LIFE Project Number

LIFE 04 ENV/D/058

PROGRESS REPORT No. 1

Covering the project activities from 01.01.04 to 31.01.05

Reporting Date

04/02/2005

LIFE PROJECT NAME

Enhanced Nutrients Removal in Membrane Bioreactor (ENREM)

Data Project

Project location (Office, present)	KompetenzZentrum Wasser Berlin Cicerostrasse 24 10709 Berlin	
Project start date:	01.01.2004	
Project end date:	30.12.2006	**Extension date:** n.r.
Total Project duration	36 months	**Extension months:** n.r.
Total budget	3,417,378 €	
EC contribution:	562,463 €	
(%) of total costs	16.5 %	
(%) of eligible costs	30.0 %	

Data Beneficiary

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1. Lists of key-words and abbreviations

Key-Words: membrane activated sludge, membrane bioreactor (MBR), semi-central treatment, remote catchment, sensitive area, bathing water, nitrification, denitrification, enhanced biological phosphorus removal (EBPR), disinfection

Abbreviations:

BWB	Berliner Wasserbetriebe
AR	Anjou Recherche
BOD	Biological Oxygen Demand
DO	Dissolved Oxygen
KWB	Kompetenzzentrum Wasser Berlin (Berlin Center of Competence for Water)
HRT	Hydraulic Retention Time
MBR	Membrane Bioreactor
MLSS	Miwed Liquor Suspended Solids
pe	population equivalent
TMP	Transmembrane Pressure
TN	Total Nitrogen
TP	Total Phosphorus
TUB	Technical University of Berlin
VFA	Volatile Fatty Acid
WWTP	Waste Water Treatment Plant

2. Executive Summary

The ENREM project aims at demonstrating a novel wastewater treatment process based on the technology of membrane bioreactor (MBR), set up in a configuration to enable enhanced biological elimination of nutrients. A new plant, and the related sewer system, is to be built in a yet unsewered remote area of Berlin. The plant will be then operated over more than one year, and the process will be optimised. Performances and costs of the treatment system will be then assessed for the size 250 – 10,000pe, corresponding to semi-central schemes.

The management of the project has been achieved according to the organisation identified in the LIFE proposal. No relevant modification has been required. **Annex 3.1** presents and discusses the key deliverables and milestones depending on the LIFE proposal and the current status.

In relation to the technical content, Task 2 "Site and process definition" and Task 4 "Detailed design" are quasi-completed, with however a **four month delay** which will put back consequently the following actions, such as start of sewer and plant construction, and plant commissioning.

Specifically, the following actions were completed, or are on the verge of completion:

- Cost-comparison of decentralised treatment solutions to serve 20 unsewered areas of Berlin and selection of demonstration site (district of Margaretenhöhe);
- Revision of cost evaluation for infrastructure;
- Planning and specification of MBR plant;
- Preparation and release of call for tender of MBR plant;
- Planning and specification of low-pressure sewer;
- Preparation and release of call for tender of low-pressure sewer construction;
- Acquisition of legal permits (for plant construction & operation, water discharge);
- Acquisition of parcel for MBR plant.

In addition, the first trials phase of Task 3 "Preliminary testing on representative site" (period with irregular excess sludge withdrawal) was completed and enabled to validate the design criteria of the MBR demonstration plant. The relationship with the inhabitants of Margaretenhöhe was initiated in order to ensure a smooth construction phase, and a quick connection to the new sewer system.

Dissemination activities were undertaken accordingly as shown in **Annexes 7.1-7.3**, and the project web-site in three languages was set up (see in www.kompetenz-wasser.de). The communications on project are expected to ramp up in 2005 and 2006, as more outcomes and results are getting available.

The main task in 2005 will be the construction and commissioning of the low sewer system and the MBR demonstration plant. The start-up of the novel treatment scheme is now expected for October / November 2005.

Project management

Figure 1 presents the organisation chart of the ENREM project, built up around the following consortium:

- KompentenzZentrum Wasser Berlin (KWB) as beneficiary
- Berliner Wasserbetriebe (BWB) and Anjou Recherche (AR) as partners

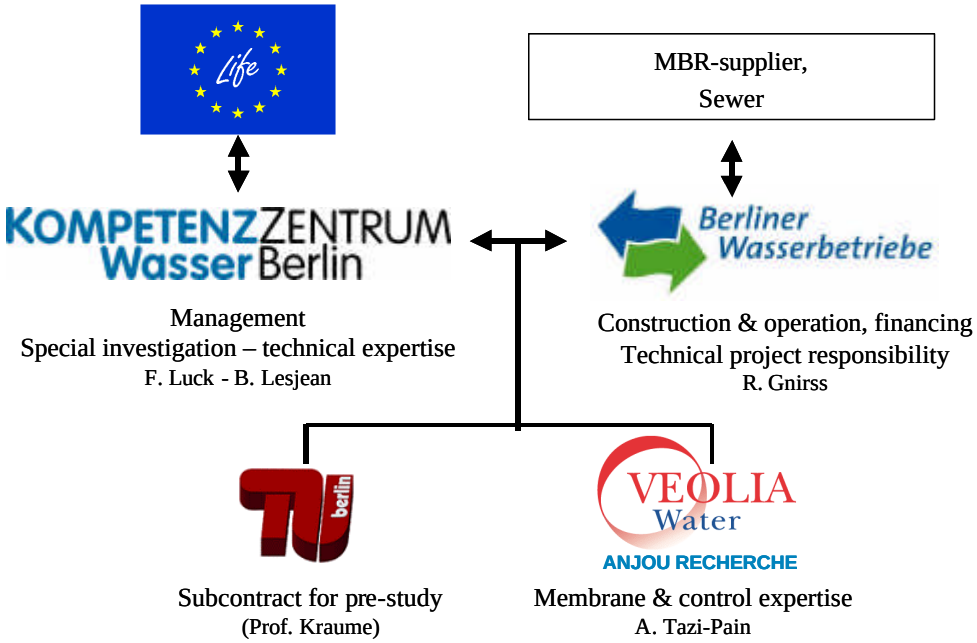

Figure 1. Organisation chart of the ENREM project

Some sub-contractors are or will be involved in the project:

- Technical University of Berlin (TUB) to conduct the preliminary pilot plant study on representative site (Task 3)
- Jung Pumpen, designer and supplier of household pumping systems, selected by BWB for a 5-year contract after tender process
- A MBR-system manufacturer, to be selected after tender process
- A construction company for the pressurised system, to be selected after tender process

To be noted that a Project Partnership Agreement was signed between beneficiary and partners, as well as a sub-contract agreement with the TUB.

3. Technical development

3.1 General

Task 1 "Management & reporting to EC" and Task 8 "Dissemination" are performed over the entire duration of the project. The actions undertaken in 2004 are summarised below. Task 2 "Site and process definition" and Task 4 "Detailed design" are (quasi) completed at the time of this report. A brief summary is provided below, with some further information in the Annexes. Task 3 "Preliminary testing on representative site" was partly undertaken in 2004 and will be continued over the first semester 2005. The achieved outcomes are set off below, and the first progress report is given in Annex. Task 5 "Construction phase" is just starting at the time of writing this report. Task 6 "Special investigations" and Task 7 "Demonstration plant start-up and operation" will be undertaken in 2005 and 2006. They are therefore not discussed here. An **updated Gantt chart** is presented in **Section 8 "Envisioned progress in 2005"**.

3.2 Task 1 "Management & reporting to EC"

On-going task over the full duration of project. The following actions were completed in 2004 up to January 2005:

- Project partnership agreement (signed on 03.12.2004) and subcontract agreement with TUB (signed on 02.04.2004)
- Organisation of official kick-off meeting between KWB and BWB
- Preparation and reporting of meetings
- Controlling of project progress
- Controlling of project financial status
- Preparation of progress report N°1

3.3 Task 2 "Site and process definition" and Task 4 "Detailed design"

The two tasks are reported together given the overlapping of period and actions. According to the LIFE proposal, they should be completed in February 2005. One month of delay is expected. The following actions were completed or are in progress.

- Cost-comparison of decentralised treatment solutions to serve 20 unsewered areas of Berlin and selection of demonstration site. Completed in April 2004. **Annex 5.1** presents the description of the 20 unsewered areas considered. **Annex 5.2** presents the cost-comparison of the potential sites for the ENREM project, after pre-selection based on technical criteria. The area of Margaretenhöhe (250 pe), with pressure sewer, was finally selected as demonstration site. **Annex 5.3** presents an overview of the site.
- Revision of cost evaluation for infrastructure. Completed in July 2004. The infrastructure costs are in line with the budget proposed in the LIFE-proposal.
- Literature research on small MBR-plants (50-5,000 pe) focused on pre-treatment and sludge handling strategy. Completed in August 2004. The main outcomes were as follows: (i) the pre-treatment should be selected and implemented depending on the type of membrane technology, with 1mm holes screen for hollow fibre, (ii) the plant should be equipped with a ca. 10m^3 tank for excess sludge storage, (iii) given the size of the plant, it should be more efficient and economically advantageous to tender the entire plant in one stage, as "integrated turn-key plant".
- Visit of MBR plant of Merkendorf, Thüringen, on 16.11.2004 (230pe, equipped with Kubota Membrane system).

- Planning and specification of MBR plant. Completed in December 2004. **Annex 5.4** provides a description of the plant specification.
- Preparation and release of call for tender of MBR plant. Completed in January 2005. Eleven German MBR-system suppliers, or European representatives, were offered to tender for the delivery of the MBR demonstration plant.
- Planning and specification of low-pressure sewer. Completed in December 2004. **Annex 5.5** provides a description of the sewer specification.
- Preparation and release of call for tender of low-pressure sewer construction. Completed in January 2005. Nine German construction companies were offered to tender for the construction of the low-pressure system.
- Acquisition of legal permits (for plant construction & operation, water discharge). In progress, to be completed by March 2005. To date, and according to the feedback from the responsible authorities, no problem is expected concerning the delivery of the permits.
- Discussion with local authorities on neighbouring protected landscape. In progress, "mitigative measures" are to be integrated in the purchase agreement of parcel.
- Acquisition of the parcel for MBR plant. In progress, to be completed by March 2005. No difficulty expected for the transaction beyond the agreement on "mitigative measures".

3.4 Task 3 "Preliminary testing on representative site"

On-going task, subcontracted by KWB to the Technical University of Berlin (TUB). The reasons for the selection of the TUB to perform this task without open tender are provided in **Annex 5.6.** The following tasks were achieved during the reported period:

- Selection of representative site for pilot plant study (Grünau pumping station, a gravity flow catchment for 800 pe). Completed in May 2004.
- Construction and commissioning of pilot plant. Completed in July 2004.
- Detailed characterisation of wastewater (quality & flow profile, in Grünau pumping station and in a low-pressure sewer). Completed in October 2004.
- Validation of design and operation criteria of demonstration plant. First scenario (irregular sludge withdrawal), completed in December 2004. Second scenario (regular sludge withdrawal) in progress.
- First progress report, including details on achieved actions and outcomes, released by TUB in January 2005 (report available separately).

3.5 Task 5 "Construction phase"

This phase, initially planned to start in October 2004, started effectively in January 2005, and will be the most significant task of the year 2005. At the date of this report, the main action undertaken as prerequisite for this task was the organisation of an "open council" organised by the BWB with the inhabitants of Margaretenhöhe on 11th January. The participation was intense, with an estimation of 270 inhabitants attending the meeting. The participants showed interest, without any major opposition to connect. The collaborators of BWB estimate that 50% of the households should connect very quickly, and an additional 30% in the first six months, which would lead rapidly to **80% connection rate**. In February and March, the collaborators of BWB will meet individually each of the house tenants in order to agree upon the position of the pump shaft on the parcel and to enter into a connection agreement. This will provide a precise idea of the readiness of the people in Margaretenhöhe to connect.

4. Problems encountered

During the first year of the project, no major technical or administrative difficulties were encountered. However, a **four month delay** can be observed, as a result mainly of the two following reasons:

- The official announcement of the EC came two months later as awaited (September 2004 instead of July 2004). The BWB envisaged starting the phase of detailed design and planning of sewer and demonstration plant only once the project was officially accepted by the EC.
- The relationships for the purchase of the parcel with the council of Wartenberg, the actual public owner of the parcel, were first not as efficient as expected. This also caused another delay of two months for the completion of the design and planning of sewer and demonstration plant.

Despite best endeavours, it is not expected that this delay can be corrected. This will result in a four-month delay for the distribution of the calls for tender, the start of the plant and sewer construction, and the commissioning of the system, which is now envisioned in **October-November 2005** instead of July 2005 as initially planned in the LIFE proposal. To date, no project duration extension is considered, the operation phase is just expected to be accordingly shortened. A request for project duration extension will be considered only if other unforeseen events occur during the next phases of the project.

Negotiations with local authorities for legal permits or parcel acquisition are in progress, and expected to be achieved by March 2005. Also no particular difficulty was noticed, it can be noted that the procedure last longer than initially planned in the proposal. However this activity is done in parallel to the design and construction of the treatment scheme, and should not cause any delay in the start of operation.

5. Dissemination

5.1 Project communication in 2004

In 2004, the communication activities consisted essentially in press release and announcements or general presentations of project objectives in conferences and specialised journals. **Annex 7.1** presents the list of presentations and publications achieved in appropriate symposia and conferences. **Annex 7.2** draws the list of other communication activities (press release, newsletter, etc) and **Annex 7.3** provides the list of official meetings during which the project was presented.

The salient communication activities were:

- 19-24 Sept. 2004: IWA Marrakech 2004, Morocco. Project announcement in a platform presentation, plus project presentation on a poster at the KWB booth (exhibition fair), with a good feedback from booth visitors
- October 2004: Press release from KWB to announce the official acceptation of EU-LIFE proposal (showed in **Annex 7.4**), which was published by a few specialist journals
- 4-6 Oct. 2004: International conference on sustainable water systems, Berlin, Germany. Project presentation for a delegation of around 100 international water professionals
- November 2004: First page article in KWB Newsletter, published in English and German and distributed per post and email to around 1,000 addressees in the water business community (showed in **Annex 7.4**)

- 25 Nov. 2004: Project presentation at top management staff of Veolia Water, BWB and TUB at the occasion of an agreement signature between Veolia Water and TUB

Furthermore the project has been summarily presented on the KWB web-site (**www.kompetenz-wasser.de**) in German, English and French since March 2004, and in details with the latest updates and downloads since January 2005.

A project logo was also ordered to a communication agency in September 2004, to enhance the impact of the communication activities on the project. This logo was included in all communication supports (posters, presentations, web site), together with the EU-LIFE logo, and the logos of the partners.

5.2 Communication strategy

The following communication activities are planned in 2005:

- Update of ENREM web-site on quarterly basis
- Full-page description of the project in the KWB 2004 activity report (German / English)
- Presentation in appropriate conferences and seminars on the outcomes of 2004 (preliminary study, conception phase and tender, etc). A list of submitted articles or abstracts is given in **Annex 7.5.** To be noted is the recent acceptance of the communication "Membrane bioreactor for semi-central sanitation with enhanced treatment performances" as platform presentation in the session "Sewer systems and wastewater treatment for small communities" of the EWA Conference Wastewater 2005 (10-12 May 2005, Teplice, Czech Republic)
- Presentations of project in Berlin to interested persons and institutions
- A workshop „MBR applications for decentral and semi-central wastewater treatment" will be organised in Berlin on 2 June 2005 with participation of around 50 water business professionals
- At/after start-up of the demonstration plant, many communication activities will be undertaken such as press release, article in KWB Newsletter, official ceremonies with residents and local authorities, press conference and visits with journalists of local or specialised press, etc.

6. Envisioned progress in 2005

Table 1 presents the actual program of plant and sewer construction over 2005. In addition to this, the following actions are expected:

- Purchase of parcel in the coming months (Task 4)
- Acquisition of required permits in the coming months (Task 4 and 5)
- Continuation of preliminary study: 2nd scenario with regular excess sludge withdrawal up to June 2005, with final reports on results (Task 3). This will enable to confirm the selected operation conditions of the demonstration plant.
- Preparation of connection strategy to ensure a quick connection of residents, together with the commissioning strategy (Task 5)
- Organisation of plant remote control and emergency plan (Task 5)
- Definition of operation and experimental plan
- Preparation of the interim report in January 2006, covering the entire costs for the construction of the system (Task 1)

Pressure sewer		**MBR plant**	
Action	**Planned period**	**Action**	**Planned period**
Distribution of call for tender	01/2005	Distribution of call for tender	01/2005
Reception of bids	02-03/2005	Reception of bids	02-03/2005
Evaluation of offers and assignment	03-05/2005	Evaluation of offers and assignment	03-04/2005
Sewer construction	06-10/2005	Plant construction	05-10/2005
Households connection	From 08/2005	Installation of storage tank	09/2005
Start of sewage collect	09/2005	Plant delivery	10/2005
Full commissioning of system	10-11/2005	Plant start-up	10-11/2005

Table 1. Program of system construction

7. Progress and planned activities

Figure 2 presents the updated Gantt chart of the project. Due to the 4-month delay, the Tasks 3-7 exhibit a shift to the right, the plant start-up being yet expected for October-November 2005. The descriptions of deliverables (D1-17) and Milestones (M1-25) are given in **Annex 3.1**.

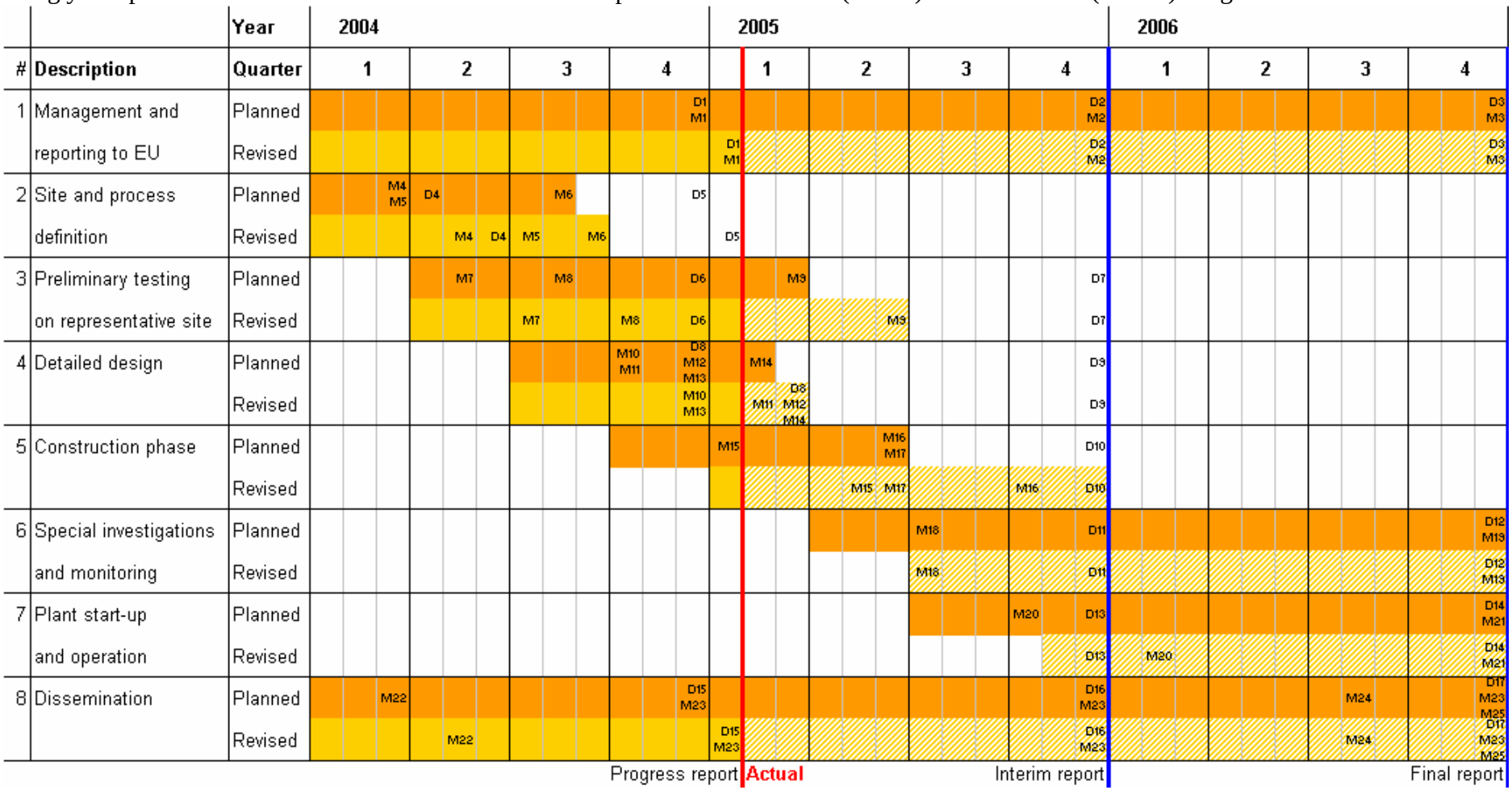

Figure 2. Updated Gantt chart of ENREM Project.

8. Annexes

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Annex 7.4 KWB press release and KWB Newsletter
Annex 7.5 List of articles or abstracts submitted for presentation in 2005

Annex 3.1 List of key deliverables and milestones

Task	Deliver. Milestone	Description	Date	Status
Task 1	**D1 & M1**	Progress report	Month 12 12.2004	Available
Task 1	**D2 & M2**	Interim report	Month 24 12.2005	-
Task 1	**D3 & M3**	Final report	Month 36 12.2006	-
Task 2	**D4**	Report on technical and economical comparison of potential demonstration sites	Month 4 04.2004	Completed by Month 6. Data of 20 potential sites in Annex 5.1 and cost comparison of pre-selected sites in Annex 5.2. Full report (19 pages + Annexes, German, available on request)
Task 2	**D5**	Documentation of public tender preparation and bids from suppliers, first project plans	Month 12 12.2004	Completed by Month 13. Design of plant and sewer presented in Annex 5.3 and Annex 5.4. Available on request (German): specification of MBR plant (15 pages); call for tender of MBR plant (80 pages + annexes), call for tender of sewer (30 pages + annexes)
Task 2	**M4**	Selection of demonstration and test site	Month 3 03.2004	Completed in Month 4 and 5. Demonstration site: Margaretenhöhe Test site: Grünau pumping station
Task 2	**M5**	Budget revision (infrastructure and equipment cost)	Month 3 03.2004	Completed in Month 7. To the latest estimation, the budget should fit with the LIFE proposal
Task 2	**M6**	End of preparative work & decision from EU LIFE	Month 8 08.2004	Completed in Month 9.
Task 3	**D6**	Plan, flow sheet and photos of pilot plant, first test results, raw water characterisation	Month 12 12.2004	Completed on time. Report available separately.
Task 3	**D7**	Complete results of preliminary tests, confirmation of process parameters	Month 24 12.2005	To be completed by June 2005, with reporting in Interim report on 12.2005
Task 3	**M7**	Start-up of pilot plant	Month 5 05.2005	Completed in Month 7
Task 3	**M8**	Verification of basic process design	Month 8 08.2004	Completed by Month 10. Reported in Annex 5.8
Task 3	**M9**	End of testing on representative site	Month 15 03.2005	Expected in Month 18
Task 4	**D8**	Detailed project plans, documentation on public tender process and sub-contactors selection	Month 12 12.2004	Call for tender released in Month 13. Selection of subcontractors expected by Month 15
Task 4	**D9**	Project plans of IT-System	Month 24 12.2005	IT architecture & requirement identified and included in MBR specifications. Details to be agreed upon with subcontractor after tender
Task 4	**M10**	Design & planning of sewer system completed	Month 10 10.2004	Completed in Month 12
Task 4	**M11**	Main equipment supplier identified	Month 10 10.2004	Completion expected by Month 14
Task 4	**M12**	Orders issued for main equipments	Month 12 12.2004	Completion expected by Month 15
Task 4	**M13**	Design and planning of demonstration plant completed	Month 12 12.2004	Completed in Month 12
Task 4	**M14**	End of detailed design	Month 14 02.2005	Completion expected by Month 15
Task 5	**D10**	Evidence of sewer and demonstration plant construction, written protocols for start-up, operation and experimental trials	Month 24 12.2005	Will be available on Month 24

Task 5	**M15**	Start of demonstration plant construction	Month 13 01.2005	Expected in Month 17
Task 5	**M16**	End of plant and sewer construction	Month 18 06.2005	Expected in Month 22
Task 5	**M17**	Legal authorisation obtained for operation	Month 18 06.2005	On time
Task 6	**D11**	First important test results from testing on real site	Month 24 12.2005	May be postponed depending on raw water availability
Task 6	**D12**	Investigations made during operation, troubles occured and solutions found	Month 36 12.2006	Will be available on time
Task 6	**M18**	Start up of pilot plant on real site and parallel operation	Month 19 07.2005	May be postponed depending on raw water availability
Task 6	**M19**	End of pilot operation on real site	Month 36 12.2006	Will be completed on time
Task 7	**D13**	Reports on demonstration plant start-up and first operation performances	Month 24 12.2005	Will be available in Month 24
Task 7	**D14**	Reports on operation performances and process evaluation & optimisation	Month 36 12.2006	Will be available in Month 36
Task 7	**M20**	End of commissioning and start-up phase, 100% connection	Month 22 10.2005	Plant expected to be started up in Month 22. 80% connection rate should be achieved in the next 6 months
Task 7	**M21**	End of demonstration phase	Month 36 12.2006	Will be completed on time
Task 8	**D15**	Update on dissemination actions	Month 12 12.2004	Available
Task 8	**D16**	Update on dissemination actions	Month 24 12.2005	-
Task 8	**D17**	Update on dissemination actions	Month 36 12.2006	-
Task 8	**M22**	Set-up of project description on internet	Month 3 03.2004	Completed in Month 5
Task 8	**M23**	Fixed update of internet pages	Mth 12, 24, 36	First update completed in Month 13
Task 8	**M24**	Organisation of final project workshop	Month 32 08.2006	Planned on time
Task 8	**M25**	Publication of project CD-ROM	Month 36 12.2006	Planned on time

Annex 5.1 Data of 19 unsewered areas considered for demonstration site

Among the areas of Berlin that are to date not connected yet to the central sewer system, or not in planning to be connected in the next years, the data of 19 of them were carefully gathered and checked in order to pre-select those that could be relevant as demonstration site for the ENREM project. The following criteria were used for the pre-selection:

- Inhabitants: > 200 pe, < 1,000 pe (representative and practical size for demonstration)
- Distance to central sewer: > 400 m (below would not be economical)
- Distance to discharge water bodies (as soil infiltration was not considered): < 1,000 m
- Population density: > 10 pe/ha (below would not be economical)

Area name	Council	Inhabitants pe	Area size ha	Population density pe/ha	Distance to central sewer in Berlin m	Distance to discharge waterbody m
Sites coping with pre-selection criteria						
Margaretenhöhe	Hohenschönhausen	250	14.3	17.5	1.000	200
Stadtrandsiedlung Blankenfelde	Pankow	670	52.9	12.6	1.000	700
Gatow-Siedlung Habichtswald	Spandau	260	13.0	20.0	1560	800
Steinstücken	Zehlendorf	319	12.6	25.3	930	800
Sites coping with pre-selection criteria except 'inhabitants < 1,000 pe'						
Blankenburg Altsiedlung	Weissensee	3,500	173.0	20.2	400 (river to cross)	On site
Sites too small (< 200 pe)						
Am Stener Berg	Pankow	60	6.1	9.8	530	2,300
Kladow - Gutstrasse	Spandau	100	1.7	58.7	0	On site
Schmöckwitz Werder	Köpenick	90	20.2	4.5	3,000	On site
Schmöckwitz Schwarzer Weg	Köpenick	12	5.3	2.3	515	On site
Rahnsdorf-Süd	Köpenick	70	23.5	3.0	430	On site
Sites too close to central sewer system (< 400 m)						
Buchholz-West II	Pankow	900	37.9	23.7	0[1]	500
Schönholz	Pankow	360	8.2	19.3	0[1]	1,000
Mahlsdorf-Nord IV	Marzahn - Hellendorf	3,500	217.2	16.1	0[1]	1,500
Heinersdorf Altsiedlung	Pankow	737	38.2	19.3	30[1]	1,400
Karow Süd	Pankow	1,130	53.8	21.0	110	800
Neu Venedig	Köpenick	214	35.3	6.0	130	214
Buchholz-Nord	Pankow	550	41.6	13.2	270 (Berlin) 70 (Brandbrg)	200
Sites too far away from discharge water body (> 1,000m)						
Wartenberg	Lichtenberg	950	49.4	19.2	820 (Berlin) 430 (Brandbrg)	No possibility
Karow Ost	Pankow	400	18,3	21,8	1,400	1,800

This qualitative analysis showed that only the four areas Margaretenhöhe, Stadtrandsiedlung Blankenfelde, Gatow-Siedlung Habichtswald and Steinstücken were the most relevant as demonstration site. A finer quantative analysis was then undertaken (**Annex 5.2**) to pick up the best site to host the ENREM demonstration project.

[1] Connection technically difficult

Annex 5.2 Cost comparison of pre-selected demonstration sites

A quantitative cost analysis was undertaken with the four pre-selected sites identified in **Annex 5.1**. A full-cost model developed by the Berliner Wasserbetriebe to compare different alternatives for sanitation of unsewered areas was used. This model enables to calculate the Net Present Value (NPV) of various technical scenarios (+/- 20%), taking into account the investition costs and the yearly operation costs over a pay-back duration of 50 years with a interest rate of 3%. For each of the four sites, nine sanitation scenarios, resulting from cross-combination of these alternatives for the sewer or the treatment plant, were analysed:

- Gravity sewer with pumping station / low-pressure sewer without pumping station / low-pressure sewer with pumping station (required when sewer length superior than 2,000m)
- Semi-central MBR plant / existing central WWTP with fix costs (the capital costs that would theoretically be required to treat the additional flow amount) / existing central WWTP without fix costs (as we can considered that no further construction or modification would be required to treat the additional flow amount)

Vacuum sewer was not considered, as previous analyses showed that it would not be competitive. The alternative of decentralised treatment with households treatment units (for example MBR or reed beds) was also not explored, as this concept is not supported by the Senat of Berlin as an option to upgrade the remaining unsewered areas.

The following table shows for each site the most economical options with the MBR technology or with connection to the central WWTP (with / without fix costs), and according to the corresponding analysis criteria:

Sanitation scheme	Capital costs (k€)	50y NPV (k€)	Yearly cost (k€)	Spec. yearly cost (€/pe)
Margaretenhöhe (250 pe)				
Pressure sewer + WWTP without fix costs	2,014	3,597	139.8	699
Pressure sewer + MBR	2,100	3,655	142.1	710 (+ 1.5%)
Pressure sewer + WWTP with fix costs	2,014	4,464	173.5	867 (+ 24%)
Stadtrandsiedlung Blankenfelde (670 pe)				
Gravity sewer with pumping station + WWTP without fix costs	6,417	8,289	322.2	481
Gravity sewer with pumping station + MBR	6,974	9,020	350.6	523 (+9%)
Gravity sewer with pumping station + WWTP with fix costs	6,417	11,194	435.1	649 (+35%)
Gatow-Siedlung Habichtswald (260 pe)				
Pressure sewer + WWTP without fix costs	2,550	4,595	178.6	687
Pressure sewer + MBR	2,699	4,714	183.2	705 (+2.6%)
Pressure sewer + WWTP with fix costs	2,550	5,722	222.4	855 (+24%)
Steinstücken (319 pe)				
Gravity sewer with pumping station + WWTP without fix costs	1,984	2,887	112.5	353
Gravity sewer with pumping station + MBR	2,311	3,338	129.7	407 (+15%)
Gravity sewer with pumping station + WWTP with fix costs	1,984	4,270	166.3	521 (+48%)

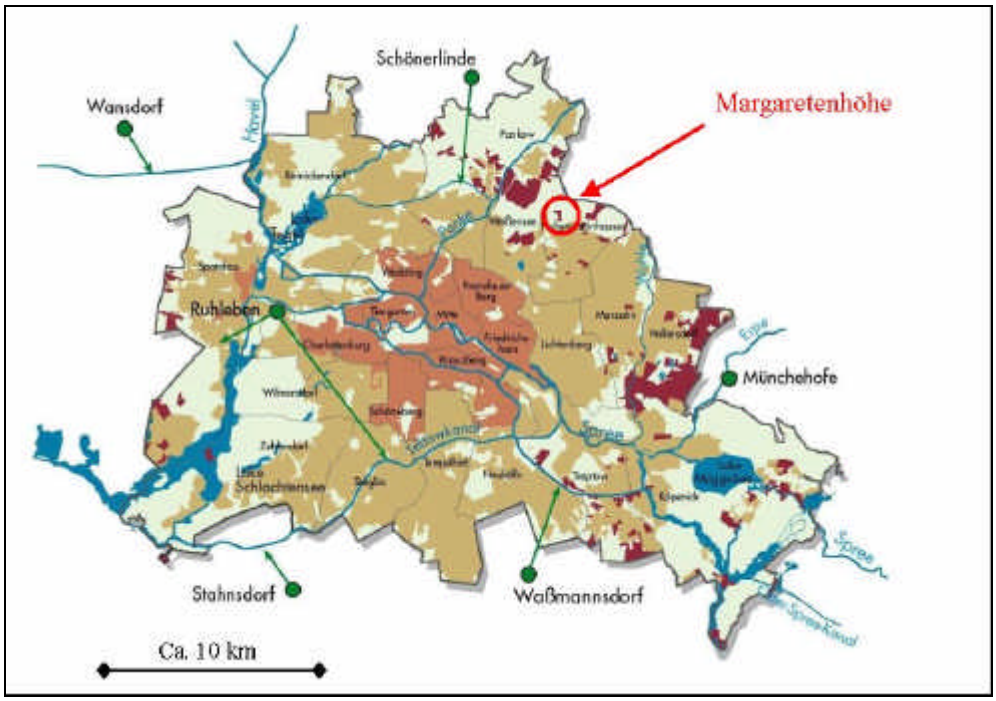
The following observations can be drawn from this analysis

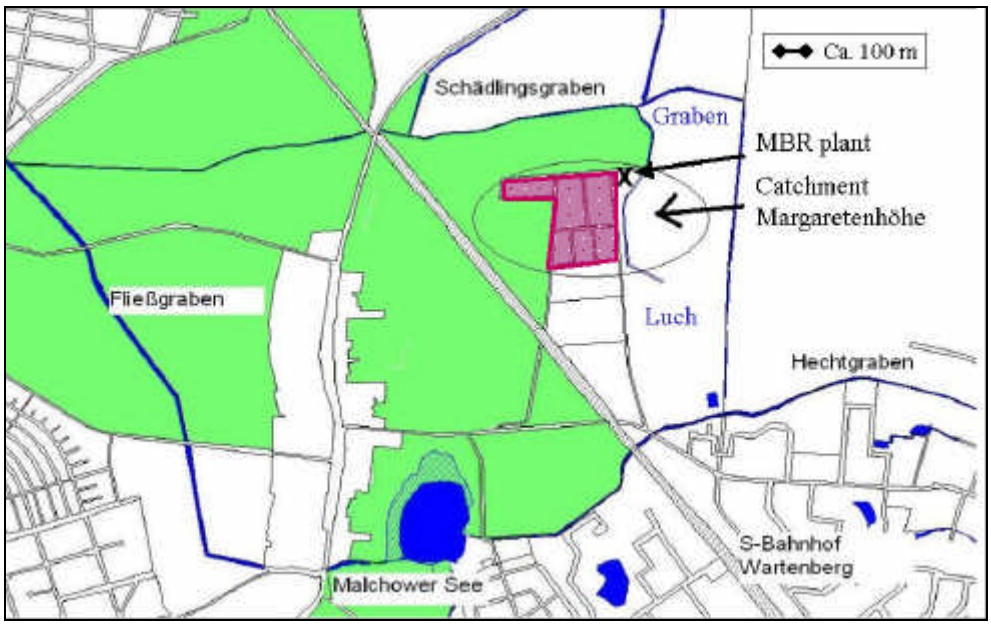
- The decentral MBR solution is slightly more expensive than the central solution *without fix costs*, but it remains within the precision of the evaluation (+/- 20%) plus it is always more economical than the central solution *with fix costs.*

- The superior quality of MBR treatment is not taken into consideration in this economical analysis: for an equal net present value, the environmental performances of the MBR solution will be greater, with also superior potential of local water reuse.

Following this economical analysis, Margaretenhöhe was selected as demonstration site for the ENREM project. Habichtswald was also attractive given similar economical results with a slightly bigger site; however the long distance to the receiving water body (800m into an intermittent trench) oriented the choice towards the site of Margaretenhöhe. The ENREM project will enable to refine the estimations of capital and operation costs of the MBR technology, and therefore precise the economical interest of the solution for these sites and others.

Annex 5.3 Situation plan of Margaretenhöhe, the selected demonstration site





Annex 5.4 MBR plant specifications (summary)

Dimensioning criteria

Connection	250 pe
Actual water demand	12 m³/d (50 L/pe/d)
Expected connection rate	80%
Most probable operation flow	10 m³/d (design for biology)
Increase potential	Up to 24 m³/d

(Hydraulic load only no increase of pollution load expected)
100% treatment. No by-pass or safety overflow.

Raw water characterisation

Wastewater of domestic origin only, collected by low-pressure system:

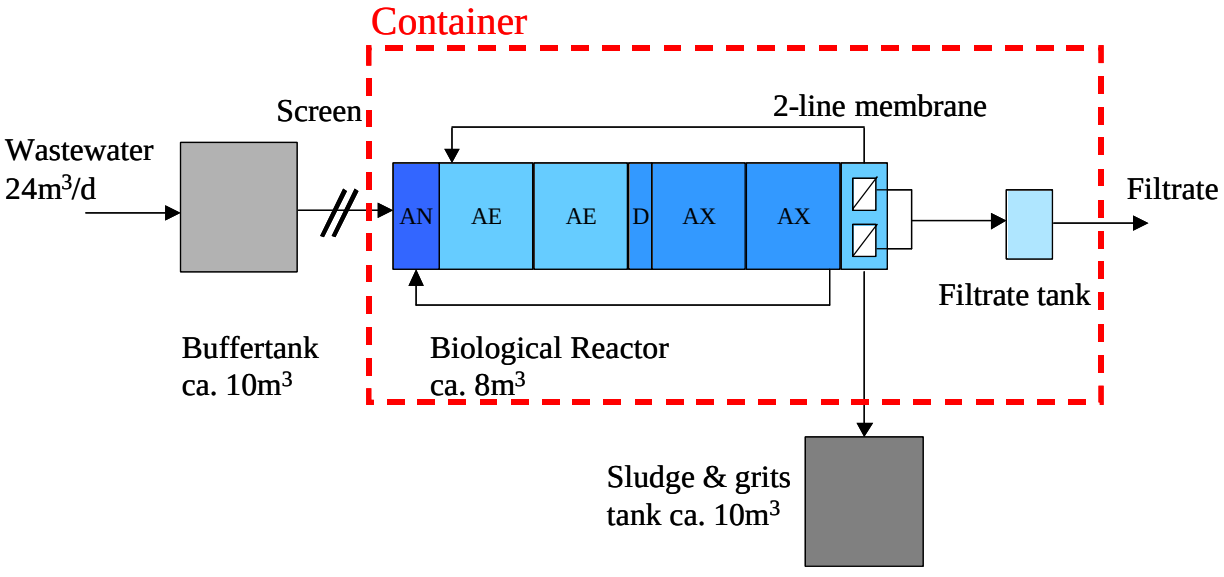
- No industrial wastewater or stormwater
- Grinding of wastewater < 7mm

50%-tile concentrations (based on wastewater characterisation of Grünau Pumping station and Rahnsdorf catchment)

Parameter	Concentration	Load
BOD5	493 mg/L	5.9 kg/d
COD	986 mg/L	11.8 kg/d
TS	356 mg/L	4.3 kg/d
TN	108 mg/L	1.3 kg/d
TP	15 mg/L	0.2 kg/d
VFA	94 mg/L	1.1 kg/d

85%-tile concentration of TN = 131 mg/L (120 mg/L after 12h-buffer tank)
=> 120 mg/L as peak-load for nitrogen
Min. Temperature: 12°C

Overall design



Equipment included in plant (in container)

- Screen (if required)
- Pumps
- Membrane & biology aeration
- Online-Sensor and analysers
- IT control and data acquisition
- Remote control and supervision with alarms

Pre-treatment

- $10m^3$ buffer reactor with bottom drain and outflow 50cm over bottom, inflow below water level, excess air to biology through ventilators
- Screen without bypass or overflow: place and type up to contractor (<1mm for HF, at the discretion of manufacturer for FM)
- PID control of flow to biology
- No possibility of mixed liquor return to buffer tank

Biological reactor

Zone	**Volume**	**Remark**
Anaerobic	400 L	+/- 10%, with mixer
Aerobic	2x 1,750 L	+/- 10%, with aerators
Deox	> 40 L, < 120 L	Eventually with mixer
Anoxic	2x 1,750 L	+/- 10%, with mixer
Membrane	Preferred < 600 L	As small as possible
Total	Ca. 8,000L	-

1.5 to 2m deep (except perhaps membrane reactor), with min. 50cm overboard
Sludge recirculation loops: 80-200% and 400-1000% (based on 12m3/d)

Biology aeration

2x fine bubble aeration (in AE1 and AE2) for oxygen transfer + sludge mixing
1 energy-efficient compressor
Removable aerators (crane)
Should warranty 2mgO2/L in both reactors, even in extreme conditions (COD-load = 11.8kg/d, TN-load = 1.3kg/d, MLSS = 18g/L, Sludge age = 50d, T° = 25°C, a = 0,5-0,7)
=> transfer of 10 g/(nm3 * mET)) required
Total aeration requirement between 2.9 and 29 Nm^3/h (without account for O2 carry-over from membrane reactor)
To be confirmed by contractor depending on DO carried over from membrane reactor and final technological choices (aerator type, reactor depth, etc). Calculation requested with demonstration of functioning in first year of operation.

Filtration system

- 2 filtration lines with separated reactors preferred but not imposed given the size of the system.
Constraint: the filtration should not be completely off-line (for cleaning, maintenance etc) for more than 5h (1/2 HRT in buffer tank).
- If 2 lines: Autonomous and independent functioning of two filtration systems, with interlocking in case of trouble on one of two lines.

- Designed with an instant flux of max. 10lmh and a throughflow of 12m3/d.
- Place reserve for addition of membrane surface to cope with up to 24m3/d (at instant flux of max 15lmh)
- Net volume: as small as possible, and preferred below 600L, with at least 50cm overboard
- Hydraulics: preferred sludge overflow from membrane tank to aerated zone (no bulking sludge in membrane tank)
- Removable modules and aerators (crane)
- If 2 lines: preferred autonomous and independent aerator per membrane line, with two separated air blowers (investment costs vs. energy efficiency + redundancy: if one fails, the other one should serve both systems). Capacity to be determined by contractor

Cleaning concept
Full protocol to be proposed by contractor.
Evidences and references should be given.
Constraints:

- no use of chlorine
- no heating preferred
- duration no longer than 5h when filtration completely off-line

On-line sensors and analysers
1. Biology (supplied by contractor, except sludge concentration)

- 1x influent flow (before buffer tank?)
- 2x sludge recirculation flow
- 2x air flow
- 1x redox (AX1)
- 2x O2 (AE1, AE2)
- 1x temperature (AE1)
- 1x pH (AE1)
- 2x sludge concentration (Membrane reactor + AE1)
- 2x water level through pressure sensor (AX1 + buffer tank)

2. Filtration units (supplied by contractor)
Per filtration line:

- 1x TMP (differential)
- 1x filtrate flow
- 1x aeration flow

Plus 1x turbidity (in bypass from either filtration line)

3. MBR-filtrate (supplied by KWB)

- 1x TP / PO4
- 1x NO3
- 1x NH3

Annex 5.5 Pressure sewer specifications (summary)

The cost estimations showed the economical benefits of implementing a pressure sewer to collect the domestic wastewater in the area of Margaretenhöhe and feed the semi-central MBR plant. This technical solution was in accordance with the corresponding construction constraints (soil and groundwater pattern).

The pressure sewer consists of:

- ca. 100 individual pumping shafts located on the parcel of each resident (ca. 600L volume, underground), each of them including a 7mm grinding pump and built with a power and control panel,
- The collection mains from the individual shafts up to the secondary sewer networks, leading to the primary mains (see Figure 3),
- The primary main (max DN 50), hydraulically designed to optimise pressure head while increasing the fluid velocity, and positioned according to the local and structural conditions,
- Two air flush stations, planned in each extremity of the sewer network in order to regularly clean the system and therefore avoid the deposition and accumulation of solids which would lead to anaerobic conditions and occurrence of odour emission through degassing at the discharge spot in the buffer tank.

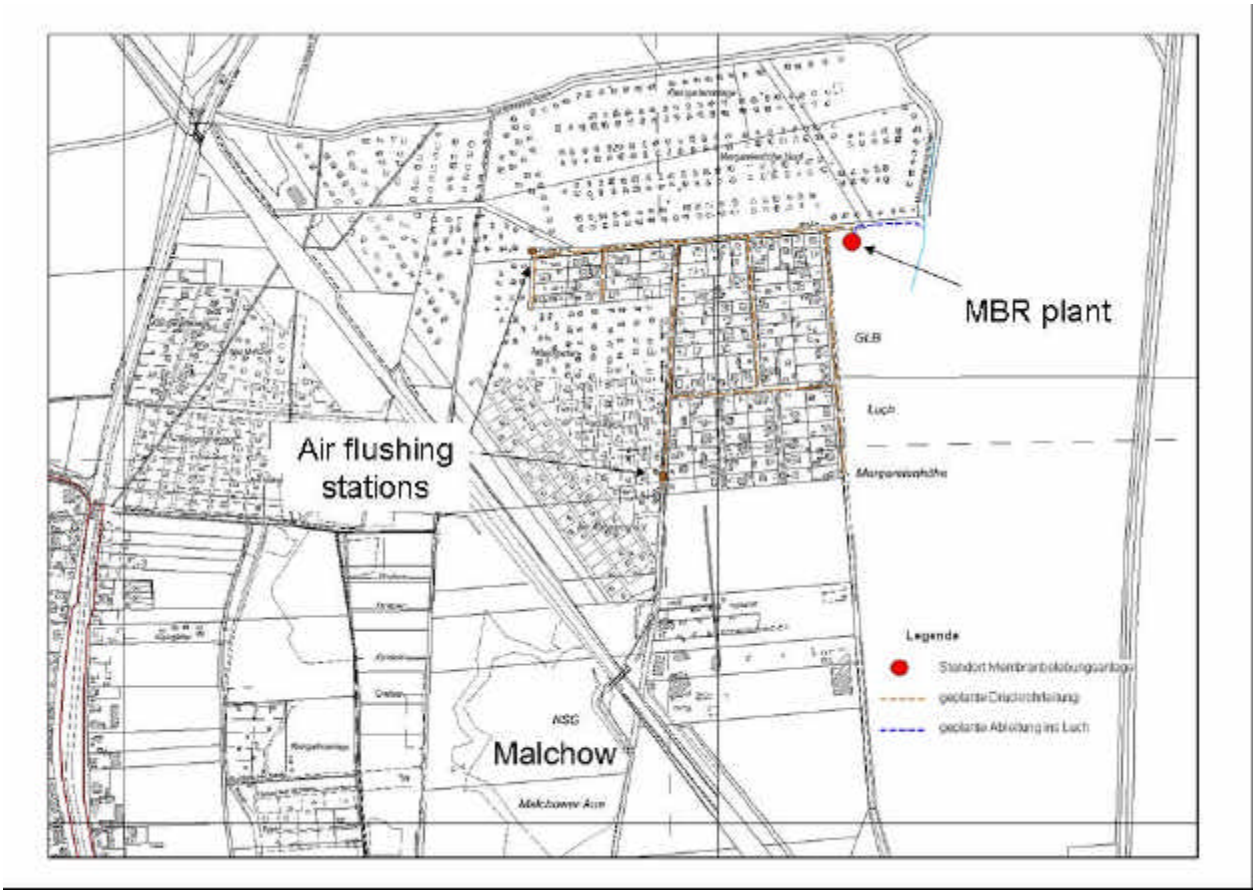


Figure 3. Site plan of pressure sewer in Margaretenhöhe

Annex 5.6 Reasons for selection of TUB as subcontractor of the preliminary trials

The subcontractor of Task ID 3 was identified as the Technical University of Berlin as early as the first proposal to the EU-LIFE programme submitted in November 2003. This choice was confirmed in the revised and final version of June 2004, following the comments received from the European Commission on 07.05.2004. In meanwhile, a subcontract agreement was signed between TUB and KWB in April 2004.

The decision not to resort to a public tender or a consultation (3 independent offers) can be justified as follows:

- In order to respect the schedule of design, construction and commissioning of the demonstration plant, this task had to be started in April 2004, which did not allow for proceeding with a public tender or even a consultation.
- The facilities of the TUB (laboratory, workshop, small pilot plants, etc), their competences (broad experience with MBR technology and realisation of pilot studies), and their location (local R&D team in Berlin) enabled them to perform task ID 3 successfully with optimised time and budget.
- The TUB was involved as sub-contractor in the 3-year R&D phase (2000-2003) undertaken between Berliner Wasserbetriebe and Anjou Recherche in the frame of the KWB to develop the considered MBR process in the ENREM project. The TUB is therefore very much familiar with the process, and a good pre-existing working relationship prevails between the TUB and the partners.

To be noted that TU Berlin is no longer shareholder of the KWB since January 2003, and that the budget of this contract has been thoroughly negotiated in relation with the expected services, according to the rules of non profit companies in Germany (as per § 55 – 3 of “Abgabenordnung” – fiscal code).

Annex 7.1 List of presentations and publications in symposia and conferences in 2004

N°	Authors	Type	Info	Event	Full title
1	Gnirss R.	Platform paper	Announcement	Fachtagung ATV-DVWK, Kassel, Germany, 29 April 2004	Langzeituntersuchungen in Berlin mit der Membranfiltration – Rückhalt von Bakterien und Mikroverunreinigungen
2	Lesjean B.	Platform paper	Announcement	Fachtagung « Abwasserbehandlung im ländlichen Raum – Probleme, Lösungen, Perspektiven » (VfU/VDGN), 29 June 2004, Berlin, Germany	Der Membranbioreaktor – eine Alternative zur dezentralen Abwasserbehandlung?
3	Lesjean B., Gnirss R., Buisson H., Keller S., Tazi-Pain A., Luck F.	Platform paper	Announcement	IWA Marrakech 2004, Morocco, 19-24 September 2004	Outcomes of a 2-year investigation on enhanced biological nutrients removal and trace organics elimination in membrane bioreactor (MBR)
4	Lesjean B., Gnirss R.	Poster	Overview	IWA Marrakech 2004, Morocco, 19-24 September 2004	(Presentation of ENREM project on KWB stand of exhibition fair)
5	Lesjean B., Gnirss R., Buisson H.	Platform paper	Announcement	EWA 2004 “Nutrient Management”, during Aquatech 2004, Amsterdam, The Netherlands, 28 Sept. – 1 Oct. 2004	Outcomes of a 2-year investigation of Membrane Bioreactor Process configurations for biological advanced nutrients removal from municipal wastewater
6	Lesjean B.	Platform paper	Context + objectives	International conference on sustainable water systems, 4-6 October 2004, Berlin, Germany	Vision of Advanced Decentralised Systems in Wastewater Management
7	Lesjean B.	Presentation	Announcement	Cours on advanced wastewater treatment for master-students of the Technical University of Berlin, 30 November 2004	Case study of trace organics and enhanced biological nutrients removal through a membrane bioreactor

Annex 7.2 List of other communication activities in 2004

N°	Speaker	Date	Type	Info	Media	Language	Full title
1	-	January 2004	Mention	Annoucement	KWB activity report 2003	German / English	-
2	-	October 2004	Press release	official acceptation of EU-LIFE submission	Distribution to all media contacts of KWB	German	-
3	-	26.10.2004	Article	Announcement	Journal "EUWID" Wasser und Abwasser	German	EU fördert Projekt des KompetenzZentrum Berlin
4	-	November 2004	First page article	Project introduction	KWB Newsletter 6	English	Membrane bioreactor technology for decentralised waste water treatment - A second EU-LIFE demonstration project for KWB
5	-	November 2004	First page article	Project introduction	KWB Newsletter 6	German	Membranbelebungsverfahren für die dezentrale Abwasserreinigung - Zweites EU-LIFE Demonstrationsprojekt für das KWB
6	-	January 2005	Article	Annoucement	International VE Newsletter "La lettre VE"	8 languages: French, English, German, Spanish etc	(Newsletter distributed to all managers & engineers of Veolia Environment)
7	-	January 2005	Article	Announcement	Journal KA "Abwasser Abfall"	German	1 Chapter in "LIFE und LIFE+: EU-Förderung auch für Projekte im Abwasserbereich"
8	-	February 2005	Full-page	Project description	KWB activity report 2004	German / English	-

Annex 7.3 List of official meeting including presentation of ENREM project in 2004

N°	Date	Speaker	Location	Occasion / Reason	Involved Persons / group
1	05.04.2004	R. Gnirss / B. Lesjean	Berlin Senat	Info Berlin Senat	Hr. Jahn (Berlin Senat)
2	28.04.2004	R. Gnirss / B. Lesjean	Berlin Senat	Wasserbehörde	Fr. Schultz (Berlin Senat), Hr. Stein (Berlin Senat), Hr. Jahn (Berlin Senat), Fr. Lemm (BWB)
3	17.05.2004	R. Gnirss / B. Lesjean	KWB	Discharge & operation permits	Hr. Schmidt (Berlin Senat), Hr. Gärke (BWB)
4	-	R. Gnirss	-	Presentation project an Bezirk Wartenberg	Fr. Kühler (Bezirk), Hr. Nabrowsky (Bezyrk)
5	05.08.2004	F. Luck	Paris	Presentation of KWB project to R&D management of Veolia Water	M. Dutang (Director R&D Veolia Environment), M. Chami (Director R&D Veolia Water), L. Herremans (Technical director Veolia Water)
6	27.09.2004	B. Lesjean	KWB	European / Australian workshop on membrane technologies	**See next table!**
7	25.11.2004	R. Gnirss	Umwelt Bundes Amt, Berlin	Signature of "Professurstiftung" between TUB and Veolia Water	**See next table!**
8	06.12.2004	R. Gnirss	BWB	Info intern	OE Abwasserwerke und Netze
9	11.01.2005	Gnirss, Schröder, Frielinghaus, etc	Margeretenhöhe	Reunion of inhabitants	Owners of parcels in Margaretenhöhe
10	28.01.2005	B. Lesjean	VE Campus	Seminar Veolia Environment R&D	All searchers & engineers of VE R&D
11	02.06.2005	-	Berlin	5th KWB Berlin Water Workshop "MBR applications for decentral and semi-central wastewater treatment"	A group of 50 local and national water business professionals

Meeting N°	External participant	Affiliation
6	Prof. Roger BEN AIM	INSA Toulouse, France
	Prof. Alain GRASMICK	University of Montpellier, France
	Ass. Prof. TorOve LEIKNES	Norwegian Uni. of Science and Technology, Trondheim, Norway
	Prof. A. G. FANE	University of New South Wales, Australia
	Ass. Prof. Greg LESLIE	University of New South Wales, Australia
	Prof. S. VIGNESWARAN	University of Technology in Sydney, Australia
	Dr. Hao NGO	University of Technology in Sydney, Australia
	Mr. Olivier LORAIN	Polymem, France
	Mr. Michael BOAKE	Veolia Water Australia
7	Henri Proglio	Veolia Environment (Pressident and CEO)
	Jerome Contamine	Veolia Environment (Finance Director)
	Michel Dutang	Veolia Environment (Research Director)
	Cyril Roger-Lacan	Veolia Water (Stellvertredender Vorsitzender)
	Christophe Hug	Veolia Water Deutschland (Vorsitzender der Geschäftsführung)
	Mr. Rupert Schmid	Veolia Environnement (Director International Communication)
	Mr. Baum	Veolia Water Deutschland (Secretary General)
	Prof. Kutzler	Technical University of Berlin (President)
	Prof. Jekel	Technical University of Berlin
	Mr. Sasse	Humbolt University, Berlin
	Mr. Simon	Berliner Wasserbetriebe (CEO)
	Mr. Pawlowski	Berliner Wasserbetriebe (CTO)
	Dr. Bartel	Umwelt Bundesamt
	Fr. Dr. Chorus	Umwelt Bundesamt
	Ms. Grützmacher	Umwelt Bundesamt

Annex 7.4 KWB press release and KWB Newsletter

KOMPETENZZENTRUM Wasser Berlin

PRESSE – Information

Berlin, 28. September 2004

Europäische Union fördert erneut ein Projekt der *KompetenzZentrum Wasser Berlin gGmbH*

Neue Technologien im Bereich der Abwasserbehandlung sind notwendig, um die Verunreinigung und Eutrophierung der Gewässer weiter zu vermindern und die Umsetzung der Umweltgesetzgebung der EU zu gewährleisten.

Im Rahmen des Programms LIFE – Umwelt fördert die EU das Demonstrationsprojekt der *KompetenzZentrum Wasser gGmbH* zur weitgehenden Nährstoffentfernung in Membranbelebungsanlagen „ENREM" *(Enhanced Nutrients Removal in Membrane Bioreactor)*. Das Gesamtvolumen des Projekts beträgt ca. 3,4 Mio.€ mit einer Laufzeit von 3 Jahren.

Ziel des Projektes ist die erstmalige Demonstration eines neuartigen Prozesses, bei dem durch die Kombination von vermehrter biologischer Phosphor- und Stickstoffentfernung in einer Membranbelebungsanlage eine Abwasserdesinfektion und eine weitgehende Nährstoffentfernung gewährleistet wird.

Im Berliner Siedlungsgebiet Margaretenhöhe, das zurzeit nicht erschlossen ist, wird im nächsten Jahr eine Demonstrationsanlage mit einer Druckentwässerung gebaut. Die dezentrale Abwasserreinigung erreicht somit eine Qualität, die über den bisher gültigen EU-Standards liegt.

Ein erfolgreicher Abschluß dieses Pilotprojektes würde eine breite Anwendung zur dezentralen Erschließung von Siedlungsgebieten in Deutschland, Europa und weltweit ermöglichen.

Unter der Leitung der KompetenzZentrum Wasser Berlin gGmbH wird das Projekt ENREM zusammen mit dem Hauptinvestor, den Berliner Wasserbetrieben, durchgeführt und vom französischen Forschungszentrum Anjou Recherche (Veolia Water) wissenschaftlich begleitet. Zur Zeit haben bereits die Arbeiten an einer Vorstudie durch die Technische Universität Berlin, dem Institut für Verfahrenstechnik, begonnen.

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Nachrichten der Berliner Wasserforschung

KOMPETENZZENTRUM Wasser Berlin

NEWSLETTER 6 November 2004

Editorial

Liebe Leserin, lieber Leser,
die technischen Voraussetzungen für den Einsatz von Membranen in Trinkwasseraufbereitung und Abwasserbehandlung haben sich in den letzten Jahren rasant entwickelt. Mit einer breiten Palette von neuen Materialien, Porengrössen und Bauarten konnten sie immer besser dazu eingesetzt werden, Probleme wie z.B. die Entfernung von Cryptosporidium und Trübstoffen in der Trinkwasseraufbereitung sowie die Reduzierung hoher BSB/CSB-Werte in Industrieabwasser zu lösen.
Durch eine weitere Steigerung der Membran- und Modulleistung zusammen mit stetig abnehmenden Investitionskosten hat sich seit den 90er Jahren schrittweise die Membranbioreaktortechnologie (MBR) auf dem Markt der kommunalen Abwasseranlagen etablieren können. Die derzeit größte kommunale MBR-Anlage befindet sich in Deutschland und reinigt 45.000 m³/d in der Stadt Kaarst.
Im Jahr 2000 wurde ein F&E-Projekt zur MBR-Technologie in der Kläranlage Berlin-Ruhleben ins Leben gerufen, an dem Experten und Forscher der Berliner Wasserbetriebe, Veolia Water/Anjou Recherche und der Technischen Universität Berlin aktiv teilnahmen. Hier konnten neue kosteneffektive Strategien der Phosphoreliminierung sowie der Entfernung von Spurenstoffen entwickelt werden, die im Januar 2002 als Patent angemeldet wurden.
Im Zusammenhang mit dem Problem unserer sensitiven regionalen Gewässer lag es nahe zu untersuchen, inwieweit es gerade für kleine Gemeinden sinnvoll sein könnte, diese Technologie zur Abwasserbehandlung einzusetzen. Der Erfolg unseres ersten EU-LIFE-Antrages für das Vorhaben "Neue Sanitärtechniken" im September 2003 und die Unterstützung durch das Land Berlin haben uns ermutigt, gleich im Anschluss ein neues Vorhaben bei der EU zu beantragen. Wir sind jetzt sehr stolz und freuen uns, dass dieses Vorhaben ENREM von der EU unter 20 Projekten im Bereich des nachhaltigen Managements von Wasserressourcen zur Förderung ausgewählt wurde.
Dank der vielen laufenden Projekte und Entwicklungen wird die kompakte und effiziente MBR-Technologie weltweit zu grundsätzlichen Änderungen im Bereich Abwasserreinigung führen und dadurch langfristig zur Verbesserung der Qualität unserer Umwelt beitragen.

Francis Luck, Geschäftsführer, Kompetenzzentrum Wasser Berlin gGmbH

Aktuelles

IWA 2004
Berliner Wasserforschung in Marrakech

Wie im letzten Newsletter schon angekündigt, hat das KWB sich im September aktiv an der 4. IWA "World Water Congress and Exhibition" in Marrakech beteiligt. Mit 2300 registrierten Teilnehmern und mehr als 900 Präsentationen ist die IWA die weltweit wichtigste Veranstaltung im Wassersektor. Mit mehr als 10 Präsentationen konnte das KWB hier die Berliner Wasserforschung hervorragend platzieren. Der vor Ort errichtete Informationsstand des KWB hat sich im Verlauf der einwöchigen Tagung - begünstigt durch seine zentrale Lage im Kongressgebäude (Foto) - zu einer wichtigen Anlaufstelle für die internationalen Fachkollegen entwickelt.

IWA **Link:** *www.iwamarrakech2004.com*

Fortsetzung Seite 2

INHALT

Membranbelebungsverfahren für die dezentrale Abwasserreinigung

Zweites EU-LIFE Demonstrationsprojekt für das KWB

ENREM

Das KompetenzZentrum Wasser Berlin und die Berliner Wasserbetriebe haben zum zweiten Mal im EU-LIFE-Programm ein Projekt beantragt und die Förderung erhalten. Das ENREM-Projekt "Enhanced Nutrients Removal in Membrane Bioreactor" wird über einen Zeitraum von drei Jahren durchgeführt, die Gesamtinvestition beträgt 3,6 Mio €. Unter der Leitung der KompetenzZentrum Wasser Berlin gGmbH wird das Projekt ENREM zusammen mit dem Hauptinvestor, den Berliner Wasserbetrieben, durchgeführt und vom französischen Forschungszentrum Anjou Recherche (Veolia Water) wissenschaftlich begleitet. Die Berliner Wasserbetriebe werden das Gebiet Margaretenhöhe erschließen und eine Membranbelebungsanlage betreiben. Zur Zeit haben bereits die Arbeiten an einer Vorstudie durch die Technische Universität Berlin, am Institut für Verfahrenstechnik, begonnen.
Die Entwicklung eines innovativen Membranbelebungsverfahrens für die dezentrale Abwasserreinigung wurde im Rahmen des Forschungsprojektes „Immersed Membrane Filtration" von den Partnern erfolgreich im Pilotmaßstab erprobt und optimiert. In dem dreijährigen IMF-Projekt wurden die weitergehende biologische Phosphorentfernung und die nachgeschaltete Denitrifikation ohne Kohlenstoffdosierung in einem Membranbelebungsverfahren erstmals eingesetzt. Die Ablaufqualität erreicht damit neben der Abwasserdesinfektion eine nahezu vollständige Nährstoffentfernung bei Gesamtphosphor (TP>99%) und bei

Fortsetzung Seite 2

Gesamtstickstoff (TN>95%) mit Ablaufkonzentrationen von TP<50µgP/L und TN<5mgN/L. Damit könnte diese Technologie eine Alternative für Siedlungsgebiete sein, die nicht kosteneffektiv an das zentrale Abwassernetz angeschlossen werden können und in denen eine Ableitung von Abwasser in den Vorfluter eine hohe Qualität erfordert (z.B. Badewasserqualität).
Im Rahmen des ENREM-Projektes wurde unter 20 Siedlungsgebieten ein repräsentatives Gebiet im Nord-Osten von Berlin ausgewählt, mit ca. 200 Einwohnern. Hier soll eine erste Membranbetriebsanlage mit dem bereits erprobten innovativen Reinigungsprozess automatisch und ferngesteuert betrieben werden. Der Betriebszustand wird über 1,5 Jahre intensiv überwacht und kontrolliert. Dabei liegt die erreichte Ablaufqualität über den EU-Kriterien für sensitive Gebiete und Badegewässer. Die Membranbelebungsanlage erfüllt damit die strengsten Qualitätsanforderungen weltweit. Das Demonstrationsprojekt soll die Zuverlässigkeit und Kosteneffektivität des Prozesses für die semi-zentrale Abwasserreinigung zeigen, insbesondere als kostengünstige Lösung für die neuen EU-Beitrittsstaaten.

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Nachrichten aus dem KWB-Netzwerkbüro

Seit Juni 2004 wird der Geschäftsführer des KWB im Begutachtungsverfahren von Projektanträgen von einer 4köpfigen Projektkommission beraten. Die Kommission hat folgende Mitglieder:

- Dieter Hainbach, B.&S.U. Beratungs- und Servicegesellschaft Umwelt mbH, Berlin
- Frank Lessig, OEWA Wasser und Abwasser GmbH, Leipzig
- Dr. Dieter Müller, TSB Technologiestiftung Innovationszentrum Berlin
- Matthias Rehfeld-Klein, Senatsverwaltung für Stadtentwicklung Berlin

Neues Forschungsvorhaben seit August 2004
Pilotuntersuchungen zur kombinierten oxidativ-biologischen Behandlung von Kläranlagenabläufen für die Entfernung von organischen Spuren- und Wirkstoffen und zur Desinfektion (PILOTOX):
Durchführung: TU-Berlin, Fachgebiet Wasserreinhaltung, mit Beteiligung der BWB, den Fachgebieten Umweltmikrobiologie und Ökotoxikologie der TU-Berlin sowie der Forschungsstelle Bad Elster des Umweltbundesamtes. Laufzeit: 9 Monate. (s. *Beitrag Seite 3*)

IWA 2004 - Berliner Wasserforschung in Marrakech

(Fortsetzung von Seite 1)

Neben den klassischen Themen der Abwasserbehandlung und Wasserversorgung wurde erstmals der Themenkomplex Ecological Sanitation als Themenschwerpunkt mit täglichen Sessions in das Programm integriert. Der in diesem Kontext vom KWB organisierte halbtägige Workshop mit abschließender Podiumsdiskussion fand große Beachtung. Weiterhin war das KWB an den Sessions "Membrane Systems", "Phosphorous Removal", "Wastewater Reuse", "Operating of Wastewater Systems" sowie "Sludge Treatment" mit eigenen Beiträgen beteiligt.

Cyanobakterium *Cylindrospermopsis raciborskii* in Berliner und Brandenburger Gewässern

Erste Ergebnisse eines Forschungsvorhabens

Im Rahmen eines seit Anfang Februar 2004 laufenden Verbundvorhabens wird in umfangreichen gewässerökologischen Studien die derzeitige Verbreitung des Toxins Cylindrospermopsin und des Cyanobakteriums *C. raciborskii* erfasst und ihr Entwicklungspotential untersucht. Ziel ist es, das derzeitige Risiko von Cylindrospermopsin und *C. raciborskii* zu ermitteln, was besonders für Gewässer, die zur Trinkwassergewinnung oder zum Baden dienen, von Bedeutung ist. Das Vorhaben wird für 3 Jahre durch das Kompetenzzentrum Wasser Berlin gefördert. Projektnehmer sind das Leibniz-Institut für Gewässerökologie und Binnenfischerei (Federführung), der Lehrstuhl Gewässerschutz an der Brandenburgischen Technischen Universität Cottbus sowie das Umweltbundesamt.
Dr. Claudia Wiedner ist die Projektleiterin.

Gibt es schon erste Ergebnisse aus diesem Sommer zur Verbreitung von C. Raciborskii?
In diesem Sommer haben wir bisher 136 Gewässer zum Vorkommen von *C. raciborskii* und anderen möglichen Cylindrospermopsin produzierenden Cyanobakterien untersucht. Dabei wurde *C. raciborskii* in 21% aller Gewässer gefunden. Darüber hinaus wurden zwei weitere Cyanobakterien-Arten entdeckt, die bisher nur aus südlicheren Regionen bekannt waren. Bei einer dieser Arten handelt es sich ebenfalls um einen möglichen Cylindrospermopsin-Produzenten.

Dieses Cyanobakterium stammt ursprünglich aus den Tropen. Wie konnte es sich bis in die Berliner Region ausbreiten?
Es kann sich langsam nach Norden hin verbreitet haben. Möglich ist auch, dass es durch Zugvögel oder Touristen eingeschleppt wurde. Uns beschäftigt vor allem die Frage, warum sich tropische Arten in unseren Gewässern etablieren können. Hierzu werden derzeit zwei Möglichkeiten diskutiert: Entweder sind einige Individuen der Art tolerant gegenüber niedrigen Temperaturen und können, einmal hier angelangt, sich auch hier entwickeln oder die Verbreitungsgrenze dieser Arten verschiebt sich weiter nach Norden durch erhöhte Wassertemperaturen in Folge des Klimawandels.

Welches Gefahrenpotential geht von dem Toxin Cylindrospermopsin aus? Wie wirkt das Toxin auf Umwelt, Tiere oder Menschen?
Als Folge von Cylindrospermopsinvergiftungen bei Säugern wurden Leberschäden sowie Effekte auf Nieren, Lunge, Herz und die Thymusdrüse beschrieben. Über Effekte auf andere Gewässerorganismen ist noch wenig bekannt. Das Gefährdungspotential hängt letztlich von der Toxinkonzentration ab. Bisher haben wir dazu nur Werte aus zwei Seen, von denen keine akute Gefahr für den Menschen ausgeht. Abschließend können wir das Gefährdungspotential erst abschätzen, wenn die Proben aus diesem Sommer und den beiden folgenden Jahren analysiert sind.

Wie wird die genetische Disposition der Cyanobakterien hinsichtlich ihrer Fähigkeit zur Toxinproduktion identifiziert? Gibt es schon erste Ergebnisse?
Einige der Gene, die das Cylindrospermopsin kodieren, sind bereits bekannt. Wir wollen mit PCR-Technologie das Vorhandensein dieser Gene in einzelnen Zellfäden von *C. raciborskii* und anderen möglichen Cylindrospermopsin-Produzenten prüfen. Auf diese Weise wollen wir alle Cylindrospermopsin-Produzenten identifizieren und ermitteln, wie groß ihr Anteil in verschiedenen Populationen ist. Diese Methode testen wir derzeit an Laborstämmen und wollen danach Zellfäden aus Freilandproben isolieren und auf das Vorhandensein der Gene analysieren.

Das Projekt wird noch bis 2007 gefördert. Was sind die nächsten Meilensteine?
Die taxonomische Zugehörigkeit der beiden neuen Cyanobakterien-Arten soll mittels DNA-Analyse abschließend geklärt werden. Die Proben aus diesem Sommer werden auf Cylindrospermopsin untersucht, um eine erste Abschätzung der Verbreitung und Konzentration dieses Toxins in der Berliner Region vornehmen zu können. Die Cylindrospermopsin-Produzenten sollen eindeutig identifiziert und eine Charakterisierung des Seentypus vorgenommen werden, der für diese Arten die geeignetsten Habitatbedingungen bietet. Schließlich soll die Regulation der Dynamik dieser Arten vertiefend untersucht werden, um ihr Entwicklungspotential besser abschätzen zu können.

Die Projektgruppe wird in Kürze erste Ergebnisse auf einer Konferenz in Kapstadt präsentieren. Welchen Stellenwert hat das Forschungsthema auf internationaler Ebene?
C. Raciborskii und Cylindrospermopsin stellen derzeit weltweit ein Problem dar. Die Art hat sich nicht nur nach Nordeuropa verbreitet, sondern auch nach Nordamerika. Eine weitere Aufklärung ihrer Verbreitung sowie eine Abschätzung des sich daraus ergebenden Gefährdungspotentials sind deshalb von internationalem Interesse.

Vielen Dank für dieses Gespräch.

Water Research in Berlin

KOMPETENZZENTRUM Wasser Berlin

NEWSLETTER 6 November 2004

Editorial

Dear Reader,
Membrane technologies have experienced a fast development pace over recent years, for both drinking water and wastewater treatment applications. With a variety of materials, pore size, and shape, they have been increasingly used to solve challenging issues such as Cryptosporidium and peak turbidity removal in drinking water production, and high BOD/COD removal in industrial wastewater.
Improvement of membrane and module performance coupled with steadily decreasing investment costs allowed the membrane bioreactor technology (MBR) to penetrate stepwise the municipal wastewater market, with the first units commissioned in the late 90's. As a matter of fact, Germany hosts the largest municipal MBR unit to date, which treats 45,000 m^3/day in Kaarst.
In 2000 a R&D project on MBR was initiated at the WWTP Berlin-Ruhleben, with an active participation of the experts and researchers of Berliner Wasserbetriebe, Veolia Water/Anjou Recherche and Technical University Berlin. Deeper insight was gained on new and cost effective phosphorus removal strategies as well as on removal of trace pollutants, paving the way to a patent filed in January 2002.
In the context of our local sensitive water bodies, it was quite logical to explore the possibility of demonstrating the benefits of the new technology, first of all for small communities. Our success with the first LIFE proposal "New sanitation concepts" in September 2003 and the support we received from the Land of Berlin encouraged us to file a new one a few weeks later. We are very proud and happy that ENREM has been recently selected among the 20 projects on sustainable management of water resources to be supported by the LIFE Environment 2004 programme of the European Commission.
Thanks to many other on-going projects and developments, the compact and efficient MBR technology will bring fundamental changes to wastewater treatment worldwide and will contribute to improve our environment.

Francis Luck
Managing director, Berlin Centre of Competence for Water

Latest News

IWA 2004
Berlin Water Research in Marrakech

As already announced in the last newsletter, the Berlin Centre of Competence for Water took part in September in the 4th IWA World Water Congress and Exhibition in Marrakech. With 2300 registered participants and over 900 presentations, the IWA conference is the most important international event in the water sector. With more than 10 presentations, the KWB could outstandingly represent Berlin's water research scene. Thanks to its central position in the congress hall (photo), the information stand of the KWB became an important contact point for the international visitors.

Link: www.iwamarrakech2004.com

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Membrane bioreactor technology for decentralised waste water treatment

A second EU-LIFE demonstration project for KWB

ENREM

The Berlin Centre of Competence for Water renewed this year his success with the recent approval by the LIFE programme of a second project. The ENREM project "Enhanced Nutrients Removal in Membrane Bioreactor" will be implemented during three years with a total budget of 3.6 Mio €. Under guidance of the Berlin Centre of Competence for Water, the ENREM project will be conducted by the main investor Berliner Wasserbetriebe, and the scientific monitoring will be ensured by the French research center Anjou Recherche (Veolia Water). Berliner Wasserbetriebe will equip and operate the site of Margaretenhöhe with a membrane bioreactor. A pre-study has already started at the Technical University of Berlin, Institute for Process Engineering.

This project follows the successful completion of the 3-year R&D project "Immersed Membrane Filtration" undertaken by the partners, during which an innovative membrane process was optimised at pilot plant scale for advanced decentralised treatment of municipal wastewater. This process combines enhanced biological phosphorus and nitrogen removal with post-denitrification without carbon source addition together with a membrane bioreactor. In addition to complete disinfection through the microfiltration membrane, improved removal of nutrients and pollutants are

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achieved for total phosphorus (TP>99%) and total nitrogen (TN>95%) with effluent concentrations of TP <50µgP/L and TN<5mgN/L. This technology can be an alternative for remote places where the connection to a central sewer is not cost-effective and where a very good effluent quality is required for discharge, such as areas under bathing water or strict environmental guidelines.

In the frame of the ENREM-project, among 20 districts a representative site with about 200 inhabitants was chosen in the North-East part of Berlin. A first full-scale decentralised membrane bioreactor with the developed innovative treatment process will be implemented and thoroughly assessed over more than 1.5 year. It will treat the collected sewage to a quality beyond the EU criteria for sensitive areas and bathing waters, and will be the full-scale MBR system with the strictest effluent quality requirement worldwide. The demonstration of the reliability and competitiveness of the process will open the utilisation of this technical solution to other semi-central applications, which could prove to be a cost-effective solution for the new EU member states.

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News from the KWB network office

Since June 2004, a project commission of four experts has been advising the managing director of the KWB with the assessment procedure of project applications. The commission consists of the following members:

- Dieter Hainbach, B.&S.U. Beratungs- und Servicegesellschaft Umwelt mbH, Berlin
- Frank Lessig, OEWA Wasser und Abwasser GmbH, Leipzig
- Dr. Dieter Müller, TSB Technologiestiftung Innovationszentrum Berlin
- Matthias Rehfeld-Klein, Senatsverwaltung für Stadtentwicklung Berlin

New research project started in August 2004

Pilot investigations covering the combined oxidative and biological treatment of sewage works effluents aiming at the removal of trace organics and active agents and at achieving enhanced disinfection (PILOTOX);
Realisation: Technical University Berlin - Department of Water Quality Control, Berliner Wasserbetriebe, Technical University Berlin - Departments of Microbial Ecology and Ecotoxicology as well as the Federal Environmental Agency, Research Unit Bad Elster.
Duration: 9 months; please refer to contribution on page 3.

IWA 2004 - Berlin Water Research in Marrakech *(Continuation from page 1)*

Besides the traditional topics "wastewater treatment" and "water supply", for the first time particular emphasis was placed on "Ecological Sanitation" issues and daily sessions covering the related topics were integrated into the congress programme. In this context, the KWB has organised a half-day workshop followed by a panel discussion which had attracted substantial interest from the congress participants. Furthermore, the KWB presented own contributions to the sessions "Membrane Systems", "Phosphorus Removal", Wastewater Reuse", "Operating of Wastewater Systems" as well as "Sludge Treatment".

Cyanobacteria *Cylindrospermopsis raciborskii* in water bodies of the Berlin and Brandenburg area

First results of a research project

Within the scope of an interdisciplinary project launched in February 2004, the current proliferation of the toxin cylindrospermopsin and the cyanobacteria *C. raciborskii* and their development potential are being investigated by ecological studies of the water bodies. The objective is to determine the present risk related to cylindrospermopsin and *C. raciborskii*, which is particularly important for water bodies used for drinking water supply or bathing activities. The project is financed by the Berlin Centre of Competence for Water over a period of 3 years. Project partners are the Leibniz Institute for Fresh Water Ecology and Inland Fisheries (lead management), the Chair for Water Protection at the Brandenburg University of Technology Cottbus and the Federal Environmental Agency.
Dr. Claudia Wiedner is the project manager.

Are there already some results from this summer about the proliferation of C. raciborskii?

During this summer we investigated the presence of *C. raciborskii* and of other cyanobacteria potentially producing some cylindrospermopsin in 136 water bodies. *C. raciborskii* was found in 21% of the water bodies. Furthermore we discovered two other cyanobacteria species, which were only known in southern regions until now. One of these species is a potential producer of cylindrospermopsin.

This cyanobacteria originates from the tropics. How could it proliferate in the Berlin area?

It may have propagated slowly towards northern regions. It may also have been introduced by migratory birds or tourists. The most important issue is to find out how tropical species could establish themselves in our water bodies. Two possibilities are currently being discussed: either some individuals of the species are tolerant to low temperatures and were able to develop here after their arrival, or the proliferation border of these species is displacing further northwards in relationship with higher water temperatures as a consequence of the climate change.

What is the potential danger related to the toxin cylindrospermopsin? What is the impact of the toxin on environment, animals or humans?

Consequences of contamination through cylindrospermopsin are described for mammals as liver damages as well as effects on kidneys, lungs, heart and thymus gland. Very little is known about effects on other water organisms. The risk potential finally depends on the toxin concentration. Until now we only have values for two lakes, showing that no acute danger is to be expected for humans. We will eventually be able to estimate the danger potential only after the samples of this summer and the two next years will have been analysed.

How is the genetic disposition of cyanobacteria identified considering their ability to produce toxins? Are there already some results?

Some of the genes that code cylindrospermopsin are already known. Using the PCR-technology, we want to check the presence of these genes in single filamentous cells of *C. raciborskii* and other potential producers of cylindrospermopsin. This is how we intend to identify all producers of cylindrospermopsin and find out their proportion in different populations. The method is currently being tested on lab strains, before isolating some filamentous cells from real samples and analysing the presence of the genes.

The project runs until 2007. What are the next milestones?

The taxonomical affiliation of the two new cyanobacteria species will be definitely cleared using DNA analysis. The samples of this summer will be checked for cylindrospermopsin in order to get a first estimation of the proliferation and the concentration of this toxin in the Berlin area. The cylindrospermopsin producers shall be clearly identified and the types of lakes representing the most suitable habitat conditions shall be characterised. Finally the regulation of the dynamics of these species should be investigated more in detail, in order to achieve a better assessment of their development potential.

In a few weeks, the project team will present first results at a conference in Cape Town. Which significance has this research theme worldwide?

C. raciborskii and cylindrospermopsin represent a worldwide issue. The species proliferates not only in Northern Europe but also in Northern America. Thus, determining its propagation and investigating the related risk potential are issues of international interest.

Thank you for this conversation.

Annex 7.5 List of articles or abstracts submitted for presentation in 2005

N°	Authors	Status	Info	Event	Full title
1	Lesjean B., Gnirss R., Tazi-Pain A.	Accepted as presentation	Economics and detailed specifications	6th International Conference and Exhibition « Wastewater 2005 », 10-12 May 2005, Teplice, Czech Republic	Membrane bioreactor for semi-central sanitation with enhanced performances
2	Vocks M., Drews A., Iversen V., Kraume M., Lesjean B., Gnirss R.	Abstract submitted	Pilot study: fouling results	International Congress on Membranes and Membrane Processes (ICOM 2005), 21-26 August 2005, Seoul, Korea.	Influence of unsteady membrane bioreactor operation on EPS formation and filtration resistance
3	Vocks M., Stumpf D., Lesjean B., Gnirss R., Kraume M.	Full article submitted	Pilot Study: nutrients removal focus on nitrogen results	IWA Specialist Conference “Nutrient Management in Wastewater Treatment Processes and Recycle Streams”, 18-21 September 2005, Krakow, Poland	Effect of irregular sludge wastage on enhanced nutrients removal in a membrane activated sludge system
4	Gnirss. R., Lesjean B.	Abstract submitted	Economics and detailed specifications	Bundestagung und Landesverbandstagung 2005, ATV-DVWK, 21-22 September 2005, Potsdam, Germany	Kostenvergleich für die semi-zentrale Erschliessung eines Siedlungsgebietes mit dem Membranbelebungsverfahren
4	Lesjean B., Gnirss R.	Poster	Overview	Bundestagung und Landesverbandstagung 2005, ATV-DVWK, 21-22 September 2005, Potsdam, Germany	(Presentation of ENREM project on common stand KWB/BWB of exhibition fair)
5	Vocks M., Stumpf D., Lesjean B., Gnirss R., Kraume M.	Abstract submitted	Pilot Study: nutrients removal focus on phosphorus results	6. Aachener Tagung "Membrantechnik in der Wasseraufbereitung und Abwasserbehandlung", 25-26 Oktober 2005, Aachen, Germany	Auswirkung der diskontinuierlichen Überschussschlammentnahme auf die vermehrte biologische Nährstoffelimination in einer Membranbelebung
6	Gnirss. R., Miels S., Lesjean B.	Abstract submitted	Site selection, process specification, tender and costs	6. Aachener Tagung "Membrantechnik in der Wasseraufbereitung und Abwasserbehandlung", 25-26 Oktober 2005, Aachen, Germany	Planung und Bau einer Membranbelebungs-anlage für die semi-zentrale Erschließung eines Siedlungsgebietes in einem empfindlichen Gebiet

Project ENREM "Enhanced Nutrients Removal in Membrane Bioreactor"
LIFE 04 ENV/D/058

Progress report N°1 (2004)

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