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Representing groundwater flow with water-level contour maps and cross sections

Harney Basin Study Advisory Committee
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USGS/OWRD

U.S. Department of the Interior
U.S. Geological Survey

"Water-level measurements from observation wells are the principal source of information about the hydrologic stresses acting on aquifers and how these stresses affect groundwater recharge, storage, and discharge."---USGS Circular 1217

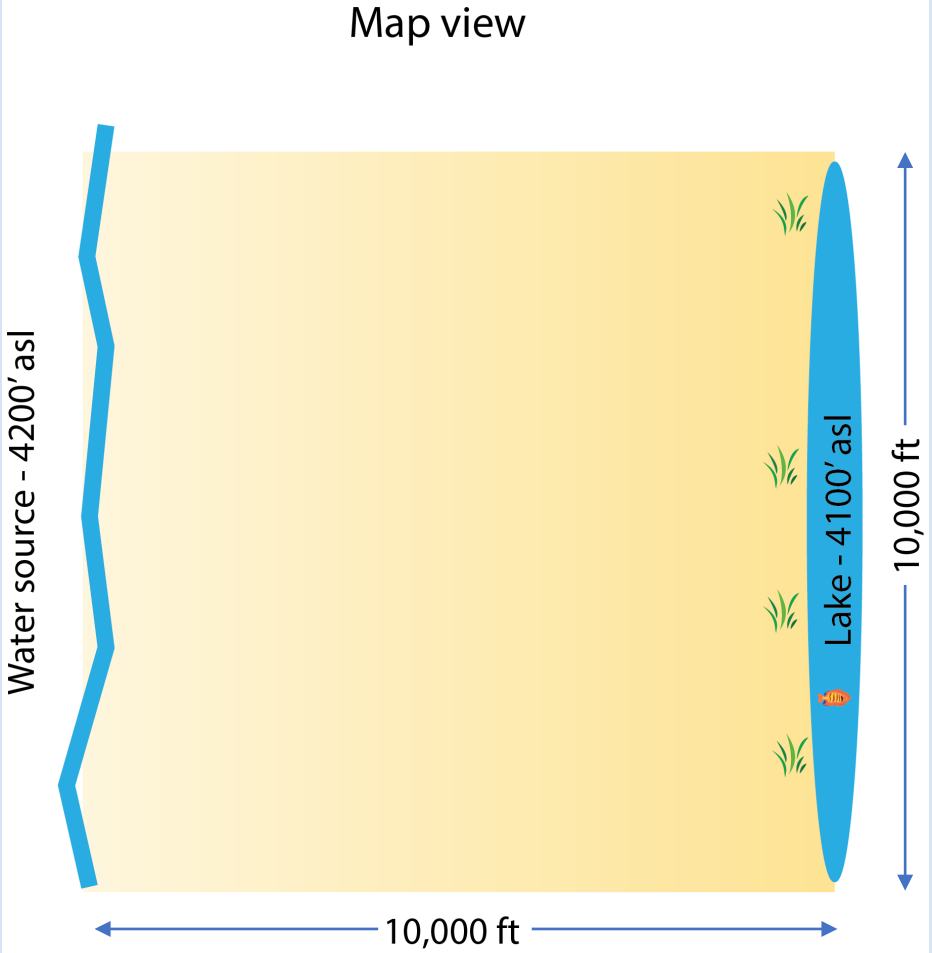
Hydraulic head is an indicator of the total energy available to move groundwater through an aquifer.

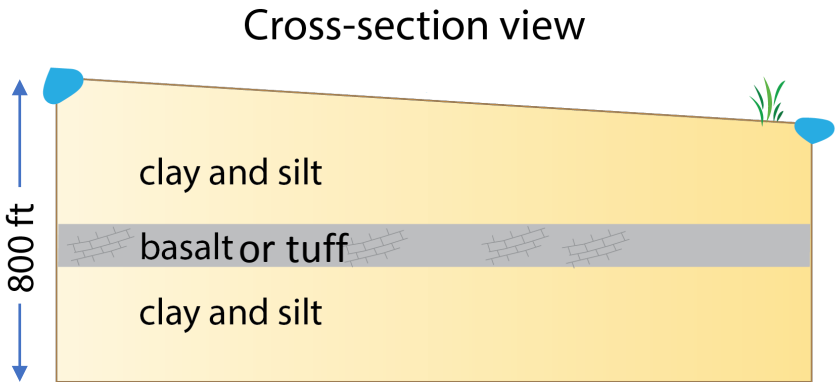
Because hydraulic head represents the energy of water, groundwater flows from higher hydraulic head to lower hydraulic head.

Groundwater levels are controlled by the balance among recharge to, storage in, and discharge from an aquifer. Porosity, permeability, and thickness of the rocks that compose the aquifer affect this balance.

The physics of groundwater flow is analogous to heat (and electricity) flow and can be described by mathematical equations. Groundwater models are based on these equations and are useful for demonstrating groundwater flow in various systems

Simple 3D model of groundwater flow





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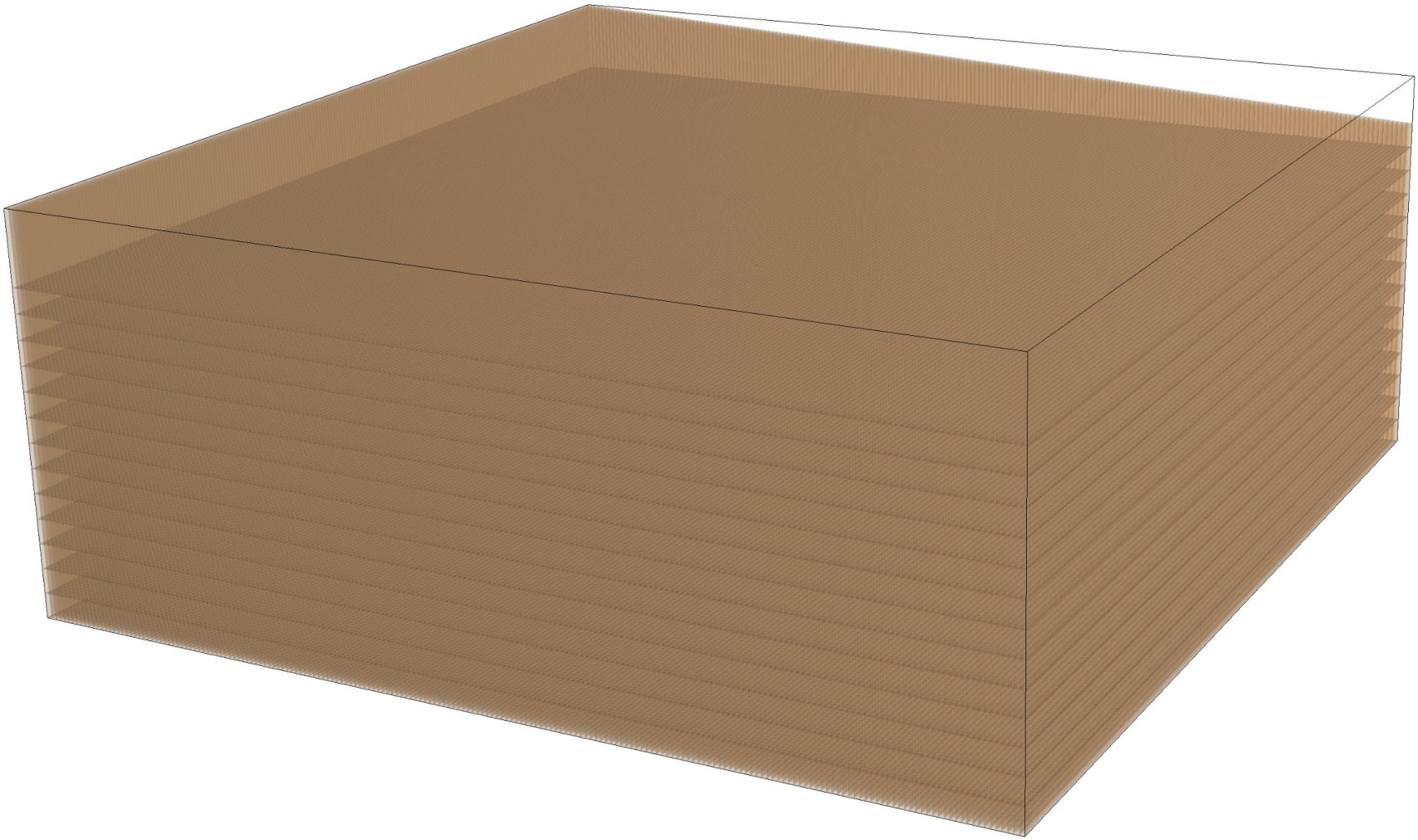
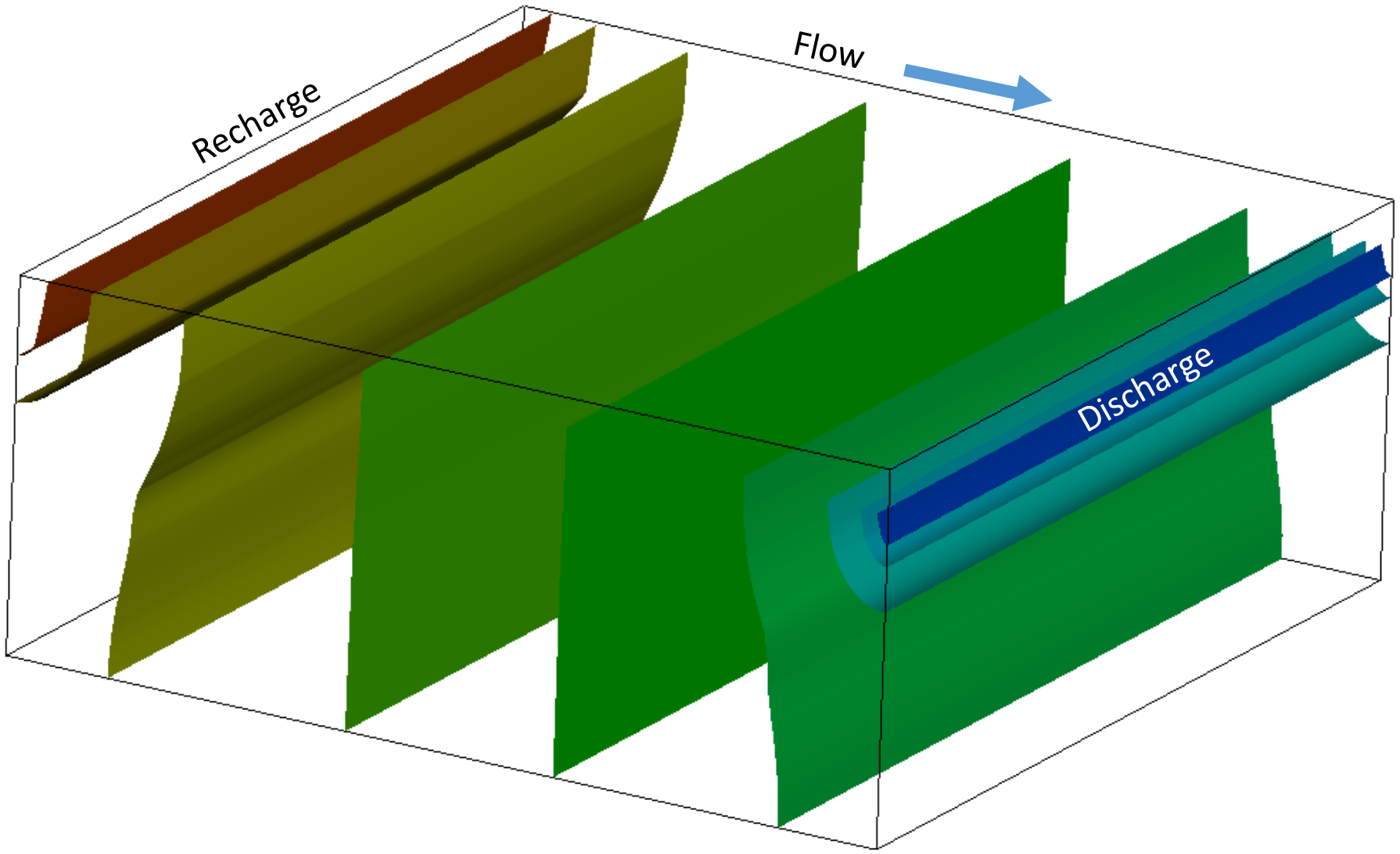
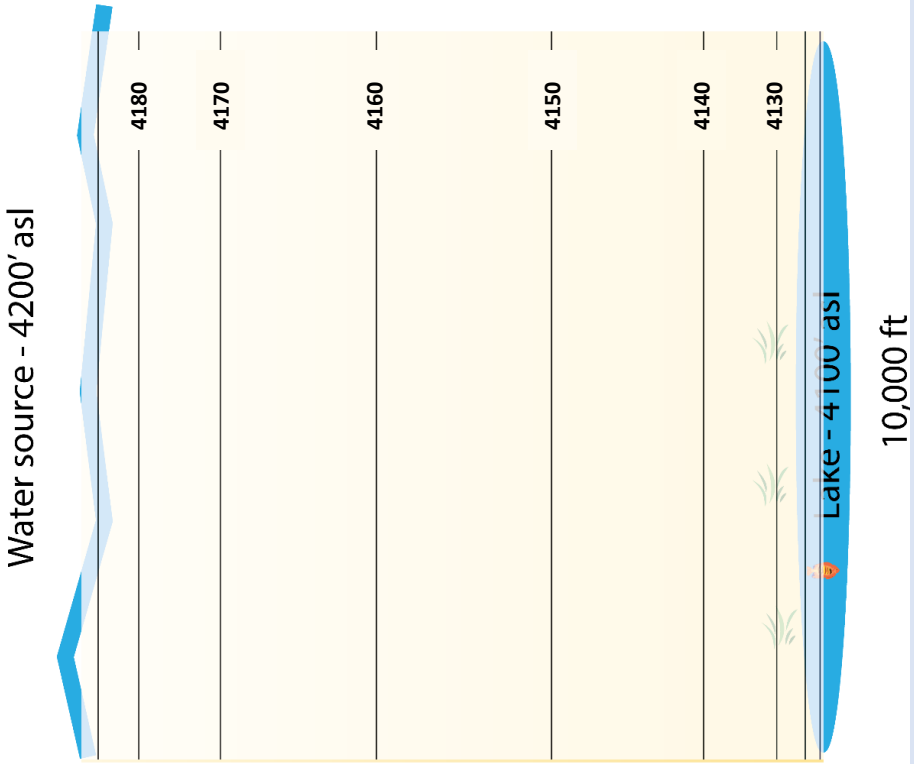
Aquifer in three-dimensional space



Head in three-dimensional space

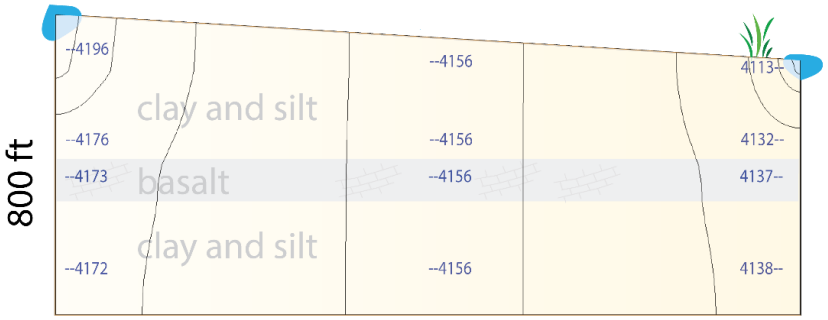


Map view - shallow

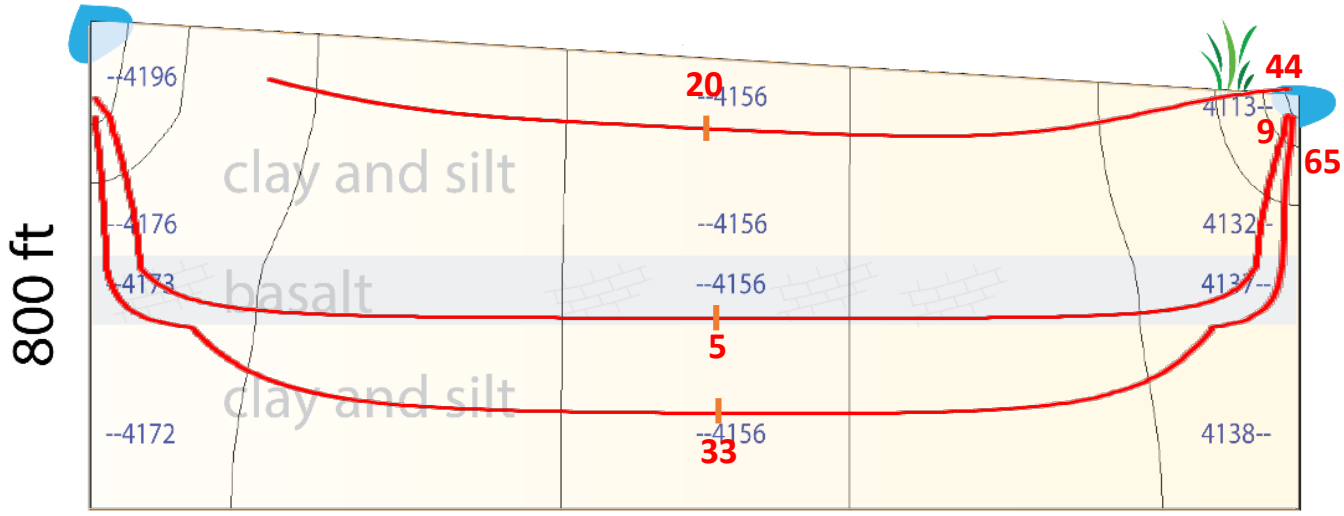


Flow

Cross-section view



Cross-section view



Groundwater flowpath

33 Relative age of groundwater

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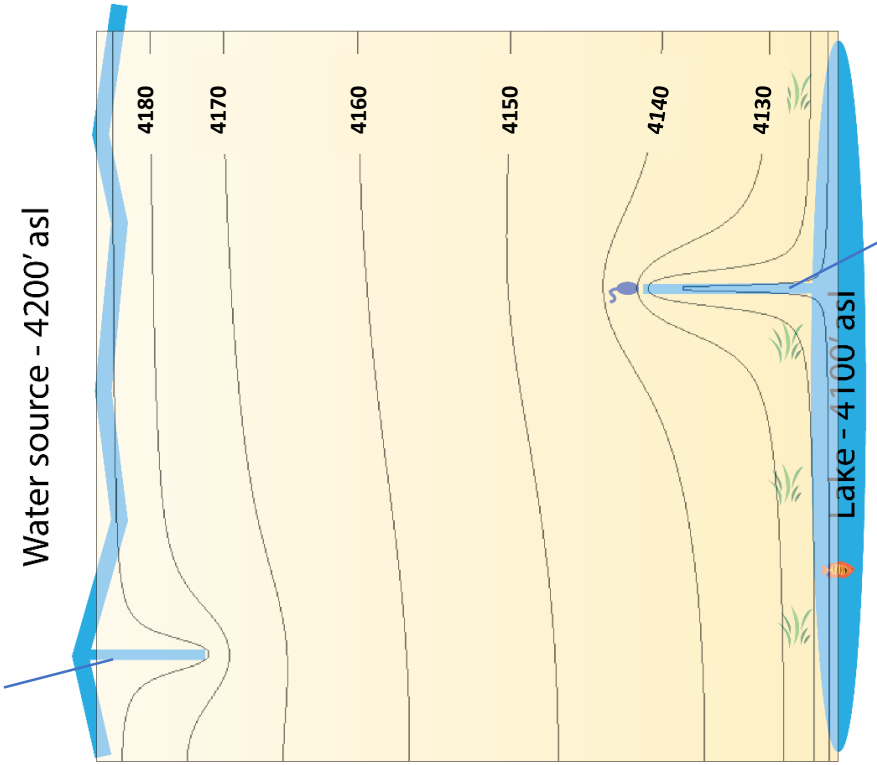
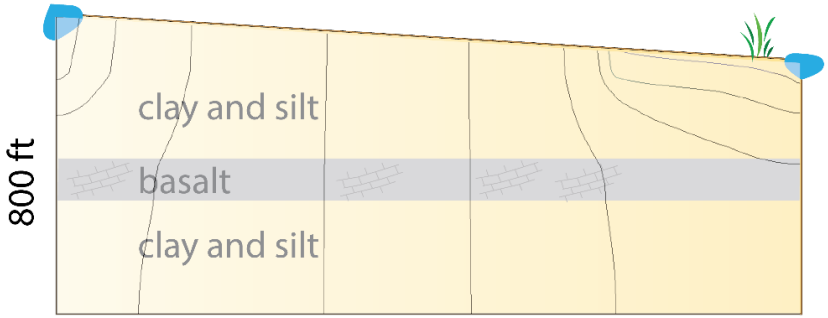
Map view - deep



Losing stream

Gaining stream

Cross-section view



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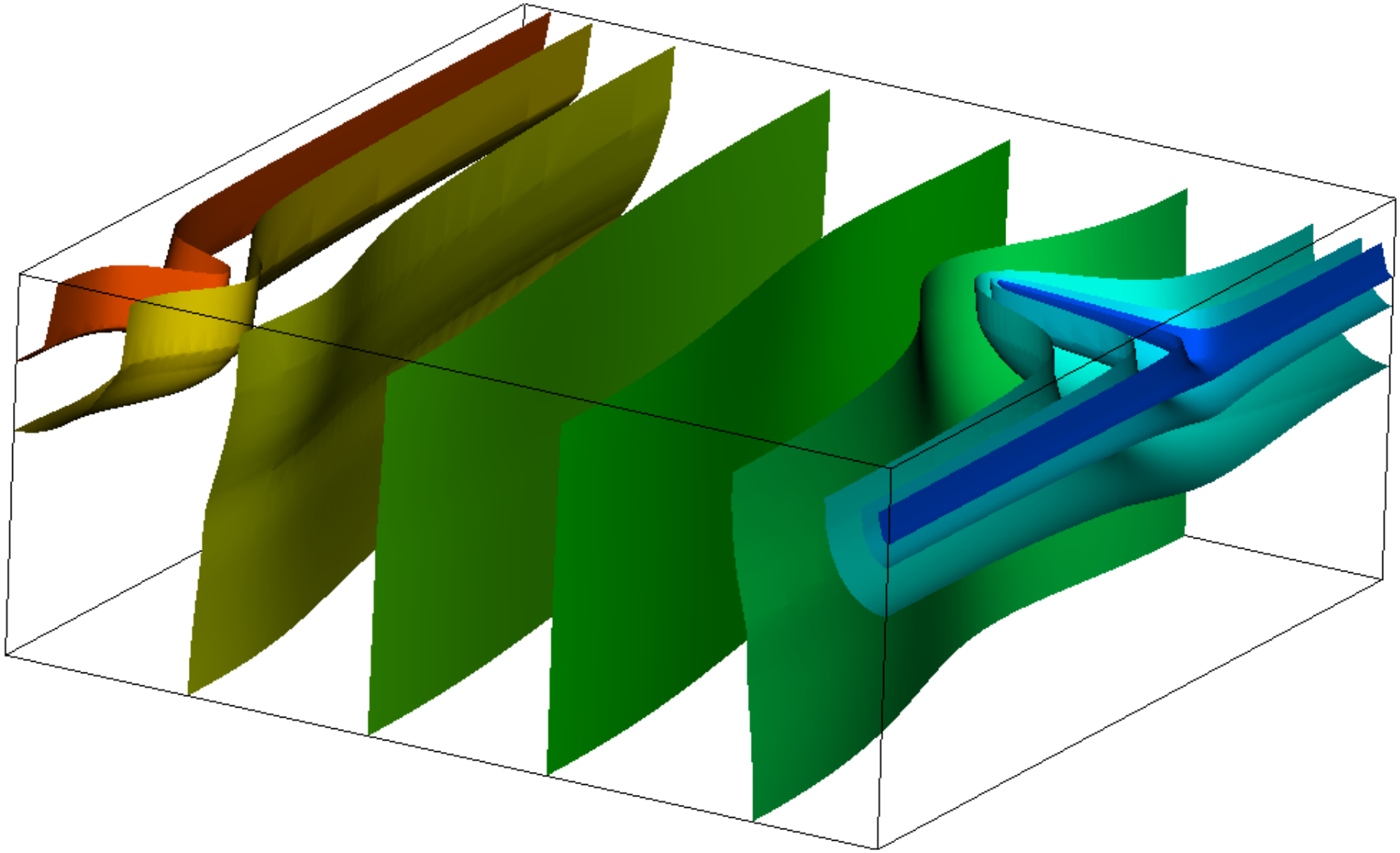
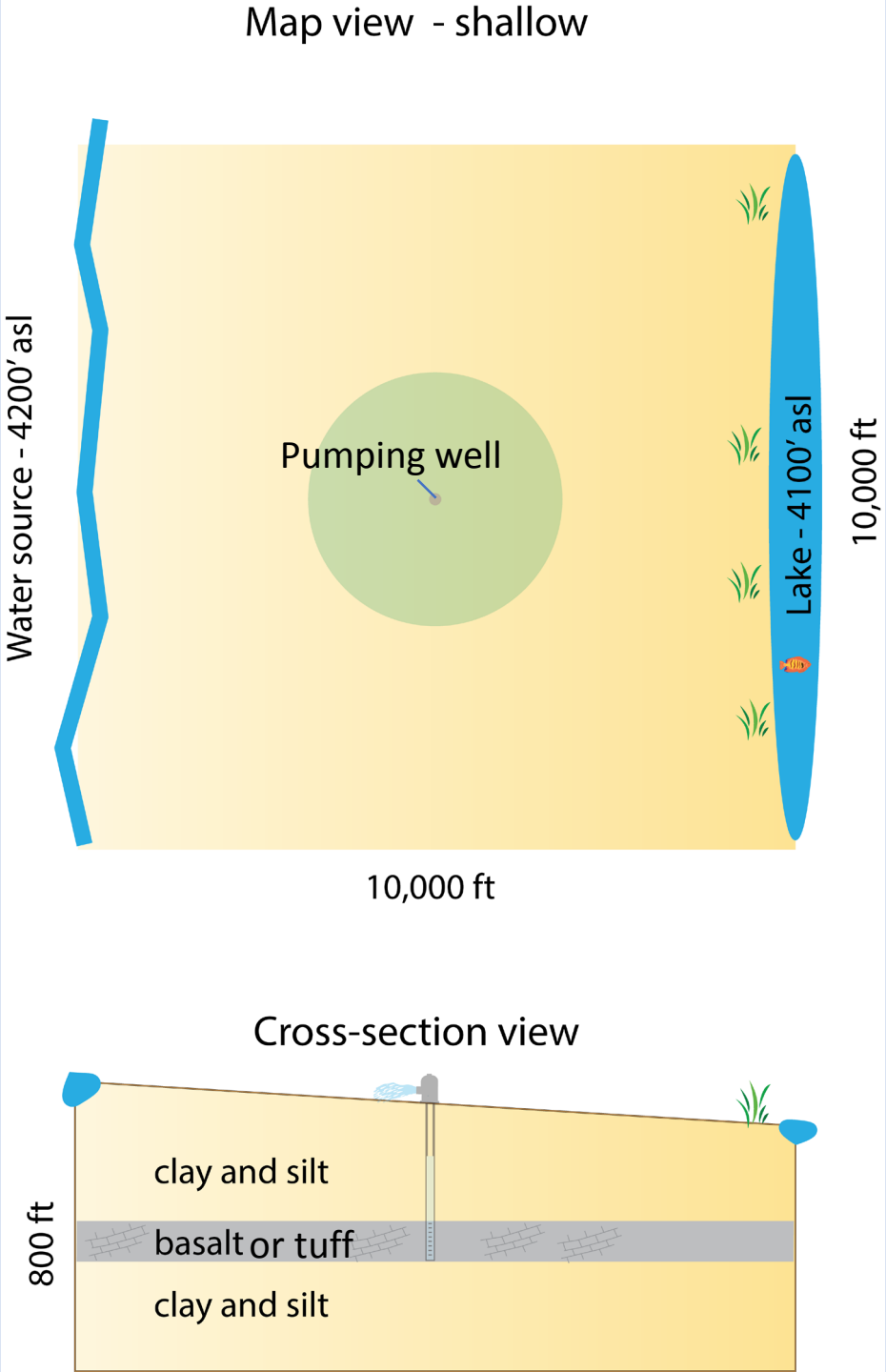
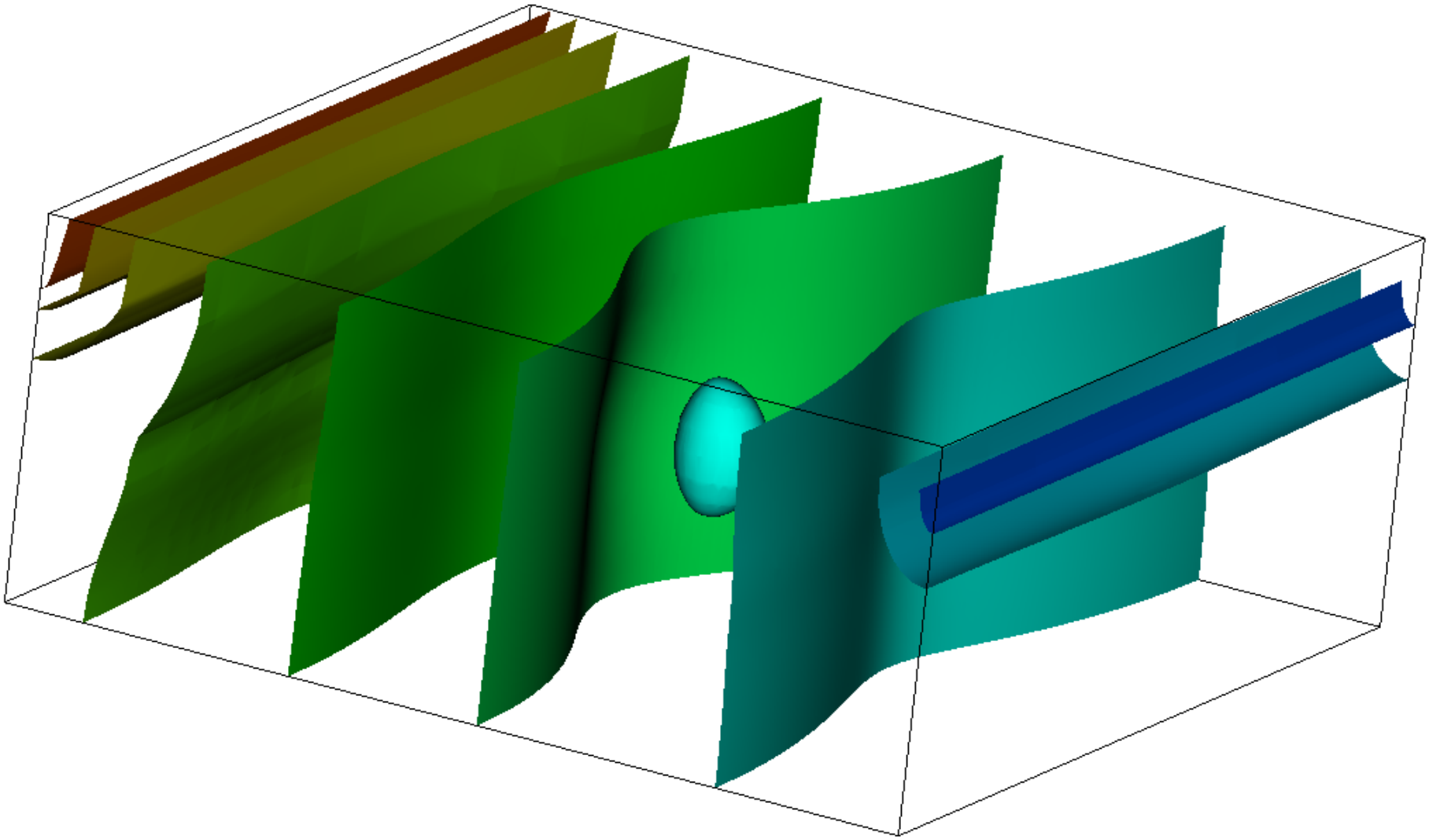
Head in three-dimensional space

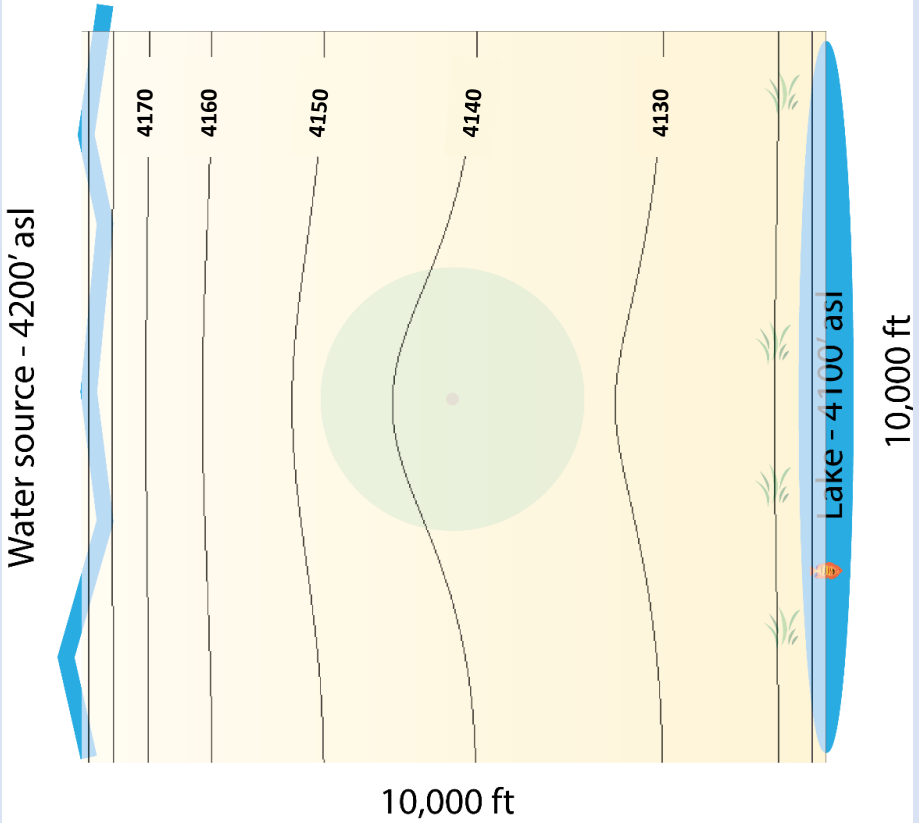



Map view - shallow
Water source - 4200' asl
Pumping well
Lake - 4100' asl
10,000 ft
10,000 ft
Cross-section view
800 ft
clay and silt
basalt or tuff
clay and silt

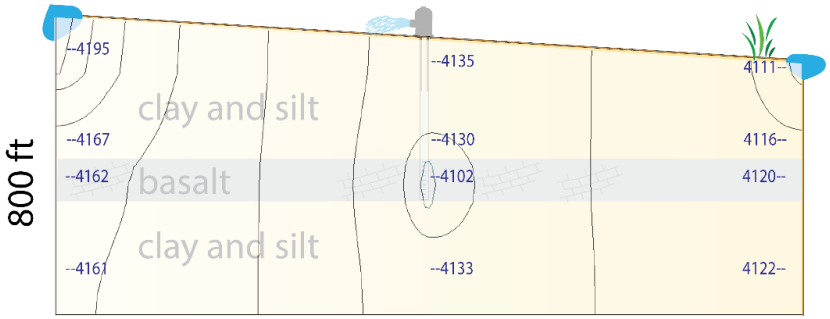
Head in three-dimensional space



Map view - shallow



Cross-section view



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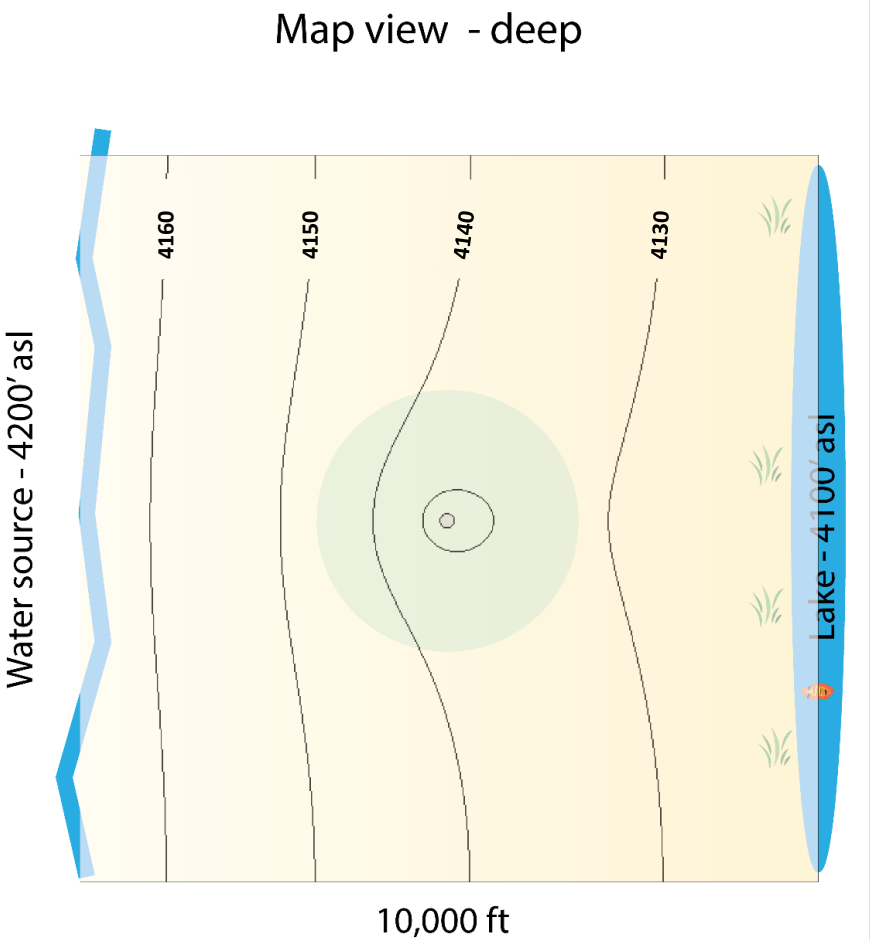
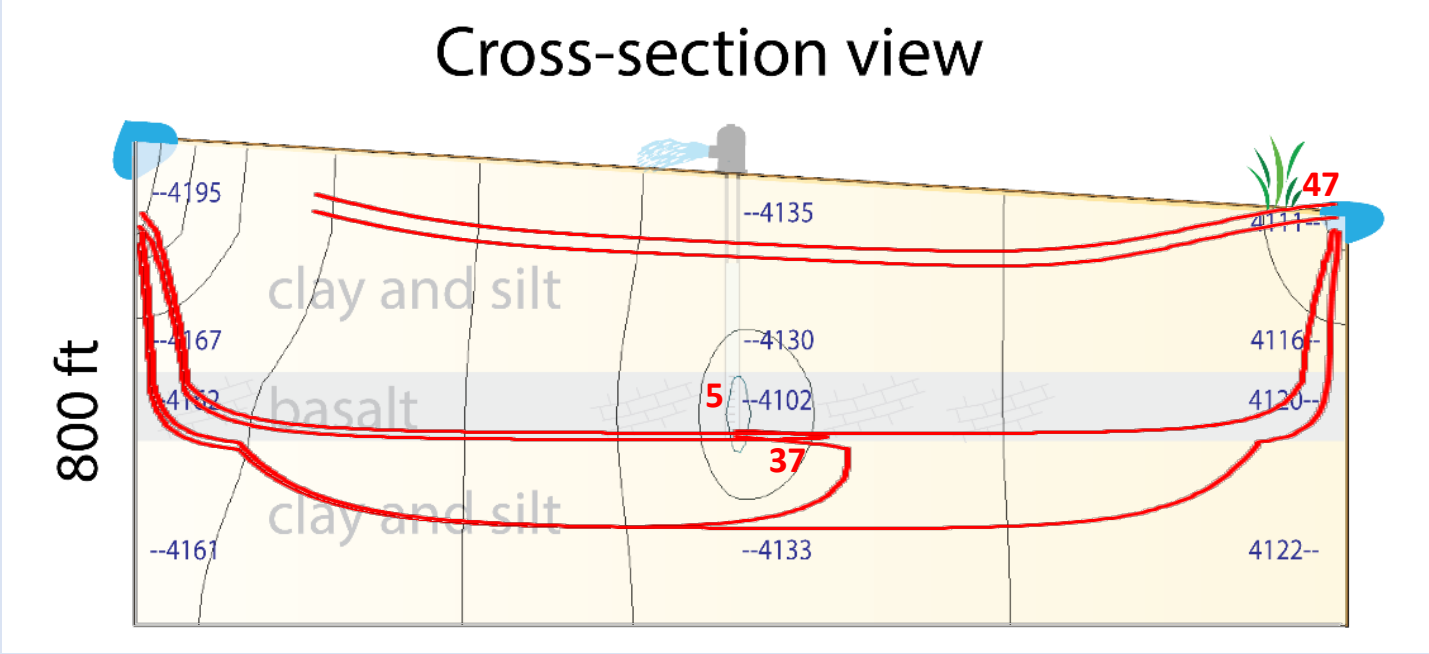
Pumping from single well open to high-permeability layer



Pumping from single well open to high-permeability layer



Groundwater flowpath

37 Relative age of groundwater

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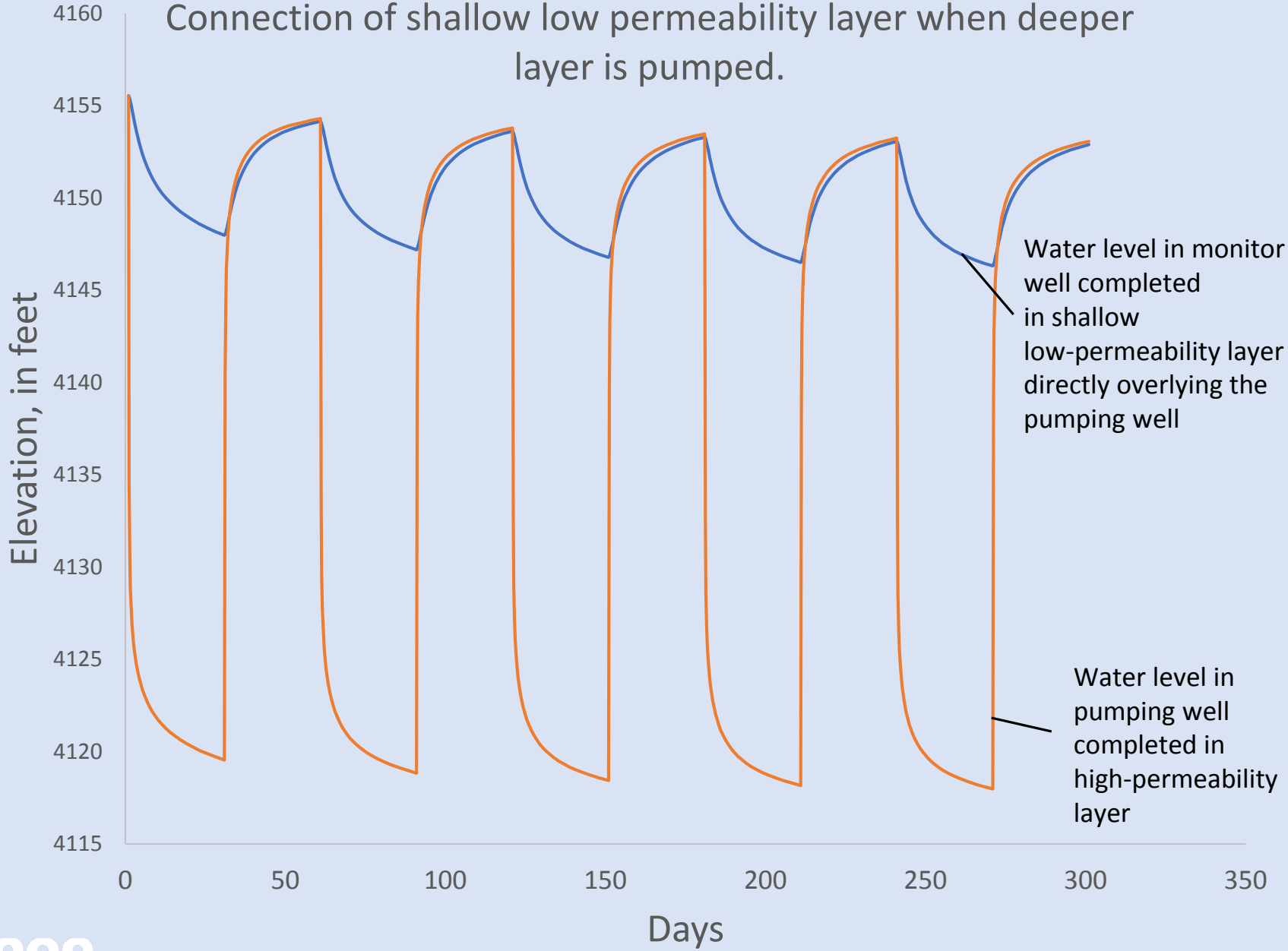
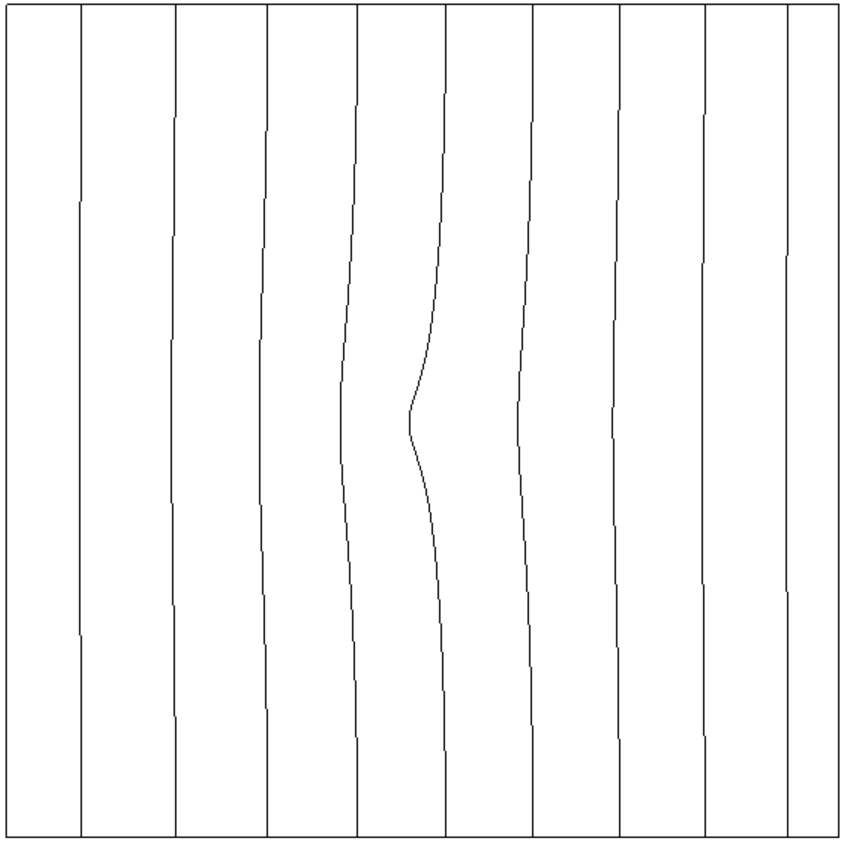
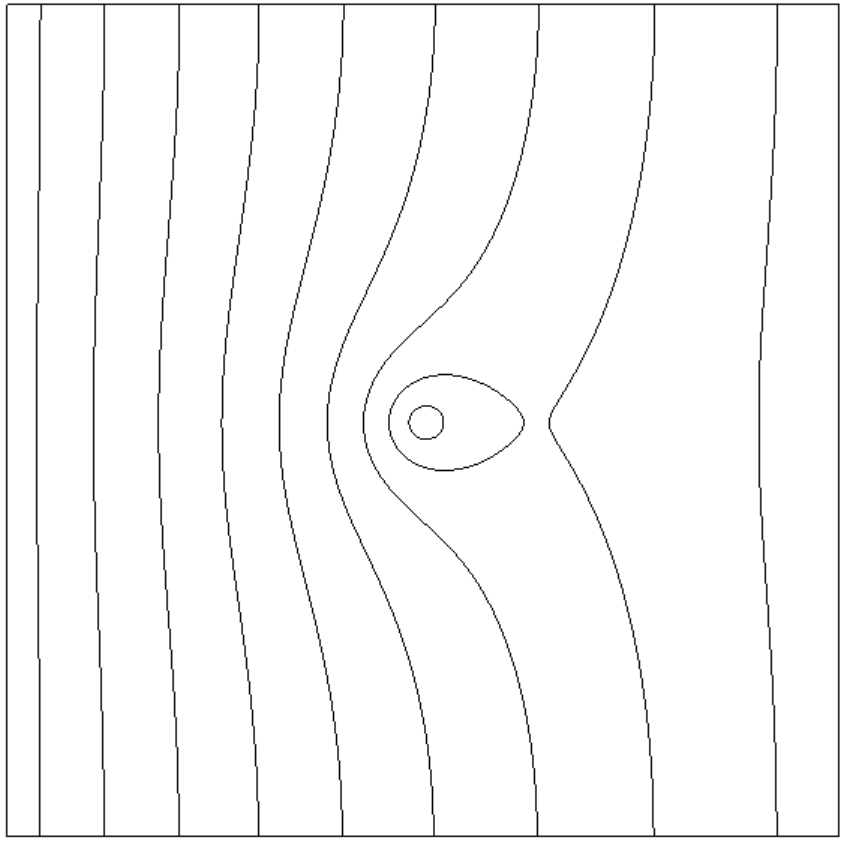

Connection of shallow low permeability layer when deeper layer is pumped.
Elevation, in feet
4160
4155
4150
4145
4140
4135
4130
4125
4120
4115
0
50
100
150
200
250
300
350
Days
Water level in monitor well completed in shallow low-permeability layer directly overlying the pumping well
Water level in pumping well completed in high-permeability layer

Pumping from a single well in different rock types
Near-surface water table



All high-permeability rocks



All low-permeability rocks

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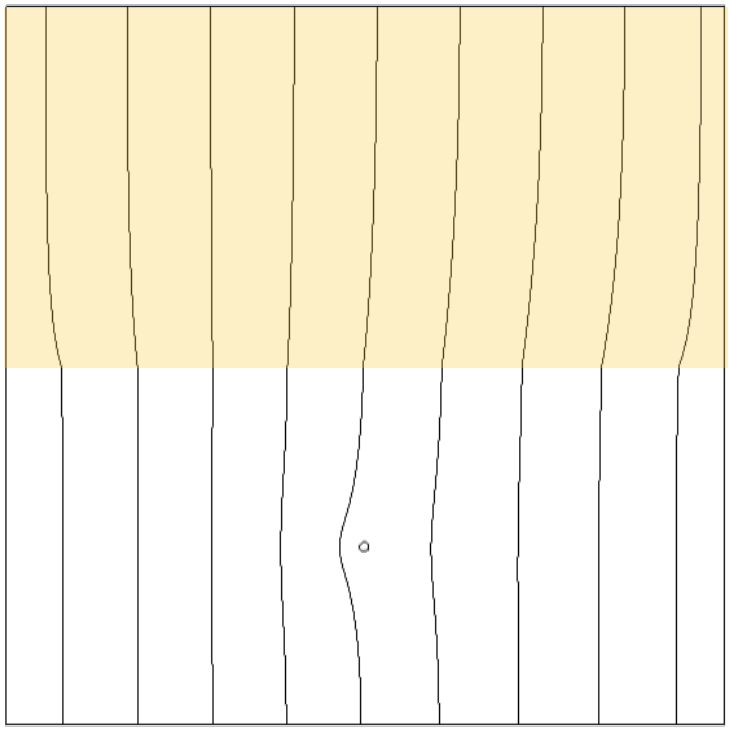
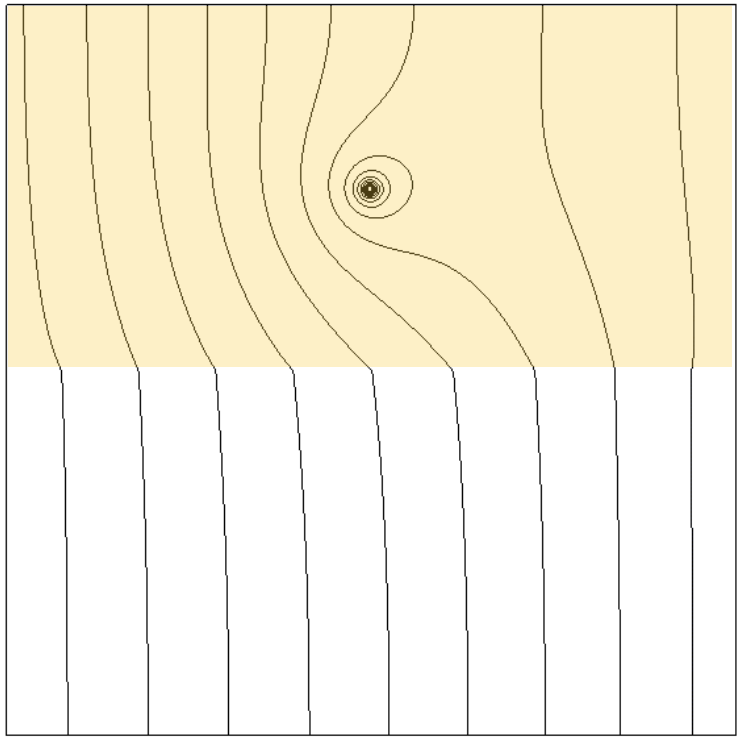
Pumping from a single well in different rock types
Near-surface water table



LOW

HIGH



Pump from high-permeability rocks

Pump from low-permeability rocks

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References

- Taylor, C.J. and Alley, W.M., 2001, Ground-Water-Level Monitoring and the Importance of Long-Term Water-Level Data: US Geological Survey Circular 1217, 68 p.