Groundwater Quality Changes after Closure In Place: 25 Years of Observations

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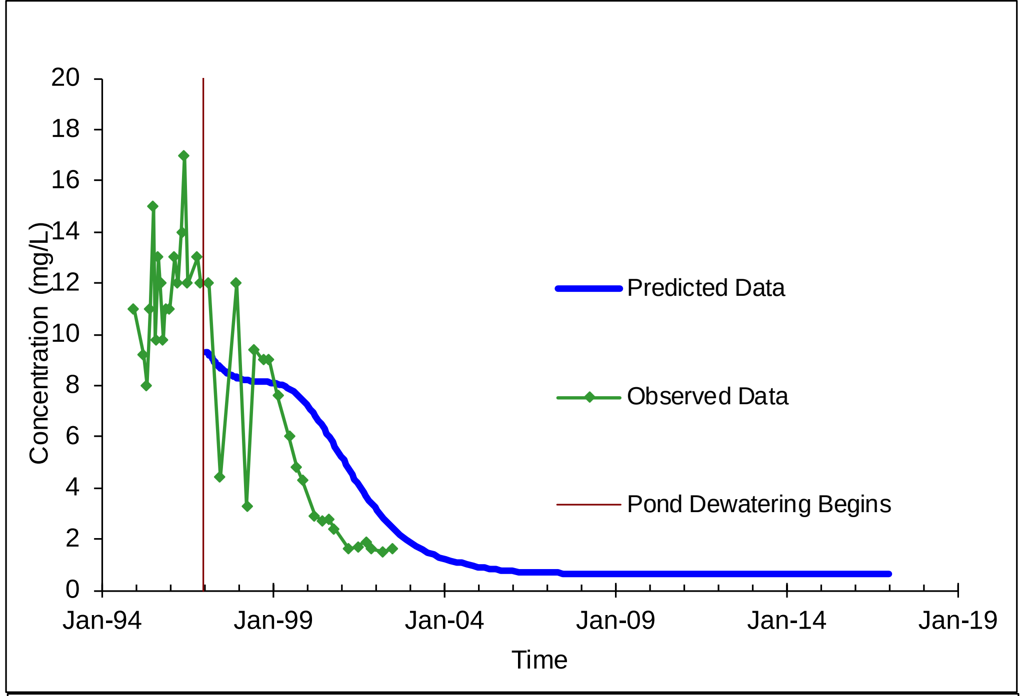
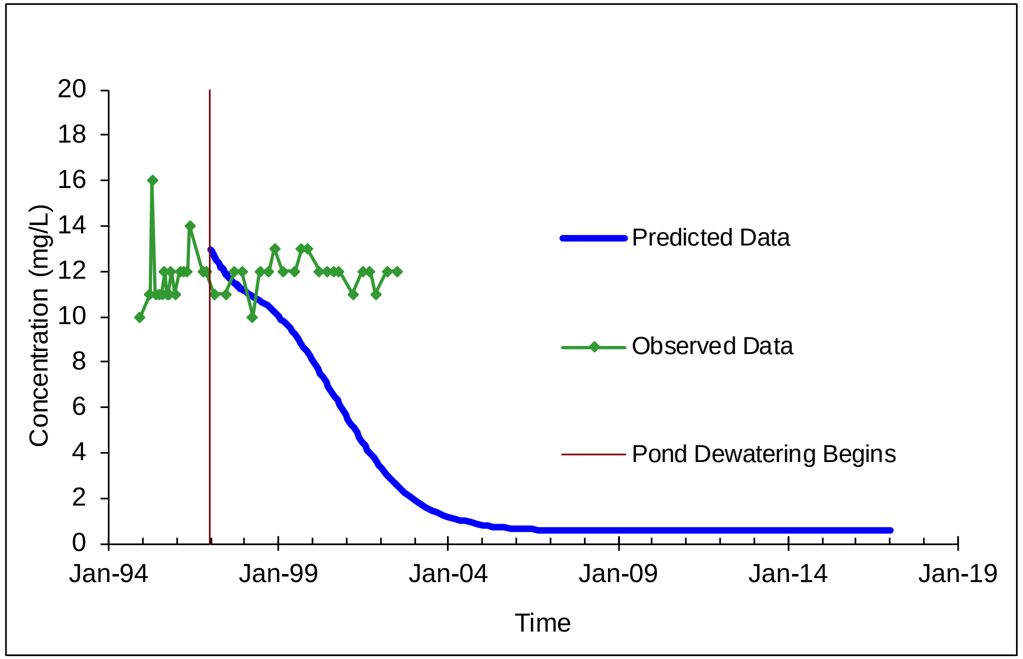
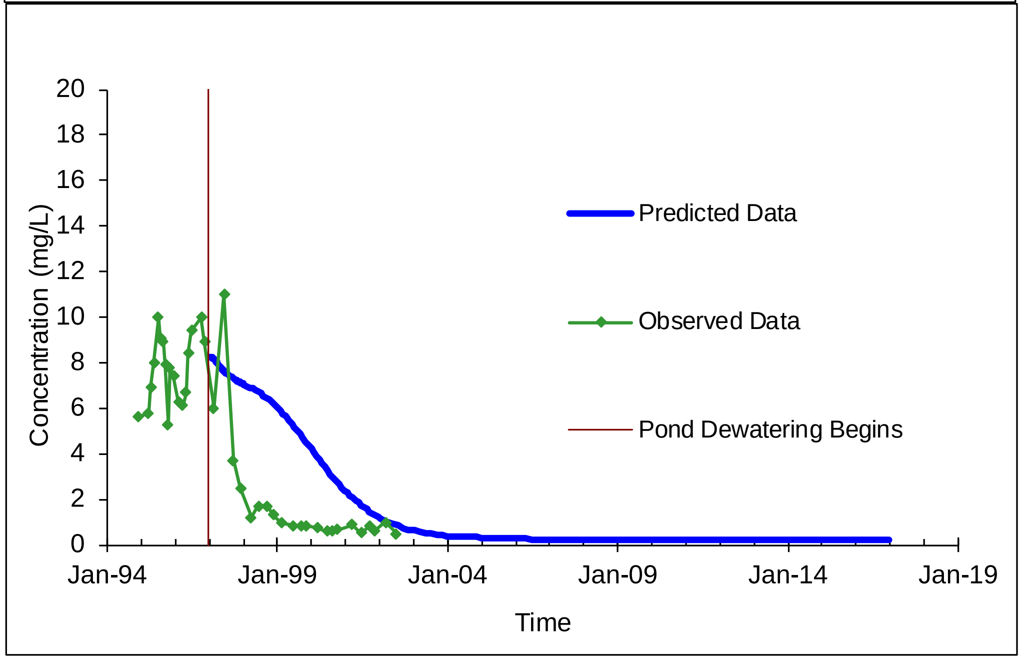
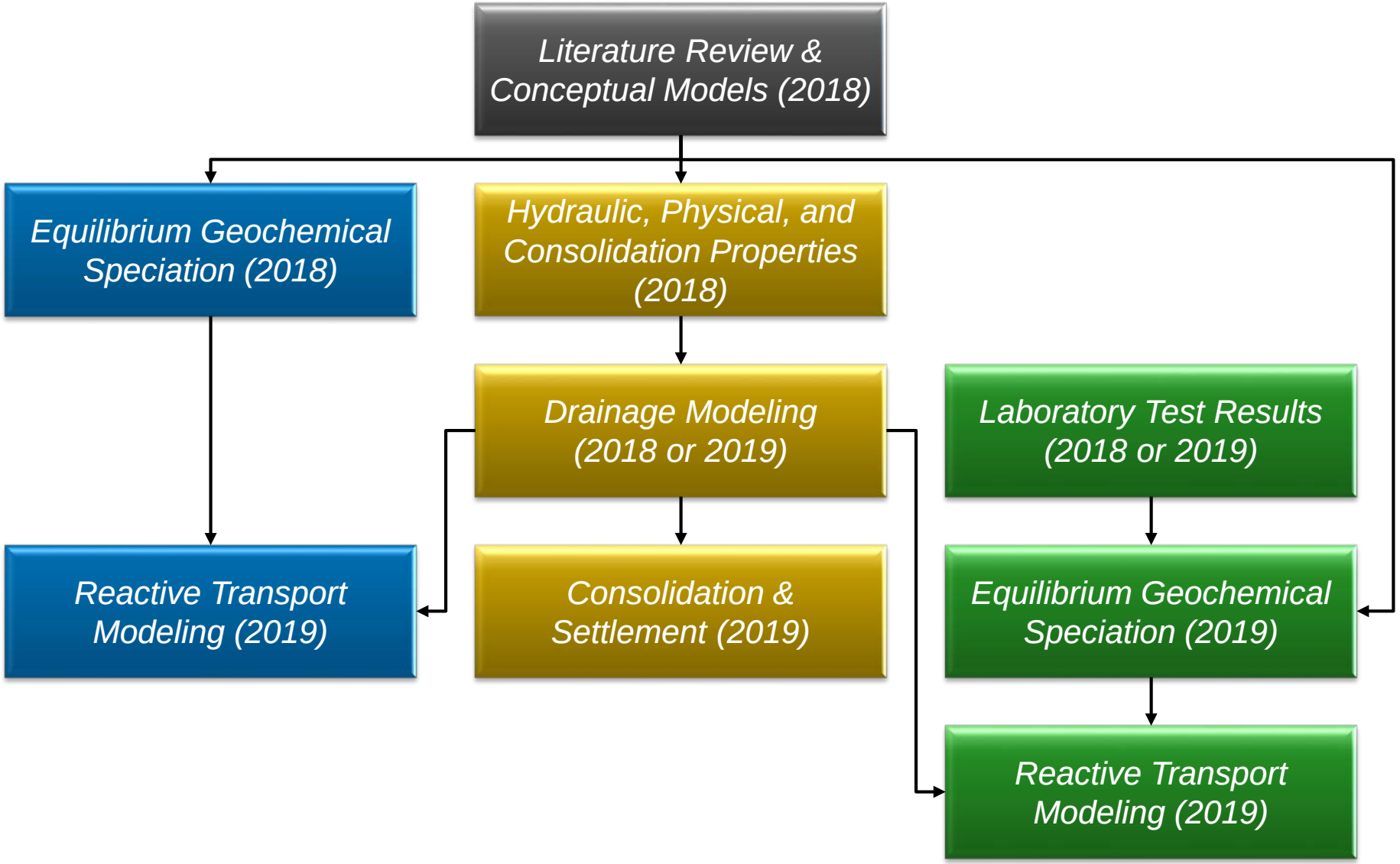
Agenda

- Concepts
- Case examples







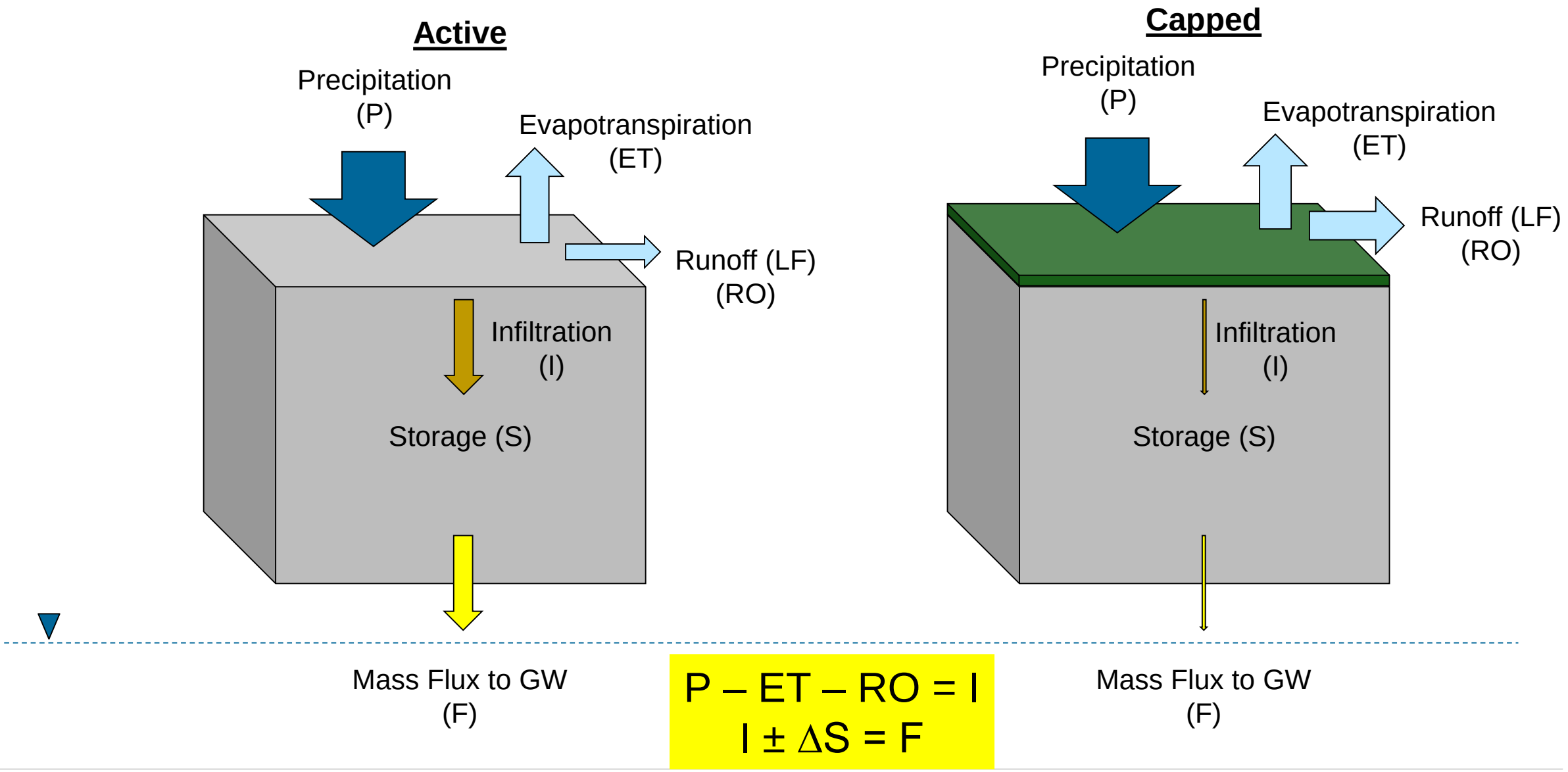


Leachate Evolution and Duration

Leachate Drainage

Wastewater & Leachate Recycling

Mass Flux (Landfill)



$$P - ET - RO = I$$

$$I \pm \Delta S = F$$

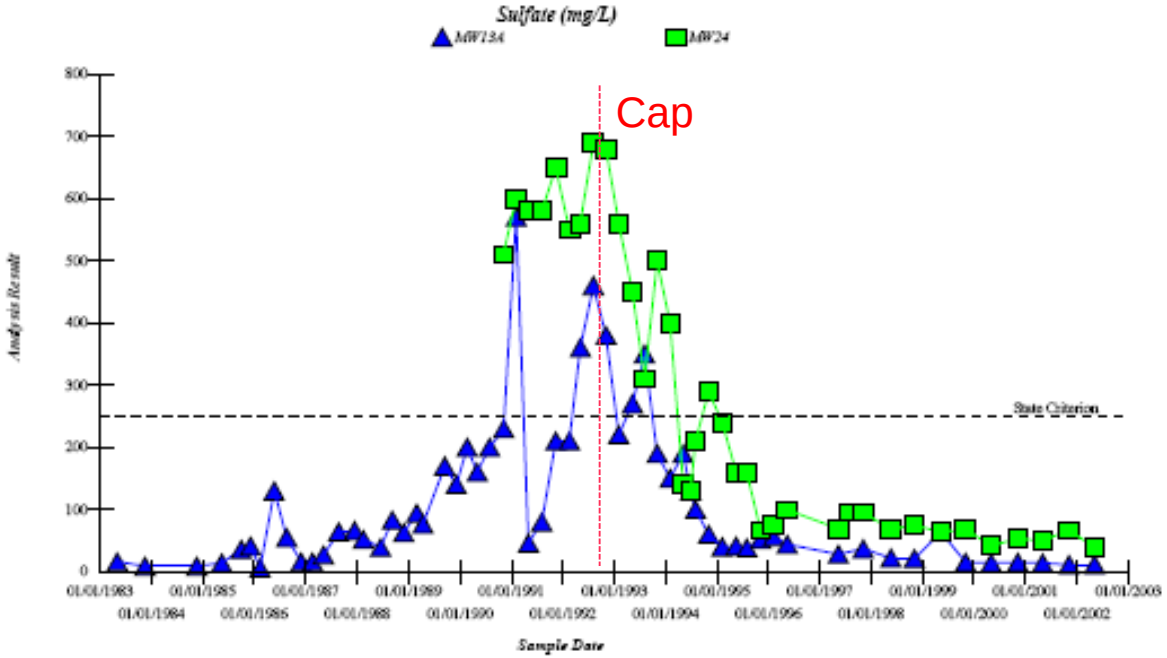
Mass Flux Change (Landfill)

$P - ET - RO = I$

$I \pm \Delta S = F$

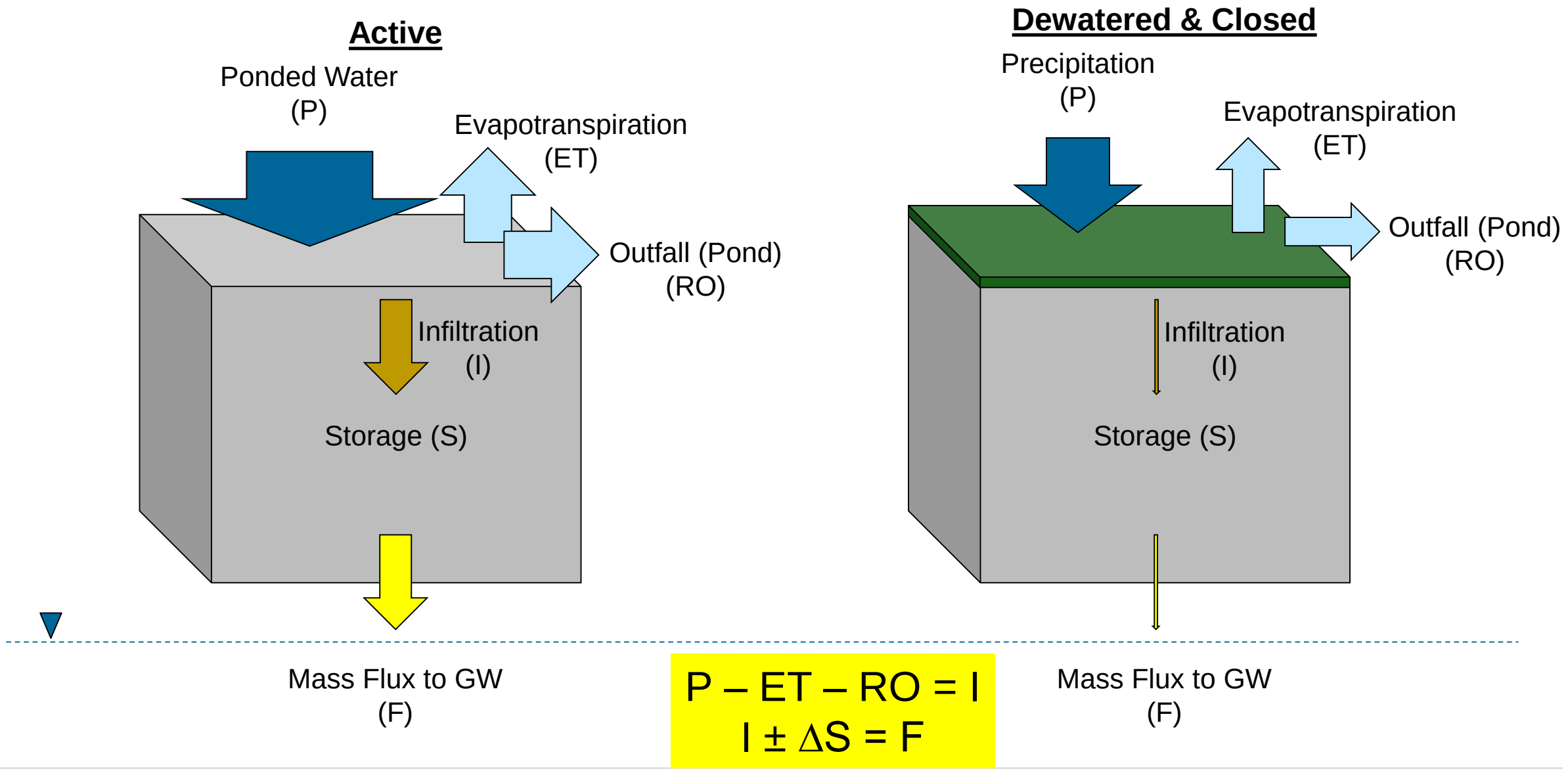
- Precipitation (P): No change
- Evapotranspiration (ET): Increase possible
- Runoff (RO): Large increase
- Storage (S): initial decrease possible, then ~steady, so $\Delta S \approx 0$ and $I \approx R$ over long ter

$P - ET_{\uparrow} - RO_{\uparrow\uparrow} = I_{\downarrow\downarrow\downarrow} \approx F_{\downarrow\downarrow\downarrow}$



EPRI 1005262 (2002)

Mass Flux (Pond)

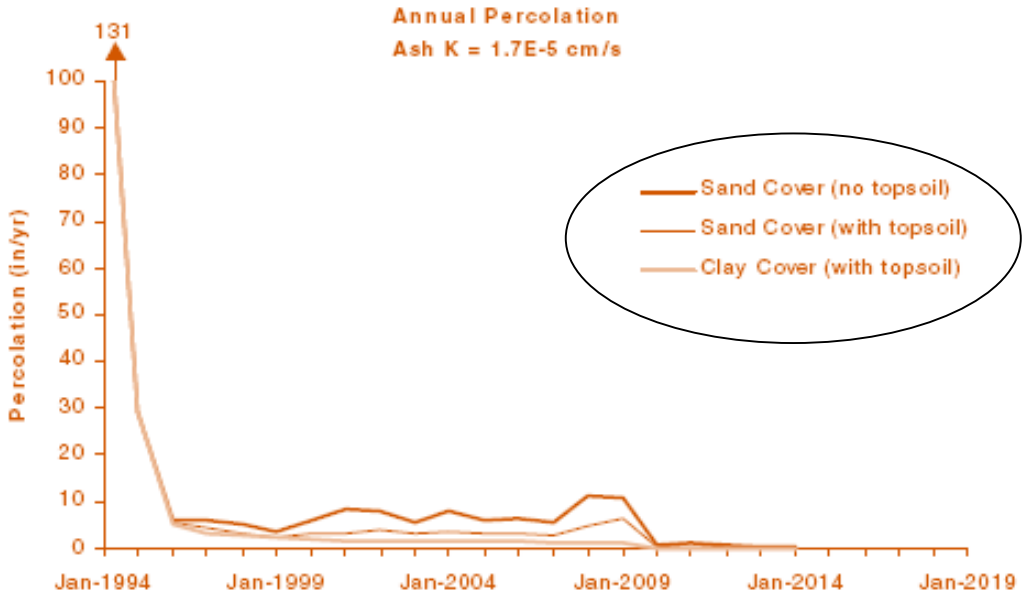


Mass Flux Change (Pond)

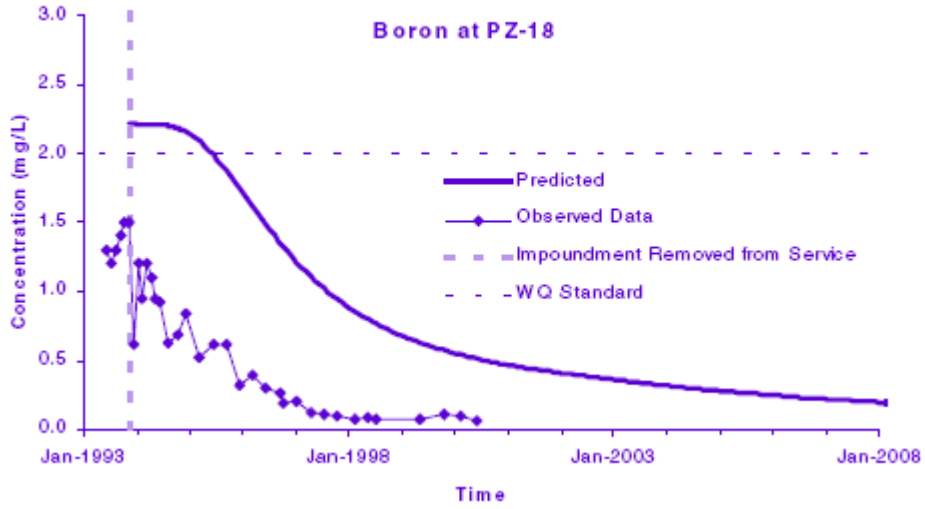
$$P - ET - RO = I$$
$$I \pm \Delta S = F$$

- Ponded Water (P): Large decrease ➔ Precipitation
- Evapotranspiration (ET): Decrease
- Outfall (RO): Decrease (usually) ➔ Runoff
- Storage (S): initial decrease during dewatering, then ~steady, so after dewatering $\Delta S \approx 0$ and $I \approx R$

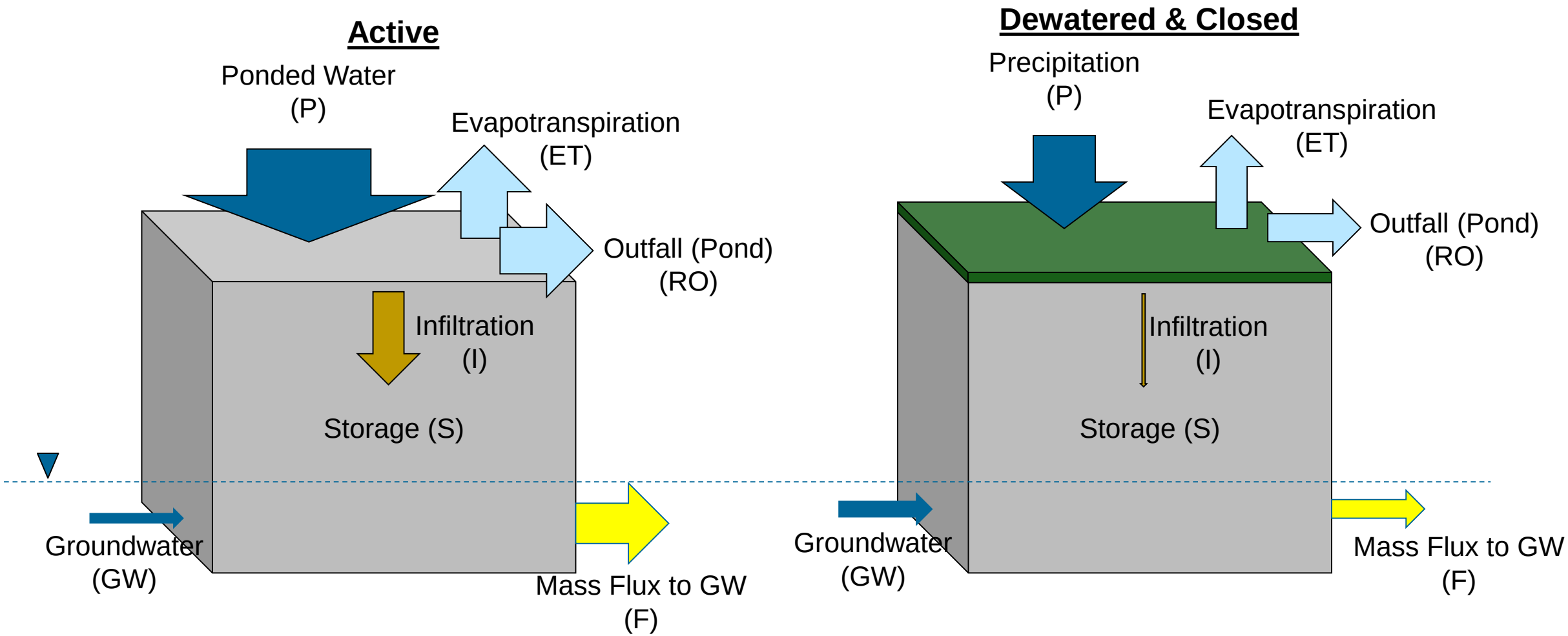
$$P_{\downarrow\downarrow\downarrow\downarrow\downarrow} - ET_{\downarrow} - RO_{\downarrow\downarrow} = I_{\downarrow\downarrow\downarrow} \approx F_{\downarrow\downarrow\downarrow}$$



EPRI 1005165 (2001)



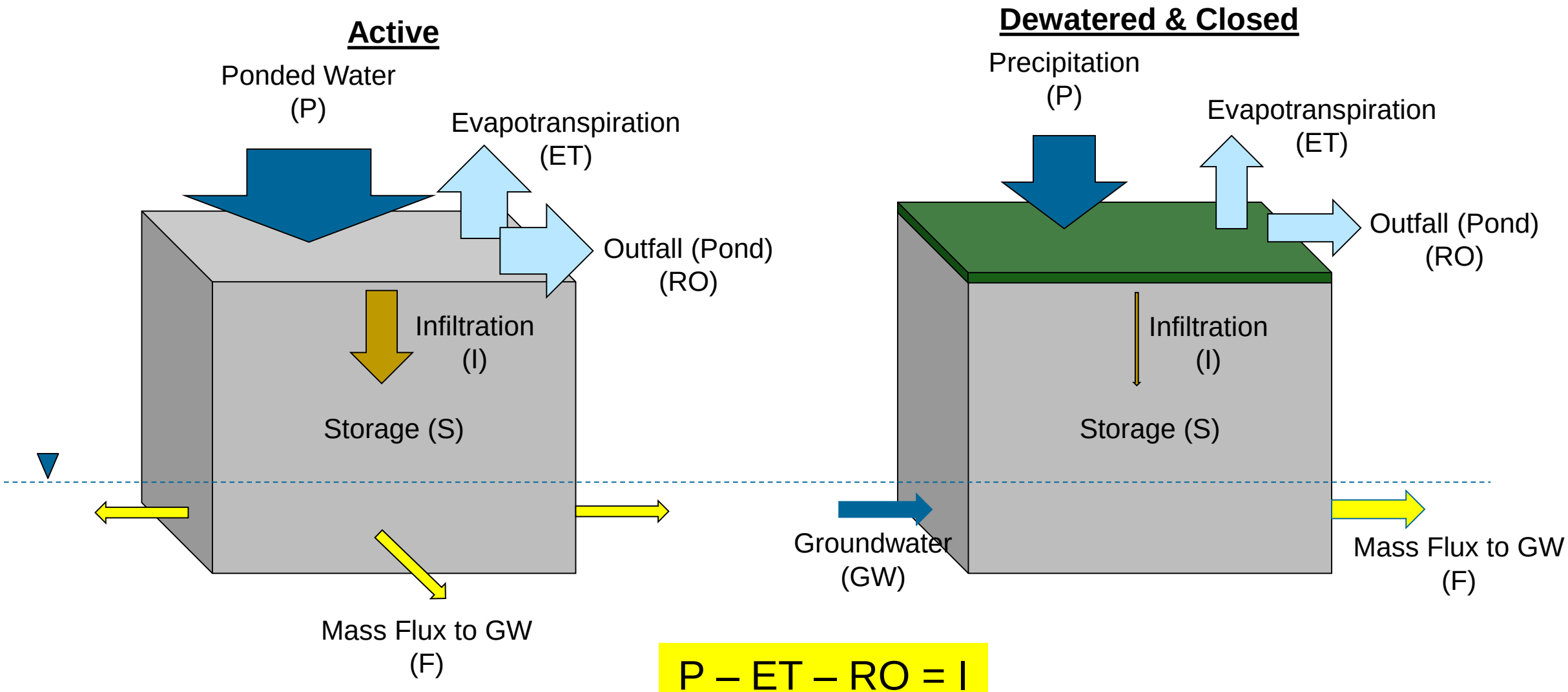
Mass Flux (Intersecting Groundwater I)



$$P - ET - RO = I$$

$$I + \Delta S + GW = F$$

Mass Flux (Intersecting Groundwater II)



$$P - ET - RO = I$$

$$I + \Delta S + GW = F$$

Mass Flux Change (Pond with Intersecting Groundwater)

$$P - ET - RO = I$$
$$I + \Delta S + GW = F$$

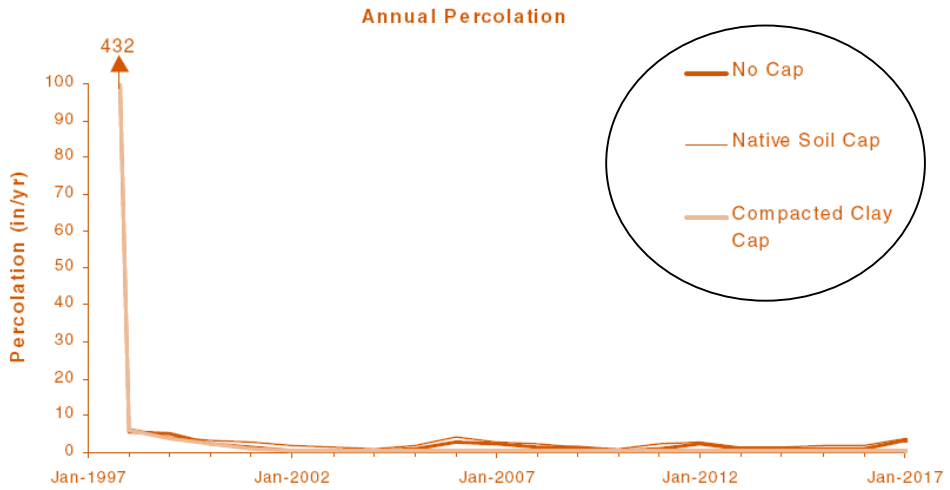
- Ponded Water (P): Large decrease ➔ Precipitation
- Evapotranspiration (ET): Decrease
- Outfall (RO): Decrease (usually) ➔ Runoff
- Storage (S): Initial decrease,
  then ~steady, so after dewatering $\Delta S \approx 0$
- Groundwater (GW): Increase

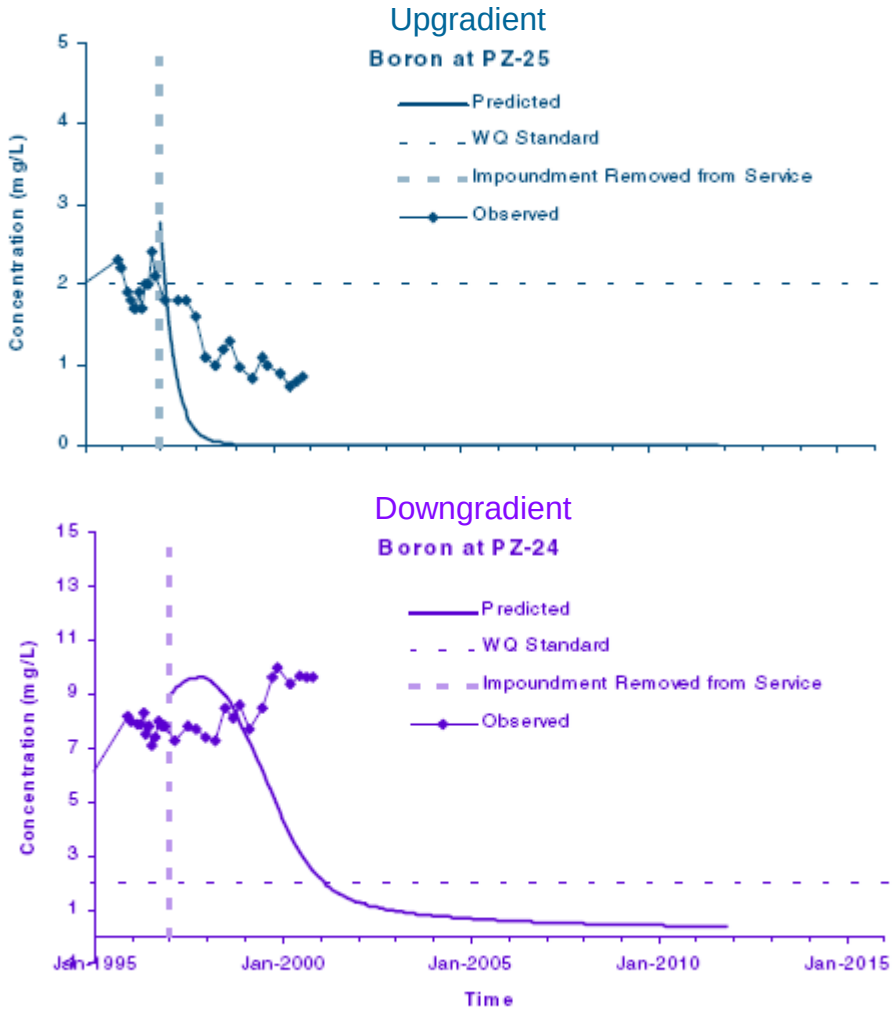
$$P_{\downarrow\downarrow\downarrow\downarrow\downarrow\downarrow} - ET_{\downarrow} - RO_{\downarrow\downarrow} = I_{\downarrow\downarrow\downarrow}$$
$$I_{\downarrow\downarrow\downarrow} + GW_{\uparrow} = F_{\downarrow\downarrow}$$

Mass Flux Change (Pond with Intersecting Groundwater)

$$P_{\downarrow\downarrow\downarrow\downarrow\downarrow\downarrow} - ET_{\downarrow} - RO_{\downarrow\downarrow} = I_{\downarrow\downarrow\downarrow}$$

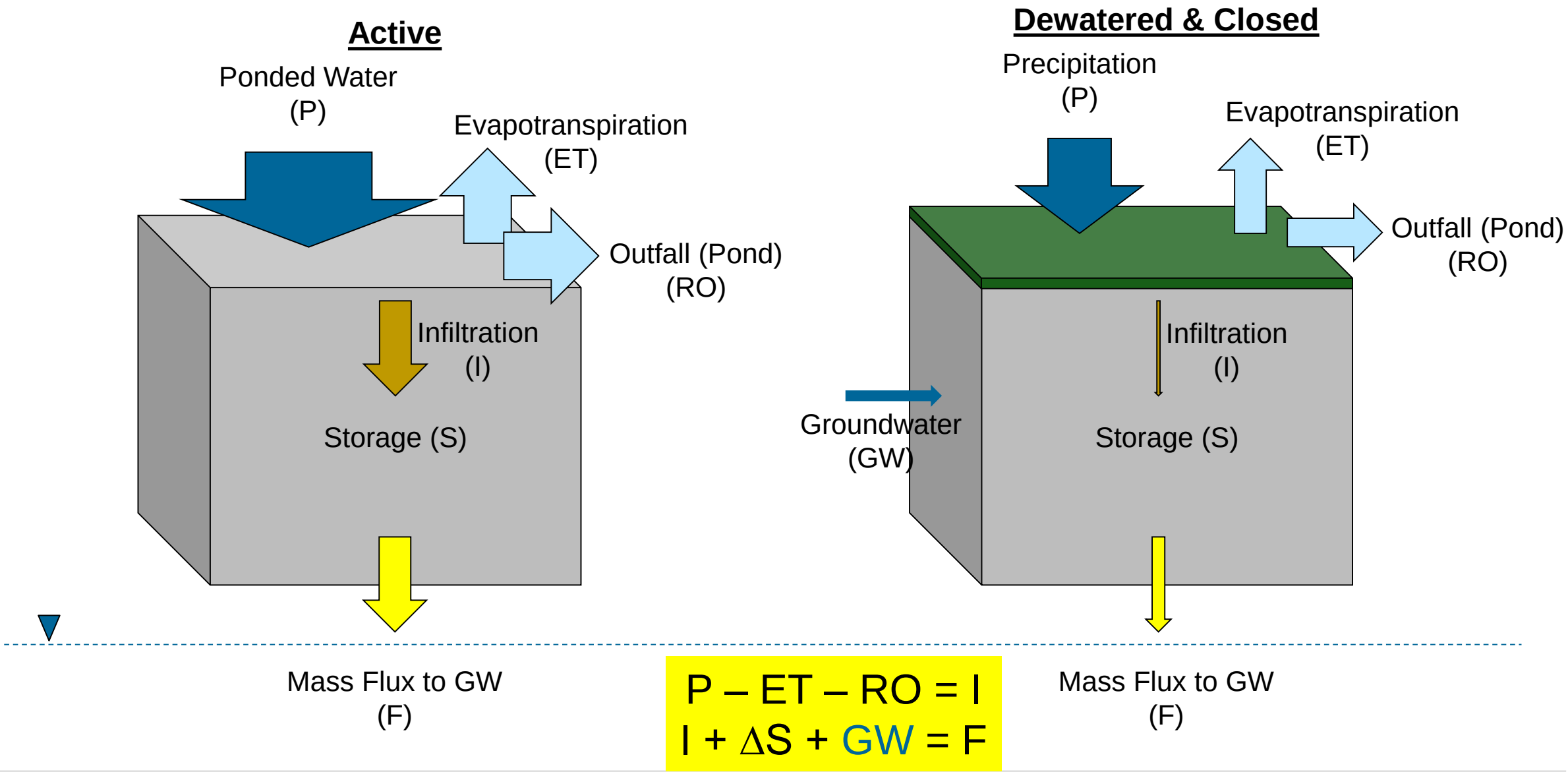
$$I_{\downarrow\downarrow\downarrow} + GW_{\uparrow} = F_{\downarrow\downarrow}$$





EPRI 1005165 (2001)

Mass Flux (Intersecting Groundwater III)



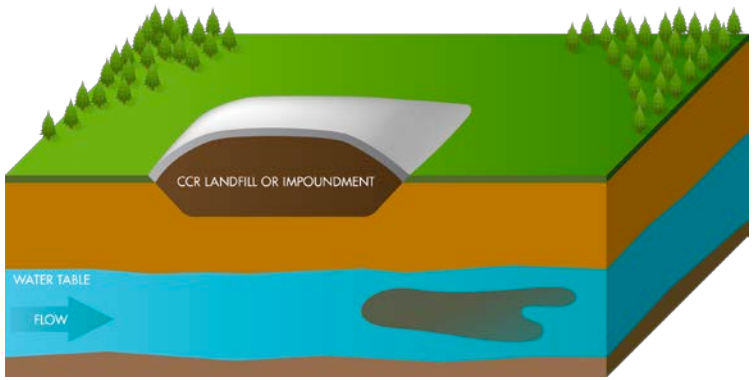
$$P - ET - RO = I$$

$$I + \Delta S + GW = F$$

Observations

CCR (after dewatering) Above Water Table

- Cap may be sufficient source control
  - Cap design
  - Hydraulic conductivity



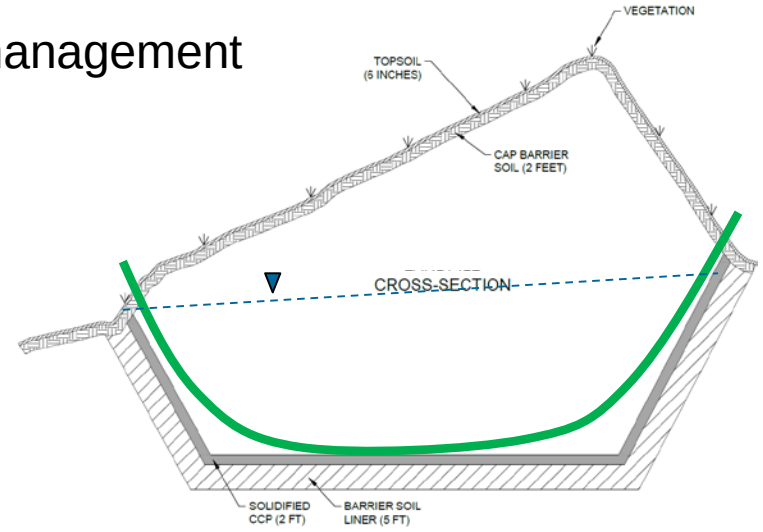
Intersecting Groundwater

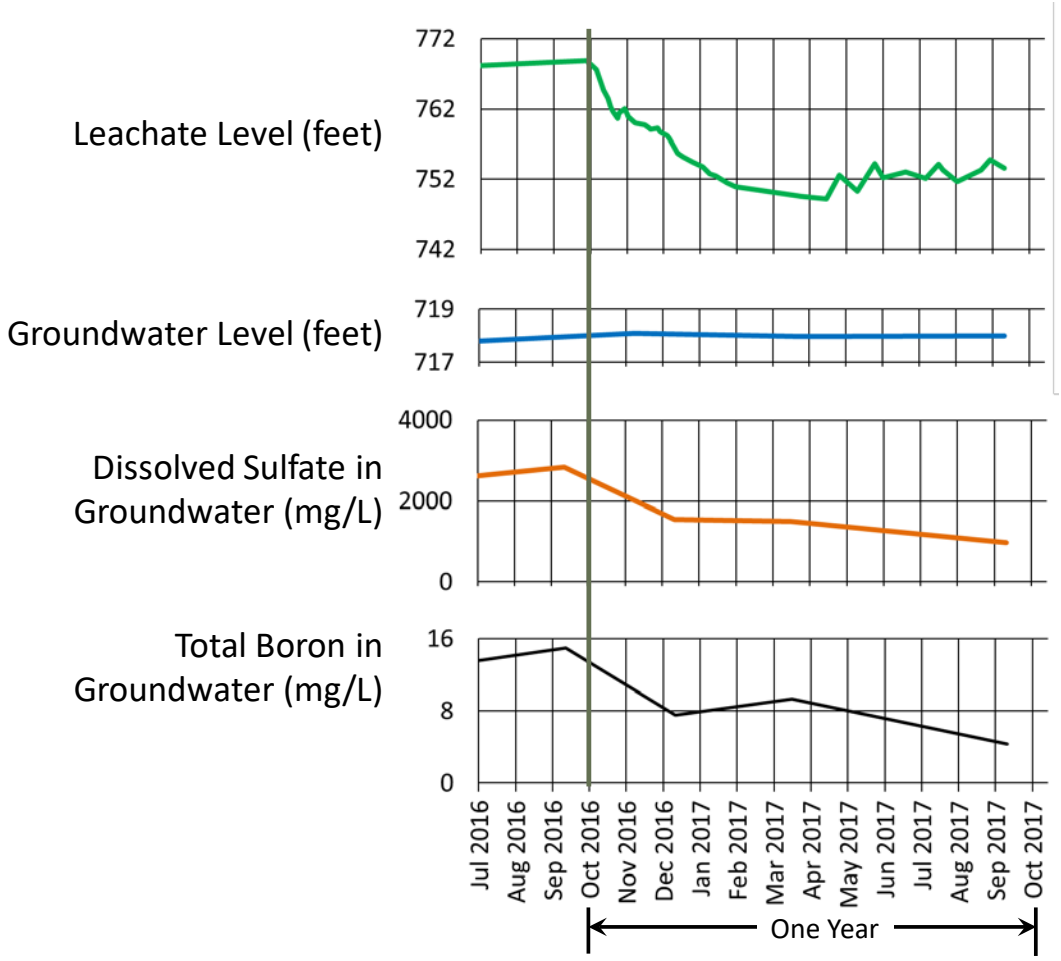
- Dewatering reduces mass flux to GW
- Cap further reduces mass flux to GW
- Liner or clay substrate limits impacts of release
- Concentration may or may not decrease
  - Well position
  - Hydrogeology
- Mass flux decrease even if concentration decrease is not evident
- Source control alternatives
  - Next slide

Source Control Alternatives for Intersecting Groundwater

- Grout or barriers above water table (for seeps)

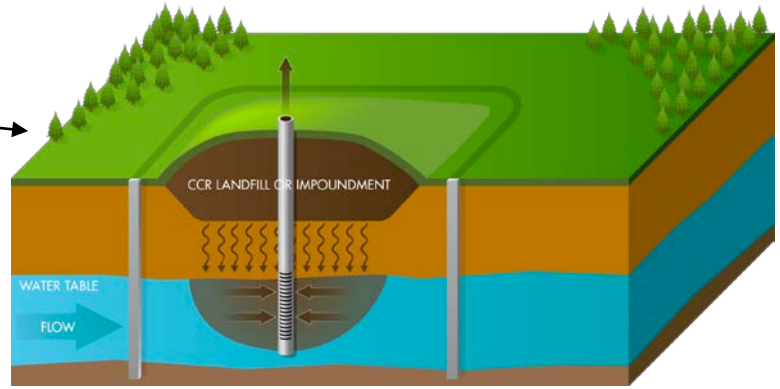
- Horizontal drain in CCR
  - Cost effective
  - Demonstrated for a site with inward seeps
  - Conceptually could work for intersecting GW
  - Ideal if liner or clay substrate
  - Long-term leachate management

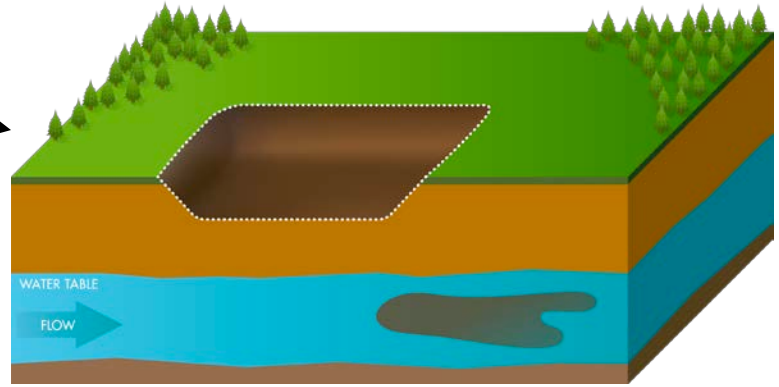




Source Control Alternatives for Intersecting Groundwater

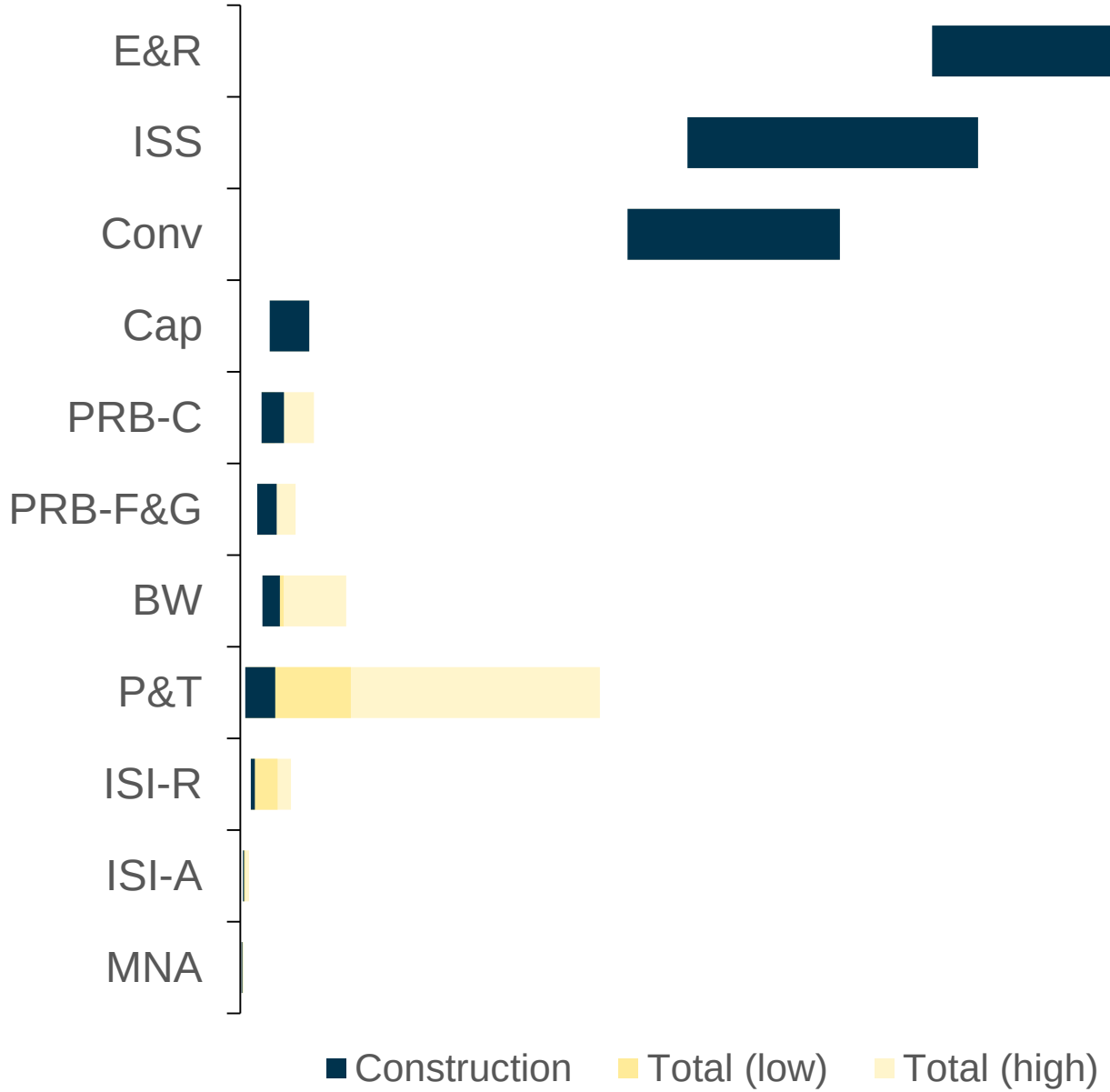
- In Situ Stabilization/Solidification (ISS)
  - Expensive
  - Consider targeted discrete
- Barrier walls
  - Most effective when key layer at reasonable depth
  - Proven technology at CCR sites
- Excavation and removal
  - Most expensive alternative
  - Potential for increased release during excavation
  - Impacts to surrounding community





Relative Cost

- Modified from EPRI 3002012313 (2018, in press)



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