دانشگاه فردوسی مشهد

عملیات مبانی و روشهای آبیاری

WATER MEASUREMENT MANUAL

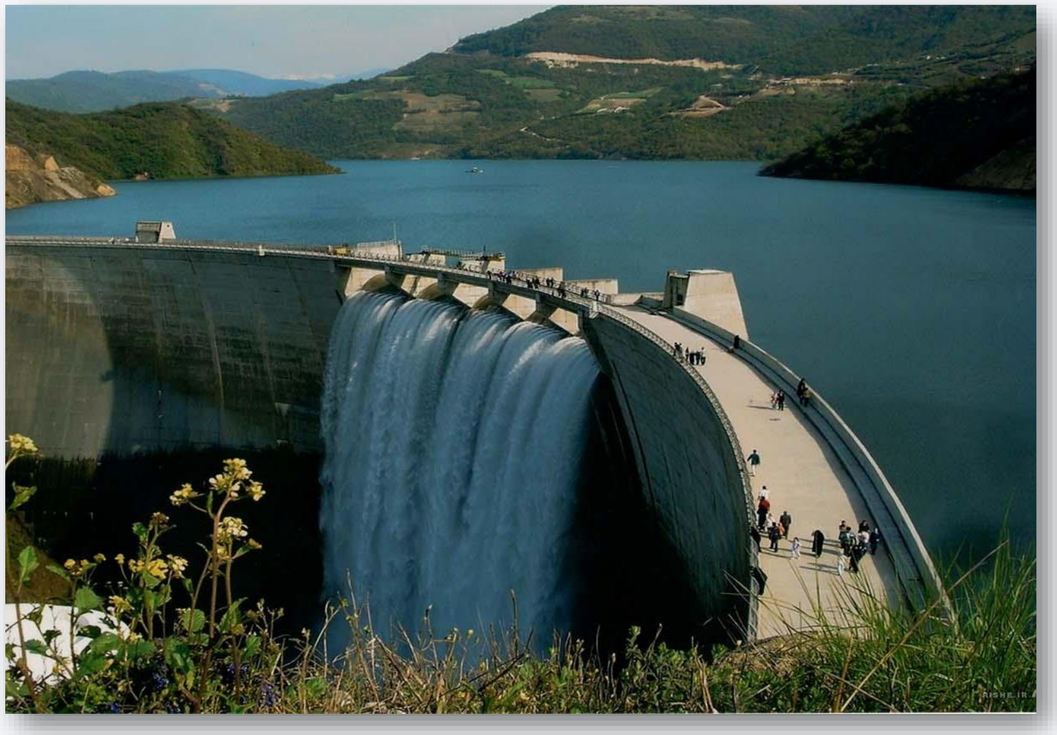
A WATER RESOURCES
TECHNICAL PUBLICATION

A guide to effective water measurement
practices for better water management

U.S. Department of the Interior
Bureau of Reclamation
Third edition

USDA
United States
Department of Agriculture

Theory



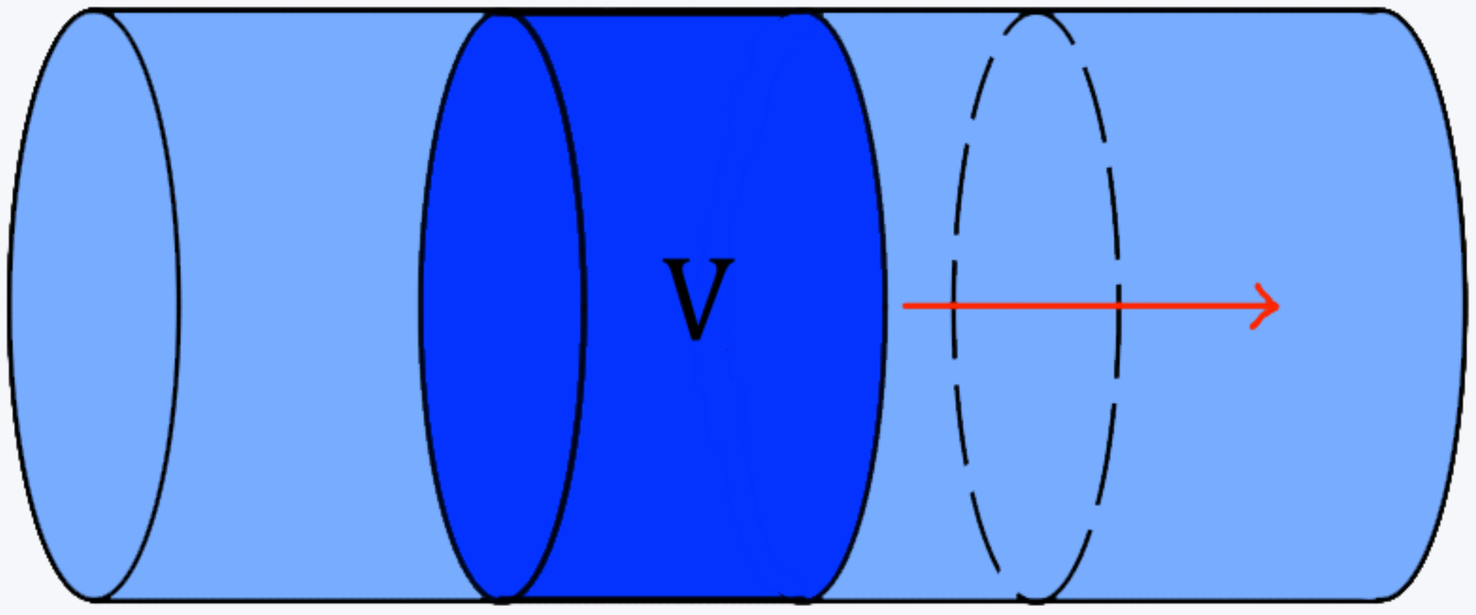
Theory

دبی یا آبده یا بده:

به حجم آب جابجاشده از یک مقطع مشخص (رودخانه، کانال آب، دریچه سد، لوله یا هر سازه دیگر) در مدت زمان مشخص بـده یا دبی گفته می‌شود.

Theory

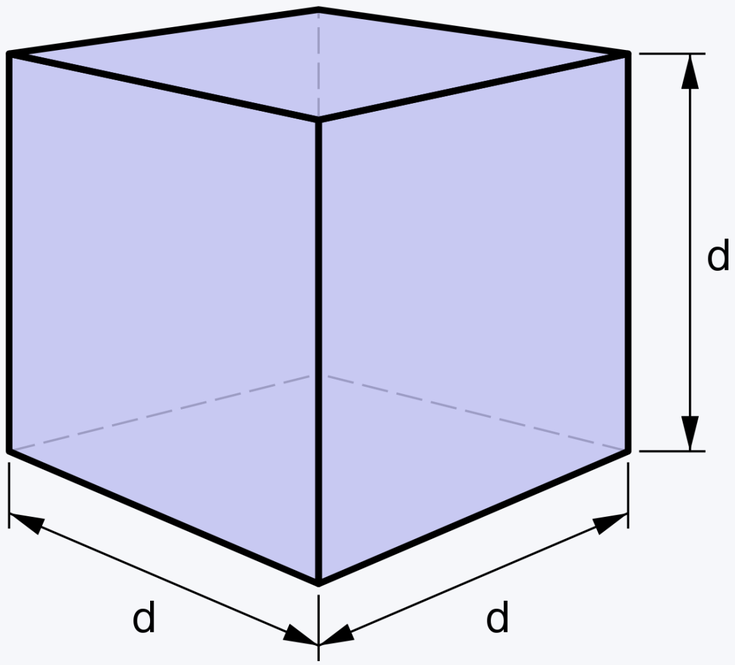
Volumetric **F**low **R**ate:



$$\boldsymbol{Q} = \lim_{\Delta t \to 0} \frac{\Delta \boldsymbol{V}}{\Delta \boldsymbol{t}} = \frac{\boldsymbol{dV}}{\boldsymbol{dt}}$$

Measure The Flow Rate Using Bucket Method

Experimental Method



$$Q = \frac{V}{t}$$

Q: Volumetric Flow Rate (L^3/T)
V: Volume of the Bucket (L^3)
T: Average Time (T)

Equipment


MODE
SPLIT RESET
START STOP
ACCUSPLIT
STOPWATCH
10:5323
MIN. SEC. 1/100
PRO SURVIVOR
601X
3V.1

Results

Trial Number	Time (Seconds)	Bucket Volume (Gallons)
1	13.2	5
2	14	5
3	14.5	5
4	13	5
5	13.4	5
6	13.1	5

$$t_{Ave} = \frac{13.2s + 14s + 14.5s + 13s + 13.4s + 13.1s}{6\ trial} = 13.5s$$

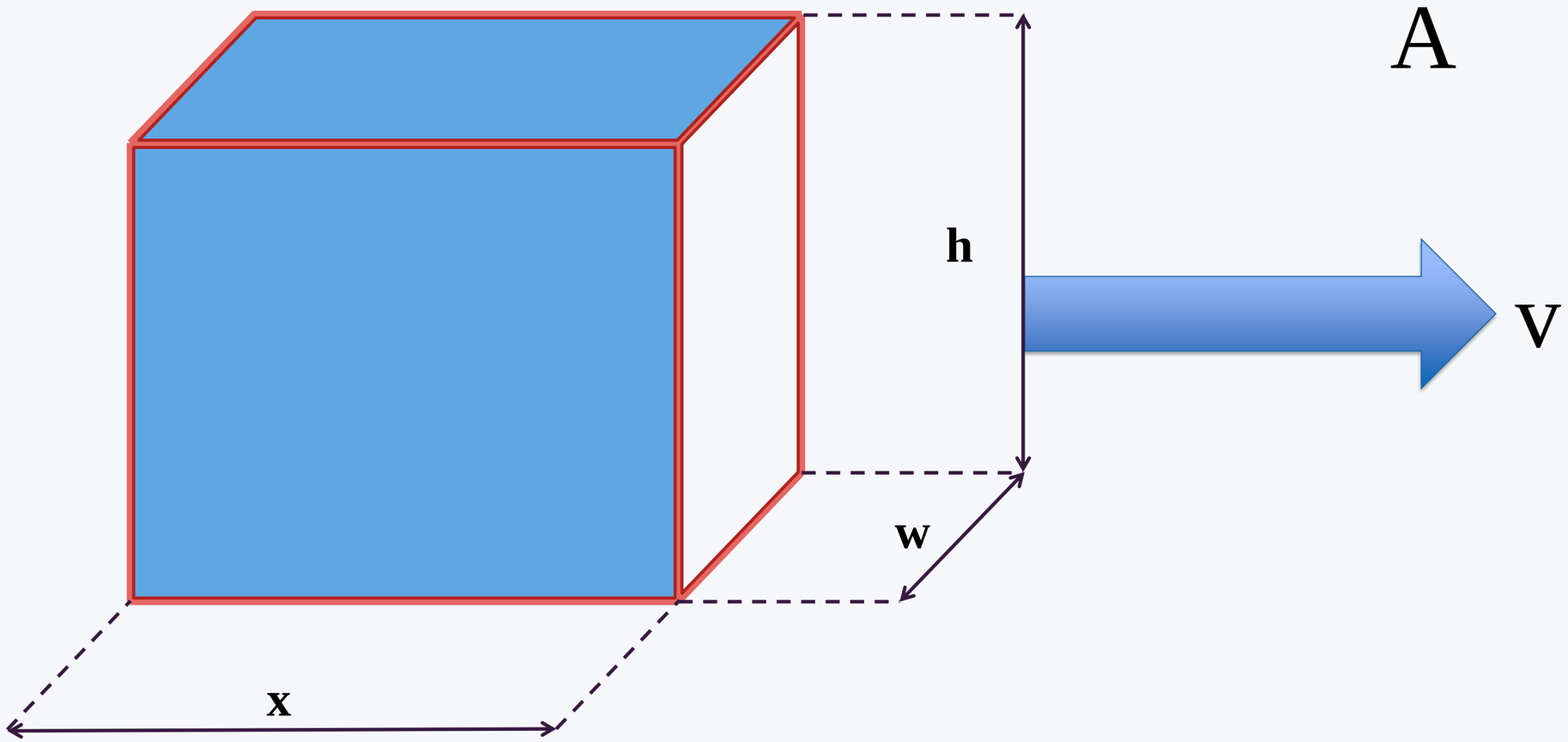
Q: Volumetric Flow Rate
V: Volume of the Bucket
T: Average Time

$$\boldsymbol{Q = \frac{V}{t} = \frac{5\ Gallons}{13.5\ Seconds} = 0.37\ \frac{Gallons}{Seconds}}$$

Float Method to Measure the Flow Rate

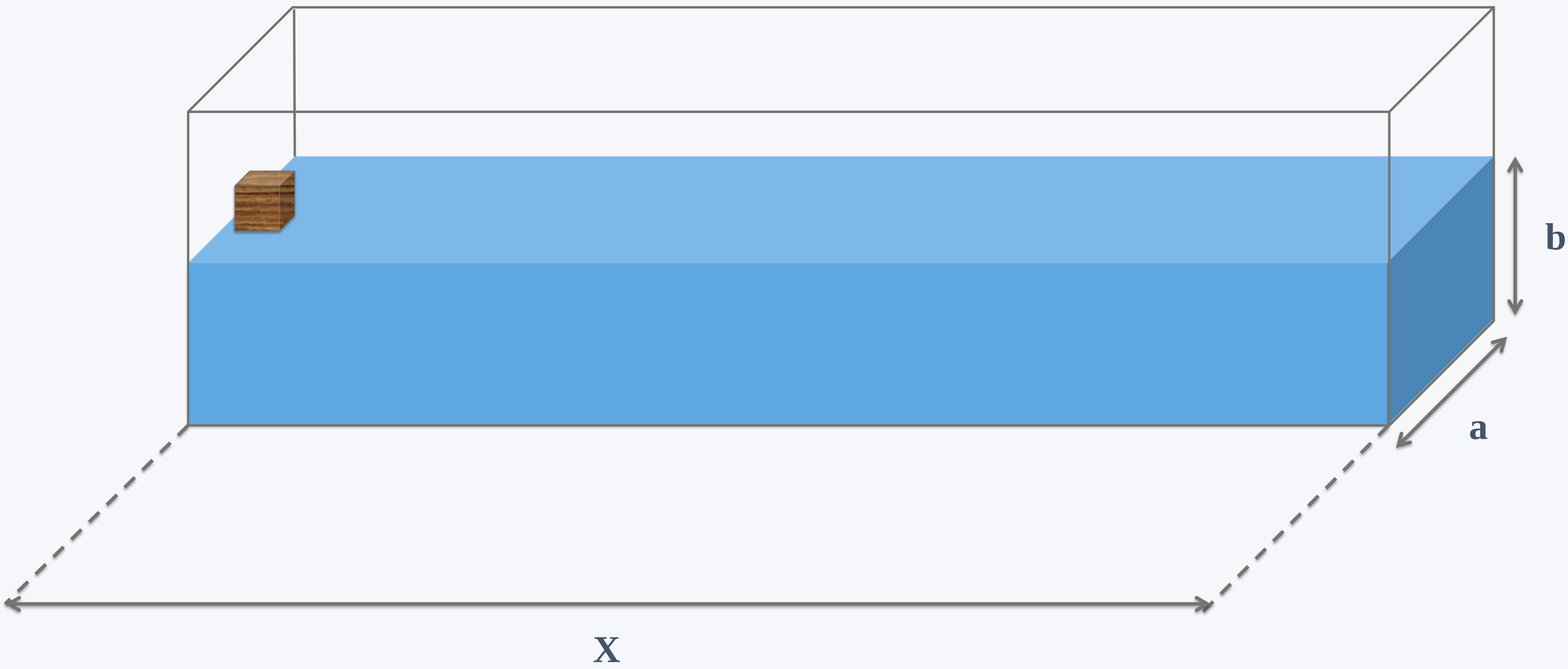
Theory

The **Volume of Water** Passing Through a **Channel Section** Per **Unit Time** Is Called The Flow Rate Or **Discharge**.

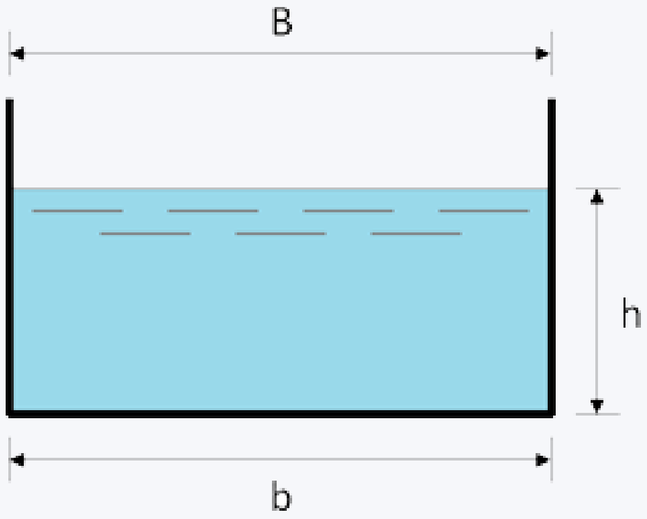


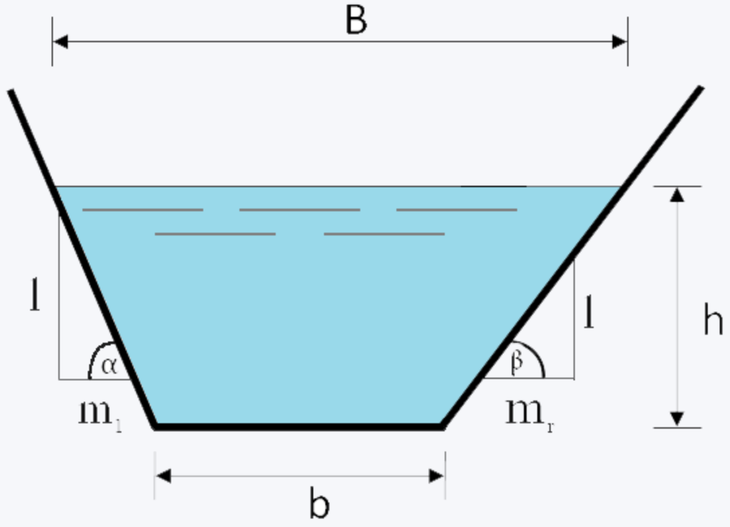
$$Q = \frac{V}{t} = \frac{x \times w \times h}{\cancel{v} \times \cancel{A}} = \frac{x}{t} \times (w \times h)$$

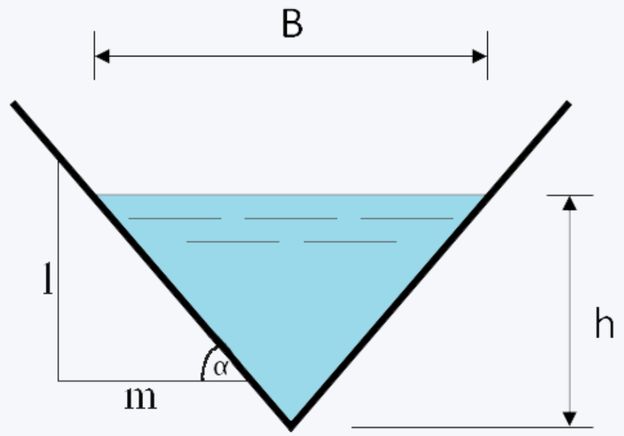
Experimental Method

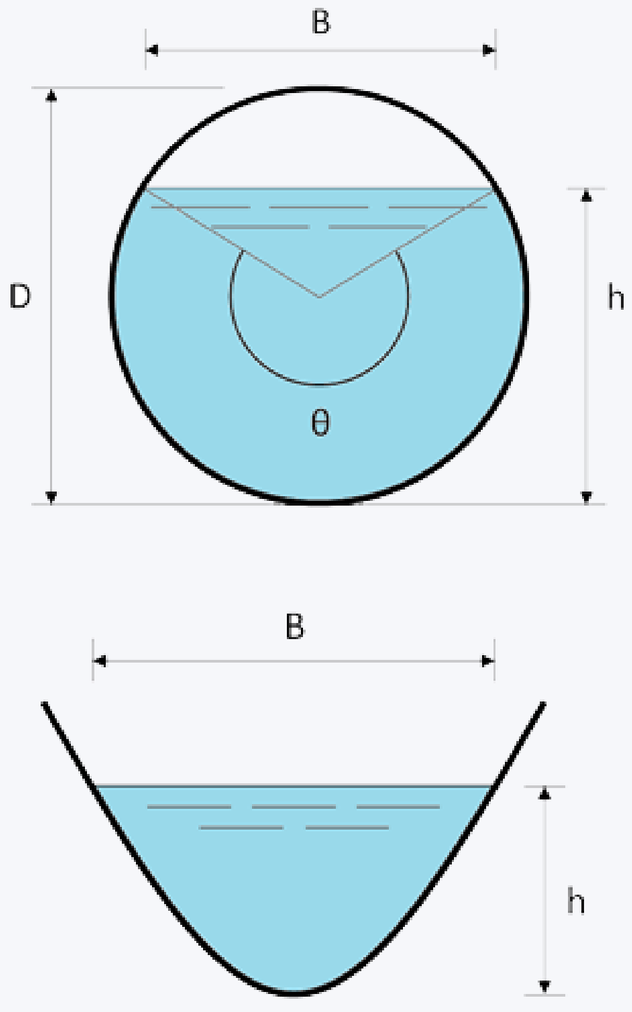


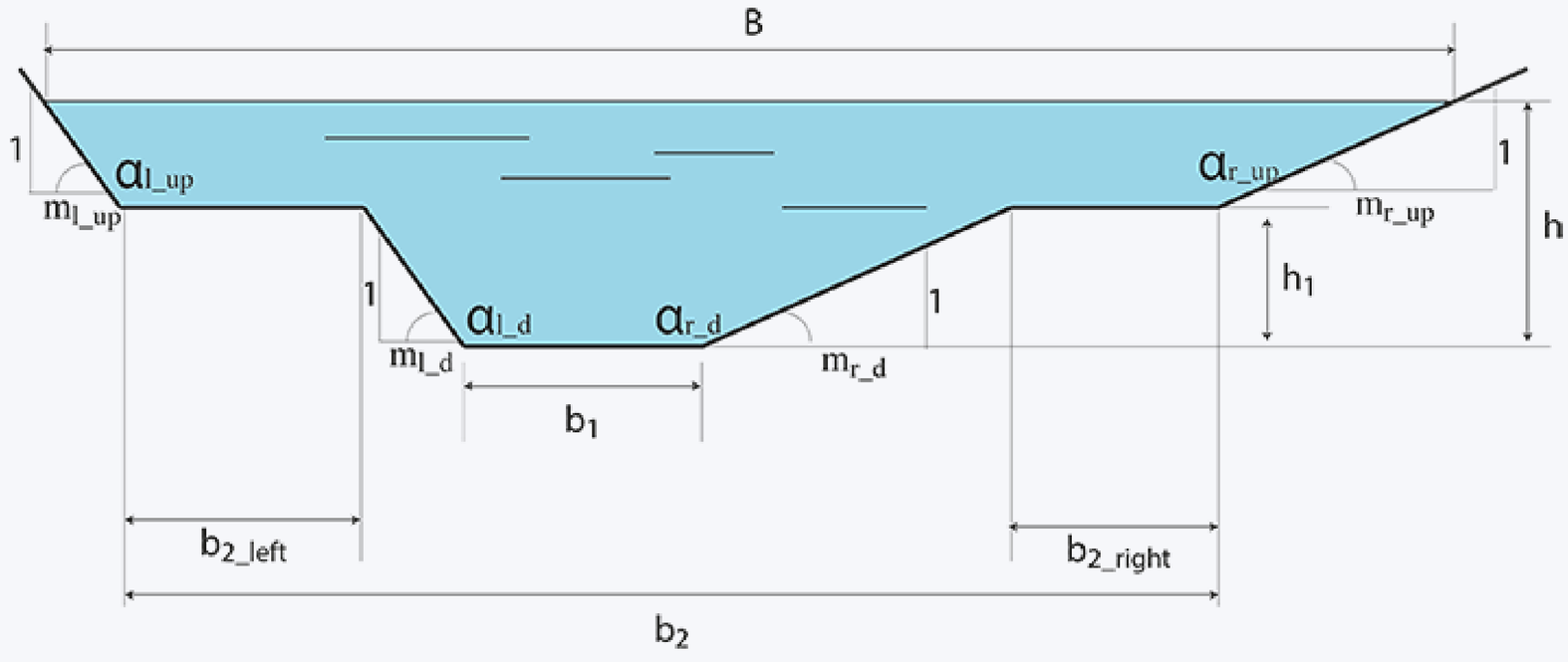
Experimental Method



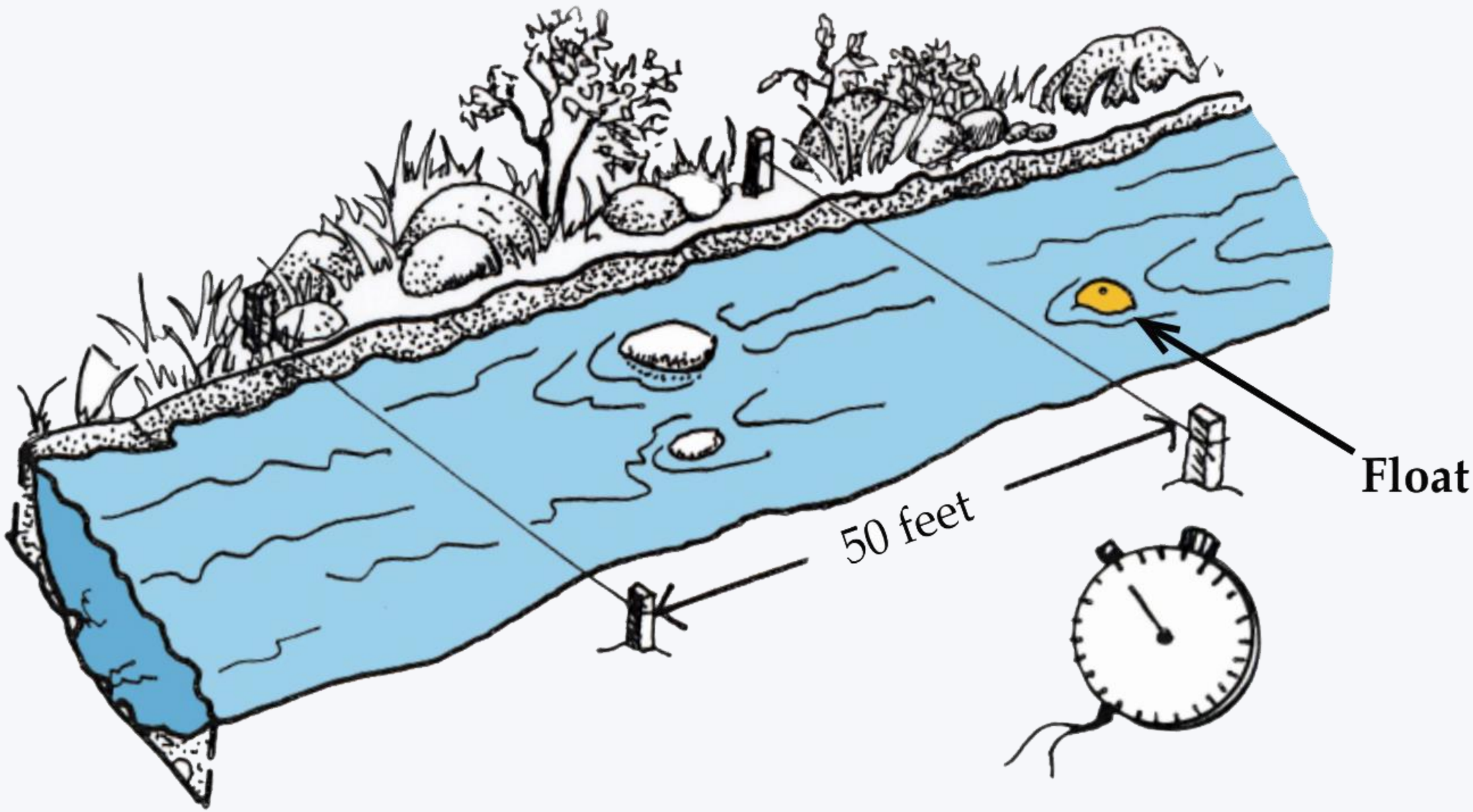




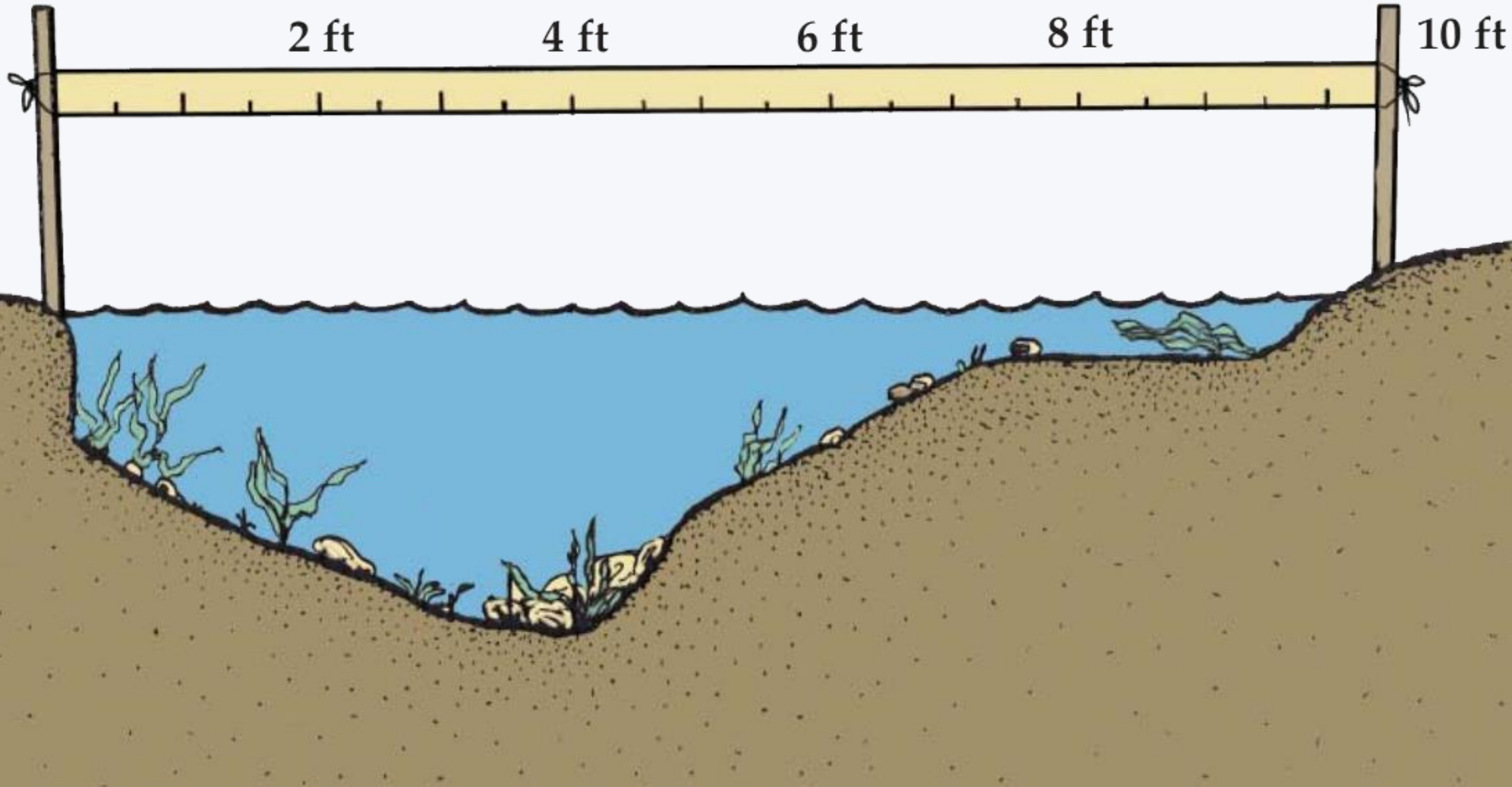




Experimental Method



Experimental Method

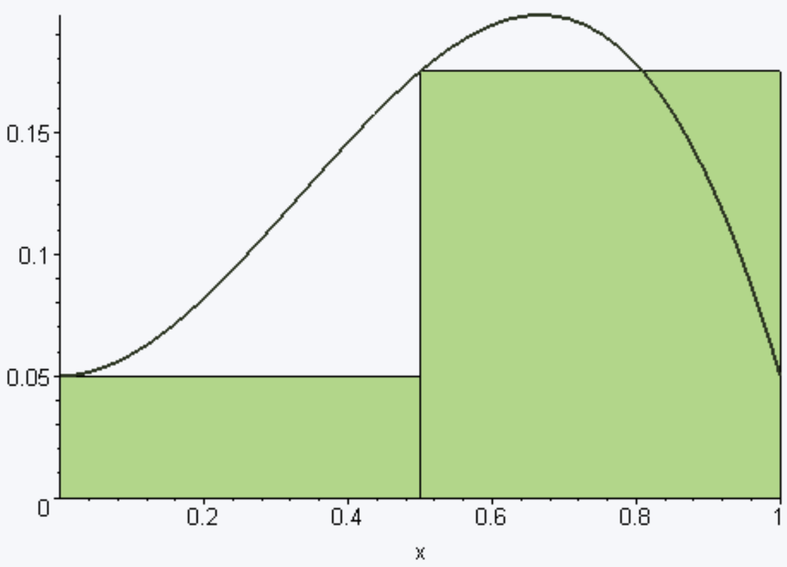


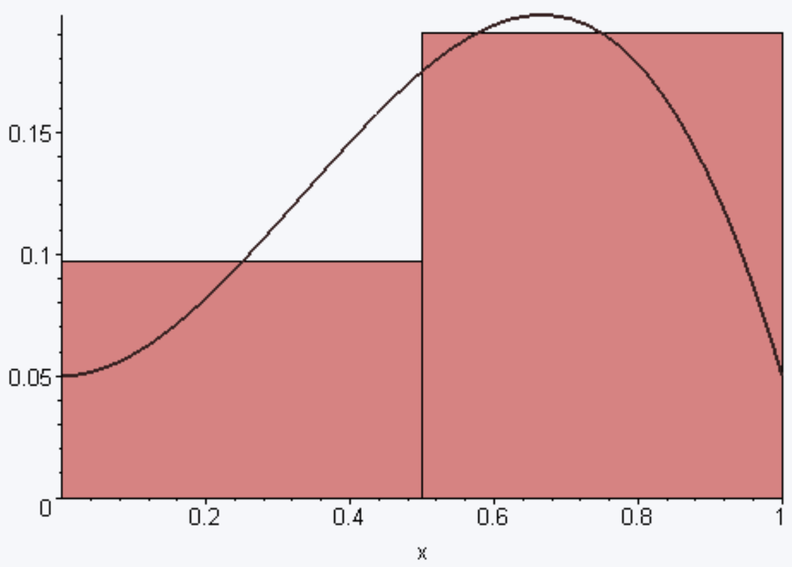
Experimental Method

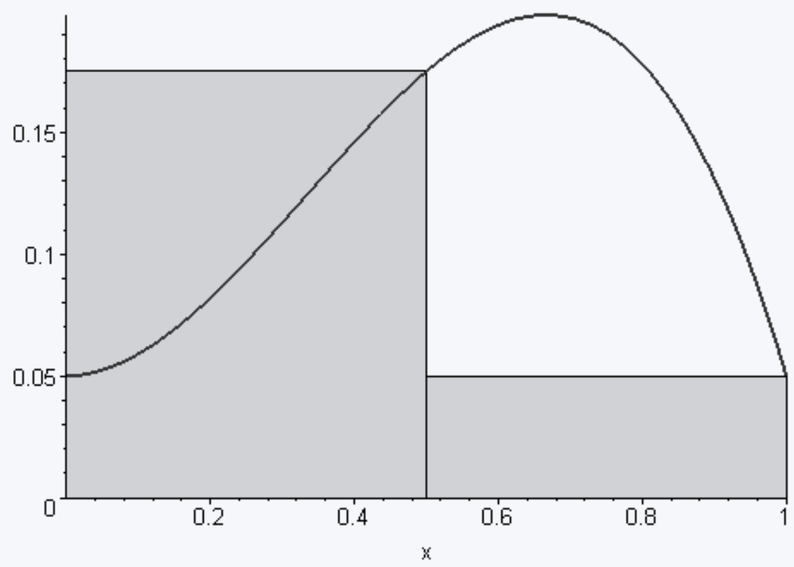
Riemann Sum

$$S = \sum_{i=1}^{n} f(x_i^*)\,\Delta x_i \qquad \Delta x = \frac{b-a}{n}$$

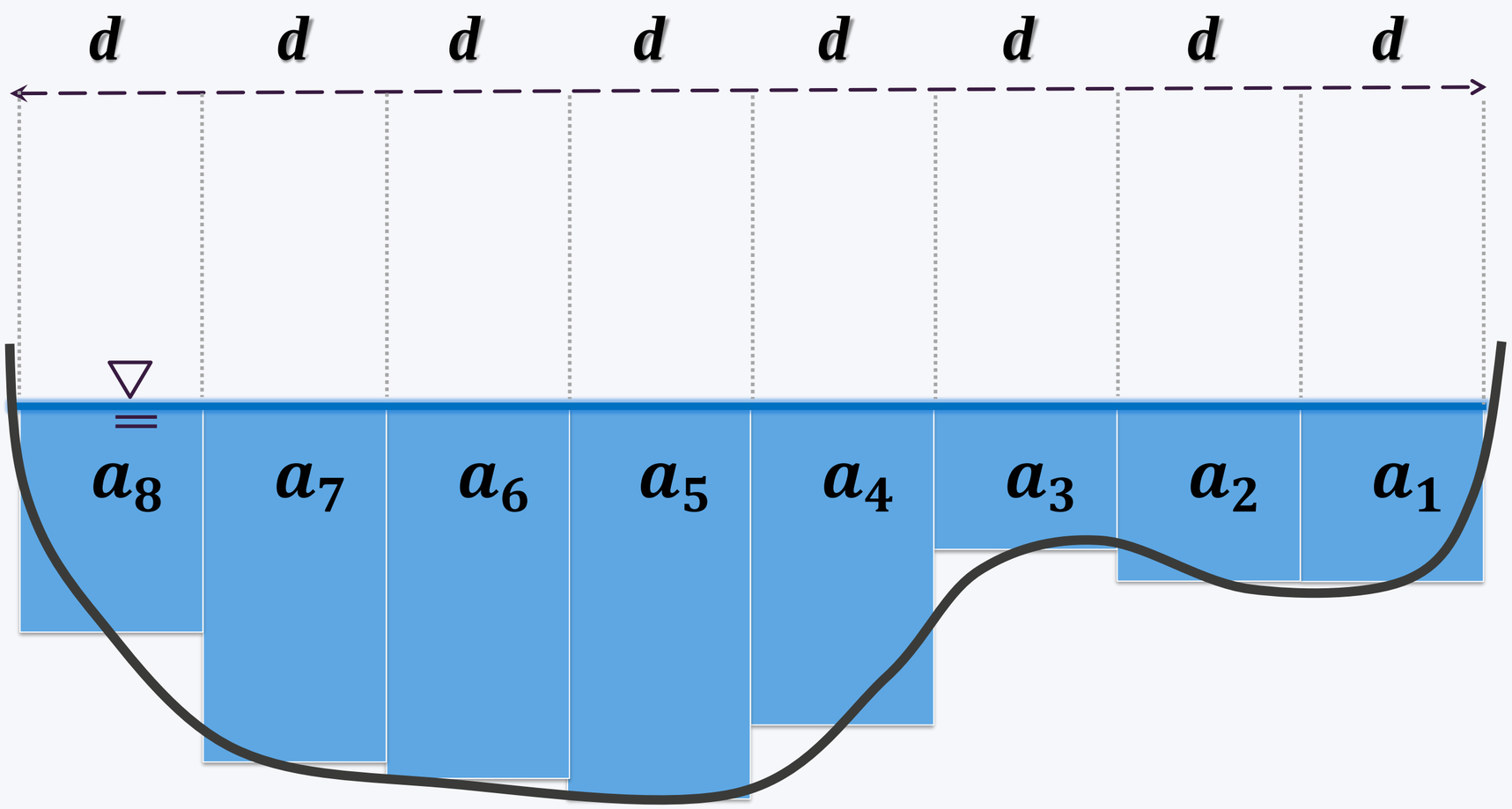
$$\Delta x \left[f(a + \frac{\Delta x}{2}) + f(a + \frac{3\,\Delta x}{2}) + \cdots + f(b - \frac{\Delta x}{2}) \right]$$





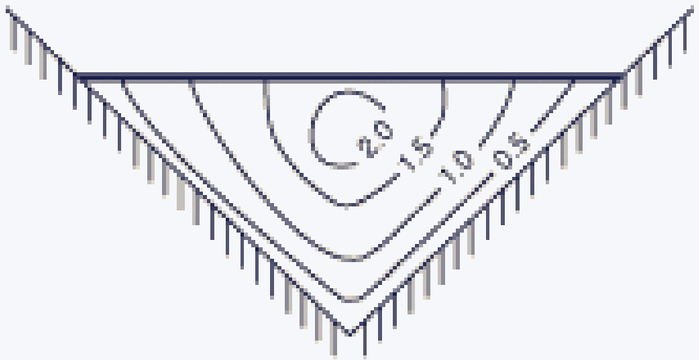


Experimental Method

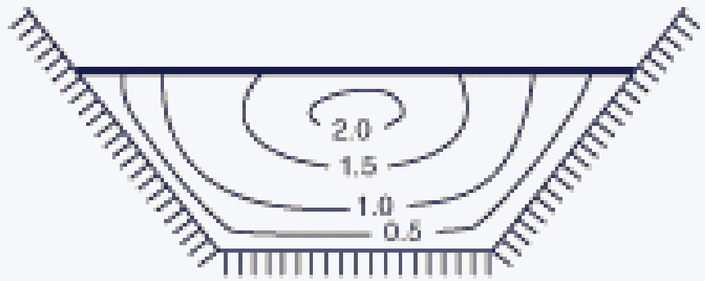


$$A = \sum_{1}^{8} a_i = a_1 + a_2 + a_3 + a_4 + a_5 + a_6 + a_7 + a_8$$

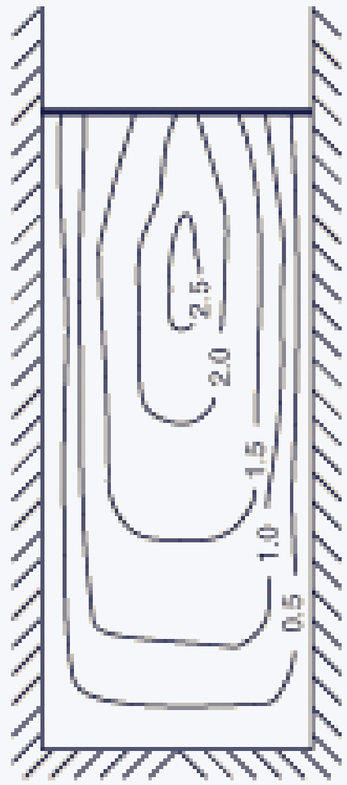
Experimental Method



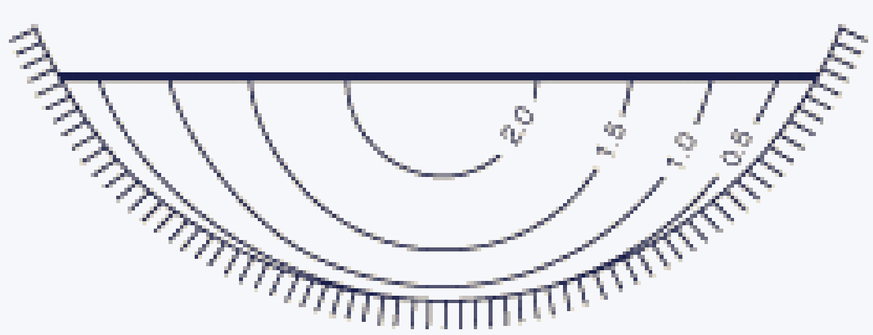
Triangular channel



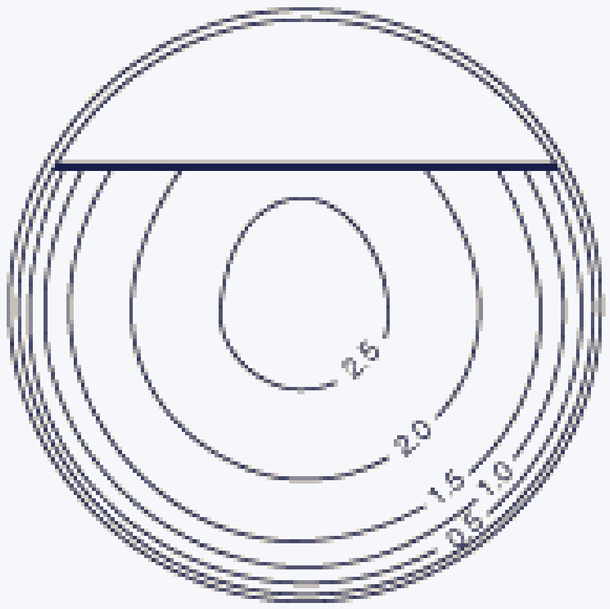
Trapezoidal channel



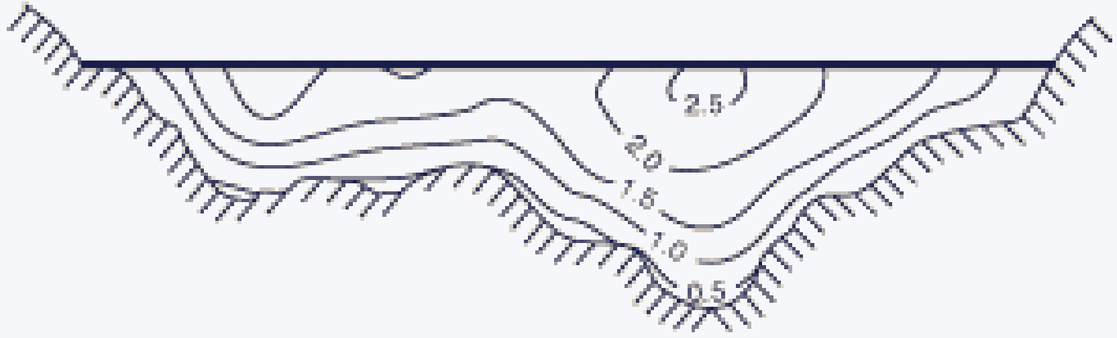
Narrow rectangular section



Shallow ditch

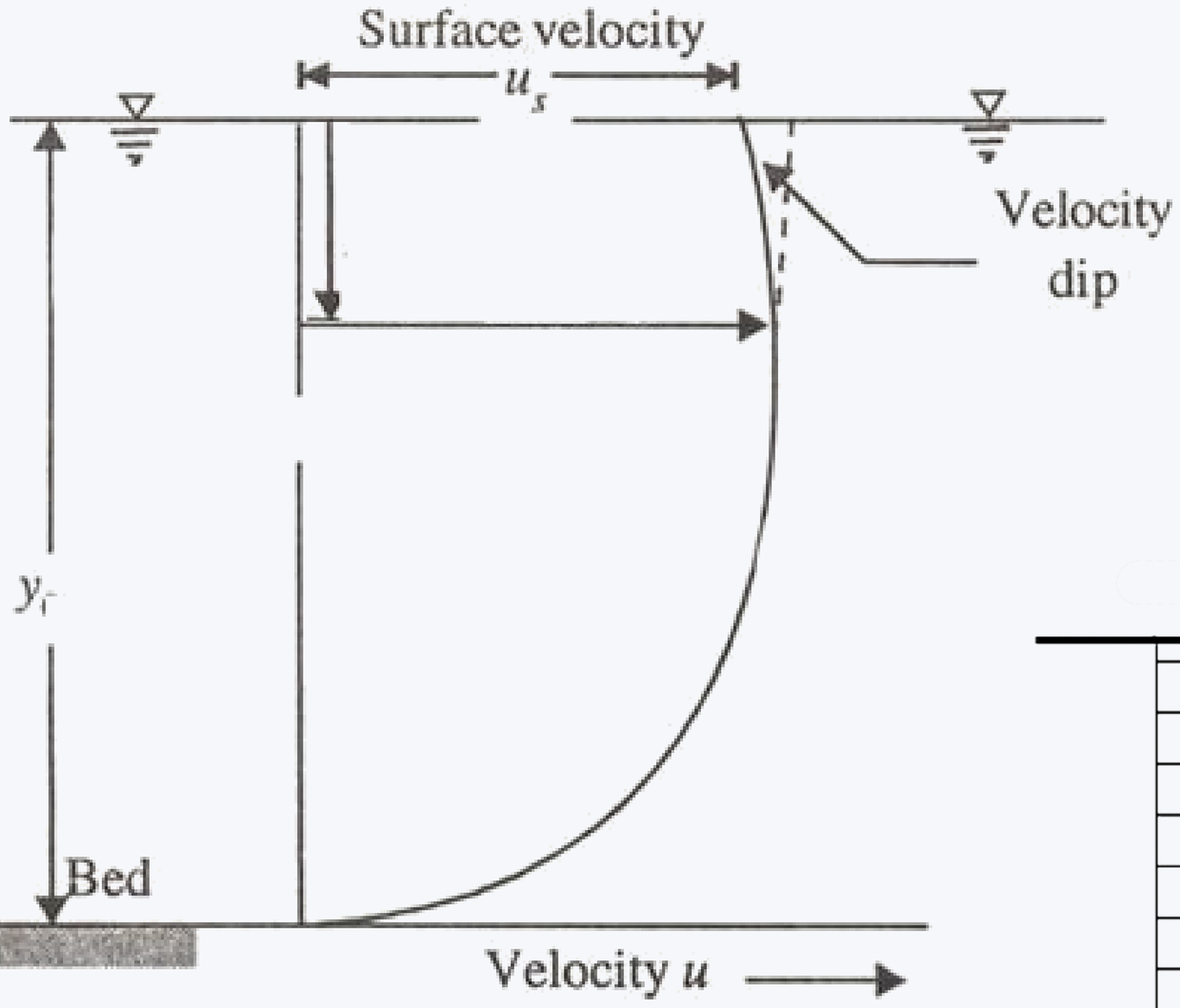


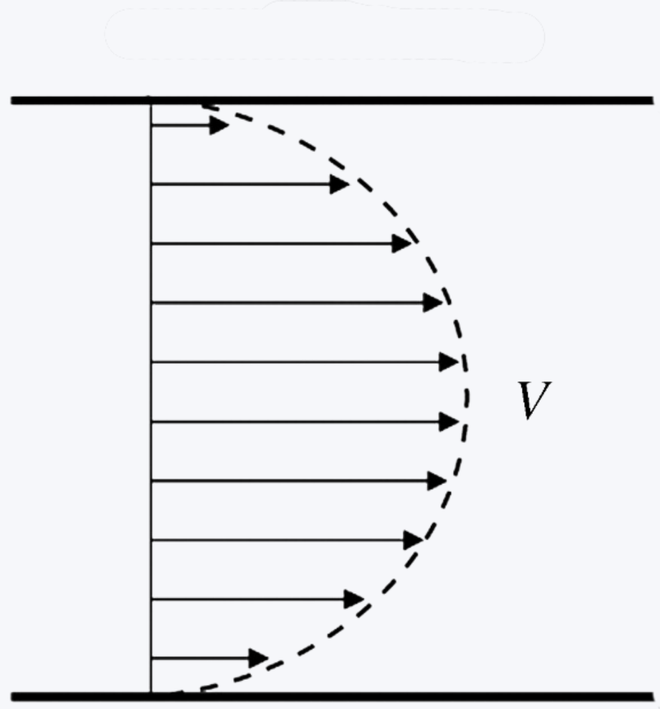
Pipe



Natural irregular channel

Experimental Method





flow direciton

Experimental Method

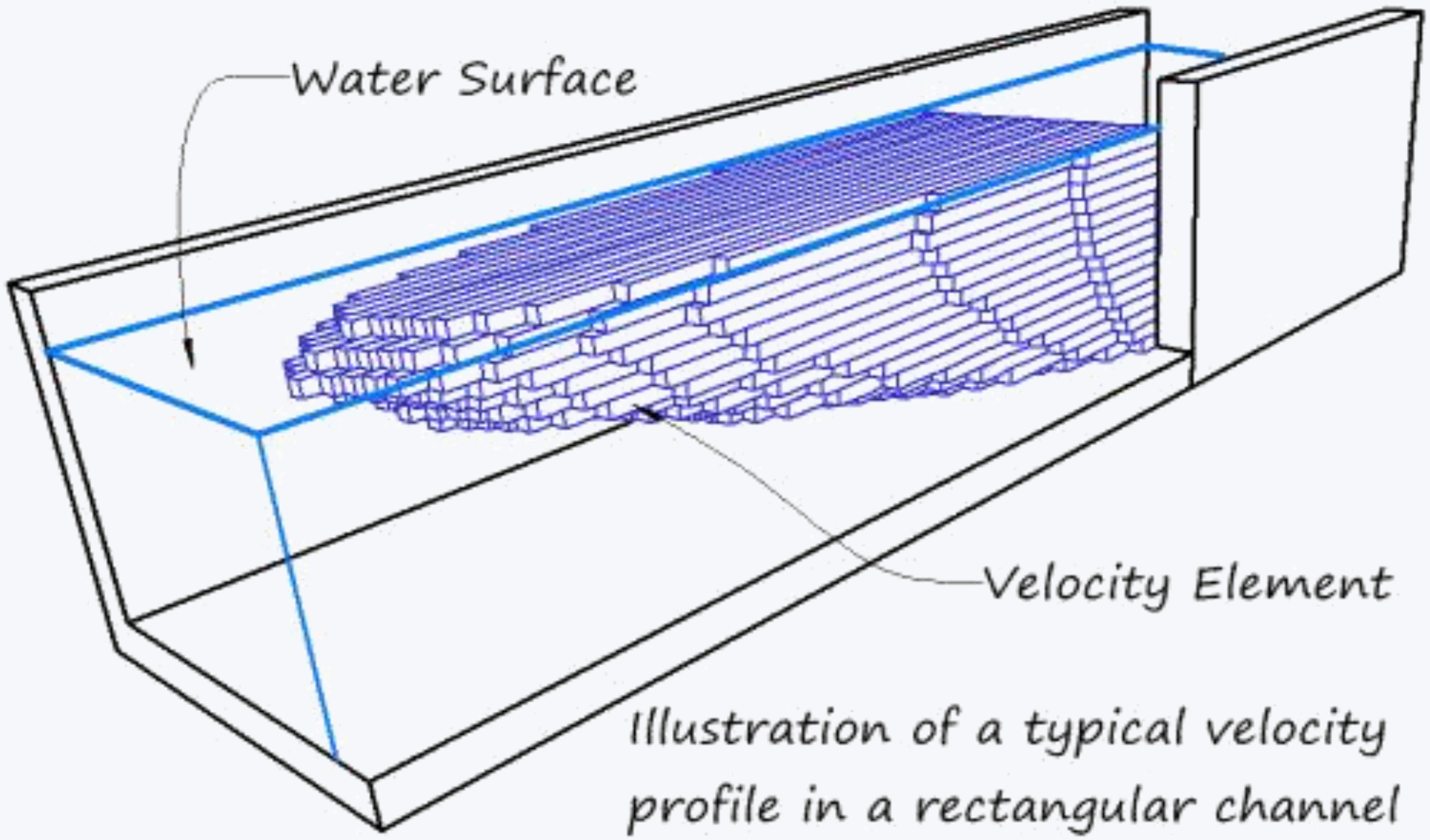


Illustration of a typical velocity profile in a rectangular channel

Experimental Method

Table 13-1. Coefficients to correct surface float velocities to mean channel velocities	
Average depth in reach (ft)	Coefficient
1	0.66
2	0.68
3	0.70
4	0.72
5	0.74
6	0.76
9	0.77
12	0.78
15	0.79
>20	0.80

Experimental Method

Trial	Time (s)	Distance (m)	Area (m^2)
1	10.25	2	0.032
2	10.63	2	0.032
3	11.02	2	0.032

$$\overline{T} = \frac{10.25 + 10.63 + 11.02}{3} = 10.63s$$

$$Q = \frac{2}{10.63} \times 0.032 = 0.006\ {}^{m^3}/_{s}$$

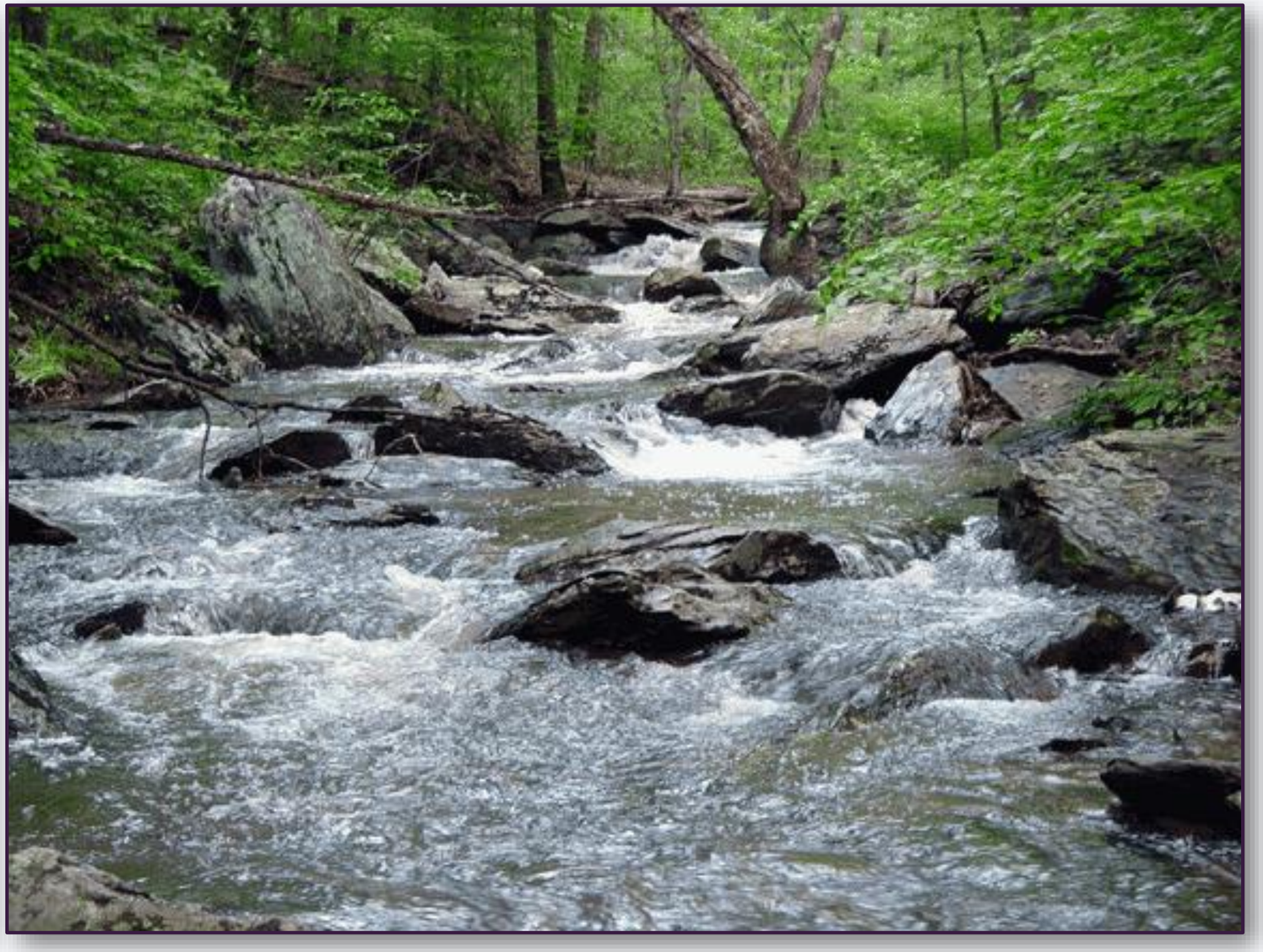
Equipment


MODE
SPLIT RESET
START STOP
ACCUSPLIT
STOPWATCH
10:5323
MIN. SEC. 1/100
PRO SURVIVOR
601X
3V.1


STAINLESS
FitMin
3m

Discharge **M**easurements **U**sing **T**racers

Theory



Theory

Kinds of **T**racers **U**sed

ردیاب‌ها انواعی از ماده یا انرژی هستند که به منظور تعیین توزیع زمانی و مکانی آب و مواد آلاینده آن در منابع آب به کار میروند

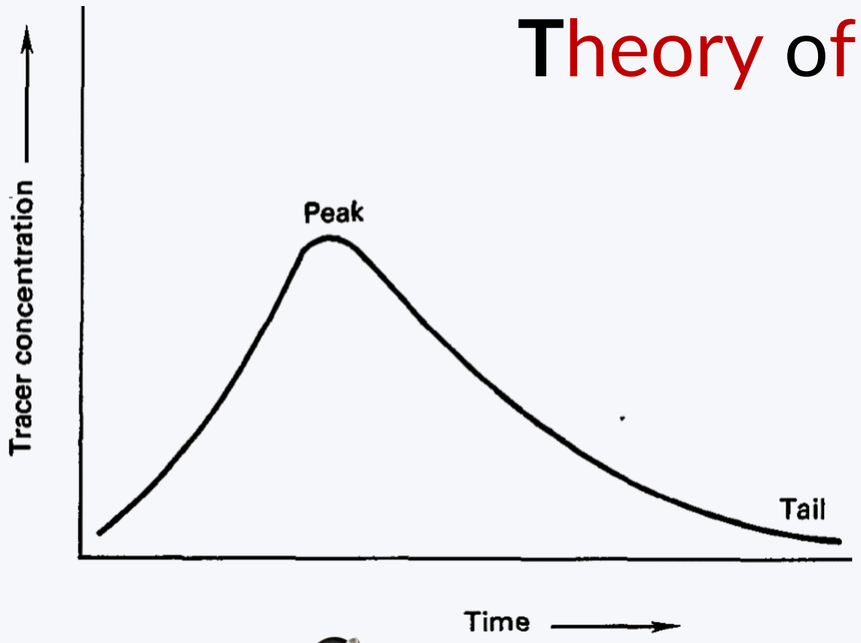
ویژگی‌های ردیاب‌ها:

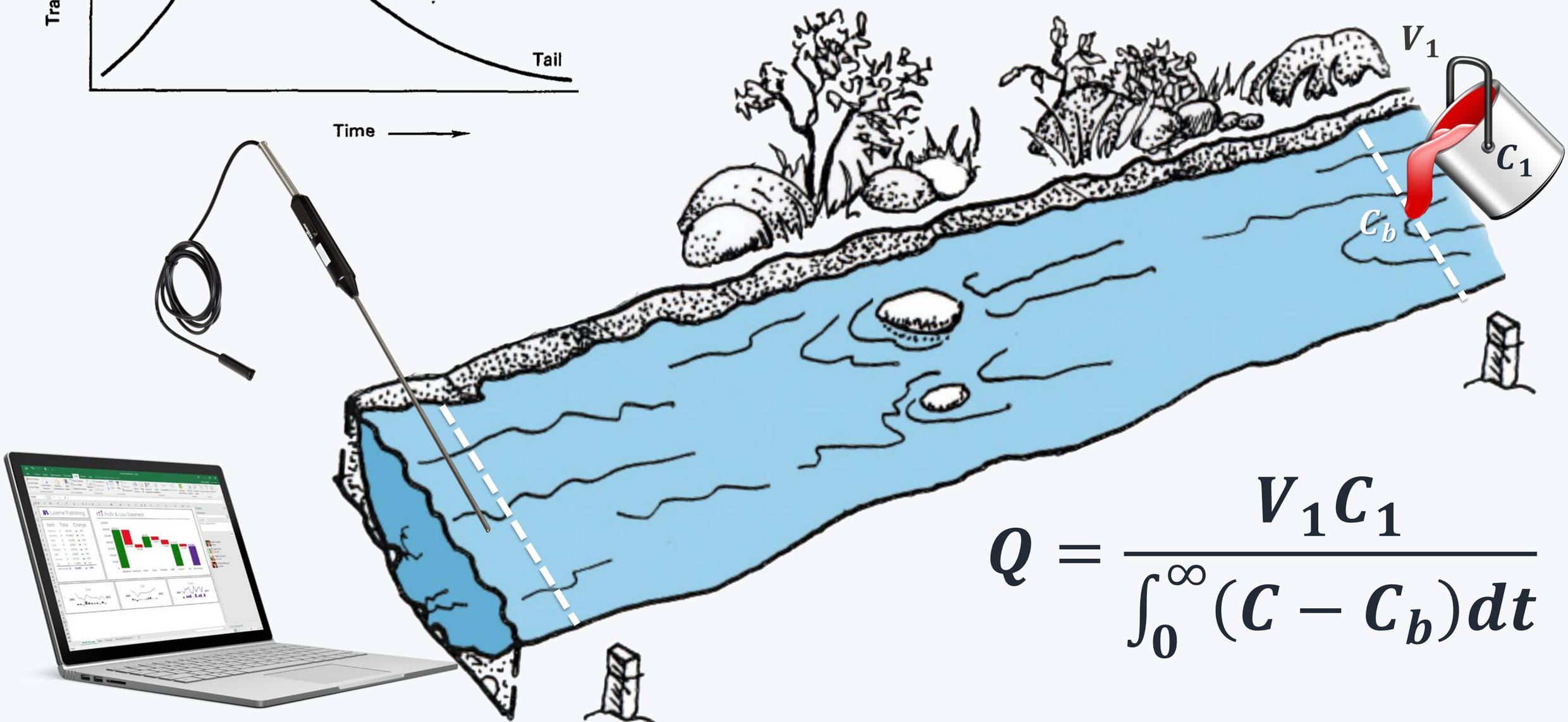
- پایداری ردیاب در طول مدت عملیات ردیابی
- بی خطر بودن برای محیط زیست حتی در غلظت کم
- امکان استفاده توام از ردیابهای مختلف
- امکان آشکارسازی با دقت بالا در غلظت کم
- انحلالپذیری در آب
- قابلیت جدایش از محیط زیست

Theory

Dilution Method

Theory of the Sudden Injection Method



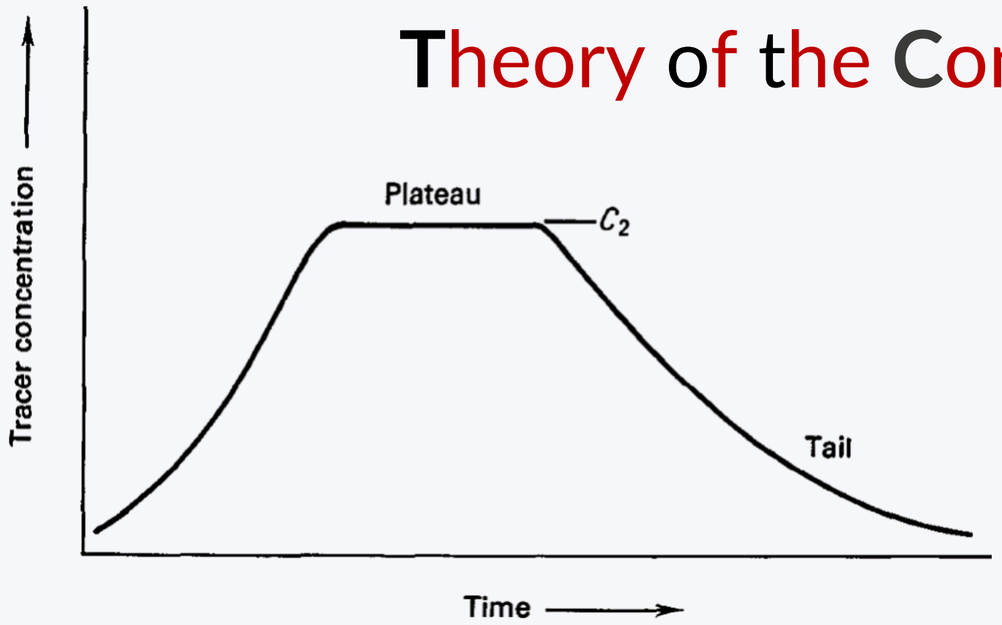


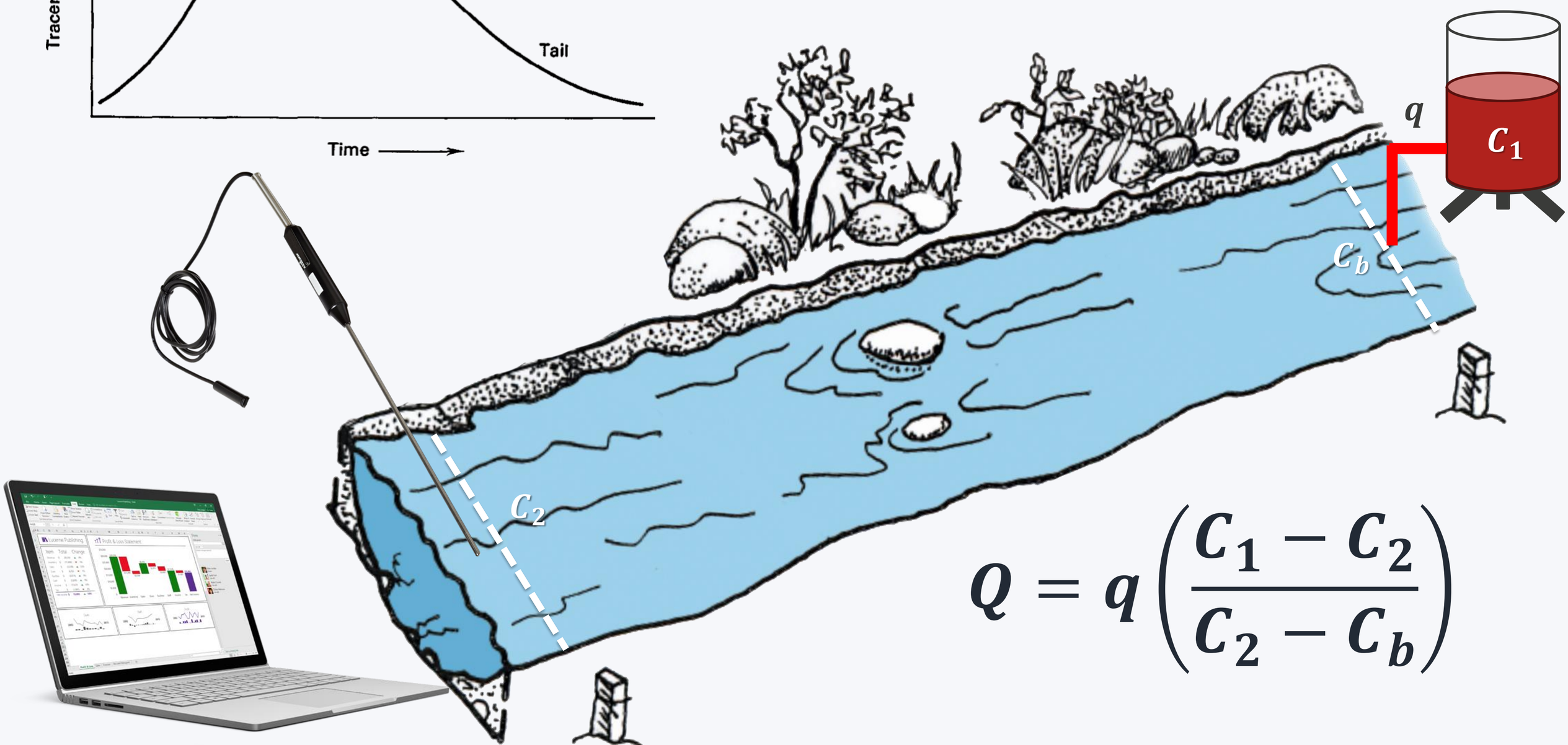
$$Q = \frac{V_1 C_1}{\int_0^\infty (C - C_b)dt}$$

Theory

Dilution Method

Theory of the Constant Rate Injection Method



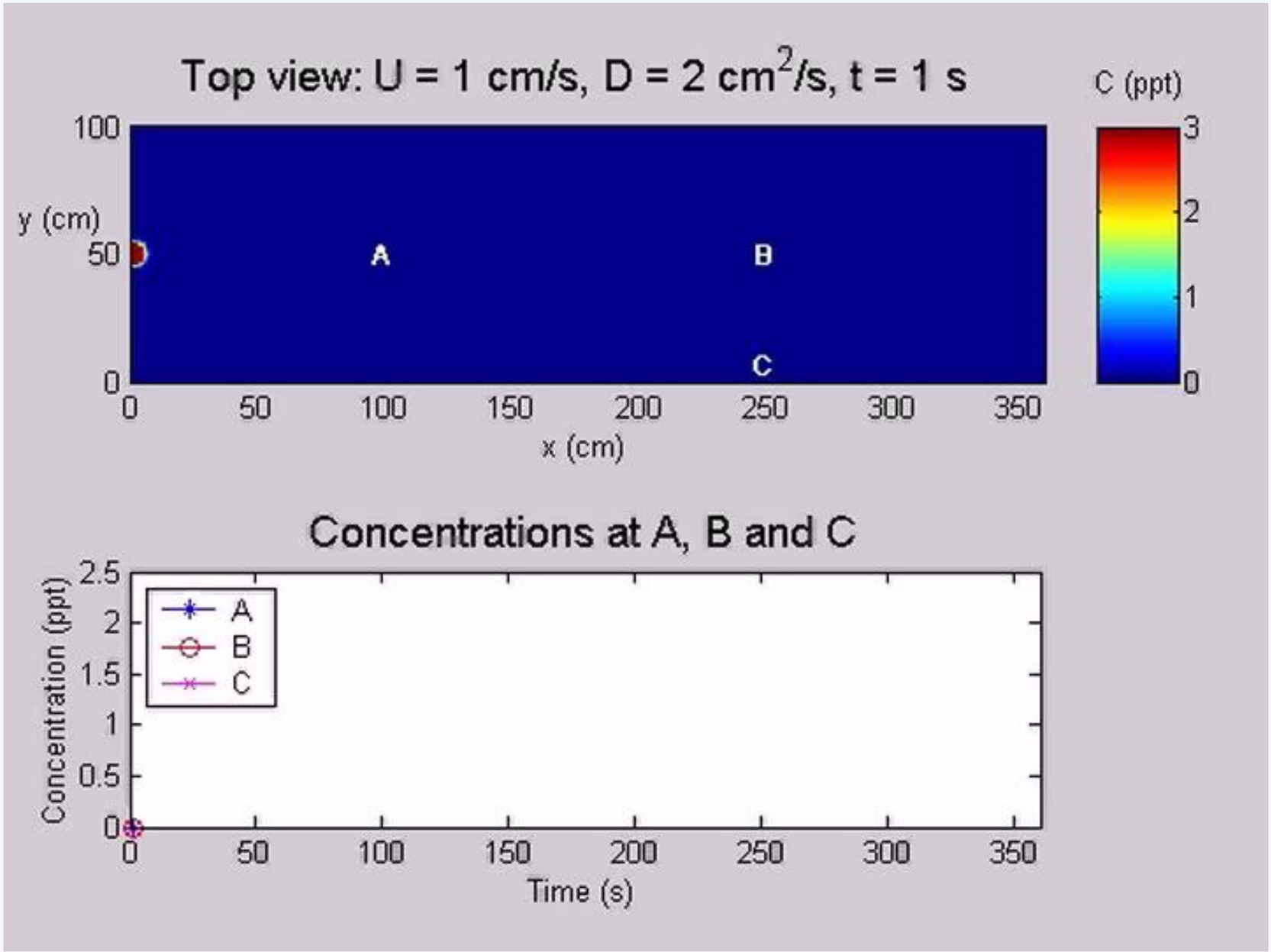


$$Q = q\left(\frac{C_1 - C_2}{C_2 - C_b}\right)$$

Theory

Dilution Method

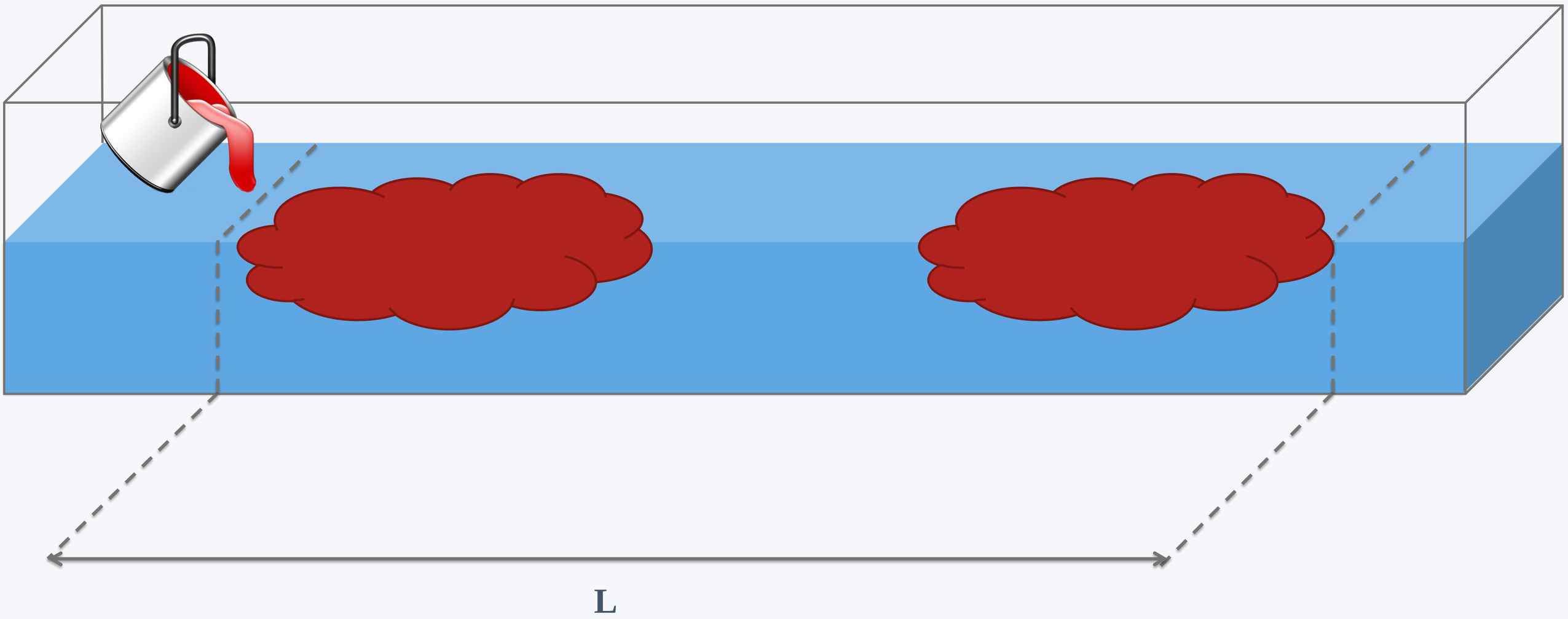
Theory of the Constant Rate Injection Method



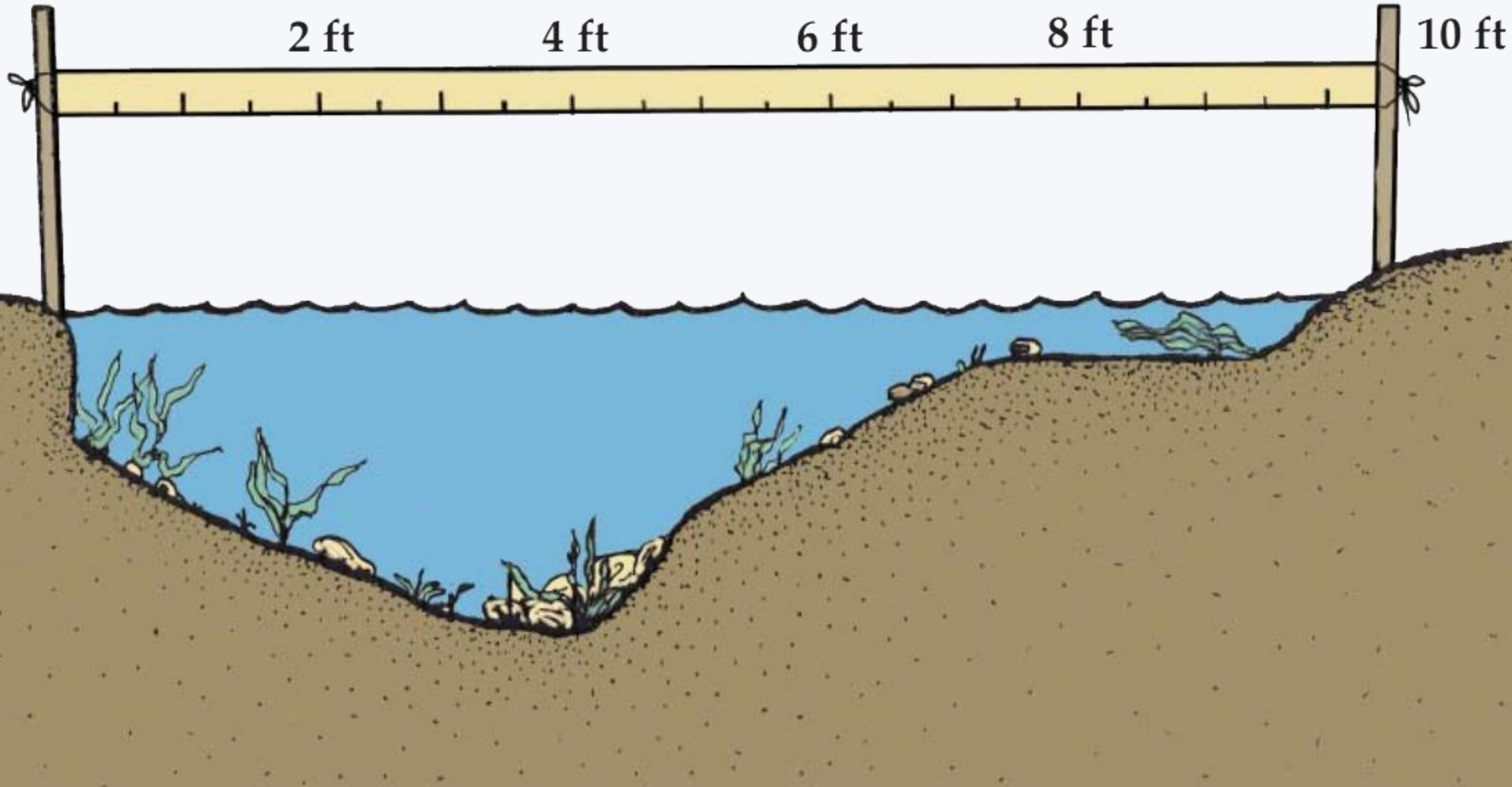
Experimental Method

$$t = \frac{t_1 + t_2}{2}$$

t_2
t_1

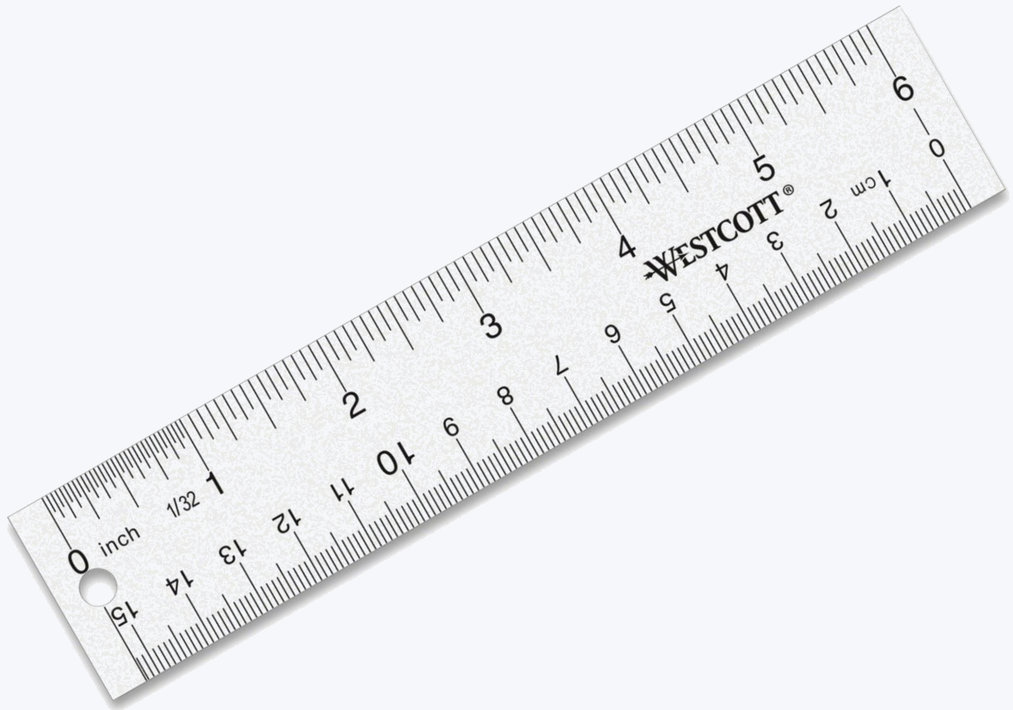


Experimental Method



Equipment


STAINLESS
FitMin
3m


WESTCOTT®
inch
cm


MODE
SPLIT RESET
START STOP
ACCUSPLIT
STOPWATCH
10:5323
MIN. SEC. 1/100
PRO SURVIVOR
601X
3V.1


BOMEX
100ml
APPROX

Any Questions?