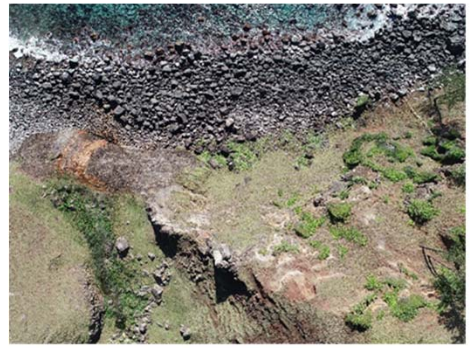
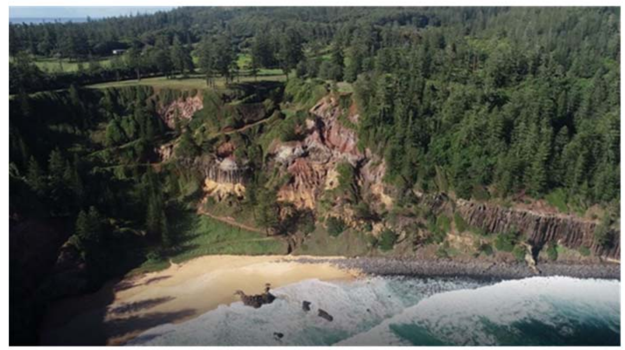
Norfolk Island Environmental Assessment

June 2021

The University of Newcastle Australia
The University of Queensland Australia
Monash University






Scope

The research project undertook the following scientific work as background evidence for discussion of long-term population targets and carrying capacity:

- Assessment of the land-use capability of the Island examining land forms, their environmental suitability, and the extent that existing use is consistent with environmental sustainability;
- Assessment of hydrology, examining the Island's surface and groundwater resources, and existing use and sustainability;
- Assessment of the Island's ecosystem and biodiversity and the requirements for ecological sustainability; and,
- Assessment of technologies and systems that have applicability on Norfolk Island that could be considered to redress existing unsustainable practices in land use, hydrology or biodiversity management.

Report Structure/Contents

1. CLIMATE, COASTAL DATA & LAND USE CAPABILITY ASSESSMENT (SOILS)

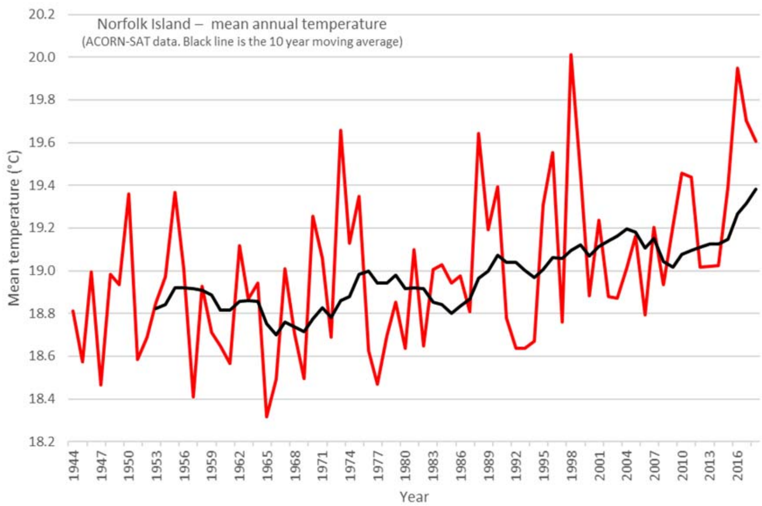
2. NORFOLK ISLAND: HYDROLOGICAL ASSESSMENT AND PRELIMINARY WATER BALANCE

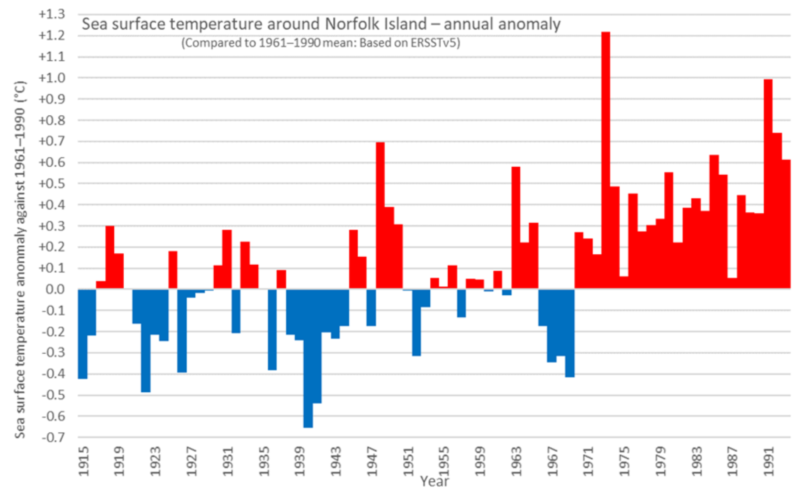
3. ASSESSMENT OF THE ISLAND'S ECOSYSTEM, BIODIVERSITY, AND THE REQUIREMENTS FOR ECOLOGICAL SUSTAINABILITY

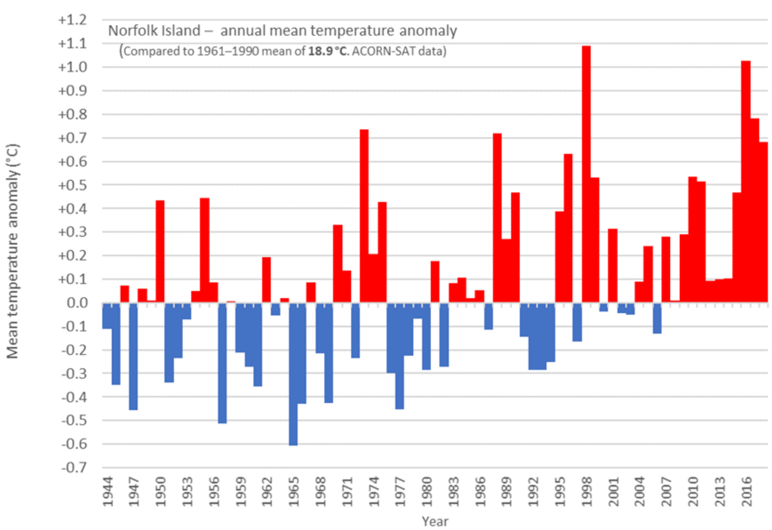
4. TECHNOLOGIES FOR SUSTAINABILITY (FOOD, ENERGY, AND WASTE SYSTEMS)

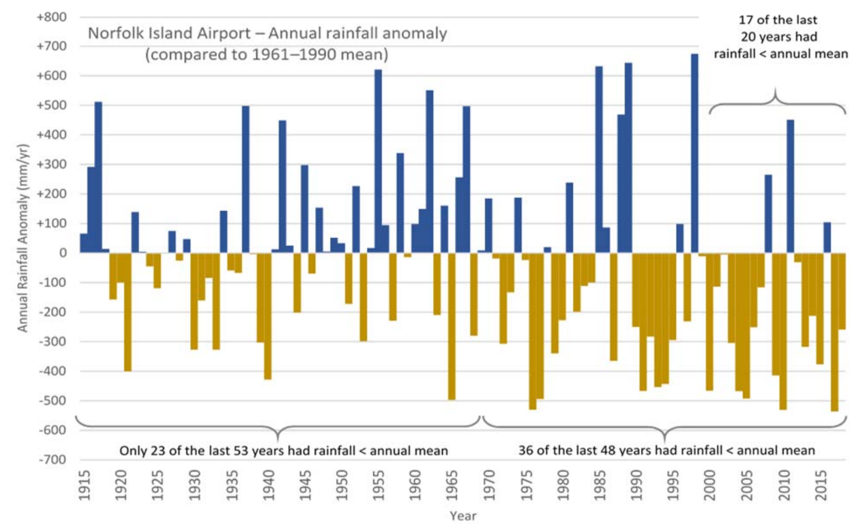
5. MAJOR GAPS IN IMPLEMENTATION AND RECOMMENDED PROJECTS/PROGRAMS

Climate Trend Summary







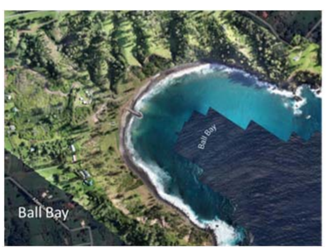


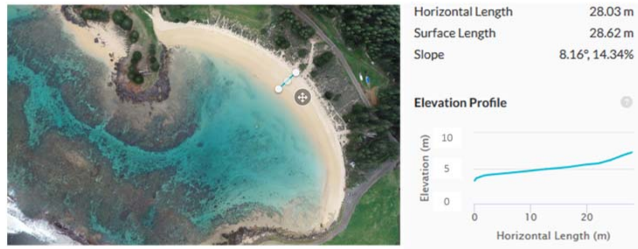
Climate Trend Summary

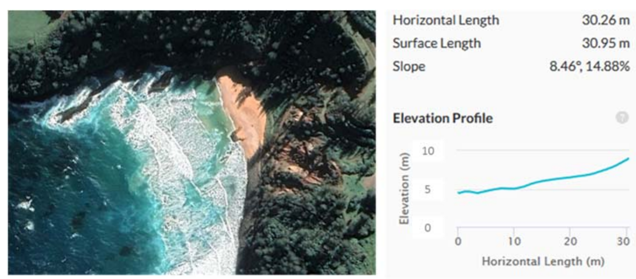
Key Trends:

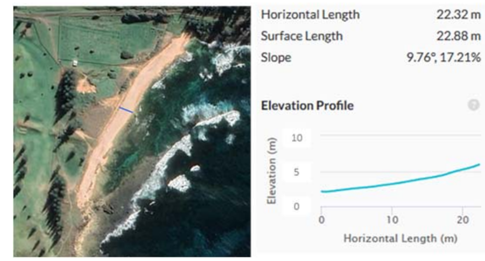
- Warming of the seas surrounding Norfolk Island
- Increasing mean annual temperatures
- Decreasing mean annual rainfall
- Increasing mean annual evaporation
- These trends indicate a shift in climate patterns that are likely to decrease available water and potentially change existing food production systems and Island biodiversity over the next 100 years.

Coastal Data and the Norfolk Island Natural Resource Plan (PB, 2009)



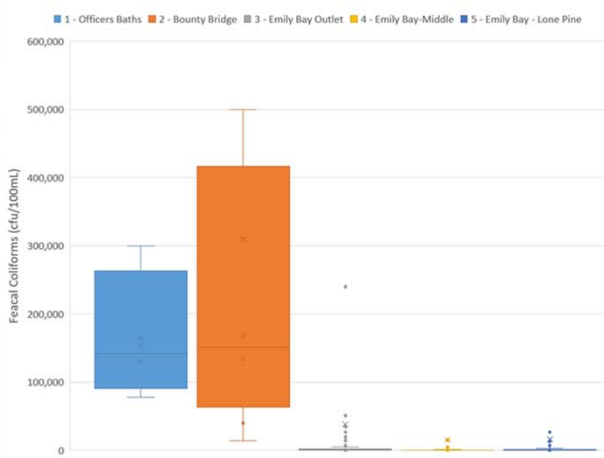






Reef Integrity around Emily Bay

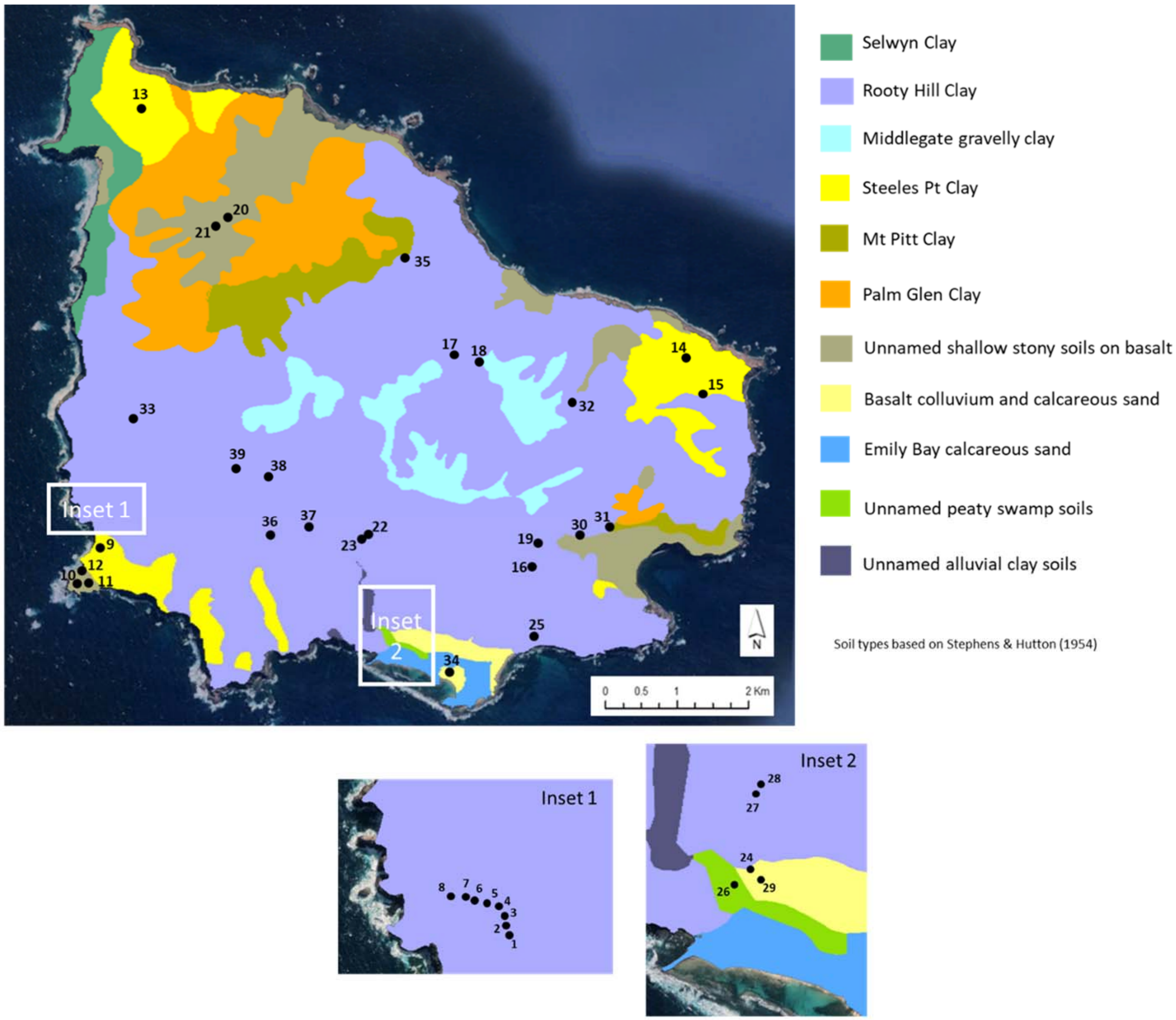
Image shows limited coral amongst dense and luxuriant algal and seagrass growth (source Mrs Corrine Parsons, 2016)



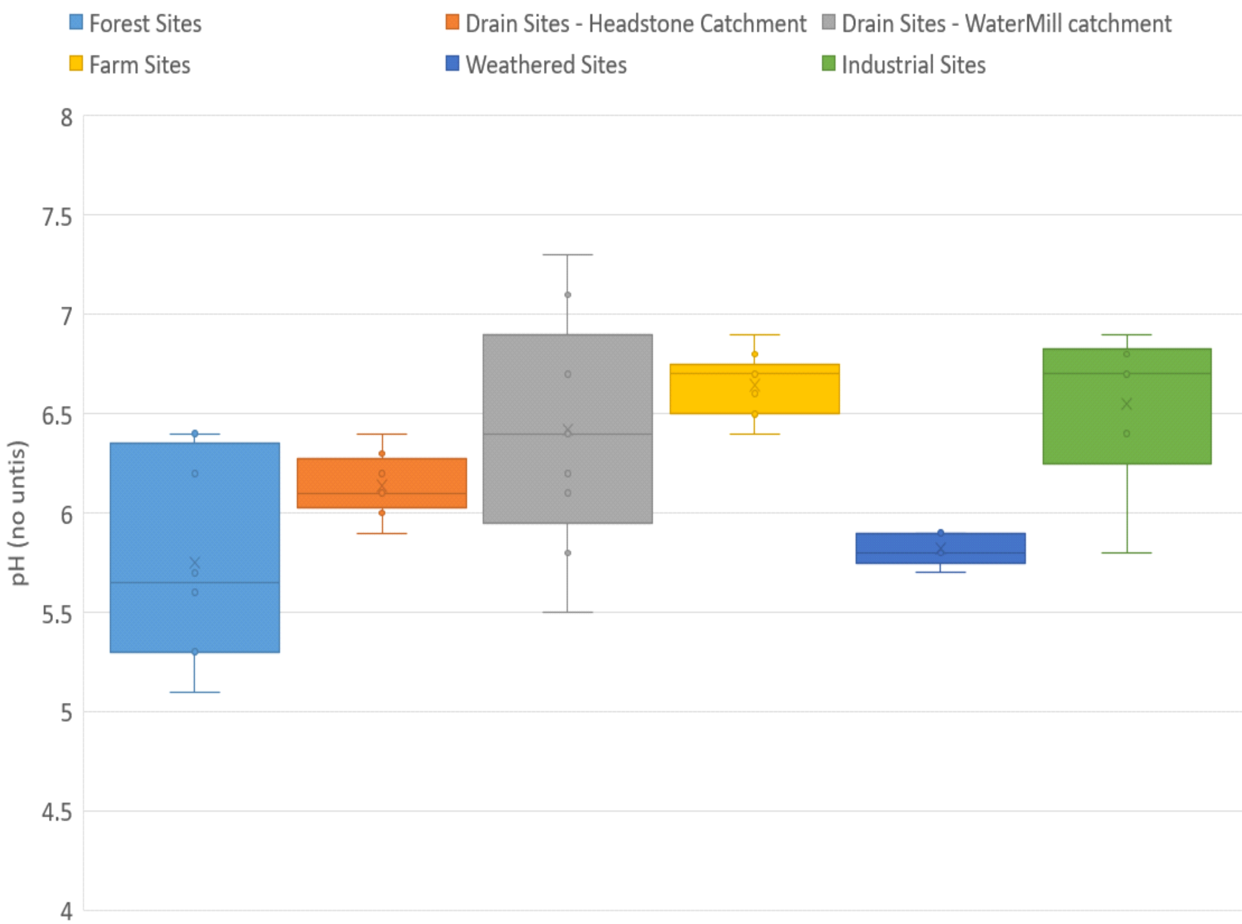
Emily Bay Plate Coral 1992 showing high coral cover and rich diversity in coral species and small fish (Source: Mr Jack Marges)

Emily Bay plate coral 2016, showing a decline in coral diversity and cover and a complete absence of small fish (source: Mrs Corrine Parsons)

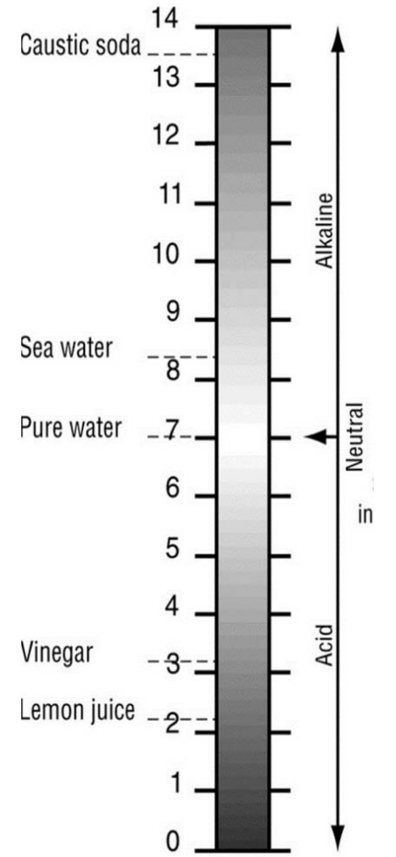
Land Use Capability Assessment: Norfolk Island Soils



Soil pH



Forest Sites
Drain Sites - Headstone Catchment
Drain Sites - WaterMill catchment
Farm Sites
Weathered Sites
Industrial Sites
pH (no untis)
8
7.5
7
6.5
6
5.5
5
4.5
4

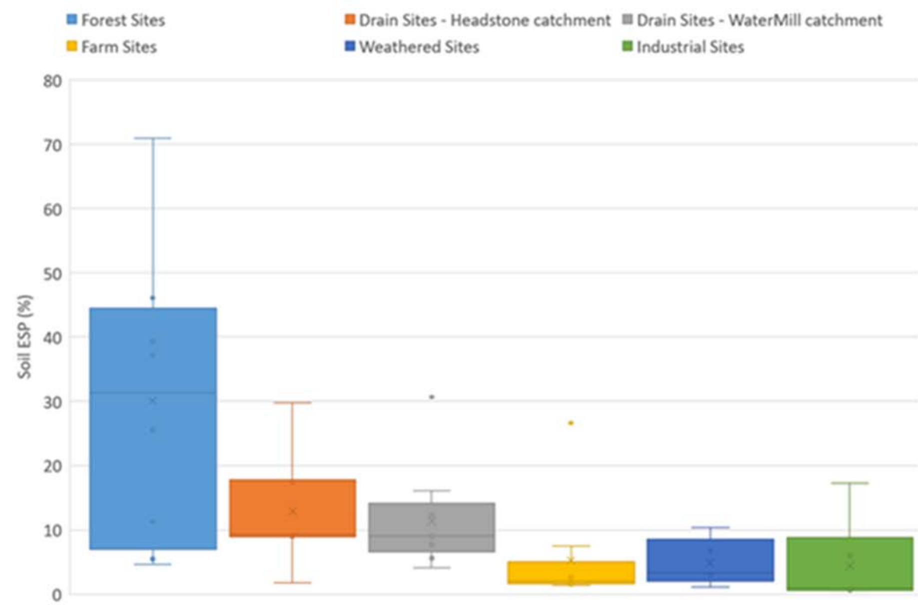


Caustic soda
Sea water
Pure water
Vinegar
Lemon juice
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Alkaline
Neutral
Acid

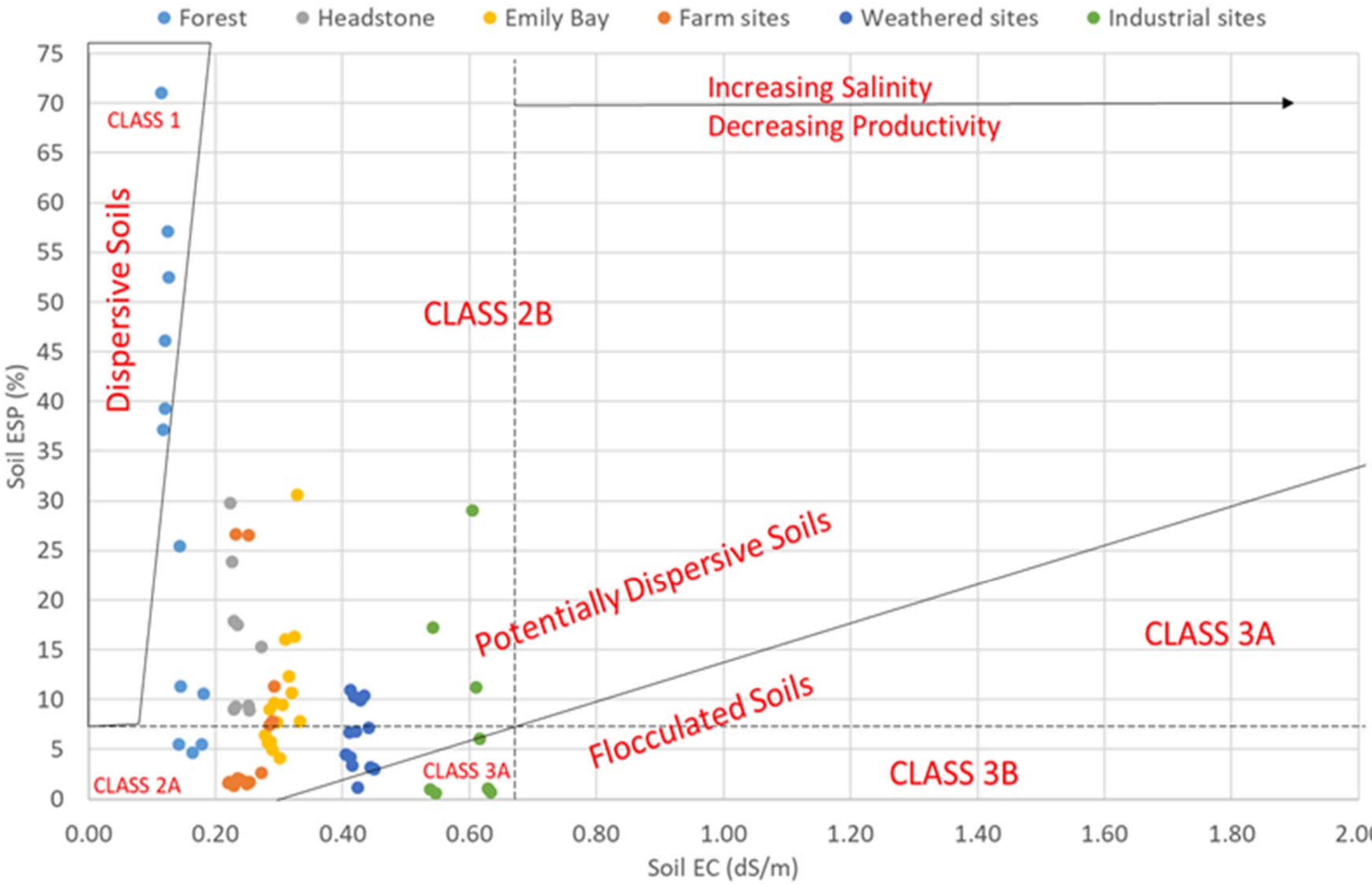
Drivers of Soil Health, Structure & Stability

Soil Electrical Conductivity (µS/cm)

Soil Exchangeable Sodium Percentage (ESP)



Land Use Capability Assessment – Norfolk Island Soils



Class 1: Dispersive soils that spontaneously in water. These are unstable, sodic soils that can have sever management problems.

Class2: Potentially dispersive soils that disperse after being mechanically worked either by raindrop impact, irrigation or tillage.

Class 2a: Soils that have few structural problems if managed using minimum tillage techniques or if maintained under full pasture growth.

Class 2b: Unlike Class 2A soils, these become spontaneously dispersive (Class 1) when leached without the addition of calcium compounds, and if there is no generation of electrolytes in the soil due to mineral weathering.

Class 3: Flocculated soils that remain flocculated, even when subjected to mechanical stress.

Class 3a: Leaching with low electrolyte water may change saline-sodic soil to Class 2b, or in extreme cases to Class 1. Soils may then disperse and cause severe crusting.

Class 3b: These soils are saline but dominated by non-sodium salts. These soils have no physical problems and the amount of leaching required on the salt tolerance of crops to be grown.

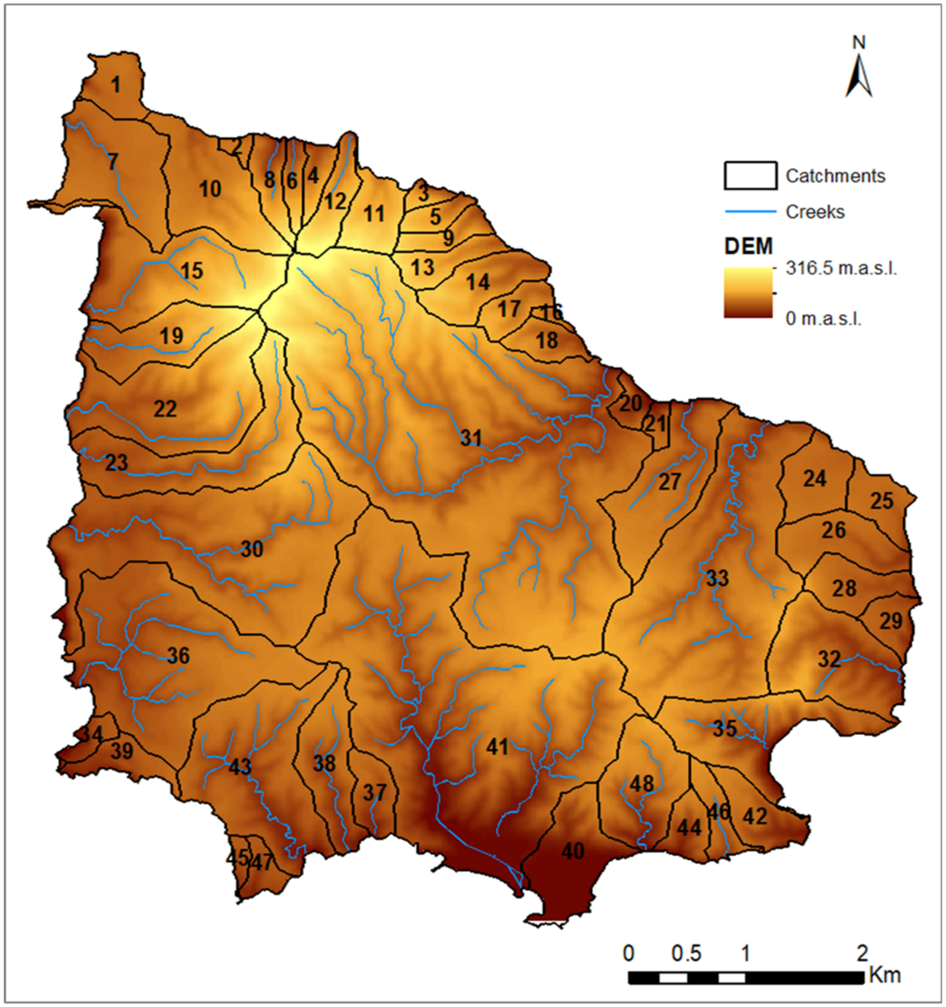
Class 3c: No dispersion and salinity problems occur where soil EC > 2 dS/m, but productivity decreases depending on crop grown.

Hydrological assessment and preliminary water balance

Main Water Management Issues:

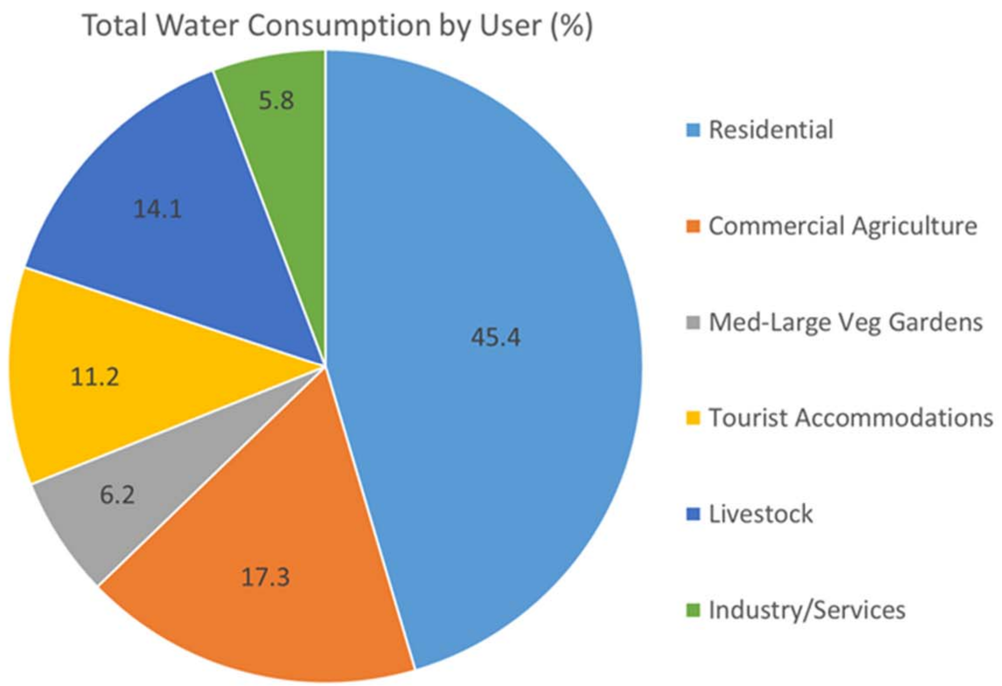
- Groundwater recharge rates/extraction rates remain uncertain
- Minimal monitoring of surface water discharge or groundwater levels
- Negligible monitoring, metering or record keeping of water use from tanks, groundwater or dam extraction
- Decreasing rainfall forecast for the future so there is a need to optimise available water…..can't manage what we don't measure
- Source of contaminants impacting on Emily Bay broadly identified (from septic tanks and cattle) and requires improved management

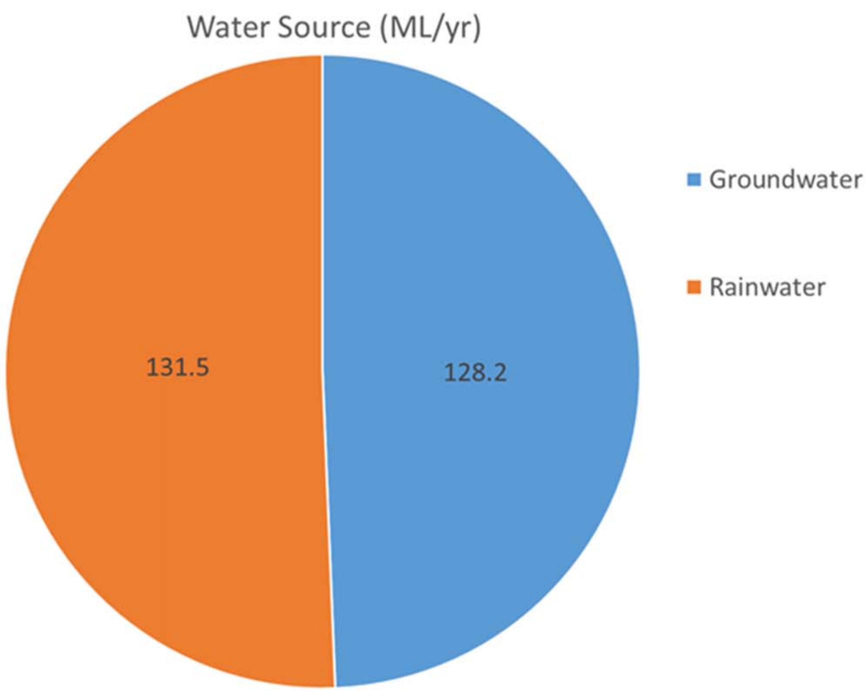
Hydrological assessment and preliminary water balance



- Rainfall
- Evapotranspiration
- Infiltration
- Surface water
- Groundwater
- Sub-catchment area
- House numbers per sub-catchment
- Water demand
- Water use

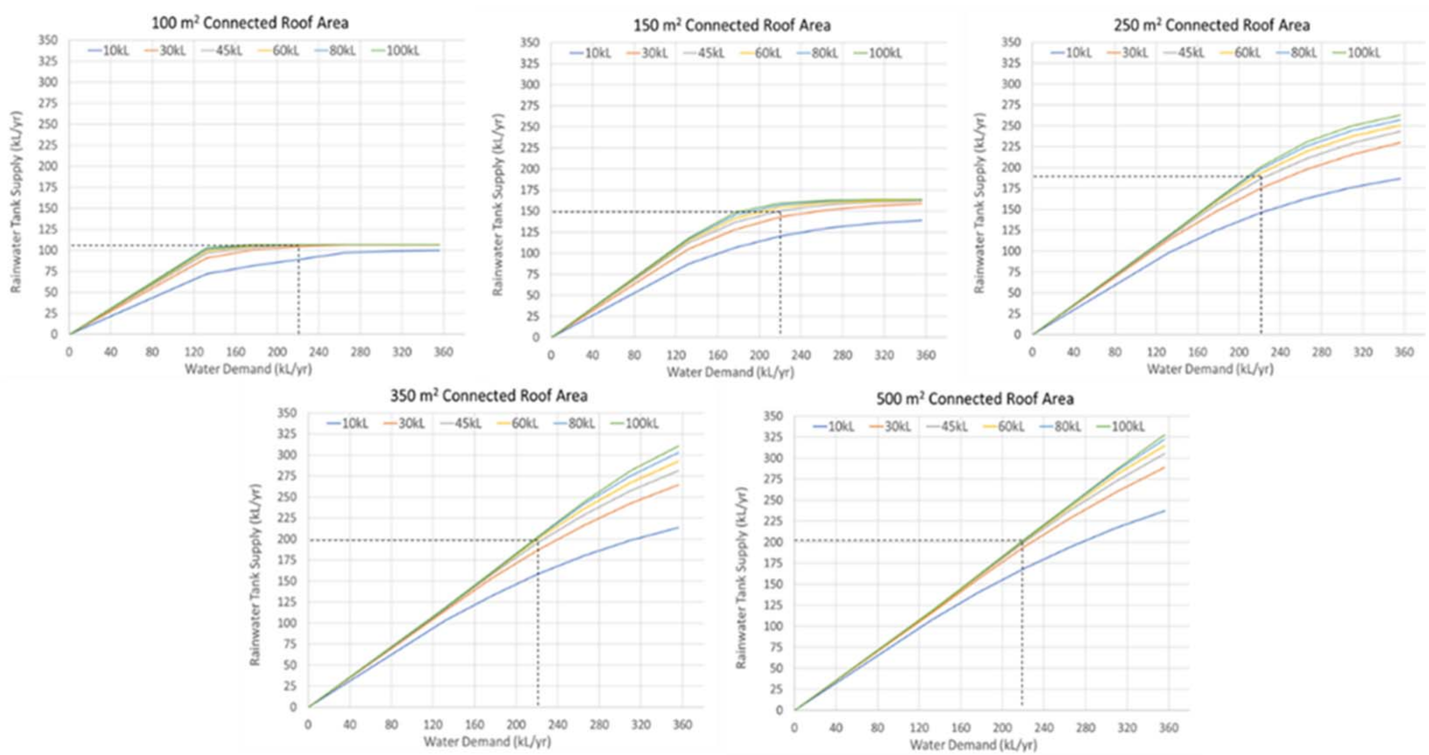
Total Water Consumption and Source





Data Source: CSIRO NIWRA Report (2021)

Hydrological assessment and preliminary water balance



Water demand input data used in PURRS

Water Demand (kL/yr)	131.9	176.6	221.3	266.1	310.9	355.6
L/person/day	361.3	242.0	202.1	182.3	170.3	162.4
Number of People	1	2	3	4	5	6

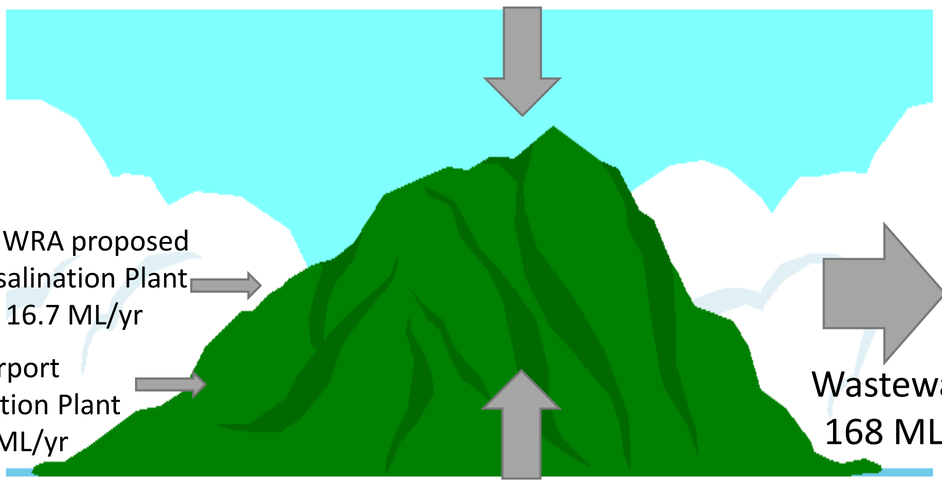
Results from continuous simulation using water demand and rainfall inputs at 6-minute timesteps.
Rainfall input file was from 1949 – 2019.

Key observations:

- Smaller roof areas (< 150 m^2) are catchment limited, indicating that roof area is more significant than tank volume in providing household water demand;
- Larger roof areas (> 250 m^2) are water demand limited and tank volume can vary;
- Knowledge of water demand will drive the optimisation of both connected roof area and tank volume;
- Knowing the water demand from any water source depends on reliable and accurate monitoring of water use and water metering on Norfolk Island is a recommendation.

“Available” Water & Water Consumed by Source

2019
(283 ML/yr)



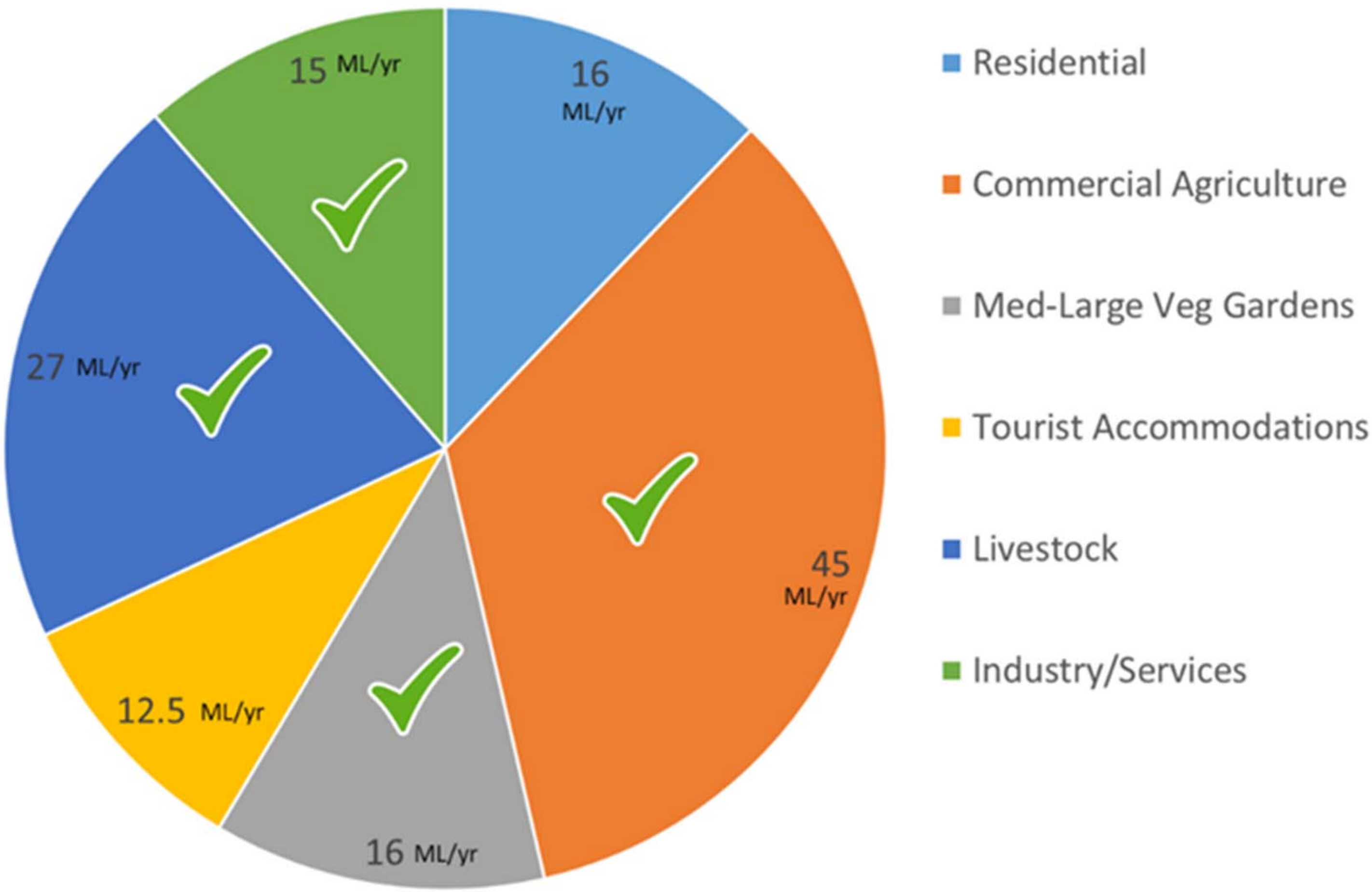
*Only the Airport Desalination Plant has been operational since 2019.
The NIWRA is a proposed plant only, but included in the Available Water total to provide indicative water availability

Data Source: CSIRO NIWRA Report (2021)

By Volume,

- Groundwater is by far the largest water resource on Norfolk Island, but it has been the most heavily depleted in the past 50 years;
- Rainfall is decreasing and will impact yields for different buildings and water demands;
- Desalination plants can only supply 24 ML/yr if running 24 hrs/7 days for 12 months;
- ALL wastewater goes out to sea (Marine Park) and is not utilised;
- The emergency situation in 2019 meant some groundwater supplies became inaccessible due to low water levels.

Potential "Users" of an alternative water supply?

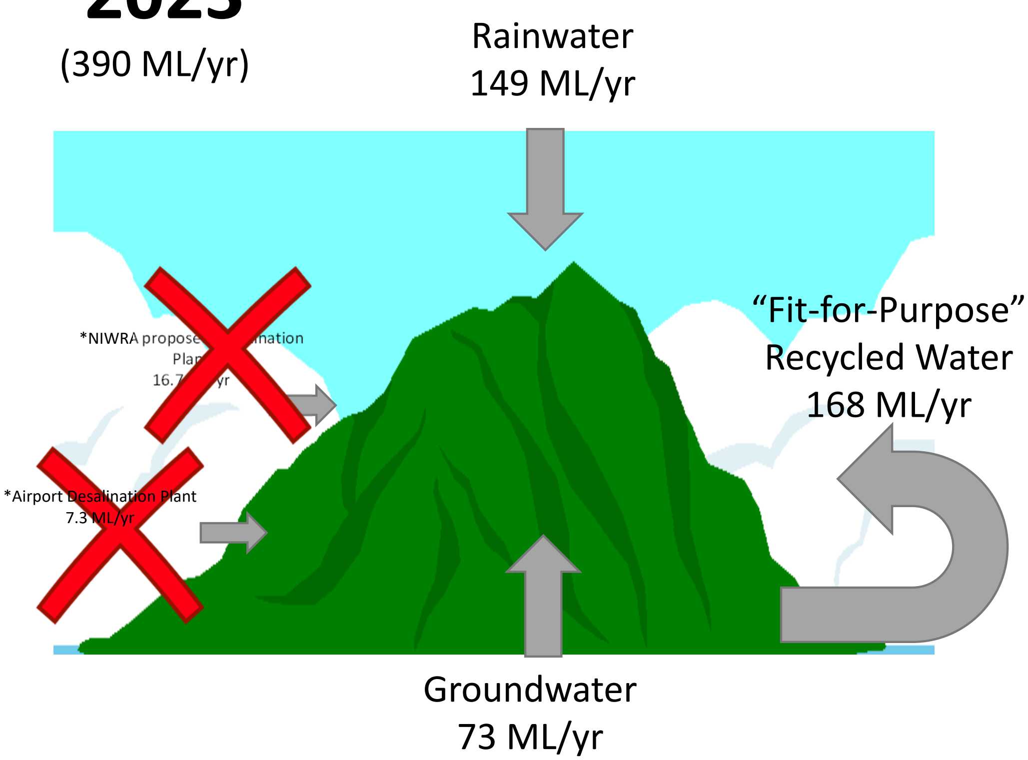


Data Source: CSIRO NIWRA Report (2021)

Available Water & Water Consumed by Source

2023

(390 ML/yr)



Benefits

- Additional 107 ML/yr available compared to 2019;
- Groundwater reliance decreased by 43.5% (Lubbe side is);
- Rainfall is decreasing, however by optimising rainwater harvesting on all buildings, the existing demand should be able to be met with additional yield (tank size and/or roof area);
- ALL wastewater treated and reused (no discharge to Marine Park);
- Deeper groundwater wells (as proposed in the CSIRO) will allow access to the 205,000 ML/yr in deeper saturated rock, however the CSIRO option suggested 13.7 ML/yr could be accessed, and predominantly for emergency situations;
- Desalination plants no longer required (significantly reduced costs and no brine discharge to the Marine Park).

Emergency Water Supply Management

Based on the groundwater recharge rate in the CSIRO NIWRA Report it is conceivable that with reduced groundwater extraction (-43%) there would be ~3,500 ML (~16 years of supply at current demand rate) available for Emergency Management Planning. To even consider this, the WWTP upgrade is a cornerstone for providing "fit-for-purpose" water for expanding food production and reducing reliance on groundwater.

Current estimations of groundwater in (deep) saturated rock is 205,000 ML/yr. No equipment is currently on Island to access this resource. If left to recharge with reduced extraction, this approach should increase the likelihood of recharge existing shallow bores to a point where groundwater potentially becomes the "Emergency Supply". Data indicates the decrease in groundwater extraction rate (after the WWTP upgrade) would be similar to pre-1990 scenarios

The groundwater store is the biggest "storage" on the Island and shallow bores constructed across the Island provide a spatial distribution for water delivery in emergency situations. Monitoring groundwater levels becomes imperative from now on to determine long-term patterns;

There is more to discuss and refine, such as timelines leading into an emergency water situation, trigger levels as determined from indicator storage levels (maybe groundwater bores, rainfall, and others), and developing a plan to improve water awareness & community behavioural patterns of users prior to these times (which locals probably do anyway).

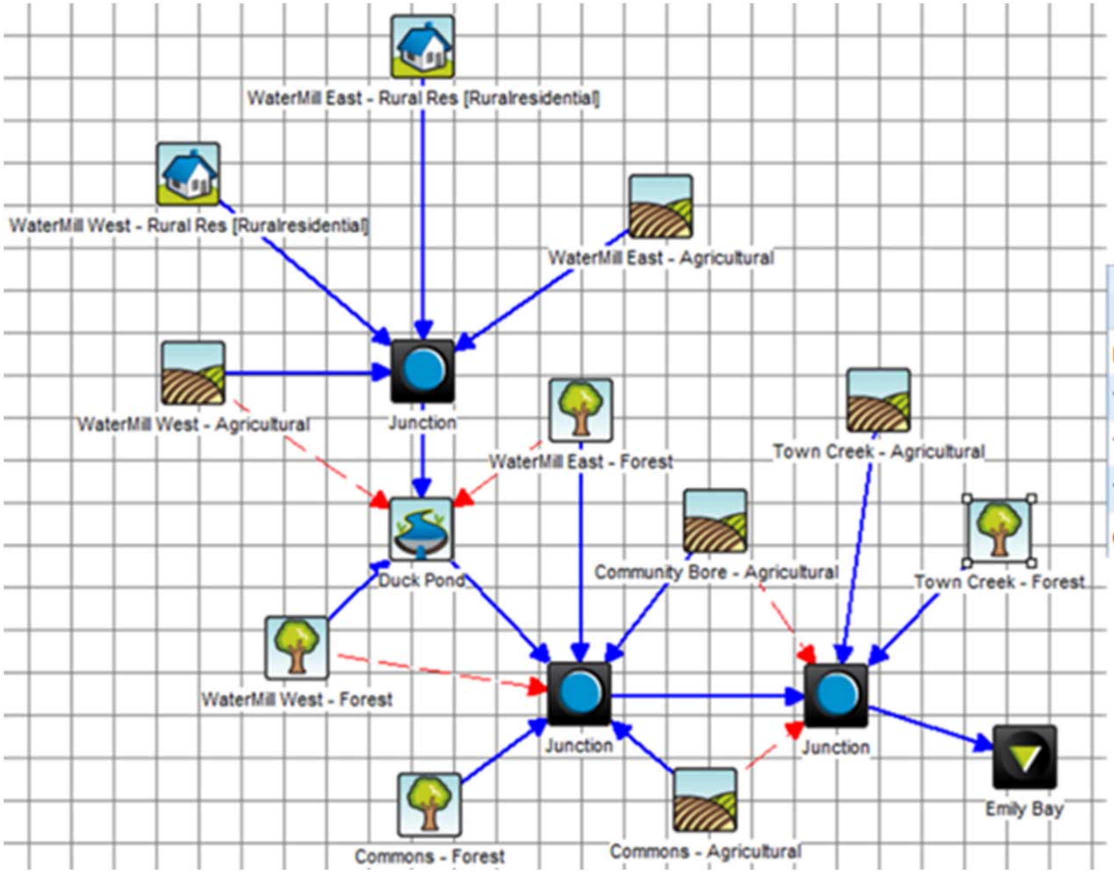
Hydrological assessment and preliminary water balance

Improving surface water quality

Source: AECOM (2017) Emily Bay and Upper Cascade Creek Catchments Norfolk Island Water Quality Study, Prepared by AECOM Australia for Norfolk Island Regional Council (REF: 60531847)

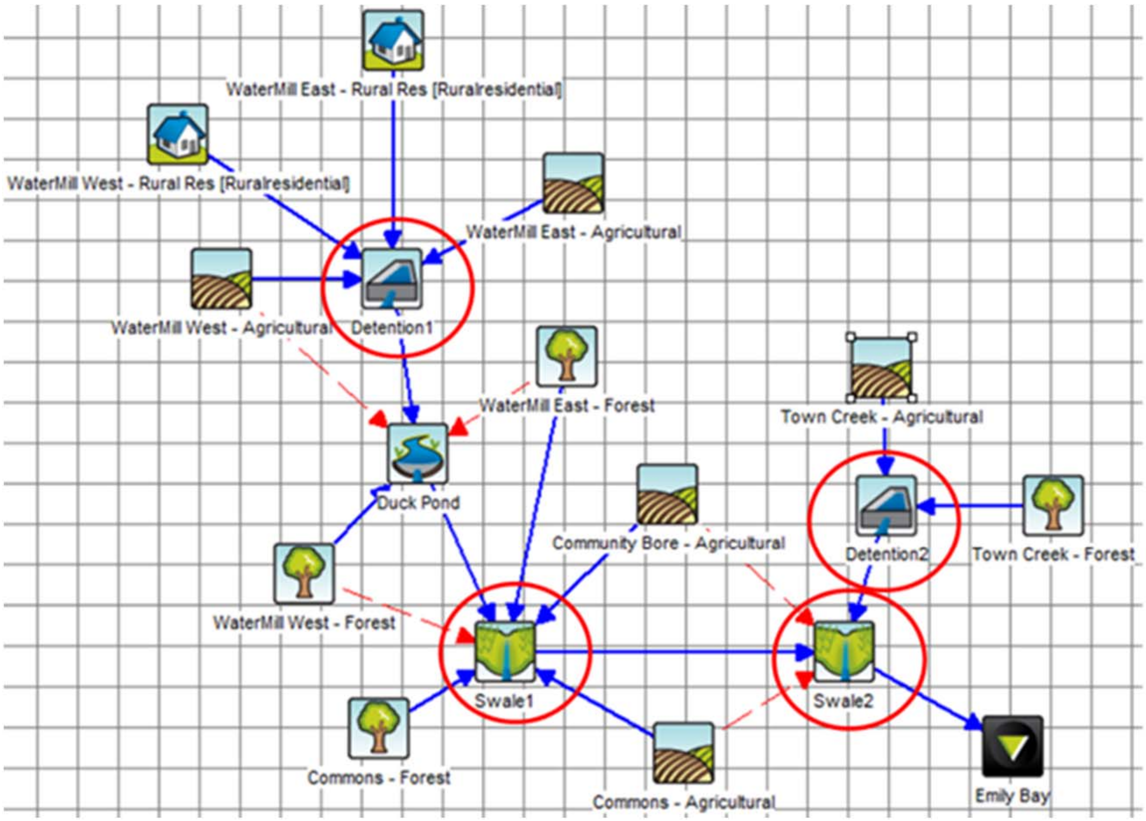
Location	Land Use	Area (ha)
Watermill Sub-catchment West	Rural Residential	105
Watermill Sub-catchment West	Agricultural	45
Watermill Sub-catchment West	Forest	28
Watermill Sub-catchment East	Rural Residential	20
Watermill Sub-catchment East	Agricultural	21.7
Watermill Sub-catchment East	Forest	20
Kingston Commons Sub-catchment	Forest	45.1
Kingston Commons Sub-catchment	Agriculture	40
Community Well Sub-catchment	Agriculture	23.6
Town Creek Sub-catchment	Agriculture	80
Town Creek Sub-catchment	Forest	59
Watermill Creek Catchment Total Area (ha)		**487.4**

Improving surface water quality



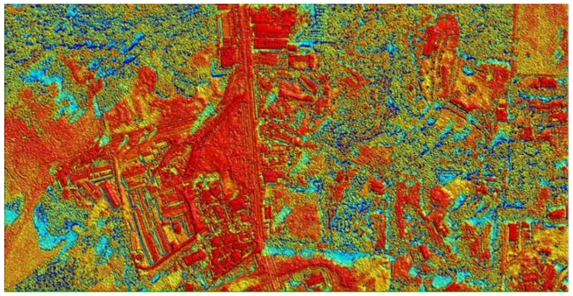
	Sources	Residual Load	% Reduction
Flow (ML/yr)	1370	1360	0.4
Total Suspended Solids (kg/yr)	144000	125000	12.9
Total Phosphorus (kg/yr)	367	338	7.9
Total Nitrogen (kg/yr)	2950	2860	2.9
Gross Pollutants (kg/yr)	21300	5440	74.5

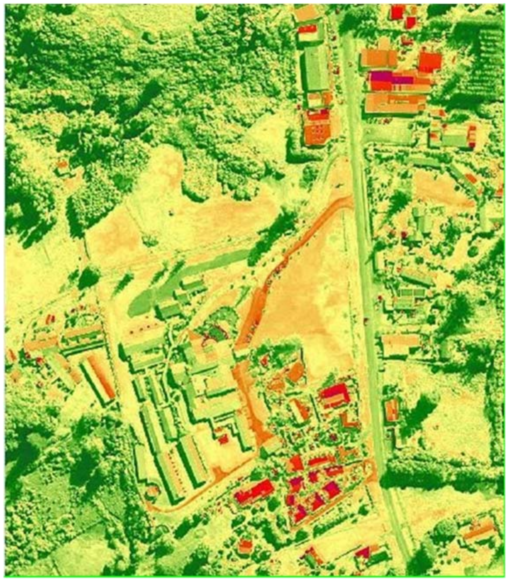
Improving surface water quality

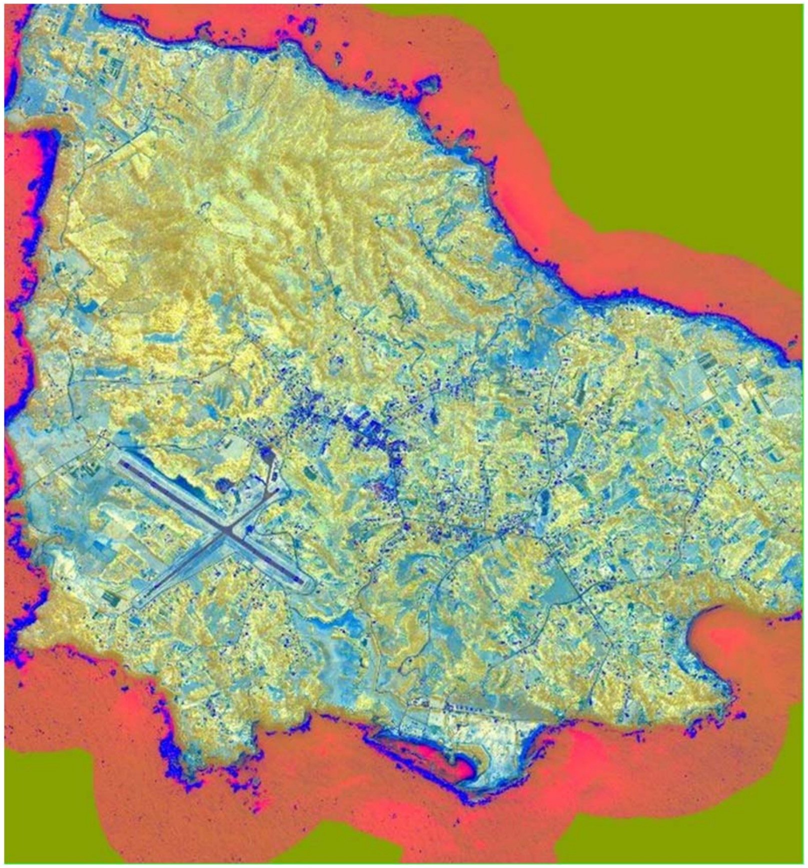


	Sources	Residual Load	% Reduction
Flow (ML/yr)	1350	744	44.9
Total Suspended Solids (kg/yr)	137000	57100	58.3
Total Phosphorus (kg/yr)	354	177	50
Total Nitrogen (kg/yr)	2870	1690	41.2
Gross Pollutants (kg/yr)	20100	0	100

Assessment of the Island's ecosystem, biodiversity, and the requirements for ecological sustainability

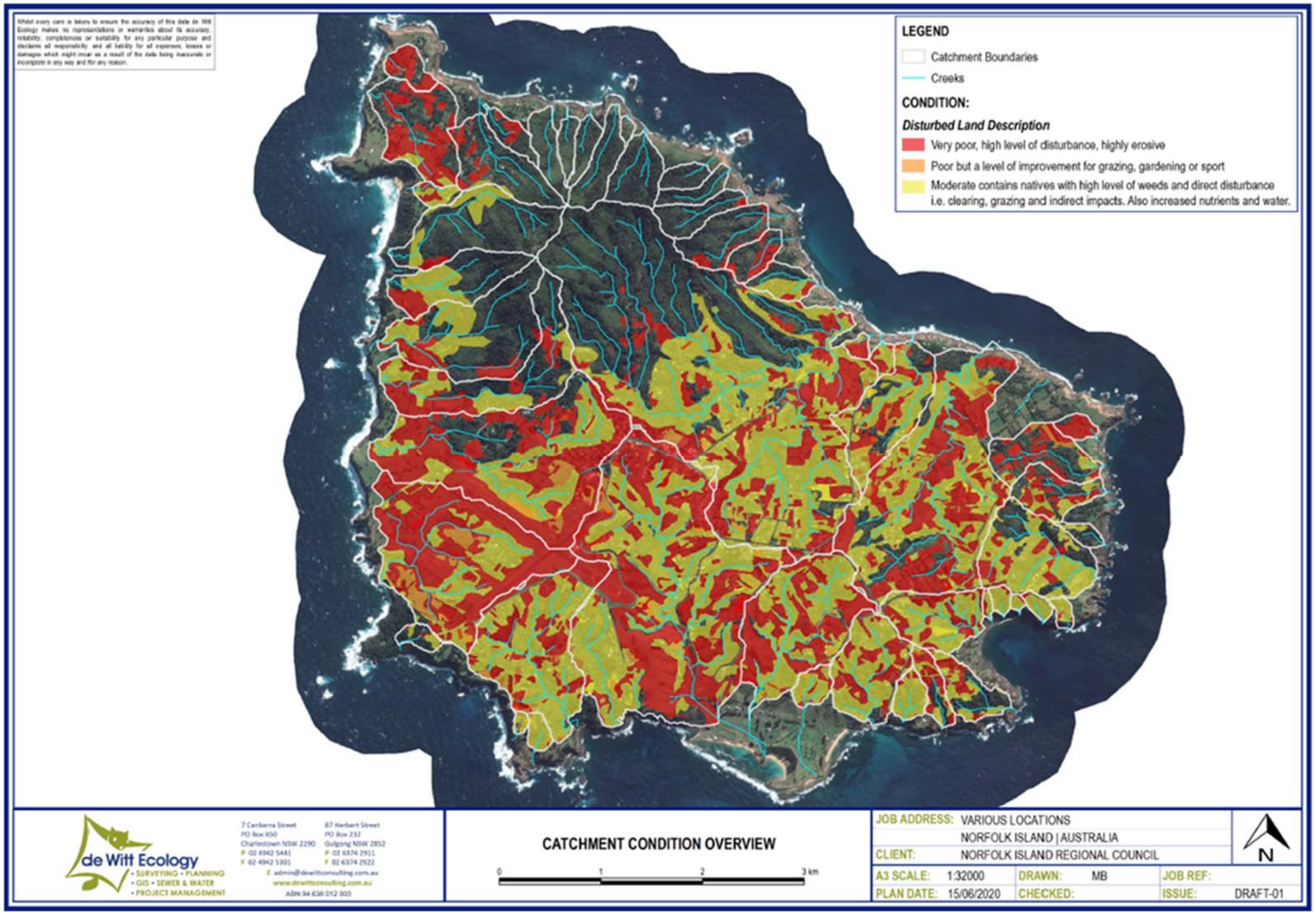

Soil adjusted vegetation index image

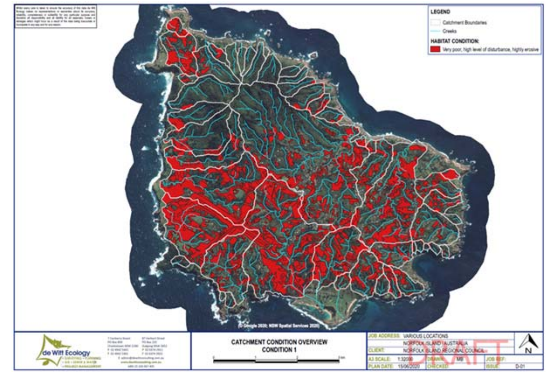

Principal Component Analysis (PCA) + "stretch"

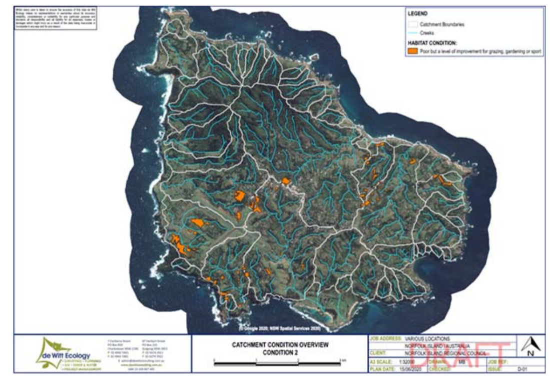

SVM classification image for Norfolk Island

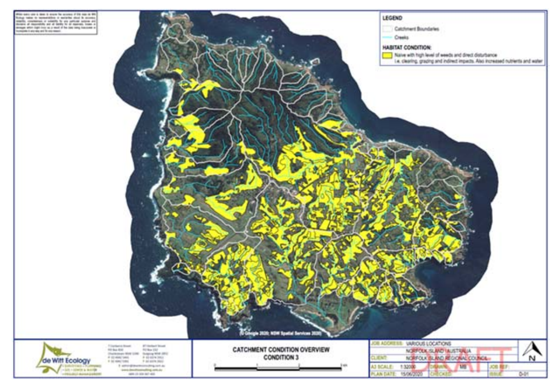
Satellite Data

Catchment Condition Overview

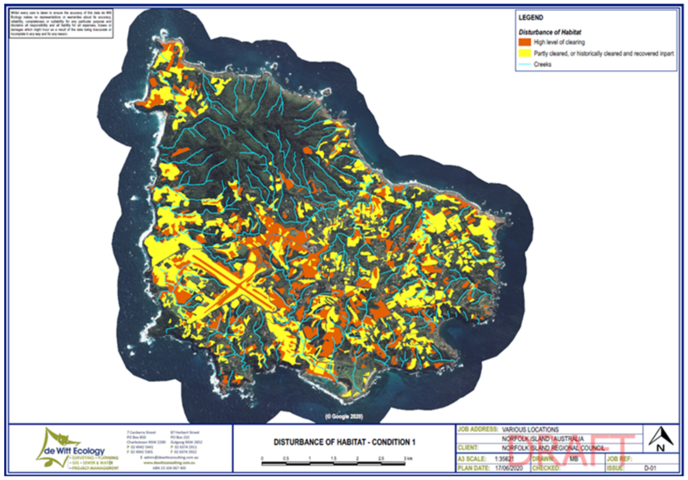


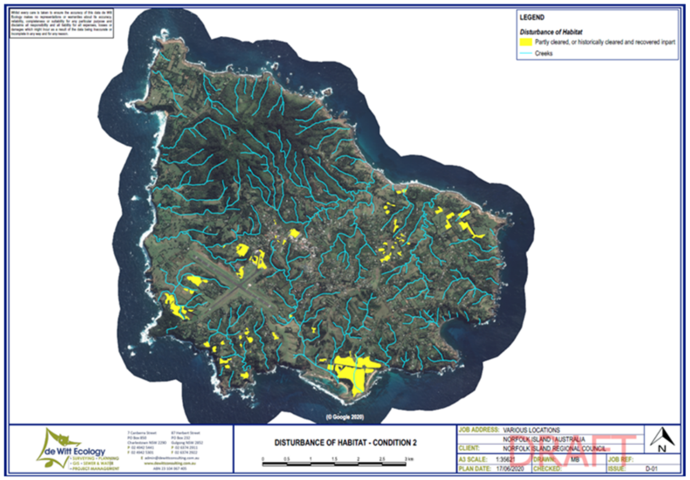


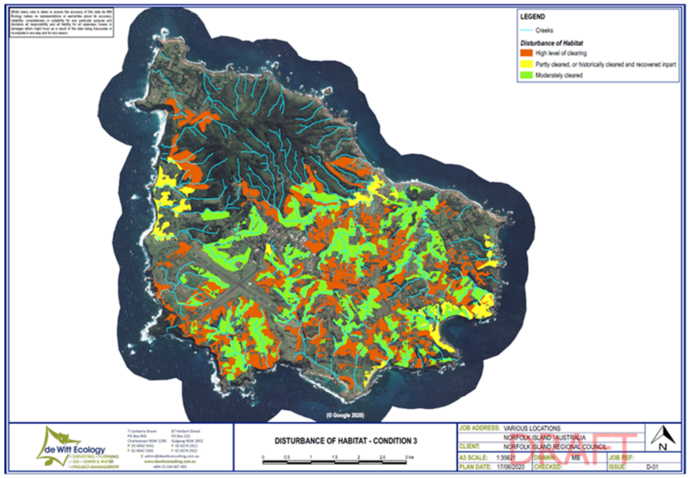


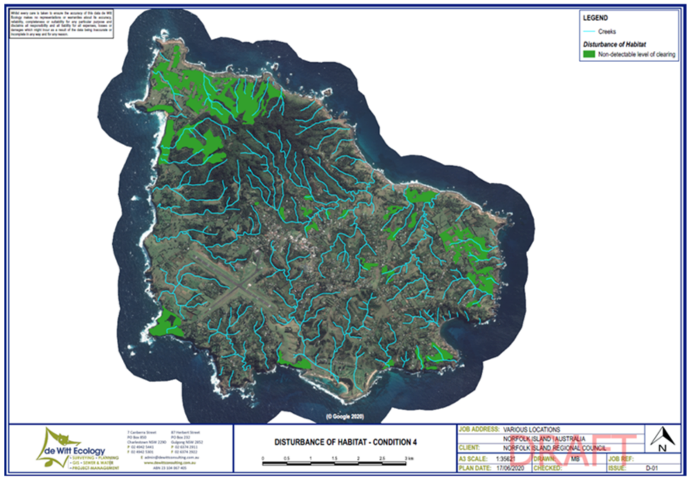


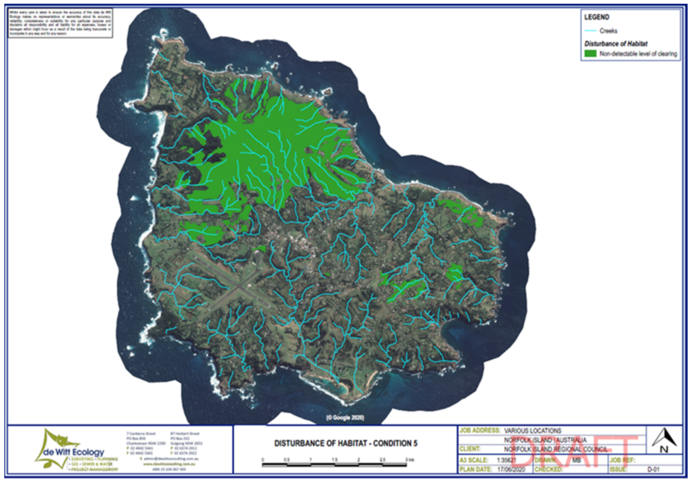
Catchment Condition – Disturbance Classes

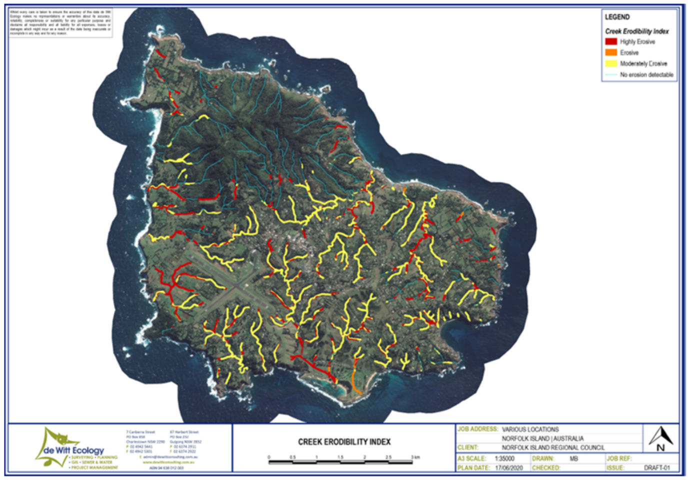




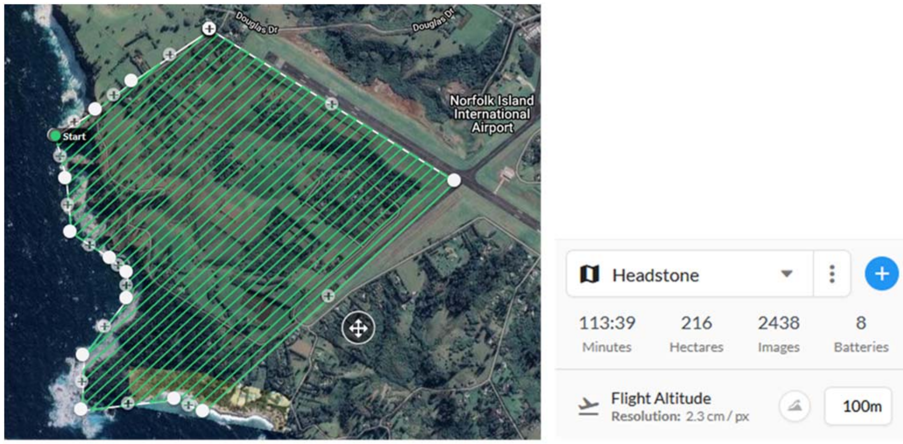


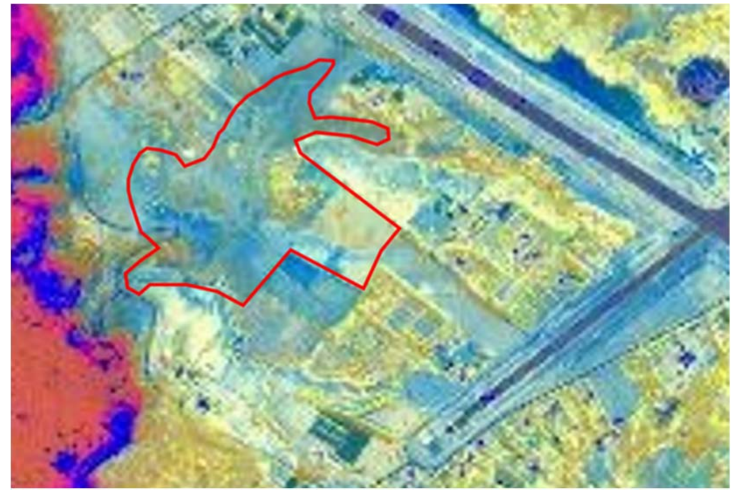


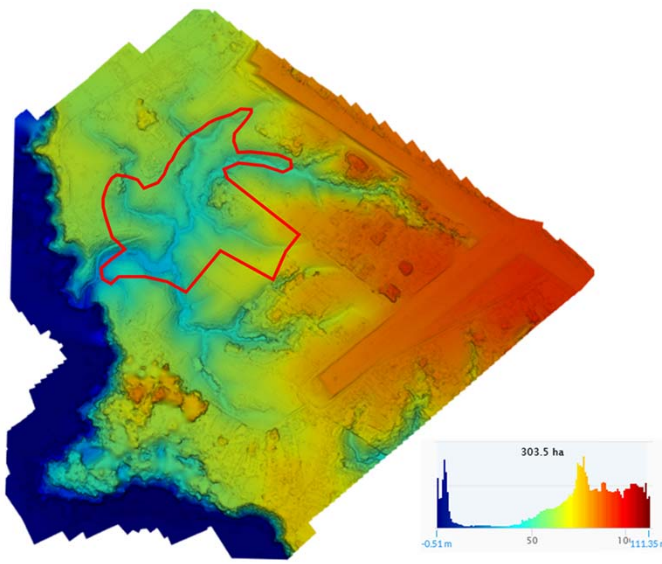


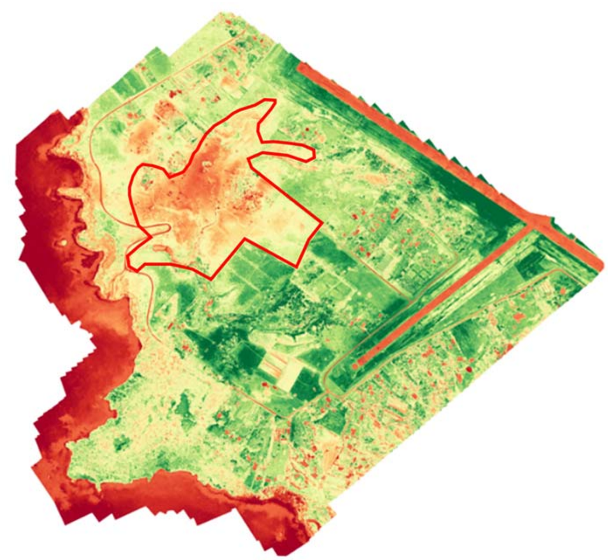


Drone survey data









Energy

RENEWABLES

- Solar
- Wind
- Wave power

ENERGY STORAGE AND DISPATCHABLE ELECTRICITY GENERATION

- Hybrid systems
- Bio-energy
- Pumped hydro
- Battery systems

BIOMASS

PLASTIC WASTE TO FUEL: CATALYTIC PYROLYSIS

BIOGAS

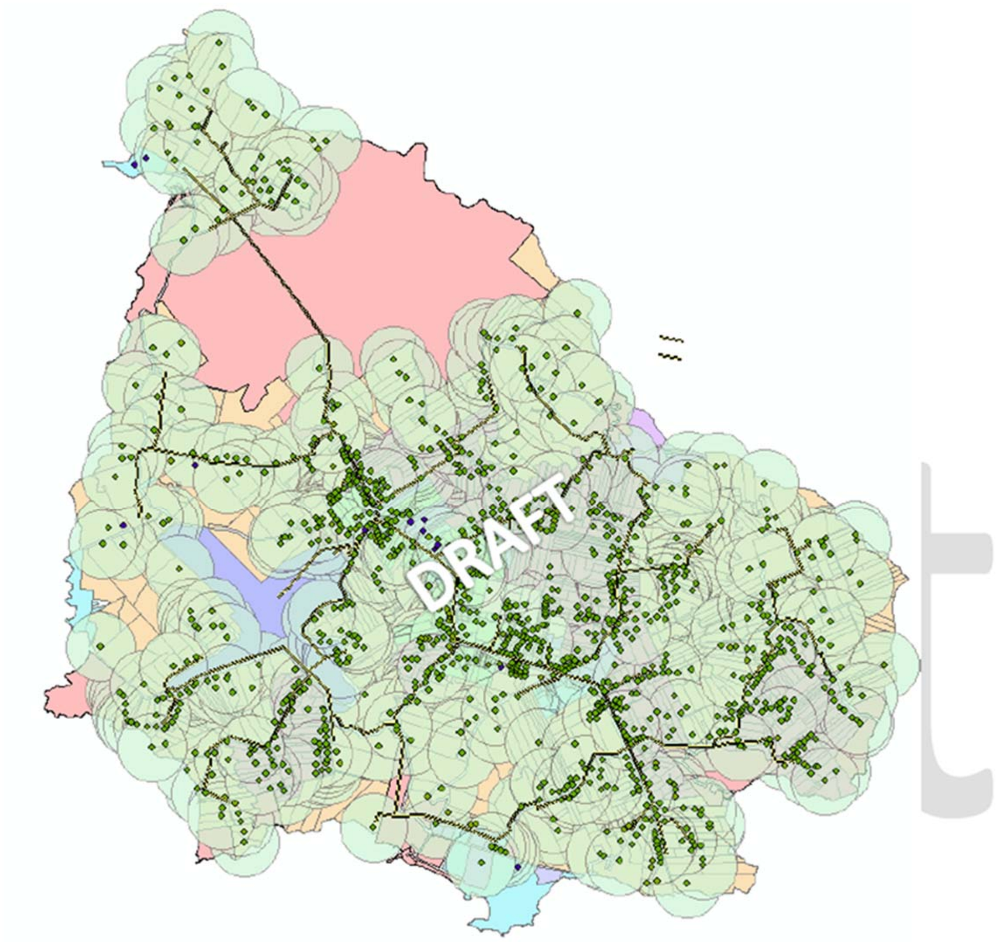


Figure 7 Draft picture of supplied data, dwellings with a 300 m buffer applied, cadastral parcels and distribution lines.

Energy

The *2016-2026 Norfolk Island Community Strategic Plan – Our Plan for the Future* identified renewable energy infrastructure as a key issue to be addressed (NIRC, 2016a). The strategic direction "An environmentally sustainable community" through the objective "Use and manage our Resources wisely" identified developing a clean energy future as a key path.

Actions to achieve these targets were detailed in the Operational Plan 2019-2020 (NIRC, 2019c) and included:

- Hydro Tasmania's detailed engineering plan to reconfigure island power generation is fully costed by an Energy Economist, and a recommendation on implementation prepared for Council,
- Discussions with the Commonwealth as to subsidise tariffs in line with other island communities,
- Installation of a new diesel generator and battery capacity to reduce the Powerhouse's diesel fuel requirements,
- Complete Grant Funding Application on Energy Solution options,
- Reform the Electricity Supply Act 1985(NI),
- Public education on electricity incentives (specifically on electricity and energy efficiency).

These were subsequently updated in the Draft Operational Plan 2020-2021 (NIRC, 2020c) to include:

- Determine optimal implementation pathway to achieve the objective of 100% renewable energy at lowest capital cost, within specified timeframes, keeping ongoing operational costs as low as possible.

Energy – Future State

ENERGY CASE STUDY 1:
PROGRAM TO STABILIZE THE ELECTRICITY GRID

ENERGY CASE STUDY 2:
PROGRAM TO EXPAND ROOFTOP SOLAR PV AND BATTERY

ENERGY CASE STUDY 3:
COMMUNITY OWNED SOLAR FARM

ENERGY CASE STUDY 4:
TRANSITIONING TO 100% RENEWABLE ENERGY

LINKAGES TO OTHER THEMES

- WASTE CASE STUDY 1 – CATALYTIC PYROLYSIS UNIT
- TRANSPORT CASE STUDY 1 – ELECTRIC VEHICLE STRATEGY