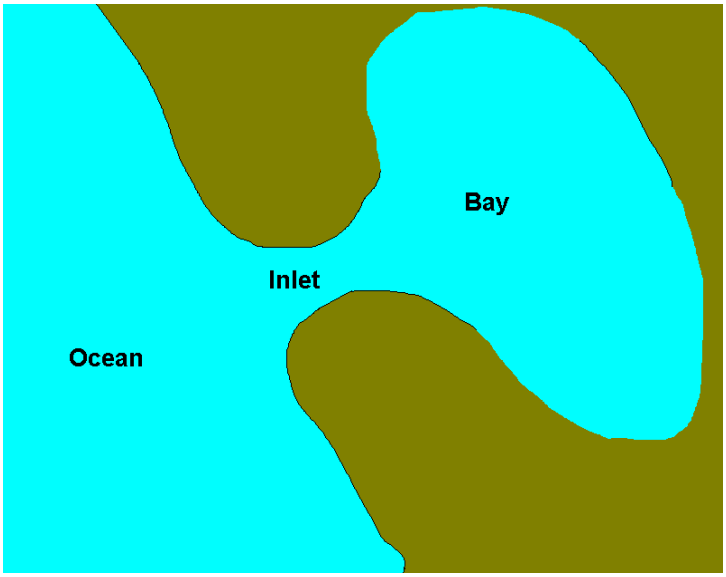
Tidal Inlets

Tidal inlets cut through barrier islands off the shore. They provide access to bays, lagoons, or the intercoastal waterway for boats and large ships. Here is an example of an inlet.

Figure 1. John's Pass, Florida.

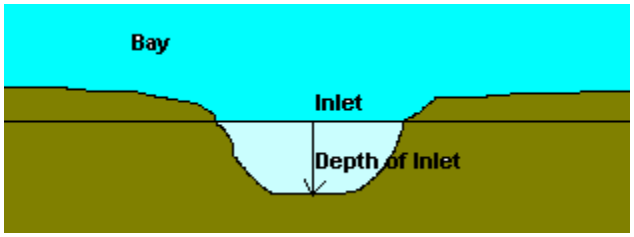
Here is an aerial view of what an inlet looks like.



Tides are responsible for water going into and out of the bay through the inlet. This also causes the material making up the land portion on either side of the inlet to be carried into and out of the inlet. The inlet can, therefore, widen or shrink. It is important to consider this and plan for what might happen to the inlet size if one were to build a bridge across the inlet. If the inlet grows too wide, the bridge piles may be floating in water rather than anchored in land. Let's look at some equations and relations that help us figure out what will happen to the inlet.

First, let us introduce some variables:

A_c = the minimum inlet cross-sectional area (the area of the lighter blue section in the picture)



P = Tidal Prism, which is the volume of water that is drawn into the bay from the ocean through the inlet during flood tide

There is a mathematical relationship between **A_c** and **P**. It is different for different locations, but let us use the Atlantic coast of the U.S. as our location.

$$\mathbf{A_c = (7.75 \times 10^{-6})P^{1.05}}$$

It is important to note that we use British units here.

Exercise 1

Consider an inlet where 1.1 x10^8 yd^3 is drawn into the bay from the ocean through the inlet at flood tide. What is the minimum cross-sectional area of the inlet?

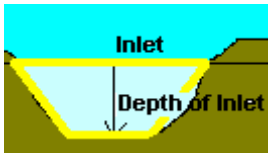
$A_c = (7.75 \times 10^{-6})P^{1.05}$

$A_c = (7.75 \times 10^{-6}) \times (1.1 \times 10^8\ yd^3)$

$A_c = 852.5\ yd^2$

Exercise 2

Now let us assume that the shape of the cross-section of the inlet is approximately a trapezoid.



If the slope of the sides of the inlet into the water is 1/2 and the inlet is 30 ft deep, obtain the width of the inlet at the surface of the water.

We start by recalling our formula for the area of a trapezoid

$$A \equiv \left(\frac{b_1 + b_2}{2} \right) h$$

where b_1 and b_2 are the lengths of the 2 parallel sides of the trapezoid and h is the height of the trapezoid.

We know the slopes of the sides of the trapezoid.

We also know that the height of the trapezoid is 30 ft. Previously, we obtained the area, 852.5 yd^2.

Using geometry, we can obtain the width of the inlet at the surface.

Begin by making sure that all the units agree. We have a depth of 30 ft and an area of 852.5 yd^2. Let us convert feet to yards.

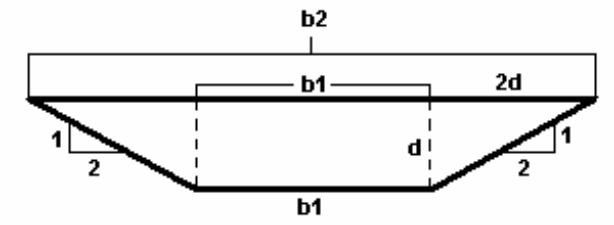
3 ft = 1 yd

30 ft = ? yd

30 ft x (1 yd / 3 ft) = 10 yd

The depth of the inlet is 10 yd. We will call this *d*.

Next, let's look at the trapezoid again and set up an algebraic equation for the length of the bases so we can obtain the width of the inlet at the surface and at the bottom.



$b_2 = b_1 + 2d + 2d$

$b_2 = b_1 + 4d$

Now, we can place that back into the equation for the area.

$$A \equiv \left(\frac{b_1 + b_2}{2} \right) h$$

$$852.5 = \left(\frac{b_1 + (b_1 + 4d)}{2} \right) 10$$

$$\frac{852.5}{10} = \left(\frac{b_1 + (b_1 + 4d)}{2} \right)$$

$$\frac{852.5 \times 2}{10} = b_1 + b_1 + 4d$$

$$170.4 = 2b_1 + (4 \times 10)$$

$$170.4 - 40 = 2b_1$$

$$130.4 = 2b_1$$

$\underline{b_1 = 65.2 \text{ yd}}$

$b_2 = b_1 + 4d$

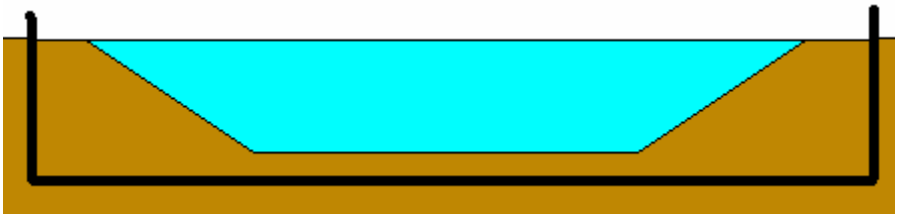
$b_2 = 65.2 + 40$

$\underline{b_2 = 105.2 \text{ yd}}$

Now, we know that the width of the inlet at the surface is 105.2 yd.

Practice Problem

An inlet on the Atlantic Coast is 40 ft deep and the slope of the sides is 2/3. The tidal prism here can range between $6x10^6$ yd^3 and $7.2x10^7$ yd^3. You want to build a pipe from your yard on one side of the inlet to your friend's yard on the other side of the inlet under the bottom of the inlet. The pipe will look something like this



You want to make sure that the pipe is always in the ground and not in the water when the inlet widens. What is the minimum that the total length of the pipe should be? What is the longest distance that the end of the pipe gets from the edge of the inlet?