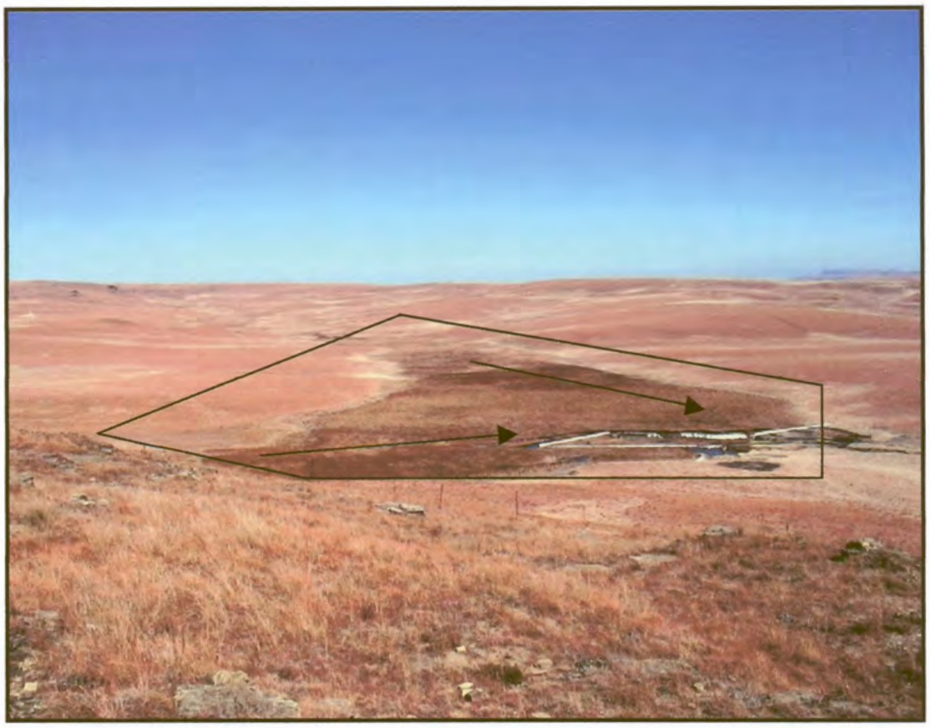

Figure 35: A headcut (consisting of a headcut and a channel) were found in the Wilge River. The remote sensing imagery will focus on the area indicated.

Figure 36: Road crossing downstream of the rehabilitation structure.

iii) Rehabilitation objectives (Collins and Thompson, 2002).

1. Flood retention and base flow support.
2. Stop further degradation and erosion of the wetland.
3. Sediment trapping.
4. Nutrient attenuation.
5. Prevent the hydrological functioning from becoming impaired or lost.
6. Conservation of rare habitat and enhancement of natural biodiversity.
7. Social upliftment (poverty relief and skills development).

iv) Offsite actions required.

1. Stakeholder involvement (Collins and Thompson, 2002).
2. Training and education, safety awareness and productivity control (Collins and Thompson, 2002).
3. Impacts of the proposed pump storage scheme in the upper part of the wetland and it's catchment need to be determined.

v) Monitoring & Maintenance.

1. Follow-up visits to the completed rehabilitation work will be done regularly for the first year after completion by the Senior Project Manager with assistance from a Technical Advisor and thereafter annually by the Department.
2. Monitor the re-established species composition through vegetation surveys.
3. Fencing around the rehabilitation structure to prevent grazing by animals.

vi) Wetland Rehabilitation site details.

The photos of the rehabilitation structure were taken during the preliminary field visit (1 July 2002). Table 8 gives a summary of the problems, rehabilitation actions taken and the desired results to attain after the rehabilitation, and Figure 37 describes the wetland rehabilitation site layout details.

Table 8: Wilge River Wetland: Summary of the problems, rehabilitation actions taken and the desired results to be attained after the rehabilitation (Collins and Thompson, 2002).

Site no.	Problems	Rehabilitation action	Desired results
1 28°13'38" 29°33'31"	Headcut (45 m) and channel (95 m donga) erosion (Figure 38)	Structural erosion control is needed. **Headcut:** - 30 m sloping: hyson cells (1:4), 15 m concrete basin, 100 m soil berm, 300 m fencing and revegetation (Figure 39). **Donga:** - 95 m sloping: hyson cells, 10 m concrete basin, channel plugs: gabions filled with rock.	• Stabilise the headcut • Stabilise headcuts developing on the banks of the channel • Dissipate the energy of floods. • To prevent further erosion of the wetland causing the affected wetland area to be drained.

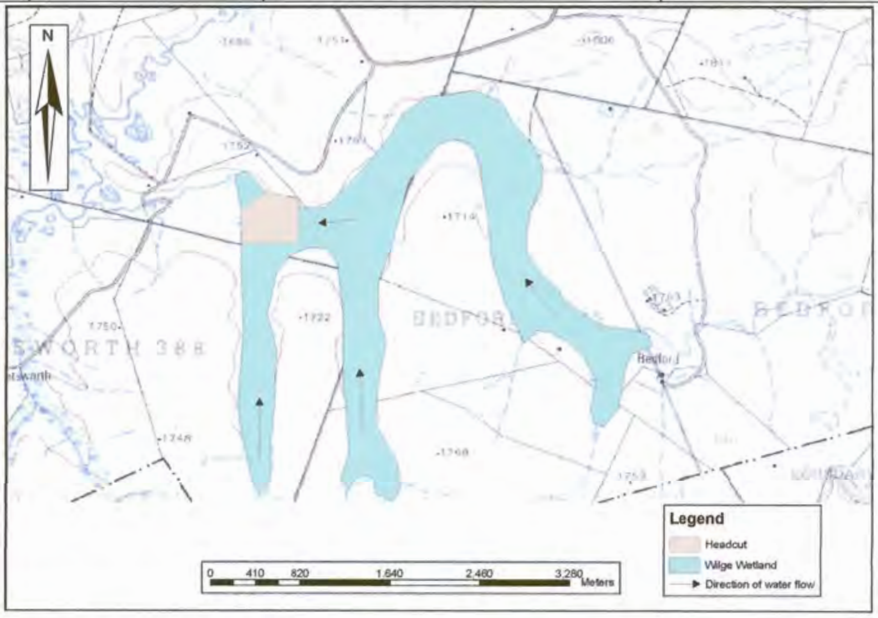

Figure 37: Topographical map (2829BA) showing the location of the rehabilitation structure.

Figure 38: Close up of the headcut rehabilitation structure.

Figure 39: Re-established wetland vegetation in the foreground.

3.1.2.4 Seekoeivlei Wetland:

i) General description of the wetland site.

The Seekoeivlei Wetland is divided in to two parts, namely: Southern Seekoeivlei in the Seekoeivlei Nature Reserve and the Northern Seekoeivlei. The Northern Seekoeivlei is the wetland area that stretches north from the Seekoeivlei Nature Reserve (Collins and Thompson, 1996). This study will focus on the Southern Seekoeivlei.

The Seekoeivlei wetland (Figure 40) is situated north of the town Memel in the Free State. The wetland in the Reserve covers approximately 3000 ha of the 12 000 ha of the Klip River flood plain that is one of the main contributors of water to Gauteng via the Vaal dam (Collins and Thompson, 1996). The Klip River is the main drainage line into which several smaller rivers and watercourses flow (Eckhardt *et al.*, 1993 a). The Reserve belongs to the Dept. Tourism, Environmental and Economic Affairs, Free State (Seekoeivlei Nature Reserve Brochure, 2002).

Figure 40: The Seekoeivlei wetland near Memel.

Aspects that make this wetland special are the fact that it is the largest wetland area on the escarpment and that it was declared under the Ramsar Convention as a wetland of international importance in March 1996 (Collins and Thompson, 1996). Furthermore it serves as an important water sponge for the Vaal River catchment area. The rainfall varies between 700 and 1000 mm per year with the maximum long-term average during December, January and February (Figure d in Appendix 2) (ARC-ISCW, 2002). Eckhardt *et al.* (1993 a) documented that the precipitation takes place, mostly in the form of thunderstorms, between November and March and that midsummer droughts occur towards the end of December until the middle of January.

This unique habitat is visited by scarce and endangered crane species. The last hippopotamus was hunted down here in 1894. In 1999 hippos were again introduced to the area (Seekoeivlei Nature Reserve Brochure, 2002).

Vegetation surveys done by Eckhardt *et al.* (1993 a) observed a decrease in species diversity if the species-richness of this community is compared with that of other vegetation types. The wetland community, *Eragrostis plana-Eragrostis curvula* grassland, occurs on wet, clay, eutrophic soils. The *Eragrostis plana-Agrostis lachnantha* plant community was described by Eckhardt *et al.* (1993 b) as a plant community associated with seasonal waterlogged soils or flooded areas. This major community is characterized by species in Table 9. Eckhardt *et al.* (1993 b) documented the silt and alluvium deposits along the banks and in some areas even peatlands can be found. The occurrence of peatlands in the environment gives the environment a high conservation status (Eckhardt *et al.*,1993 b).

Table 9: Diagnostic species of the *Eragrostis plana – Agrostis lachnantha* Wetlands (Eckhardt *et al.,* 1993 b).

Agrostis lachnantha	*Juncus inflexus*
Conyza bonariensis	*Trifolium africanum*
Pseudognaphalium oligandrum	*Persicaria attenuata*
Mariscus congestus	*Hermarthria altissima*
Phragmites australis	*Cyperus fastigiatus*
Verbena brasiliensis	*Cineraria lyrata*
Veronica anagallis-aquatica	*Leersia hexandra*

ii) Rehabilitation information.

The major impacts are the drainage channels, which were dug as agricultural methods to drain the wetland (Collins and Thompson, 1996). These alterations changed the hydrology of the wetland system. Today the Klip River flows through the western part of the wetland. Numerous horseshoe pans are evident on the eastern side of the wetland and indicate that the Klip River originally flowed on the eastern side of the wetland. The Survey general map Seekoeivlei no. 341 dated 1860 confirmed this fact. Ten years later (1870) the flow of the river was noted on the western side of the wetland.

The channels dug by the farmers (Figure 41) caused the Klip River to overflow its banks less frequently. This had a negative impact on the wetland system and wetland functions were lost (Collins and Thompson 1996).

Figure 41: Photo taken at Merel's vlei. This erosion channel forms the main flow of the Klip River.

iii) Rehabilitation objectives (Collins and Thompson, 1996).

1. Improve the natural wetland functions (e.g. flood attenuation).
2. Prevent the deviation of the Klip River.
3. Supply high quality water to the Gauteng region via the Vaal dam.
4. Employment opportunities for the local community and skills development.
5. Revegetate the uncovered riverbanks.
6. Control and stabilise the erosion dongas and headcuts.
7. Regulate surface erosion, grazing and the cutting of vegetation for fodder.
8. Prevent the increase of siltation in the wetland due to runoff from the surrounding catchment area by offsite mitigation measures, such as grazing control.
9. Improve the density and quality of the vegetation cover.

iv) Offsite actions required (Collins and Thompson, 1996).

1. Stakeholder involvement.
2. Create ecotourism.
3. Catchment management.

v) Monitoring & Maintenance (Collins and Thompson, 1996).

1. To monitor water purification, water samples will need to be taken at the major inflows of the wetland.
2. Plant communities change because of the changes in the hydrological regime of the wetland. Long-term fixed-point photography by the Dept. Tourism, Environmental and Economic Affairs, Free State are used for monitoring.
3. Follow-up visits to monitor the stability of the rehabilitation structures by the Implementing Agent.
4. Monitor bank erosion by measuring the rate of sedimentation and

the revegetation of wetland plant species.

5. Monitoring the ecological value (habitat for wetland dependent plant and animal species, enhancing the biodiversity of the region) through fixed-point photography, bird counts and vegetation surveys.
6. Monitoring the economical value (record products provided to the surrounding community and the amount of visitors to the Seekoeivlei Nature Reserve). This would only be possible when the rehabilitation of the wetland increases the biodiversity and the ecological integrity of the wetland is restored.

vi) Wetland Rehabilitation site details.

The rehabilitation done at the Southern Seekoeivlei Wetland implied the usage of eight channel plugs and two erosion prevention structures (Collins and Thompson, 1996). The photos of each rehabilitation structure were taken during the preliminary field visit (2 July 2002). Figure 42 describes the wetland rehabilitation site layout details and Table 10 gives a summary of the problems, rehabilitation actions taken and the desired results to attain after the rehabilitation.

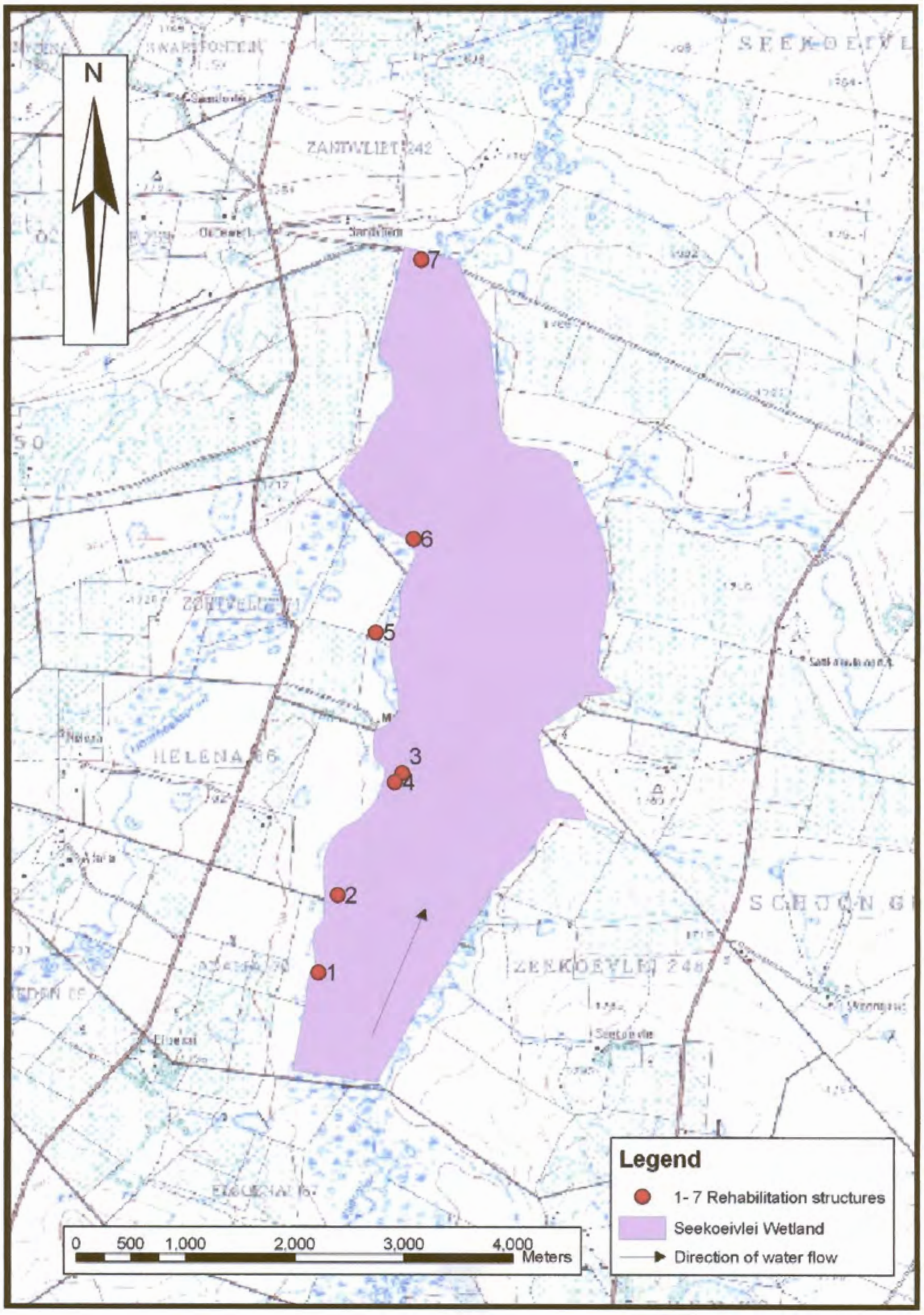

Figure 42: Topographical map (2729DA) showing the locations of the rehabilitation structures.

Table 10: Seekoeivlei Wetland: Summary of the problems, rehabilitation actions taken in 1996 and the desired results to attain after the rehabilitation (Collins and Thompson, 1996).

Site no.	Problems	Rehabilitation action	Desired results
1 29°34' 41" 27°35' 56"	Drainage channel eroding the wetland (Figure 43).	Concrete weir has been constructed (Figure 44).	• Structure must act as a silt trap. • Lift the water table • Dissipate the energy of the floods. • Prevent further erosion of the wetland.
2 29°34' 47" 27°35' 33"	Drainage channel eroding the wetland.	Concrete weir (Figure 45) has been constructed.	• Stabilise bank erosion (Figure 46). • Structure must act as a silt trap. • Lift the water table. • Dissipate the energy of the floods. • Prevent further erosion of the wetland.
3 29°35' 06" 27°34' 57"	Merel's vlei. River channel erosion and bank erosion.	Gabion structure constructed in 1997/8 (Figure 47). Measures to stabilise bank erosion.	• Stabilise bank erosion. • Structure must act as a silt trap. • Lift the water table. • Dissipate the energy of the floods. • Prevent further erosion of the wetland.
4 29°35' 04" 27°34' 59"	Merel's vlei. Channel erosion and bank erosion.	Concrete weir has been constructed and features below the water surface (Figure 48).	• Stabilise bank erosion. • Structure must act as a silt trap. • Lift the water table. • Dissipate the energy of the floods. • Prevent further erosion of the wetland.

Site no.	Problems	Rehabilitation action	Desired results
5 29° 34' 58" 27° 34' 15"	River channel erosion and bank erosion.	Gabion structure (Figure 49).	• Stabilise bank erosion. • Structure must act as a silt trap. • Lift the water table. • Dissipate the energy of the floods. • Prevent further erosion of the wetland.
6 29° 35' 10" 27° 33' 48"	River channel erosion and bank erosion.	Lift the existing structure higher and close it up with plugs (Figure 50).	• Stabilise bank erosion. • Structure must act as a silt trap. • Lift the water table. • Dissipate the energy of the floods. • Prevent further erosion of the wetland.
7 29° 35' 12" 27° 32' 25"	Northern border of the Seekoeivlei Nature Reserve. River channel erosion and bank erosion.	Gabion structure in the flow of the Klip River (Figure 51).	• Stabilise bank erosion. • Structure must act as a silt trap. • Lift the water table. • Dissipate the energy of the floods. • Prevent further erosion of the wetland.

Figure 43: Site no. 1. Area north of the confluence of the drainage channel that stretches from east to west across the width of the floodplain.

Figure 44: Site no. 1. Concrete weir.

Figure 45: Site no. 2. Concrete weir.

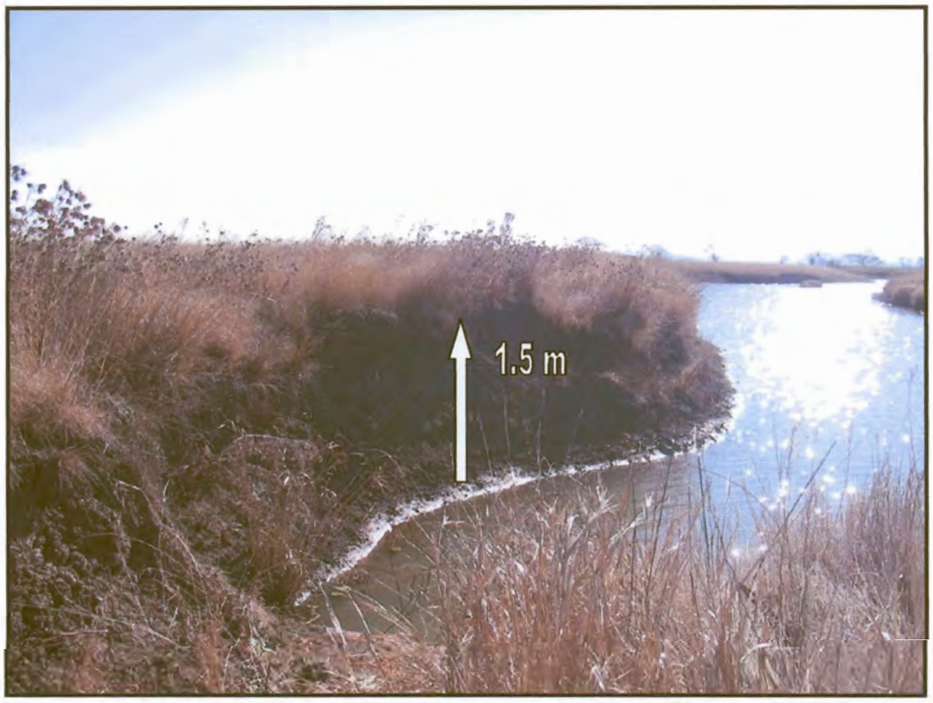

Figure 46: Site no. 2. Bank erosion.

Figure 47: Site no. 3. Merel's vlei. The gabion structure was Constructed in 1997/8. Measures were put in place to try and stabilise the bank erosion.

Figure 48: Site no. 4. Merel's vlei. A small weir drowned below the water surface.

Figure 49: Site no. 5. Gabion structure.

Figure 50: Site no. 6. The work involved lifting the existing structure higher, strengthening the structure and closing the drain holes (1997). Note that most of the plugs have been washed out.

Figure 51: Site no. 7. The Northern border of the Seekoeivlei Nature Reserve. A gabion structure was constructed in the flow of the Klip River to promote the flooding of the floodplain and to raise the water table.

3.1.2.5 Zoar Wetland:

i) General description of the wetland site.

The Zoar Wetland is situated in Eastern Mpumalanga in the upper part of the catchment of the Hlelo River. The wetland length is 3 600 m and the widest part is 600 m.

Mondi Forestry has been the landowner for the last 30 years (Figure 52). Private owners own the land up-and downstream of the wetland. The maximum rainfall for the area occurs during November, December and January (Figure e in Appendix 2) (ARC-ISCW, 2002).

Figure 52: The Zoar wetland in a Mondi Forestry area. Photo taken on 3 July 2002 after a veld fire.

ii) Rehabilitation information.

Rennies Wetland Project, now the Mondi Wetlands Project (MWP) started rehabilitation work at the Zoar wetland in September 2000. The rehabilitation took two years to complete. The Zoar wetland has been completely destroyed by the drainage of the wetland for agricultural purposes 60 years ago. The eight drains running parallel down the length of the wetland caused the desiccation of the wetland (Figures 53 & 54).

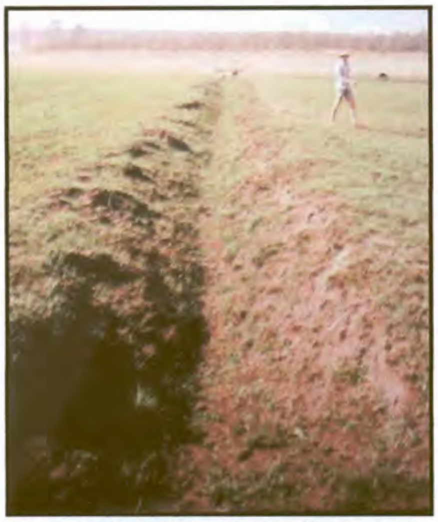

Figure 53: Drain in the wetland before rehabilitation (80 m long and 0.7 m deep). Photo taken from Mondi Wetlands Project report (2000).

Figure 54: Artificially straightened channel before rehabilitation. Photo taken from Mondi Wetlands Project report (2000).

Because the wetland remained unflooded for 60 years, terrestrial vegetation replaced the aquatic plants. The only indication of a once forgotten wetland was the sign of water flowing in the deep drains and some sedge species. *Pinus* and *Eucalyptus* plantations were planted in the wetland area. To determine the buffer distance from where plantations should begin, it was important to delineate the wetland. An initial study of the soils confirmed that the area had indeed once been part of a highly saturated system, probably wet throughout the year. The plantation trees in the wetland had to be removed for successful rehabilitation (Figure 55).

Figure 55: Photo of the Zoar wetland after the plantation trees were removed from the wetland (Photo: D. Lindley).

The channel erosion in the drains was 0.5 – 3 m deep and up to 4 m wide at some places. It was decided to construct a series of clay plugs every 20 – 50 m using the clay from the mound next to the drain to level the mound with the surrounding land and thereby diverting water into the wetland. Water runoff attempting to re-enter the gully / drain could cause problems of side-cutting. In order to overcome this, the plugs have been sited fairly close together in order to keep the water level in the gully / drain fairly high

(Haigh, 2002). The 0.5 m deep drains have plugs 0.5 m broad at the top and the 1 m deep drains must have 1 m broad at the top (Mondi Wetlands Project, 2000).

These clay plugs act like dam walls, lifting the water table, dissipating the water energy in rewetting the once dry wetland. On 6 January 2002 the Zoar wetland flooded for the first time in 60 years (Figure 56).

Figure 56: View of a flooded Zoar wetland. Note how the clay plugs act like dam walls (Photo: D. Lindley).

iii) Rehabilitation objectives.

1. Stabilise the channel erosion in the drains.
2. Structures must act as silt traps.
3. Flood retention and base flow.
4. Raising the water table.
5. Ground water recharge.
6. Removal of plantation trees in the buffer zone and wetland.
7. Conservation of wetland habitat and biodiversity.
8. Wetland awareness and training.
9. Regain wetland functions.

iv) Offsite actions required.

1. Stakeholder involvement.
2. Training and education in wetlands awareness.
3. Ongoing environmental monitoring.
4. Improve catchment management (control fires, over-grazing, draining wetlands and plantations in wetland areas).

v) Monitoring & Maintenance.

1. Follow-up monitoring and maintenance visits by the Implementing Agent to monitor the stability of the structures.
2. Re-establishment of wetland plant species. Changes in plant communities as a result of the change in the hydrological zones of the wetland (long-term fixed point photography).
3. Monitor wetland bird life ("The return of the birds is a sure sign of successful rehabilitation" – Duncan McKenzie, MWP field assistant in KwaZulu-Natal).

vi) Wetland Rehabilitation site details.

The photos of the rehabilitation structures were taken during the preliminary field visit (3 July 2002).

Figure 57 describes the wetland rehabilitation site layout details and Table 11 gives a summary of the problems, rehabilitation actions taken and the desired results to attain after the rehabilitation.

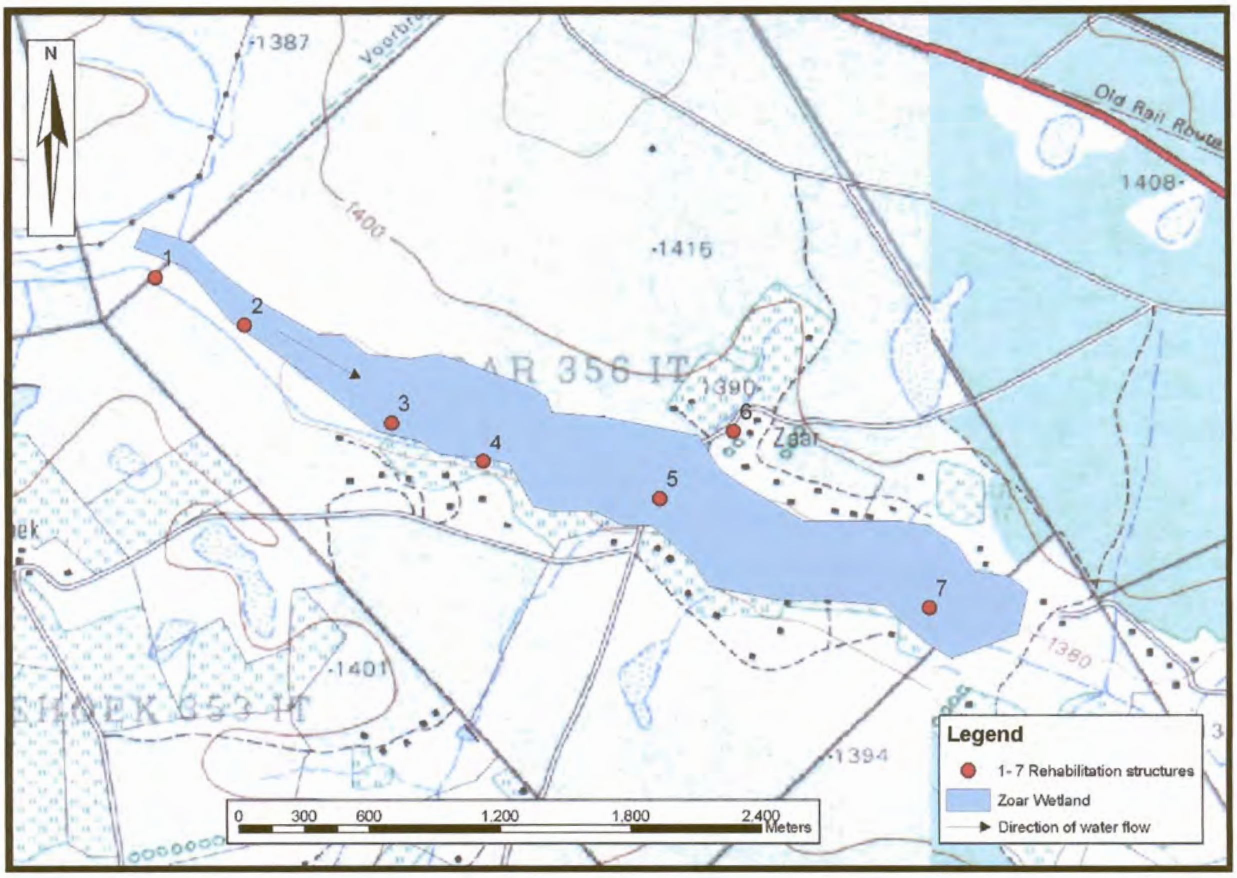

Figure 57: Topographical map (2630CD) showing the locations of the rehabilitation structures.

Table 11: Zoar Wetland: Summary of the problems, rehabilitation actions taken and the desired results to attain after the rehabilitation.

Site no.	Problems	Rehabilitation action	Desired results
1 S 30°28' 04.0" E 26°50' 34.0"	Zoar wetland North border. Eroded channel (Figure 58)	Built in clay plugs . The plugs must be keyed into the sides so that erosion cannot form around the plugs. Plugs must be well compacted.	• Dissipates the water energy. • Prevent channel erosion. • Spread the water and re-wet the wetland.

Site no.	Problems	Rehabilitation action	Desired results
2 S 30°28' 17.0" E 26°50' 41.0"	Main natural channel artificially straightened (Figure 59).	Channel must be emplaced	• Dissipate the energy of the floods. • Prevent channel erosion. • Spread the water and re-wet the wetland.
3 S 30°28' 39.0" E 26°50' 56.0"	Controlled service road cuts through the wetland and compacts the wetland soils resulting in the road acting as a dam wall hindering surface and subsurface flow (Figure 60).	Stop using the road.	• Dissipate the energy of the floods. • Prevent channel erosion. • Spread the water and re-wet the wetland.
4 S 30°28' 53.0" E 26°51' 02.0"	Drains (Figure 61).	Ideal time to bum is at the end of winter and the beginning of spring. Built in clay plugs. The plugs must be keyed into the sides so that erosion can't form around the plugs. Plugs must be well compacted.	• Spread the water and re-wet the wetland that will result in • Cool fires that are not so damaging to the organic matter/peat accumulating in a wetland. • Dissipate the energy of the floods. • Prevent channel erosion.
5 S 30°29' 19.0" E 26°51' 07.0"	Dirt road with culverts (Figure 62 & 63). Main drain with smaller drains along the side	Enlarge the culverts underneath the road to Facilitate the more evenly spread of water to the wetland down stream.	• Spread the water across the width of the wetland downstream. • Stabilise channel erosion.
6 S 30°29' 30.0" E 26°50' 57.0"	Drain inside a (1m wide, 1m deep) tributary feeding into the wetland (Figure 64). They use this tongue as a fire break between the plantations but bumed it at the wrong time of the year	Ideal time to bum is at the end of winter and the beginning of spring. Built in clay plugs every 30m and 0.5m broad at the top. The plugs must be keyed into the sides so that erosion can't form around the plugs. Plugs must be well compacted.	• Spread the water and re-wet the wetland that will result in • Cool fires that are not so damaging to the organic matter/peat accumulating in a wetland. • Dissipate the energy of the floods. • Prevent channel erosion.
7 S 30°29' 59.0" E 26°51' 23.0"	Zoar wetland South border (Figure 65) of the Mondi fence. Headcut on private property erodes back into the wetland.		• Stabilise the headcut erosion • Dissipate the energy of the floods.

Figure 58: Site no 1: Clay plugs in a badly eroded channel at the northern border with private owners.

Figure 59: Site no 2: Main natural channel.

Figure 60: Site no 3: Service road controlled by Mondi Forestry.

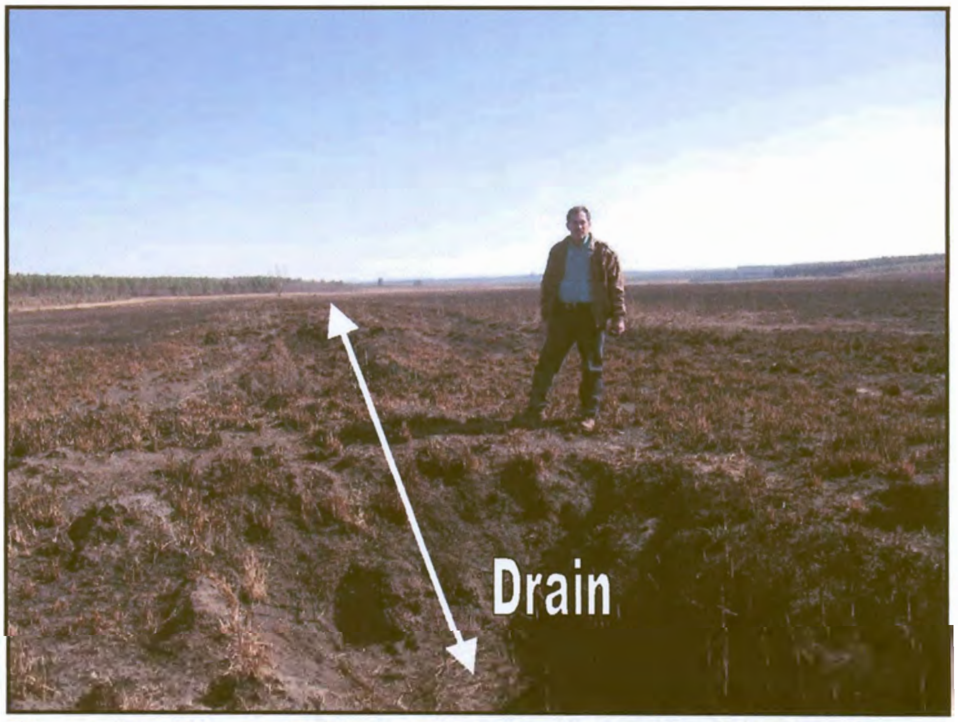

Figure 61: Site no 4: Drains draining the wetland lead to the desiccation of the wetland.

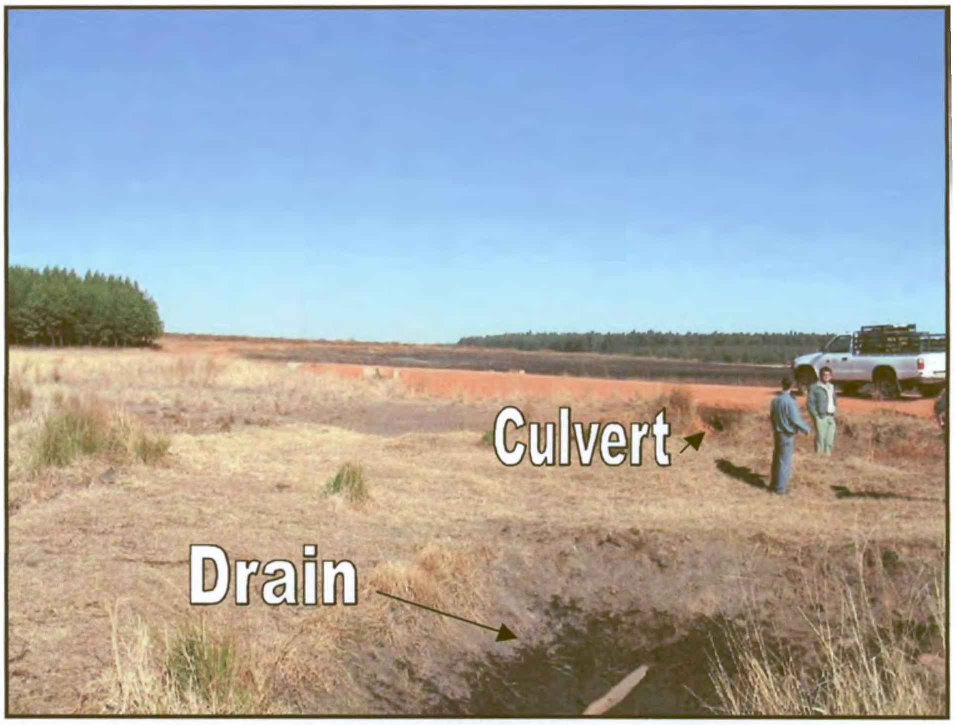

Figure 62: Site no. 5: Dirt road with culverts. The culverts concentrate the flow of the water and cause eroded channels.

Figure 63: Site no. 5: Main drain with smaller drains along the side. Clay plugs act like dam walls.

Figure 64: Site no 6: Note the drain in the burned tributary area that feeds into the wetland.

Figure 65: Site no 7: Zoar wetland southern border with private owners. Headcut erodes back into the wetland.