Ministry of Forests, Lands, Natural Resource Operations and Rural Development

TIMING AND EFFECT OF GROUNDWATER USE

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Key Points

- WSA requires EFN consideration
- Potential for hydraulic connection must exist for EFN consideration
- Multiple lines of evidence should be used to establish or exclude hydraulic connection
- Timing of use/lag time needs to be considered where connection exists
- WSA has elevated expectations from groundwater consultants
- EAB case (Bessette Creek) area reinforced decision-maker authority to request data required to make a WSA license decision

Some (not all) lines of evidence re Hydraulic connection

Hydraulic Connection	ASSUME YES	ASSUME NO
Aquifer type (ENV)	1-4a	4b,4c
Aquifer Worksheet text (ENV)	"The north boundary of the Aquifer X is drawn along Creek X as it appears to be an area of groundwater recharge/discharge…"	
Consultant (cross-section, other?)		
Pumping Test	Recharge boundary or delayed drainage?	Test behaviour consistent

NOT EXHAUSTIVE LIST

** Many other scientific methods exist*

Some tools: Hydraulic Connection

- Water Science Series
- Other Case Studies
- Analytical or Numerical Models
- Water Chemistry analysis – major ions, isotopes, other?
- Site Specific Evidence, field measurements of chemistry, temperature
- Exposures of geology
- Academic research

NOTE: information presented may be 'tools' to use selectively but are not a recipe, not a 'how-to' for every case.

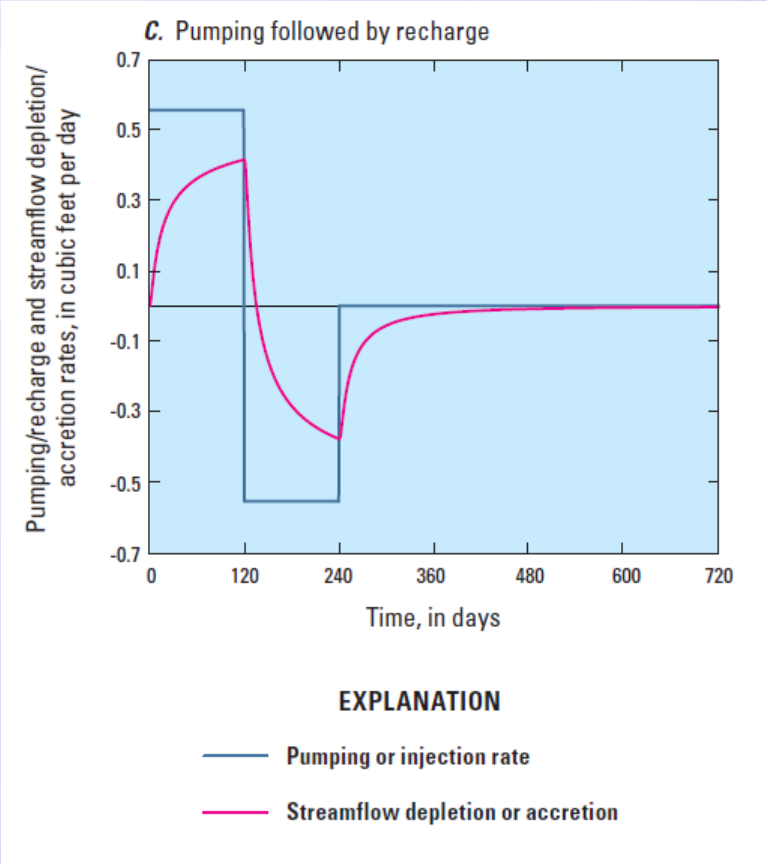
Hydraulic Connection Guidance

- Provincial guidance to considering hydraulic connection exist in Water Science Series (ENV publications):
  - WSS2016-01: *Determining the Likelihood of Hydraulic Connection – Guidance for Determining the Effect of Diversion of Groundwater on Specific Streams*
  - WSS2016-08: *Guidance for Technical Assessment Requirements in Support of an Application for Groundwater Use in British Columbia*
  - WSS 2016-09: *Modelling Tools for Estimating Effects of Groundwater Pumping on Surface Waters*
  - WSS2017-02 and -04: *Assessment of Aquifer-Stream Connectivity Related to Groundwater Abstraction in the Lower Fraser Valley*

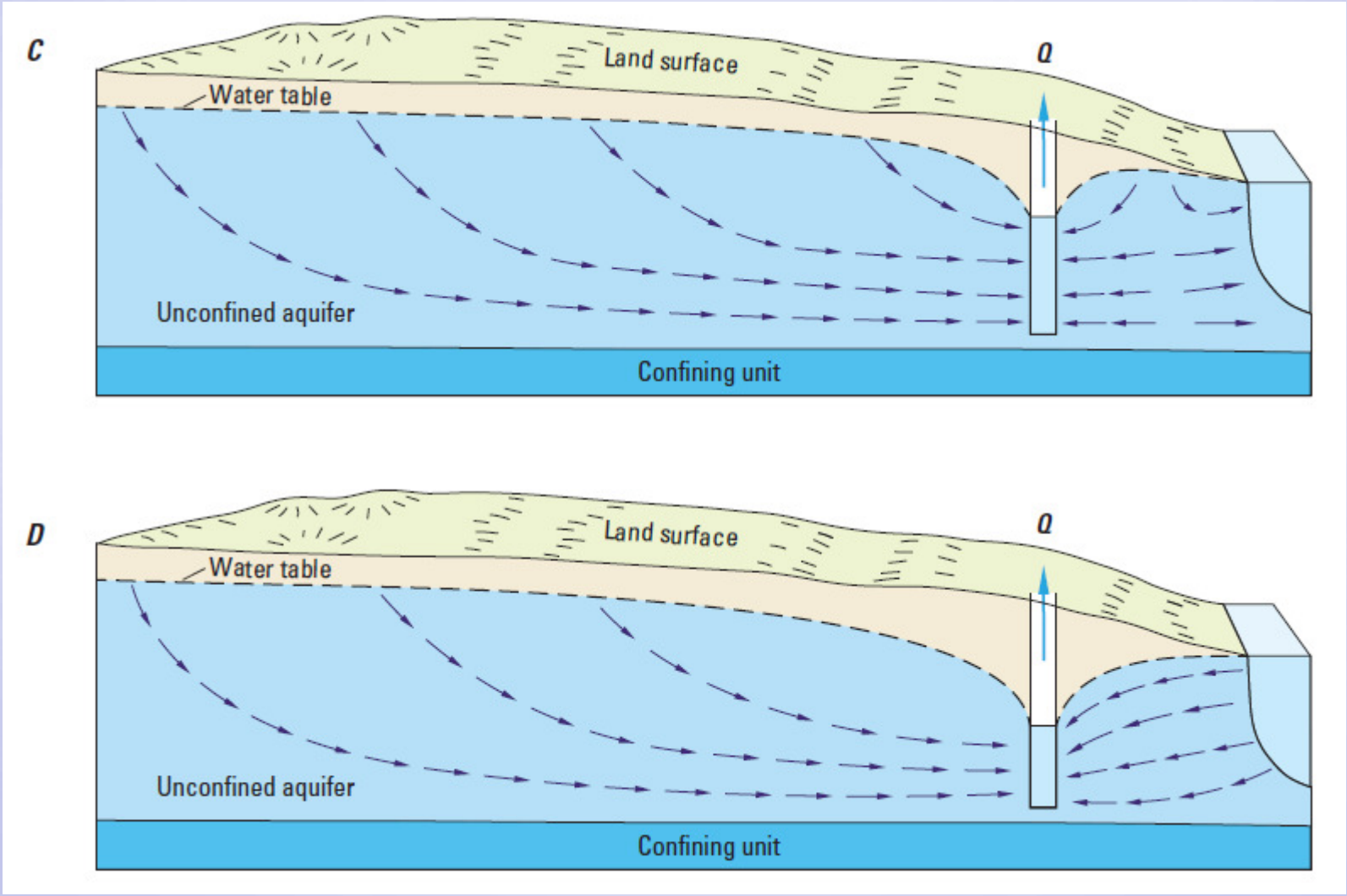
Review: Hydraulic Connection affecting streamflow

- Hydraulic Connection exists in direct and indirect forms:
  - Well pumping causes water removal from stream
  - Pumping intercepts water that otherwise would discharge to stream

- This occurs annually as cycles of pumping and recharge

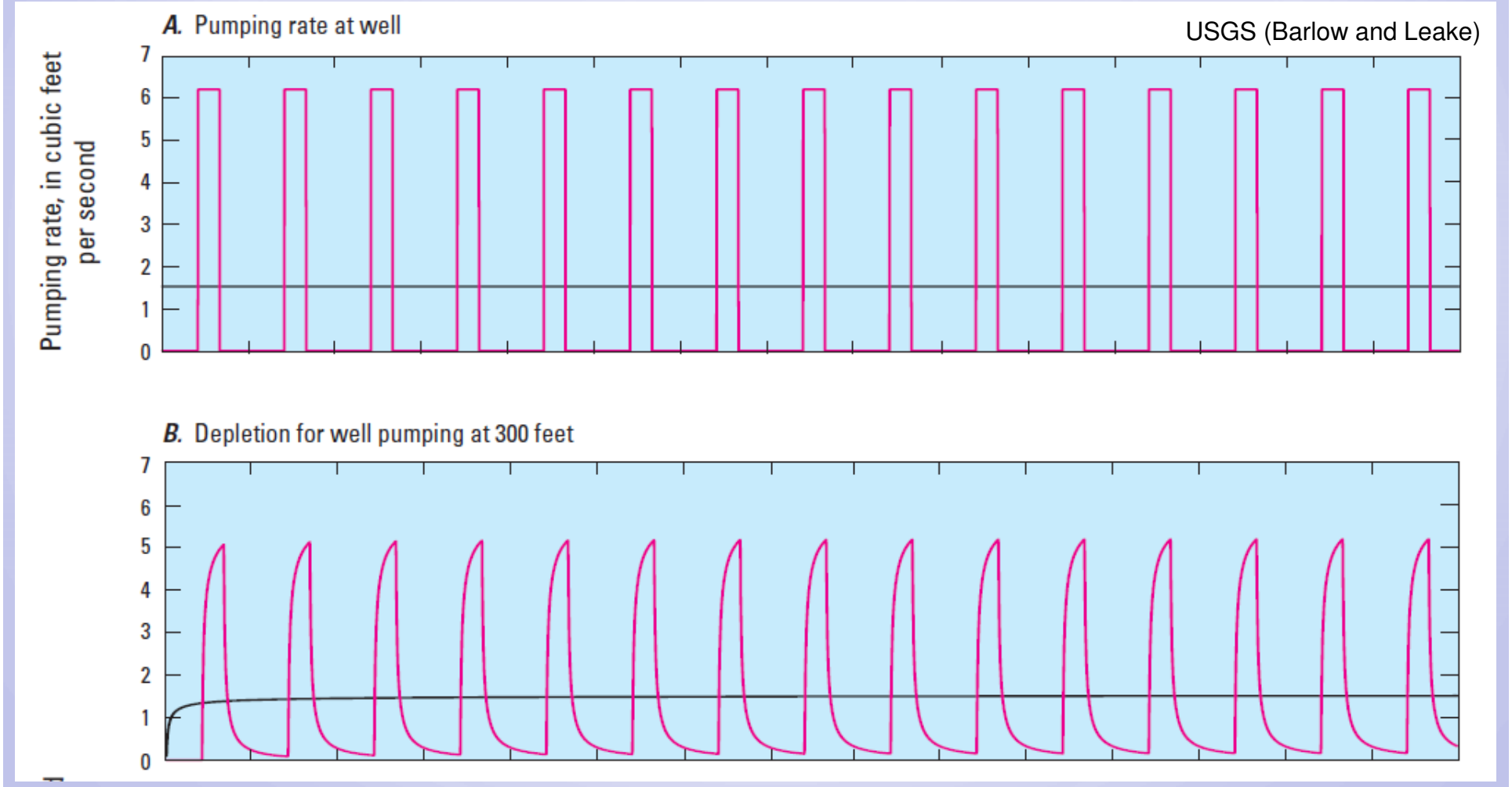


Indirect and Direct Hydraulic Connection



USGS (Barlow and Leake)

Seasonal versus annual pumping at various distances from hydraulically connected well



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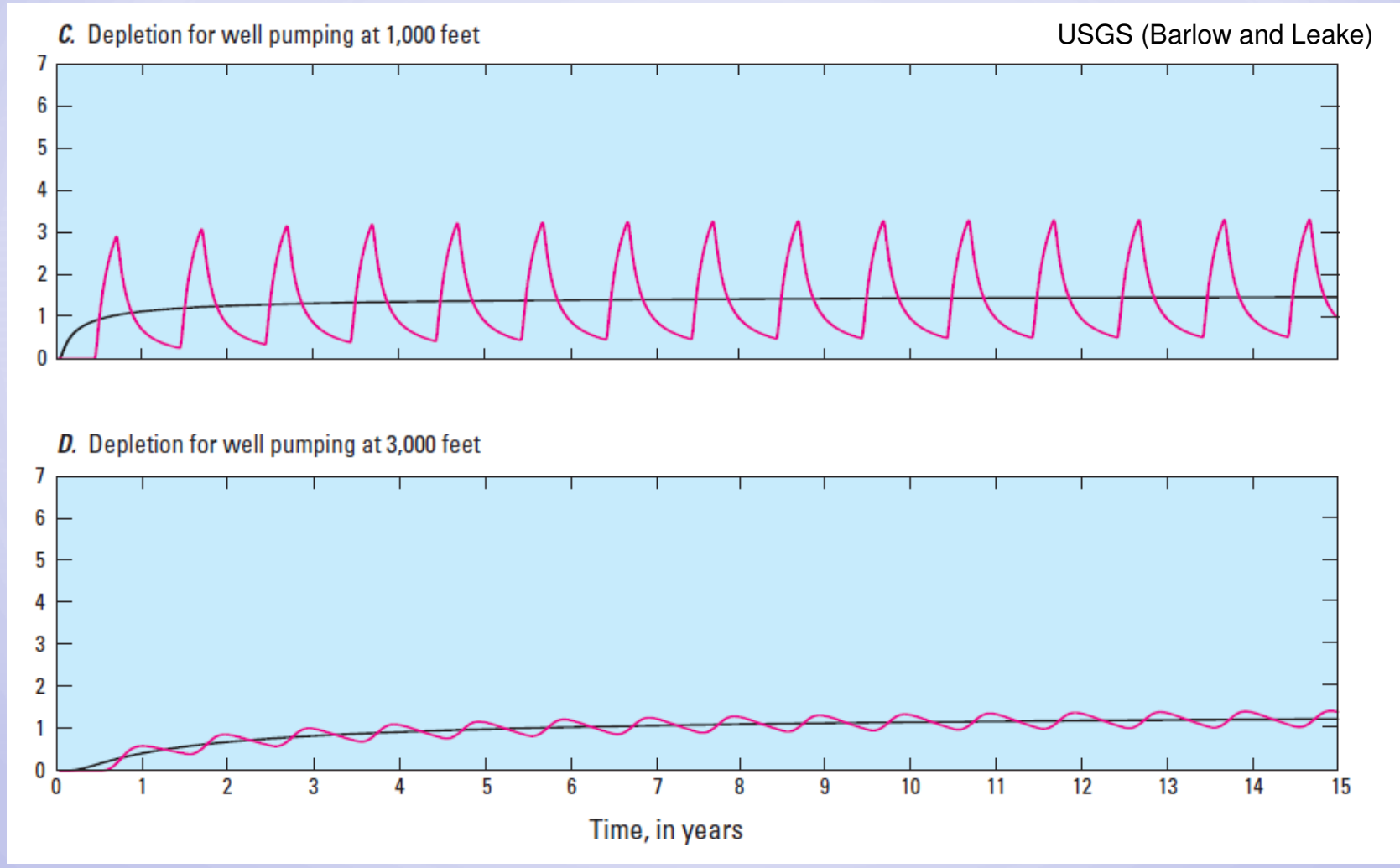
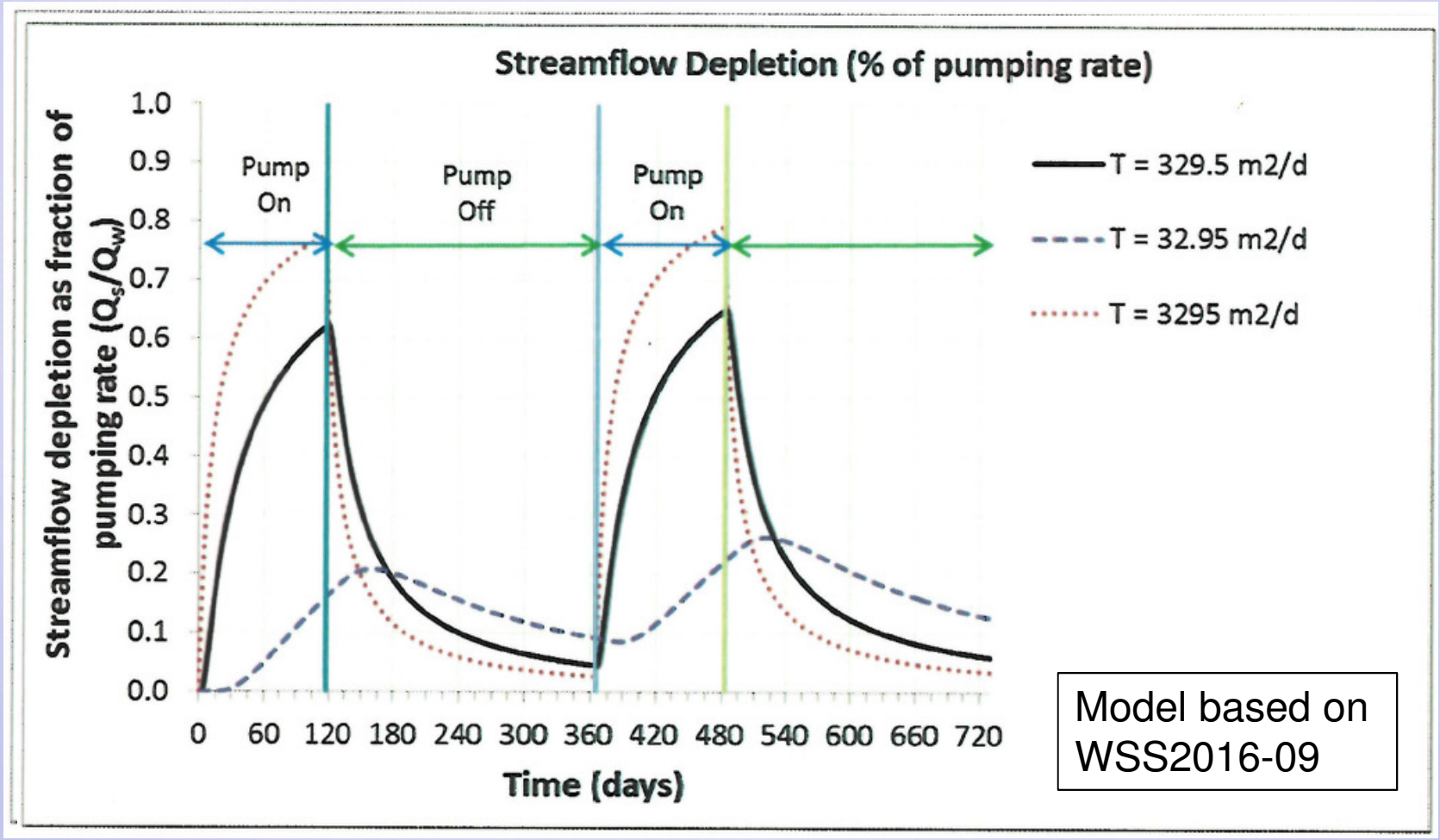


Analytical model to estimate timing and magnitude of depletion



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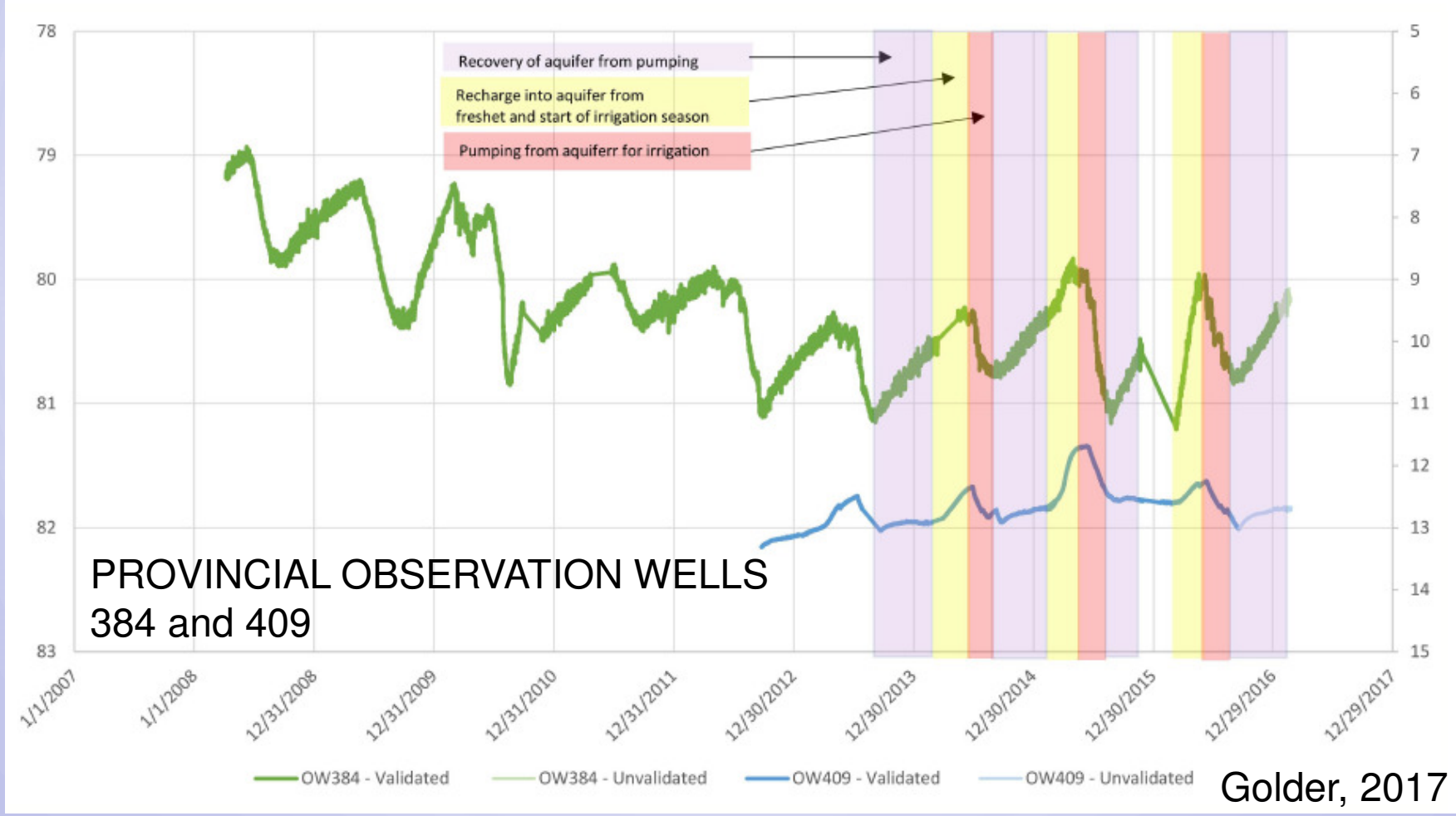
Complicating Factors: Estimating Irrigation within Annual Cycles of Groundwater Depletion and Recharge



Golder, 2017

Conclusions

- Hydraulic Connectivity potential for each application, well, usage rate, timing of use, and aquifer are unique
- Hydrogeology and hydraulic connectivity is not always an exact science, and groundwater license applicants can propose monitoring to address uncertainties
- Accurate understanding of timing and effect of pumping allows management of the resource
- Qualified Professionals need to use professional judgement, and be thorough in reports