

# Airports

natural waste water treatment

# ARM Group Ltd

## natural wastewater treatment



Whether you're thinking about a new reed bed system, or you just want some timely expert advice about effective operation, we can help.



### Harnessing natural technology

**E**ver since natural waste water treatment systems came of age in the 1980s, ARM Ltd has led the way in reed bed and constructed wetland technology.

Working with the UK water companies, councils, contractors, industrial clients and research institutes, we have designed, built and maintained many hundreds of reed bed systems. These range in size from 10m<sup>2</sup> up to 20,000m<sup>2</sup>, and we have consulted on reed beds of many hundreds of hectares.

Harnessing natural processes, we engineer them to deliver all the advantages of cost-effective, versatile and sustainable wastewater treatment – and we guarantee the performance of every system we design and install.

As the largest dedicated UK company by far in this specialised field, with a reputation dating back to 1947, ARM brings you unique expertise and experience. We can support you at every stage of the process – from initial planning and design through construction and commissioning to ongoing maintenance – ensuring the optimum performance of your reed bed system.

We continue to pioneer new and innovative ideas. Recent developments include an aggregate recycling system to reduce landfill costs and material usage, and a plough to retrofit FBA™ airlines into existing reed beds.

### Why use reed beds?

**T**he Chinese used wetlands more than two thousand years ago for their impressive effluent and water treatment capabilities.

Reed beds provide an ideal environment for a wide range of treatment processes. The combination of micro-organisms, plant roots, rhizomes and substrate matrix remove contaminants in a variety of natural ways.

They treat waste water as it flows through the system just like the process in conventional sewage treatment, but without using energy-intensive machinery.

With low maintenance requirements,

low or zero power consumption and a long, productive lifespan, reed bed systems are both proven and sustainable, enhancing any landscape. Their removal mechanisms include settlement, filtration, biological and chemical action, containment and plant uptake. They can reduce levels of soluble organic matter, suspended solids, ammonia, pathogens, hydrocarbons, and metals.

The various types of reed bed can be used in different configurations to treat a variety of pollutants from industrial or municipal sources.

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## Performance guaranteed

**O**ur reed beds are used at all stages of the sewage treatment process providing primary, secondary and tertiary treatment as well as sludge dewatering.

They can also extend the life of older treatment works by providing a tertiary polish to effluent, bringing it within regulator consent, and saving capital expenditure.

They are increasingly used for tackling industrial effluent. Uses range from treating fire-fighting foam and metal removal from minewater drainage, to reducing ammonia levels in leachate and removing hydrocarbons from groundwater.

Other applications include treatments connected with:

- agriculture
- pharmaceutical
- food processing
- chemicals
- refinery waste
- distillery wastewater
- airport run off
- Sustainable Urban Drainage Systems (SUDS)

They can also be used to create wetland habitats – enhancing bio-diversity.

*Whatever the application, we provide contractual guarantees of effectiveness, performance and quality – so you can be sure you're going to get the results you're looking for.*



## Our comprehensive range of services includes:

**Consultancy:** feasibility studies, process design, site surveys, landscape design, and advice on managing future changes

**Project management:** our experienced managers will look after your entire project from conception through to completion.

**Design and build:** our turnkey service delivers systems on time and within budget, including liaising with regulators and enforcement authorities on your behalf.

**Design and supply of materials and equipment:** a service we provide on request, for example to framework contractors.

**Construction service:** using our design or your own, we make it easy for contractors and save our clients significant amounts of money through design reviews based on experience – without compromising quality or performance.

**Field services for system maintenance:** we extend the life of your system, bring you peace of mind and help you get the best possible results.

**Asset assessment:** we evaluate process efficiency, check your system is operating at top performance, and make recommendations.

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# ARM Group Ltd

## About Us



ARM Group Ltd, a Staffordshire based privately owned company, is the leading designer and constructor of natural waste water treatment systems and associated technologies for the industrial and municipal waste water treatment market in the UK. The Company is noted for its invention and subsequent commercial development of equipment and processes within its chosen markets.

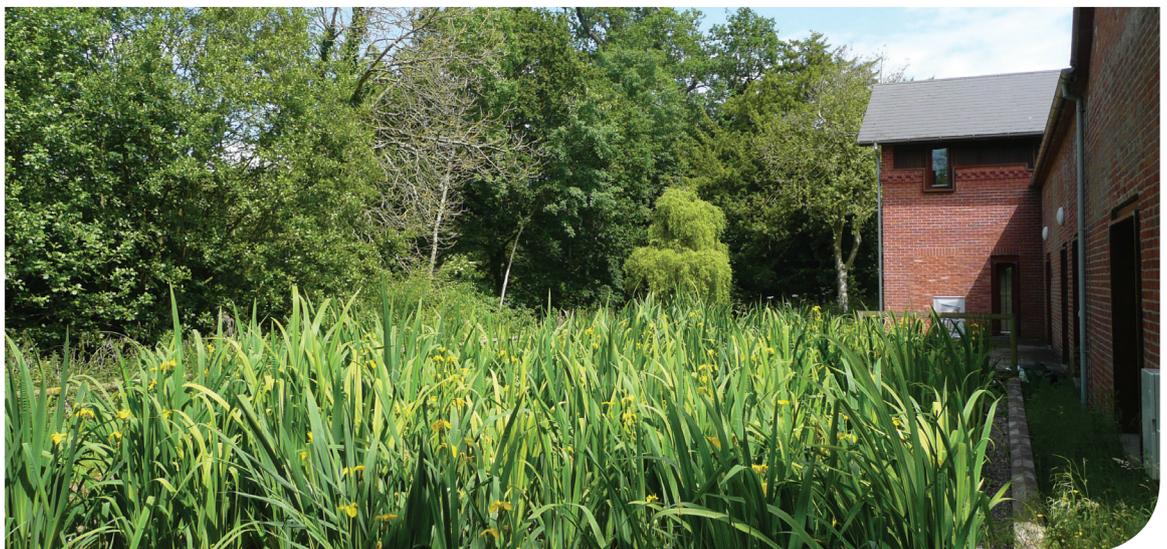
ARM Group Ltd has been trading since 1947 and was originally involved in development, design, manufacture, and construction within Agricultural Engineering. However, in the late 1980s ARM Group Ltd redefined its objectives and moved its customer and product bases into the global market of wastewater treatment specialising in the use of reed bed/wetland systems.

Today the Company operates out of offices in Rugeley, Staffordshire employing 21 people and using Associates and sub-contractors as required.



ARM Group Ltd is broadly divided into seven operating functions these can provide client support either individually, as a team, incorporating the requisite elements, or as a whole providing continuity of support for turnkey solutions from project conception through design construction, commissioning and maintenance, depending on the specific needs of the client. The functions are:

- Sales
- Design
- Project management
- Construction
- Research and Development
- Refurbishment and Maintenance
- Administration





## Experience

For the past 30 years ARM Group Ltd have specialised in reed bed and wetland systems having designed and installed over 700 beds during this period. This provides us with unique and extensive experience of their application, design and construction across the wastewater treatment spectrum. Our experience and knowledge has been accumulated through:

- Design and construction of reed bed systems
- Value engineering optimisation
- Application experience
- Working with academic institutions.
- The international constructed wetlands conference circuit
- Presenting papers
- Personal contact with leading researchers
- Working relationships with leading specialist in specific reed bed applications
- Founder member of the Constructed Wetland Association (CWA)
- Founder member of Global Wetland Technology (GWT)
- Over 1000 reed bed surveys

We have designed and constructed reed beds that provide treatment for:

- Mine water
- BOD and COD reduction
- Methanol removal
- Copper removal
- Pathogens
- Landfill leachate
- Hydrocarbons
- Septic tank waste
- Ammonia
- Surface water run off
- Solids
- Sludge dewatering
- Storm water
- Metals
- Glycol



# Belfast International Airport

## Horizontal flow: Fire training ground run off



### Project

Northern Ireland Reed Bed Company (NIRBC)

### End User

Belfast International Airport

### Location

Belfast, Northern Ireland

### Project Type

Design

### Wastewater Type

Fire training ground run off

### Completion Date

2007

### Need

ARM Ltd were approached by the Northern Ireland Reed Bed Company (NIRBC), in conjunction with RPS consultants, to provide a design for a wetland treatment system to attenuate and treat surface run off generated on a new fire training area (FTA) at the Belfast Aldergrove International Airport.

The design criteria are indicated in the table below and are based on a 1 in 10 year storm. The wetland was to attenuate flows and treat run off contaminated with residual fire fighting foam prior to discharge to local watercourse. The existing discharge route was to local sewer and Belfast Aldergrove Airport were looking for a more economic solution.

DURATION (mins)	MAXIMUM FLOW (l/s)	AVERAGE RAINFALL (mm/d)	EVENT INLET VOL (m <sup>3</sup> )	MAX EVENT OUTLET (m <sup>3</sup> )	VOLUME BALANCE (m <sup>3</sup> )
120	59	4	178	43.2	135

Two biodegradable foams are used on the site which break down at different rates the slowest achieving 34% degradation over 5 days. Adequate attenuation and retention times are required to ensure there is sufficient foam reduction to conform to the discharge consent of 10 mg/l Biological Oxygen Demand (BOD) and 10 mg/l suspended solids on a 95<sup>th</sup>ile basis.



## Belfast International Airport



### Solution

Horizontal sub-surface flow reed bed systems are a proven natural wastewater treatment technology for reducing low level BOD contamination. The treatment solution comprised a balancing tank with a working volume of 200m<sup>3</sup> to provide equalisation of flows passing forward to the reed bed which is a single horizontal flow reed bed with an 80m<sup>2</sup> process area.

### Benefits

The lagoon and horizontal flow reed bed designed by ARM Ltd provided Belfast Aldergrove International Airport with a low maintenance natural waste water treatment solution for the run off generated on their FTA. It allows discharge to a local watercourse eliminating the costs associated with discharge into the local sewerage network.



# Buffalo Airport

## Airport de-icing



### Project

Buffalo Airport, New York

### Location

New York, USA

### Project Type

Design and construct

### Wastewater Type

Glycol loaded run off

### Completion Date

September 2009

### Treatment System

Four aerated vertical flow reed beds

### Need

Buffalo Airport situated in New York State USA is subject to significant range of climatic conditions through the year. Temperatures in winter can drop well below freezing for extended periods requiring the use of substantial levels of antifreeze, in the form of glycol, to keep runways open and aircraft operational. Subsequently, when the ice and snow melt, or following rainfall, the run off generated is contaminated with glycol which constitutes an environmental hazard if it is discharged to the environment without treatment. This had been managed by collection and delivery to the local sewage network which carried significant annual costs charged by the local municipal treatment company based on flows and loads. Buffalo Airport was keen to determine a method of controlling and managing these costs.

Buffalo Airport investigated the options for onsite treatment of the run-off water. The conditions to be met included:

- Fit within the airport
- Treatment of cold, dilute de-icing fluid
- Low profile
- Not a bird-strike hazard
- Low sludge and odour production
- Capable of handling seasonal variations
- Capable of integration into the existing storm management handling system



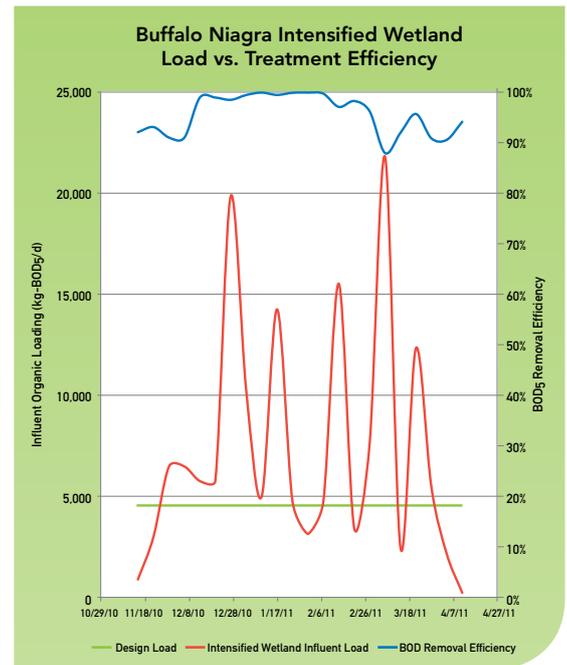
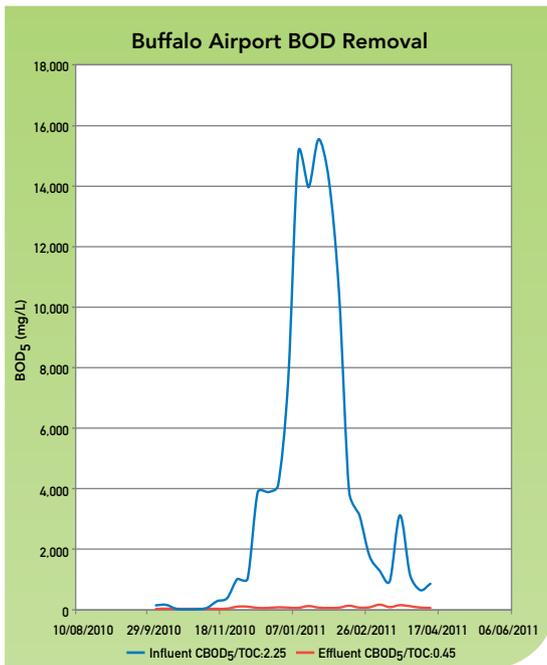


## Solution

The airport chose to use aerated wetland technology to manage the 'first flush' storm water generated on site which carries the highest loading of glycol. Initially a treatability study was undertaken to identify the reaction rates for the treatment of used de-icing fluid. This guided design to maximise the efficiency of the four vertical flow aerated reed beds subsequently constructed on site. Low profile planting of the beds, and sub-surface operation ensured that wildfowl was not attracted to the system and Naturally Wallace's patented Forced Bed Aeration™ ensured air was delivered efficiently and consistently to the microbial biomass which effected treatment.

## Benefits

The use of aerated vertical flow gravel reed beds provides a simple and robust low maintenance solution to the run off treatment issues at Buffalo Airport. The system handles a hydraulic load of 4,500m<sup>3</sup>/d with a glycol based BOD load of 13,600 Kg/d of CBOD.



# Heathrow Airport

## Aerated subsurface horizontal: Airport run off



### Project

BAA, Heathrow Airport

### Location

Heathrow, Middlesex

### Project type

Upgrade existing works:  
Retrofit FBA™

### Wastewater type

Airport run off contaminated  
with Glycol

### Completion date

March 2011

### Treatment

Aerated lagoons, partial and  
complete mix zones and  
subsurface horizontal flow  
wetland system with FBA™

### Need

Mayfield Farm Treatment Works, commissioned in 2001 was designed to treat run off from Heathrow Airport's Southern Catchment. The run off is contaminated with glycols resulting from the airports de-icing operations. Treating glycol contaminated run off is a challenge at every airport faced with varying cold-climate winter conditions. The run off can contain over 20,000 mg COD/L at 1°C. The original system consisted of balancing ponds, aeration lagoons, rafted reed beds and 12 horizontal subsurface flow reed beds covering 2.08 hectares. Designed to treat influent COD at 170 mg/l with a design flow of 40l/s, the wetland cells consisted of open water zones and gravel zones and were planted with *Phragmites australis*. The original system operated passively with oxygen transfer rate of 2.4 – 7.7 g/m<sup>3</sup>/d, removing 4 – 13 g/m<sup>3</sup>/d of COD. This system was unable to treat current volumes of effluent and was failing to achieve compliance.



### Solution

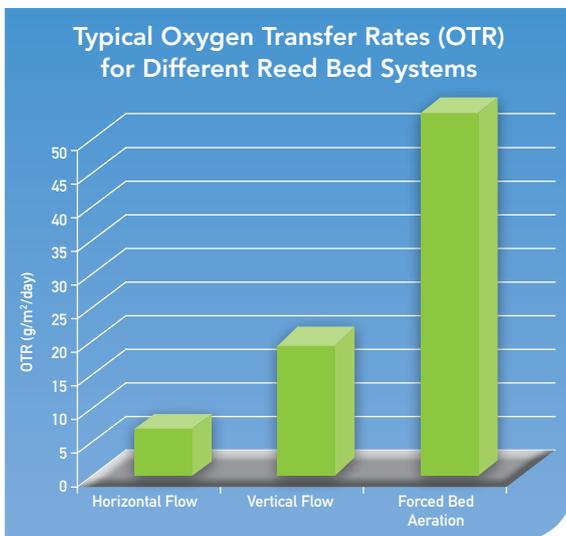
ARM conducted a full scale trial comparing the existing reed bed design with a reengineered reed bed and one fitted with Forced Bed Aeration™ (FBA™). The results indicated that there is enough wetland volume at Heathrow, but the limited oxygen transfer rate is limiting treatment performance.





ARM reengineered the distribution and collection system and retrofitted FBA™ into the existing reed beds. The open water zones were filled with gravel and the gravel depth increased by 500mm. The upgrade works at the Mayfield Farm included the addition/modification of:

- Primary Reservoir Aeration + nutrient dosing point
- Complete aerated mix zone + nutrient dosing
- Partial aerated mix zone
- Balancing Pond aeration and nutrient dosing points



- Horizontal subsurface flow reed beds with FBA™
- Variable Speed Transfers
- Primary Treatment bypass facility (motorised shut-off valve)

The upgraded reed beds transfer up to 165 g/m<sup>3</sup>/d of oxygen and is now capable of treating 3500kg/BOD/day at 40l/s average flow.

### Benefits

ARM delivered a cost-effective treatment upgrade with increased system capacity and operational flexibility. System optimization minimized life cycle costs for BAA.

# Teeside Airport

## Vertical flow: Fire training ground run-off



### Project

Teeside Airport, International  
Fire Training Centre

### Location

Teeside Airport, Darlington,  
County Durham

### Project type

Design and construct

### Wastewater type

Training ground run-off

### Completion date

1992

### Treatment system

Passive 3 stage vertical flow

### Needs

The International Fire Training Centre (IFTC) is based at Teeside Airport in County Durham. They provide specific aviation based training for fire crews from around the world running session 4-5 times per day. Significant amounts of water contaminated with hydrocarbons and fire fighting foam is generated in the form of run-off from the site. The IFTC required that this be treated to Environment Agency specifications prior to discharge into a local watercourse. They also requested that ARM Ltd consider recycling of the water for reuse on the training ground. The required distance of the training ground from infrastructure necessitated the use of a decentralised treatment solution. Flows and loads were variable based on client demand and thus required some form of balancing. Also, the training ground, being hard standing, has a significant rainwater catchment and so in quiet periods a facility was needed for this water, being within consent, to bypass the treatment system and discharge to watercourse. Average flows of 130m<sup>3</sup>/d were determined with average loads of 808 mg/l COD. Discharge parameters were set at 20 mg/l BOD and 30 mg/l suspended solids.



## Teeside Airport



### Solution

A surface water collection system was installed which delivered the effluent into an oil separator. The collected oil could then be reused as an ignition source for fire training purposes. Water then passes into a 'dirty water' lagoon where flows and loads are balanced. These flows are then pumped forward through a passive three stage vertical flow wetland populated with *Phragmites australis* with a total area of approximately 1000m<sup>2</sup>. Treated water is then delivered into a 'clean water' lagoon which provides a source of recycled fire fighting water. In periods of low use this water is discharged to watercourse. A bypass was installed allowing water to pass directly from the training ground through an oil interceptor to the watercourse.

### Benefits

The solution provides the client with a sustainable means of recycling contaminated training ground water for reuse as well as allowing the discharge of excess water within consent. The installation of the bi-pass system meant that the wetland did not need to be excessively large and costly to accommodate the additional hydraulic load associated with rainfall events.



# Wetland Treatment Systems and Cold Weather

The question of the performance of reed beds or treatment wetlands through winter and in cold climates is a common one.



**R**eed bed systems in general are subject to the vagaries of local climate conditions particularly temperature. They are, however, used and operate successfully, all around the world including the northern United States and Canada where air temperature can remain well below freezing for extended periods.

## Introduction

Popular belief is that treatment is associated with plant growth and that winter die-off adversely affects performance. In truth, treatment performance is related to bacterial activity, and are essentially attached growth microbial reactors. Using below ground systems and mulch or reed litter for insulation, over 50 wetlands are currently being operated year round in cold climates in North America with consistent performance. In each case, the success of performance is related to creating a stable environment for bacterial growth and sizing the wetland to accommodate slower bacterial

removal rates associated with winter water temperatures.

There are numerous case studies from around the world which have increased our understanding of the heat balances that occur in wetlands across the year and the best means of mitigation under freezing winter conditions.

Our designers have over twenty years of experience routinely designing and installing treatment systems combining lagoon and wetland technology, in North America that are capable of operating at short-term temperatures of as low as  $-40^{\circ}\text{C}$ .

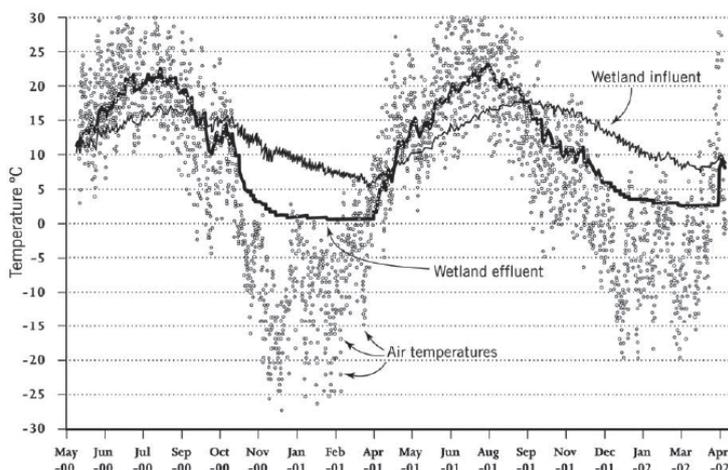
## Energy Balance

The operating temperature of a wetland treatment system is governed primarily by the temperature of the effluent within the system.

The Water temperature in reed beds is determined by energy gains and losses which fluctuate throughout the year and can be critical to certain removal mechanisms. These energy gains and losses are effected through:

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- Influent temperature
- Evaporation
- Evapotranspiration
- Solar radiation
- Seasonal changes in surrounding ground temperature and resulting heating/cooling effects.



(Wallace & Nivala: IWA Specialist Group on the Use of Macrophytes in Water Pollution Control Newsletter; No 29, Feb 2005)

On entering a reed bed effluent temperatures rapidly stabilise around a balance point temperature, where energy inputs and outputs are balanced.

In the warmer months, balance point temperatures stabilise closely around average air temperature.

In the colder months system design and operational management can be used to maintain performance depending on local climate conditions.

### Mitigation

- In **Surface Flow Systems** the ice and snow are often the most important insulating layers. An ice/air 'blanket' is often purposefully generated by raising effluent levels before a freeze and subsequently lowering it.



- In **Subsurface Flow Systems** the reed litter and/or additional peat/mulch can be added as insulation.

The net effect of these methods of insulation is to produce a balance point water temperature that is a few degrees above freezing allowing key treatment mechanisms to continue operating in severe weather conditions. The following graph indicates how the insulative effect of mulch can maintain an effluent above 0°C whilst surrounding air temperatures are well below freezing.

### General points

A review of the local climatic conditions is undertaken in the detailed design phase of a project and relevant heat balance calculations will determine exactly what mitigation steps will be needed for the system be it mulch, water depth, covers or other operational factors.

The civil components of the plant will also be reviewed with respect to frost protection as in any other construction project.

If you have queries on the above or other aspects of the proposed scheme please do not hesitate to contact us.



# Forced Bed Aeration (FBA)

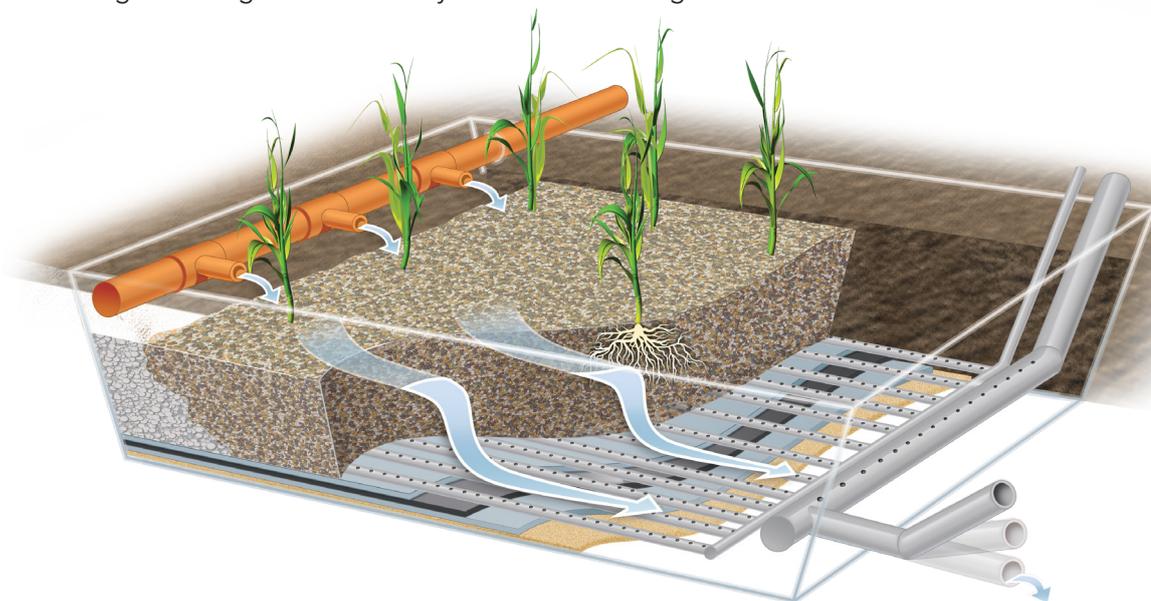
Forced Bed Aeration™ compliments and enhances existing reed bed technology, increasing treatment capacity by up to 15 times.



**F**orced Bed Aeration™ (FBA™) is a new wastewater treatment technology which enhances constructed wetland treatment performance. Significantly higher contaminant removal rates are attained along with an increased consistency of performance. Developed in the USA, by our partners Naturally Wallace, FBA™ can be used in both horizontal and vertical flow constructed wetland systems. Blowing air through the wetland system

makes the system oxygen unlimited increasing the treatment capacity by up to 15 times. This new technology can treat wastewaters high in BOD, SS, NH<sub>4</sub>-N and other organic contaminants.

Forced Bed Aeration™ reed beds can reach performance levels which have been unobtainable in standard reed bed systems with less performance variability. Aeration of horizontal and vertical flow reed beds has multiple advantages.



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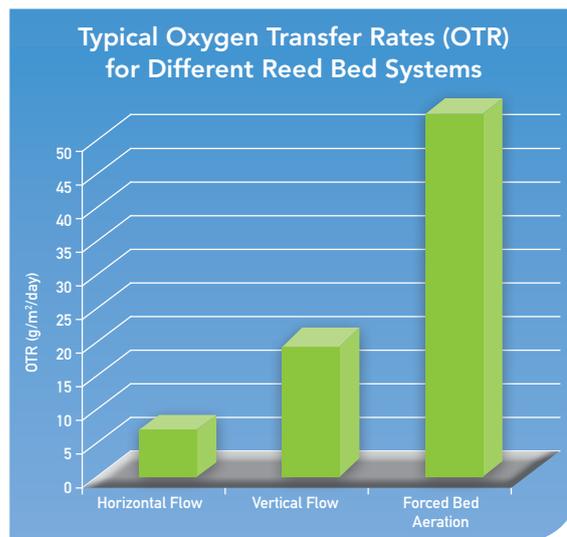


- FBA™ can completely nitrify wastewater
- FBA™ systems can be deeper than conventional reed beds therefore taking up 50% less space than passive systems.
- Plants thrive in FBA™ systems because the introduced oxygen prevents the formation of toxic products that can stunt plant growth in strongly anaerobic, passive system
- FBA™ reed beds can be divided into aerobic and anoxic zones to both nitrify and denitrify.
- FBA™ reed beds are ideal for treating fluctuating loads such as CSO's and locations with variable occupancy.
- Initial studies indicate FBA™ systems have reduced clogging rates extending the operational life of a treatment system.

technology prevents root rhizomes penetrating the emission points.

### Adapting FBA™

FBA™ can be retrofitted to existing reed bed systems, especially those which are overloaded. This prolongs the life of the reed bed and enhance effluent treatment.

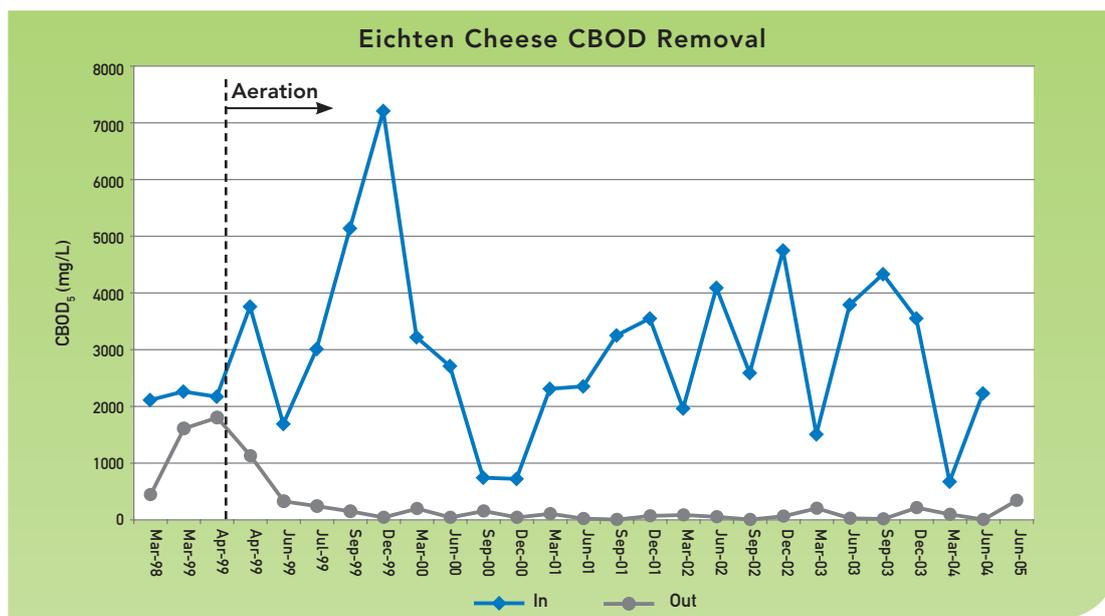


### Pipelines

FBA™ has a unique network of pipelines which provides a constant flow of oxygen into the reed bed. Patented rootguard

### FBA™:

- Improves treatment capability.
- Reduces clogging rates.
- Requires minimum power input.



Graph indicating the treatment performance of an FBA™ wetland system treating cheese production effluent

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## Asset Assessment & Support Package

Knowledge and proactive management of assets is a key area where water companies can cut operational and capital expenditure. The optimisation and enhancement of remote reed bed treatment systems can secure performance for many years without the need for full site refurbishment and the associated costs.



In the September 2012 issue of *Water & Wastewater Treatment* it was reported by the editor that knowledge by the majority of water companies of the condition of their assets is poor. According to the report from the consultancy company E C Harris, some 90% of maintenance in the UK water industry is reactive. Yet it is well known that proactive maintenance will cut costs by upwards of 50%.

Although this is not the case with all water companies we thought it would be an ideal opportunity to offer a simple solution. ARM Ltd have been designing, constructing, refurbishing and retrofitting reed beds for many of the UK's water companies

for decades. It is for this reason we feel best placed to offer you our new Asset Assessment and Support Package (**AASP**).

Reed beds are generally tucked away in Sewage Treatment Works and because they provide treatment with minimal maintenance requirements often get overlooked until the works are close to breaching consent. Our Asset Assessment and Support Package will highlight the condition of the system and give an indication of when refurbishment may be required. This allows expenditure to be planned and therefore controlled and ensures the works performs to its full capability.



Our Asset Assessment and Support Package works in two ways:

## 1. Asset Assessment

### Visual Appraisal

- Condition of the reeds
- Extent of sludge build up on and in the gravel matrix
- Condition of the flow path
- Site layout and accessibility
- Photographic evidence

### Fitness for Purpose

- Review design basis, 'as built' drawings and O & M Manual
- Review current and future loads and recent performance data

### Monitoring program

- Sampling and monitoring program to include influent flows/loads and discharge levels to characterise performance

### Reporting

- Verbal and written report of the assessment complete with conclusions, recommendations and indicative prices of any required remedial work

## 2. Support Service

- Asset longevity prediction
- Sampling and monitoring to establish performance
- Refurbish to 'as built'
- Re-engineering to improve performance
- Maintenance
- System operation
- Retrofit with latest technologies to enhance capability

We would be happy discuss any aspects of this service with you and can be contacted at [info@armgrouppltd.co.uk](mailto:info@armgrouppltd.co.uk) or telephone on 01889 583811.