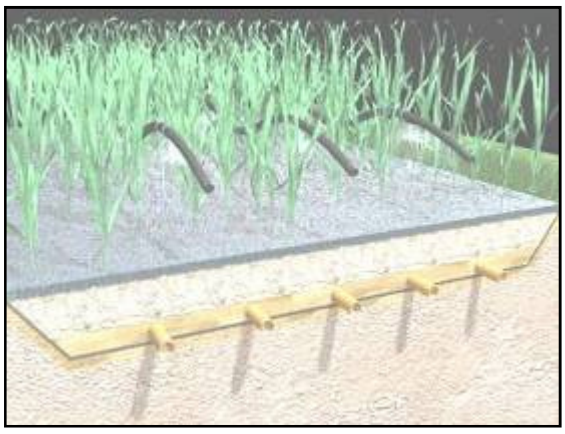
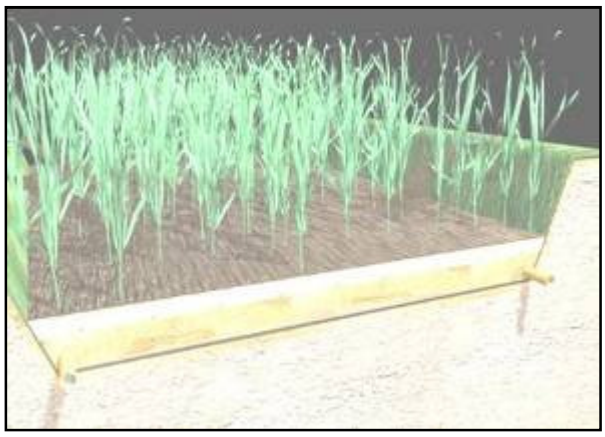
REED BED SYSTEMS
IN
THE MIDDLE EAST

Jordan, Oman, U.A.E.



Reed Bed for sewage



Reed Bed for sewage sludge

Reed Bed Systems Middle East

Drilling Camp Oman

Client:
British Gas

Contractor:
Bauer Emirates Environment

Capacity:
200 population equivalent
35 m³/d

Pre-treatment:
- Raw sewage lift station with grinder

Biological treatment step :
- 2 reed planted sand filter
1. (vertical flow) for SS removal and organic load reduction
- 2. reed planted gravel filter (horizontal flow) for biological treatment

Outlet:
- Storage pond and direct reuse for Irrigation

Sludge treatment:
- Directly sludge mineralization in first Step

Area requirement:
- 1,800 m²

Operating costs
Power consumption
5 kWh/d
Amount of composted sludge:
10 m³/year
Period of sludge removal
20 years
Maintenance staff: 0,03 skilled worker


Reed bed 1. stage, under construction


Reeds after 8 month of operation (08-2008)


Reed Beds after 2 years operation (01-2010)

	COD	BOD	NH4-N	TDS	TSS	pH	FC
	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]		/100ml
Reed Bed 2 OUT, FINAL	30	5	<0.1	2,000 – 8,800	< 5	7.9	Not detected

Reed Bed Systems Middle East

Workshop Jadaf, Dubai

Client :
Dubai Municipality

Contractor :
Waagner Biro Gulf

Population equivalent:
60 PE

Planning: 03 – 05/2005
Construction: 07 – 08/2005

Pre-treatment:
- existing septic tank
- pump station

Biological treatment step :
- 2 parallel reed bed filter (vertical flow)

Outlet:
- Direct use for irrigation

Space requirement:
- 195 m²

5 m high reeds (Arundodonax) after 2 years of operation

Palm trees in front of reed bed irrigated with TSE

	COD	BOD	TKN	NO_3-N	NH_4-N	PO_4-P	TDS	TSS	CL	SO_4	Salinity	pH
	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[‰]	
Septic IN	984	577			23	15	265	510				6.4
Septic Out / Reed Bed IN	208	77			38	12	350	69				7.1
Reed Bed OUT	15	3	3.7	5.2	0.5	0.5	978	0	170	63	0.6	7.4

Reed Bed Systems Middle East

Boat wash water -
DM-Workshop Jadaf

Client :
Dubai Municipality

Contractor :
Waagner Biro Gulf

Wash water :
1000 litre / day

Planning: 03 – 05/2005
Construction: 07 – 08/2005

Pre-treatment:
- oil-separator
- pump station

Biological treatment step :
- 2 reed planted artificial wetlands (vertical flow)

Outlet:
- Storage tank and reuse for boat washing

Special features:
- automatic fill up of storage tank with treated and disinfected sewage water

Space requirement:
40 m²

Reed Bed Systems Middle East

Grey-water
Recycling system -
Jumeirah Beach

Client :
Dubai Municipality

Contractor :
Waagner Biro Gulf

Reuse of grey water from a shower for irrigation


Shower with reed bed surrounded

Population equivalent:
2 – 300 users per day

Planning: 09/2006
Construction: 11/2006

Pre-treatment:
- sedimentation tank, sand trap


After 6 month of operation

Biological treatment step :
- reed planted artificial wetlands (horizontal flow)

Outlet:

- Most water is consumed by the reed

- Surplus treated water flows into soakaway trench

Space requirement:
- 20 m²


After 1 year of operation

Reed Bed Systems Middle East

Grey-water
Labour camp Al Awir

Client :
Waagner Biro Gulf

Contractor :
Waagner Biro Gulf

Treatment of grey-water
(Showers, hand wash basin)
at a labour camp.

Population equivalent:
250 PE

Planning: 12/2005
Construction: 01-03/2005

Pre-treatment:
- Settlement tanks
- Pump station

Biological treatment step :
- reed planted artificial wetlands (vertical flow)

Outlet:

25 m³ of blended water per day.

- Direct reuse of the water for:

Irrigation
Road watering
Car washing
..Fish pond

Space requirement:
- 450 m²


Filling of filter material


Reed Bed after 1 year of operation


Reed bed and fish pond with treated water

	COD	BOD	TKN	NO_3-N	NH_4-N	PO_4-P	TDS	TSS	CL	SO_4	Salinity	pH
	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[‰]	
Septic IN	162	67	2.1	1	3.6	7.0	314	47				7.1
Septic Out / Reed Bed IN	131	18			6.7	8.2	257	36				7.1
Reed Bed OUT	10.5	2.0	2.5	2.6	0.7	4.8	420	0	113.5	45	0.4	7.7

Reed Bed Systems Middle East

Site camp, Lagoons, Dubai

Client :
Wade Adams

Contractor :
Waagner Biro Gulf

Treatment of waste water
from a site camp.


Filling of filter material

Population equivalent:
200 PE

Planning: 03/2006
Construction: 03/2006

Pre-treatment:
- Septic tanks
- Pump station

Fresh planted reed

Biological treatment step :
- reed planted artificial wetlands (vertical flow)

Outlet:

6 m³ of treated water per day.

- Direct reuse of the water for:

Irrigation


After 2 month of operation

Space requirement:
- 150 m²

	COD	BOD	TKN	NH_4-N	PO_4-P	TSS	pH
	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	
Septic IN	400	193			9	186	6.9
Septic Out / Reed Bed IN	301	114			8	70	7.0
Reed Bed OUT	16	3	2.8	0.2	1.8	0	7.4

Reed Bed Systems Middle East

Raw sewage treatment plant - Labour camp Al Awir

Client :
Dubai Municipality

Contractor :
Waagner Biro Gulf

Treatment of mixed raw sewage at a labour camp.


Distribution point raw sewage

Population equivalent:
250 PE

Planning: 10/2009
Construction: 11/2009

Pre-treatment:
- Cutter pump


Vertical flow reed bed after reed harvesting and installation of solar panels above reed bed

Biological treatment step :
- reed planted artificial wetlands (vertical flow for filtration)
- reed planted artificial wetlands (vertical flow for biological treatment)

Outlet:

25 m³ of blended water per day.

- Direct reuse of the water for:

Irrigation
Road watering
Car washing
..Fish pond

Space requirement:
- 700 m²


Garden irrigated with TSE

	COD	BOD	TKN	NO_3-N	NH_4-N	PO_4-P	TDS	TSS	CL	pH
	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	
Raw sewage	496.0	284.0	45.0	0.5	30.8	10.0	296.0	80.0	99.0	7.7
Reed Bed 1 OUT	26.0	3.0	15.0	14.3	0.6	2.1	968.0	0.0	128.0	7.3
Reed Bed 2 OUT	14.0	2.0	9.8	9.2	0.1	3.0	924.0	0.0	142.0	7.9

Reed Bed Systems Middle East

**Waste water Separation,
Treatment and Reuse -
Site office, Lagoons**

Client :
The Lagoons Project, Halcrow

Contractor :
Waagner Biro Gulf


Filling of filter material

Population equivalent:
200 PE

Planning: 02/2006
Construction: 03-06/2006

Pre-treatment:
- Septic tanks for black water
- Settlement tanks for grey water
- pump station


Installation of subsurface drip lines

Biological treatment step :
- reed planted artificial wetlands (vertical flow) for black water (100m²)
- reed planted artificial wetlands (vertical flow) for grey water (40 m²)

Sludge treatment :
- reed planted sludge composting bed (10 m²)


Grey water reed bed and black water reed bed

Reuse of treated water:

- Subsurface drip irrigation for black Water (400 m²)

- Manual irrigation for grey water.

Space requirement:
- 200 m²

Reed Bed Systems Middle East

Car wash water -
Workshop Al Awir

Client :
Waagner Biro Gulf

Contractor :
Waagner Biro Gulf

Treatment of car wash water

Car wash area

Wash water :
1000 litre / day

Planning: 05/2006
Construction: 05/2006

Pre-treatment:
- oil-separator

Biological treatment step :
- 1 reed planted artificial wetlands (horizontal flow)

Outlet:
- Storage tank and reuse for irrigation

Oil separator and fresh planted reed bed

Reed bed after one year

Special features:
- no energy consumption, all in gravity flow

Space requirement:
15 m²

	COD	Oil and Grease	TSS	pH
	[mg/l]	[mg/l]	[mg/l]	
Reed Bed IN	182	9.0	21	7.9
Reed Bed OUT	59	0.0	23	7.3

Reed Bed Systems Middle East

Private villa, Dubai

Client :
Private

Contractor :
Waagner Biro Gulf

Treatment of waste water from a villa, for reuse as irrigation water.


Installation of liner

Population equivalent:
4 PE

Planning: 04/2007
Construction: 05/2007

Pre-treatment:
- Pump station
- Septic tanks
- gravity flow into reed bed

Biological treatment step :
- reed planted artificial wetlands (horizontal flow)

Outlet:

0.5 m³ of treated water per day.

- Direct reuse of the water for:

Irrigation


Use of different plants in the reed bed

Space requirement:
- 30 m²

	COD	BOD	TN	NH_4-N	PO_4-P	TSS	FC	pH
	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	MPN/100 ml	
Reed Bed OUT	35	6	2.25	1.63	6.92	0	0	7.72

Reed Bed Systems Middle East

Private villa, grey water, Ajman

Client :
Private

Contractor :
Waagner Biro Gulf


Levelling of basin

Population equivalent:
10 PE

Planning: 01/2007
Construction: 03/2007

Pre-treatment:
- Sedimentation tank
- Pump station

Biological treatment step :
- reed planted artificial wetlands
  (vertical flow)


Planted filter

Outlet:

1 m^3 of treated water per day.

- Direct reuse of the water for:

  Irrigation

Space requirement:
- 30 m^2


Filter after 6 month of operation

Reed Bed Systems Middle East

Waste water treatment on roof

Client :
Dubai Municipality

Contractor :
Waagner Biro Gulf


Container before installation

Population equivalent:
4 PE

Planning: 10/2007
Construction: 12/2007

Pre-treatment:
No pre-treatment
- only grinder pump station

Biological treatment step :
- reed planted artificial wetlands
  (vertical and horizontal flow)


Container with roof reed bed, fresh planted

Outlet:
- No outlet
- Direct reuse of the waste water for:
Roof top irrigation

Advantages:
- No septic tank
- No sewer connection
- Direct reuse of waste water
- No contact of people with sewage
- Cooling of container by green roof

Space requirement:
- 15 m²


Container after 3 years of operation

Reed Bed Systems Middle East

Sewage sludge mineralization, Resort Zighybay, Oman

Client :
Six Senses Resort Zighy Bay

Contractor :
Bauer emirates Environment

Filter layer

Population equivalent :
1400 PE

Planning: 05/2009
Construction: 07-10/2009

Sewage treatment:
Extended aeration in concrete basins

- Buffer & aeration basin
- Aeration basin
- Settling tanks
- Multimedia filtration

Planting

Sewage sludge treatment :
- reed planted artificial wetlands (vertical flow)

Outlet:
- Sludge liquor is pumped back to STP
- Reuse of TSE for irrigation

Advantages:
- No sludge storage & discharge
- Green technology for the hotel
- Production of fertilizer

After 6 month operation, view from the private hotel beach

Space requirement:
- 350 m²

Reed Bed Systems Middle East

Labour camp, Al Sifa, Oman

Client :
Muriya Tourism Development Oman

Contractor :
Bauer Oman


Earth works

Population equivalent :
100 PE, 14 m³/day

Planning:09/2009
Construction: 11-12/2009

Sewage treatment:
Raw sewage reed bed

- Cutter pump station
- Vertical filtration reed bed
- Horizontal biological reed bed
- Storage tank, tanker filling

Sewage sludge treatment :
Directly in filtration reed bed


Basins after planting

Outlet:
- Storage and reuse for construction

Advantages:
- No sewage storage & discharge
- Green technology for the project
- Production of fertilizer

Space requirement:
- 1400 m²


Basins after 1 yearof operation

	COD	BOD	NH4-N	NO3-N	TDS	TSS	pH
	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	
Raw sewage	910	330	62	-	1000	680	7.3
Reed Bed 1 OUT	20	8	22	5	1150	52	7.8
Reed Bed 2 OUT, FINAL	18	7	1.6	6	1200	7	7.9

After 1 year operation

Reed Bed Systems Middle East

Reed irrigation fields with oil drilling water, Nimr, Oman

Client :
PDO Oman

Contractor :
Bauer Oman


Basins under construction

Daily flow:
45.000 m³/day oil drilling water

Planning: 2009
Construction: 2010-2011

Oil water treatment:
Reed irrigation fields

Salt lagoons


Basins after planting

Outlet:
- Total evaporation of oil water

Advantages:
- No recharge of oil water
- Greening the desert
- Production of biomass for energy or eco building materials


Basins after 1 year operation

Space requirement:
6.000.000 m² (600 ha)

Reed Bed Systems Middle East

Tertiary treatment
of sewage (Pilot test)

Client :
Ajman Sewerage

Contractor :
Waagner Biro Gulf

Location:
Industrial area Ajman, U.A.E.

Daily flow:
30 m³/day

Planning: 07/2009
Construction: 09-11/2009

Sewage treatment:
UASB

Tertiary treatment :
Vertical flow reed planted irrigation fields

Outlet:
- Recharge of ground water

Advantages:
- No TSE discharge into the sea
- Tertiary treatment of TSE
- Ground water recharge& storage
- Future reuse of TSE from ground water storage
- Greening the desert

Space requirement:
- 200 m²


Drainage pipes


Distribution points


Reed plants, 11/2009


05/2010

	COD	BOD	NO_3-N	NH_3-N	PO_4-P	TDS	TSS	pH
	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	
TSE from UASB	319	144	4.7	48.7	11.3	3559	36.7	7.3
Drainage collection in 1.2m	38	5	0.8	3.4	1.3	2084	7	7.1

Infiltration rate desert sand:90 l/m²xday

Reed Bed Systems Middle East

Labor Camp
Mirfa, Abu Dhabi

Client :
Waagner Biro Gulf

Contractor :
Waagner Biro Gulf


Installation of dams

Treatment of complete waste water, for reuse as irrigation water.

Population equivalent:
80 PE

Planning: 04/2011
Construction: 05-07/2011

Pre-treatment:
- Macerator pump station
- Sludge Filtration & Mineralization Reed Bed
  (2 basins, vertical flow)

Biological treatment step :
- Reed Bed, vertical flow
  (1 basin, vertical flow)

Outlet:
- 20 m³ of treated water per day.
- Direct reuse of the water for:
  Irrigation

Space requirement:
- 400 m²


Spray nozzles test Stage B


Reed Bed after 6 month operation

	COD	BOD	NH4-N	PO4-P	TDS	TSS	DO	Turbidity	pH
	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	NTU	
Raw sewage, Inflow	383	279	45.4	5.53	357	129			7.65
Reed Bed Stage B, TSE	<12	< 5	0.2	0.02	933	< 10			7.8
ADSSC/RSB-Standard P1	-	10	-	-	-	10	1	5	6 - 8
ADSSC/RSB-Standard P3	-	50	2	2	-	50	>3	75	6 - 9

Reed Bed Systems Middle East

Anantara Hotel,
SirBaniYasIsland, Abu Dhabi

Client :
TDIC

Contractor :
Hilalco

Main Consultant:
Parsons

Population equivalent:
Phase 1: 300 PE
Phase 2: 1200 PE

Planning: 2010
Construction: 04-10/2011

Pre-treatment:
- Tanker discharge station
- Manual bar screen
- Macerator pump station
- Sludge Filtration & Mineralization
  Reed Bed Stage A
  (4 basins, vertical flow, 4 x 248 m²)

Biological treatment step :
- Reed Bed, vertical flow
  (4 basins, vertical flow, 4 x 360 m²)

Outlet:
- 62.5 m³ of treated water per day.
- Direct reuse of the water for:
  Irrigation

Space requirement total:
- 8000 m²
-


Excavation of pump station


Pump station


Basins


First TSE discharge

	COD	BOD	NH4-N	PO4-P	TDS	TSS	DO	Turbidity	pH
	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	NTU	
Raw sewage, Inflow	86	91	22.6	2,27		55	2	24.6	7.55
Reed Bed Stage B, TSE	28.5	11	nd	0.355		3.5	7.46	1.53	7.75
ADSSC/RSB-Standard P1	-	10	-	-	-	10	>1	5	6 - 8
ADSSC/RSB-Standard P3	-	50	2	2	-	50	>3	75	6 - 9

Reed Bed Systems Middle East

Savannah Lodge,
SirBaniYasIsland, Abu Dhabi

Client :
TDIC

Contractor :
Hilalco

Main Consultant:
Parsons

Population equivalent:
90 PE

Planning: 2010
Construction: 04-10/2011

Pre-treatment:
- Macerator pump station
- Sludge Filtration & Mineralization Reed Bed (2 basins, vertical flow)

Biological treatment step :
- Reed Bed, vertical flow (2 basins, vertical flow)

Outlet:
- 18 m³ of treated water per day.
- Direct reuse of the water for: Irrigation

Space requirement:
- 1100 m²


Excavation of basins


Casting pump station


Sand filling basins


Basins after 3 month

Reed Bed Systems Middle East

Sewage sludge mineralisation reed bed
Al Salt, Jordan

Client :
KfW, Waj Jordan

Contractor :
Bauer Emirates Environment


Filter layer installation

Capacity:
8 m³/day surplus sludge (2.5 %DS)

Planning: 05/2011
Construction: 07-10/2011

Sewage treatment:
Extended aeration

- Aeration basin
- Settling tanks
- Multimedia filtration


Basin 2 month under operation

Sewage sludge treatment :
- sludge mineralization reed beds
  (vertical flow)


Basins 7 month under operation (Oct.- Mai)

Outlet:
- Sludge liquor is pumped back to STP

Advantages:
- No sludge storage & discharge
- Green technology for the project
- Production of fertilizer

Space requirement:
- 640 m²

Reed Bed Systems Middle East

Labor Camp
Sila, Abu Dhabi

Client :
Waagner Biro Gulf

Contractor :
Waagner Biro Gulf


Reed Bed after 1 month operation

Treatment of complete waste water, for reuse as irrigation water.

Population equivalent:
200 PE

Planning: 07/2011
Construction: 08/2011 - 04-2012

Pre-treatment:
- Macerator pump station
- Sludge Filtration & Mineralization Reed Bed
  (2 basins, vertical flow, 260 m²)


Stage A, fresh planted

Biological treatment step :
- Reed Bed, vertical flow
  (1 basin, vertical flow, 340 m²)

Outlet:
- 40 m³ of treated water per day.
- Direct reuse of the water for: Irrigation

Space requirement:
- 800 m²

System after 3 month operation

	COD	BOD	NH4-N	PO4-P	TDS	TSS	DO	Turbidity	pH
	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	NTU	
Raw sewage, Inflow	320	148	48.7	8.8	364	50			6.9
Reed Bed Stage B, TSE	16	2	0.13	2.1	1324	<5			7.14
ADSSC/RSB-Standard P1	-	10	-	-	-	10	1	5	6 - 8
ADSSC/RSB-Standard P3	-	50	2	2	-	50	>3	75	6 - 9