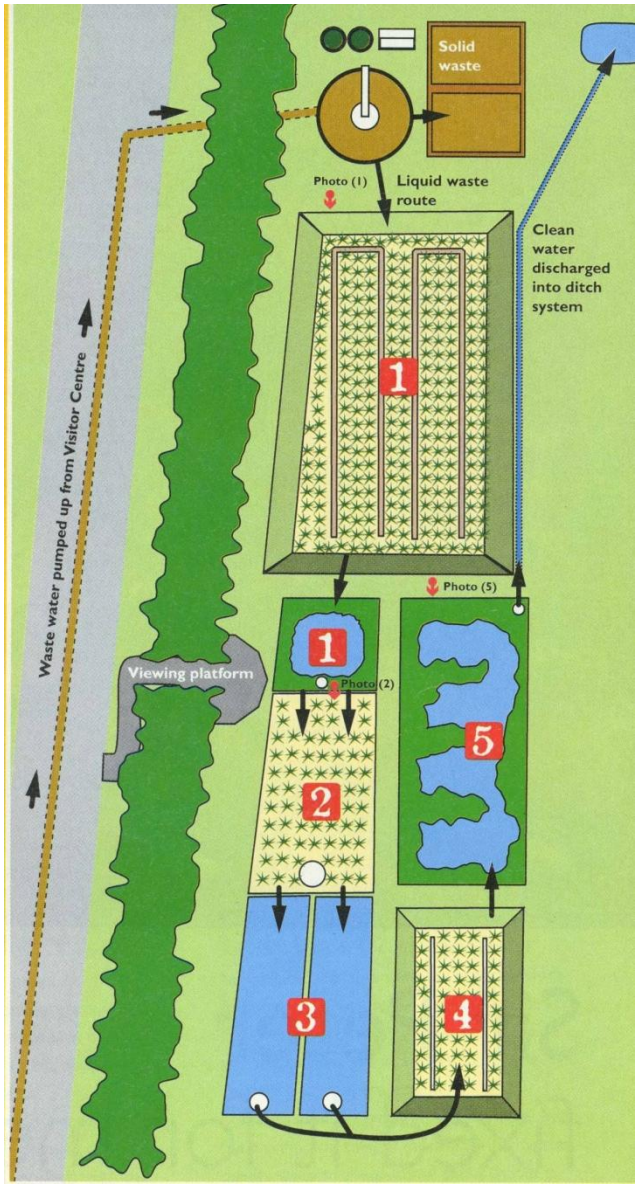
The state of the art of constructed wetlands and SuDS treatment train - Cartland Low Carbon Pilot Plant and The Barge, Runcorn compact SuDS

Ian Griffin (ECUS Ltd.) & Dave Naismith (WWT Consulting Ltd.)

WWT - Wildfowl and Wetlands Trust

- A charity founded at Slimbridge, UK, in 1946 by the naturalist and artist Sir Peter Scott
- Vision to integrate people and wildlife whilst protecting the habitats that they depend on
- Now has 60 years of experience in wetland conservation and visitor centre management
- 9 centres, 7,000 acres of wetlands (including 7 SSSI, 5 SPA and 6 Ramsar sites)

Millennium Reedbed - Slimbridge



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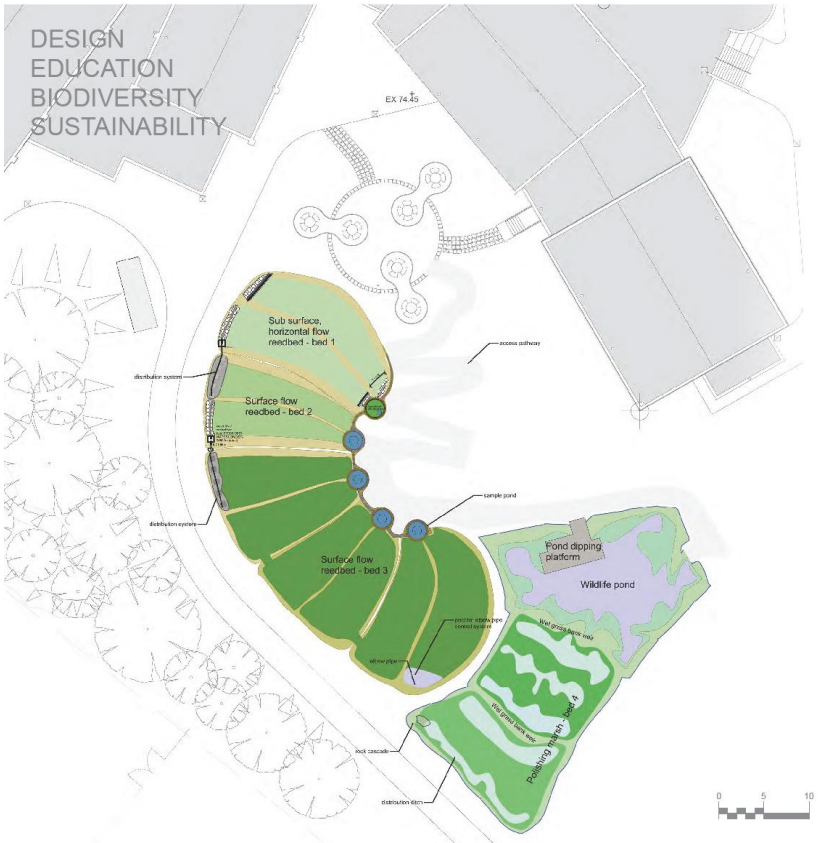
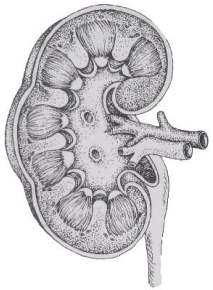
- Domestic sewage
- Industrial wastewater
- Commercial buildings (visitor centres)
- Agricultural pollution
- Acid mine drainage
- Landfill leachate
- Groundwater remediation
- Stormwater and SuDS
- Hydrocarbons

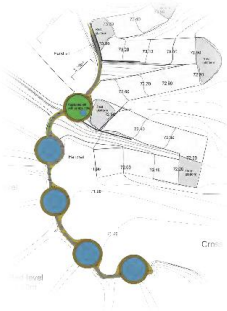



Wetland Treatment System applications

DESIGN
EDUCATION
BIODIVERSITY
SUSTAINABILITY

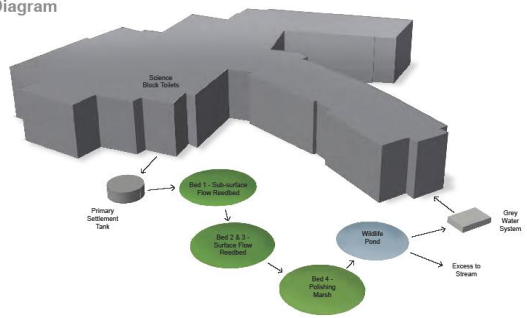






Sampling Points

Water Flow Diagram



Concept - Developed in close consultation with students, and taking inspiration from the shape and function of a kidney, the Attenborough Garden at Abraham Guest High School in Wigan:

- treats wastewater from toilets in the science block in a sustainable way;
- provides a supply of off-mains grey-water, reducing the school's water bill;
- provides the school with an outdoor laboratory and learning space;
- is a natural greenspace that can be enjoyed by students between lessons;
- slows the passage of stormwater into local streams, thus reducing flood risk; and
- provides a variety of valuable habitats for wildlife.

Water Sampling - A retaining wall was specially designed to contain a series of pools that intersect the flow of water through the treatment system. These act as sampling points where students can measure the water quality and track its improvement as it progresses though the beds. In addition to this, WWT Consulting will be undertaking laboratory testing of the water quality, the data from which will be shared with the school.

Recreation - As the Abraham Guest High School was a new build under the Pathfinder Schools scheme, there was the opportunity to integrate the design of this facility with the overall programme of the school's grounds. This has meant that this area is used by the students as a recreational space during their free-time.

Sustainable Water Management - Effluent from the science block toilets is passed through a series of treatment beds. Plants, bacteria and natural processes within these beds act to break down and remove contaminants. The clean water enters a wildlife pond before being extracted by a grey-water system for reuse in the toilets. In the future it is hoped that the project will be expanded to include a series of student allotments. Irrigation for these could also be supplied by this grey-water system.

This system also treats and stores stormwater, allowing it to be slowly released into the local watercourse, providing the school with the ability to limit the impact of climate change on the surrounding environment.

Biodiversity - Unlike other treatment systems that work on this principle, this design uses a wide variety of native plants. This increases the value of this area to wildlife, improves the efficiency of the treatment process and provides the students with an opportunity to monitor the natural changes within these plants communities as they mature.

Pond-dipping - Located on the wildlife pond at the culmination of the treatment process, a pond-dipping platform provides students with safe access to the water's edge. From here they can explore the marginal habitats, identifying and recording the various species they encounter. Annual records will be maintained by the school, building a data set that can be analysed over the long term.

Pond-dipping Platform

ABRAHAM GUEST HIGH SCHOOL
ATTENBOROUGH GARDEN
From the 'Knowledge Garden' concept by Stakeholder Design under Project Faraday

Client: Wigan Council
Principle Stakeholder: AGHS
Project Faraday Concept Originator: stakeholderdesign

Wildfowl & Wetlands Trust (Consulting) Limited
Slimbridge,
Gloucestershire GL2 7BT, UK
T +44(0)1453 891222
F +44(0)1453 890827
E consulting@wwt.org.uk
W wwtconsulting.co.uk

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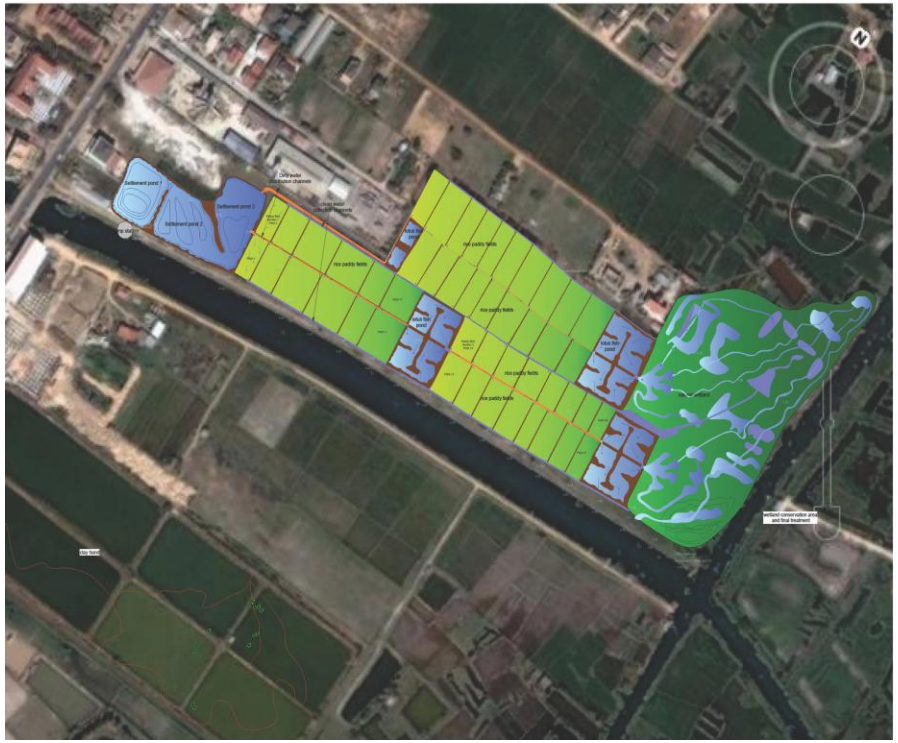
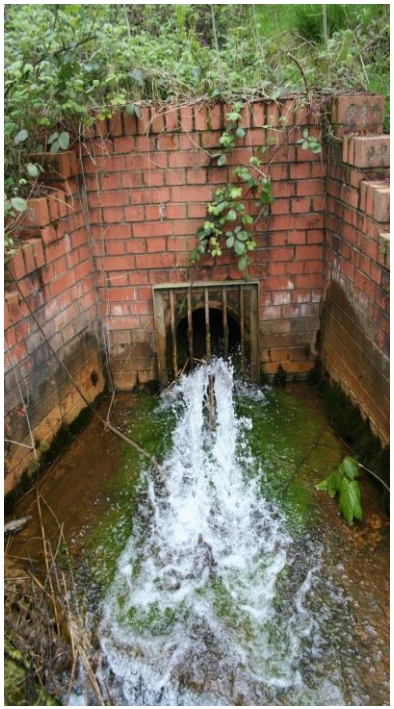
School Projects - Wastewater Treatment, Biodiversity, Recreation and Education

Laos Vientiane City – City scale treatment wetlands



Multiple contaminants from municipal and industrial sources


132 m
Image © 2011 The GeoInformation Group
©2010 Google
Imagery Date: 6/1/2004 1945
51°40'58.05" N 3°17'53.55" W elev 167 m
Eye alt 828 m



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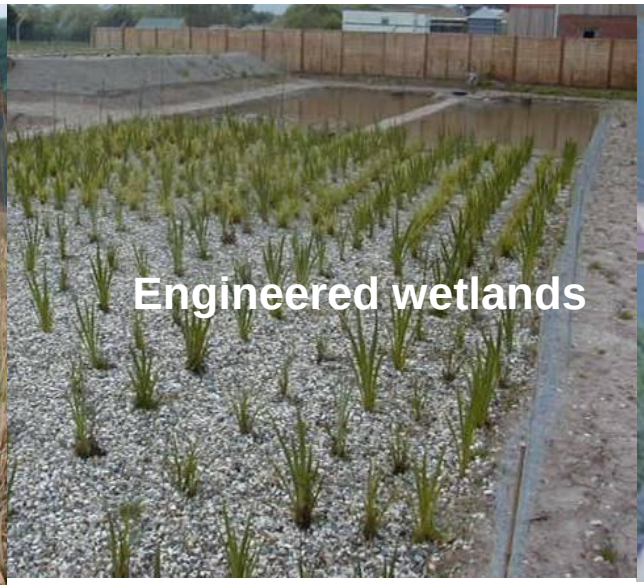
Least Energy and O&M needs most



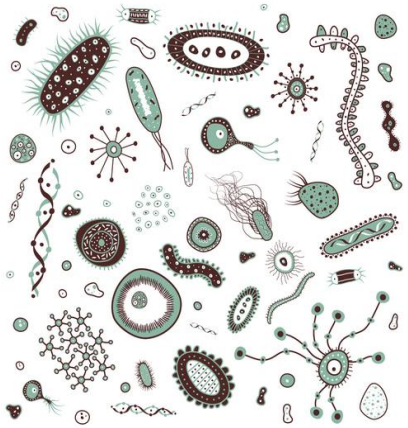
Most Area requirements least

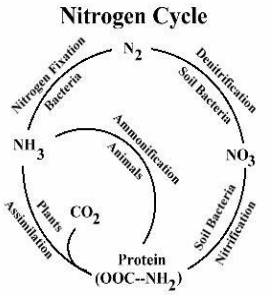
Natural v's mechanical systems

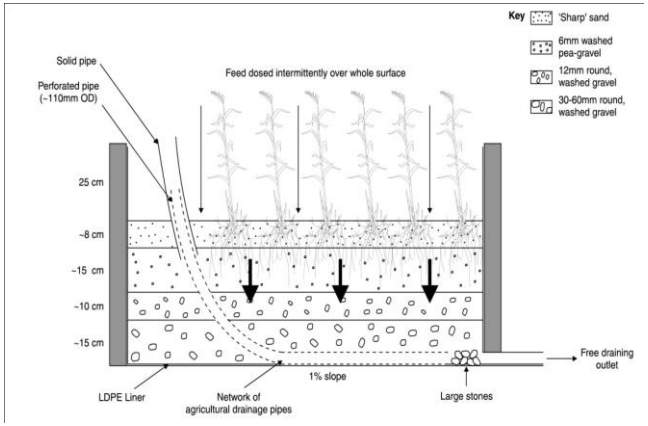
BP Casper Wyoming, USA

Removal of hydrocarbons from groundwater

How they work







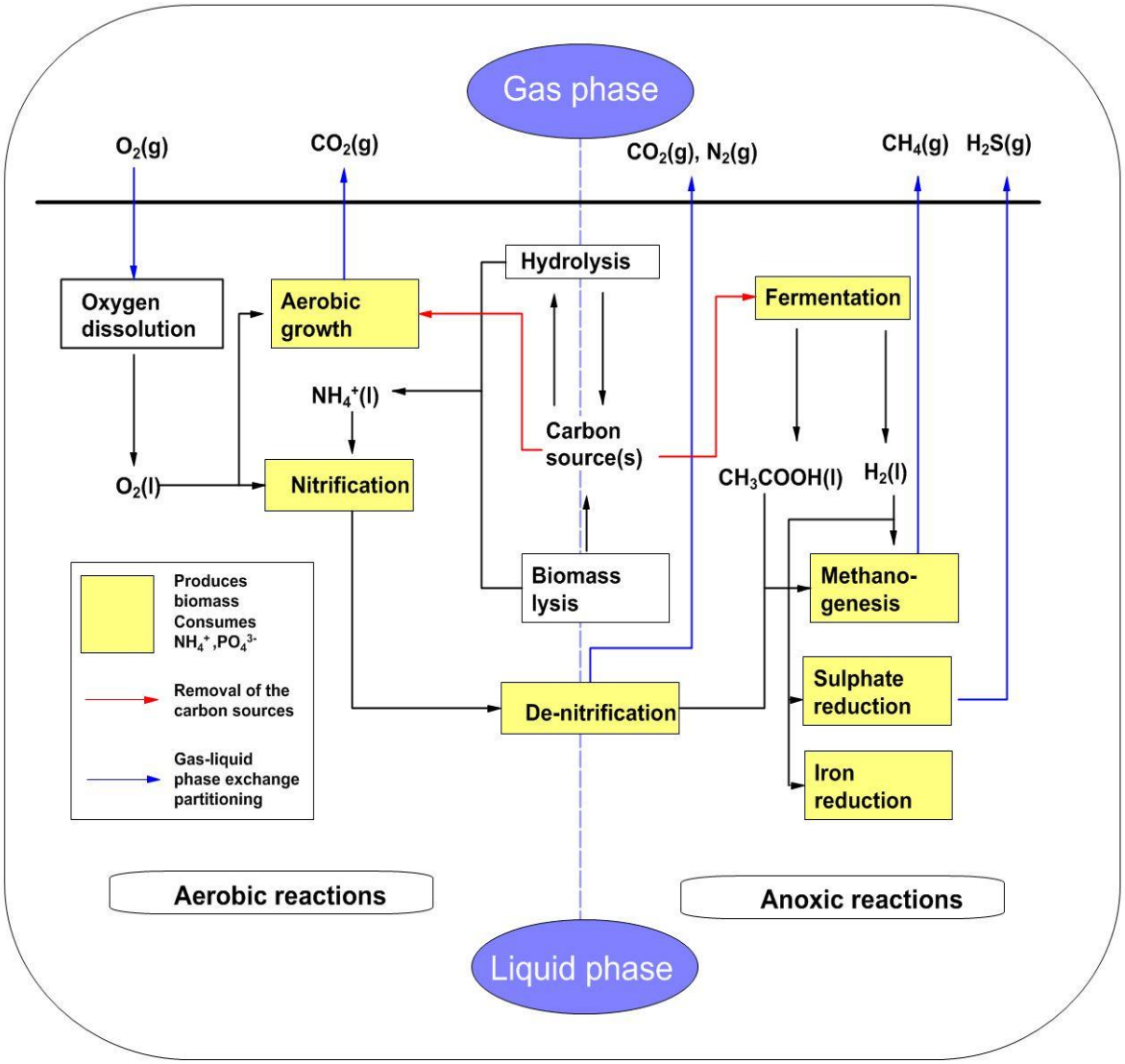
- Complex physical and biological processes

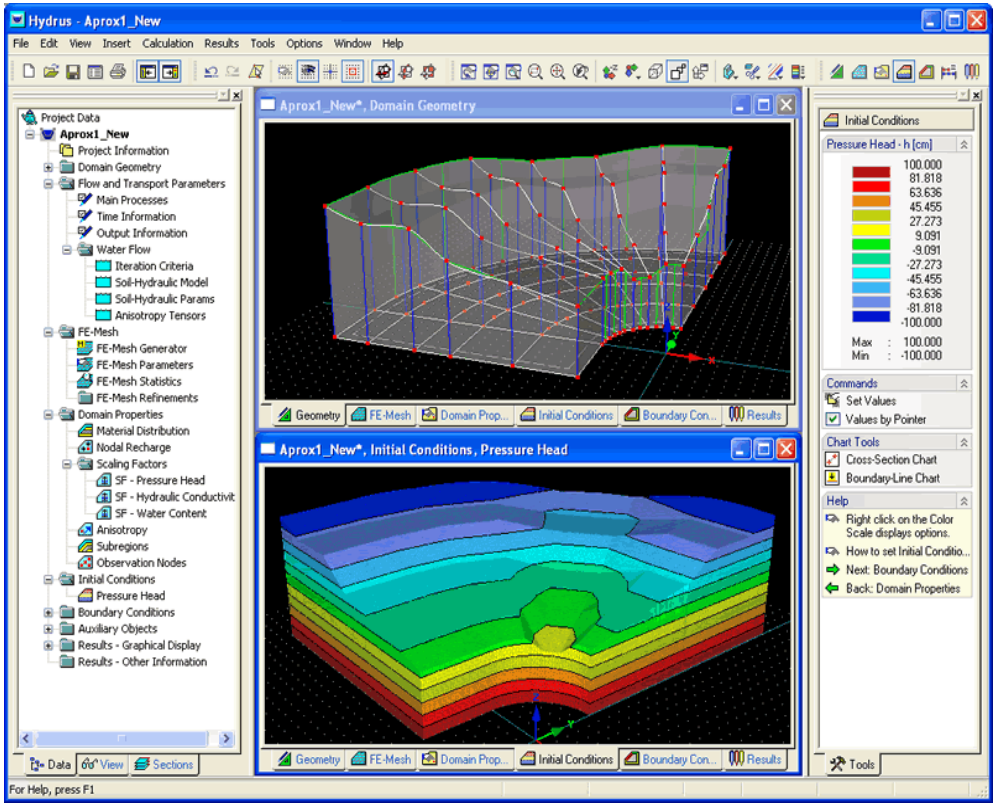
- Not just bugs, wetlands have a complex ecology and food web

- Black box, we know it works for certain things but don't fully understand all the mechanisms and processes

- Understanding, technology and design has advanced considerably in the last decade

Bio-geochemical reaction network





HYDRUS - 2D/3D modeling of constructed wetlands

Growing evidence base for performance

$$C_{out} = \frac{\left((Q_{in} * C_{in}) + (k * A_1 * C^*)\right)}{Q_{in} + \left((P - ET) * A_1\right) + (I * A_1) + (k * A_1)}$$

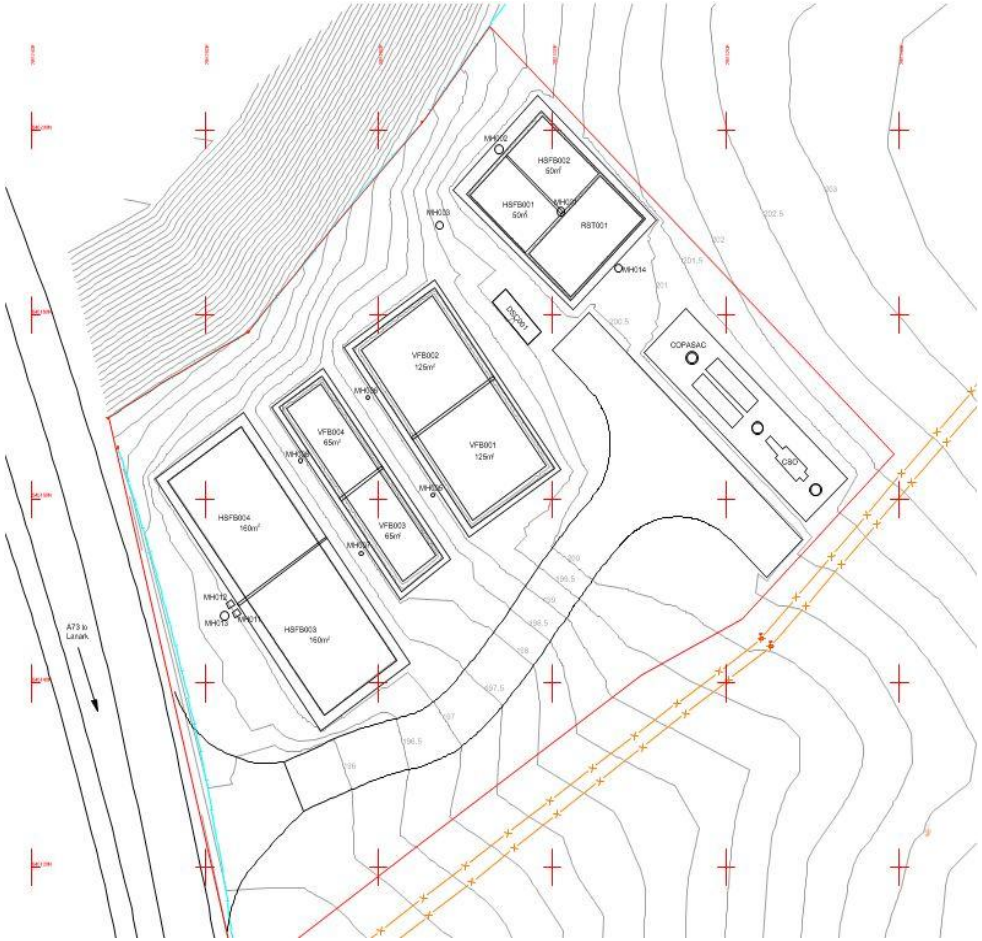
Capabilities and limitations

- Excellent BOD & TSS reduction
- Possible to fully nitrify and denitrify using hybrid bed configurations (e.g. VF – HF)
- COD can be problematic - enhanced through aeration of beds, large areas and long residence times
- Suspended solids and clogging can occur
- Phosphorous saturation and release

Maintenance and Lifespan

- Principal reason for failure is lack of maintenance
- Can’t fit and forget!
- Water level control routines
- Rotational or annual harvesting
- Inclusion of sumps, flushing and access
- Replacement of bed media and gravel recycling

Cartland Low Carbon Demonstration project



A total of £1.8 million was spent by Scottish Water installing a zero/low carbon emission facility aimed at protecting the Brocklinn Burn, a tributary of the River Clyde

Ammonia target -

<2mg/l at 95%ile

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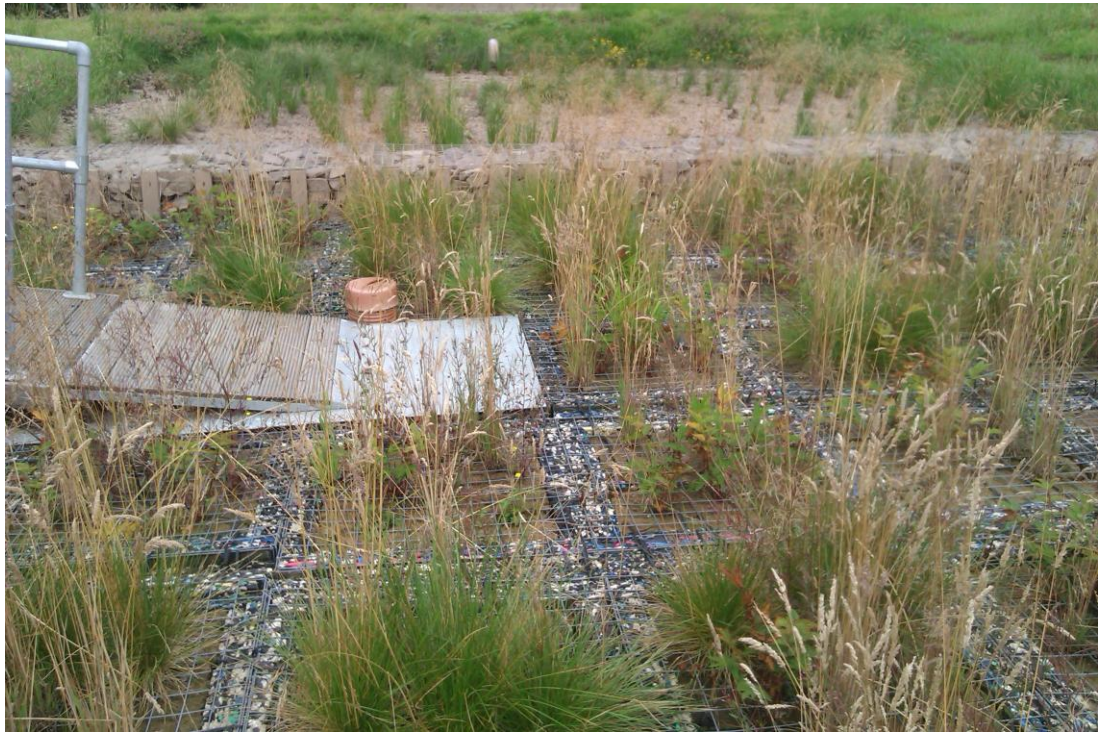
AREA NOT SURVEYED
AREA NOT SURVEYED
AREA NOT SURVEYED
CHARGE TO
CKLINN BURN
MH 21
HB001/MH11
MH 12
HORIZONTAL SUBSURFACE FLOW BED HSSFB001
RAFTED SETTLEMENT TANK RST001
OVERFLOW DISCHARGE ROUTE
DOSING CHAMBER (SIPHON) DSC001
W1004
W1005
MH 9 COPASAC CHAMBER
MH 6A
GATE
FLOW TO TREATMENT
MH 5
SEPTIC TANK
COPASAC SCREENING BIN
MH 6 CSO CHAMBER
MH 7 INTERCEPTOR
MH 8 FLOW CONTROL
VERTICAL FLOW BED VFB002
VERTICAL FLOW BED VFB004
VERTICAL FLOW BED VFB001
VERTICAL FLOW BED VFB003
HORIZONTAL SUBSURFACE FLOW BED HSSFB003
HORIZONTAL SUBSURFACE FLOW BED HSSFB002
MH 22
MH 20
INSTRUMENT CHAMBER
MH 19
MH 18
MH 17
MH 16
MH 15
MH 14
MH 13
EXISTING WALL
GAS MAIN
GAS MAIN (APPROX LOCATION)
A73
15 INCH WATER MAIN
18 INCH WATER MAIN
CULLY
FIELD GATE
SOAKAWAY
POWER LINES
EP
10m
4m
1m
1m
KEY:
BOLLARD
NEW PIPELINE UPVC 150mm DIA
NEW PIPELINE UPVC 225mm DIA
WATER MAIN
GAS PIPELINE
POWER LINES
UNSURFACED COMPACTED TYPE1 ROAD/PATH REFER TO DRG. No. 5000004570-WW-DRA-00009648
UNSURFACED STONE PATHS REFER TO DRG. No 5000004570-WW-DRA-00009662
WETLAND
GABION WALL
GRAVEL AREA – 150mm THK COMPACTED TYPE1 OVERLAID WITH 60mm THK GRAVEL TO FINISH
VALUE OF FINAL GROUND LEVEL



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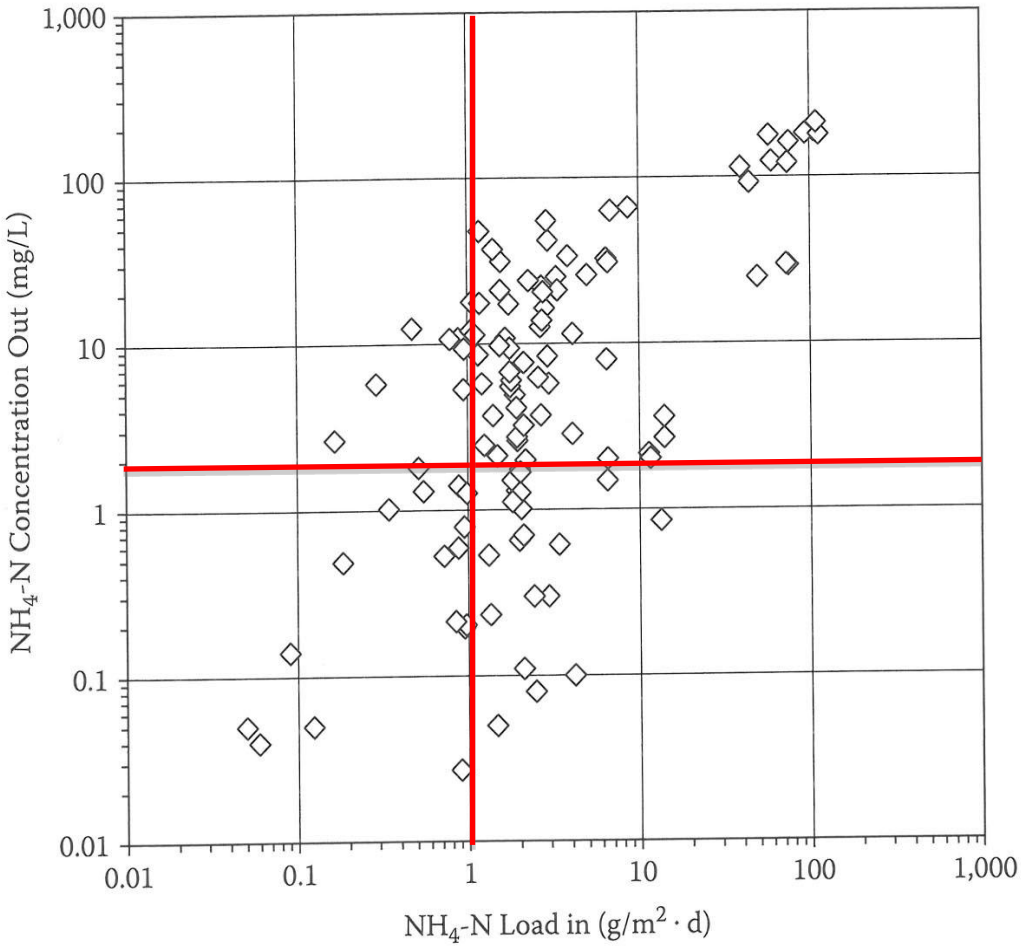
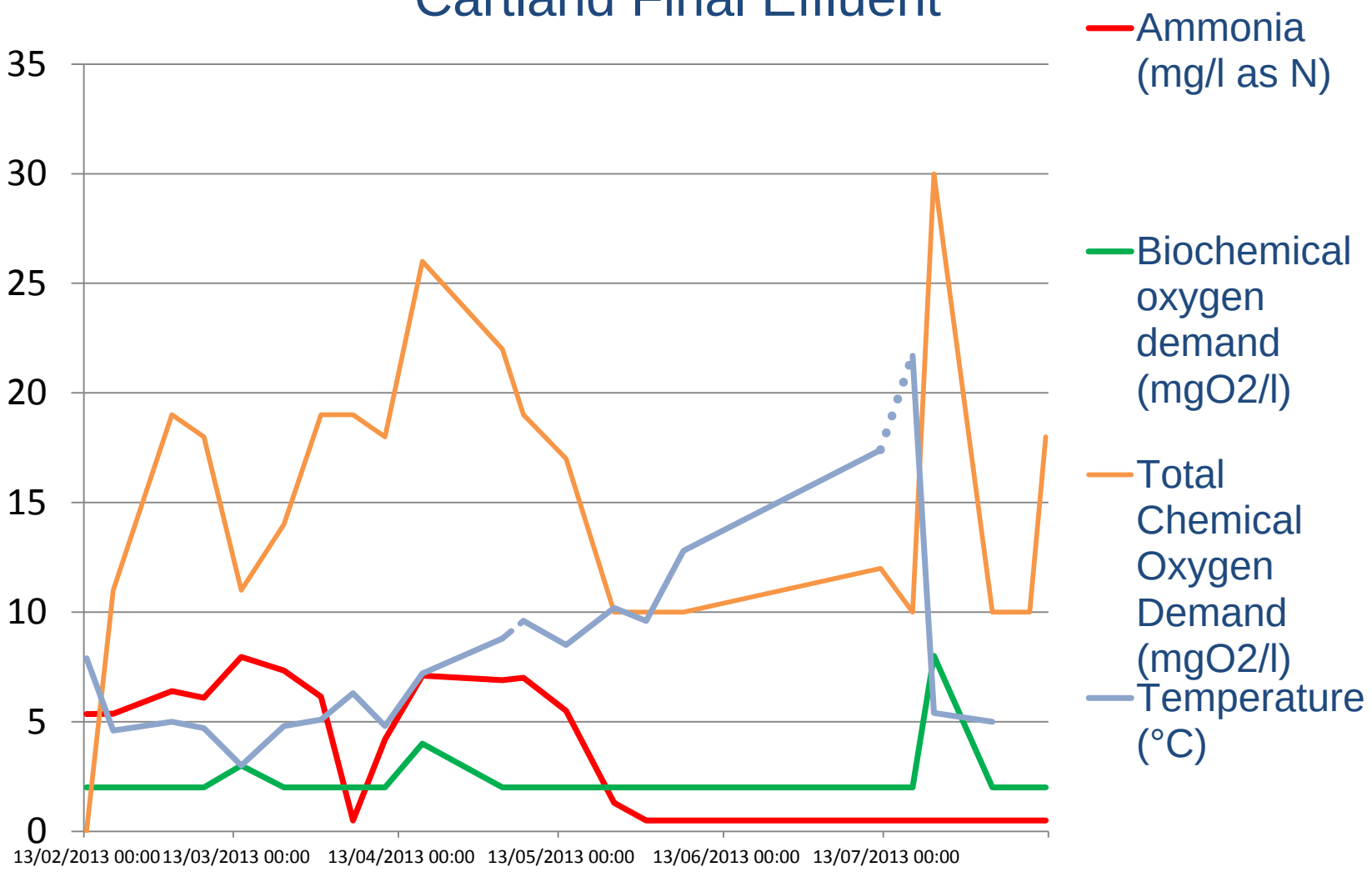


FIGURE 20.5 Ammonia load response for pulsed VF wetlands. (N = 118 system-years of data.)

Cartland Final Effluent



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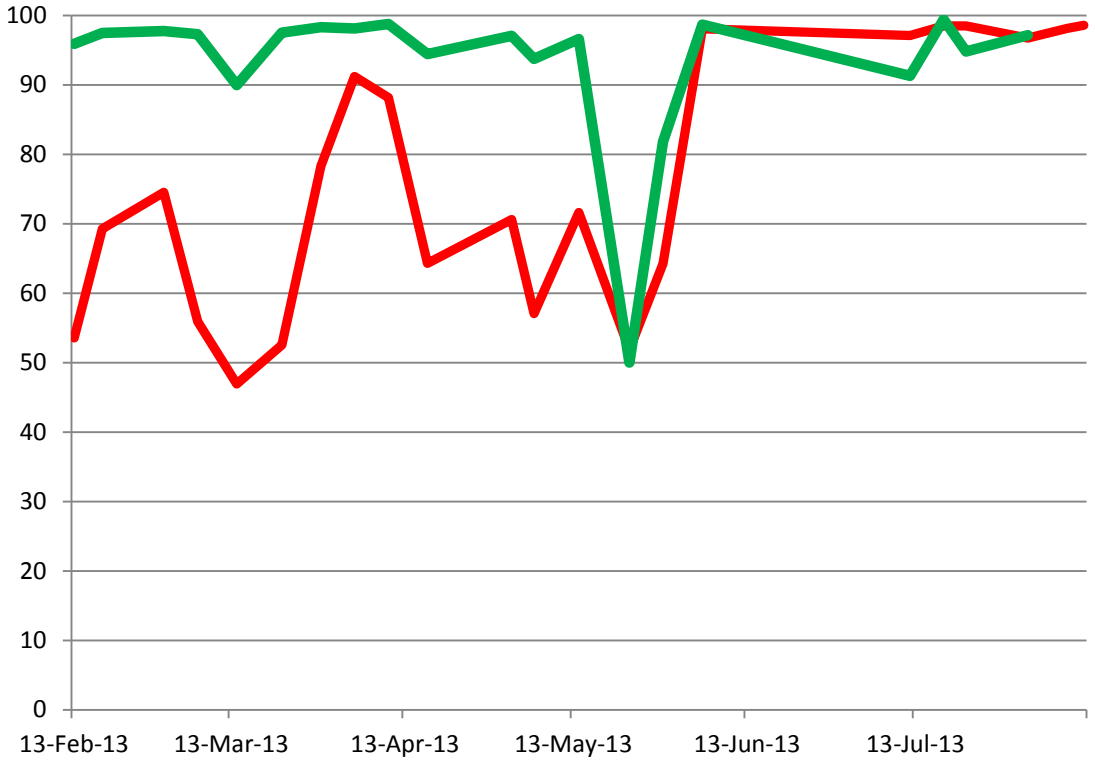
Percentage reduction of BOD and Ammonia, settled sewage to final effluent



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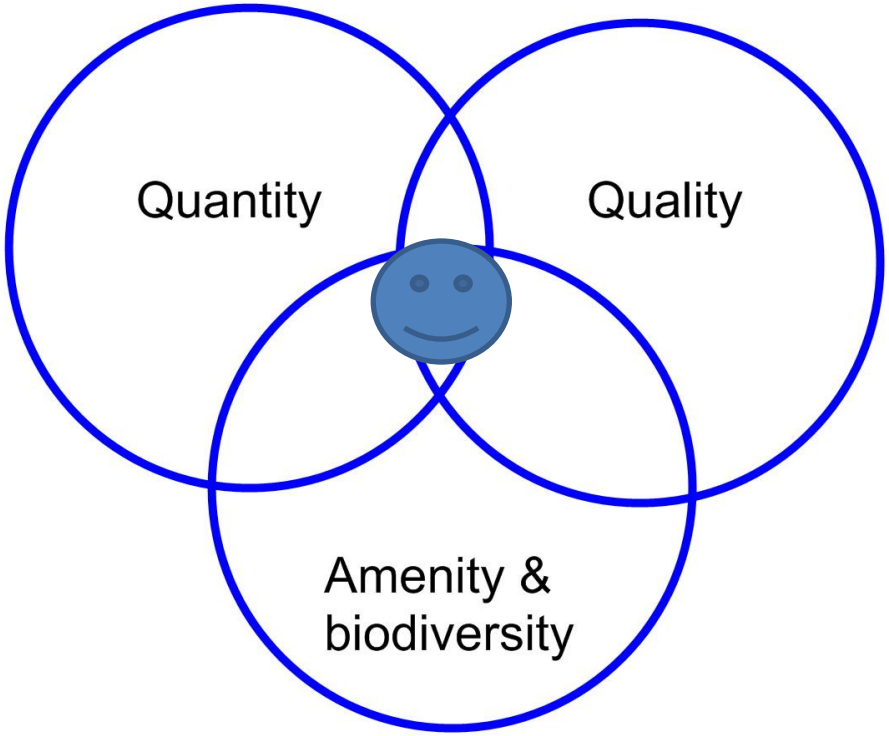
SuDS and the Treatment Train

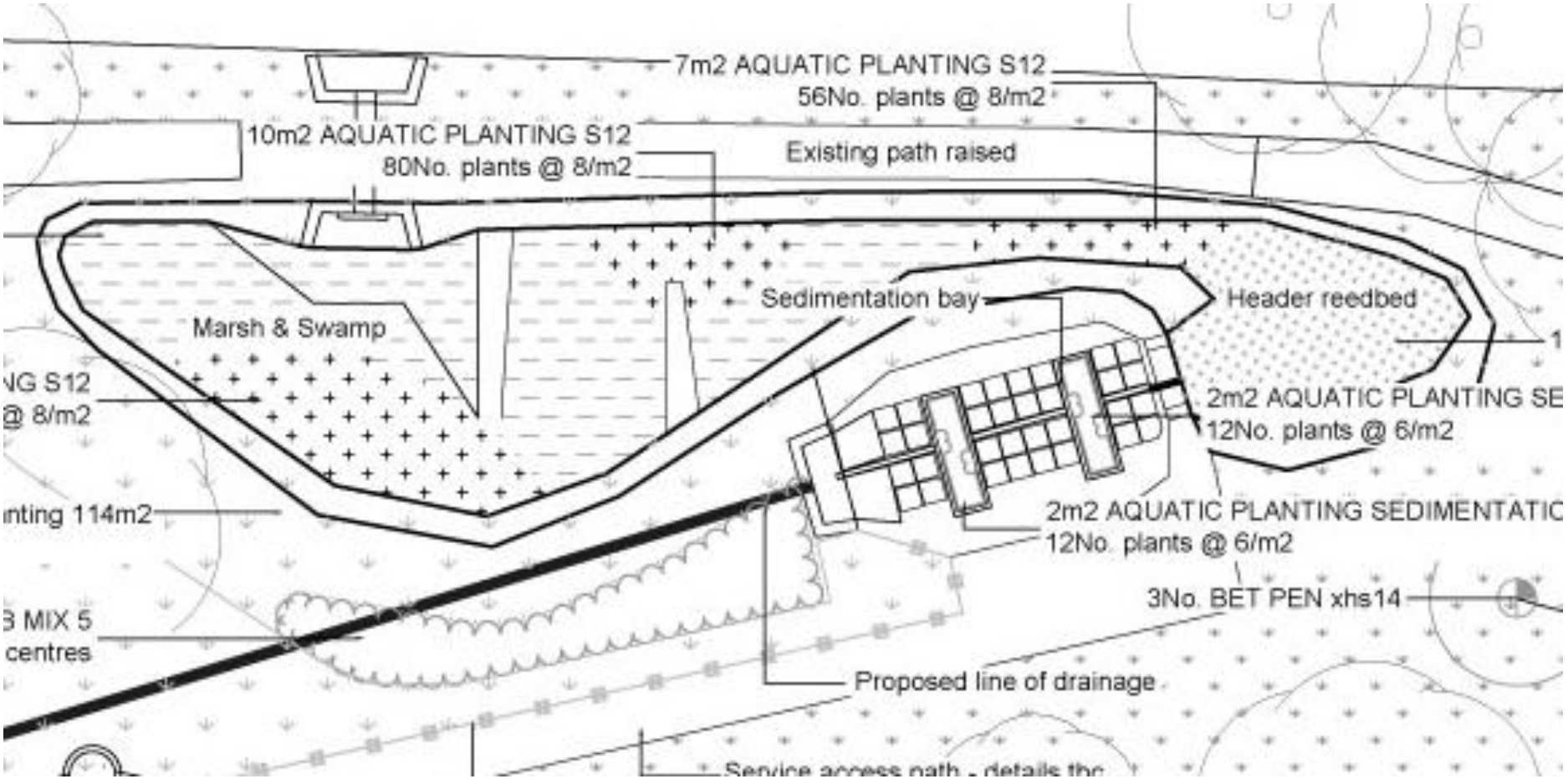
SuDS philosophy



- **Little design guidance on effective treatment areas needed to meet acceptable standards**
- **Quality has a potential impact on amenity and bio-diversity**
- **Treatment wetland design has much to offer the SuDS treatment train**

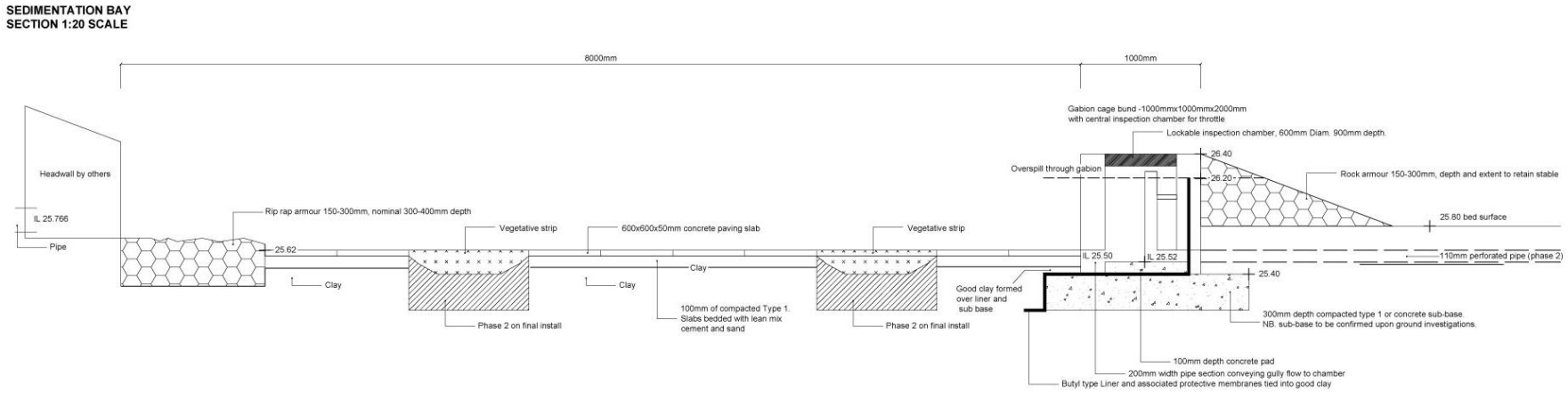
'Sustainable urban drainage is a concept that includes long term environmental and social factors in decisions about drainage. It takes account of the quantity and quality of runoff, and the amenity value of surface water in the urban environment' – SuDS design manual, CIRIA C522 2000

The Barge, Runcorn



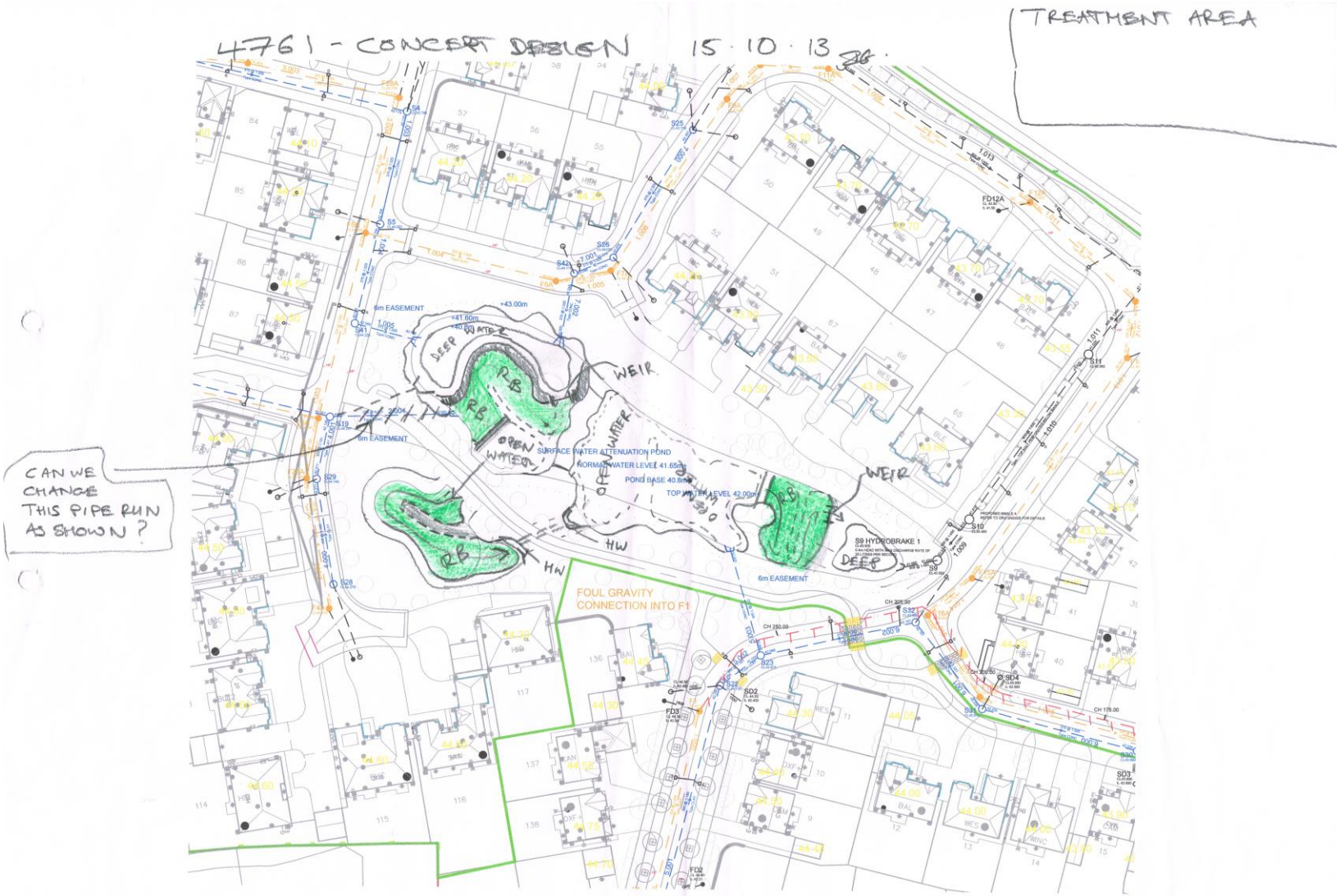
The Barge, Runcorn

- Treatment elements comprised of a sedimentation bay and HSSF reedbed and marsh
- Sized based on treatment wetland design
- Submerged gravel wetland system – as defined in Ciria 2007). They are of particular use for retro-fitting, or when space is at a premium and safety concerns are an issue, (Ciria, 2007).



SuDS Retrofit

SuDS Retrofit



Visual impression of wetland habitats and the diversity of wildlife they can attract

Marshes

Ditches

Reedbeds

Open water pools