Form and Content of The Proposed Conjunctive Management Framework

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Outline

- Background to groundwater / surface water interaction
- Outline of the proposed management framework
- Specific provisions relating to the classification and management of stream depletion effects (Appendix P / Table 4.1)

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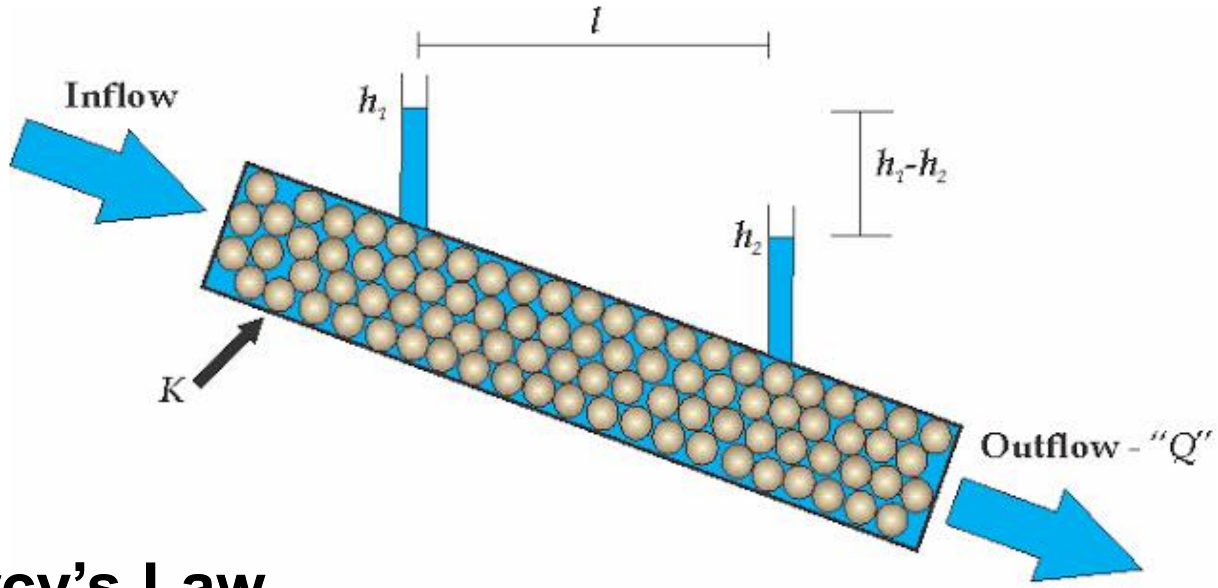
Groundwater/Surface Water Interaction

Significant interaction between groundwater and surface water is observed throughout the Wellington Region

- Rivers lose flow (and in some cases dry up) due to losses to groundwater
- Baseflow discharge maintains river flows during periods of low rainfall (including springs)
- Groundwater and surface water support wetlands and a range of groundwater dependant ecosystems

Groundwater Flow



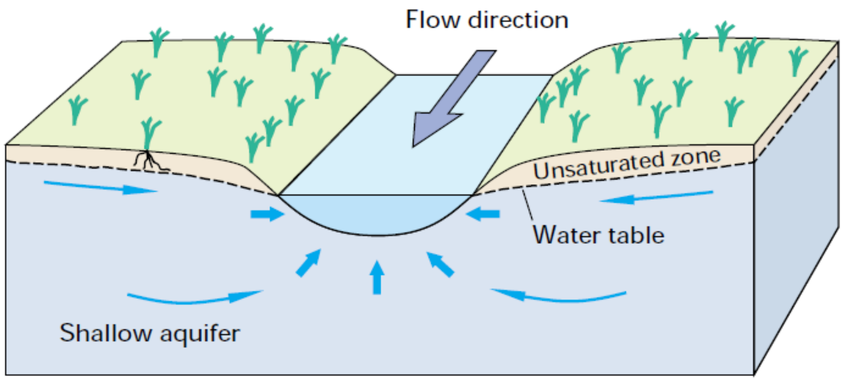
Darcy's Law

Groundwater flow (including flow exchange between groundwater and surface water) is proportional to permeability and hydraulic gradient

Natural Groundwater/Surface Water Interaction

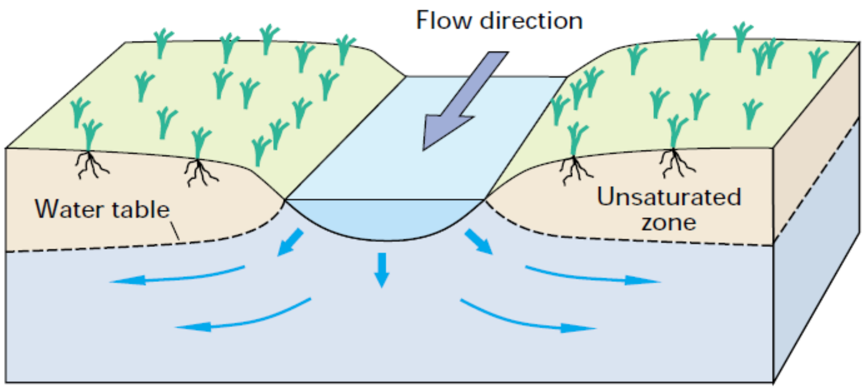
Gaining Stream

- Baseflow from groundwater



Losing Stream

- Flow lost to groundwater



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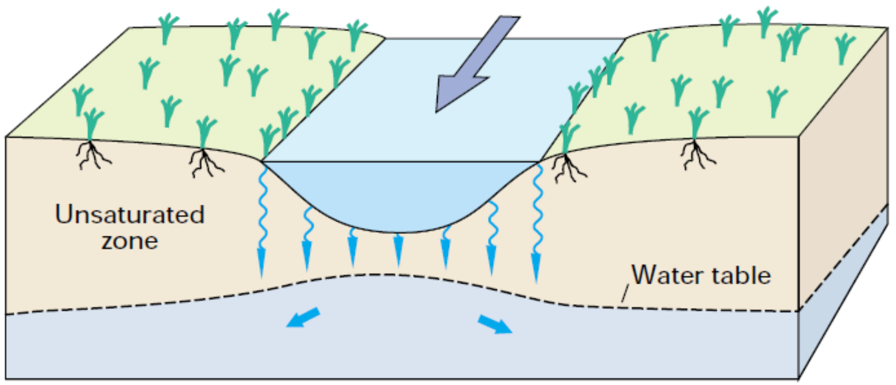
Natural Groundwater/Surface Water Interaction

Disconnected (perched) Stream

- May/may not lose water
- Not directly connected to the water table



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Hydraulic Connectivity

Describes the nature and extent of interaction between groundwater and surface water.

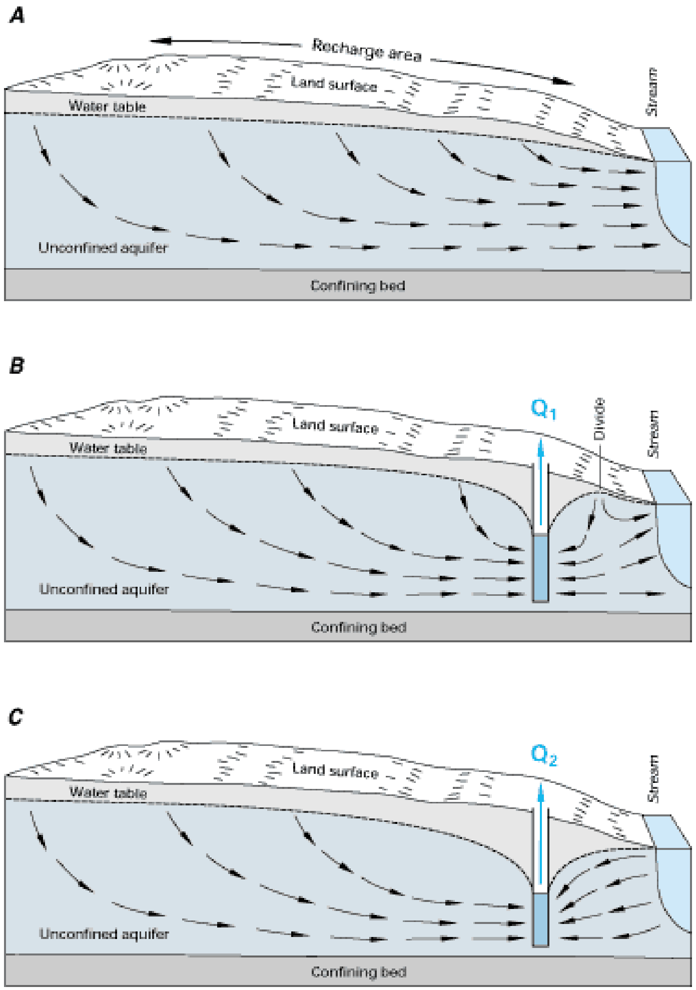
- High connection where water can move freely between groundwater and surface water (e.g. shallow, highly permeable riparian aquifers)
- Low connection where movement of water is restricted (e.g. stream separated from an underlying aquifer by a layer of low permeability material)

Stream Depletion

Groundwater abstraction has the potential to:

- Increase flow loss from rivers/streams
- Reduce flow in spring-fed streams
- Reduce infiltration to rivers, streams and springs

Typically expressed in terms of stream depletion ratio (q/Q)



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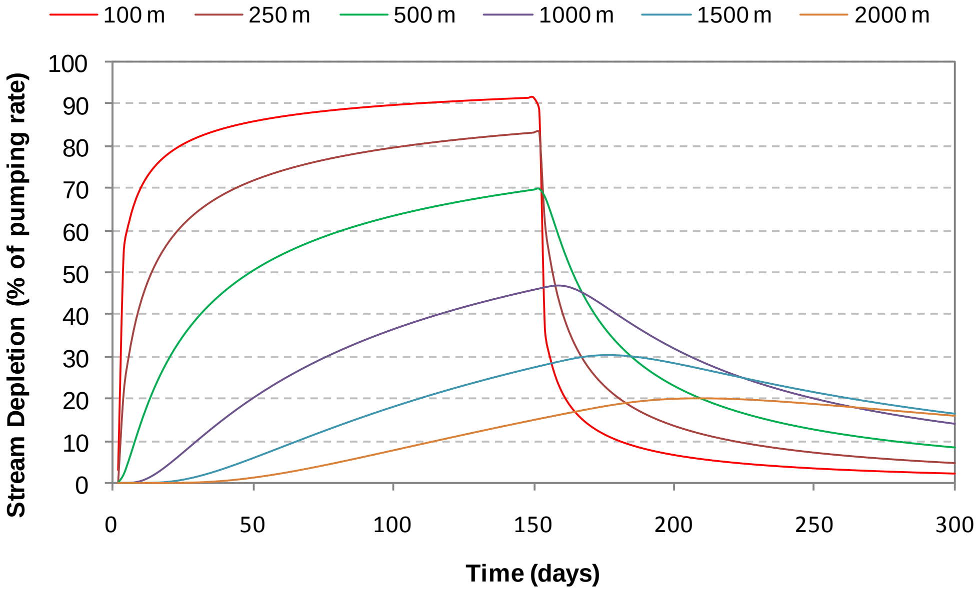
Magnitude and timing of stream depletion effects

The potential for stream depletion depends on:

- the distance between the bore and the stream
- the rate of pumping
- the hydraulic properties of the aquifer
- the permeability of the stream bed

Is not a 1:1 ratio

Magnitude and timing of stream depletion effects



Managing stream depletion effects

Stream depletion from individual groundwater takes occur along a continuum

- High hydraulic connection
  - Stream depletion effects occur and dissipate rapidly
  - Significant proportion of water pumped derived from surface water (high q/Q)

- Low hydraulic connection
  - Effects on surface water occur slowly over an extended period
  - Minor proportion of water pumped derived from surface water (low q/Q)

Managing stream depletion effects

Managing stream depletion effects at a catchment scale requires an approach that:

- Manages the local-scale effects of groundwater abstractions with a high degree of hydraulic connection
- Accounts for the cumulative effects of groundwater takes with a moderate to low hydraulic connection on catchment baseflow

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Proposed Conjunctive Management Framework

High hydraulic connection

Category A

Category B
(high connection)

- *Included in surface water allocation*
- *Minimum flow cut-offs (may) apply*

Category B
(moderate connection)

Category C

- *Groundwater allocation only*
- *Cumulative effects managed by groundwater allocation volume*

Low hydraulic connection

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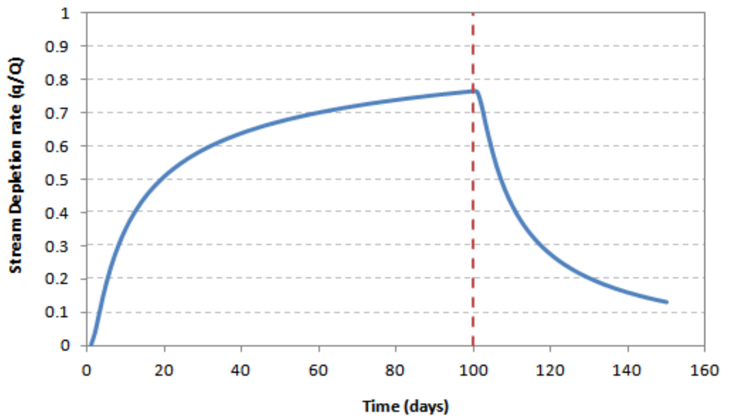
Category A

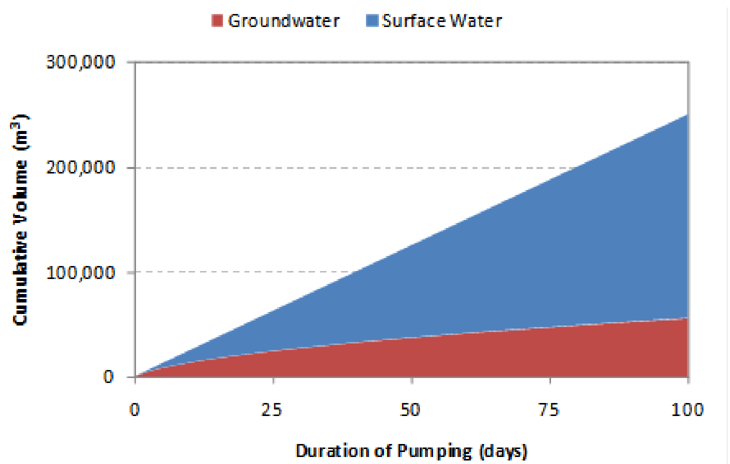
Areas which exhibit a high connectivity to surface water

- Depletion effects develop/dissipate rapidly
- Significant proportion of volume pumped derived from surface water



Analogous to surface water abstraction

- Included in surface water allocation
- Minimum flows apply



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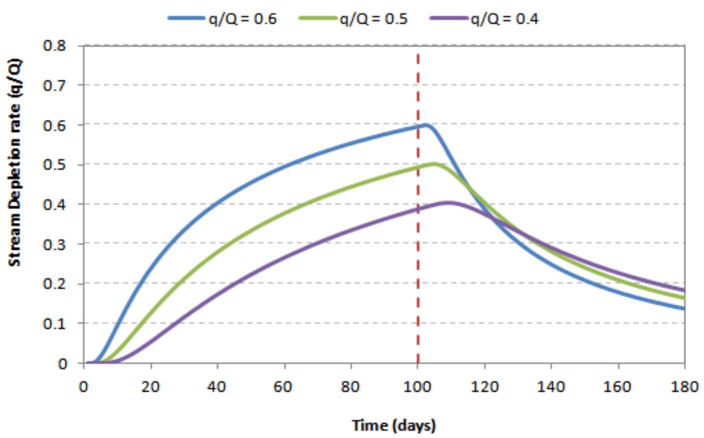
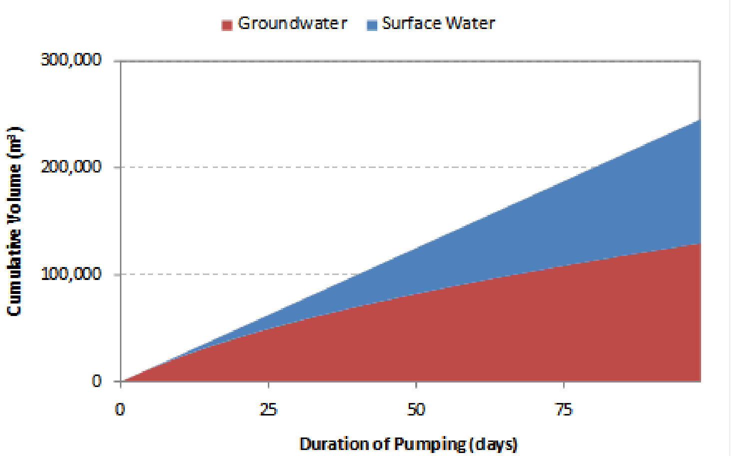
Category B

Areas where groundwater abstraction can have a significant impact on surface water but where minimum flow cut-offs may/may not provide mitigation during low flows





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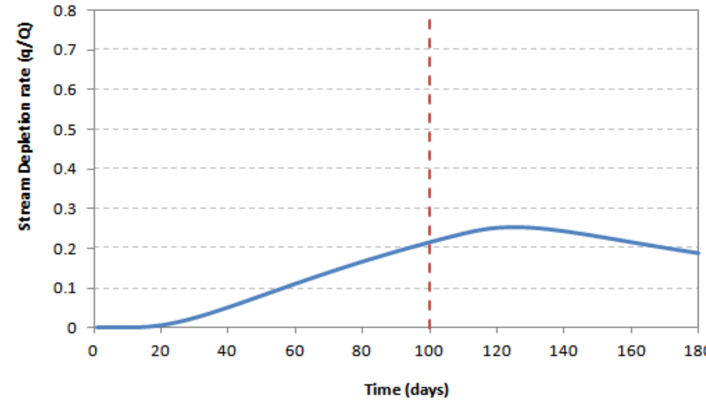
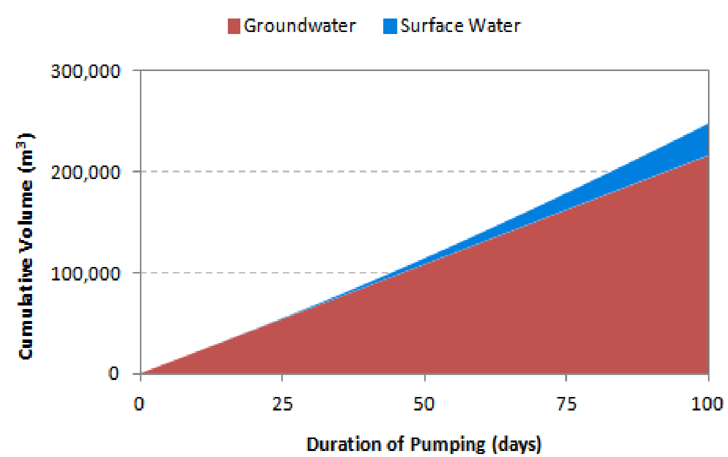
Category C

Areas where groundwater abstraction may contribute to a cumulative reduction in baseflow at a catchment scale but where minimum flow controls provide limited mitigation





Spatial Delineation of Hydraulic Connectivity Categories

Why map hydraulic connectivity categories?

- Certainty for users (potential water availability and management controls)
- Reduce requirements for hydrogeological assessment
- Simplify consent process
- Retain flexibility for boundaries to be reclassified

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Spatial Delineation of Hydraulic Connectivity Categories

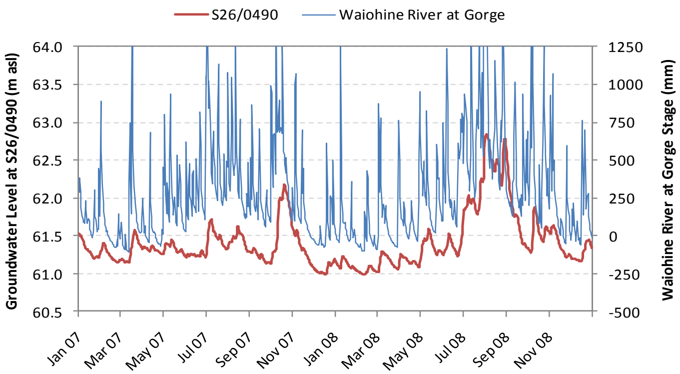
Hydraulic connectivity categories delineated (spatially and with regard to depth) on the basis of:

- Geology and associated hydraulic properties
- Observations of temporal groundwater level variations
- Observed flow gains/losses
- Occurrence of springs and spring-fed streams
- Groundwater quality and hydrochemistry
- Verified using groundwater modelling

Approach utilised detailed in Hughes and Gyopari (2011)

Spatial Delineation of Hydraulic Connectivity Categories

Physical Observations



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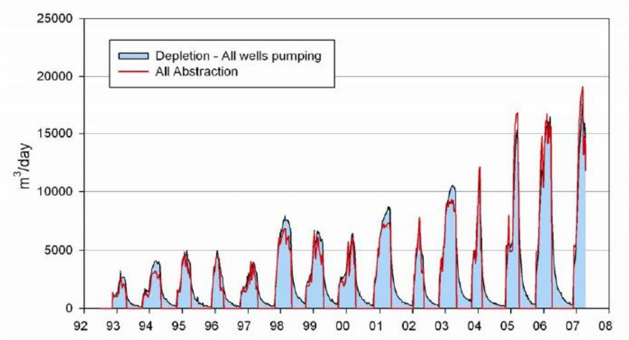
Groundwater Modelling



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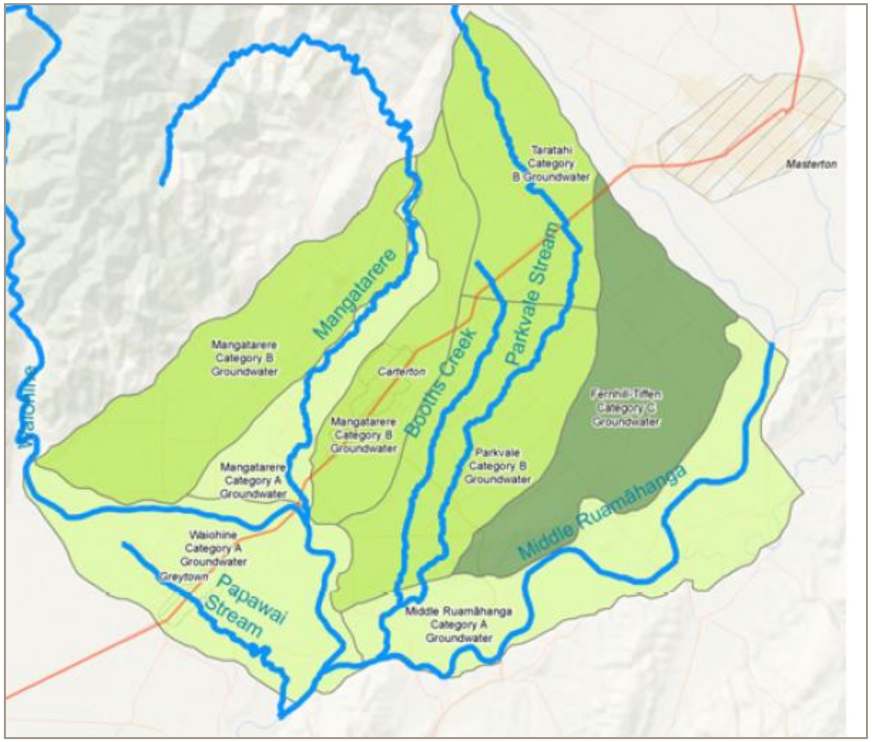
Hydraulic connectivity zone maps



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Hydraulic Connectivity Classification (Category A)

<u>Category A</u>

Significant and direct effect on surface water

- Included in surface water allocation (based on weekly average pumping rate)
- Subject to minimum flow cut-offs (cease take v 50% reduction)
- Opportunity to reclassify hydraulic connection if supported by hydrogeological assessment

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Hydraulic Connectivity Classification (Category B)

Category B

Represents ‘transition’ areas where nature and magnitude of stream depletion is influenced by local factors

Assessment criteria defined to establish if an individual take is better managed in terms of:

- localised surface water effects (Category B high connection) or
- catchment-scale (cumulative) groundwater allocation

Minimum rate of take 5 L/s (takes <5 L/s default to Category C)

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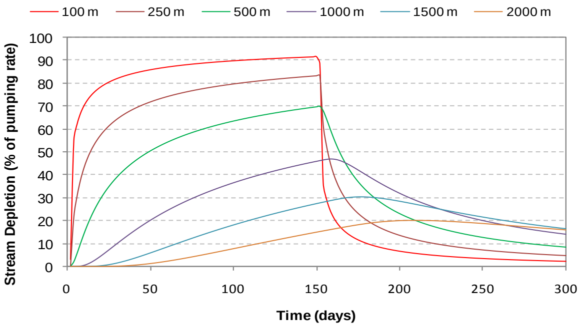
Hydraulic Connectivity Classification (Category B)

- Stream depletion ratio >0.6 used to differentiate Category B (high connection) from Category B (moderate connection).

	Time since pumping stopped			
q/Q	**10 Days**	**20 days**	**30 days**	**40 days**
0.8	54%	71%	79%	83%
0.7	31%	53%	64%	71%
0.6	13%	34%	48%	57%
0.5	2%	18%	32%	43%
0.4	-4%	2%	13%	24%



- Calculated stream depletion component of Category B (high connection) takes included in surface water allocation and take may be subject to minimum flow cut-off
- Category B (moderate connection) takes managed in terms of groundwater allocation (no minimum flow)

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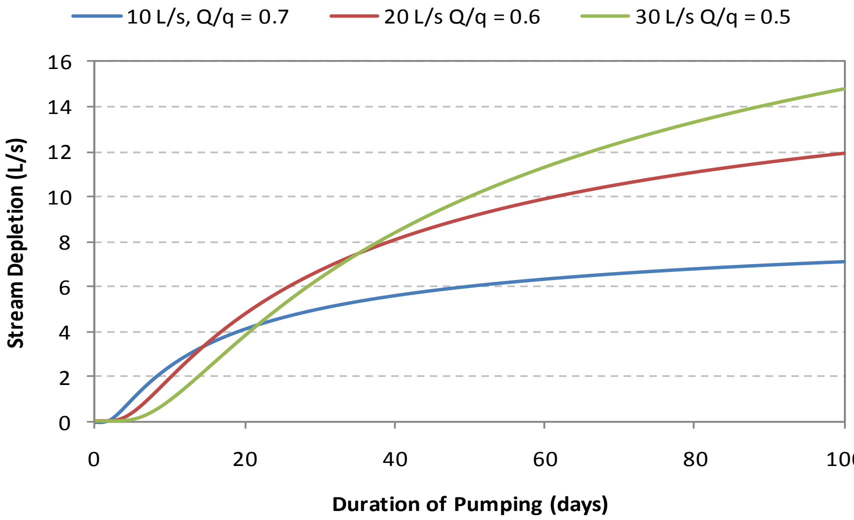
Hydraulic Connectivity Classification (Category B)

Takes with a calculated effect >10 L/s default to Category B (high connection) even if stream depletion ratio <0.6.

- Ensures takes with a large effect included in surface water allocation
- Does not descriminate on the basis of stream size



Hydraulic Connectivity Classification (Category B)

The assumed pumping rate and duration of pumping significantly influence the calculated rate of stream depletion. Proposed assessment based on:

- Average pumping rate occurring over the 90 day period of maximum demand occurring 1 in 10 years (90% reliability)
- Representative of ‘reasonable’ maximum irrigation demand in the Wairarapa Valley
- Applicable to other water uses as well

Hydraulic Connectivity Classification (Category C)

Category C groundwater takes:

- Managed in terms of total groundwater allocation (which takes into account cumulative effects on baseflow at a catchment scale)
- Not subject to minimum flow cut-offs

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Spatial Resolution of Mapping

Application of regional-scale mapping at a local-scale, particularly in complex geological environments, always involves uncertainty. Such uncertainty is addressed by proposed framework in two ways:

- The Category B classification identifes areas where there is uncertainty regarding the potential magnitude and nature of stream depletion effects
- Schedule P / Table 4.1 provides opportunity for reclassification of takes in Category A and Category C areas based on a specified set of criteria

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Summary

"Any abstraction from an aquifer has an effect that eventually propagates throughout the whole aquifer. This effect may be a lowering of piezometric levels or induced additional recharge from a river.

The effect from any one well may be infinitesimal in terms of practical measurement, but the cumulative long-term effects of many wells can be very significant.

The result is that every user of groundwater from an aquifer is a contributor to environmental effects such as reduction of low flows in streams or salt water intrusion which are determined by natural outflow to surface waters at the whole-aquifer scale."

Dr Vince Bidwell, 2003

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