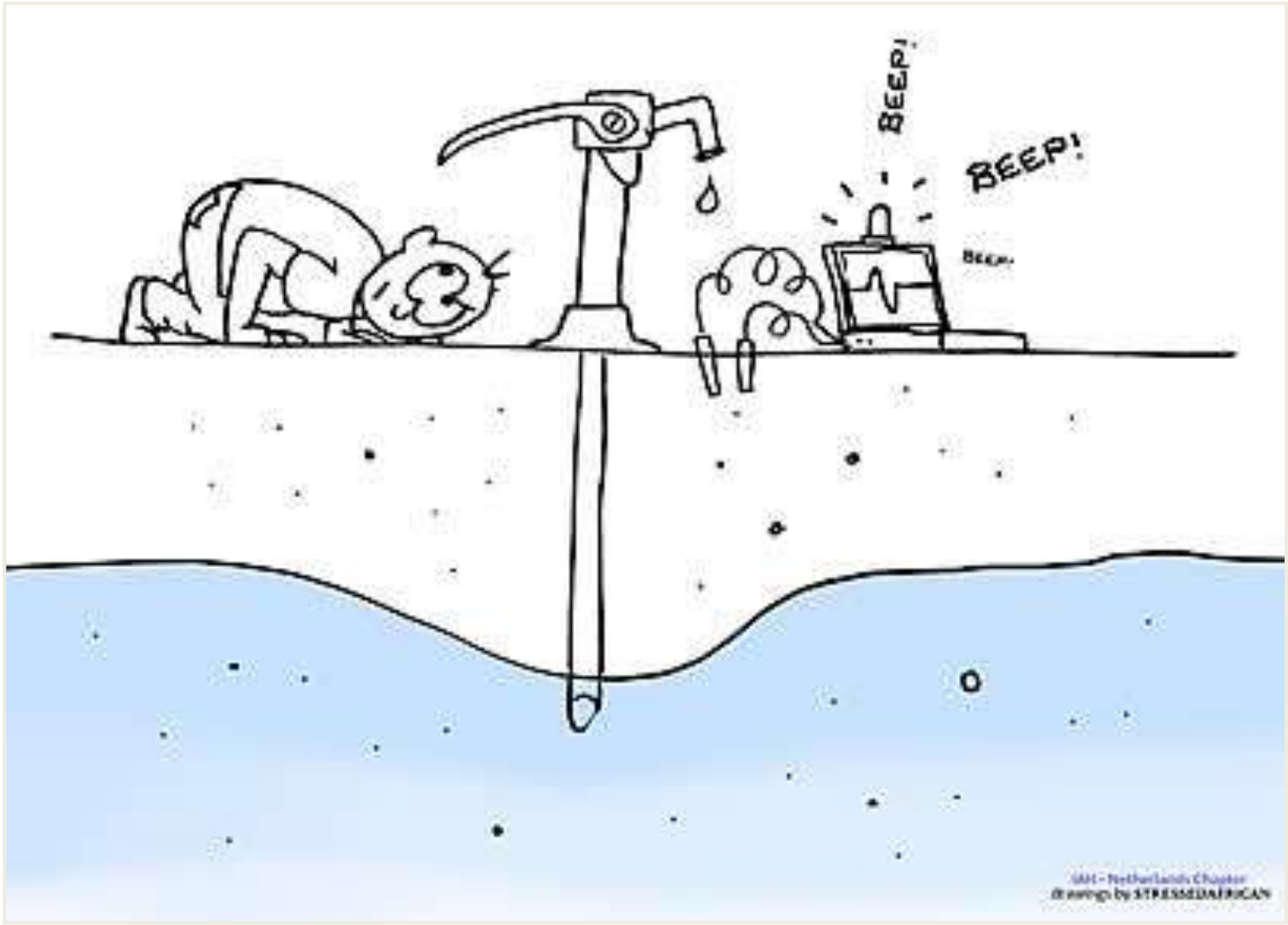
South Nation Conservation
de la Nation Sud

Water Budget/Balance





A little about me...



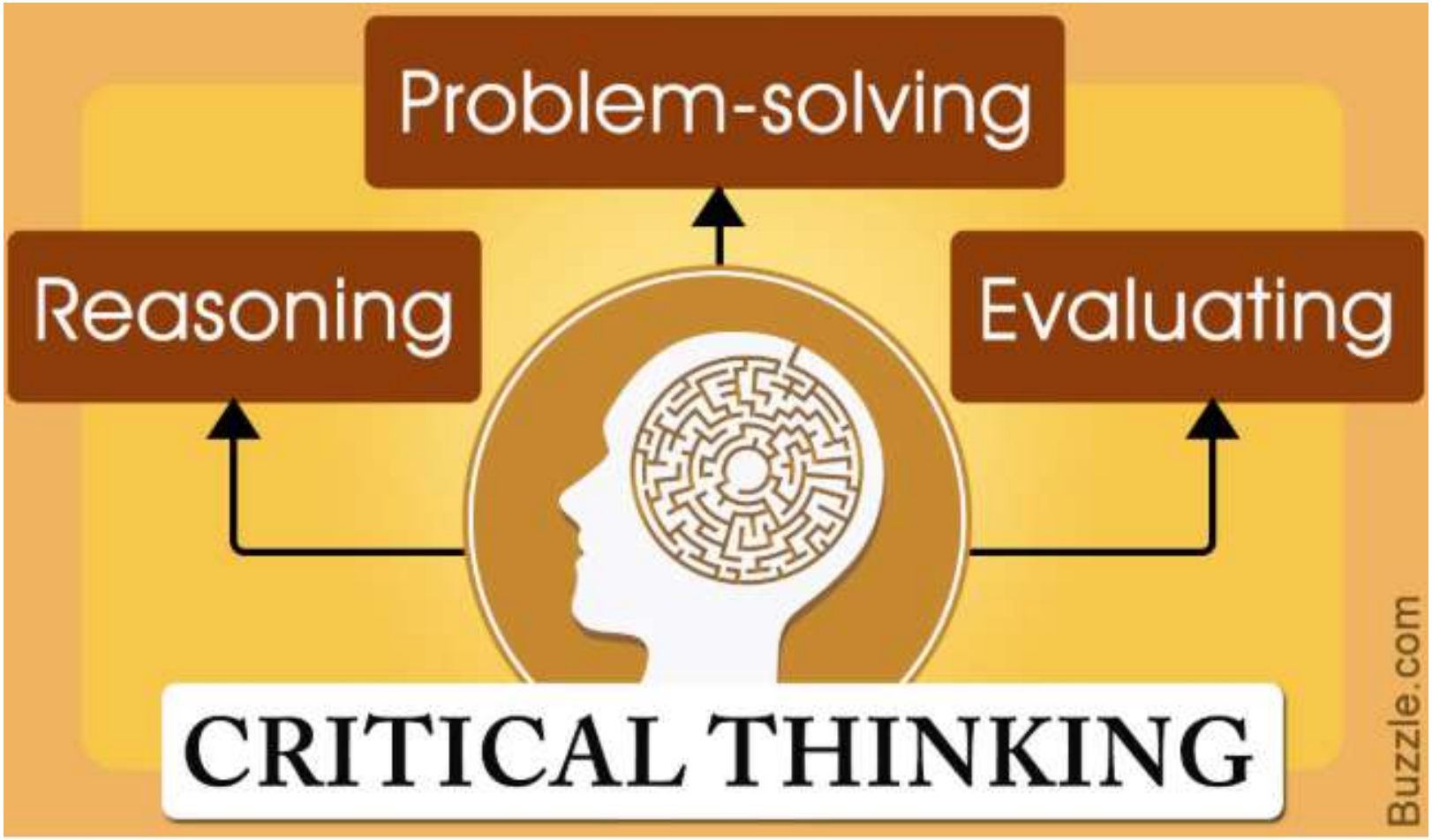
PURPOSE of a Water Budget (Balance)

- The purpose of the water budget analysis is to reasonably estimate the current water components (Hydrology/Hydrogeology) and relationships (inputs, outputs, diversions) and to then determine how much will change as a result of the proposed development.
- Impacts (Negative or Positive)
- Presenting the Data (Communication)

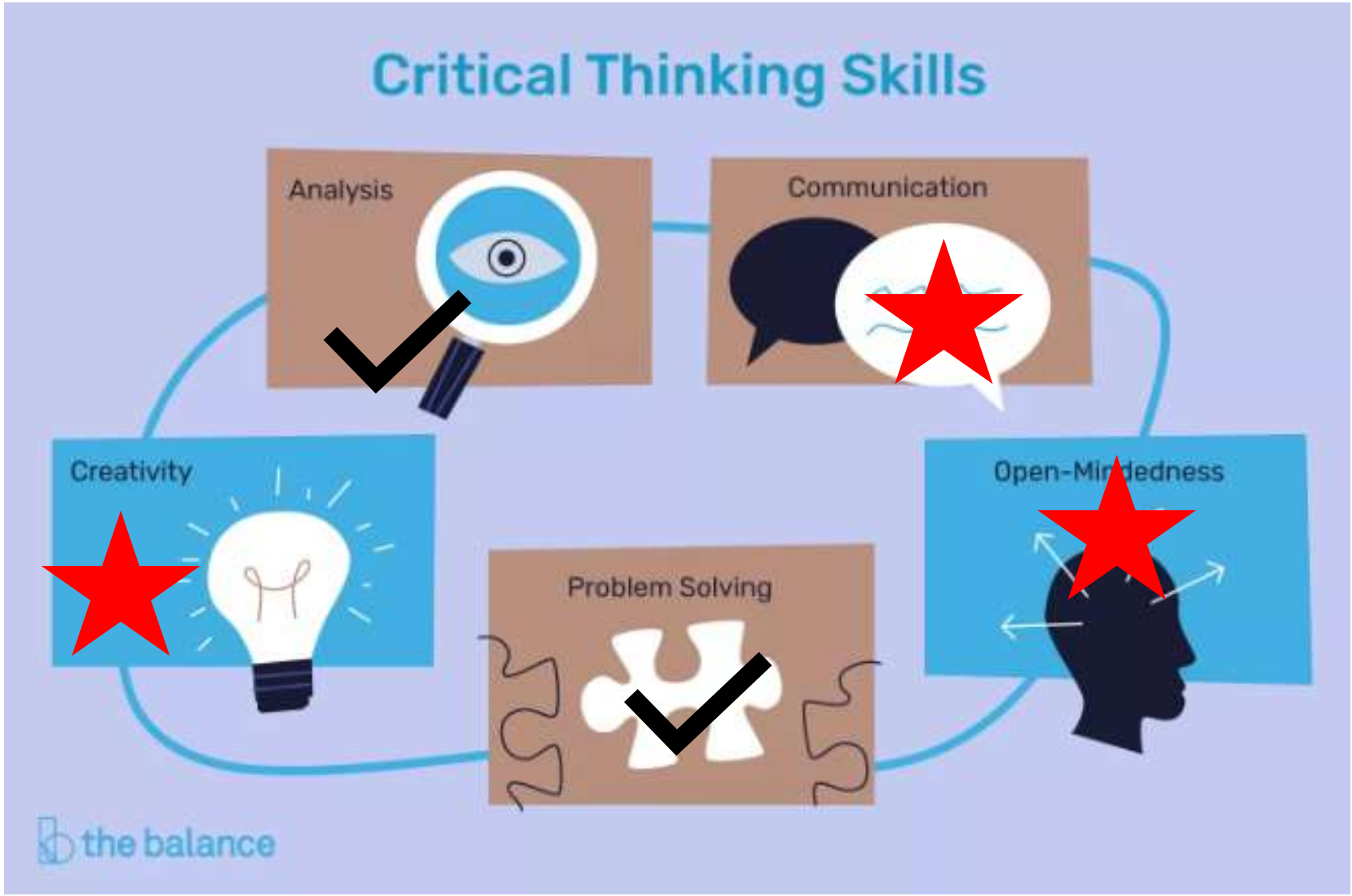
PURPOSE of a Water Budget (Balance)

- Maintain quantity/quality of surface water and groundwater contributions that ensures the pre-development hydroperiod (seasonal pattern of water level fluctuation) of the wetland **(important features)** is protected. TRCA

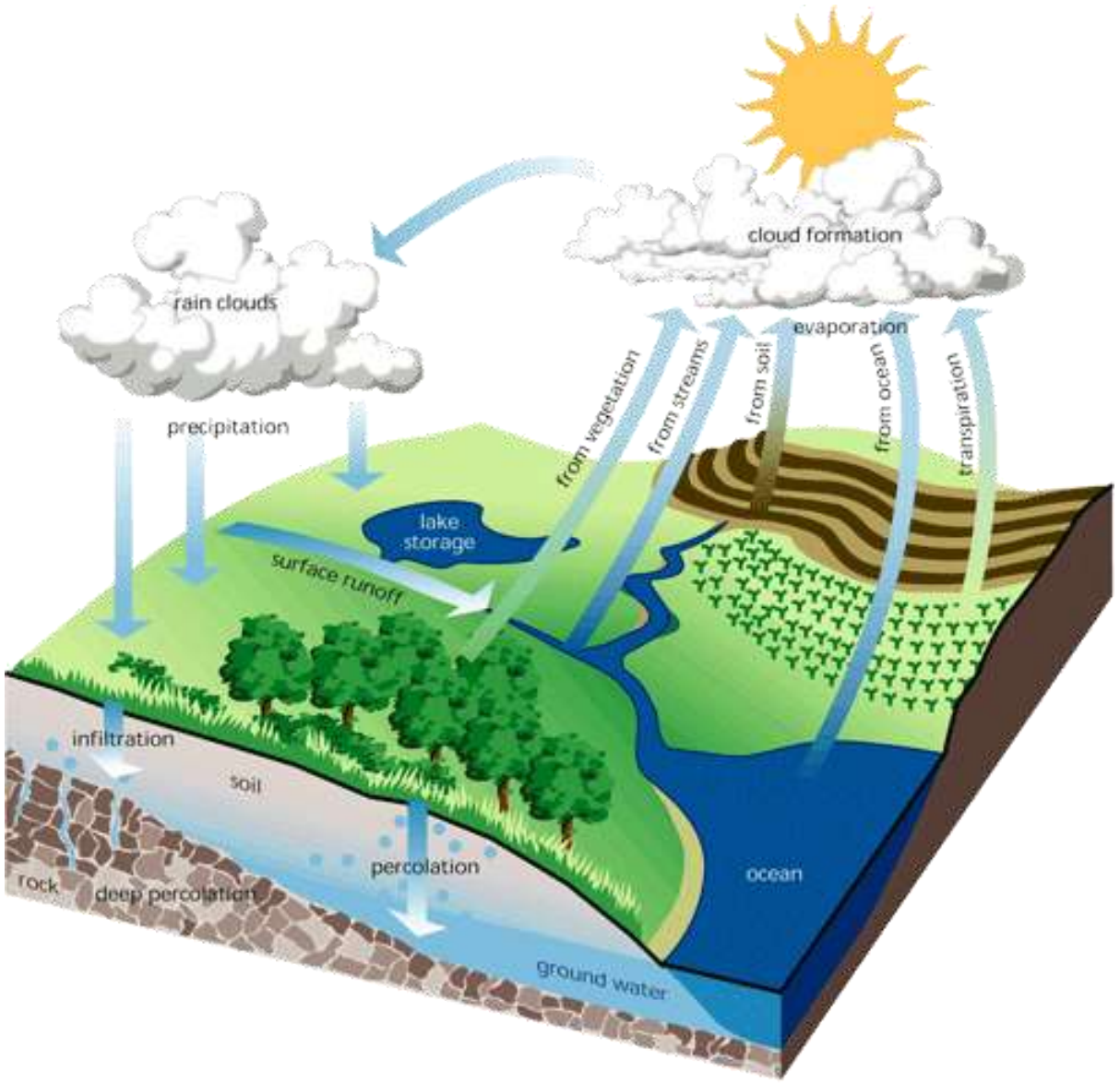
PURPOSE of a Water Budget (Balance)



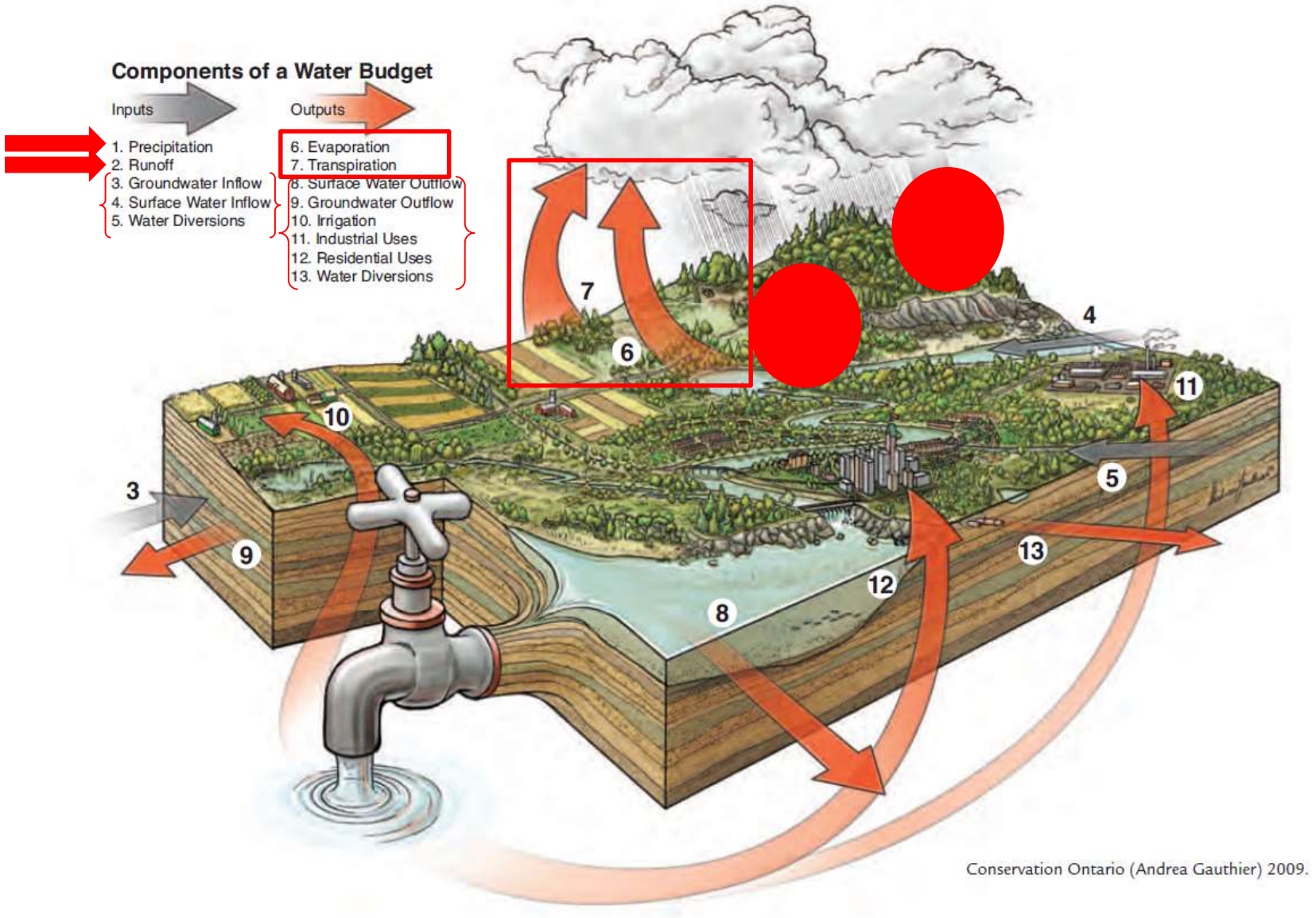
Water Budget (Balance)



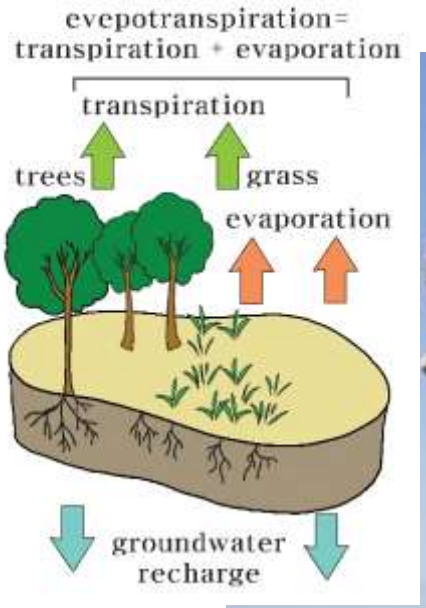
Water Budget (Cycle)



Water Budget (Balance)



Water Budget (Balance)



Water Budget (Balance) Equation

Mathematically, the water budget can be expressed as follows:

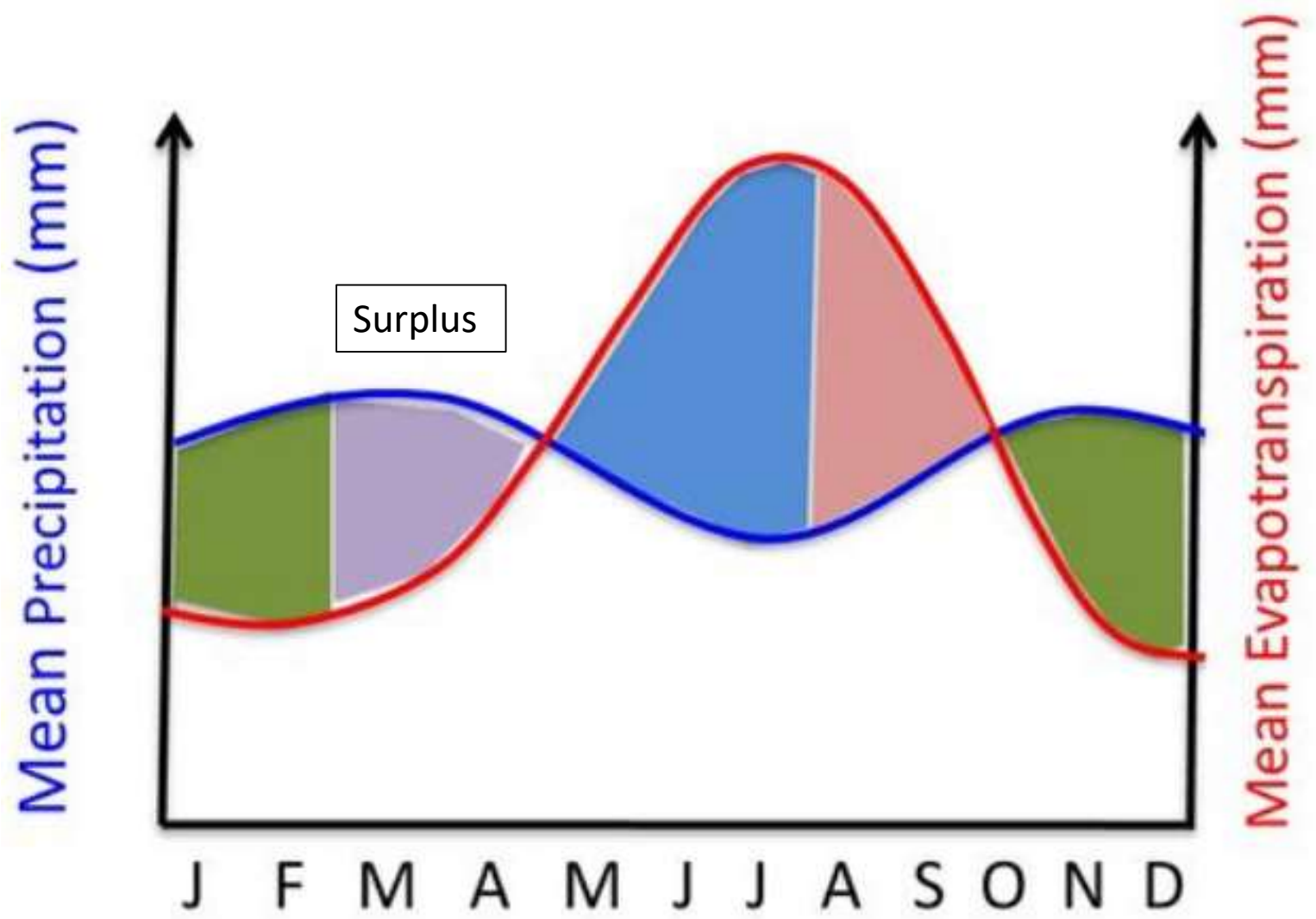
$$P = RO + AET + I + D + A \pm \Delta l \pm \Delta s \pm \Delta g \quad [1]$$

Where;
P = precipitation
RO = surface runoff
AET = actual evapotranspiration
I = interflow
D = groundwater discharge
A = anthropogenic inputs (septic systems) and/or supplies/abstractions
Δl = change in land surface storage
Δs = change in soil moisture storage
Δg = change in groundwater storage

Major Components

- **Precipitation**
- **ET**
- **Surplus**
- **Runoff**
- **Infiltration**
- **ETC. (NEED TO EVALUATE THE SITE)**

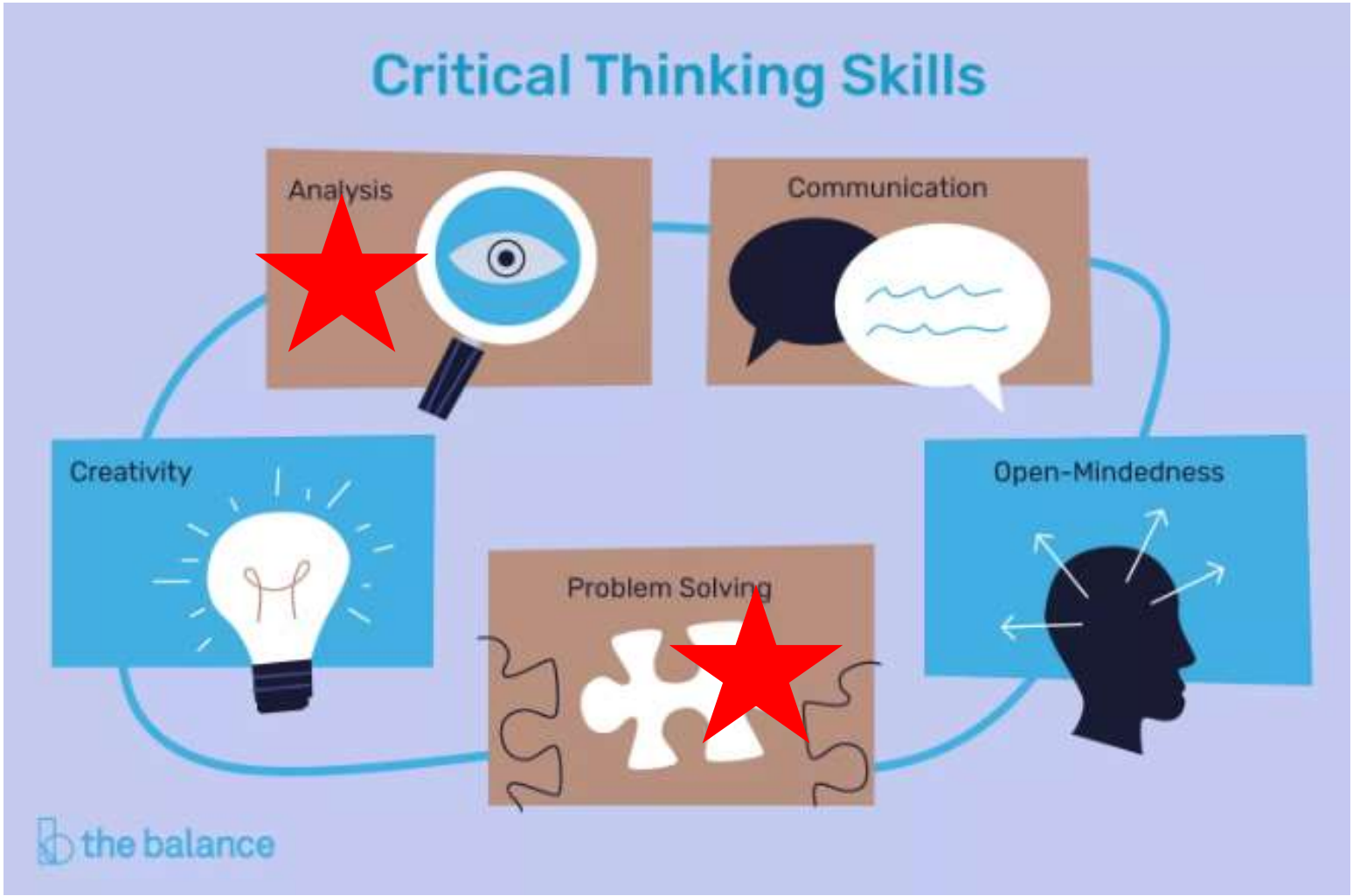
Water Budget (Surplus Hydroperiod)



General Steps

- Determine the need for a water balance
- Establish baseline (data collection)
- Develop existing conditions
  - Soils, topography
  - Determine (infiltration vs runoff), ETC
- Compare Pre and Post development water conditions
- Identify mitigation measures
- Reporting

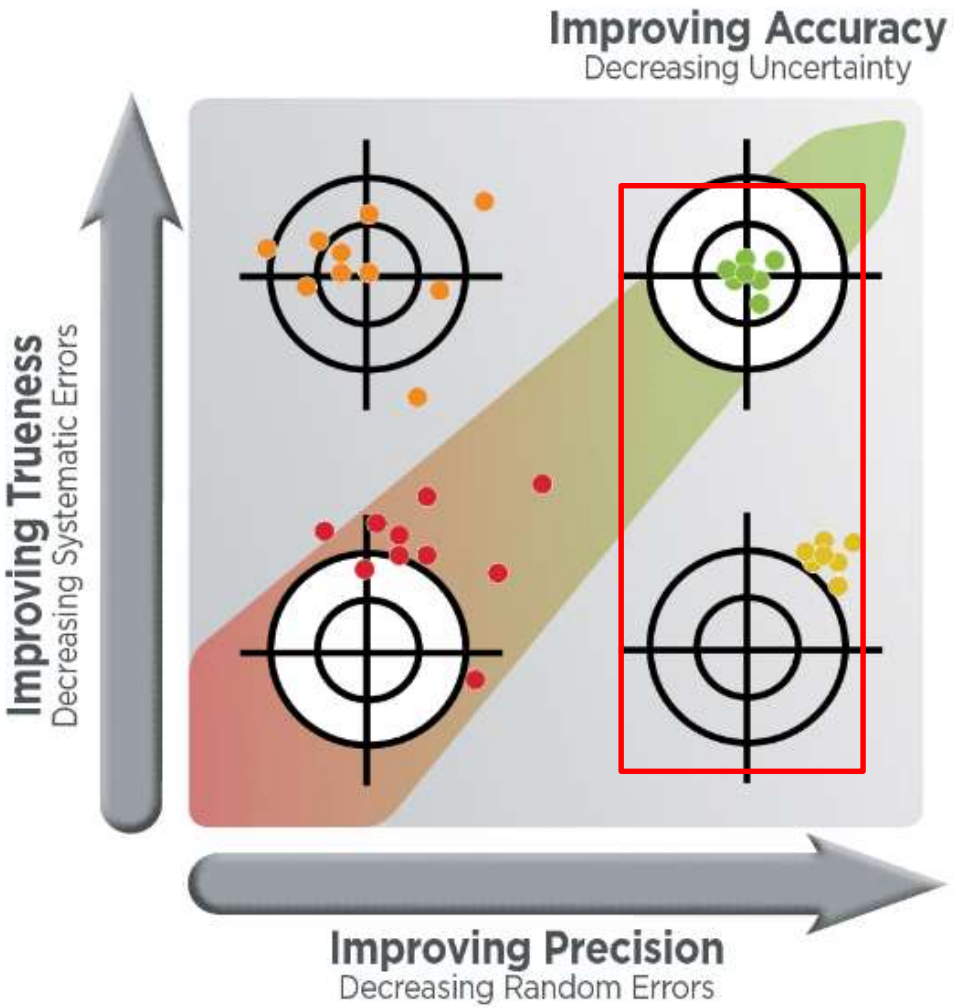
Critical Thinking



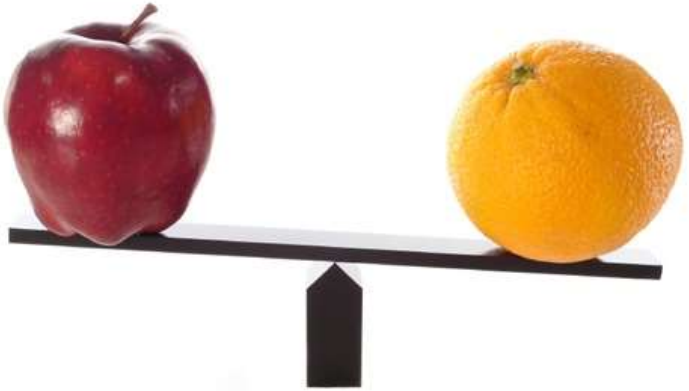
Critical Thinking

Critical Thinking

Water Budget (Balance)

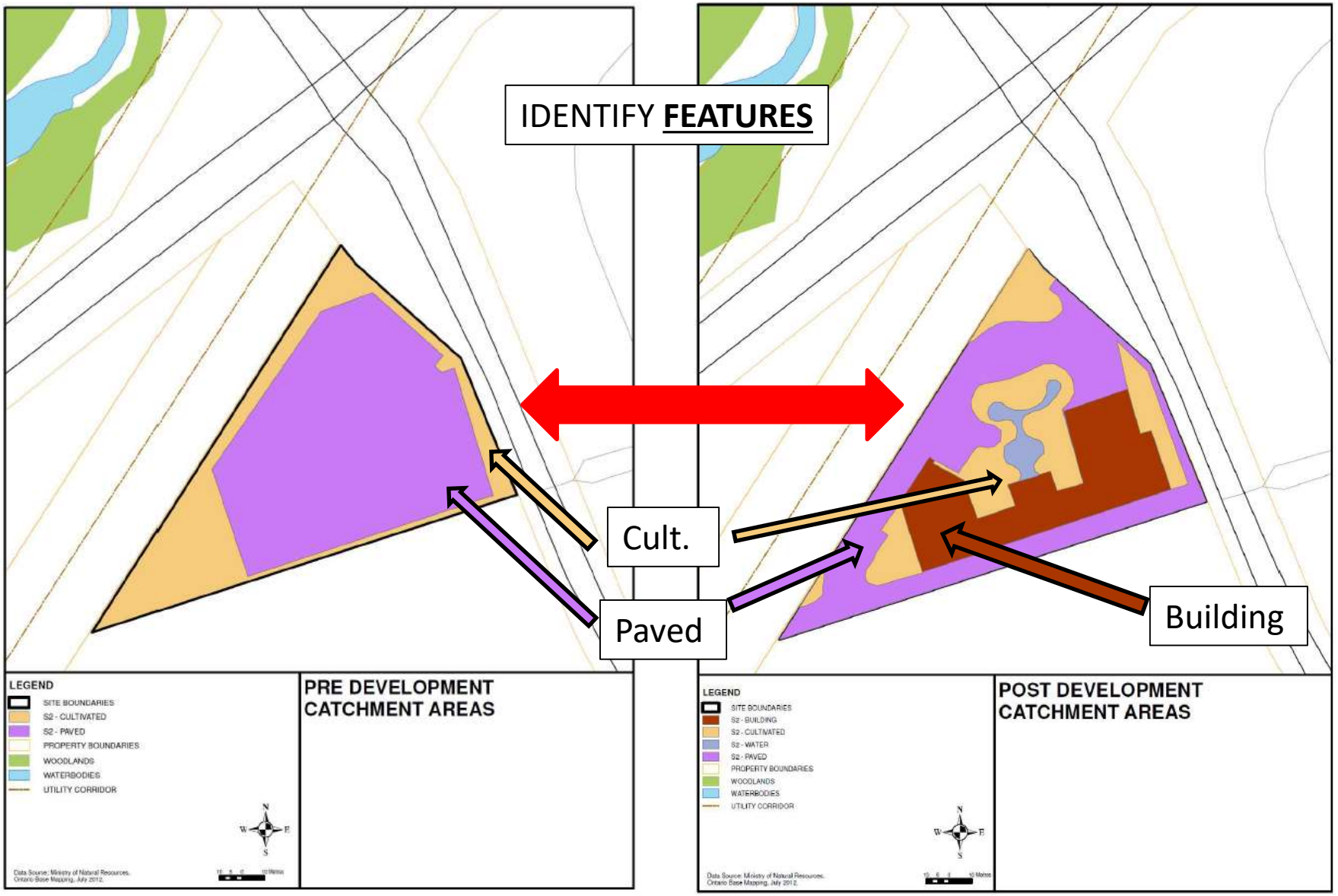


- Pre vs Post



- Pre vs Post
- THIS IS NOT A STORM WATER FACILITY DESIGN EXERCISE

Water Budget (Balance) Example



Water Budget (Balance) Example

TABLE 1
CLIMATIC WATER BUDGET: CLIMATE NORMAL 1971-2000 (TORONTO LESTER B. PEARSON INT'L AIRPORT
Potential Evapotranspiration
TRILLIUM HEALTH CENTRE

	Thornthwaite (1948)							
Month	Mean Temperature (°C)	Heat Index	Potential Evapo-transpiration (mm)	Daylight Correction Value	Adjusted Potential Evapo-transpiration (mm)	Total Precipitation (mm)	Surplus (mm)	Deficit (mm)
January	-6.3	0.0	0.0	0.81	0.0	52.2	52.2	0.0
February	-5.4	0.0	0.0	0.81	0.0	42.6	42.6	0.0
March	-0.4	0.0	0.0	1.02	0.0	57.1	57.1	0.0
April	6.3	1.4	28.4	1.12	31.8	68.4	36.6	0.0
May	12.9	4.2	61.8	1.27	78.5	72.5	0.0	6.0
June	17.8	6.8	87.7	1.29	113.1	74.2	0.0	38.9
July	20.8	8.7	103.8	1.30	134.9	74.4	0.0	60.5
August	19.9	8.1	98.9	1.20	118.7	79.6	0.0	39.1
September	15.3	5.4	74.4	1.04	77.4	77.5	0.1	0.0
October	8.9	2.4	41.3	0.95	39.3	64.1	24.8	0.0
November	3.2	0.5	13.6	0.80	10.9	69.3	58.4	0.0
December	-2.9	0.0	0.0	0.74	0.0	60.9	60.9	0.0
TOTALS		37.5			604.6	792.8	332.8	144.6

Water Budget (Balance) Example

TABLE 3
WATER BUDGET, POST-DEVELOPMENT
WATER BALANCE/ WATER BUDGET ASSESSMENT

Catchment Designation	Site				
	S2 - Cultivated	S2 - Paved	S2 - Building	S2 - Water	S2 - Totals
Area (m^2)	3,609	5,977	3,655	415	13,656
Pervious Area (m^2)	3,609	0	0	0	3,609
Impervious Area (m^2)	0	5,977	3,655	415	10,047
Infiltration Factors					
Topography Infiltration Factor	0.15	0.15	0.15	0.15	
Soil Infiltration Factor	0.1	0.1	0.1	0.1	
Land Cover Infiltration Factor	0.1	0	0	1	
MOE Infiltration Factor	0.35	0	0	0	
Actual Infiltration Factor	0.35	0	0	0	
Run-Off Coefficient	0.65	1	1	1	
Runoff from Impervious Surfaces*	0	0.8	0.8	0.8	
Inputs (per Unit Area)					
Precipition (mm/yr)	793	793	793	793	793
Run-On (mm/yr)	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0
Total Inputs (mm/yr)	**793**	**793**	**793**	**793**	**793**
Outputs (per Unit Area)					
Precipitation Surplus (mm/yr)	188	634	634	634	516
Net Surplus (mm/yr)	188	634	634	634	516
Evapotranspiration (mm/yr)	605	159	159	159	277
Infiltration (mm/yr)	66	0	0	0	17
Rooftop Infiltration (mm/yr)	0	0	0	0	0
Total Infiltration (mm/yr)	66	0	0	0	17
Runoff Pervious Areas	122	0	0	0	122
Runoff Impervious Areas	0	634	634	634	1,765
Total Runoff (mm/yr)	122	634	634	634	499
Total Outputs (mm/yr)	**793**	**793**	**793**	**793**	**793**
Difference (Inputs - Outputs)	0	0	0	0	0
Inputs (Volumes)					
Precipition (m^3/yr)	2,862	4,740	2,898	329	10,829
Run-On (m^3/yr)	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0
Total Inputs (m^3/yr)	**2,862**	**4,740**	**2,898**	**329**	**10,829**
Outputs (Volumes)					
Precipitation Surplus (m^3/yr)	678	3,789	2,317	263	7,048
Net Surplus (m^3/yr)	678	3,789	2,317	263	7,048
Evapotranspiration (m^3/yr)	2,183	950	581	66	3,781
Infiltration (m^3/yr)	237	0	0	0	237
Rooftop Infiltration (m^3/yr)	0	0	0	0	0
Total Infiltration (m^3/yr)	237	0	0	0	237
Runoff Pervious Areas (m^3/yr)	441	0	0	0	441
Runoff Impervious Areas (m^3/yr)	0	3,789	2,317	263	6,370
Total Runoff (m^3/yr)	441	3,789	2,317	263	6,811
Total Outputs (m^3/yr)	**2,862**	**4,740**	**2,898**	**329**	**10,829**
Difference (Inputs - Outputs)	0	0	0	0	0

Site Characteristics (Areas)

Site Factors (Coefficients)

INPUTS (Precip, Runon, GW, etc)

OUTPUTS (Runoff, ET)

Water Budget (Balance) Example

WATER BUDGET SUMMARY
WATER BALANCE/ WATER BUDGET ASSESSMENT

Characteristic	Site				
	Pre-Development	Post-Development	Change (Pre- to Post-)	Post-Development with Mitigation	Change (Pre- to Post- with Mitigation
Inputs (Volumes)					
Precipition (m^3/yr)	10,829	10,829	0.0%	10,829	0.0%
Run-On (m^3/yr)	0	0	0.0%	0	0.0%
Other Inputs (m^3/yr)	0	0	0.0%	0	0.0%
Total Inputs (m^3/yr)	**10,829**	**10,829**	**0.0%**	**10,829**	**0.0%**
Outputs (Volumes)					
Precipitation Surplus (m^3/yr)	6,772	7,048	4.1%	7,048	4.1%
Net Surplus (m^3/yr)	6,772	7,048	4.1%	7,048	4.1%
Evapotranspiration (m^3/yr)	4,057	3,781	-6.8%	3,781	-6.8%
Infiltration (m^3/yr)	278	237	-14.7%	237	-14.7%
Rooftop Infiltration (m^3/yr)	0	0	0.0%	37	0.0%
Total Infiltration (m^3/yr)	278	237	-14.7%	274	-1.5%
Runoff Pervious Areas (m^3/yr)	517	441	-14.7%	441	-14.7%
Runoff Impervious Areas (m^3/yr)	5,977	6,370	6.6%	6,333	6.0%
Total Runoff (m^3/yr)	6,494	6,811	4.9%	6,774	4.3%
Total Outputs (m^3/yr)	**10,829**	**10,829**	**0.0%**	**10,829**	**0.0%**

Water Budget (Balance)

- Highlight the Difference
- Need to be critical thinkers (hydroperiod)

Water Budget (Balance)

- Change in Balance
  - Positive
  - Negative

Water Balance Outputs

- WHY Care
- Save the world

Water Balance (Erosion)

- Erosion

Water Balance (flooding)

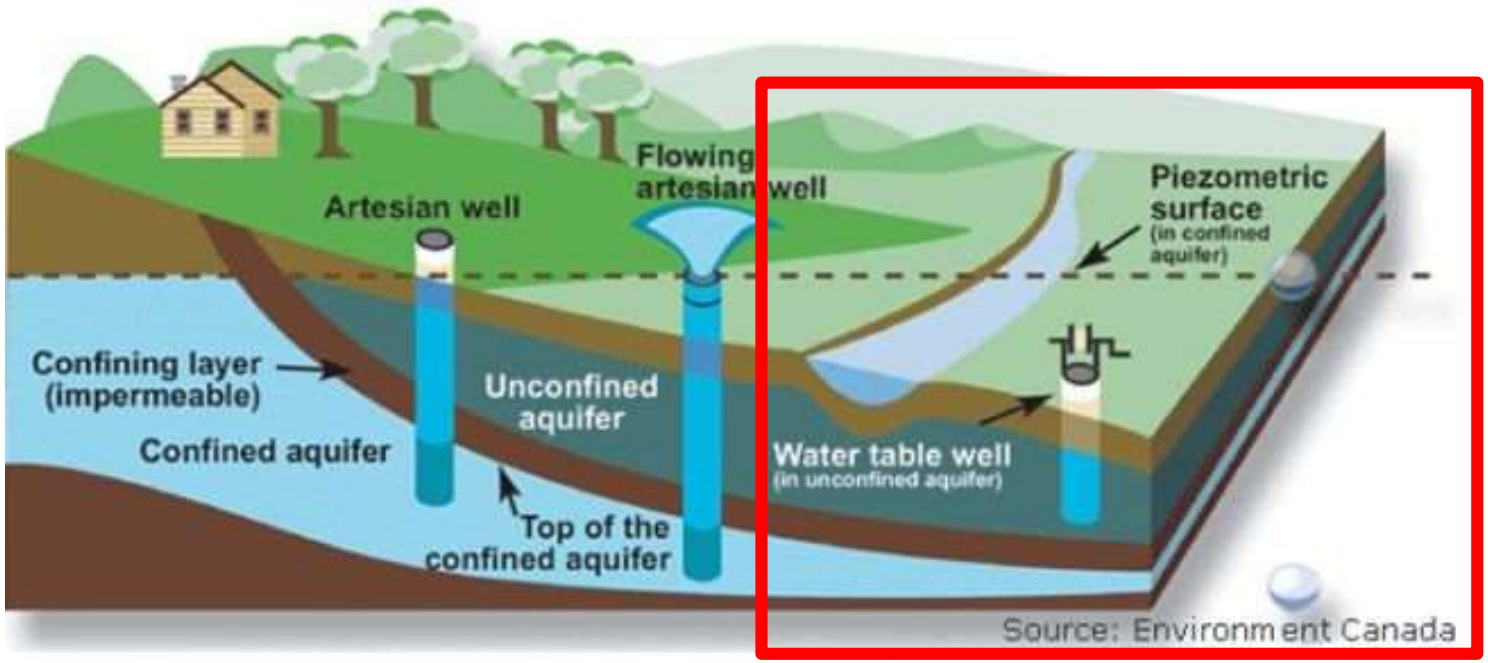
- Nuisance Flooding (Grading) water diversion

Water Balance (Wetlands)

- Too Much or too little

Water Balance (Maintain Recharge)

- Wells (Specific)



Water Balance Mitigation Measures

- Depends on the Balance (Implications of Stormwater Design)
- Increase infiltration (LID)
- Water Diversion (Outlet locations)

Large Outlet

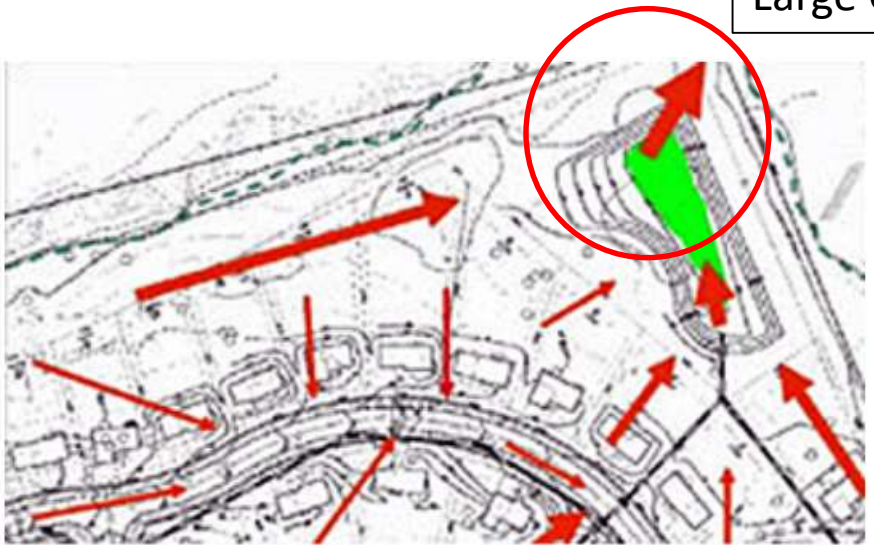


Figure 2: Conventional site design
Courtesy PGDER

Multiple outlets and increased infiltration

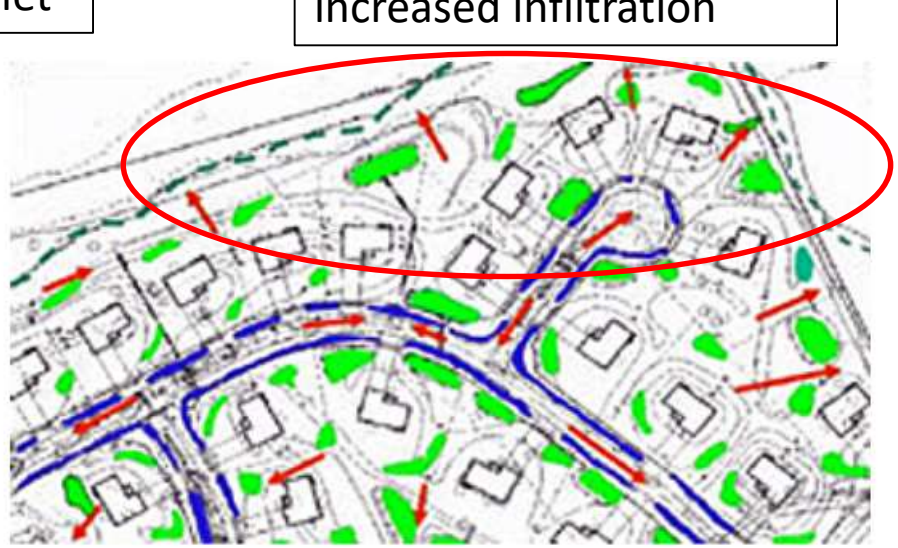


Figure 3: LID site design
Courtesy PGDER

Our Local Environment, We're in it Together.

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