CRC for Water Sensitive Cities

Australian Government
Department of Industry, Innovation and Science

Business Cooperative Research Centres Programme

Integrated Research Project 5 – Knowledge based water sensitive solutions for development in high groundwater environments

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22 March 2019

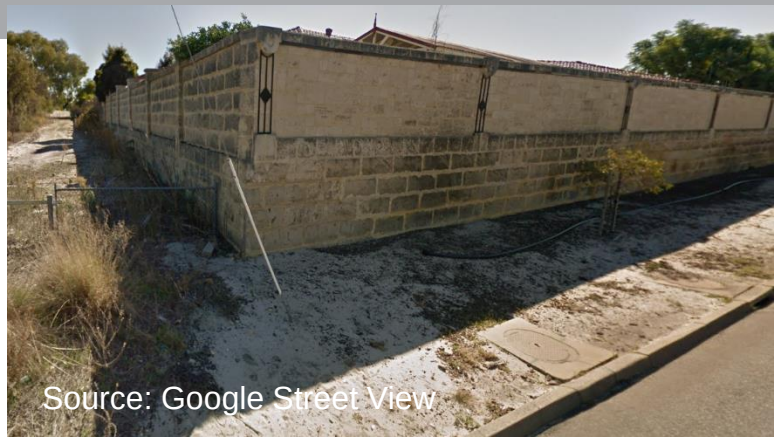
watersensitivecities.org.au

GHD

THE UNIVERSITY OF WESTERN AUSTRALIA

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Defining the problem


Source: Google Street View

- Whilst “fill-and-drain” has generally served us well in areas of high groundwater, it is creating problems with:
  - Affordability – cost of sand fill and retaining walls
  - Environment – land clearing at source and destination of sand, sustainability and embodied energy, changes to water and nutrient cycle

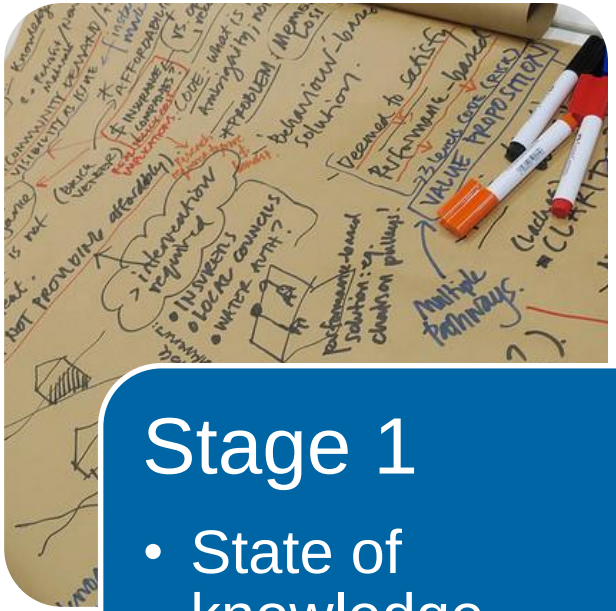

Source: Google Street View

Defining the problem

The CRC for Water Sensitive Cities approached IRP5 with the following questions (amongst others) for high groundwater environments:

- How do we challenge business-as-usual?
- How do we reduce uncertainties embedded/ implicit in urban water models?
- What is the optimal performance, design and management of WSUD in these areas?
- How can we make better use of MAR and groundwater harvesting in these areas?
- What are the social, economic and environmental values that can be achieved by more effective water management in high groundwater environments?

Staged approach



Stage 1

- State of knowledge

Stage 2

- Implementation and evaluation through research activities supported by the Brabham project

State of Knowledge report

- Project Steering Committee:
  - Local and interstate mix of regulators, consultants, developers, asset owners, and researchers

- Stage 1 Project Objectives:
  1. Collate and critically evaluate current state of knowledge (interviews and literature)
  2. Identify contested or unknown design and implementation parameters and methodologies

About the Team

- Key authors:
  - Carlos Ocampo (UWA): Water balance/ Water quality
  - Kelsey Hunt (GHD): Water quality
  - Nick Deeks (GHD): Lead author/ Surface water
  - Anastasia Boronina (GHD): Groundwater

- Editors:
  - Tony McAlister (Water Technology)
  - Andrew Telfer (Water Technology)

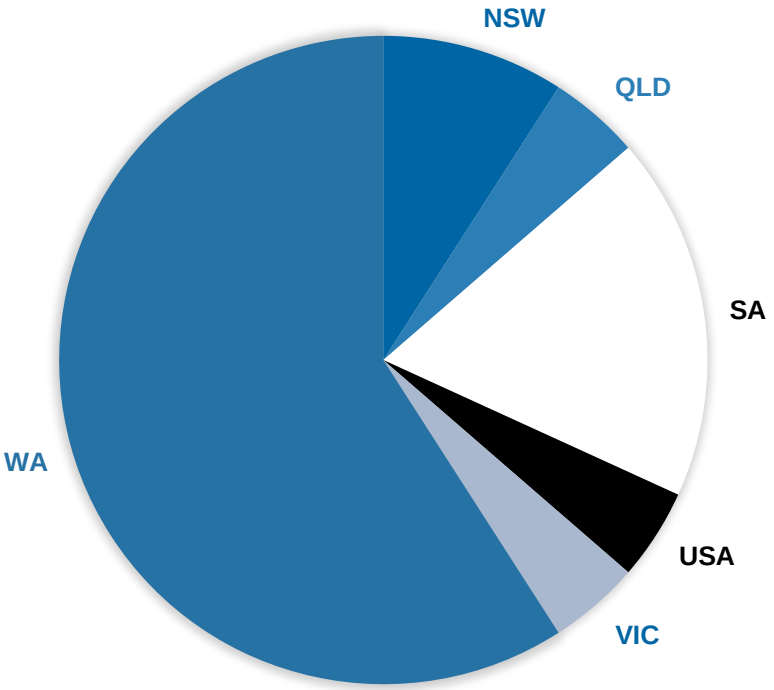
Literature review

- 167 Citations from state, national and international publications, books, journals, reports, and conference proceedings

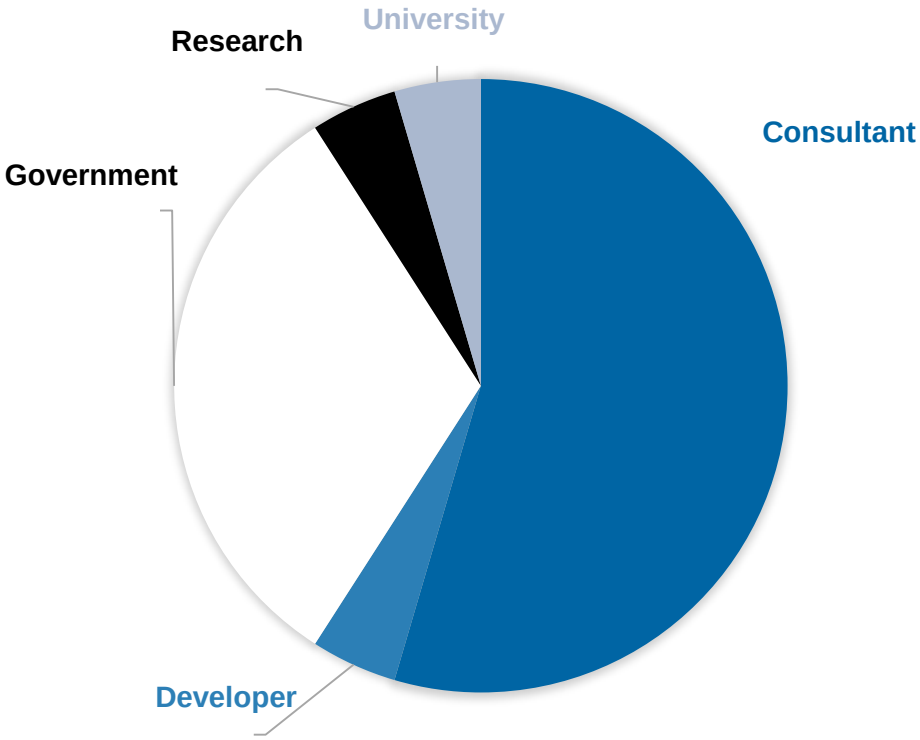
Information Sources

22 expert interviews:

INTERVIEWEE BY LOCATION



INTERVIEWEE BY ASSOCIATION



Report Outline

	Pre-development	Development impacts on water resources and environment	Impacts of high groundwater on infrastructure	Impacts of high groundwater on liveability
Water Balance				
Water quality				
Management measures	N/A			

State of Knowledge:

Evidenced
Agreed
Contested
Unknown

- 98 findings

Pre-development water balance

Evidenced

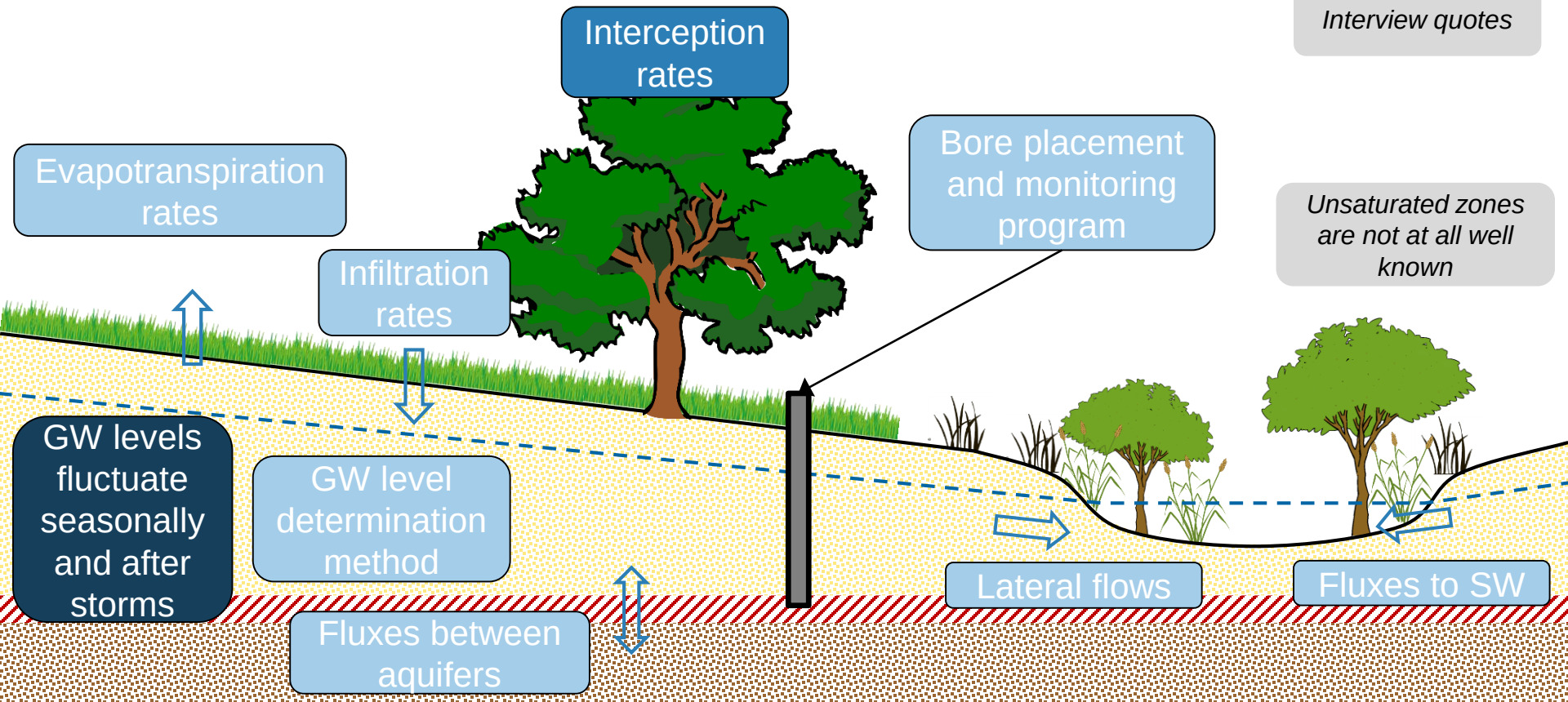
Agreed

Contested

Unknown

Interview quotes

Rainfall intensity, duration, temporal patterns



Pre-development water quality

Evidenced

Agreed

Contested

Unknown

Interview quotes

Elevated pre-development nutrients frequently dominated by organic nitrogen

Detailed site investigations completed for site works where risk of acid sulfate soils is high

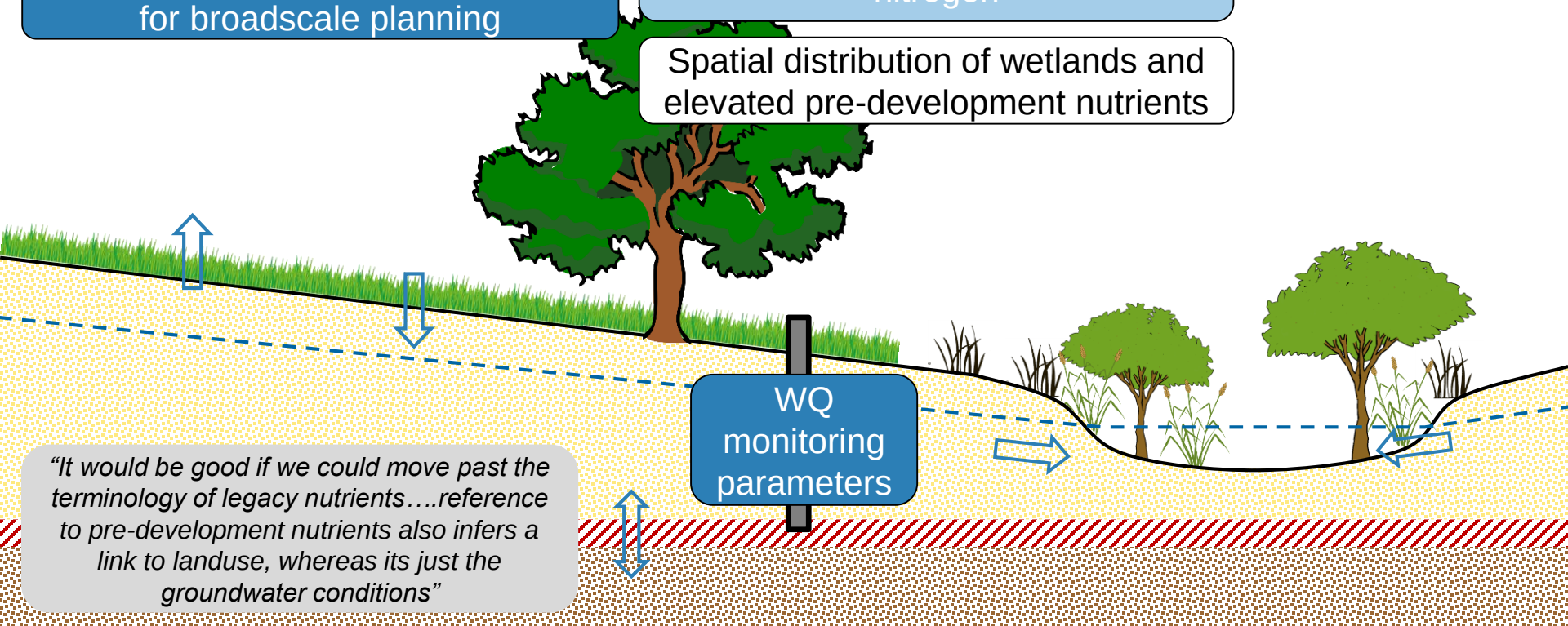
High groundwater areas (< 3 m) of Swan Coastal Plain have high risk of acid sulfate soils

Source of elevated pre-development nutrients

Acid sulfate soil risk mapping used for broadscale planning

Lab method for dissolved organic nitrogen

Spatial distribution of wetlands and elevated pre-development nutrients



"It would be good if we could move past the terminology of legacy nutrients….reference to pre-development nutrients also infers a link to landuse, whereas its just the groundwater conditions"

Development impacts on water resources and environment

Urbanisation alters vegetation cover, soils and ground cover

Potable water leakage adds to GW balance

Post-development GW levels fluctuate both seasonally and due to storms

Impervious surface impacts on water balance in low GW environments

Potable water used for irrigation adds to GW balance

Concentrated infiltration causes local increases in GW level

MAR adds water to the target aquifer water balance

Urban development impacts water quality

Urban development has high nutrient load compared to low intensity agriculture

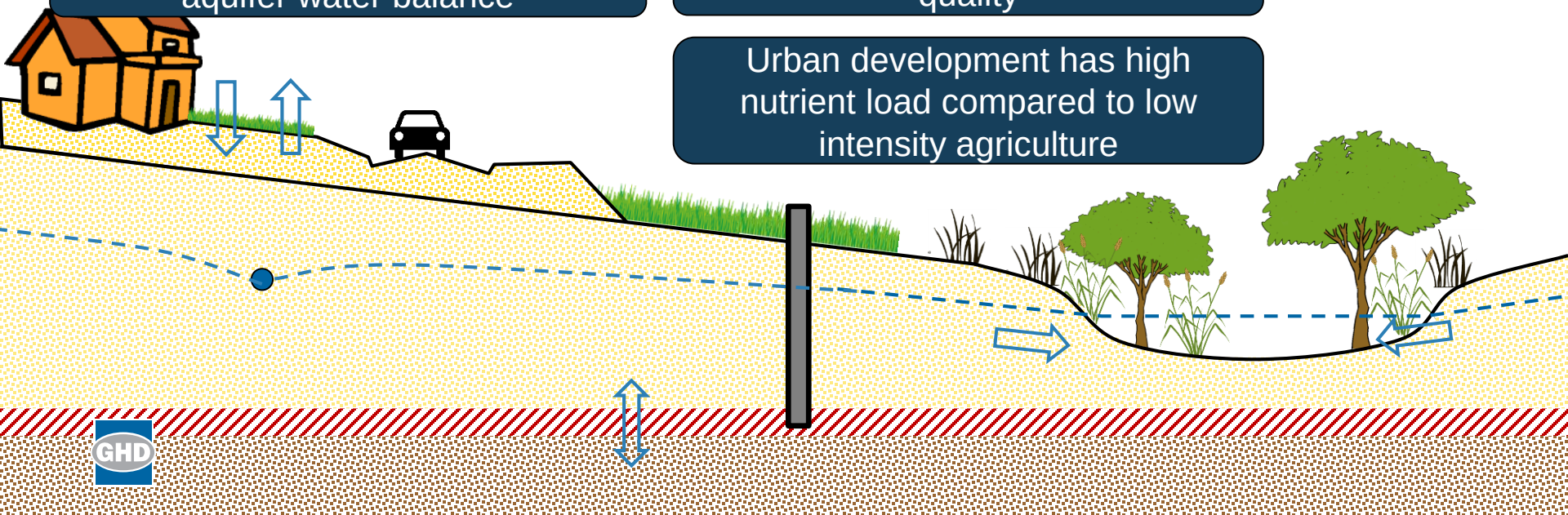
Evidenced

Agreed

Contested

Unknown

Interview quotes



Development impacts on water resources and environment

Fertiliser is key nitrogen input in sewered urban development

Urban development may disturb acid sulfate soils

Acid sulfate soils impact receiving ecosystems

Source control most effective management measure

WSUD element design targets pollutants in surface water

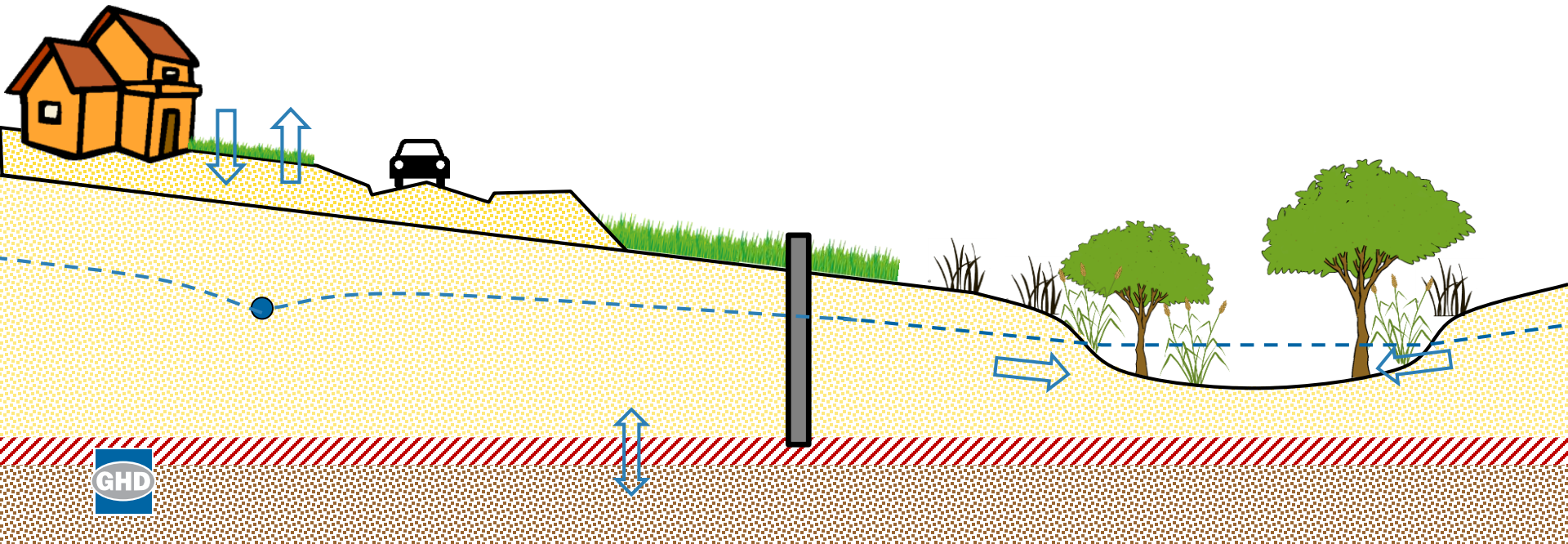
Evidenced

Agreed

Contested

Unknown

Interview quotes



Development impacts on water resources and environment

Post-development groundwater levels with groundwater controls

Granular fill increases infiltration potential

Groundwater controls remove water from groundwater balance

Impacts to groundwater levels, flows and quality

Groundwater controls reduce groundwater residence time and potential for nutrient attenuation

Change in water balance impacts WDE water regime

Shallow groundwater short-circuits nutrient pathway between source and receiving water resource

Elevated pre-development nutrients common where pre-development land use is rural or semi-rural

Gravity sewer systems remove water from groundwater balance in high groundwater environments

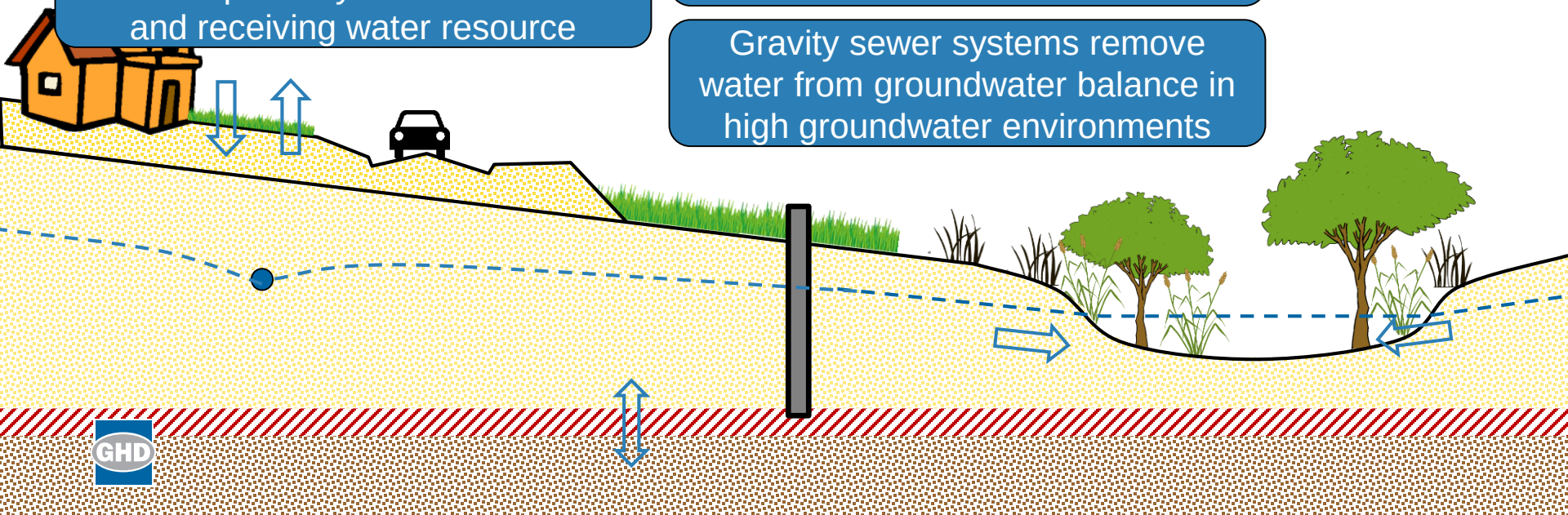
Evidenced

Agreed

Contested

Unknown

Interview quotes



Development impacts on water resources and environment

Underground structures may expose acid sulfate soils

Areas of Swan Coastal Plain with high groundwater (< 3 m) have high risk of acid sulfate soils

Organic nutrient forms difficult to treat using unlined bioretention WSUD elements

Local government preferences impact WSUD element design

Smaller lot sizes reduce nutrient input

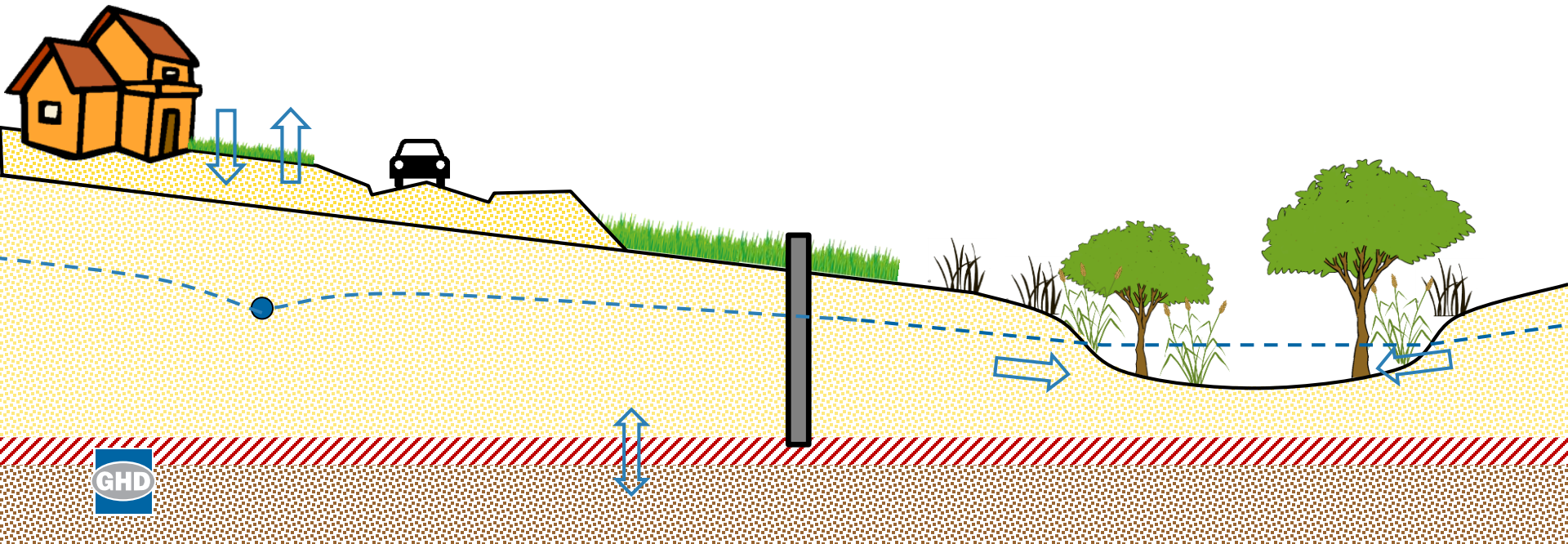
Evidenced

Agreed

Contested

Unknown

Interview quotes



Development impacts on water resources and environment

Evidenced

Agreed

Contested

Unknown

Interview quotes

Infiltration device infiltration rates

Infiltration device blockage rates

Rainwater tank water balance impacts

Initial & continuing losses

ET Rates

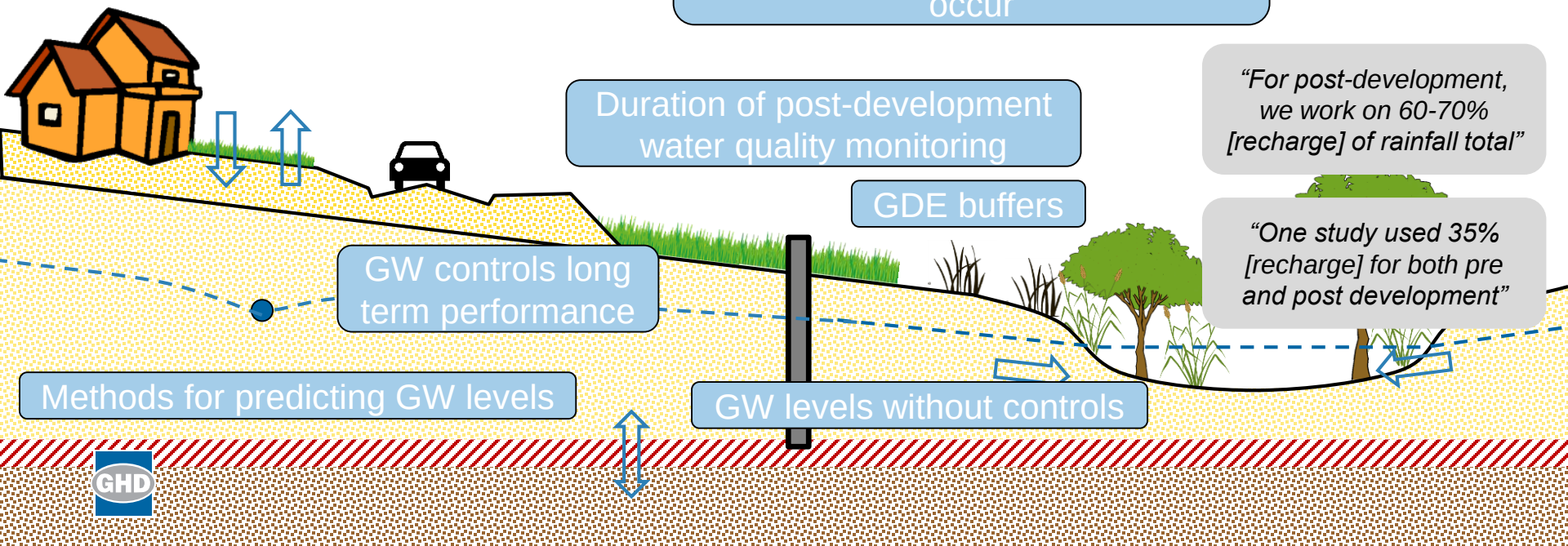
Runoff coefficients

Recharge rates

Discharge rates from groundwater controls for different soil types, lot sizes, etc.

Groundwater controls at pre-development MGL reduce interception of pollutants

Water quality targets where elevated pre-development nutrients occur



"For post-development, we work on 60-70% [recharge] of rainfall total"

"One study used 35% [recharge] for both pre and post development"

Development impacts on water resources and environment

- Methods for predicting post-development ET rates
- Impact of land form modification
- Rainwater tank impact on stormflow
- Level of risk of organic nutrient forms on receptors
- Nutrient retention effectiveness of living streams
- Infiltration device clogging potential and rates
- MAR backwash requirements
- Post-development water quality data
- Impact of WSUD elements on subsurface hydrology and nutrient cycling

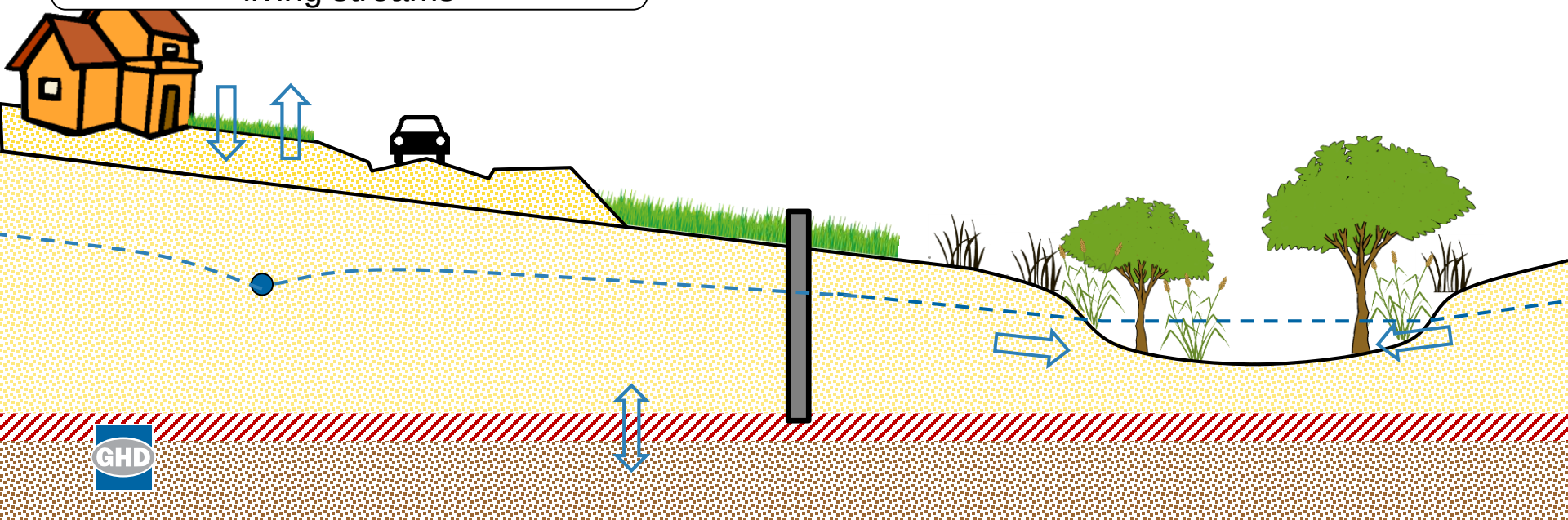
Evidenced

Agreed

Contested

Unknown

Interview quotes



Impacts of high groundwater on infrastructure

- High groundwater levels reduce structural bearing capacity and can weaken and damage pavements
- Acid sulfate soils and salinity impact on infrastructure
- Imported fill and groundwater controls are used to achieve multiple objectives
- Alternative building methods achieve BCA requirements
- High groundwater has negligible impact on most utilities in the long term
- High groundwater impacts utility construction methods
- High groundwater requires special measures for electrical substations
- High risk ASS sites require detailed site investigations to quantify risk from site works
- High groundwater can infiltrate into sewer systems

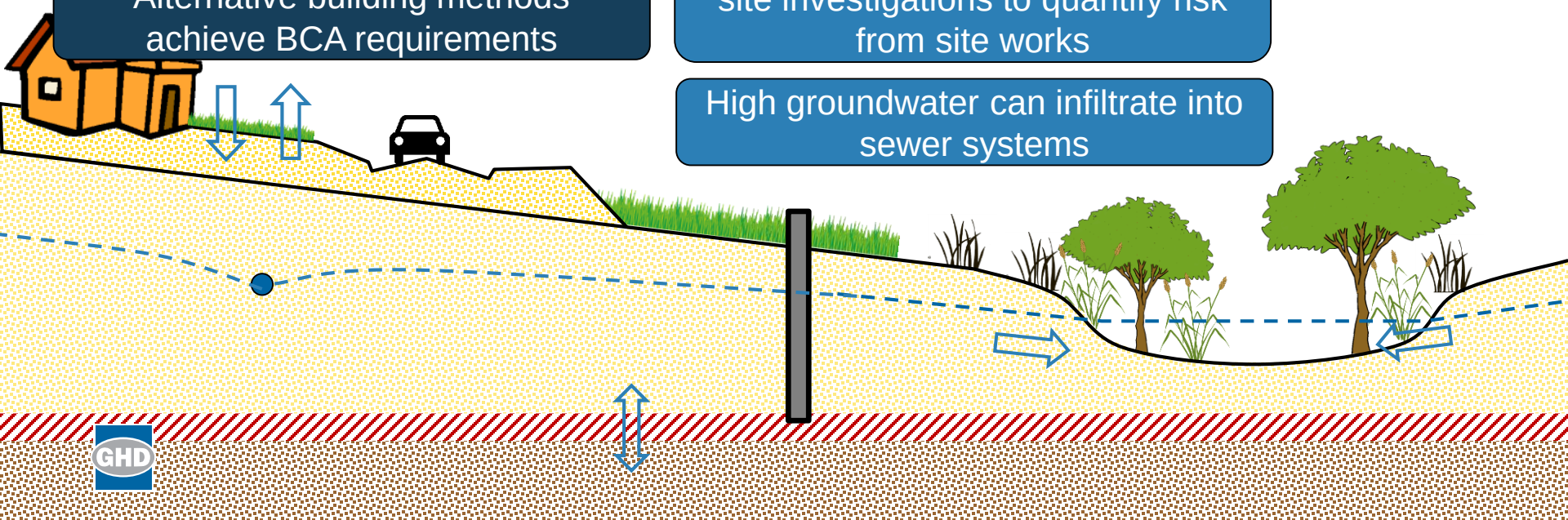
Evidenced

Agreed

Contested

Unknown

Interview quotes



Impacts of high groundwater on infrastructure

- Potential for urban salinity to develop where high salt concentrations in soil profile or groundwater
- Fill not an effective solution to salinity due to capillary action
- Salinity hazard managed through maintaining water balance
- Some groundwater has high NOx potential
- Planning measures for high groundwater and salinity hazard areas
- Trees as a groundwater management measure

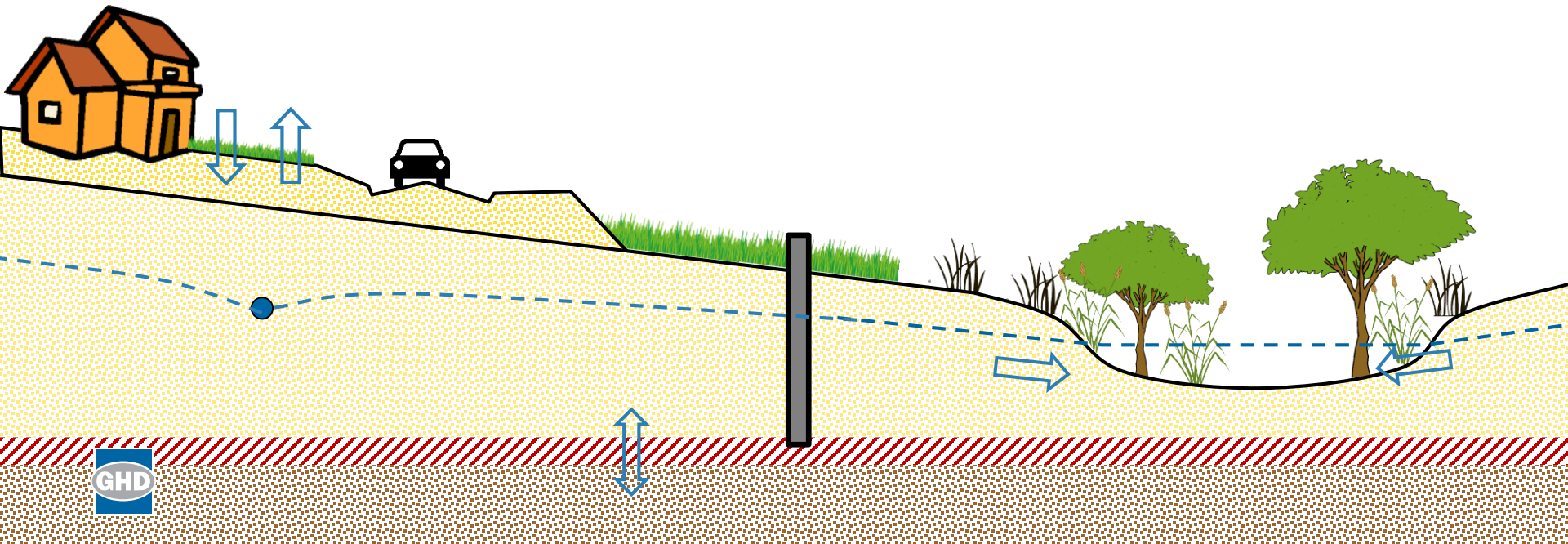
Evidenced

Agreed

Contested

Unknown

Interview quotes

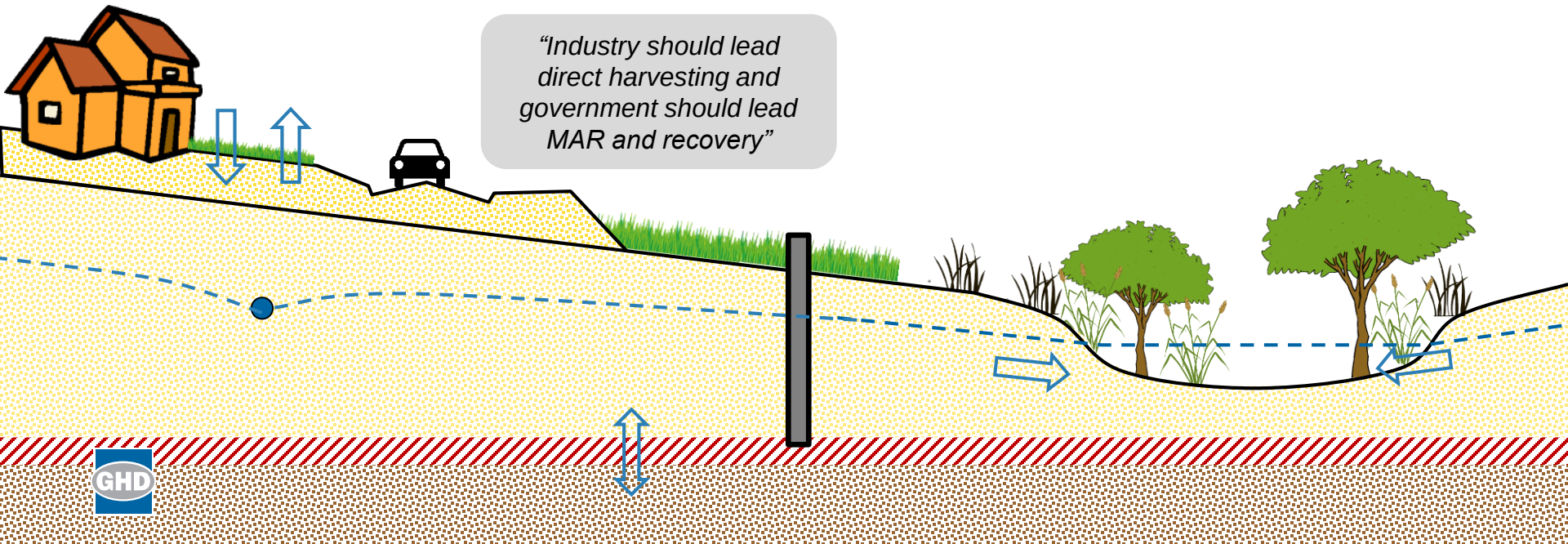


Impacts of high groundwater on liveability

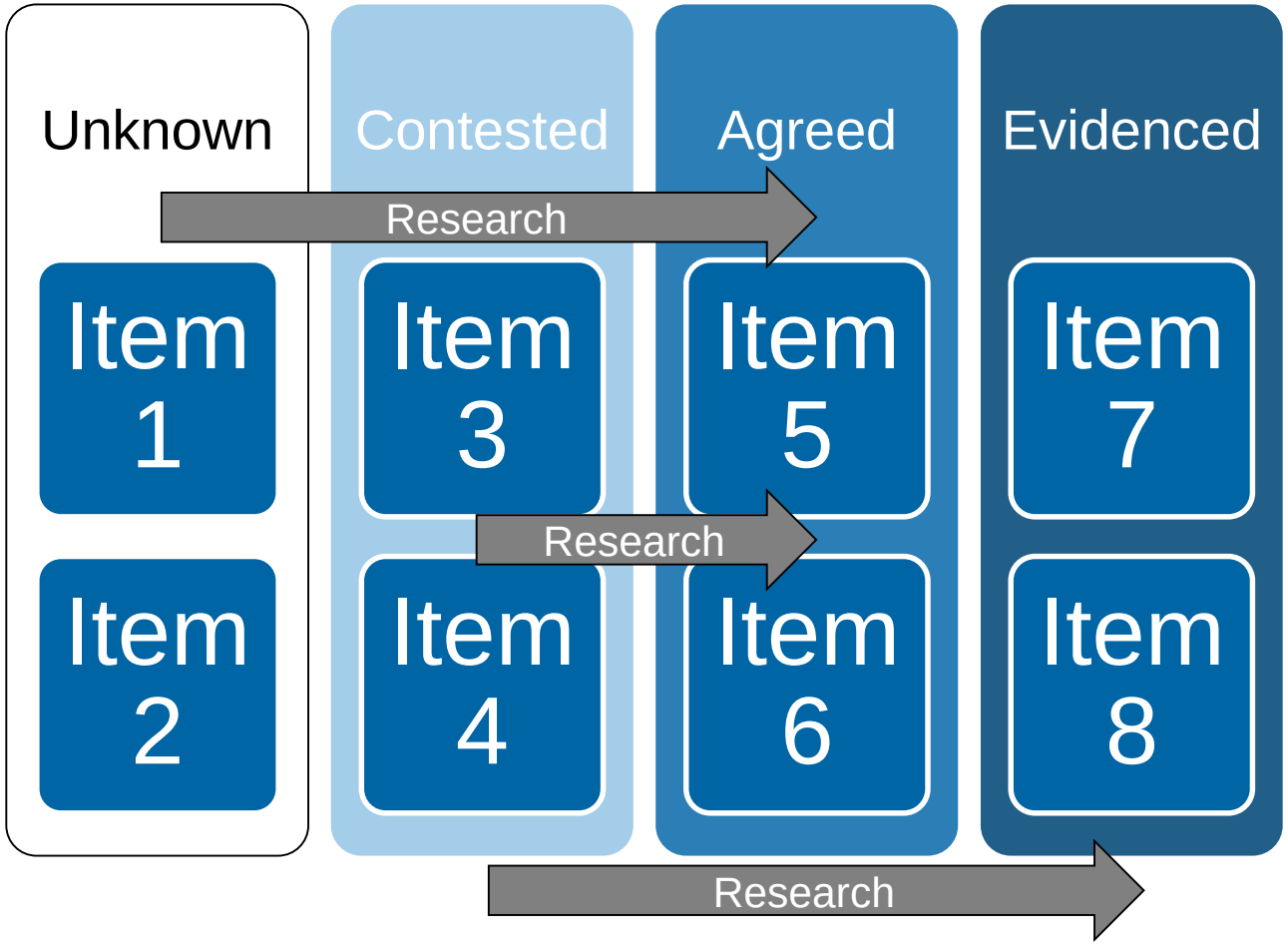
- Acidification of waterbodies increases mosquito breeding
- Eutrophication increases algal blooms and mosquito breeding
- Positive impact on liveability through change in land use
- MAR has positive impact on liveability
- ASS, nutrients and salinity associated with high groundwater have negative impacts on liveability
- High groundwater increases stormwater disposal impacts on liveability

Evidenced
Agreed
Contested
Unknown
Interview quotes

"Industry should lead direct harvesting and government should lead MAR and recovery"



Next steps


Unknown
Contested
Agreed
Evidenced
Research
Item 1
Item 3
Item 5
Item 7
Research
Item 2
Item 4
Item 6
Item 8
Research

Next steps

Pre- and post-development assumptions for modelling: infiltration rates and fluxes to aquifer, recharge rates, runoff rates, continuing losses, evapotranspiration rates, impact of trees and rainwater tanks

What is the difference in quality of groundwater and drainage between pre-development, construction and post development? What is the source of pre-development nutrients?

Post development performance of WSUD in high GW

Long term performance of MAR sources from subsoil drainage

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