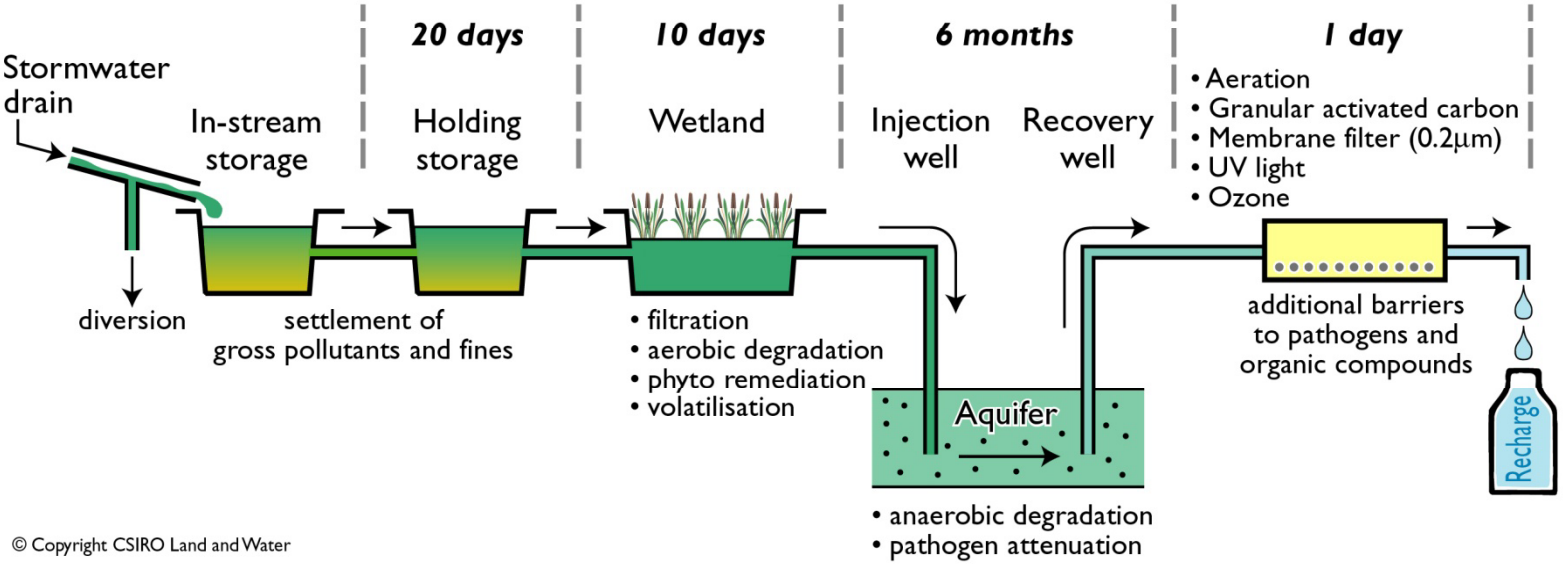

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帯水層のストレージ転送の回復 (ASTR)プロジェクト

Declan Page, Joanne Vanderzalm, Karen Barry, Kerry Levett, Sarah Kremer, Maria Neus Ayuso-Gabella, Peter Dillon, Simon Toze, Jatinder Sidhu, Mark Shackleton, Rudi Regel and Mark Purdie

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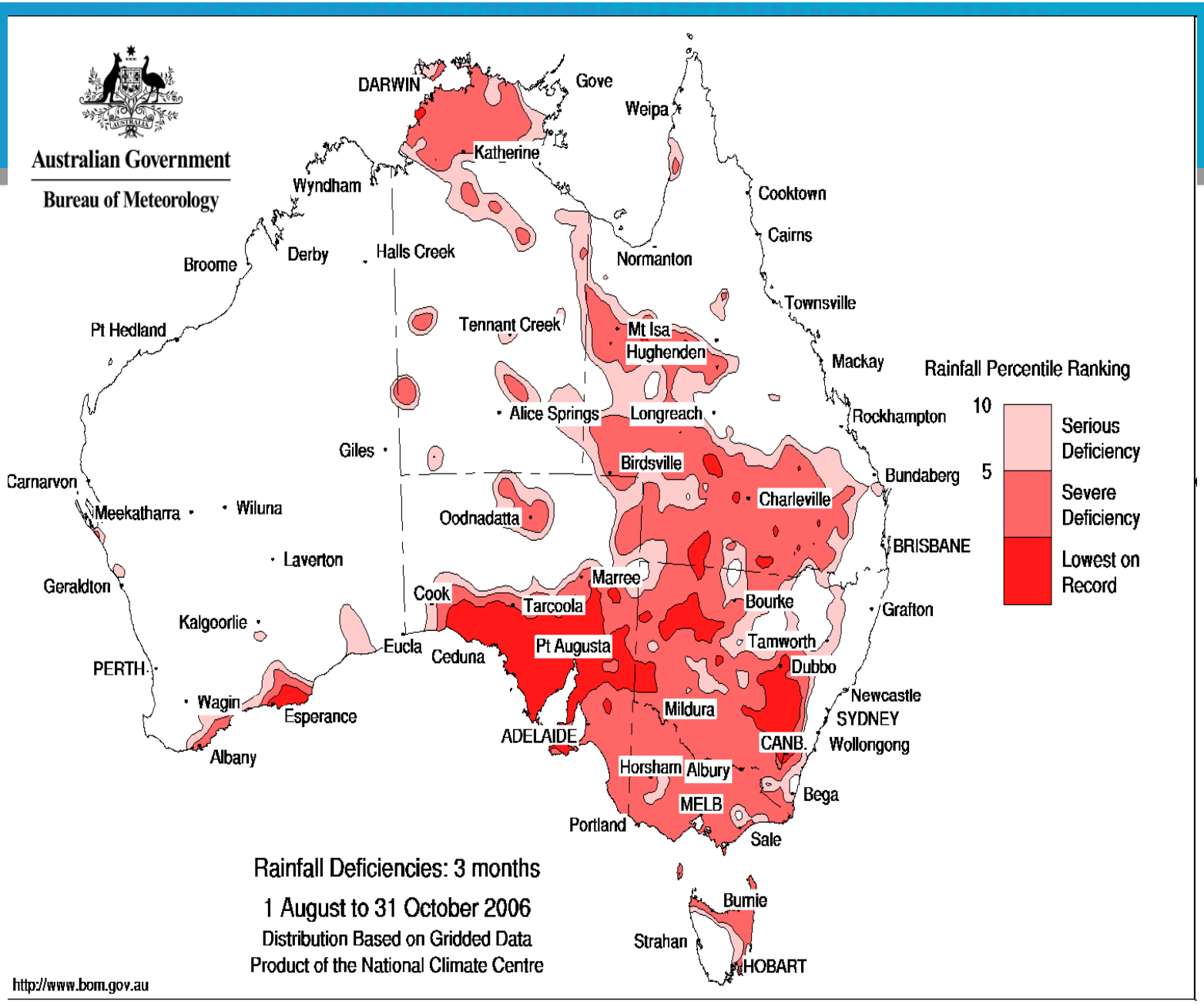
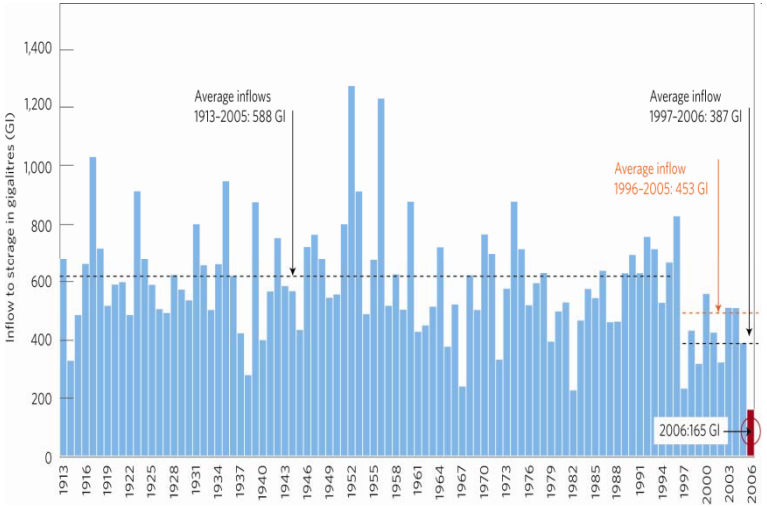
Outline (概要)

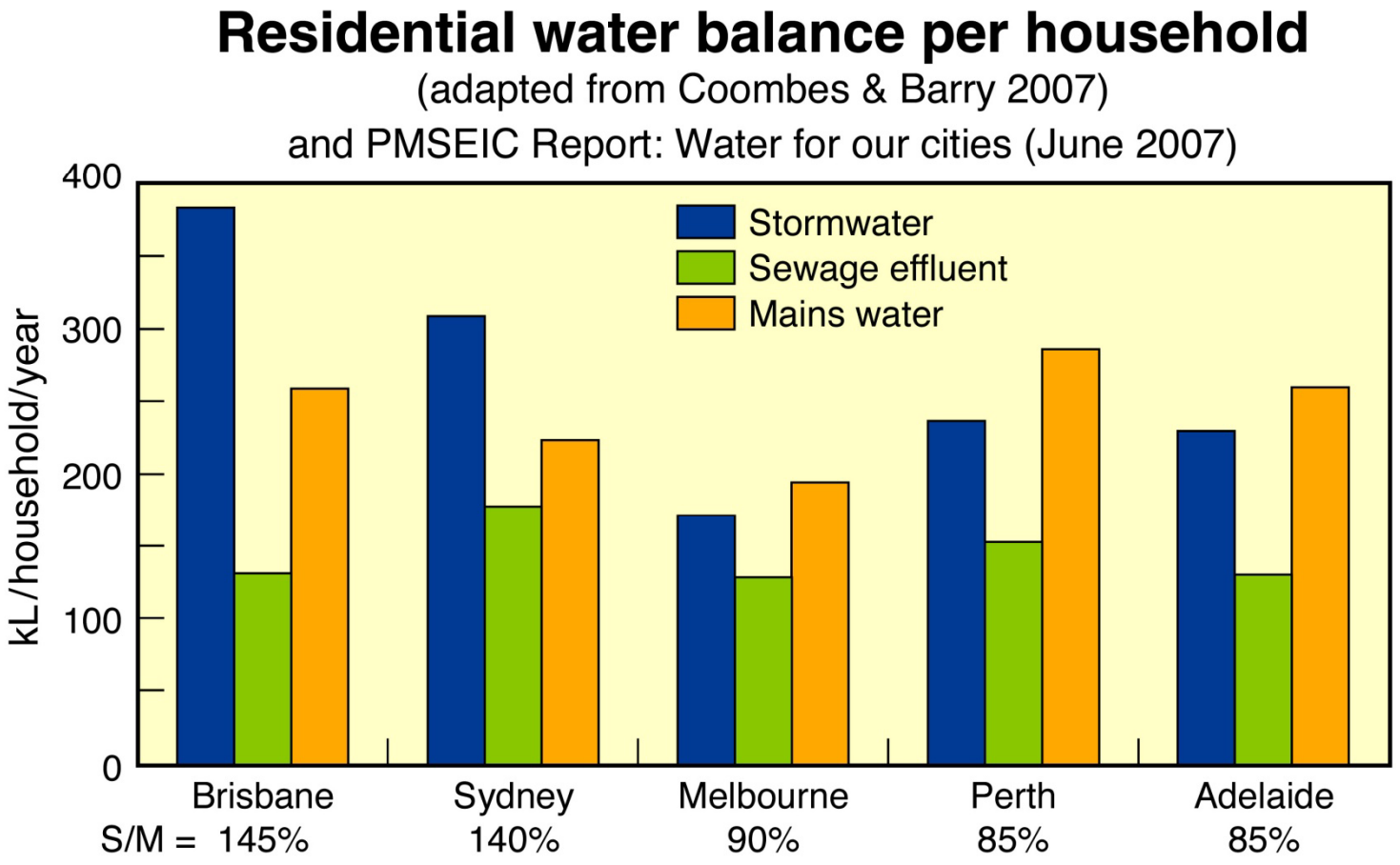
- Drought in Australia (干ばつのオーストラリア)
- Managed Aquifer Recharge in Australia (オーストラリアでの管理帯水層の涵養)
- Introduction to the Aquifer Storage Transfer Recovery project (帯水層ストレージ転送復旧プロジェクトの概要)
- The Australian MAR Guidelines Risk Assessment Stages (オーストラリア MAR Guidelinesリスク評価段階)
- ASTR Maximal Risk Assessment (最大のリスク評価)
- Pathogens (病原体)
- Inorganic chemicals (無機化学)
- Organic chemicals (有機化学)
- Turbidity and colour (濁度と色)
- Conclusions (結論)


Australian Government
Bureau of Meteorology
DARWIN
Gove
Weipa
Katherine
Wyndham
Cooktown
Cairns
Broome
Derby
Halls Creek
Normanton
Townsville
Pt Hedland
Tennant Creek
Mt Isa
Hughenden
Mackay
Rainfall Percentile Ranking
Alice Springs
Longreach
Rockhampton
10
Serious Deficiency
Giles
Birdsville
Bundaberg
5
Severe Deficiency
Carnarvon
Meekatharra
Wiluna
Oodnadatta
Charleville
Lowest on Record
BRISBANE
Laverton
Marree
Geraldton
Cook
Tarcoola
Bourke
Grafton
Kalgoorlie
Tamworth
Eucla
Ceduna
Pt Augusta
PERTH
Dubbo
Newcastle
Wagin
Mildura
SYDNEY
Esperance
ADELAIDE
CANB.
Wollongong
Albany
Horsham
Albury
Bega
MELB
Portland
Sale
Rainfall Deficiencies: 3 months
1 August to 31 October 2006
Distribution Based on Gridded Data
Product of the National Climate Centre
Burnie
Strahan
HOBART
http://www.bom.gov.au
© Commonwealth of Australia 2006, Australian Bureau of Meteorology
Issued: 02/11/2006

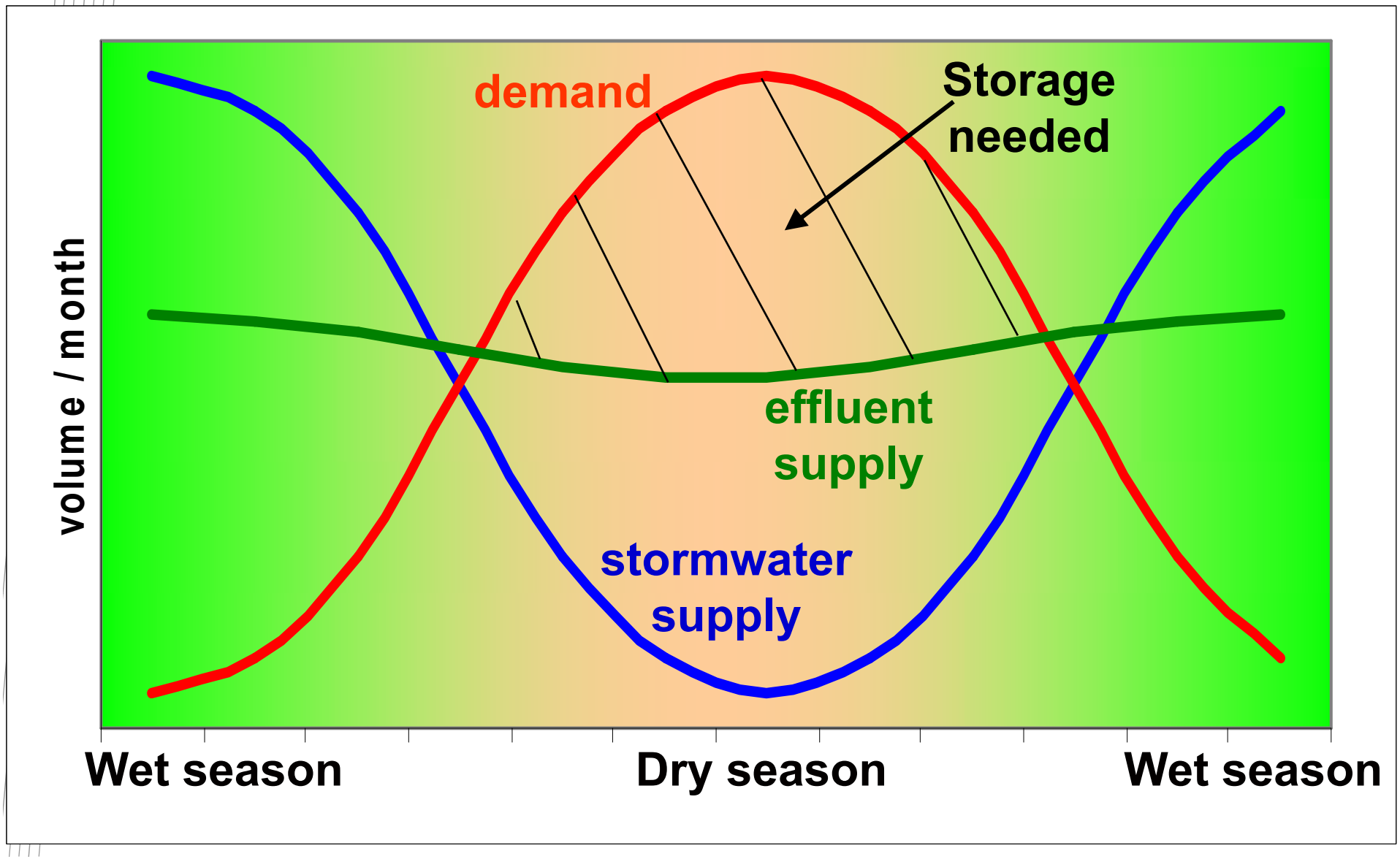
Drought across Australia (オーストラリア全土で干ばつ)



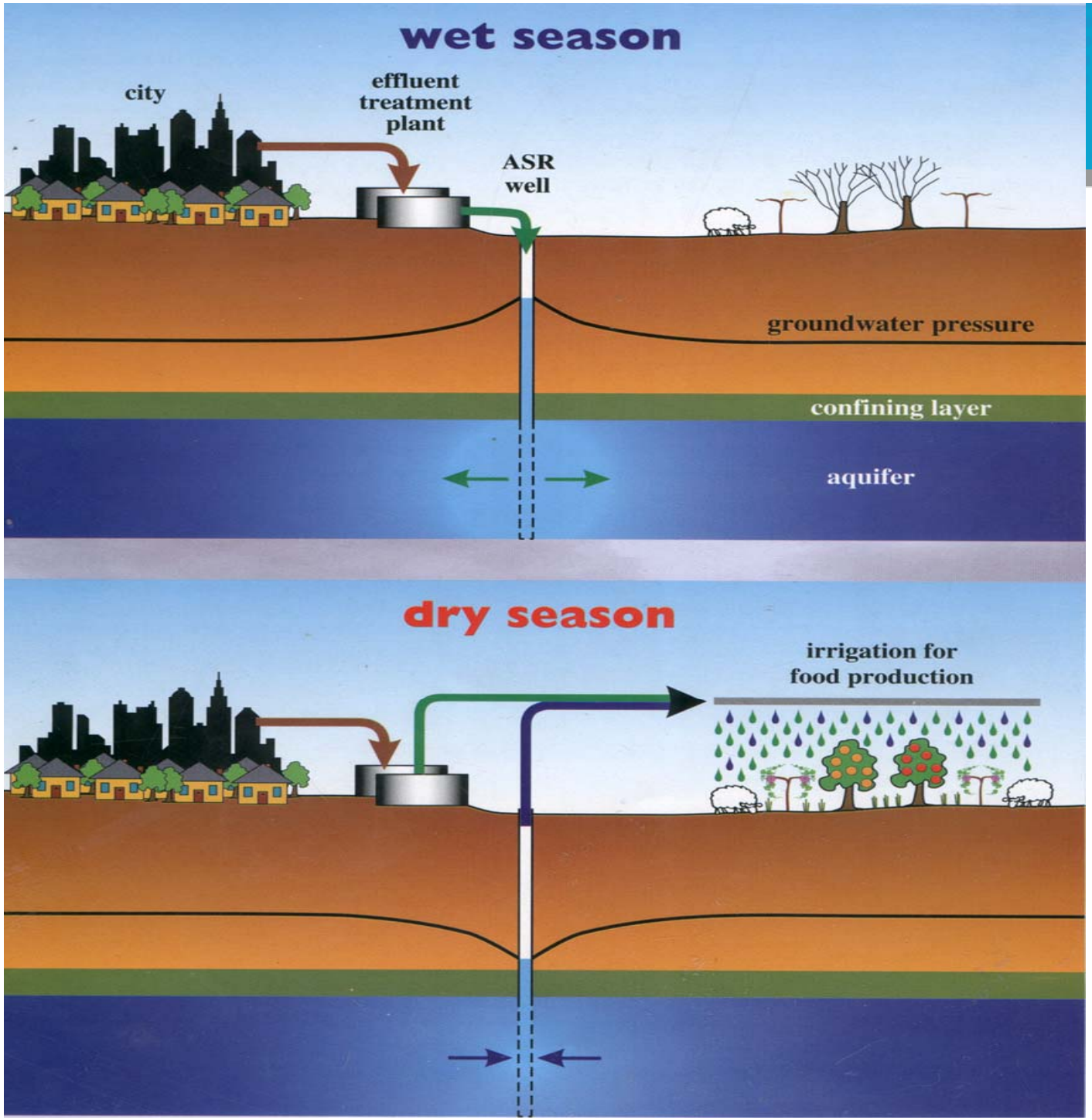
But most cities are net exporters of water (しかし、ほとんどの都市は、水の純輸出は、)



Storage is needed if demand exceeds supply at any time (需要はいつでも、電源を超える場合はストレージが必要です)



Where to store
(どこに保存する)…..?



WATER BANKING

(水銀行)

via

Aquifer Storage & Recovery (ASR)

(帯水層のストレージおよびリカバリ)

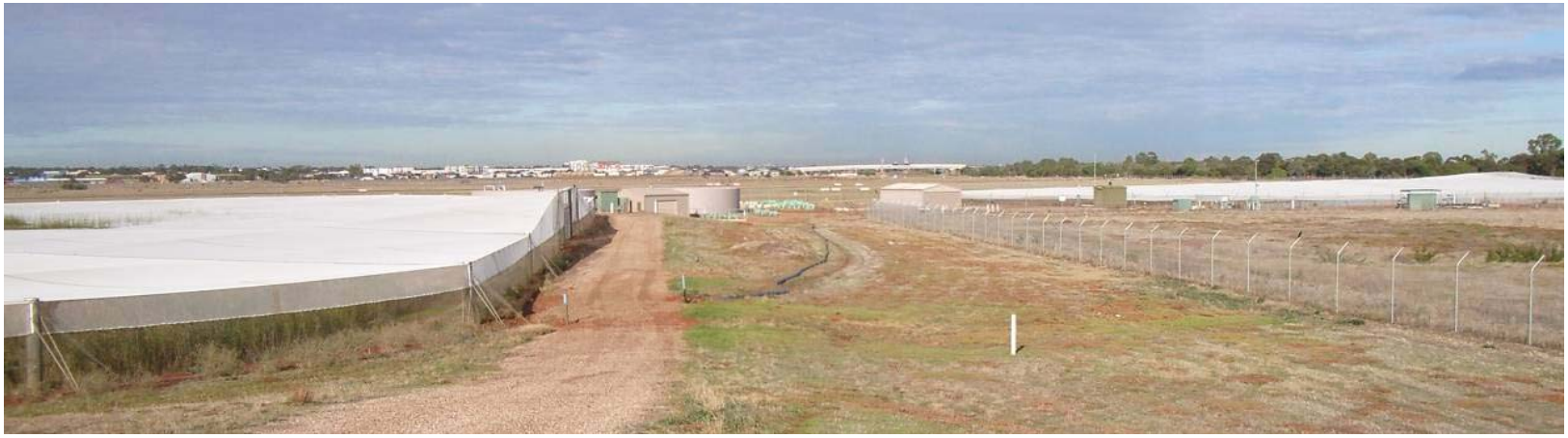
CSIRO

Introduction: The ASTR project

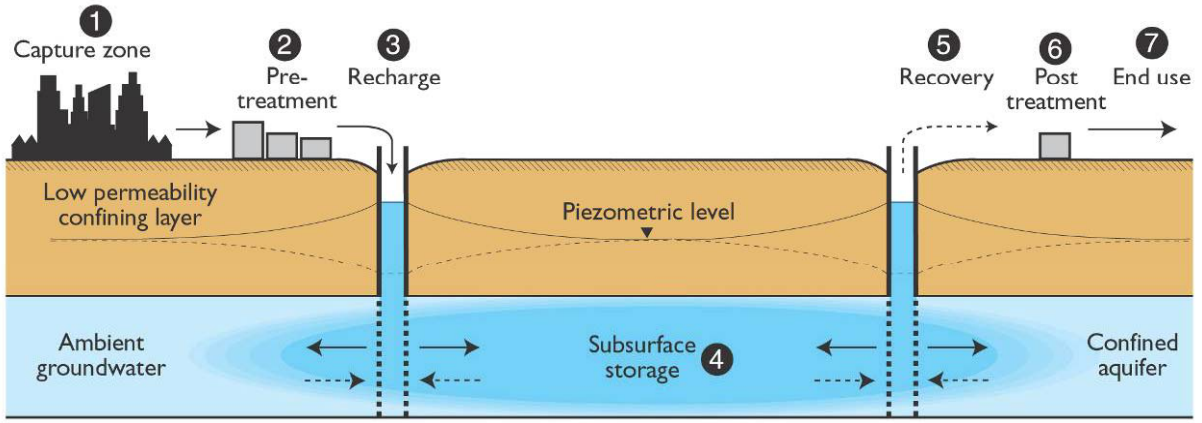
- **Research project (2005-2009): Can Urban stormwater (250 µS cm^{-1}) treated via Parafield Stormwater Recycling Scheme (settling basins and a constructed wetland) be injected into a brackish aquifer (3,600 µS cm^{-1}) & recovered at a potable quality? (研究プロジェクト（2005-2009）：できません都市雨水（250µ秒cm - 1の）Parafield雨水リサイクルスキーム（セトリング流域及び人工湿地）を介して処理汽水帯水層（3,600µ秒cm - 1の）＆飲料で回収に注入される品質？)**
- **Involves using separate injection & recovery wells to extend residence time & enhance passive treatment within the aquifer (別の注射＆リカバリ井戸を使用して関係は、滞留時間を延長すると帯水層内の受動的な治療を向上させる)**
- **Recovered water to be used for irrigation (回収水は灌漑に使用される)**

Recycled water system analysis – Harvesting facility (施設を収穫嵐水)

ASTR configuration (インフラストラクチャ)

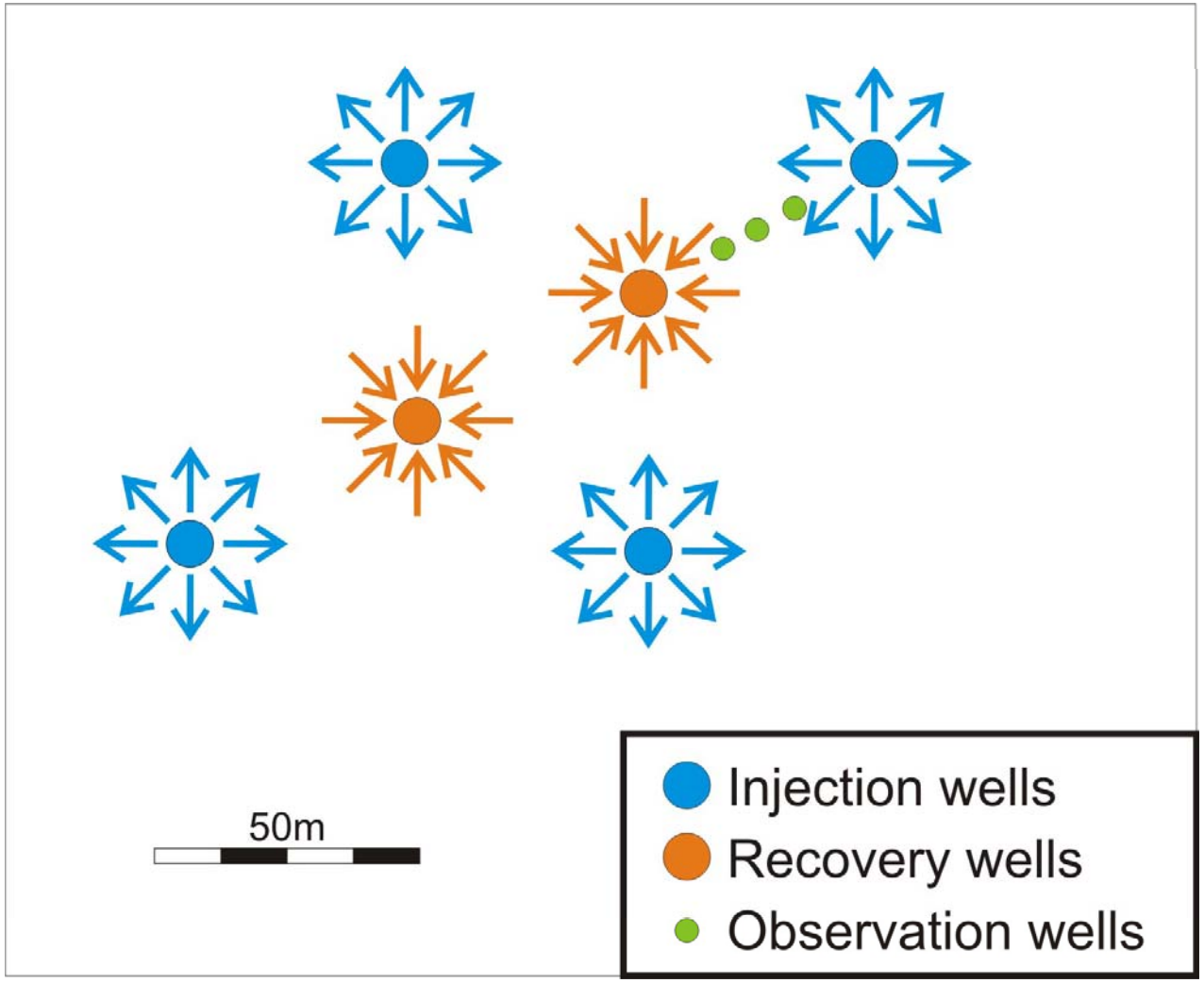


ASTR configuration (構成)

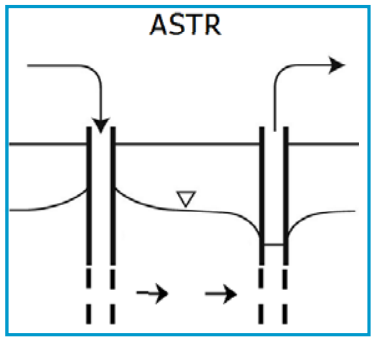


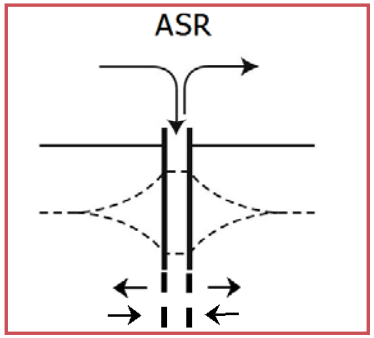
Component	ASTR system
1. Capture zone	Parafield stormwater harvesting system (Parafield drain, 47 ML in-stream basin, 48 ML holding storage)
2. Pre-treatment	Settlement in the in-stream basin and holding storage and passive treatment in the reedbed only.
3. Recharge	Four injection wells (IW1, IW2, IW3, IW4)
4. Subsurface storage	T2 aquifer – confined limestone Tertiary aquifer
5. Recovery	Two recovery wells (RW1, RW2)
6. Post-treatment	Currently none – post-treatment measures discussed include aeration, UV and chlorine disinfection
7. End use	Currently discharged to storage tanks, then distributed to end-users such as Mawson Lakes non-potable supply and municipal irrigation. Potential future use in drinking water supply is being evaluated.

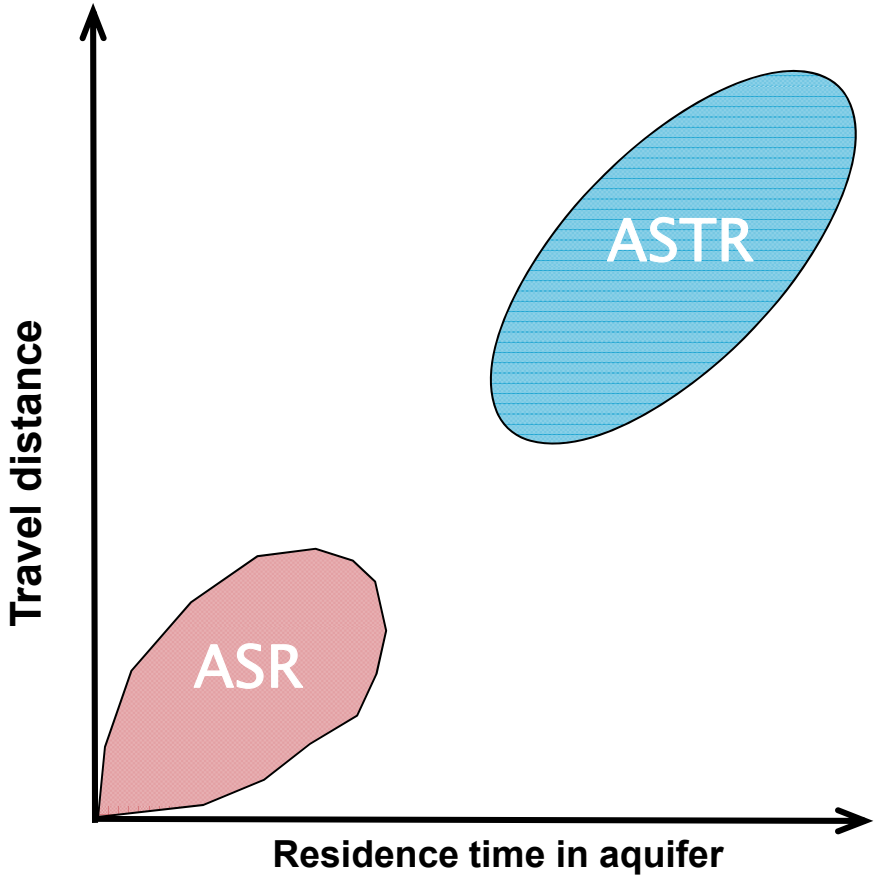
Well configuration (フィールドの設定を退屈させる) in Salisbury



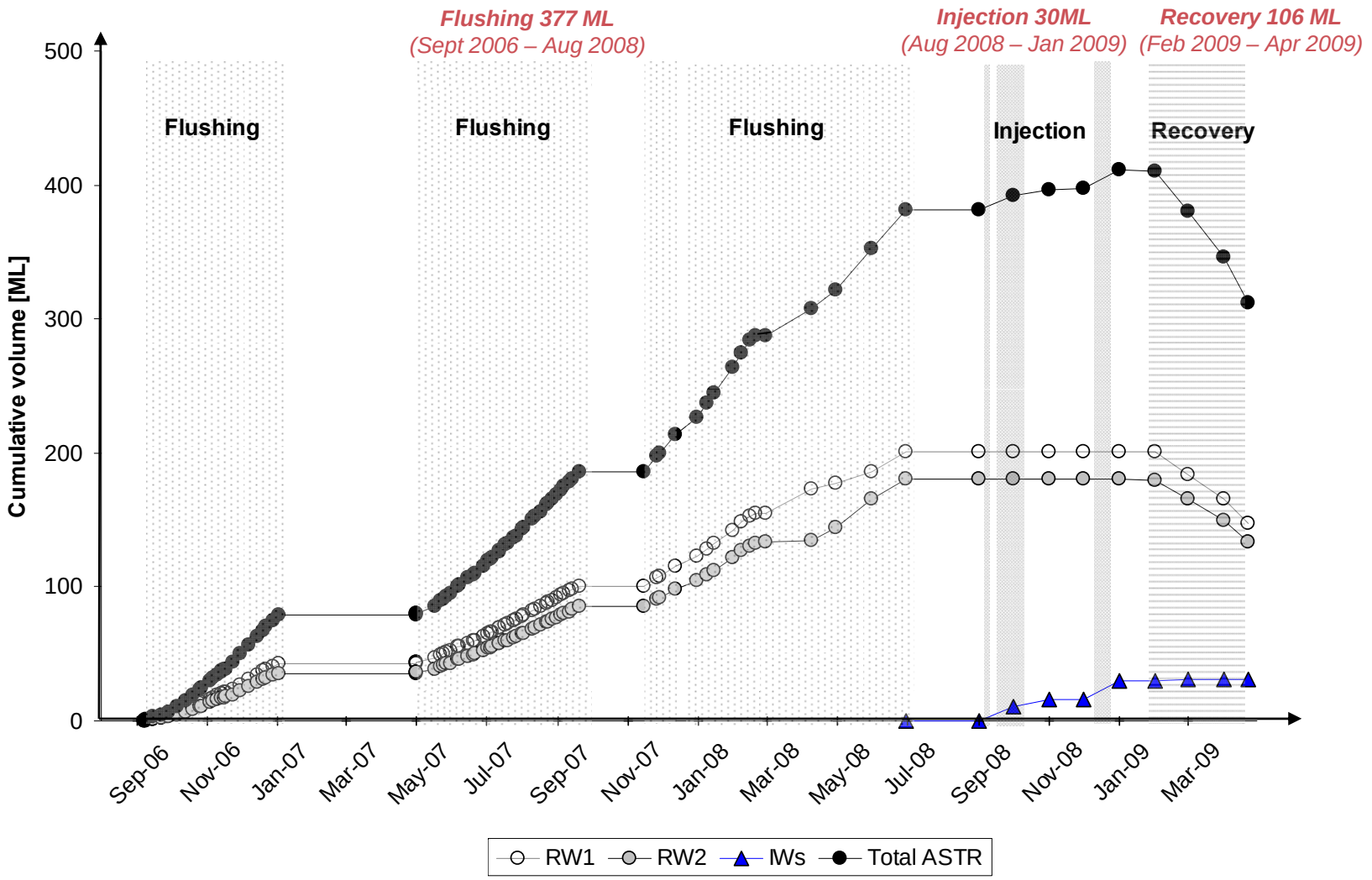
ASR versus ASTR





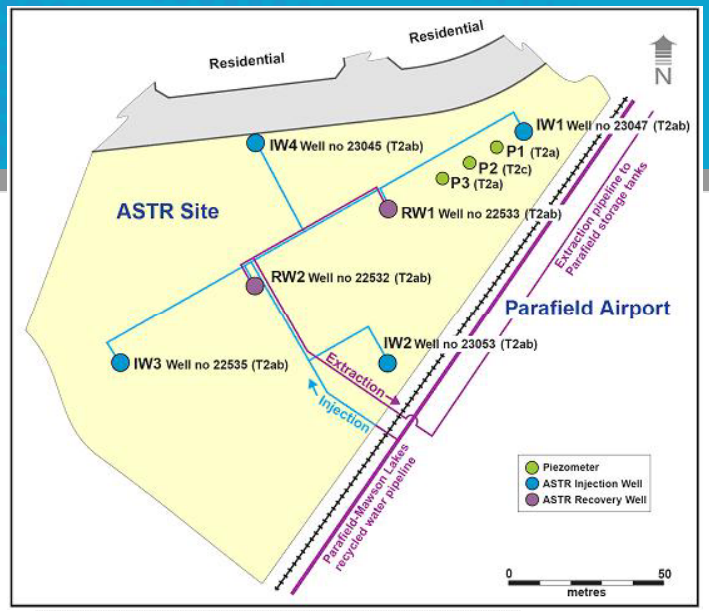


Operation of the site (サイト運営)

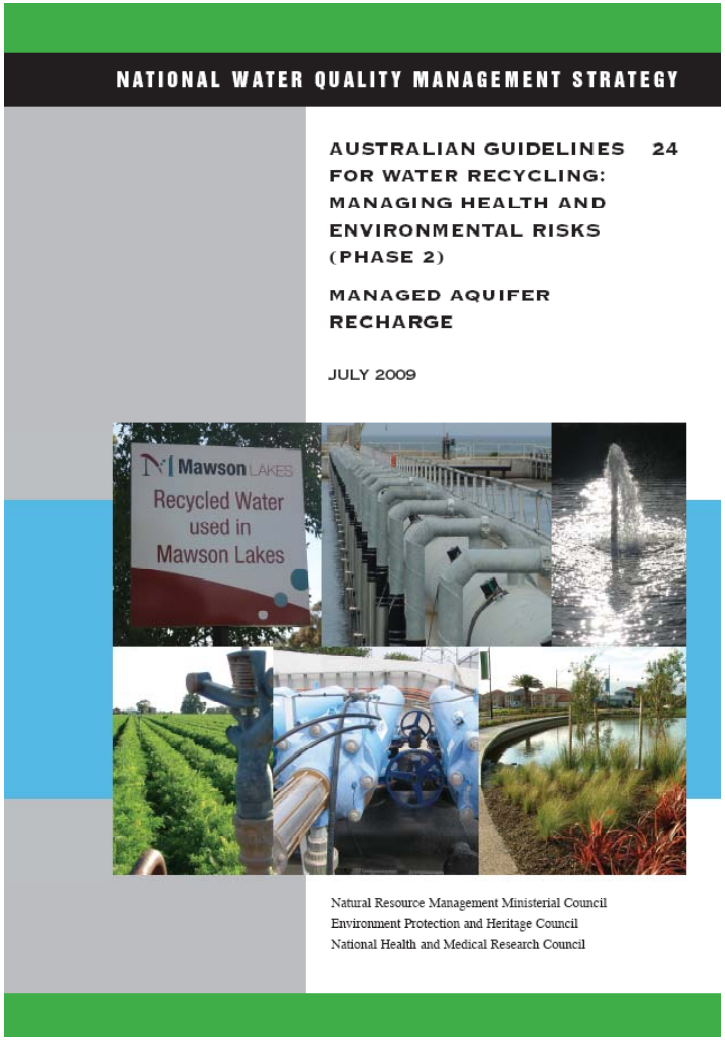


Flushing – injection using RW wells (帯水層のフラッシング)

Flushing of the aquifer (帯水層のフラッシング)

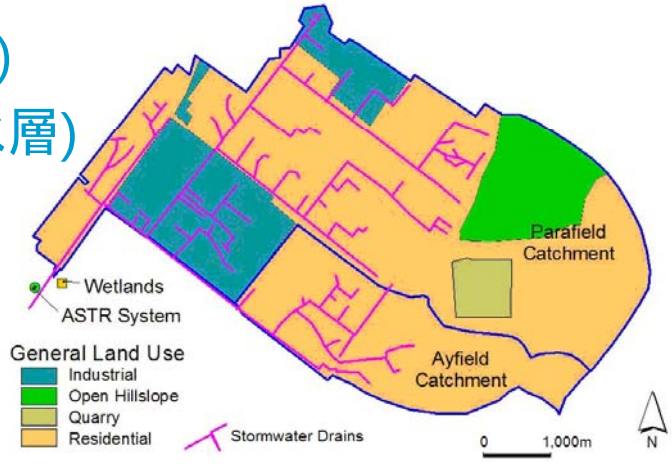


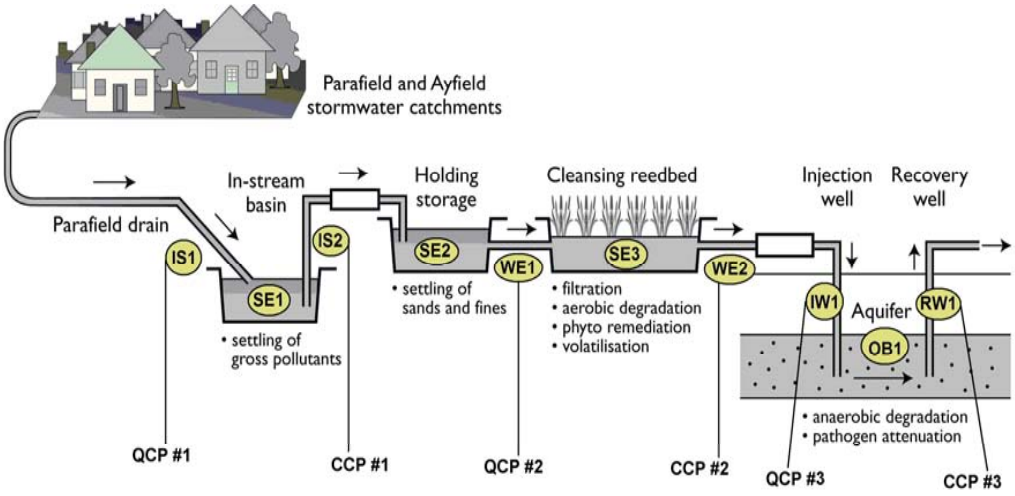
MAR Guidelines and risk assessment (リスクアセスメント)



Risk Assessment: Source, treatment, exposure (リスクアセスメント:ソース、治療、露出)

- Source water: urban stormwater from a mixed use residential catchment (都市雨水)
- Intended uses: drinking water (飲料水)
- Receiving environments: aquifer (帯水層)
- Routes of exposure:
  - Human end points: Drinking Water
  - Environmental end points: Aquifer





Risk Assessment: Hazard identification (ハザードの同定)

- The following hazards were considered:
  - Pathogens (病原体)
  - Inorganic chemicals (無機化学)
  - Salinity and sodicity (塩分濃度)
  - Nutrients (栄養素)
  - Organic chemicals (化学物質)
  - Turbidity and particulates (濁度)
  - Radionuclides (放射能)
  - Pressure, flow rates, volumes and levels (圧力、体積、流量)
  - Contaminant migration in fractured rock and karstic aquifers (岩盤とカルスト帯水層)
  - Aquifer dissolution and aquitard and well stability (帯水層の溶解)
  - Impacts on groundwater-dependent ecosystems (生態系への影響)
  - Greenhouse gases (エネルギー効率)

Maximal Risk Assessment (最大のリスク評価)

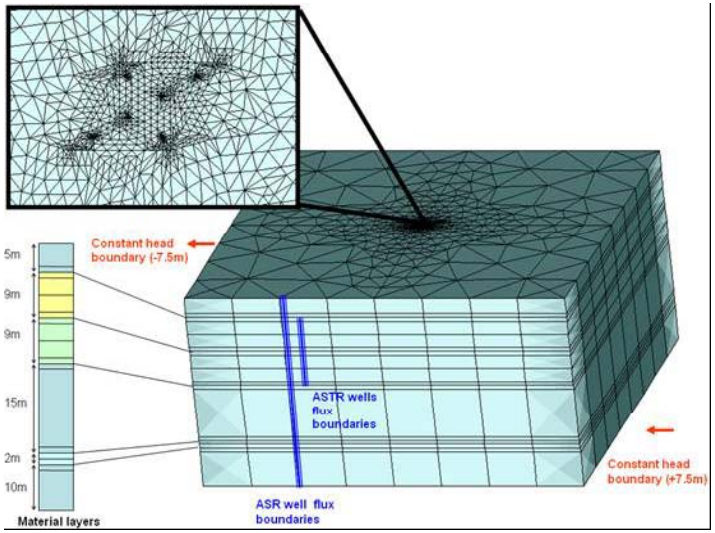
MAR Hazards / Human and Environment endpoints	Human (人々)	Environmental (環境)
Pathogens (病原体)		
Inorganic chemicals (無機化学)		
Salinity and sodicity (塩分濃度)		
Nutrients (栄養素)		
Organic chemicals (化学物質)		
Turbidity and particulates (濁度)		
Radionuclides (放射能)		
Pressure, flow rates, volumes and levels (圧力、体積、流量)		
Contaminant migration in fractured rock and karstic aquifers (岩盤とカルスト帯水層)		
Aquifer dissolution and aquitard and well stability (帯水層の溶解)		
Impacts on groundwater-dependent ecosystems (生態系への影響)		
Greenhouse gases (エネルギー効率)		

Residual Risk Assessment (残留リスクアセスメント)

MAR Hazards / Human and Environment endpoints	Human (人々)	Environmental (環境)
Pathogens (病原体)		
Inorganic chemicals (無機化学)		
Salinity and sodicity (塩分濃度)		
Nutrients (栄養素)		
Organic chemicals (化学物質)		
Turbidity and particulates (濁度)		
Radionuclides (放射能)		
Pressure, flow rates, volumes and levels (圧力、体積、流量)		
Contaminant migration in fractured rock and karstic aquifers (岩盤とカルスト帯水層)		
Aquifer dissolution and aquitard and well stability (帯水層の溶解)		
Impacts on groundwater-dependent ecosystems (生態系への影響)		
Greenhouse gases (エネルギー効率)		

Pathogens: Quantitative Microbial Risk Assessment (定量的微生物リスク評価)

- Monte Carlo simulation
- 3 pathogens: *Cryptosporidium*, Rotavirus and *Campylobacter*
- UV and chlorination disinfection (消毒)
- DALYs (Disability Adjusted Life Years)
- Aquifer decay rates and residence times (帯水層の滞留時間と病原体の減衰率)



CSIRO. The Aquifer Storage Transfer Recovery (ASTR) project

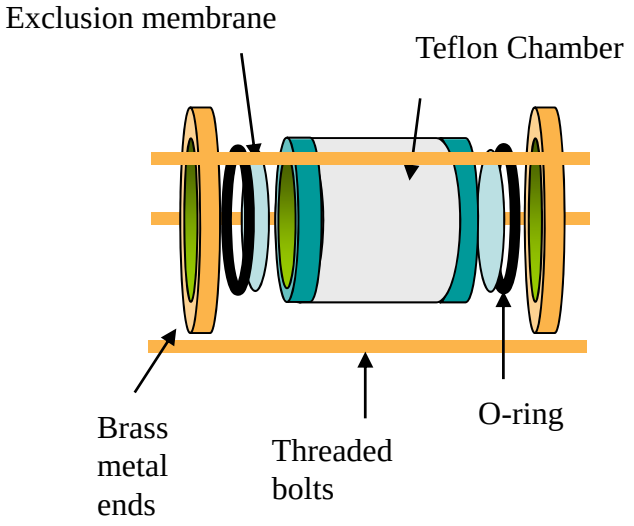
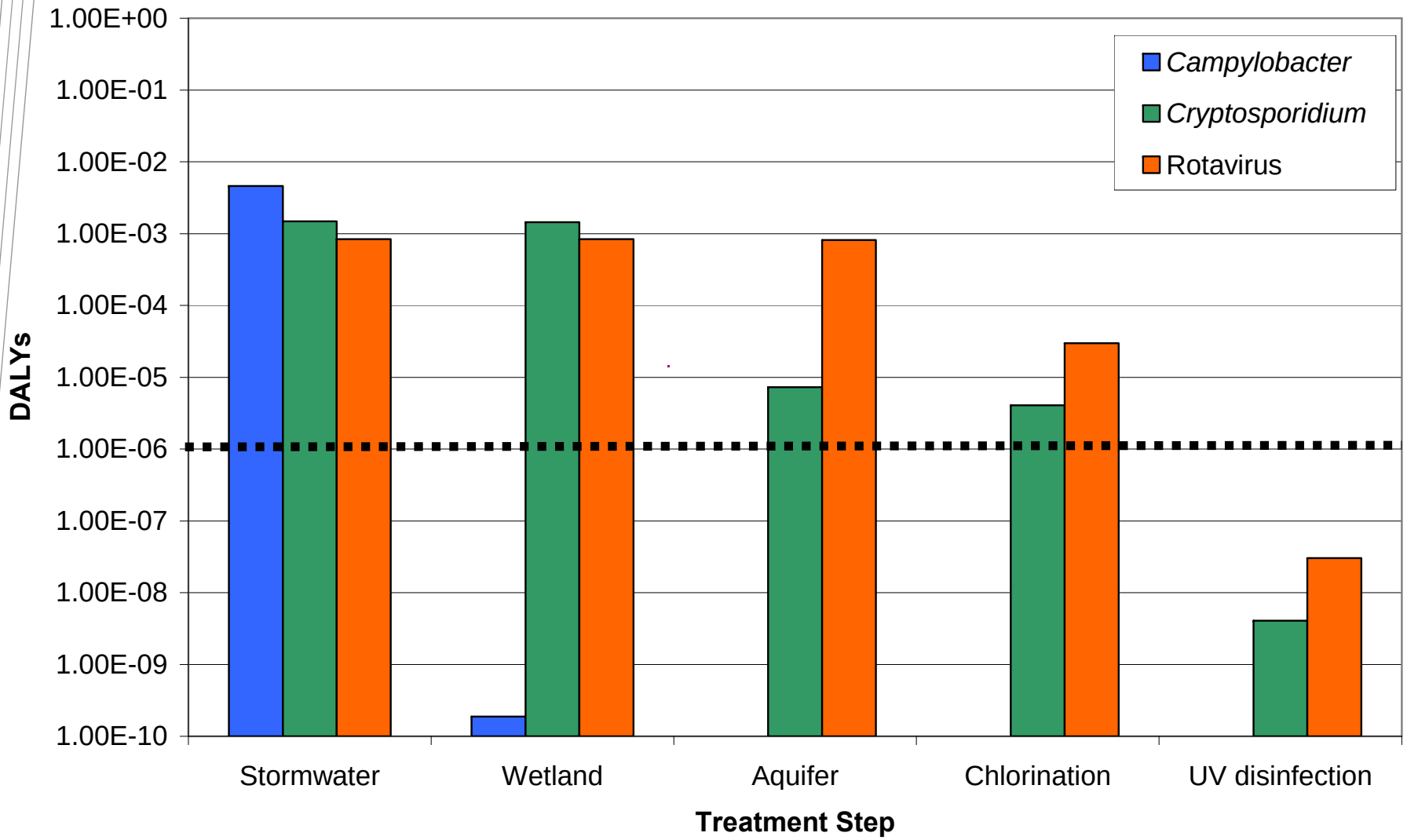


Figure 1 Schematic of pathogen diffusion chambers

Human Health Risk Assessment (DALYs)
(ヒトの健康リスク評価)



Organic chemical risk assessment (有機化学のリスク評価)

- Integrated sampling (統合されたサンプリング)
  - Simazine
- Grab sampling (スポットサンプリング)
  - Simazine
- Passive sampling (受動的サンプリング)
  - Atrazine, BTEX, Caffeine, Chlorpyrifos, DEET, Desisopropyl Atrazine, Detergents, Diazinon, Dicamba, Diuron, Endosulfan sulphate, Fluometuron, MCPA, Mecoprop, Metolachlor, Nitroso-piperidine, Oxadiazon, Paracetamol, Phosphate tri-n-butyl, Piperonyl butoxide, Propiconazol isomers, Simazine, Terbutryn, Triclopyr, Trifluralin
- All chemicals detected were below guideline values (すべての化学物質は指針値以下であった検出)

Turbidity and colour risk assessment (濁りや色のリスク評価)

- Source water exceeds turbidity 5 NTU and colour 15 HU (aesthetic guideline) (回収水は、濁りや色で高くすることができます)
  - interferes with disinfection (消毒の問題)
  - can impact on pumps and irrigation infrastructure
  - well clogging (よく目詰まり)
  - particulate can transport contaminants

- Initial groundwater samples high turbidity and colour
- IW wells during 2nd year of flushing & recovered water <5 NTU
- Continue to monitor during operation (使用の濁度の2年目は減少した後、水質を監視し続ける)

Inorganic chemical risk assessment (無機化学のリスク評価)

- Residual risks associated with inorganic chemical hazards arise from subsurface storage and reactions (無機化学物質リスク)
- Fe (鉄)
  - Reedbed increases soluble Fe in source water (湿地は、鉄を解放する)
  - Fe in sediments in oxidised (hematite, goethite) and reduced (pyrite, siderite) forms (黄鉄鉱)
  - Fe in ambient groundwater (地下水の鉄濃度) 1.6 mg/L
  - Fe in recovered water is expected to be >0.3 mg/L (aesthetic guideline)
- As (ヒ素)
  - As in sediments (ヒ素鉱物) 6-144 ppm
  - As in ambient groundwater (ヒ素、地下水濃度) 9-11 µg/L (>7 µg/L health guideline)
  - Potential release from aquifer (帯水層からの解放の可能性)
  - Release not observed to date
- Continue to monitor during operation (水質モニタリングを継続)

Conclusions (結論)

- Risks to be considered as unacceptable/not well defined currently are (いくつかのリスクがよく理解されていない):
  - Pathogens (病原体): residual risk below the 10^{-6} DALYs set limit, supplementary disinfection
  - Inorganic chemicals (鉄と砒素): potential release of arsenic, iron >0.3 mg/L, iron removal treatment
  - Organic chemicals (化学物質と農薬): further work required to verify low risk, catchment assessment
  - Turbidity and colour (濁度と色): high turbidity and colour in the source water and initial groundwater samples
- Subsurface treatment (帯水層の処理およびストレージの水質の重要な) is an additional barrier that requires further validation during the initial recovery
- A risk management plan (人間の健康と環境を守るためにリスク管理計画を必要とする) is required to be implemented to manage risks to human health and the environment

Water Reuse
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