

State of knowledge for receiving environments for the Omaha WWTP

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Purpose

- Personal details
  - 35 years as a freshwater and marine ecological scientist
  - Previously NIWA's Regional Manager Hamilton, Director of Operations, General Manager Environmental Information
  - Have had my own consulting practice for the last 6 years

- Watercare has asked me to review the available environmental information relating to the Omaha WWTP and to identify further technical work that I think is required to fill these information gaps.

Review of information

Have considered four aspects:

- Wastewater quality as it leaves the Omaha WWTP
- The environments that receive the wastewater discharges (both the land into which it discharges and the "downstream" coastal areas)
- How land treatment affects water quality
- The effects of the discharge on the receiving environments

Review of information

Based on:

- Review of published and unpublished reports, websites
- Compliance reporting
- Relevant published papers
- Discussions with authors of reports (Townsend, Diffuse Sources, Mark Morrison)

Information summary

Discharge Quality

- Extensive monitoring of discharge for key indicator parameters

- Lot of information available, annual reports

Information summary

Receiving Environments

<u>Land</u>

- Little "hard data" regarding forest land
- Good information about the golf course characteristics, but assessments have been somewhat piecemeal

<u>Coastal Areas</u>

- Lots of certain types of data but some areas not as comprehensive

Information summary

Water quality after discharge

- Extensive monitoring of some drains and wells, for key indicator parameters

Effects assessments

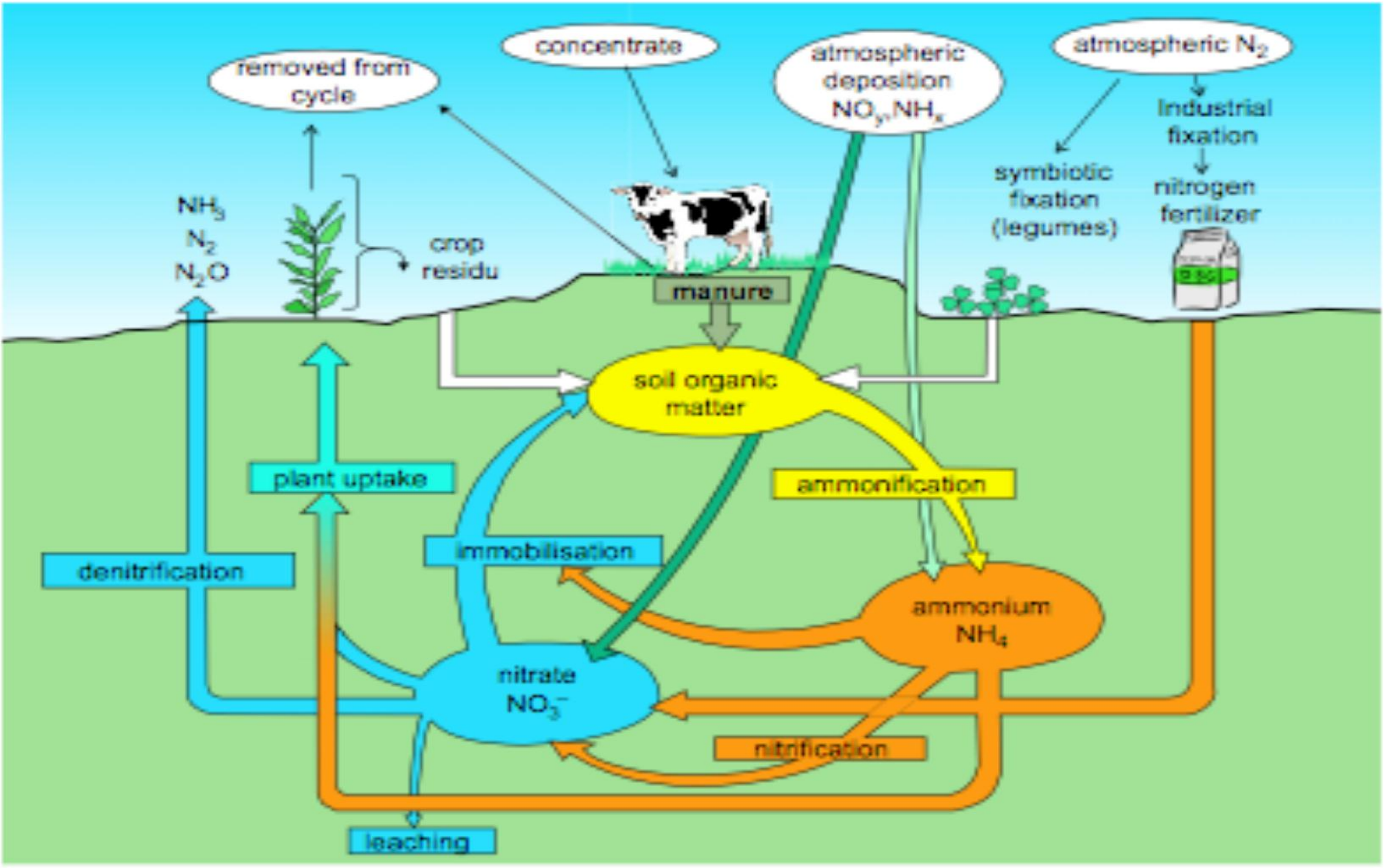
- Largely focussed on water quality - nutrients, microbial contaminants (Diffuse Sources 2008)
- Little information on parts of receiving environments
- No recent integrated assessment

Contents

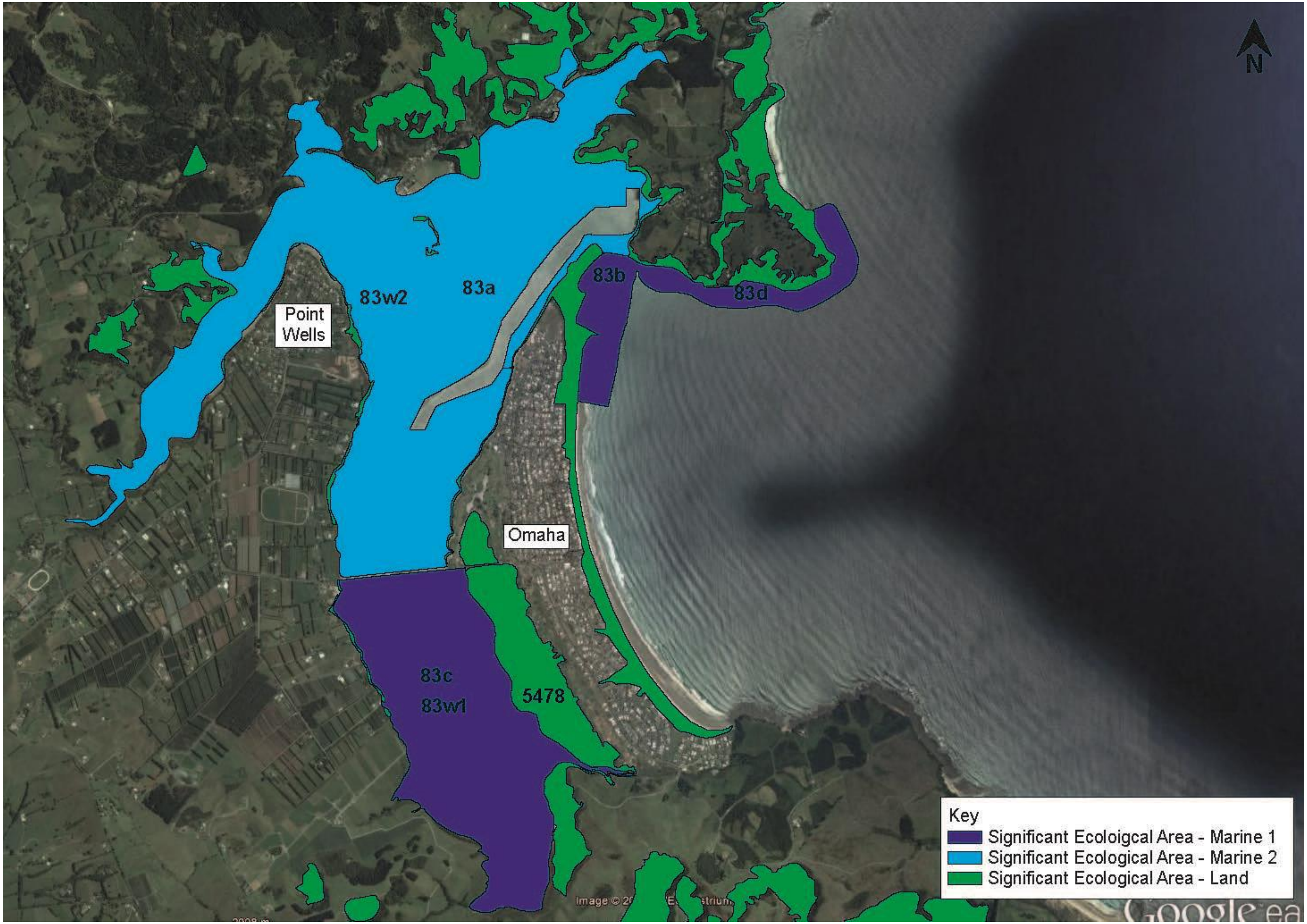
Typical nutrient processes

- Overview of nutrient cycles, potential removal rates in soils, riparian zones, groundwater and wetlands (see diagram)
- Uptake in vegetation
- Differences in soil types and importance of organic carbon
- Expected fate of phosphorus and nitrogen

Typical nutrient processes



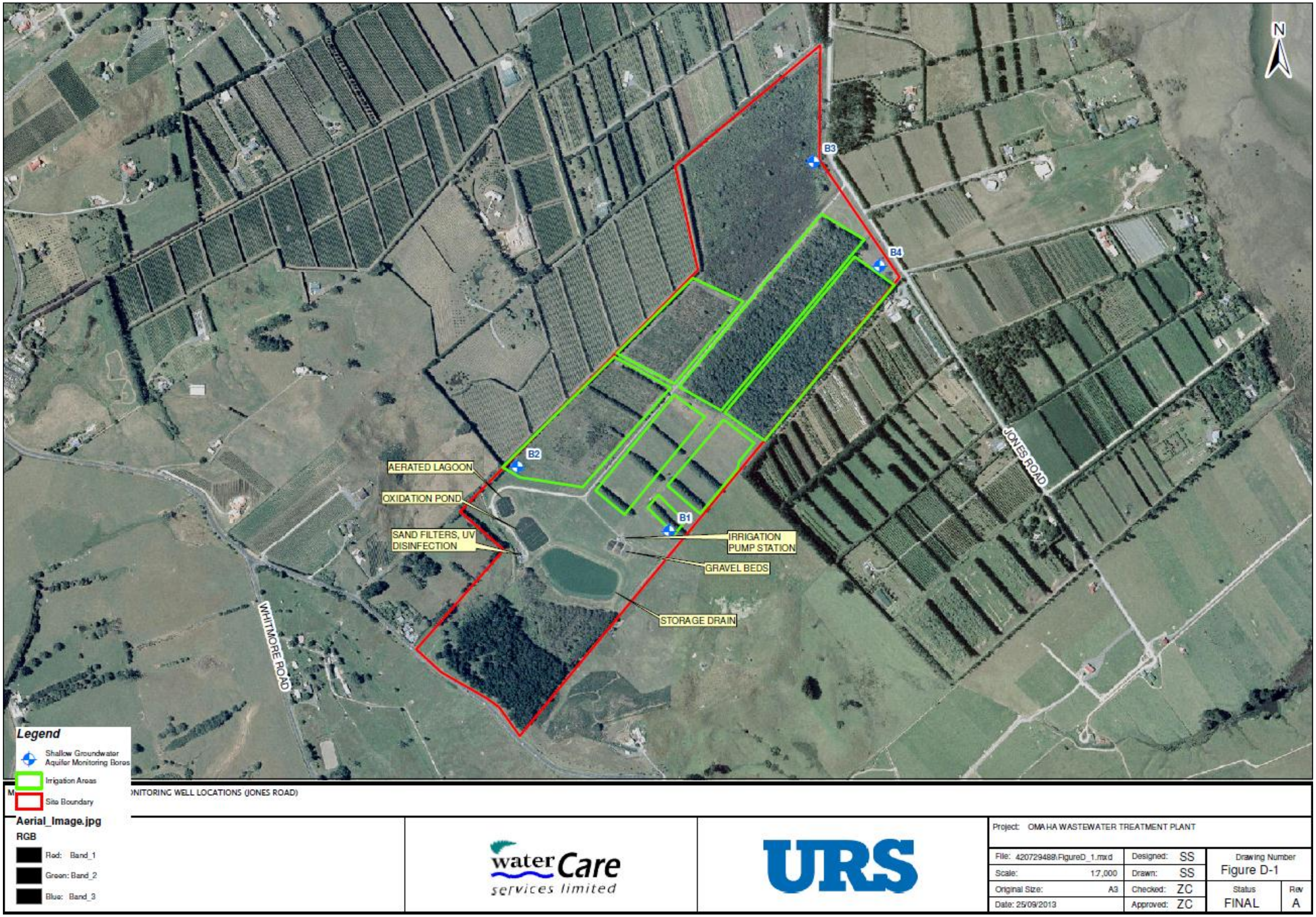
Description of environments - general



Description of environments - general

- Ecologically important
  - Highly regarded regionally and in some cases nationally and internationally
  - Estuary rated as one of Auckland's best, Coastal Protection Areas (CPA1 at entrance and W side of spit), lot of harbour is CPA2
  - Area of Significant Conservation Value and Site Special Wildlife Interest
  - Kahikatea forest/wetland-saltmarsh-tidal flats
  - Shellfish gathering, wading and migrating birds and fish nursery

Monitoring of discharges



Monitoring of discharges

Monitoring of discharges

Map Title: BOUNDARY DRAIN SAMPLING LOCATIONS

Legend:

× Boundary Drain Sampling Points

watercare services limited

URS

Project: OMAHA WASTEWATER TREATMENT PLANT			
File: 42072948\Overview_A3.mxd	Designed: SS	Drawing Number Figure D-3	
Scale: 1:20,000	Drawn: SS		
Original Size: A3	Checked: ZC	Status	Rev
Date: 25/09/2013	Approved: ZC	FINAL	A

Monitoring of discharges

- Compliance monitoring of discharge
  - Volume*, pH, dissolved oxygen, faecal coliforms (FC)*, suspended solids (TSS)*, CBOD*, ammonia, nitrate
  - FC <10cfu/100ml (consent 500)
  - TSS <20 mg/l (consent 20)
- Compliant for all parameters (*) in 2011/12, 2012/13

Monitoring of discharges

- Drains surveyed 6 monthly – 4 drains Jones Rd
  - TSS and FC elevated in drains following rainfall but generally low and constant levels
  - Includes input from wider agricultural catchment
- Bores surveyed 6 monthly – 4 at Jones Rd irrigation, 2 at edge of Golf Course (nitrite and DRP also measured here)
  - FC, ammonia and nitrate at Jones Rd higher closer to WWTP at times
  - No significant levels detected in bores at Golf Course (nitrate low but marginally higher 2012) – nitrate <5 g/m^3, ammonia <0.5 g/m^3

Nutrient processes and loadings

Nutrient processes and loadings

- Diffuse Sources 2008:
    - Desktop study only, but comprehensive document covering contaminants, nutrient loads and fate of nutrients, sensitivity of receiving environment
    - Overview of nutrient cycles, potential removal rates in soils, riparian zones, groundwater, wetlands (see diagram)
    - Comparison of nutrient loads with wider catchment

Nutrient processes and loadings

- Estimated 90% of dissolved inorganic N that is irrigated on Golf Course, after treatment, is likely to be removed by grass, soils, wetlands (mostly microbial)

- Estimated 70% at Jones Rd

- Important processes are nitrification (converts ammonia to nitrate) and denitrification (converts nitrate to nitrogen gas)

- Need carbon (i.e. organic material) in the soil for denitrification

Nutrient processes and loadings

- Irrigated wastewater contributes 0.5% (1.2% excluding tidal exchange) of Total Nitrogen (TN) to Waikokopu Arm and 0.06% of that reaches Whangateau Harbour (2006)

- Adding Matakana and Pt Wells gives 3.6% (10% excluding tidal exchange) and 0.5% in the Harbour by 2036

- Septic tanks – estimate was ~2% of load – 2006 data

Nutrient processes and loadings - Gaps

Significant gaps

- What are flow pathways, transformations and losses of nutrients in soils, wetlands, groundwater?
- Require measured data on process rates to assess capacity to reduce nutrients reaching Harbour
- Catchment loadings and relative input of WWTP uses old data – need to update

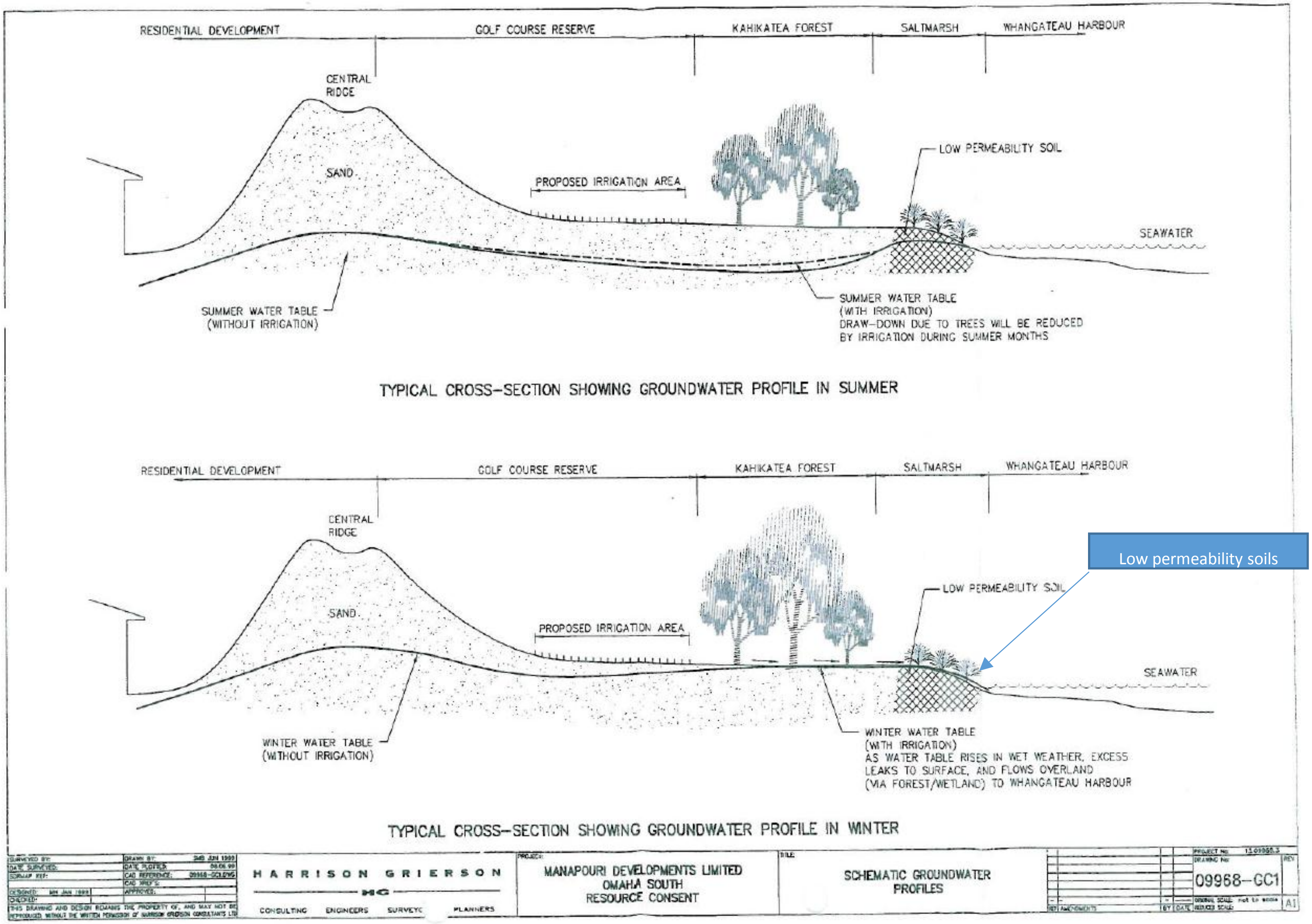
Groundwater

Groundwater

Number of reports:

- Bates 1982 (soils, aquifers)
- Harrison Grierson 1999 (general characteristics, conceptual cross-section)
- Thorley 2004 (hydrogeology and groundwater)
- PDP 2007, Diffuse Sources 2008 (reviews)
- URS 2010 (irrigation potential)

Groundwater Setting



Groundwater – golf course

- A proportion of the discharge applied to the golf course infiltrates down through the soil to shallow groundwater (‘the water table’)
- Depth to groundwater is typically 6-9 m below the ground surface on the high side (east), and 1-3 m below ground level on the low side (west). Groundwater levels fluctuate naturally with rainfall and seasons
- Conceptual understanding and existing monitoring data indicate that the vast majority of the shallow groundwater beneath the golf course flows westwards towards the Whangateau Harbour - eventually flowing through the soil into the harbour itself
- Surface water features i.e. small streams and creeks are known to exist within the Kahikatea Forest, and some groundwater will also emerge into these creeks, which also flow into the harbour

Groundwater – golf course

- The shallow geology is understood to comprise the following:
  - golf course– dominated by sandy material, but lenses/discrete layers of silty or peaty material are likely to be present in certain areas and depths
  - Kahikatea Forest - likely to consist of silty material with high organic content within at least the top 1m
  - harbour – dominated by silty material with some organic content in the top 1 -2 m of geology. Beneath this; sandy material is likely present
- The flow paths of shallow groundwater from the golf course to the harbour will be influenced by:
  - The distribution of the different soil / geology types; both horizontally and vertically
  - Tidal fluctuations in the harbor
  - The natural presence of salt water from the harbour, beneath the fresh groundwater body.

Groundwater – golf course

- Deep groundwater resources exist in pore space and fractures within formations of hard-rock beneath the Mangatawhiri Spit at depths of >~50 m

- These deeper groundwater resources operate separately from the shallow groundwater. The separation is primarily due to the deep, hard-rock resource being isolated by tens of meters of overlying clay dominated geology.

Groundwater – Jones Rd

- Fresh water exists in groundwater at shallow depths of 0.5-2 m (water table) and fluctuates with rainfall and season

- Proportion of treated waste water infiltrates down to this

- Flows thought to be eastwards through soils to Harbour, some from NW could go NNW towards Omaha River, constructed drainage channels present.

Groundwater – Jones Rd

- Shallow geology (current understanding) :
  - Upper 2m – silt and sand, high organic content below JRS
  - Below 2m sand with some peat layers at 15m
  - Beneath Harbour – silty, some organic material in top 1-2m, sand below 2m, peat deposits present
- Deeper groundwater >50 m depth separated by clay layers
- Flows influenced by:
  - soils, geology
  - Tides
  - Saltwater layers beneath groundwater

Groundwater - summary

- Flows ultimately to Harbour edge via soils, peat deposits and groundwater aquifers (can take many years to reach Harbour)

- Limited trials for increasing irrigation by 6x – no observable effects (but limited in space and winter only trial)

Groundwater - gaps

Significant gaps

- Confirmation of flow paths and rates at which discharge flows to the harbour
- Confirm the geology under Golf Course and Jones Rd through to Harbour and wider area, need to verify conceptual models
- How important is surface runoff for irrigation?
- Where are peat layers and how effective are they at nutrient removal?
- Require data to calibrate and verify models of flow pathways and speed, verify and refine conceptual models
- Water balances need quantifying for disposal fields and the Kahikatea forest/wetlands areas (i.e. system capacity)

Microbial and contaminants

- Good data from discharge (E.coli)
- Most removed through treatment and then filtered through sand, soils, groundwater, wetlands before Harbour
- Low levels of E.coli at Ti Point, never exceeding MFE guidelines (AC monitoring)
- Elevated levels bacteria at Pt Wells – septic tank seepage, shellfish contamination in 1996-98 attributed to rainfall events
- No data on viruses or emerging contaminants

Microbial and contaminants - Gaps

Significant gaps

- What is the impact of contaminants on Harbour from WWTP vs septic tanks?
- Efficacy of treatment on viruses and emerging contaminants?
- What is current understanding and potential issues around emerging contaminants?

Wetland /Forests

- Regionally, nationally and internationally significant
- Kahikatea forest – saltmarshes - mangroves habitats and gradient

Forest/wetlands

- Surveys 1980s (Rodney Protected Natural Area Programme), 1999-2000 (Manapouri Developments - Boffa Miskell), 2000s (Rodney wide survey of forest health), Landcare plots in wetland database

- Forest dominated by nikau, *Coprosma*, kahikatea, mapau, tanekaha, lancewood

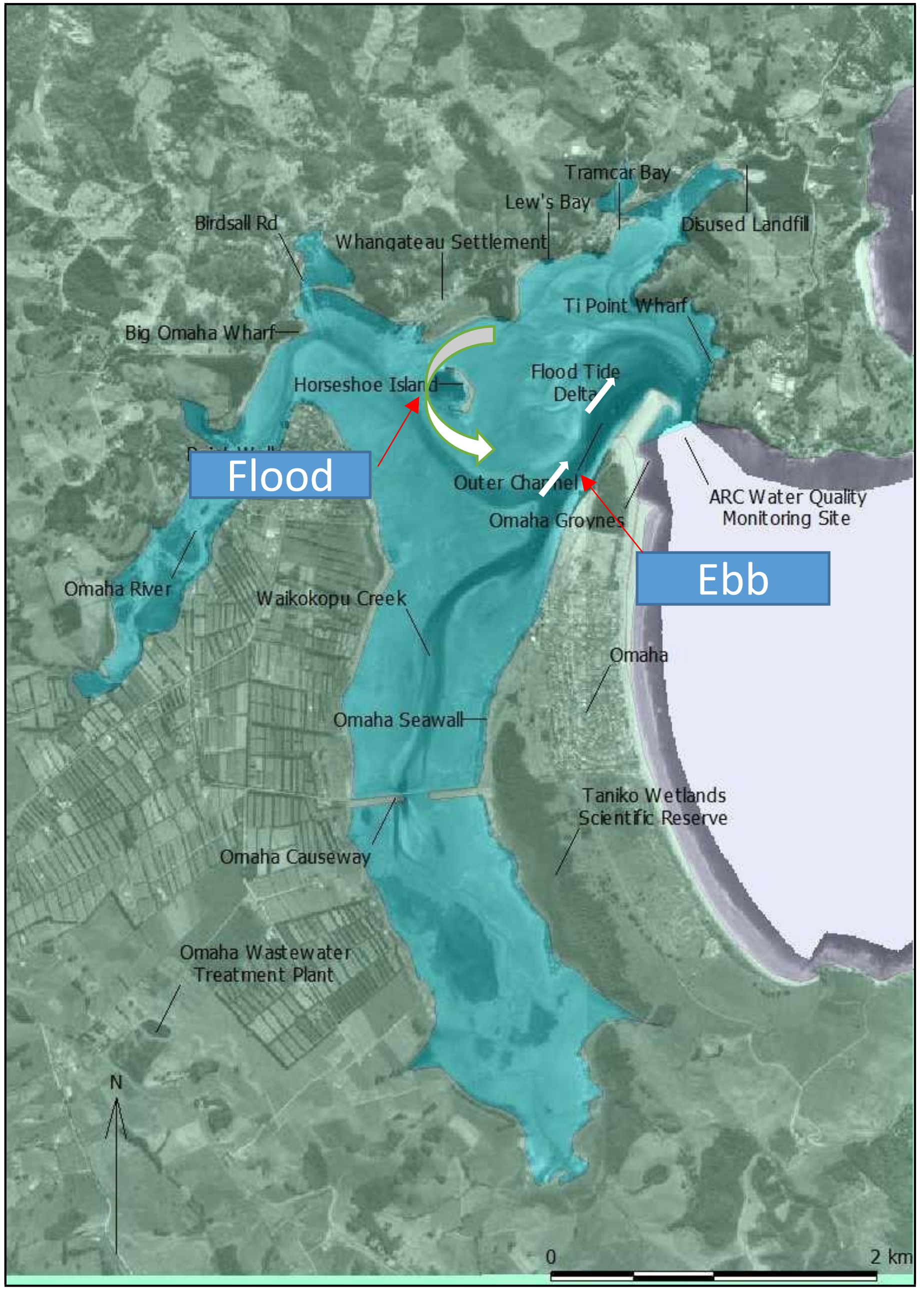
- Groundwater levels can vary by at least 1.5 m in Kahikatea forest

- DoC – possum control only

Wetland /Forests - Gaps

Significant gaps

- Existing information/data difficult to find
- Need an updated description of existing state of forest/wetland
- Assessment of effects of water level changes and nutrient inputs on wetland and forest communities (update 1999 application)



Strongest tidal flow

- Tichener 1993

Diagram adapted from Kelly 2009

Harbour Hydrodynamics

- Basic hydrodynamic parameters summarised in Diffuse Sources (2008), Kelly (2009)

- Titchener (1993) describes tidal characteristics and currents with focus on tidal delta
    - Dye studies, current meters

- Characteristics:
    - Estuary is well mixed/flushed
    - 98% is drained each tide
    - Freshwater is 0.3% of tidal volume
    - Currents anti-clockwise circulation in northern part of Harbour

Hydrodynamics

Significant Gaps

- A wider spatial hydrodynamic model
- Need estimates of exchange rates especially for Waikokopu Arm with main Harbour
- Effect of causeway on exchange
- Assess impact of freshwater flows on salinity

Harbour Water quality

Harbour Water quality

- Water Quality in Harbour measured by Auckland Council (AC) at Ti Point since 1991
- Water quality high, low levels phytoplankton, nutrients, Total P and chl increased 1991-2007, also Barr 2002-2004, recent data?

Harbour Water quality - gaps

Significant gaps

- No data on Waikokopu Arm, Ti Point only site for AC

- What is capacity of estuary waters for nutrients – nutrient limitation - algal and macroalgal growths?

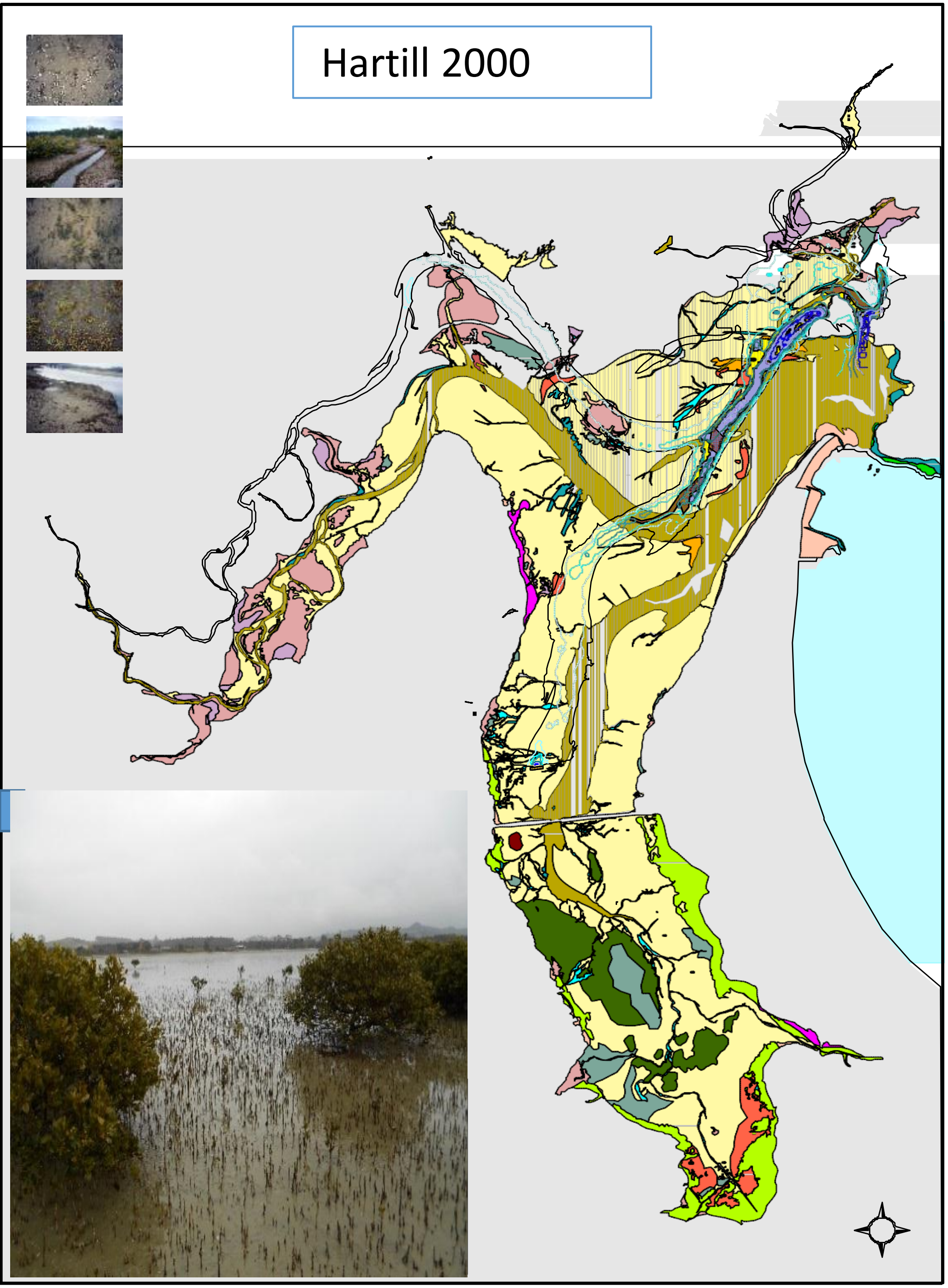
Aquatic plants

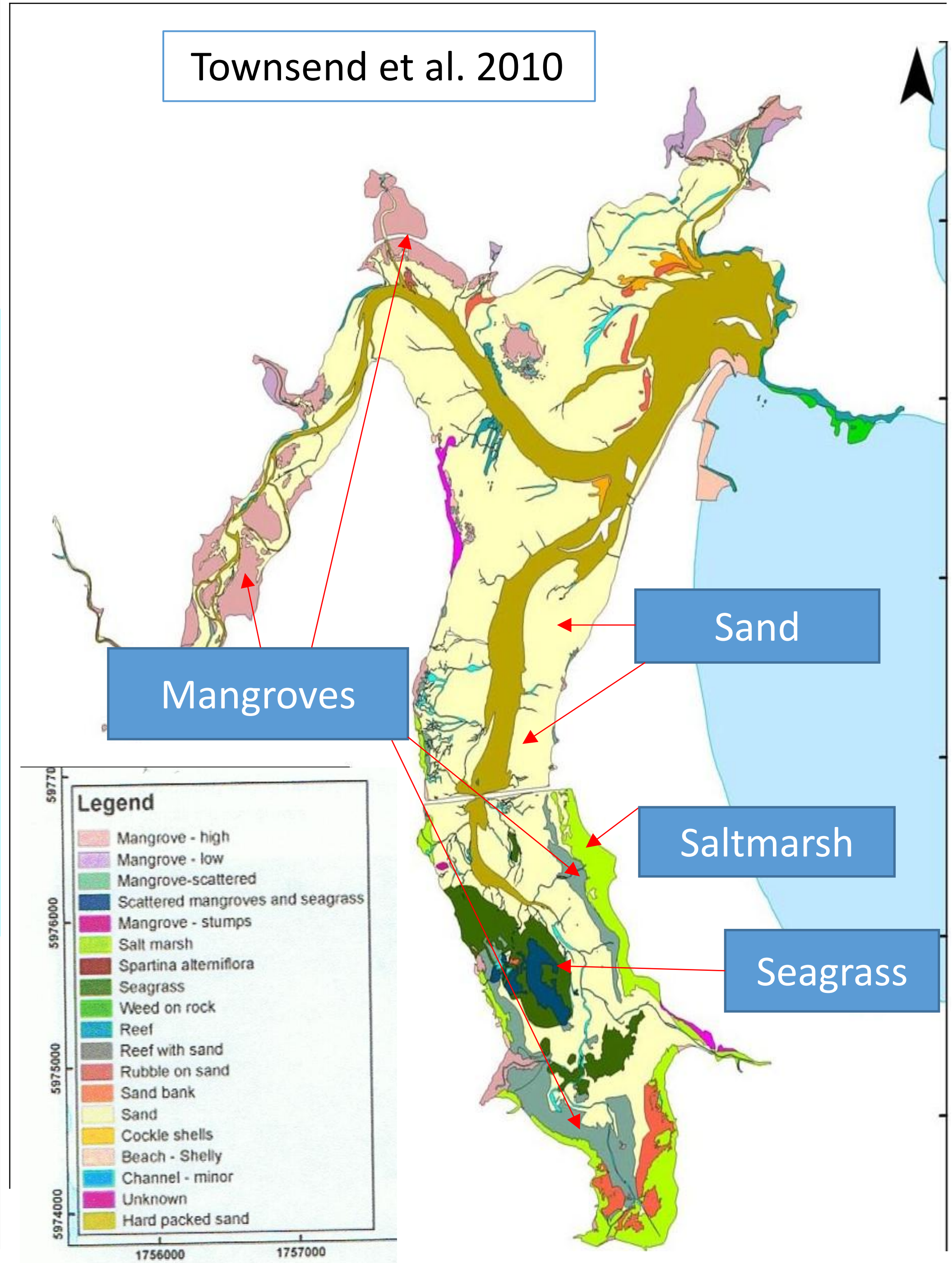
- Mangroves, saltmarsh, seagrass, benthic habitats have been mapped (Hartill 2000, Townsend et al 2010)

- Area adjacent to kahikatea forest one of largest saltmarshes in Harbour

- Mangroves spreading, seagrass changed distribution

- Limited data on phytoplankton, only recent data is monitoring at Ti Point (low levels <1 chl ug/l)


Hartill 2000


Townsend et al. 2010
Sand
Mangroves
Saltmarsh
Seagrass
Legend
Mangrove - high
Mangrove - low
Mangrove-scattered
Scattered mangroves and seagrass
Mangrove - stumps
Salt marsh
Spartina alterniflora
Seagrass
Weed on rock
Reef
Reef with sand
Rubble on sand
Sand bank
Sand
Cockle shells
Beach - Shelly
Channel - minor
Unknown
Hard packed sand
5976000
5975000
5974000
1756000
1757000

Aquatic plants - Gaps

Significant gaps

- Confirm that phytoplankton is unlikely to be near concern levels, mangroves and macroalgae?
- Are nuisance algae and macroalgal growths found in Waikokopu Arm, potential impact of WWTP?
- Are mangroves spreading and could WWTP be having an impact vs sedimentation?
- Very limited data on phytoplankton

Benthic habitats

- Early surveys by Boyd (1972), data in Grace (1972), various studies on species or other parts of Harbour (students), Whangateau HarbourCare monitoring cockles (2002-2009, Causeway since 2006?)

- Hartill et al. (2000), Townsend et al. (2010) mapped habitats (drop camera)

- Every 6 months from 2009 seven intertidal sites monitored by AC, three sites in Waikokopu Arm – fauna, sediments, contaminants

Benthic habitats

- Intertidal sandflats, salt marshes, mangroves, seagrass beds, reefs, sand and shell banks important, have been mapped

- Cockle and wedge shells, *Zeacumantus* common, pipis more towards entrance

- Shell beds important for recreational harvest (pipi beds)

- Cockle die-offs (2009, 2014)
  – warm conditions
  - Bacterium, parasite (2009)
  - Natural bacteria (2014)

Benthic habitats - Gaps

Significant Gaps

- Description of the present state of the shoreline habitats and communities in the vicinity of the discharge fields – maps need updating
- Analyses of the intertidal data collected by Auckland Council
- Is WWTP water impacting on benthic community?

Fish

- Number of fish studies – Grace 1971 (37 species), 1972 (5 more added), Kelly 2009, Mark Morrison NIWA, observations on HarbourCare website

- Octopus, eagle ray and flatfish studied

- Reefs and mangroves important nursery for juvenile parore (only one known in Hauraki Gulf), also snapper, kahawai, trevally, yellow eye and grey mullet

- Seagrass important for snapper nursery

Birds

- Grace 1971, Diffuse Sources 2008, Kelly 2009, NZ Ornithological Society records
- Rated as CPA 1 & 2 and SSWI, recognising important bird habitat
- Important estuary habitat for migratory and wading birds, feeding, roosting and breeding
- Threatened species - banded rail, Caspian tern, fernbird, North Island dotterel, fairy terns
- Kahikatea Forest edge – fernbird nesting

Fish and birdlife - Gaps

Significant gaps

- Lot of information available but could be updated
- What is importance of the shoreline and intertidal areas adjacent to the discharge fields for bird feeding, resting and nesting and for fish habitat?
- Tap into local knowledge

Conclusions

- Good general information available
  - Diffuse Sources 2008, Kelly 2009, HarbourCare website
- Number of aspects need updating eg nutrient loads, habitat maps
- New data/measurements required eg. flow pathways, nutrient processes
- Collation of information and data eg emerging contaminants, forest/wetlands, benthic data
- Assessment of effects
  - Description of existing environment
  - Assessment of effects now and in future
- Need input from Consultative Group
- Suggest incorporating feedback and presenting a detailed "project plan"