APPENDIX 5.8
WETLANDS CASE STUDIES

WETLAND CREATION CASE STUDIES

Case Study 1 - Yorkshire Water Macrophyte treatment systems

Yorkshire Water is one of the UK water service companies most involved in the use of reedbed type systems for sewage treatment. Since 1985 they have created about 25 such systems at various sites across Yorkshire. The company has concentrated on using overland flow systems for tertiary treatment, principally at works dealing with small populations (maximum of 47,500, most <2,000). Consequently, the reedbeds that have been created have been very small, the largest covering just 0.2 ha, thus limiting their potential as wildlife habitat.

The company has been quite experimental in its approach, investigating a range of different design parameters. One aspect it has looked at has been the choice of plants. A wide range of species have been tried in various locations and good results have been obtained in cells planted with Reed Canary-Grass and Reed Sweet-Grass, as well as Common Reedmace and Common Reed. In situations away from the lowlands where most of the specialist reedbed birds are found, these alternative emergents could offer wildlife habitat as valuable as beds planted with Common Reed. The majority of Yorkshire Water's systems do in fact utilise Common Reed, in recognition of its value to birds combined with its effectiveness in terms of water treatment. However, where reeds are used, the uppermost 5 m of the cell (i.e. nearest the inflow) are usually planted with Common Reedmace. This quick-growing, robust plant is particularly tolerant of high nutrient and suspended solid concentrations, making it ideal for preventing the formation of channels in the region where it would cause most problems.

The overland flow systems have been designed to work with a water depth of 100 mm. However, most of these constructed wetlands have been linked into combined sewage systems, and this has caused problems during storms in terms of reduced treatment efficiency, re-mobilisation of sediments and potential damage to plants, all good reasons for investigating the potential to separate wastewater from drainage water.

As well as creating various 'conventional' reedbed cells, Yorkshire Water has tried to add some of the features of these systems into existing systems. At Brighouse, for example, Reed Canary-grass and Common Reedmace have been introduced into a grass plot, while, at another site, some disused sludge pits have been converted into a tertiary treatment system consisting of tiered, emergent-fringed ponds linked by short cascades that provide additional oxidation. A further line of investigation has involved looking at the incorporation of floating mats of vegetation within polishing lagoons.

In general, Yorkshire Water has found that such macrophyte-based systems offer cost- effective, reliable treatment. To date, the systems used have been small and have not had any specific wildlife features included, but perhaps in the future the company's experience will enable it to construct some more ambitious schemes of greater value to wildlife.

Case Study 2 - Marston Sewage Treatment works, Lincolnshire (Anglian Water Services Ltd)

The Marston sewage plant treats about 13.6 million litres of effluent a day, which has to be fed into the relatively small River Witham, and thus requires tertiary treatment. To carry out this treatment the site utilises four large grass plots which cover a total of about 24 ha, probably the largest remaining grass plot system in the UK. The plots lie on the gentle slopes (c.1:8 - 1:15) of a river plain (Figure 14.4). The site has sandy soils, which allow mainly subsurface flow which is encouraged by a French drain running parallel with, and c.10 m distant from, the feeder channel. Ponding occurs in some of the plots owing to fine sediments settling out in hollows. These areas of shallow flooding have not caused problems in terms of water quality, possibly because the whole system has been designed with 30% spare capacity, but do provide useful habitat for birds, attracting ducks and providing feeding for breeding Lapwing and Redshank.

As well as the surface water, the site offers other attractions to waterbirds: large area, open aspect and lack of human disturbance. The site is of most importance for birds during the migration periods, when it can attract many Yellow Wagtails and various waders of grassy and marshy habitats, including up to about 1,000 Snipe, 20 Jack Snipe, 25 Ruff and 50 Curlew. Observations suggest that many birds flight into the grass plots to feed at night, including up to 200 Wigeon in winter, demonstrating that birds may rely on several sites at any one time. The rougher, grassy areas attract Kestrels and Barn Owls hunting for small mammals, and Anglian Water has erected a number of nestboxes on poles in the hope of enticing these species to breed.

The plots are left fallow, on rotation, for up to two months to allow them to dry out. Until 1990, they were grazed using a local farmer's sheep. Concern over the health of the animals, particularly in relation to foot-rot, and the potential for contracting diseases, led the site manager to change the management regime. The plots are now cut by tractor, which has proved far more expensive as none of the local contractors had a suitable machine, forcing Anglian Water to buy a tractor specially to carry out this work. Before the tractor was acquired, the plots were left unmanaged for a while and the resulting tall sward prevented use by waders owing to physical constraints and behavioural preferences. However, the new management regime is proving more flexible and allows a matrix of different grass heights to be left within the managed plots, benefiting the full range of waders associated with the site as well as the birds of prey. Inflows to the operational plots are varied by the site staff from day to day according to ground conditions. In an attempt to prevent channelling along the upper margin of the plots a band of Common Reeds has been planted parallel with the inflow.

In 1989, parts of the plots had to be regraded and, in line with company policy, Anglian Water looked at the opportunities to enhance the site's wildlife interest at the same time. As a consequence, a 0.8 ha wader scrape was created in the corner of a grass plot. The scrape is fed from the same inflow that feeds the grass plots and designed so that the water level could be manipulated in all seasons. The nicely designed scrape has a shallow floor excavated in accordance with a carefully prepared plan, incorporating contours at 100 mm intervals. Management of the scrape consists mainly of adjusting the water level; about 50% of the scrape bed is exposed during the periods of wader migration, with higher levels at other times to suppress plant colonisation. Small scale manipulations can be carried-out on a daily basis by the staff involved in managing the grass plots; key members of the Lincolnshire Bird Club provide the guidance. The scrape is preferred by some migrant waders, such as Common Sandpiper and Little Stint, while in the drier summer months it offers a secure feeding site for breeding waders. As part of the enhancement scheme a public viewing hide was erected overlooking the scrape.

Case Study 3 - Wick St Lawrence Sewage Treatment Works, Avon (Wessex Water)

Originally designed as a small works to deal with sewage for a population equivalent of 10,000, this treatment facility is undergoing modification to cope with an anticipated expansion of the conurbation of Weston-super-Mare to the south. The site lies 200 m from the Severn Estuary, a site of international importance for its bird-life, making habitat creation for birds particularly appropriate.

Owing to the site's proximity to Weston's bathing beach, Wessex Water was keen to reduce the levels of infectious microbes in the discharge from the works. The chosen solution was to use polishing lagoons, and in November 1991 a series of two 1ha lagoons were connected to the outflow of the original system. The lagoons were actually excavated by the NRA as a source of clay for adjacent sea defence works, while advice on enhancing their value to wildlife was provided by the Avon Wildlife Trust.

The nitrified effluent (the ammonia having been converted to nitrate) coming from the conventional treatment system is passed along a short, artificial stream channel, that has been planted with reeds, and into the first lagoon. The inflow consists of nothing more than a 'stream-mouth', the lagoon design being used to improve circulation, rather than the elaborate distributor pipes seen in some other systems. The two lagoons are roughly square in shape, with an extensive area of shallows along the eastern margin of the first lagoon. The combined capacity of the lagoons was designed to allow a retention time of at least 10 days, which was considered long enough to reduce infectious microbes at all seasons. The microbes are destroyed by exposure to UV light and so the lagoons have been constructed with a maximum depth of only 1.5m to ensure that light penetrates to the bottom of the water column. To help to prevent effluent short-circuiting the system, the outflows have been sited such that the effluent has to move against the prevailing wind to reach them, and around the islands that also provide loafing and nesting areas for birds in the centre of each lagoon. Most of the associated tree and shrub planting (mainly willows and alders) has been sited downwind of the lagoons so as not to reduce the benefits of wind turbulence on water quality. A constant through-flow and a system of spillways give the lagoons a stable water level.

The shallows were planted with Common Reed in 1992 using rhizomes from local stock as part of the enhancements for wildlife. When fully established, the reeds should help to break up the artificial outline, screen the entrance track and provide valuable cover for birds. A few aquatic plants, such as Fool's Watercress, Floating Sweet-grass and water-starwort, have colonised the inflow, possibly having been introduced with the reeds. Wattle hurdles have been pegged along the unplanted shoreline, providing an aesthetically pleasing form of wave protection that should allow natural colonisation by plants.

The system has proved highly effective at reducing the levels of indicator bacteria in the effluent. The first two years' monitoring gives mean results of a 7,500-told reduction in total coliforms and a 1,340-fold reduction in faecal coliforms, and mean discharge levels of 358.4/ml and 59.2/ml respectively. There has been some seasonal variation in effectiveness with the best results achieved in the summer months when a mean kill of 99.9% of both total and faecal coliforms has been achieved and the discharge has been within the limits set out in the Bathing Water Directive. Water clarity is generally excellent, although submerged vegetation, consisting of Rigid Hornwort, pondweeds and filamentous algae, is still sparse, perhaps reflecting the smooth nature of the alluvial clay bed rather than a problem with water quality. Bird usage has gradually increased since the lagoons were created, with a range of waterfowl, including Little Grebe and Goldeneye, being recorded in the second winter period and Mute Swans successfully nesting in the subsequent summer. Other birds should be attracted as the vegetation becomes established. Situated close to other wetlands, the lagoons will, at the very least, provide an alternative refuge for waterbirds. In addition, the fringing emergents and constant water level could make the lagoons attractive to dragonflies, three species of which were identified in the first two summers.

Case Study 4 - Minworth Sewage Treatment Works, West Midlands (Severn Trent Water)

Minworth is one of the largest sewage works in the UK occupying over 170 ha of land and treating an average of 1,100 million litres of raw sewage every day (c.1.5 million pe). The processing of the sewage generates c.3,000 m^3/day of sludge and large areas of the site are involved in its treatment and disposal.

About 55 ha of the site are taken up with drying beds, offering a substantial area of potential bird habitat. As such a large area and such large quantities of sludge are involved, the beds always exhibit a wide range of conditions, including some that are suitable as wader feeding areas. The individual beds typically measure c.40 m x 40 m and are enclosed by earth banks, which make them too enclosed to attract a full range of wader species, although ideal for Green Sandpipers and Snipe. The small bed size has been selected to offer maximum flexibility in terms of rotation. On sites where space is less critical, larger beds could be used to provide better wader habitat. In the past the banks around the beds were regularly mown to help air circulation and hence speed up the drying process; this no doubt helped to create the more open aspect preferred by most waders. This management ceased some time ago as part of cost-cutting measures.

A series of large lagoons is maintained to store excess sludge. In practice, they are rarely required and a lot of plants, such as willows, have colonised naturally, while rainwater helps to prevent excessive BOD levels persisting. The lagoons have been used in rotation and the operational lagoon is kept shallow in order to maintain capacity. The lagoons attract a wide range of duck species, including good numbers of Teal, Shoveler and Mallard, with diving ducks using areas of deeper water in the non-operational lagoons. The high levels of organic matter presumably encourage a rich source of invertebrate prey for these ducks.

About 80% of the dried sludge is sent to a nearby incinerator (Coleshill Sludge Destructor Plant) for disposal. Most of the rest is dumped in a large on-site tip. The tip has been designed so that the run-off drains inwards into a lake formed from a disused gravel pit. Dense stands of Common Reed have developed around the lake which may help to treat the run-off. Despite the dubious source of much of the water, the lake continues to attract good numbers and variety of waterfowl species, including breeding Little Grebe, Tufted Duck and Shoveler. The tip is continually growing; not only does this reduce the size of the lake, but also gives it a more enclosed feel, factors that are likely to reduce its appeal to wildfowl.

Although Minworth has not been modified to attract wildlife, it none the less supports a rich bird-life, including many waterbirds. The site's value results from a number of factors relating to its large size:

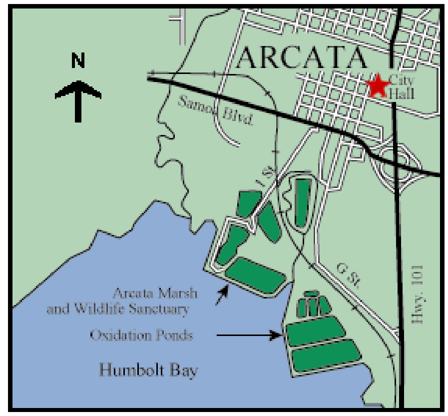
- Many areas are used on rotation and, consequently, there are always some areas in a suitable condition for feeding birds.
- There are usually alternative areas of suitable habitat to which birds can resort when maintenance works, or other disturbance, affect a particular area.
- There are areas of both highly maintained land and areas left largely neglected.
- Inevitably, there are large areas left undisturbed at any one time.

Case Study 5 - Des Plaines River, Illinois - The Des Plains River Wetlands Project
(http://www.epa.gov/owow/wetlands/construc/desplain.html)
The Des Plaines River Wetlands Demonstration Project is designed to produce the criteria necessary for rebuilding our river systems through the use of wetlands and for developing management programs for the continued operation of the new structures. The research program is assessing wetland functions through large-scale experimentation, controlled manipulation of flow rates and water depths, testing of soil conditions, and the employment of a wide variety of native plant communities.
Four wetlands have been constructed near Wadsworth, Illinois, for purposes of river water quality improvement. The river drains an agricultural and urban watershed, and carries a non-point source contaminant load of sediment, nutrients and agricultural chemicals. The site is located 35 miles north of Chicago. It incorporates 2.8 miles of the upper Des Plaines River and 450 acres of riparian land. The river flows south, draining 200 square miles in southern Wisconsin and northeastern Illinois. Eighty percent of the watershed is agricultural and 20 percent urban. The river is polluted with non-point source contaminants from a variety of land use activities, and point source contaminants from small domestic treatment plants. In support of previous agricultural uses, low-lying portions of the site were drained by means of tiles. Past uses of the site included pasture and a Christmas tree farm which resulted in the demise of most of the original wetlands and associated fauna and flora.
Water is pumped from the river to the wetlands, from a point just south of Wadsworth Road. This energy intensive alternative was necessary because of site constraints, and because of the desire to explore a wide range of hydraulic conditions. Gravity diversion would be a preferred alternative in most applications of this technology.

Case Study 6 - Arcata Wetlands, California
(http://www.epa.gov/owow/wetlands/construc/arcata.html)
The constructed wetland system is the cornerstone of Arcata's urban watershed renovation program. This program includes major urban stream restoration, log pond conversion to a swamp habitat, pocket wetlands on critical reaches of urban streams, and an anadramous wastewater aquaculture program to restore critical commercial recreational and ecological important populations. The Arcata project is a demonstration of wastewater reuse, ecological restoration, and reuse of industrial, agricultural and public service land.

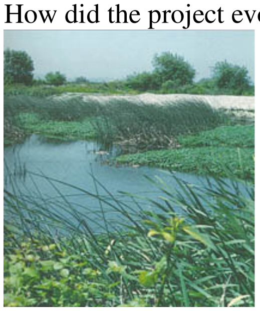
Situated in the heart of the redwood country and along the rocky shores of the Pacific Northcoast, the City of Arcata is located on the northeast shore of Humboldt Bay in Northern California, 280 miles north of San Francisco. Arcata, with a population of approximately 15,000, is a diverse community whose resourcefulness and integrity has demonstrated that a constructed wetland system can be a cost efficient and environmentally sound wastewater treatment solution. In addition to effectively fulfilling wastewater treatment needs, Arcata's innovative wetland system has provided an inspiring bay view window to the benefits of integrated wetland enhancement and wastewater treatment.

What is the Arcata Marsh and Wildlife Sanctuary?



Arcata is a small town located on the north-eastern side of Humboldt Bay, about 280 miles north of San Francisco. Humboldt Bay is a focal point where timber resources and marine resources cross paths as they struggle to sustain Humboldt County's economy. Resource management is a practice that receives high priority and expert advice in this scenic niche of the Pacific Northcoast. Arcata, with a population of approximately 15,000, is a diverse community whose resourcefulness and integrity has served to lead the city down a successful path marked by innovative decisions and maintained by pride. So, when the city faced making a change in their wastewater treatment methods, they demonstrated that a constructed wetland system can be a cost efficient and environmentally sound wastewater treatment solution. In addition to effectively fulfilling wastewater treatment needs, Arcata's innovative wetland system has provided an inspiring bay view window to the benefits of integrated wetland enhancement and wastewater treatment.

How did the project evolve?



Arcata established its innovative treatment system as a result of extensive community involvement and a series of political events. In the early 1970's, Arcata's active wastewater treatment plant discharged unchlorinated primary effluent into Humboldt Bay. In 1974 the State of California enacted a policy which prohibited discharge of wastewater into bays and estuaries unless enhancement of the receiving water was proven. In response to this policy the local Humboldt Bay Wastewater Authority proposed the construction of a state sponsored regional wastewater treatment plant that would serve all the communities in the Humboldt Bay vicinity. The plant was to have large interceptors around the perimeter of the bay with a major line crossing under the bay in the region of active navigation. The proposed treatment facility was energy intensive, with significant operational requirements. Effluent from the proposed plant was to be released offshore into an area of shifting sea bottom and heavy seas during winter storms. As the scale of the regional treatment plant grew, the costs and difficulties of incorporating other communities became apparent

Recognizing the constraints of the local environment and criteria for wastewater treatment, the City of Arcata began exploring the design of a decentralized system which employed constructed wetlands. Wastewater aquaculture projects at the City of Arcata started as early as 1969 and had been successful in raising juvenile Pacific Salmon and Trout in mixtures of partially treated wastewater and seawater. This project demonstrated that wastewater was a "resource" that could be reused and not simply to be viewed as a disposal problem. With this philosophy a city Task Force on Wastewater Treatment determined that the natural processes of a constructed wetland system could offer the city an effective and efficient wastewater treatment system. From 1979 to 1982 the city, and associated proponents of alternative wastewater treatment, experimented with partially treated wastewater and the natural processes of wetland ecosystems. These experiments demonstrated that constructed freshwater wetlands could be utilized to treat Arcata's wastewater and at the same time enhance the biological productivity of the wetland environment into which treated wastewater was discharged. The Task Force determined that a constructed wetland system was extremely cost effective. Moreover, a successful system offers the city a vital wetland ecosystem that could be used for the rearing of salmon and steelhead as well as offer the community a unique site for recreation and education.

With the aid of the Arcata City Council and political representatives in the state capital, the city received authorization in 1983 to develop the constructed wetland system and incorporate its use at the original Arcata Wastewater Treatment Plant. The wetland system that exists today was completed in 1986. Since that time the natural ability of marsh plants, soils and their associated microorganisms has successfully been utilized to meet the need for a cost-effective and environmentally sound wastewater treatment technology that meets federal and state mandated water quality requirements.

Who cares and what are the benefits?

At the same time that wetland wastewater technology has been used to successfully meet water quality criteria, it has also aided in restoring a degraded urban waterfront. Prior to the installation of its wetland treatment system, the City of Arcata's waterfront was the site of an abandoned lumbermill pond, channelized sloughs, marginal pasture lands, and a closed sanitary landfill. Today, Arcata's waterfront has been transformed into 100 acres of freshwater and saltwater marshes, brackish ponds, tidal sloughs and estuaries. Because of the wetland communities and wildlife habitats that the waterfront now supports, the area in its entirety has come to be known as the Arcata Marsh and Wildlife Sanctuary (AMWS.) The AMWS's three freshwater wetlands are Gearheart, Allen and Hauser Marshes. They were constructed to receive treated wastewater, thereby treating the wastewater further and enhancing the receiving water at the same time. These enhancement marshes are a host of aquatic vegetation that, in association with Klopp Lake and the adjacent estuaries and ponds, have further provided an extraordinary habitat for shorebirds, waterfowl, raptors and migratory birds.

As a home or rest stop for over 200 species of birds, the AMWS has developed a reputation as one of the best birding sites along the Pacific North Coast. The Redwood Region Audubon Society uses the site on a regular basis for its weekly nature walks. For the past 10 years, docents trained by the Society have explained the role the wetlands play in attracting birds and mammals, as well as their role in managing the water quality of Humboldt Bay. The beauty and uniqueness of the AMWS has served as inspiration to many artists, whose products range in form from plays and poems to photographs and paintings.

Arcata has become an international model of appropriate and successful wastewater reuse and wetland enhancement technologies. Over 150,000 people a year use the AMWS for passive recreation, bird-watching, or scientific study. Visitors from around the world have come to Arcata to investigate its success in wastewater management.