



**BUNDESANSTALT FÜR
GEWÄSSERKUNDE**

Koblenz

**(German Federal Institute of Hy-
drology)**



**BUNDESANSTALT
FÜR WASSERBAU**

Karlsruhe

**(German Federal Waterways
Engineering and Research
Institute)**



**Studies on Alternative Technical-
Biological Bank Protection Measures
Applied on Inland Waterways**

Part 2:

**Test Stretch Stolzenau / Weser
Km 241.550 – 242.300
(Appendices)**

**R & D Project
(BAW - BfG)**

October 2008

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Chapter 4



Bundesanstalt für Gewässerkunde

Bundesanstalt für Wasserbau

**Studies on alternative technical-biological bank protection measures
applied on inland waterways (R&D project)**

Part 2: Test stretch Stolzenau / Weser Km 241,550 – 242,300

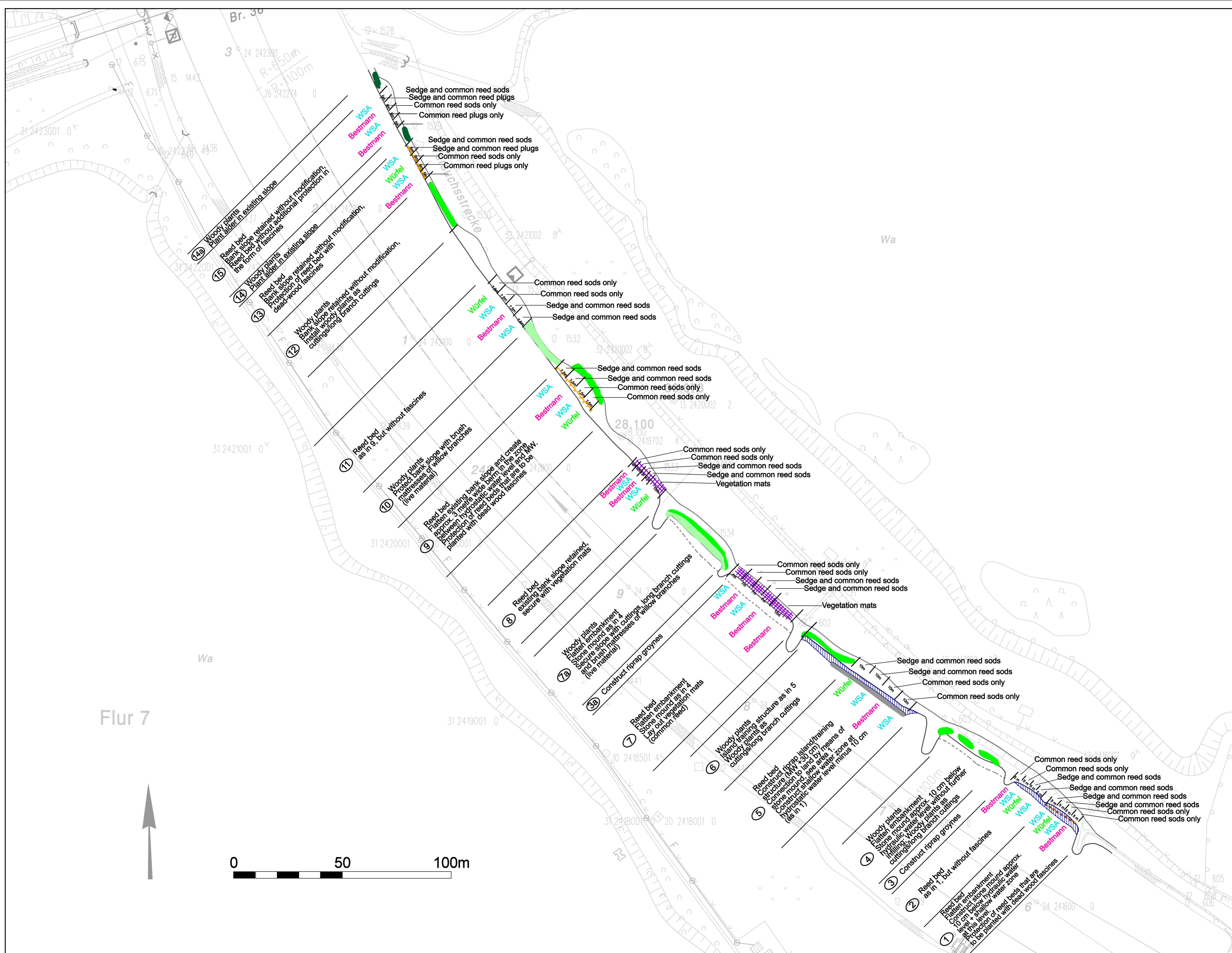
BfG-Nr.:1579

BAW-Nr.: 2.04.10151.00



Appendix 4.1

Planning



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- Stone mound
- Island-type training structure
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- Willow cuttings, long branch willow cuttings
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- Rows of alder plants

Project: Studies on alternative technical-biological bank protection measures applied on inland waterways (R&D project) Part 2: Test stretch Stolzenau/Weser Km 241.550 - 242.300		
Type of plan: Planning	Scale: 1:1000 (original)	
Prepared by: FEDERAL INSTITUTE OF HYDROLOGY KOBLENZ	Appendix no.: 4.1	
Processed by: Liebenstein		
CAD/GIS: Hoppe / Buscher		
Issued: 1988	Format modified: September 2008	

Appendix 4.2

Vegetation and bank structure; survey from 1989



Appendix 4.2-1 Sections 1 - 8

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Key
Plants in the stretch

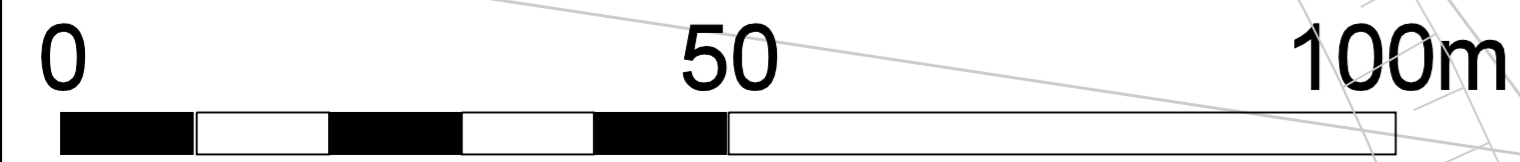
- * Carex spp. types of sedge
- G Glyceria maxima reed sweetgrass
- I Iris pseudacorus yellow flag (iris)
- J Juncus effusus soft rush
- + Phalaris arundinacea reed canary grass
- ⊗ Phragmites australis common reed
- W Alopecurus pratensis meadow foxtail
- A Elymus repens s.str. couch grass
- F Festuca rubra red fescue
- L Lythrum salicaria purple loosestrife
- P Phleum pratense timothy
- R Rumex spp. varieties of sorrels and docks
- S Symphytum officinale comfrey
- U Urtica dioica stinging nettle
- Alnus glutinosa black (European) alder
- willow cuttings/long branch willow cuttings
- ▨ brush mattresses of willow
- ⊕ willow fascines
- ⊗ coir rolls
- common reed mats
- ⑨ planning section no.
- new bank line
- - - stone mound
- ⊖ island-like training structure



Project: Studies on alternative technical-biological bank protection measures applied on inland waterways (R&D project) Part 2: Test stretch Stolzenau/Weser Km 241.550 - 242.300		
Type of plan: Vegetation and bank structure; survey from Sept. 1989		
Prepared by: FEDERAL INSTITUTE OF HYDROLOGY KOBLENZ		Scale: 1:500 (original) Appendix no.: 4.2-1
Processed by: Herz		
CAD/GIS: Hoppe / Buscher		
Issued: 1989	Format modified: September 2008	



Key
Plants in the stretch

- * Carex spp. types of sedge
- G Glyceria maxima reed sweetgrass
- I Iris pseudacorus yellow flag (iris)
- J Juncus effusus soft rush
- + Phalaris arundinacea reed canary grass
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- W Alopecurus pratensis meadow foxtail
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- R Rumex spp. varieties of sorrels and docks
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Project: Studies on alternative technical-biological bank protection measures applied on inland waterways (R&D project) Part 2: Test stretch Stolzenau/Weser Km 241.550 - 242.300		
Type of plan: Vegetation and bank structure; survey from Sept. 1989	Scale: 1:500 (original) Appendix no.: 4.2-2	
Prepared by: FEDERAL INSTITUTE OF HYDROLOGY KOBLENZ		
Processed by: Herz		
CAD/GIS: Hoppe / Buscher		
Issued: 1989	Format modified: September 2008	



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**Studies on alternative technical-biological bank protection measures
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Part 2: Test stretch Stolzenau / Weser Km 241,550 – 242,300

BfG-Nr.:1579

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Appendix 4.3

Detailed planning of the WSA Verden 1989

Appendix 4.3: Detailed planning of the WSA Verden 1989

WSA Verden Test stretch Stolzenau Issued at: Verden on 12.1.1989 Sheet 1
 4-231-2/33 Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groynes	Infilling of a training struc- ture	Planting	Laying out vegetation fabric/ vegeta- tion mats	Installing of live brush mat- tresses
1	a.) b.)	removal of existing riprapp inclination 1:7 w ~ 5 m l ~ 15 m i.e. 75 m ² h ~ 0.3 m i.e. 22.5 m ³	1) gathering of "dead" wood and production of the fascines 2) production of wooden stakes 1) l = 5 m ø = 0.30 m single layer; distance from stone mound ~ 2.50 m 2) l = 1 m ø = 0.10 m e = 2 pcs/m	- ~ 100 m ² ~ 25 m av. length ~ 4 m av. width; filling to hydr. water level minus 10 cm, i.e. 26.40 m a.s.l. ~ 0.30 m average filling height	- (sketch) 25 running m; w ₁ = 0.40 m, w ₂ = 1.50 m, h = 0.40 m connection to groynes 2; distance to bank line ~ 3.5 m; top = hydr. water level + 20 cm i.e. 26.70 m a.s.l.	Groyne 2: clearance of old groyne surface area infilling of groyne; width of back: 2 m; length of back: 16 m; head height at 1.40 m above hydr. water level i.e. 27.90 m a.s.l.; inclination of back = 1:40; side above water = 1:2; underwater = 1:3	- reed bed plugs dia. ~ 25 cm; plug height ~ 35-40 cm type of plant: common reed vegetation tussock ø ~ 15 cm; tussock height ~ 25 cm; type of plant: common reed and sedges, as per plan	- Selection of terrain and gathering of 45 pcs reed bed plugs; order- ing of 55 pcs vegetation tussocks	- -	- -
c.)	-	-	fascines: 20 running m; wooden stake: 40 pcs	~ 30 m ² over- size particles i.e. 54 t	9.5 m ³ riprapp i.e. 16 t	riprapp 40 t	-	45 pcs common reed plugs; 15 pcs sedge tussocks; 40 pcs common reed tussocks; 20 m x 3 m x 0.2 m = 12 m ³ topsoil (mix with subsoil)	-	-
2 + 3a	a.)	removal of existing riprapp	-	-	-	-	-	Selection of terrain and acquisition of 45 reed bed plugs; ordering of	-	-

WSA Verden 4-231-2/33 Test stretch Stolzenau
 Issued at: Verden on 12.1.1989
 Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

Sheet 1

Area	a. Preparation description b. Technical requirements c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groyne	Infilling of a training structure	Planting	Laying out vegetation fabric/vegetation mats	Installing of live brush mattresses
b.)		inclination 1:7 w ~ 5.0 m l ~ 15.0 m i.e. 75.0 m ² h ~ 0.3 m i.e. 22.5 m ³	-	~ 100 m ² ~ 25 m av. length ~ 4 m av. width; filling to hydr. water level minus 10 cm, i.e. 26.40 m a.s.l.; ~ 0.30 m average filling height	(sketch) 25 running m; w ₁ = 0.40 m, w ₂ = 1.50 m, h = 0.40 m connection to groyne 2a; distance to bank line ~ 3.5 m; top = hydr. water level + 20 cm i.e. 26.70 m a.s.l.	Groyne 2a Use existing remains of groyne and extend with riprap to form stub groyne. width of back: 2 m; length of back: ~ 5 m; groyne head at hydr. water level + 10 cm, i.e. 26.60 m a.s.l.	-	55 vegetation tussocks reed bed plugs dia. ~ 25 cm; plug height ~ 25-40 cm type of plant: common reed vegetation tussock ø ~ 15 cm; tussock height ~ 25 cm; type of plant: common reed and sedges, as per plan	-	-
c.)		-	-	~ 30 m ³ over-size particles i.e. 54 t	9.5 m ³ riprap i.e. 16 t	as suits local conditions approx. 1.0 m ³ , i.e. 1.6 t	-	45 pcs common reed plugs; 15 pcs sedge tussocks; 40 pcs common reed tussocks; 20 m x 3 m x 0.2 m = 12 m ³ topsoil (mix with subsoil)	-	-

WSA Verden 4-231-2/33 Test stretch Stolzenau Sheet 2
 Issued at: Verden on 12.1.1989
 Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groynes	Infilling of a training struc- ture	Planting	Laying out vegetation fabric/ vegeta- tion mats	Installing of live brush mat- tresses
4	a.)	removal of existing riprapi	-	-	-	Groyne 3: clearance of old groyne surface area	-	ordering of: 90 cuttings 85 long branch cuttings	-	-
	b.)	inclination 1:7 w ~ 5.0 m l ~ 30.0 m i.e. 150.0 m ² h ~ 0.3 m i.e. 45 m ³	-	-	(sketch) 38 running m; w ₁ = 0.40 m, w ₂ = 1.50 m, h = 0.40 m connection to groynes 3 + 2a; distance to bank line ~ 3.5 m; top = hydr. water level + 20 cm, i.e. 26.70 m a.s.l.	packing of groyne; width of back: 2 m; length of back: 18 m; head height at 1.40 m above hydr. water level i.e. 27.90 m a.s.l.; inclination of back = 1:40; inclination of side: above water = 1:2; underwater = 1:3	-	willow cuttings: ø ~ 2 cm; l ~ 60 cm; long branch willow cuttings: ø 3 cm; planted alternately with a distance of ~ 1 m between rows of plants, and of 0.4 m between plants on the steep slope and 0.6 m on the flat slope, starting at MW + 50 cm	-	-
5	c.)	-	-	-	riprap ~ 14.5 m ³ i.e. 24 t	riprap ~ 30 t gravel ~ 30 t	-	90 pcs willow cuttings; 85 long branch willow cuttings; approx. 30% salix purpurea; 40% salix triandra, 30% salix viminalis	-	-
	a.)	-	-	-	-	-	-	Selection of terrain and gathering of 90 reed bed plugs; ordering of 110 vegetation tussocks	-	-
	b.)	-	-	~ 180 m ² ~ 40 m av.	(sketch) 5.00 running m;	-	(sketch) 40 running m;	reed bed plugs dia. ~ 25 cm;	-	-

WSA Verden 4-231-2/33 Test stretch Stolzenau
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				<p>length ~ 4.5 m av. width, infilling to hydr. water level minus 10 cm, i.e. 26.40 m a.s.l. ~ 0.3 m; average infill height</p>	<p>w₁ = 0.40 m, w₂ = 1.50 m, h = 0.40 m connection to bank and training struc- ture; top = hydr. water level + 20 cm, i.e. 26.70 m a.s.l.</p>		<p>w₁ = 0.50 m, w₂ = 4.50 m, h = 1.20 m distance from groyne 3 ~ 15 m; from groyne 4 ~ 7 m; from bank ~ 3.5 m; top = MW + 10 cm i.e. 26.94 m a.s.l.</p>	<p>plug height ~ 35-40 cm type of plant: common reed vegetation tussock: ø ~ 15 cm; tussock height ~ 25 cm; type of plant: common reed and sedges, as per plan</p>		
c.)			<p>~ 55 m³ over- size particles i.e. 100 t</p>	<p>~ 1.9 m³ riprap i.e. 3 t</p>	-	<p>~ 120 m³ riprap i.e. 190 t</p>	<p>90 pcs common reed plugs; 30 pcs sedge tussocks; 80 pcs common reed tussocks; 40 m x 3 m x 0.2 m = 24 m³ topsoil (mix with subsoil)</p>	-		

WSA Verden 4-231-2/33 Test stretch Stolzenau
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Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groyne	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
6	a.) b.)	- -	- -	- ~ 135 m ² ~ 30 m av. length ~ 4.5 m av. width; infilling to hydr. water level minus 10 cm, i.e. 26.40 m a.s.l.; ~ 0.3 m av. infill height	- (sketch) 7 running m; w ₁ = 0.40 m, w ₂ = 1.50 m, h = 0.40 m connection to training structure and groyne 4; distance to bank line ~ 3.5 m, top = hydr. water level – 10 cm, i.e. 26.40 m a.s.l.	Groyne 4: clearance of old groyne surface area paving of groyne; width of back: 2 m; length of back: 11.5 m, head height at 1.40 m above hydr. water level i.e. 27.90 m a.s.l.; inclination of back = 1:40; inclination of side: above water = 1:2; underwater = 1:3	(sketch) 22 running m; w ₁ = 0.50 m, w ₂ = 4.50 m, h = 1.20 m distance to bank ~ 3.5 m; top = MW + 10 cm i.e. 26.94 m a.s.l.	ordering of: 90 cuttings 85 long branch cuttings willow cuttings: ø ~ 2 cm; l ~ 60 cm; long branch willow cuttings: ø 3 cm, planted alternately with a distance of ~ 1 m between rows of plants, and of 0.4 m between plants on the steep slope and 0.6 m on the flat slope, starting at MW + 50 cm	- -	- -
7.1+ 3b	a.)	removal of existing riprap	-	- ~ 40 m ³ oversize particles i.e. 70 t	-	Groyne 4a: Gathering pf "dead" wood and production of stakes	-	- 90 pcs willow cuttings; 85 long branch willow cuttings; approx. 30% salix purpurea; approx. 40% salix triandra; approx. 30% salix viminalis	ordering 45 m ² of vegetation mats (+ wooden stakes/ soil cramps for	-

WSA Verden 4-231-2/33 Test stretch Stolzenau Issued at: Verden on 12.1.1989 Sheet 3
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Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groynes	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
b.)		inclination 1:7 w ~ 5 m l ~ 20 m i.e. 100 m ² h ~ 0.3 m i.e. 30 m ³	-	-	(sketch) 25 running m; w ₁ = 0.40 m, w ₂ = 1.50 m, h = 0.40 m distance to bank line ~ 3.5 m; top = hydr. water level minus 10 cm, i.e. 26.40 m a.s.l.	(sketch) wire bracing; wood filling; construct groyne as brushwood double-row palisade; wooden stakes ø 0.10 m; l = 1.00 m; height = hydr. water level + 10 cm, i.e. 26.60 m a.s.l.; connection to groynes 4 + 4a	-	-	securing) vegetation mats: length: 5 m; width: 1.5 m; 6 pcs Installation starting at height of hydr. water level	-
c.)		-	-	-	9 m ³ riprap, i.e. 15 t	wooden stakes: 9 pcs	-	-	3 mats with sedges/com mon reeds, half and half widthwise across mat; 3 mats with common reed; stones for cover: topsoil 9 m ³ , 15 m x 3 m x 0.2 m (combine with in situ gravel)	-

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Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groyne	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
7a	a.) removal of existing riprap	-	-	-	-	Groyne 5: clearance of old groyne surface area	-	ordering of: 15 cuttings; 15 long branch cuttings	-	Gather live and dead material consisting of branches and twigs – live material from willow shrubs, dead material also from other plants. (Wooden stakes, wire). Install an approx. 10 cm thick live brush mattress of branches and twigs (well mixed) covering an area of 45 m x 4 m = 180 m ² . Brace and secure on the ground. Cover with soil to a depth of approx. 15 cm. From level of hydr. water level and water level and upwards.
	b.) inclination 1:7 w ~ 5.0 m l ~ 37 m i.e. 185 m ² h ~ 0.3 m i.e. 55 m ³	(sketch) 41 running m; w ₁ = 0.40 m, w ₂ = 1.50 m, h = 0.40 m connection to groyne above hydr. water level, i.e. 27.90 m a.s.l.; inclination of back = 1:40; inclination of side: above water = 1:2; underwater = 1:3	-	-	-	infilling of groyne; width of back: 2 m; length of back: 15.75 m; head height at 1.40 m above hydr. water level, i.e. 27.90 m a.s.l.; inclination of back = 1:40; inclination of side: above water = 1:2; underwater = 1:3	-	willow cuttings: ø ~ 2 cm; l ~ 60 cm; long branch willow cuttings: ø 3 cm; planted alternately with a distance of ~ 1 m between rows of plants, and of 0.4 m between plants on the steep slope and 0.6 m on the flat slope, starting at MW + 5 cm	-	Approx. 18 m ³ branches and twigs
	c.)	-	-	-	16 m ³ riprap i.e. 25 t	40 t riprap	-	15 pcs willow cuttings; 15 long branch willow cuttings; approx. 30%	-	-

WSA Verden Test stretch Stolzenau Issued at: Verden on 12.1.1989 Sheet 4
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Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groyves	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
8.1	a.)	removal of existing riprap	-	-	-	-	-	salix purpurea, approx. 40% salix triandra; approx. 30% salix viminalis	-	approx. 27 m³ topsoil
	b.)	existing inclination retained	-	-	-	-	-	-	ordering of 25 m² vegetation mats (+ wooden stakes/ soil cramps)	-
	c.)	-	-	-	-	-	-	-	vegetation mats: length: 5 m; 2 pcs 1.5 m wide; 2 pcs 1 m wide	-
									2 mats (w = 1.5 m) half and half sedges and common reeds; 2 mats (w = 1 m) common reeds only; stones for cover; topsoil 5 m³, 10 m x 2.5 m x 0.2 m	-

WSA Verden Test stretch Stolzenau Sheet 4
 Issued at: Verden on 12.1.1989
 Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groynes	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of five brush mat-tresses
									(combine with in situ gravel)	

WSA Verden 4-231-2/33 Test stretch Stolzenau Issued at: Verden on 12.1.1989 Sheet 4.a
 Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groynes	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
7.II	a.)	removal of existing ripraps	-	-	-	-	-	selection of terrain and gathering of 70 pcs reed bed plugs; ordering of 80 pcs vegetation tussocks	ordering of 150 m ² vegetation fabric MW 25B (+ anchoring)	-
	b.)	inclination 1:7 w ~ 5 m l ~ 20 m i.e. 100 m ² h ~ 0.3 m i.e. 30 m ³	-	-	(sketch) 22 running m; w ₁ = 0.40 m, w ₂ = 1.50 m, h = 0.40 m distance to bank line ~ 3.5 m; top = hydr. water level minus 10 cm, i.e. 26.40 m a.s.l.	-	-	reed bed plugs dia. ~ 10-15 cm; plug height ~ 20 cm type of plant: common reed; vegetation tussock ø ~ 8 cm; tussock height ~ 8 cm; type of plant: common reed and sedges	vegetation textile MW 25B width = 1 m length = 150 running m; mesh size: 25 mm; soil anchor 0.8 cm x 40 cm	-
	c.)	-	-	-	9 m ³ ripraps i.e. 15 t	-	-	70 pcs common reed plugs; 15 pcs sedge tussocks; 65 pcs common reed tussocks; topsoil: 30 x 2 x 0.2 m = 12 m ³ ; 30 x 3 x 0.1 = 9 m ³	150 m ² vegetation fabric MW 25B (+ anchoring)	-
8.II	a.)	removal of existing ripraps	-	-	-	-	-	selection of terrain and gathering of 30 pcs reed bed plug plants; ordering of 45	ordering of 75 m ² vegetation fabric MW	-

WSA Verden 4-231-2/33 Test stretch Stolzenau Sheet 4.a
 Issued at: Verden on 12.1.1989 Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groyne	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
	b.)	existing slope retained	-	-	-	-	-	pcs vegetation tussocks reed bed plugs dia. ~ 10-15 cm; plug height ~ 20 cm type of plant: common reed; vegetation tussock ø ~ 8 cm; tussock height ~ 8 cm; type of plant: common reed and sedges	25B (+ anchoring) vegetation fabric MW 25 width = 1 m length = 75 running m mesh size: 25 mm soil anchor 0.8 cm x 40 cm	-
	c.)	-	-	-	-	-	-	30 pcs common reed plugs; 15 pcs sedge tussocks; 30 pcs common reed tussocks	75 m ² vegetation fabric MW 25 (+ anchoring)	-

WSA Verden 4-231-2/33 Test stretch Stolzenau
 Issued at: Verden on 12.1.1989 Sheet 5
 Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groynes	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mat-tresses
9	a.) b.) c.)	removal of existing ripraps inclination 1:7 w ~ 5 m l ~ 35 m i.e. 175 m ² h ~ 0.3 m i.e. 52.5 m ³	1) gathering of "dead" wood and production of the fascines 2) production of wooden stakes 1) l = 5 m ø = 0.30 m single layer, distance from bank line ~ 2 m 2) l = 1 m ø = 0.10 m e = 2 pcs/m	-	-	-	-	selection of terrain and gathering of 65 reed bed plugs; ordering of 85 vegetation tussocks reed bed plugs ø ~ 25 cm; plug height ~ 35-40 cm type of plant: common reeds; vegetation tussock ø ~ 15 cm; tussock height ~ 25 cm; type of plant: common reed and sedges, as per plan 65 pcs common reed plugs; 20 pcs sedge tussocks; 65 pcs common reed tussocks; 30 m x 3 m x 0.2 m = 18 m ³ topsoil (mix with subsoil)	-	-
10	a.)	removal of	-	-	-	-	-	ordering of 10 pcs each cuttings and	-	Gather live and dead material

Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a mound	Repair of groynes	Infilling of a structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
		existing riprap						long branch cuttings		consisting of branches and twigs – live material from willow shrubs, dead material also from other plants. (Wooden stakes, bracing wire).
b.)		existing slope retained	-	-	-	-	-	willow cuttings: ø ~ 2 cm; l ~ 60 cm; long branch willow cuttings: ø 3 cm; planted alternately with a distance of ~ 1 m between rows of plants, and of 0.4 m between plants on the steep slope and 0.6 m on the flat slope, starting at MW + 50 cm	-	Install an approx. 10 cm thick live brush mattress of branches and twigs (well mixed) covering an area of 30 m x 4 m = 120 m ² . Brace and secure on the ground. Cover with soil to a depth of approx. 15 cm. From level of hydrostatic water level and upwards.
c.)		-	-	-	-	-	-	10 pcs willow cuttings; 10 pcs long branch willow cuttings; approx. 30% salix	-	Approx. 12 m ³ twigs approx. 24 m ³

WSA Verden Test stretch Stolzenau Issued at: Verden on 12.1.1989 Sheet 5
 Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groynes	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
								purpurea, approx. 40% salix triandra; approx. 30% salix viminalis		topsoil

Issued at: Verden on 12.1.1989 Sheet 6
 Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

WSA Verden Test stretch Stolzenau

Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groynes	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
11	a.)	removal of existing ripraps	-	-	-	-	-	selection of terrain and gathering of 65 pcs reed bed plugs; ordering of 85 pcs vegetation tussocks	-	-
	b.)	inclination 1:7 w ~ 5 m l ~ 35 m i.e. 175 m ² h ~ 0.3 m i.e. 52.5 m ³	-	-	-	-	-	reed bed plugs ø ~ 25 cm; plug height ~ 35-40 cm type of plant: common reeds; vegetation tussock ø ~ 15 cm; tussock height ~ 25 cm; type of plant: common reed and sedges, as per plan	-	-
	c.)	-	-	-	-	-	-	65 pcs common reed plugs; 20 pcs sedge tussocks; 65 pcs common reed tussocks; 30 m x 3 m x 0.2 m = 18 m ³ topsoil (mix with subsoil)	-	-
12	a.)	-	-	-	-	-	-	ordering of: 75 pcs cuttings; 75 pcs long branch cuttings	-	-

WSA Verden 4-231-2/33 Test stretch Stolzenau Sheet 6
 Issued at: Verden on 12.1.1989
 Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

Area	a. Preparation	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groynes	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
	b.)	existing slope retained	-	-	-	-	-	willow cuttings: ø ~ 2 cm; l ~ 60 cm; long branch willow cuttings: ø 3 cm; planted alternately with a distance of ~ 1 m between rows of plants, and of 0.4 m between plants on the steep slope and 0.6 m on the flat slope, starting at MW + 50 cm	-	-
	c.)	-	-	-	-	-	-	75 pcs willow cuttings; 75 pcs long branch willow cuttings; approx. 30% salix purpurea; approx. 40% salix triandra; approx. 30% salix viminalis	-	-

WSA Verden
 4-231-2/33

Test stretch Stolzenau

Issued at: Verden on 12.1.1989

Sheet 7

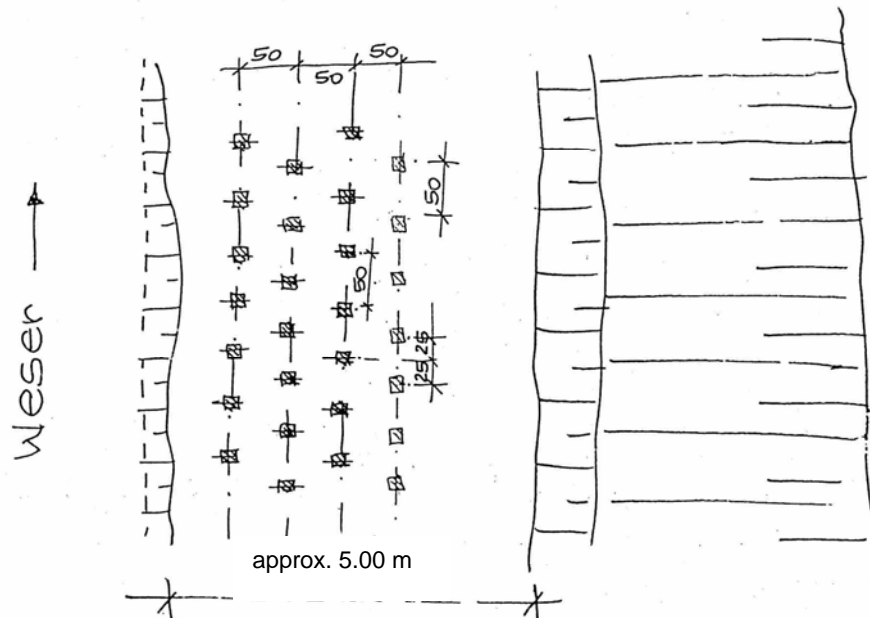
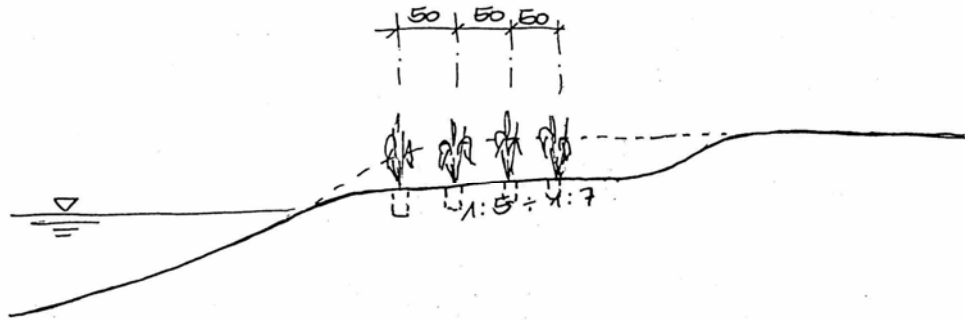
Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groynes	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
13	a.) b.)	- existing slope retained	1) gathering of "dead" wood and production of the fascines of the fascines of wooden stakes 2) production of wooden stakes 1) l = 5,00 m ø = 0,30 m single layer, distance from bank line ~ 1 m 2) l = 1,00 m ø = 0,10 m e = 8 pcs/m	-	-	-	-	selection of terrain and gathering of 45 pcs reed bed plugs; ordering of 55 pcs vegetation tussocks reed bed plugs ø ~ 25 cm; plug height ~ 35-40 cm type of plant: common reeds; vegetation tussock ø ~ 15 cm; tussock height ~ 25 cm; type of plant: common reed and sedges, as per plan	-	-
	c.)	-	fascines: 20 running m; wooden stakes: 40 pcs	-	-	-	-	45 pcs common reed plugs; 15 pcs sedge tussocks; 40 pcs common reed tussocks; 20 m x 3 m x 0,2 m = 12 m³ topsoil (mix with subsoil) ordering of: 20 pcs alder (alnus glutinosa); 20 pcs wooden stakes	-	-
14	a.)	-	-	-	-	-	-	ordering of: 20 pcs alder (alnus glutinosa); 20 pcs wooden stakes	-	-

WSA Verden 4-231-2/33 Test stretch Stolzenau Sheet 7
 Issued at: Verden on 12.1.1989 Nitsch, Graduate Engineer; Processed by Freese, Technical Employee

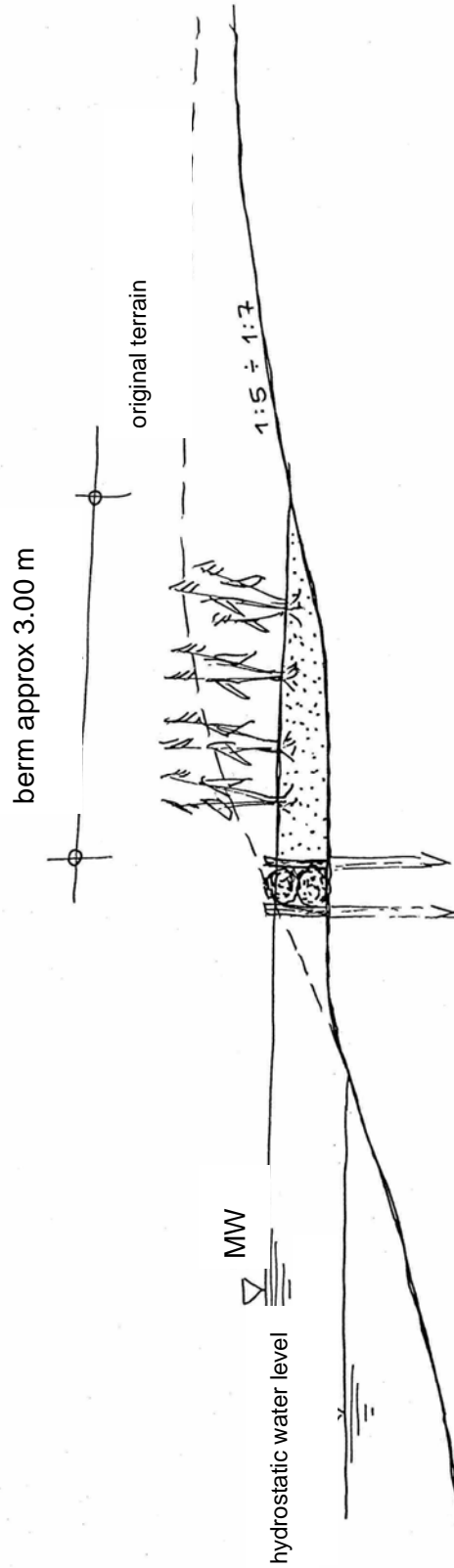
Area	a. Preparation b. Technical description c. Material requirements	Flattening of bank slope	Installation of sunk fascines	Creation of a shallow-water area	Infilling of a stone mound	Repair of groynes	Infilling of a training structure	Planting	Laying out vegetation fabric / vegetation mats	Installing of live brush mattresses
15	b.)	existing slope retained	-	-	-	-	-	Alder saplings, 125 – 150 cm tall; transplanted twice; starting at MW + 50 cm in 2 rows; distance between rows: 1 m; plant alternately in the two rows	-	-
	c.)	-	-	-	-	-	-	20 pcs alder; 20 pcs wooden stakes, 2 m long; 4 m ³ topsoil	-	-
	a.)	-	-	-	-	-	-	selection of terrain and gathering of 45 pcs reed bed plugs; ordering of 55 pcs vegetation tussocks as in area 13	-	-
	b.	existing slope retained	-	-	-	-	-	as in area 13	-	-
	c.)	-	-	-	-	-	-	as in area 13	-	-

Planting plan for root plugs



WSA Verden, 23.3.1989 / Freese, TAN

COVER SHEET for Cross section 9 from draft dated 23.9.1988 of the BfG Koblenz



WSA Verden, 23.3.1989 Freese, Tang

Appendix 4.4

Description of the measures implemented by the WSA Verden, execution of construction work and costs, 1989

Appendix 4.4 – Description of the measures implemented by the WSA Verden, execution of construction work and costs, 1989

1.3 Description of the measures

In the vicinity of Stolzenau, a 750 m long section of riverbank (Weser Km 242.550 to Weser Km 242.300, right bank) shall be prepared for the testing of bioengineering construction methods in cooperation with the Federal Institute for Hydrology (BfG).

The various preliminary construction works that are required can be subdivided as follows:

1.3.1 Hydraulic engineering measures

In this area, there were groynes which were completely destroyed above the waterline. These groynes were rebuilt in their original dimensions.

In order to compare the individual types of groyne construction with regard to production costs, durability and effectiveness of protection for the planting work, the groynes were repaired using a variety of techniques.

Of the five groynes which lie inside the test stretch, two groynes were paved, two consist of riprap and one of packed stone.

The structural design of the individual groynes can be seen in Appendix A2. A total of 70 t of paving stones, 315 t of riprap and 250 t of gravel were used to repair the groynes.

The groyne fields that were reconstructed by these means are divided up by stone mounds of riprap with varying heights. The mounds run parallel to the bank line, at a distance of 5 m. The areas between the stone mound and the bank were filled with gravel to a level of 0.10 m below hydrostatic water level in order to create shallow water zones for the planting of reed plants.

The stone mounds simultaneously serve to reduce the force of waves generated by shipping.

The heights of the stone mounds can be seen in Appendix A1.

The construction of the mounds required 1400 t of riprap stone.

1.3.2 Earth works

For the planting of the reed beds, the banks, which in this section were partially still stabilised, were flattened and existing revetments were removed.

The flattening of the banks created a slope inclination of 1:5 in a section of 280 m in length and, on average, 4 m in width and 1 m in height, as measured from the water line.

The transitions from the flattened embankment to the in-situ soil were left as a vertical break in the surface. No remodelling was carried out in the transition area (see A3).

The existing breaks in the banks were flattened slightly and integrated into the test stretch in an otherwise unmodified form.

The revetments were removed in a section 80 m in length and on average 3 m in width (240 m²).

1.3.3 Installation of the bioengineering elements

The entire stretch was divided into individual sections in which the various options for biological-technical bank settlement were to be tested. The individual elements can be specified as follows:

1.3.3.1 Sinking fascines

The sinking fascines were produced by the personnel of the local office of the WSA Verden at Windheim.

The 5 m long fascines were made from cut willow rods with a diameter of 0.30 m which were tied into bundles.

They were installed between two rows of wooden stakes. The stakes were driven into the ground 0.5 m apart and in rows 0.30 m apart, and braced with criss-cross wires. The bracing serves to prevent the fascines from swelling.

All in all, 70 running metres of fascines were installed in a single layer to protect the newly planted reed beds from wave action.

At the same time, a vegetation fascine with a total length of 10 m (diameter 0.30 m) will be planted with sedges and reed tussocks from the company Bestmann and integrated into the test scheme.

1.3.3.2 Live brush mattresses

The material for the brush mattresses was gathered during essential tree maintenance work by the local office of the WSA Verden at Windheim. It consists of willow branches and twigs.

A 0.10 m thick live brush mattress will be installed at two sites of the test stretch, covering a total area of 300 m² on the cleared or flattened bank slope.

It will be secured with criss-cross wire bracing.

The toe of the live brush mattress is secured by embedding the end of the live brush mattress and weighing it down with riprap stone (see A4).

Simultaneously, two rows of willow cuttings are to be planted along the live brush mattress. These are to be placed 0.5 m apart in rows 1 m apart.

A total of 50 willow cuttings and approximately 30 m³ of branch and twig material will be used.

The live brush mattress serves as covering layer of living material in order to protect and stabilise newly installed bank slopes that are not too steep. The advantage is that the interwoven material provides mechanical protection for the bank until the willow cuttings can produce new shoots.

1.3.3.3 Planting of reed bed plants and woody plants

Protected by technical and technical-biological measures, planting was carried out on the flattened or existing slopes and in shallow water zones partly using plant material gathered by the office itself and partly plant material purchased from or provided by the two companies participating in the project.

Planting was carried out in single planting sections that were precisely specified. The chosen arrangement ensures that the individual planting sections can be clearly identified and examined.

On the one hand, planting represents the only protection for the bank and, on the other, planting will be carried out in conjunction with a woven coir fabric or coir mat as protection for the bank slope.

The individual options which will be tested in the test stretch include planting the bank with:

- a) reed and sedge plugs gathered by the office's own personnel
 - b) pre-cultivated reed and sedge tussocks
 - c) pre-cultivated common reed and sedge tussocks in conjunction with a woven coir fabric (vegetation fabric)
 - d) pre-cultivated common reed and sedge tussocks in conjunction with a coir mat (bio-erosion protection mat)
 - e) willow cuttings (1.0 m in length) gathered by own personnel
 - f) pre-cultivated vegetation mats or pallets planted with sedges and common reed plants
 - g) pre-cultivated willow plants
-

h) pre-cultivated alder

The test stretch was planted or covered with 680 gathered plants, 625 pre-cultivated plants, 367 cultivated willow plants, 133 gathered willow cuttings, 20 cultivated alders and 45 m² of vegetation mats or pallets, 25 m² of bio-erosion protection mats and 225 m² of vegetation fabric.

A distinction was made between gathered and cultivated plants to compare the growth of the individual plants under the same boundary conditions.

4.0 Execution of construction work

4.1 Execution timeline

The work required was carried out, with some interruptions due to high water events, in the period from November 1988 to May 1989.

4.2 Personnel

The work was largely carried out by the personnel of the local office of the WSA Verden at Windheim with support from the local office at Nienburg.

The detailed deployment of personnel is given in Appendix 5.

The detailed deployment of personnel can be calculated as 5 persons/day and one 5-day week.



Appendix 4.5

Compilation of costs



Source **Wasser und Schifffahrtsamt (local Waterways and Shipping Office) Verden
Außenbezirk
from IfG 12/04**

**Test stretch Stolzenau
Km** **241.550 to 242.300**

Abbr.: Some abbreviations exist only in the original source material and not in the Excel compilation.

MB	motor boat / workboat
SAR	work accommodation barge
SF	motorised floating grab dredger with loading crane
WBS	armour stones

Numbering corresponds to that of the original documents.

2.1.1.	Earth works
2.1.2.	Bank and bottom protection
2.1.3.	Vegetative construction: acquisition and delivery of plant material
2.1.4.	Vegetative construction: installation of plant material
2.1.5.	Combined construction methods
2.2.	Other construction costs

(1) Earth works (2.1.1)
Earth-moving works (2.1.1)

K5	[DM]	10289
VSg 308	[DM]	18274
Motor boats "Aue" + "Wölpi"	[DM]	2536
HGV rental	[DM]	431
Personnel costs	[DM]	5968
Personnel costs in percent	[%]	16
Total costs	[DM]	37497

Details of volume of earth removal		
Length	[m]	500
Width	[m]	8
Depth	[m]	0.25 bis 0.3

(2) Bank and bottom protection (2.1.2)
Improvements to groynes

		Groyne 1	Groyne 2	Groyne 3	Groyne 4	Groyne 5	Total amount
Other / labour	[DM]	19060	3778	13414	14139	6215	56606
Other / labour in percent	[%]	14	52	11	25	35	28
Material costs	[DM]	3192	4104	1710	4788	3420	17214
Costs in percent per running metre	[%]	424	100	191	239	121	
Total costs per groyne	[DM]	22252	7882	15124	18927	9635	73820
Costs per running metre	[DM/running m]	420	99	189	237	120	213

		Groyne 1	Groyne 2	Groyne 3	Groyne 4	Groyne 5
Length	[m]	10	15	15	15	15
Paved area	[m ²]	53	80	80	80	80
Volume	[m ³]	30	45	45	45	45

Rock filling with natural stone (stone mound) (2.1.2.1)

		Groyne field 1 (between groyne 1 and 2)	Groyne field 2 (between groyne 2 and 3)	Groyne field 3 (between groyne 3 and 4)
Labour costs	[DM]	3990	2800	2503
Equipment costs (MB)	[DM]	4176	2387	9667
SAR 253	[DM]	626	291	
VPD 284	[DM]	1810	970	
V.PKL 303				4740
VSG 295 + 308	[DM]	16786	12702	18144
Equipment rental; Bobcat with operator				673
Armour stones	[DM]	8208	11970	9234
Total costs	[DM]	35597	31120	44961
			111677	
Costs per running metre	[DM]	356	415	450
Per metric tonne (t)	[DM]	170	89	167

Length	[m]	100	75	100
Height	[m]	0,7	1	1
Depth	[m]	1,2		
Material requirements: Class III armour stones	[t]	210	350	270

Production and installation of fascines (2.1.2.3)

		Production	Installation	Installation plus mat. (Bestmann)
Labour costs	[DM]	840	2485	1120
SAR (in percent)	[DM]	34	78	
Costs for production	[DM]	874	2563	
			3437	
Costs per running metre	[DM]	17	51	140
			69	

Length [m]	50
Diameter [m]	0,3



Bundesanstalt für Gewässerkunde

Bundesanstalt für Wasserbau

**Studies on alternative technical-biological bank protection measures
applied on inland waterways (R&D project)**

Part 2: Test stretch Stolzenau / Weser km 241.550 – 242.300

BfG-No.: 1579

BAW-No.: 2.04.10151.00



Live brush mattress (2.1.2.4)

		Mat. acquis.	Installation
Labour costs	[DM]	4165	11253
SAR 254	[DM]	335	358
MBs "Föge" + "Wölpi"	[DM]	6191	
VPD 284	[DM]	1765	
HGV BH Hoja	[DM]		2240
Total costs	[DM]	12457	13850
		26307	
Costs per running metre	[DM]		351
Costs per m ²	[DM]		88

Compilation of costs for bank and bottom protection (2.1.2)

		Costs	
		[DM]	[€]
Groynes		73820	37226
Training structures	(2.1.2.1)	111677	56317
Fascines	(2.1.2.3)	3437	1733
Live brush mattress	(2.1.2.4)	26307	13266
Total costs		215241	108543

(3) Vegetative construction: acquisition and delivery of plant material (2.1.3)

		Acquisition of reed plugs	Acquisition of cuttings	Delivery of reed bed plants (Bestmann)	Delivery of reed bed plants (Würfel)	Delivery of cuttings	Delivery of vegetation pallets	Delivery of vegetation fascines	Delivery of alder	Delivery of organic erosion mats
Labour costs	[DM]	4690	245	490						
HGV costs	[DM]	840		280						
Rental tractor	[DM]	240								
Additional costs SAR and MB			25							
Total costs	[DM]	5770	270	770	1063	made available free of charge				260
Price per plant	[DM]	6,84	0,72							
Costs: vegetative construction	[DM]	8133								

(4) Vegetative construction: installation of plant material (2.1.4)

		Planting of reed plugs	Setting of cuttings and live stakes	Planting of alder	Overhead costs
Labour costs	[DM]	13825	2783	350	
Equipment	[DM]				4362
SAR	[DM]				1342
MB (motor ship) "Fösse"	[DM]				3020
Total costs	[DM]	25682			
Price per plant	[DM]	8,9	4,0	16,7	


(5) Combined construction methods 2.1.5

		Installation vegetation textiles	Production of willow fence
Labour costs	[DM]	420	1943
Tractor rental	[DM]		240
Willow stakes	[DM]		884
HGV transport	[DM]	-	-
Total costs	[DM]	420	3066
	[DM]	3486	
per running metre	[DM]		10,95

(6) Other construction costs	[DM]	2240
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Compilation of all costs

Item of work	Reference	Costs	
		[DM]	[€]
(1) Earth works	2.1.1	37497	19172
(2) Bank and bottom protection	2.1.2	215241	110051
(3) Vegetative constr.: acquisition/delivery of plant	2.1.3	8133	4158
(4) Vegetative constr.: installation of plant material	2.1.4	25682	13131
(5) Combined construction method	2.1.5	3486	1782
(6) Other construction costs	-	2240	1145
Construction management costs (15% of total (1)-(6))	-	43842	22416
Total costs		336121	171856



Bundesanstalt für Gewässerkunde

Bundesanstalt für Wasserbau

**Studies on alternative technical-biological bank protection measures
applied on inland waterways (R&D project)**

Part 2: Test stretch Stolzenau / Weser Km 241,550 – 242,300

BfG-Nr.:1579

BAW-Nr.: 2.04.10151.00



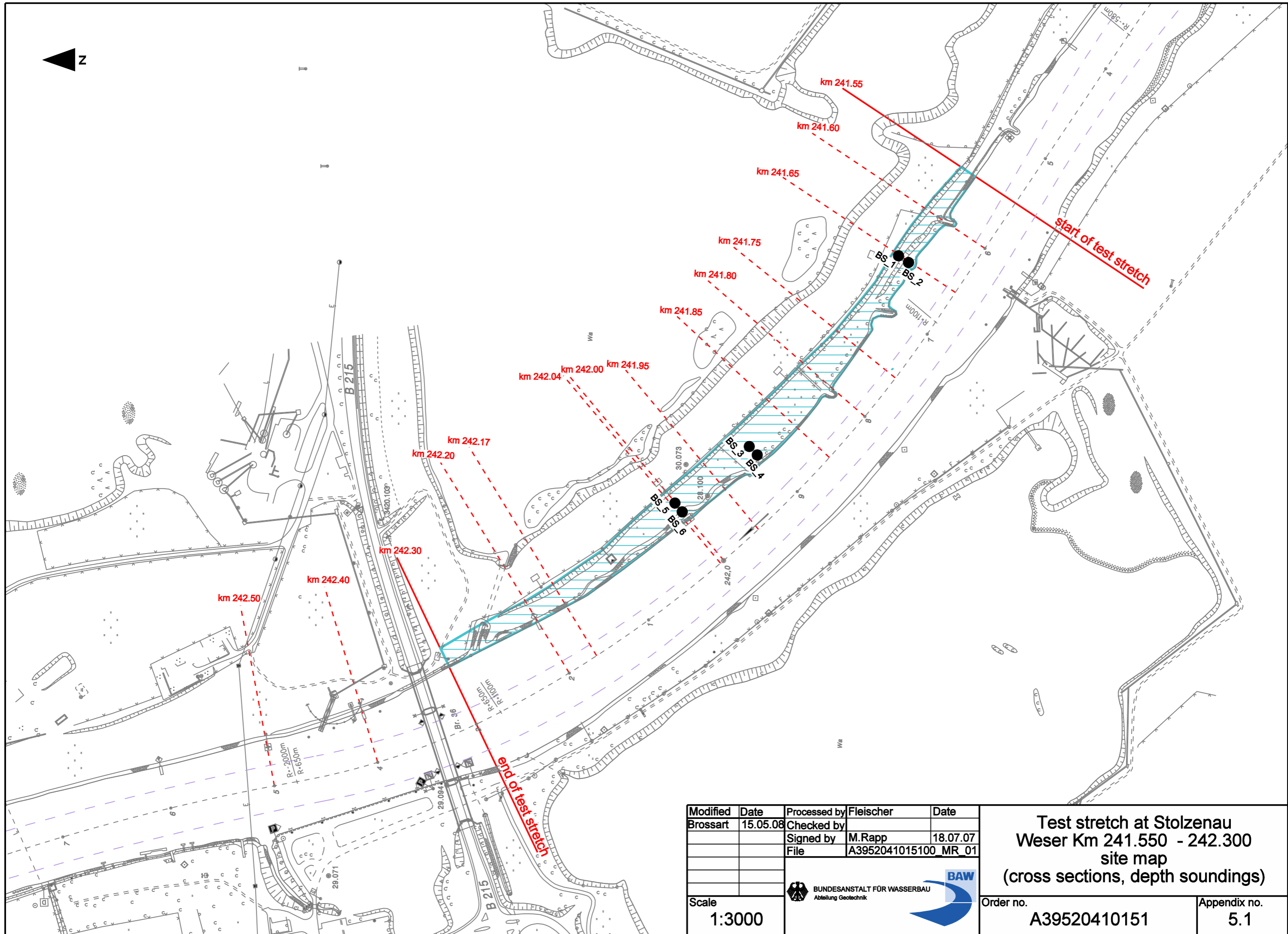
Appendices

to

Chapter 5

Appendix 5.1

Site map (Cross sections, soundings)



Modified	Date	Processed by	Fleischer	Date
Brossart	15.05.08	Checked by		
		Signed by	M.Rapp	18.07.07
		File	A3952041015100_MR_01	

Scale
1:3000

Order no.	A39520410151
Appendix no.	5.1

**Test stretch at Stolzenau
Weser Km 241.550 - 242.300
site map
(cross sections, depth soundings)**

Appendix 5.2

Soil data

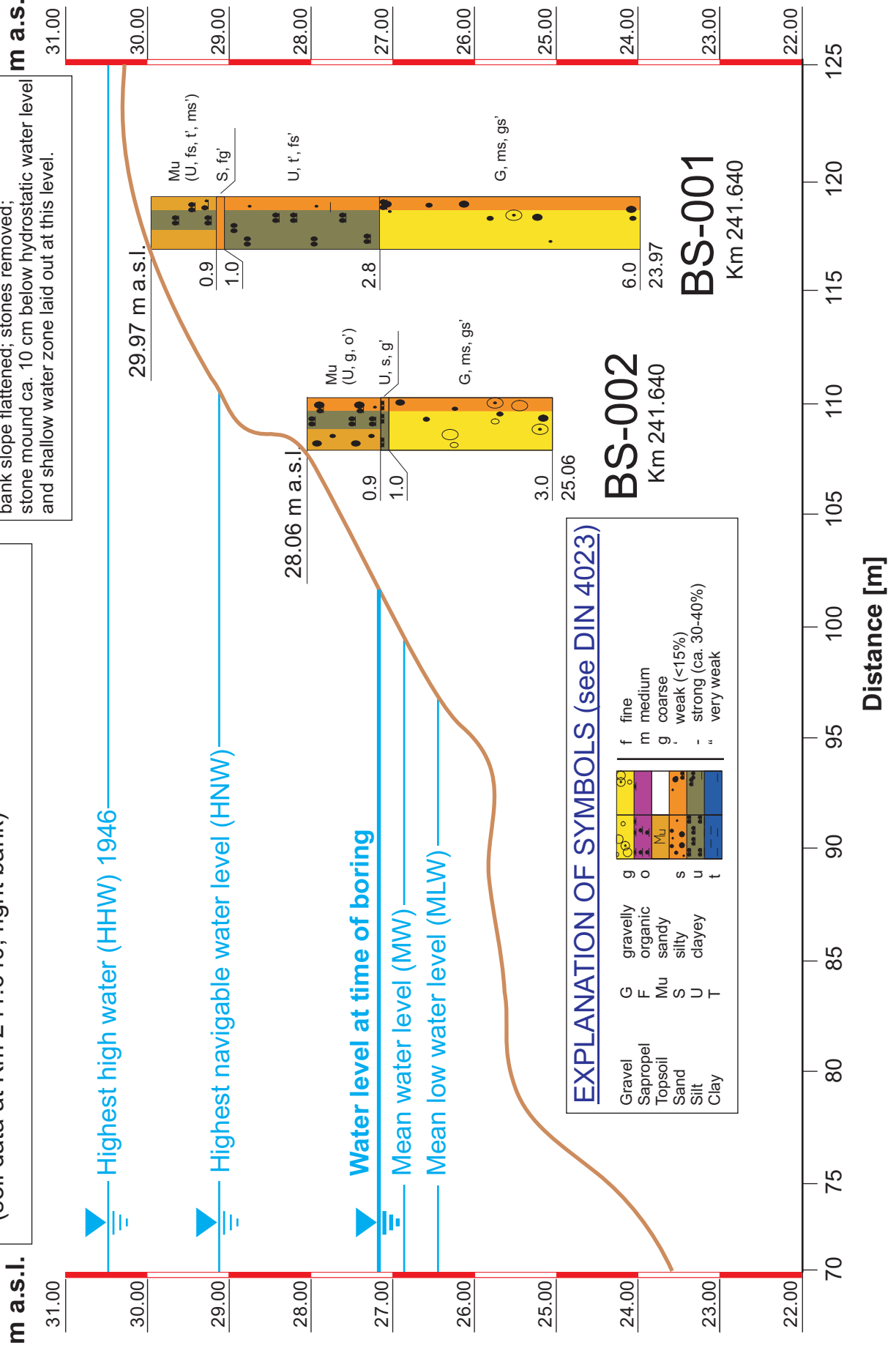
Appendix 5.2-1 Results of borings BS 001 / BS 002

Appendix 5.2-2 Results of borings BS 003 / BS 004

Appendix 5.2-3 Results of borings BS 005 / BS 006

Cross section of River Weser at Km 241.650, right bank
(soil data at Km 241.640, right bank)

Area 2: Located in groyne field; reed bed without protection by fascines, bank slope flattened; stones removed; stone mound ca. 10 cm below hydrostatic water level and shallow water zone laid out at this level.

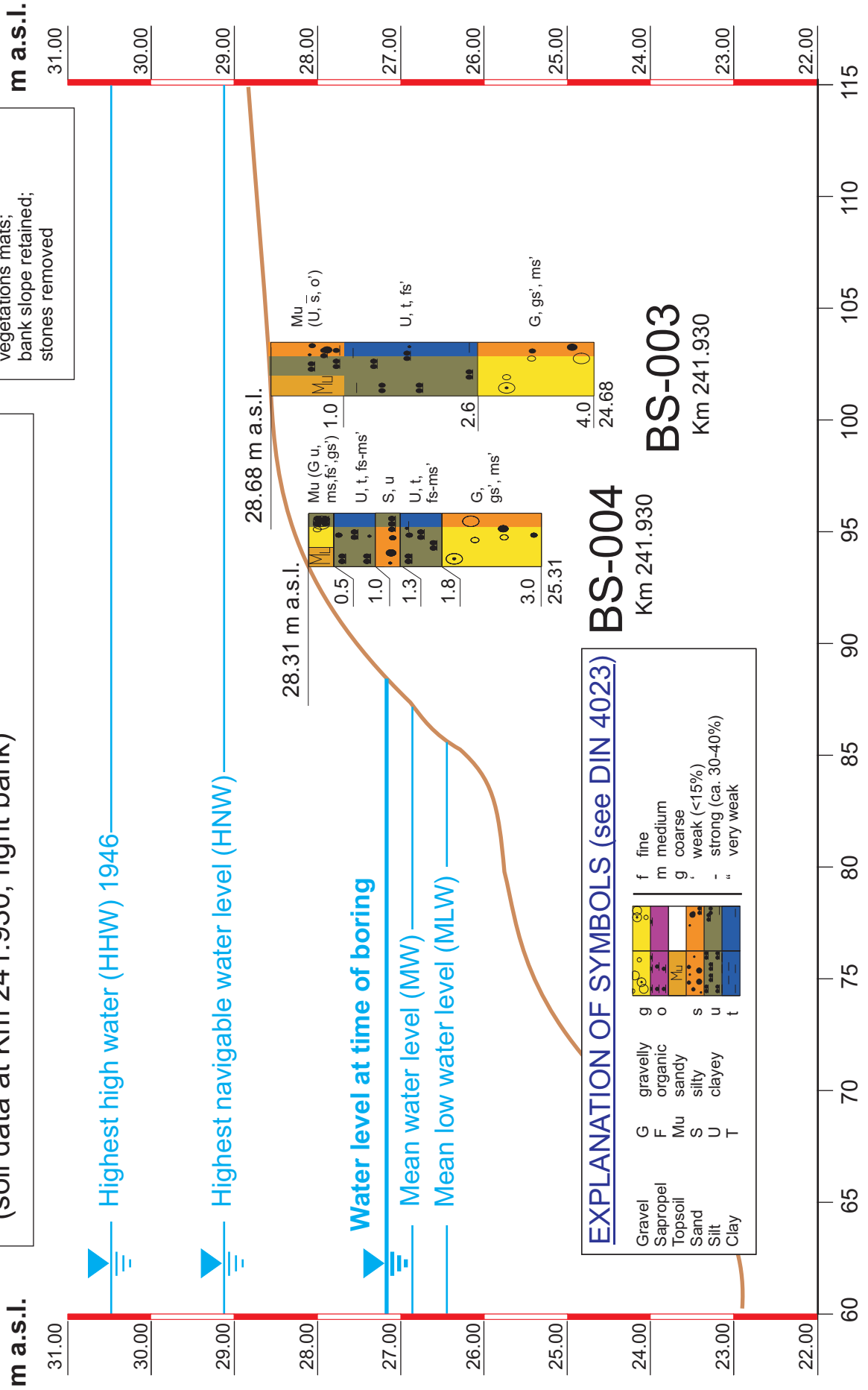


Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	5.05.08
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		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 results of borings BS 001/BS 002	
Order no.	2.04.10151.00
Appendix no.	5.2-1

Cross section of River Weser at Km 241.950, right bank
(soil data at Km 241.930, right bank)

Area 8:
Located outside groyne field;
vegetations mats;
bank slope retained;
stones removed



EXPLANATION OF SYMBOLS (see DIN 4023)

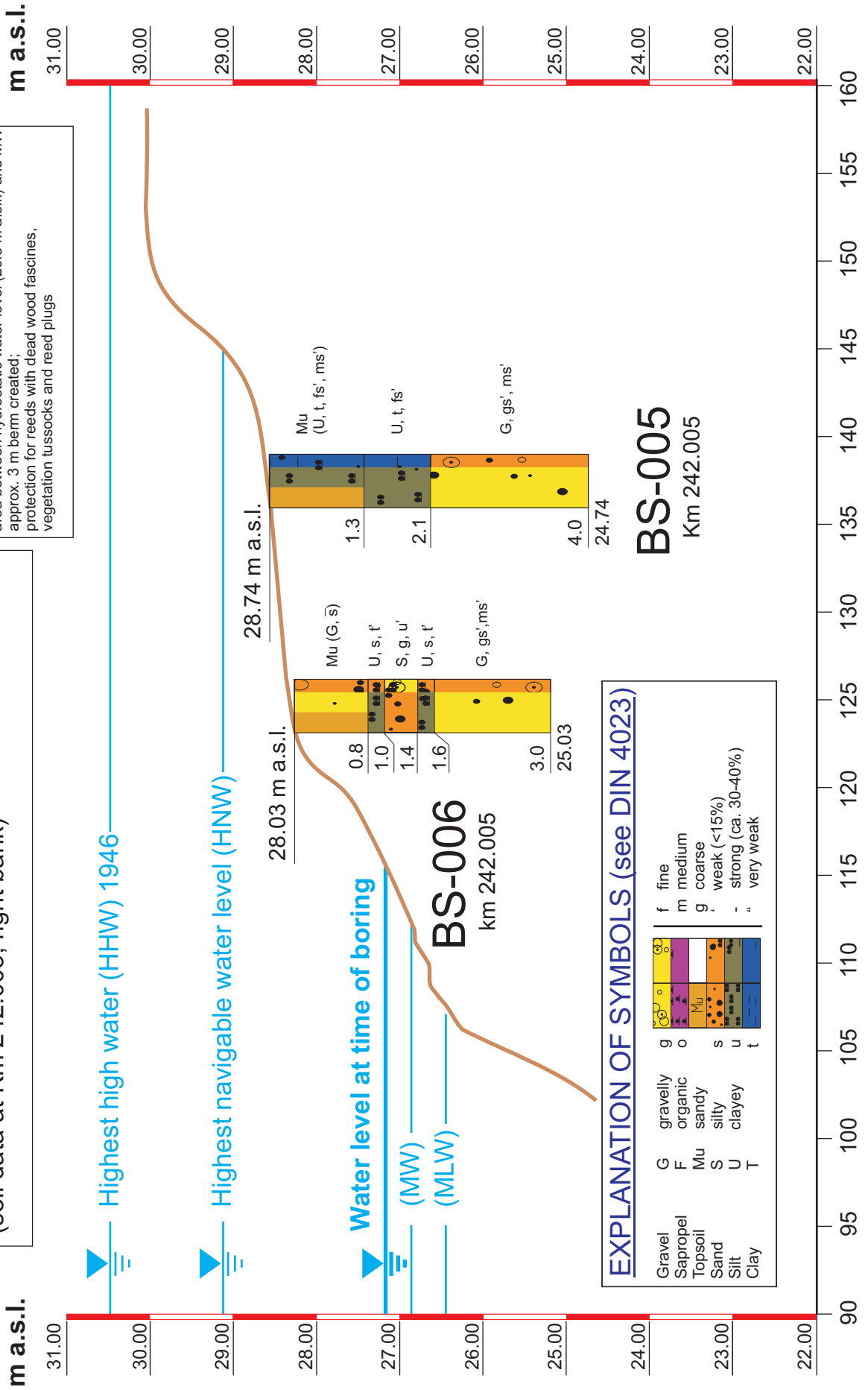
Gravel	G	gravelly	g	f	fine
Sapropel	F	organically	o	m	medium
Topsoil	Mu	sandy	u	g	coarse
Sand	S	silty	s	.	weak (<15%)
Silt	U	clayey	u	-	strong (ca. 30-40%)
Clay	T		t	"	very weak

Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	5.05.08
Scale		File	A2.04.10151.00_5.2-2	
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Test stretch at Stolzenau Km 241.550 - Km 242.300 results of borings BS 003/BS 004	
Order no.	2.04.10151.00
Appendix no.	5.2-2

Cross section of River Weser at Km 242.000, right bank
(soil data at Km 242.005, right bank)

Area 9: Location outside groyne field; reed beds; bank slope flattened; stones removed in the area between hydrostatic water level (26.5 m a.s.l.) and MW approx. 3 m berm created; protection for reeds with dead wood fascines, vegetation tussocks and reed plugs



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	5.05.08
Scale		File	A2.04.10151.00_5.2-3	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 results of borings BS 005/BS 006	
Order no.	2.04.10151.00
Appendix no.	5.2-3

Appendix 5.3

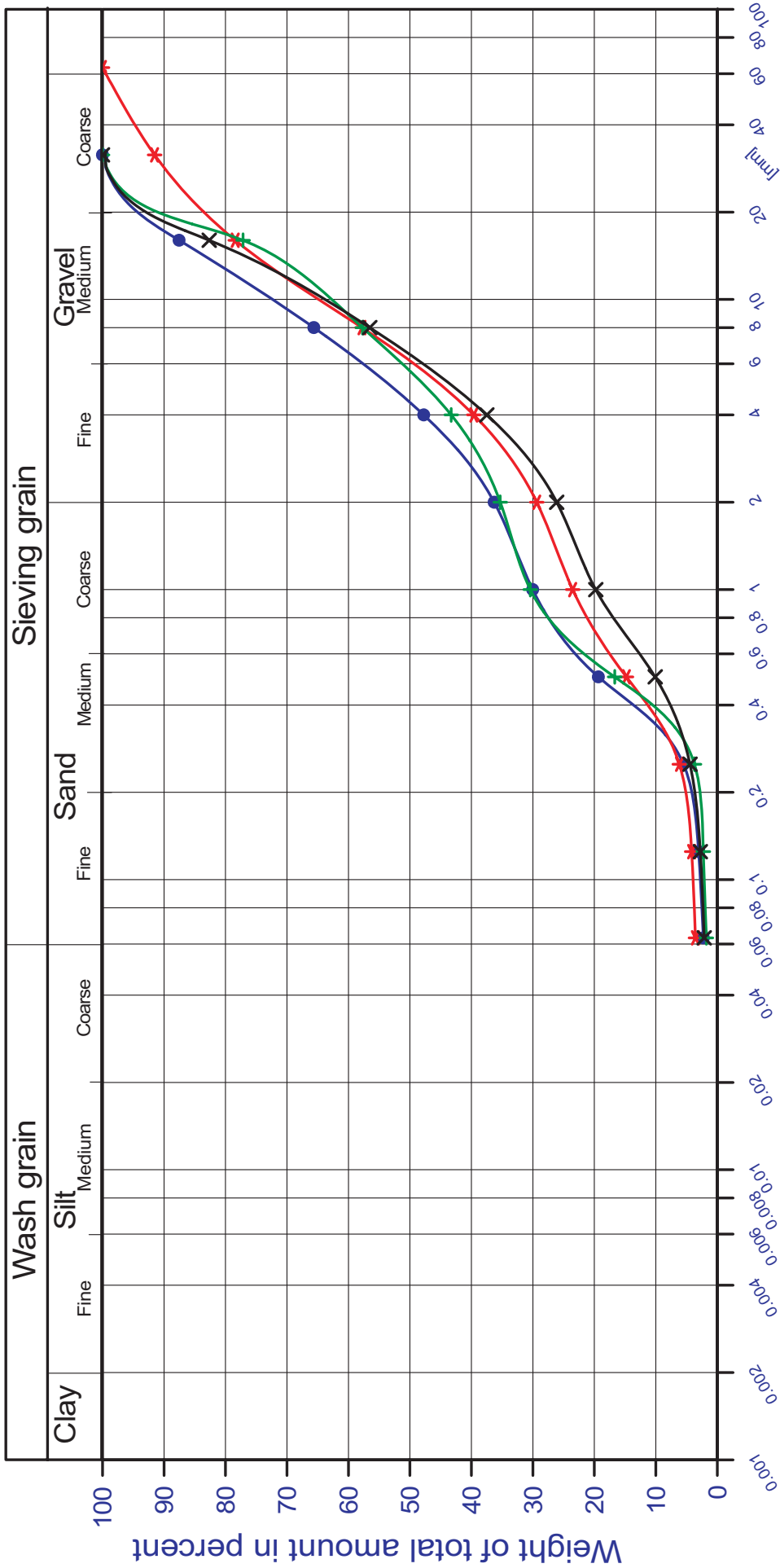
Grading curves

Appendix 5.3-1 Grading curve sands and silts

Appendix 5.3-2 Grading curve silts

Appendix 5.3-3 Grading curve Weser gravel

Grading curve as per DIN 18123



Laboratory no	Exploratory boring	Depth	Soil type determined by grain distribution	D10	D60	U	KKZ
20071235	BS_001	4	G, ms, gs'	0.3428	6.553	19.12	0037
20071236	BS_001	6	G, ms', gs'	0.3628	8.532	23.52	0037
20071237	BS_002	2	G, ms, gs'	0.3925	8.870	22.60	0037
20071239	BS_004	3	G, gs', ms'	0.5011	8.923	17.81	0028

KKZ = grain identification no.

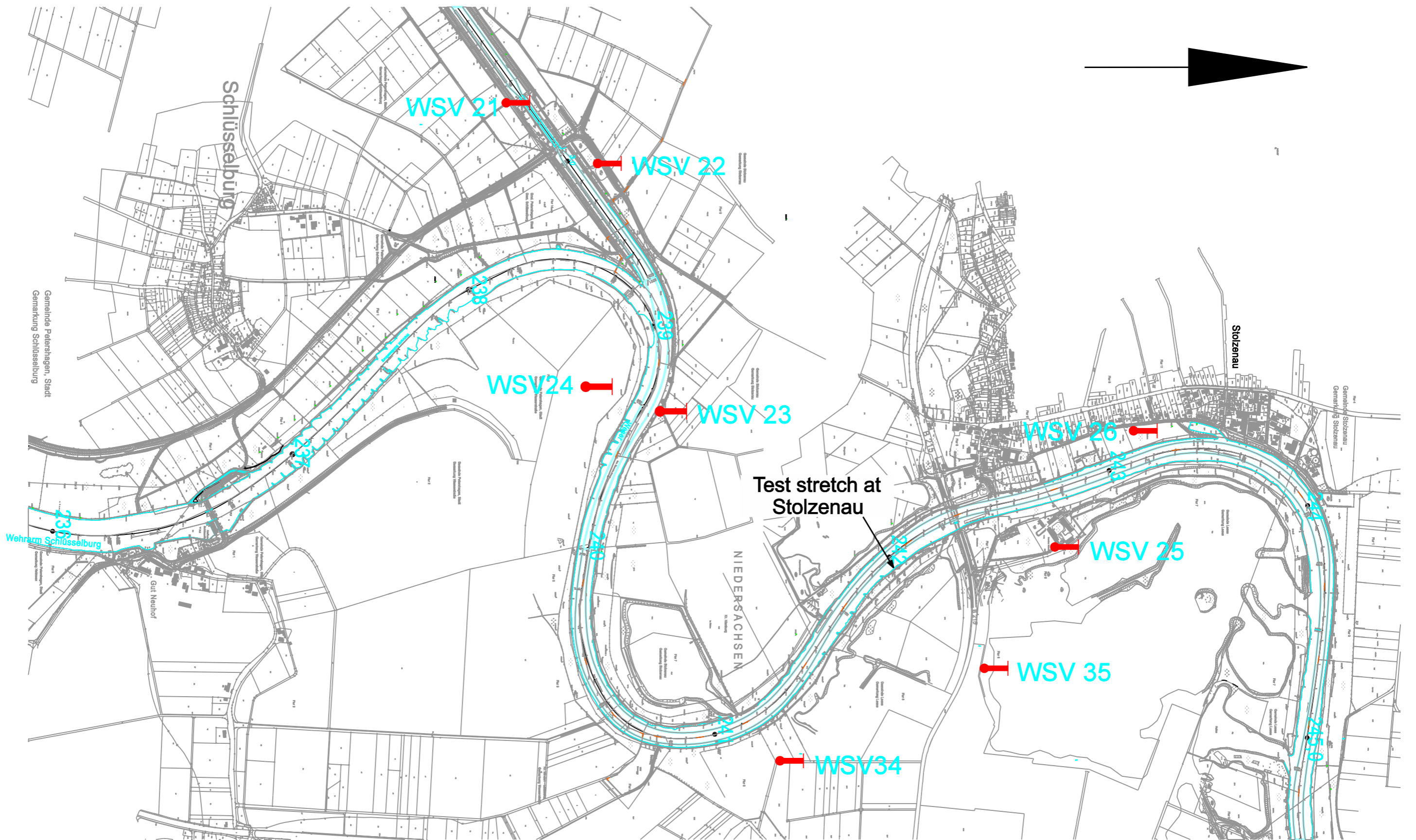
Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	28.04.08
Scale		File	A2.04.10151.00_5.3-3	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 grading curve Weser gravel	
Order no.	2.04.10151.00
Appendix no.	5.3-3

Appendix 5.4

Site plan

(Ground water measurement points)



Modified	Date	Processed by	Fleischer	Date
Brossart	15.05.08	Checked by		
		Signed by	Brossart	18.07.07
		File	A39520410151-CB-001.dgn	

Scale
1:15,000

BUNDESANSTALT FÜR WASSERBAU
Abteilung Geotechnik



**Test stretch at Stolzenau
Weser Km 241.550 - 242.300
site map
(GW measurement points)**

Order no.
A39520410151

Appendix no.
5.4

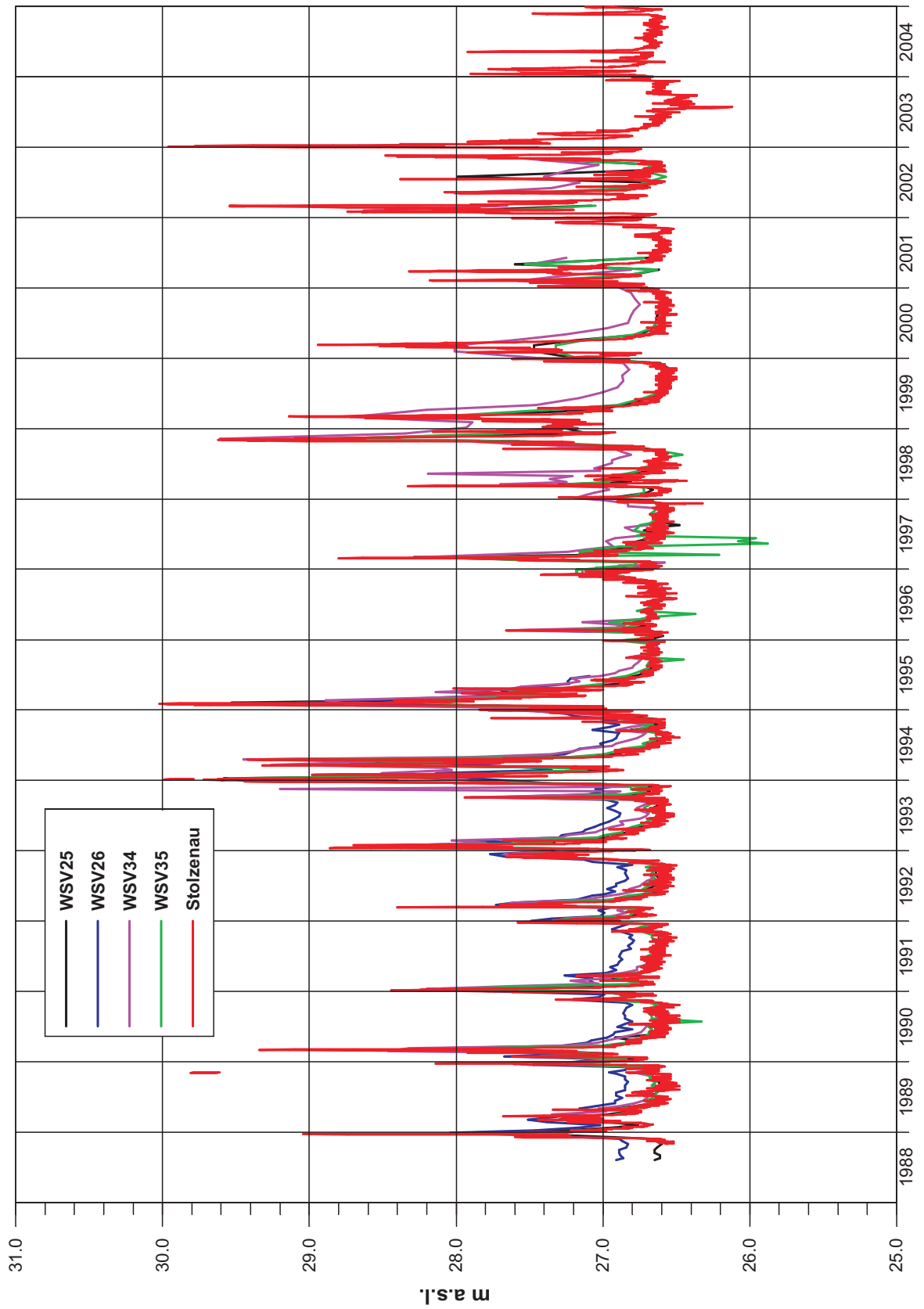
Appendix 5.5

Ground water

**Appendix 5.5-1 Ground water hydrographs
1988 - 2004**

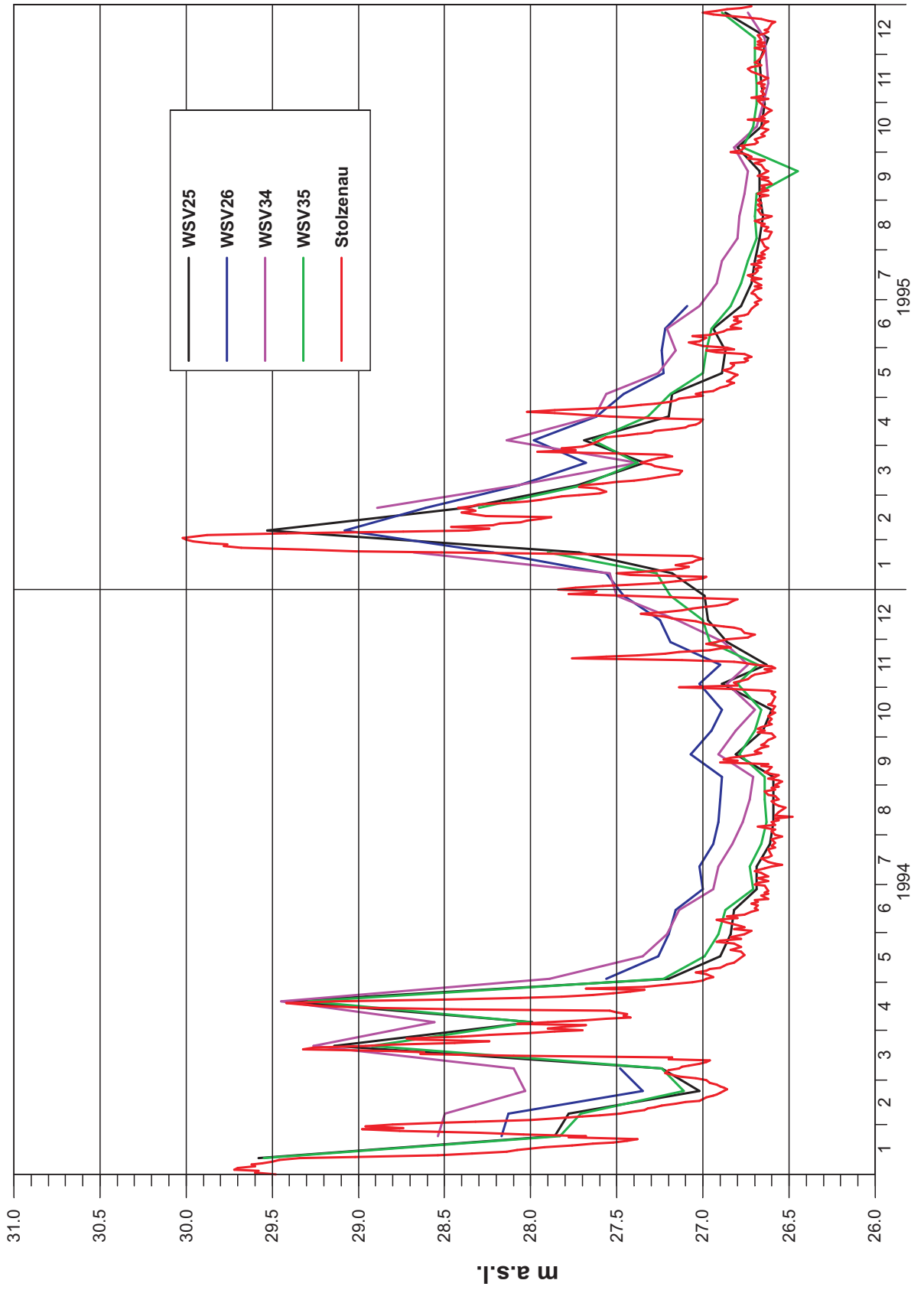
**Appendix 5.5-2 Ground water hydrographs
1994 - 1995**

**Appendix 5.5-3 Analysis of ground water
measurements**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.5-1	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 bis Km 242.300 ground water hydrographs 1988 - 2004	
Order no.	2.04.10151.00
Appendix no.	5.5-1



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	18.12.07
		File	A2.04.10151.00_5.5-2	
Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau
 Km 241.550 bis Km 242.300
 ground water hydrographs 1994 - 1995

Order no.	2.04.10151.00	Appendix no.	5.5-2
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Statistics "System - River Weser - Ground water"

Explanation:

Infiltration: inflow of ground water to the River Weser as a result of a higher ground water table

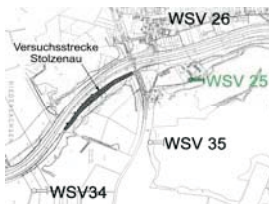
Exfiltration: loss of river water as a result of a lower ground water table

Equilibrium: no gravity-related exchange of water thanks to equal levels in the water tables

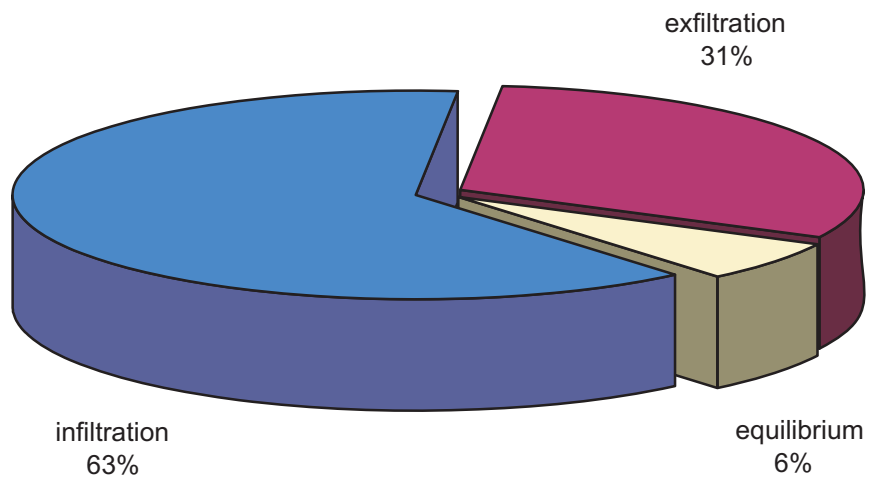
The following data is based on readings taken between December 1988 and November 2002. Until 1998 the readings were taken every two weeks and thereafter at intervals of one month.

Ground water table	WSV 25	WSV 26	WSV 34	WSV 35	total
readings	303	168	290	290	1051
infiltration	190	162	245	216	813
exfiltration	94	6	39	58	197
equilibrium	19	0	6	16	41

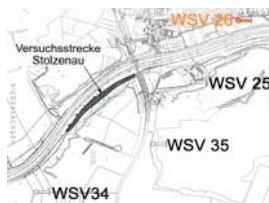
Ground water movements gauge WSV 25
(303 readings, Dec. 88 - Nov. 02)



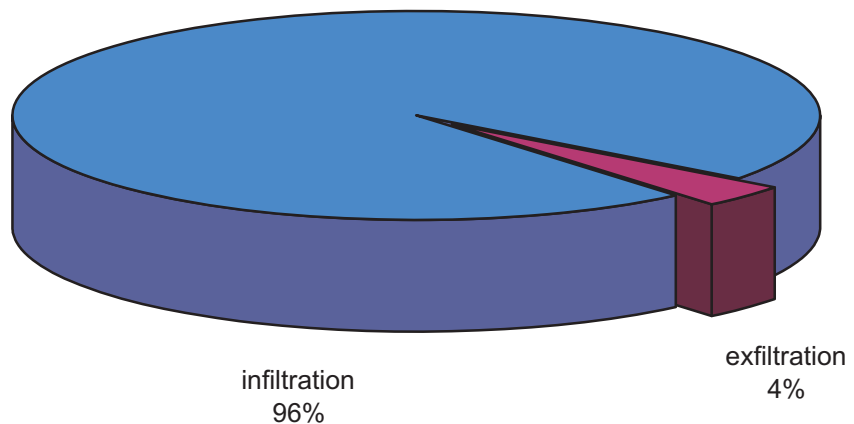
- infiltration
- exfiltration
- equilibrium



Ground water movements gauge WSV 26
(168 readings, Dec. 88 - Jun. 95)



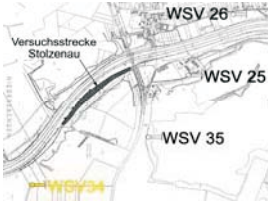
- infiltration
- exfiltration



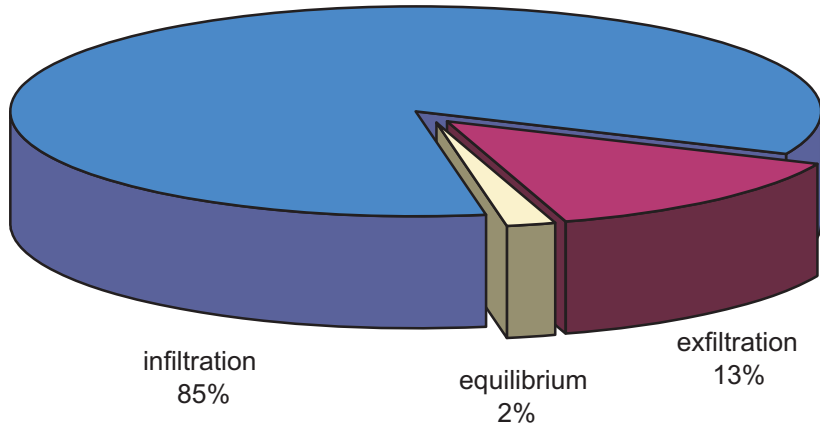
Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
		File	A2.04.10151.00_5.5-3	
Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau Km 241.550 bis Km 242.300 analysis of ground water measurements	
Order no.	2.04.10151.00
Appendix no.	5.5-3a

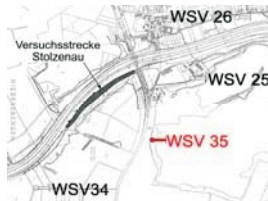
**Ground water movements
gauge WSV 34**
(290 readings,
Apr. 89 - Nov. 02)



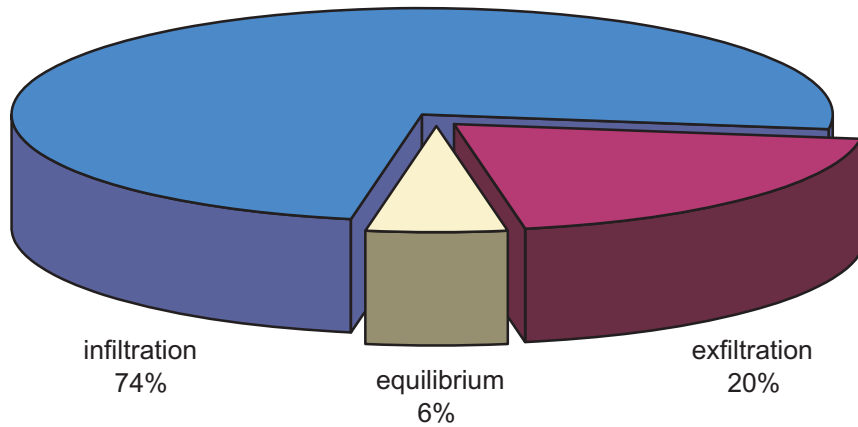
- infiltration
- exfiltration
- equilibrium



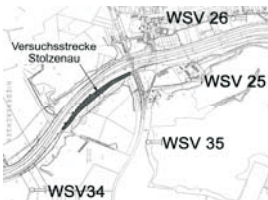
**Ground water movements
gauge WSV 35**
(290 readings,
Apr. 89 - Nov. 02)



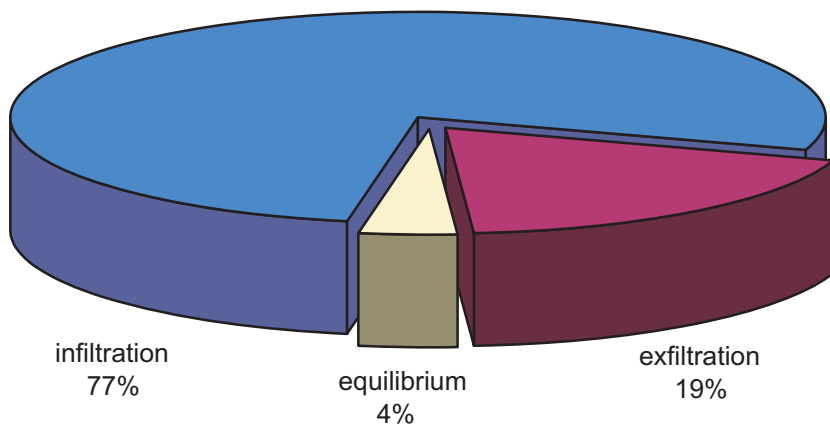
- infiltration
- exfiltration
- equilibrium



**Ground water movements
gauge WSV 25-35**
(1051 readings,
Dec. 88 - Nov. 02)



- infiltration
- exfiltration
- equilibrium



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
		File	A2.04.10151.00_5.5-3	
Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau Km 241.550 bis Km 242.300 analysis of ground water measurements	
Order no.	2.04.10151.00
Appendix no.	5.5-3b

Appendix 5.6

Water level hydrographs

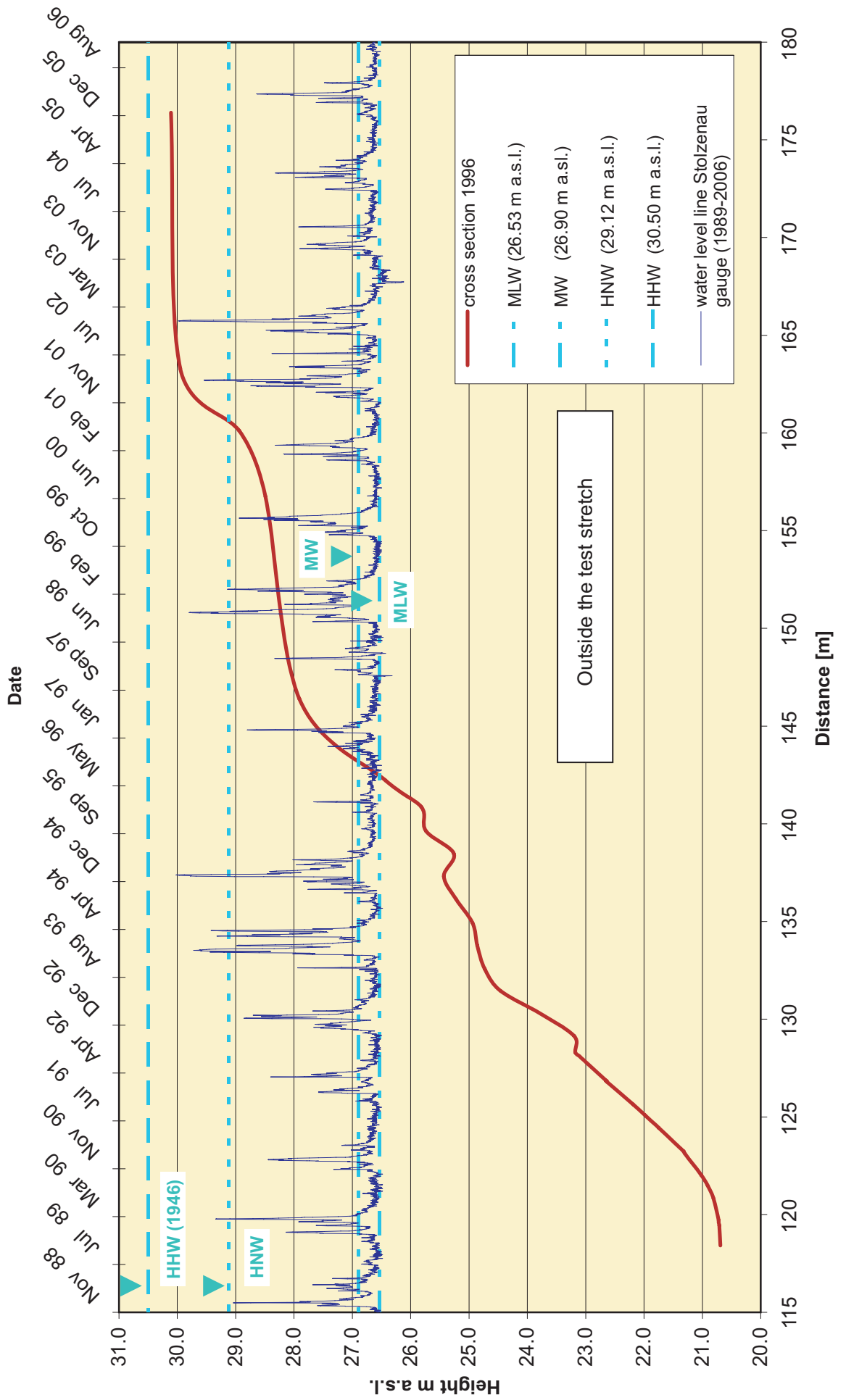
Nov. 1988 – Aug. 2006

plotted over cross sections

at the right bank

Appendix 5.6-1	Cross section Km 241.500
Appendix 5.6-2	Cross section Km 241.600
Appendix 5.6-3	Cross section Km 241.650
Appendix 5.6-4	Cross section Km 241.750
Appendix 5.6-5	Cross section Km 241.800
Appendix 5.6-6	Cross section Km 241.850
Appendix 5.6-7	Cross section Km 241.950
Appendix 5.6-8	Cross section Km 242.000
Appendix 5.6-9	Cross section Km 242.040
Appendix 5.6-10	Cross section Km 242.170
Appendix 5.6-11	Cross section Km 242.200
Appendix 5.6-12	Cross section Km 242.400
Appendix 5.6-13	Cross section Km 242.500

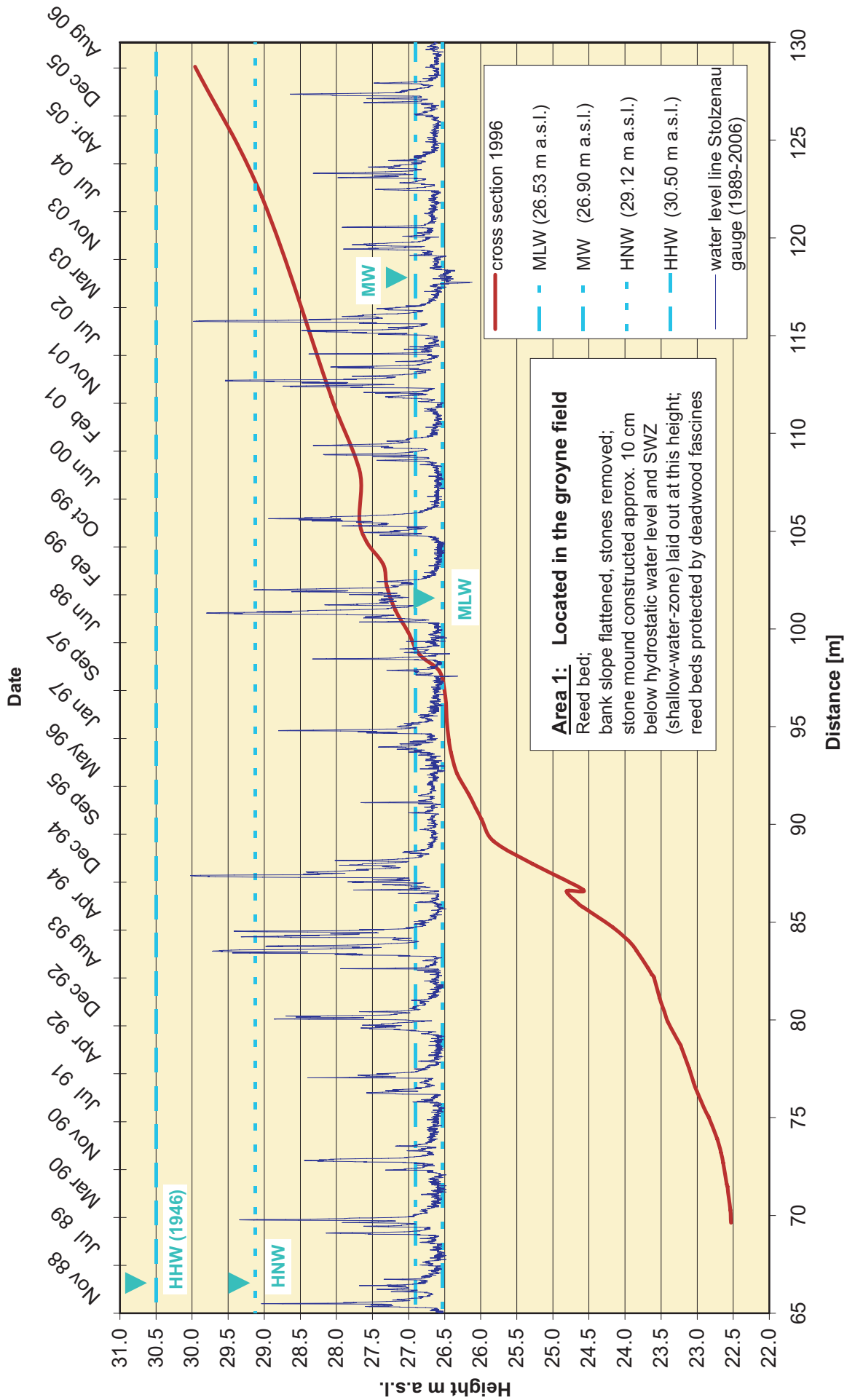
**Cross section of River Weser at Km 241.500, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 241.500, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-1

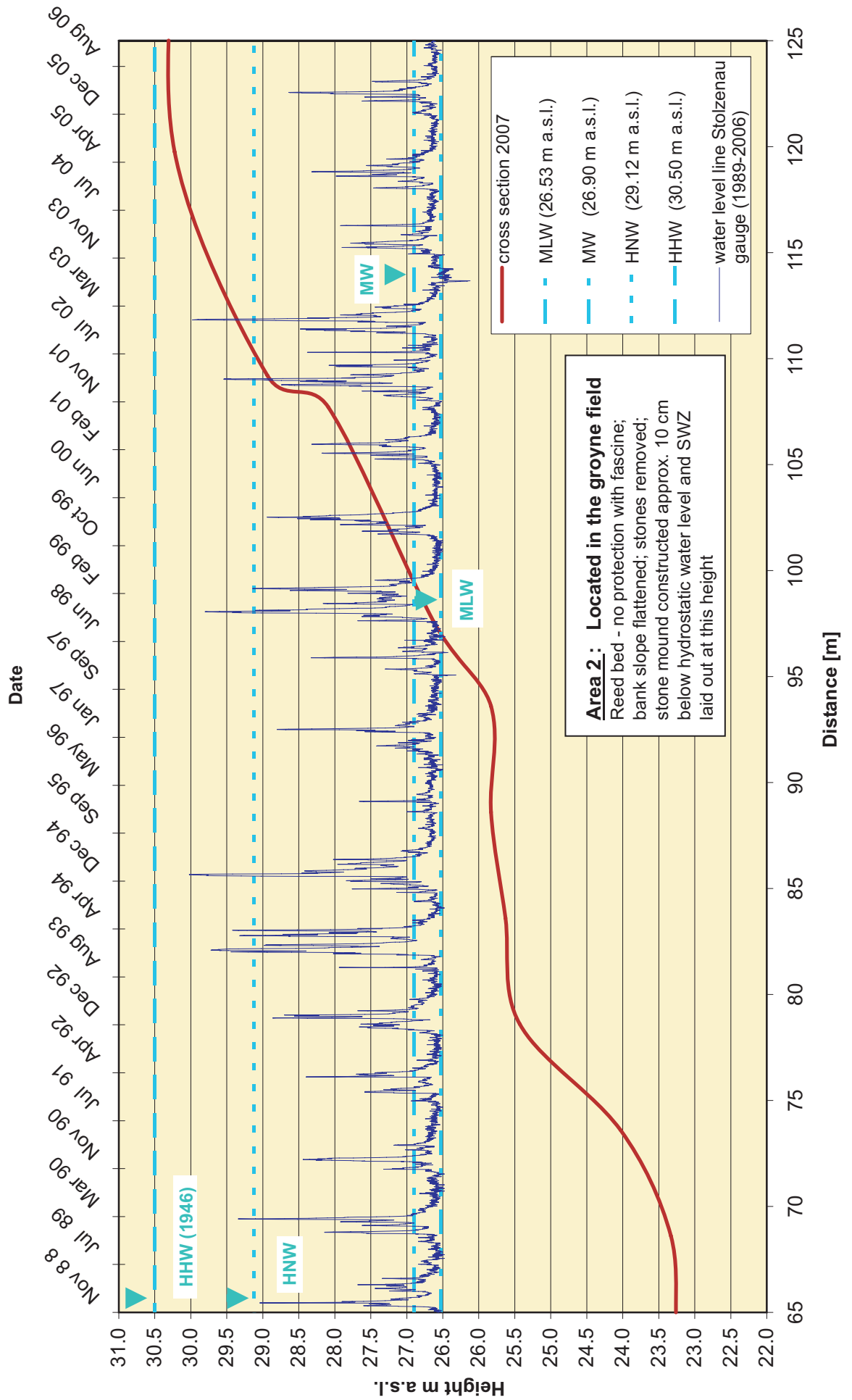
**Cross section of River Weser at Km 241.600, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 241.600, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-2

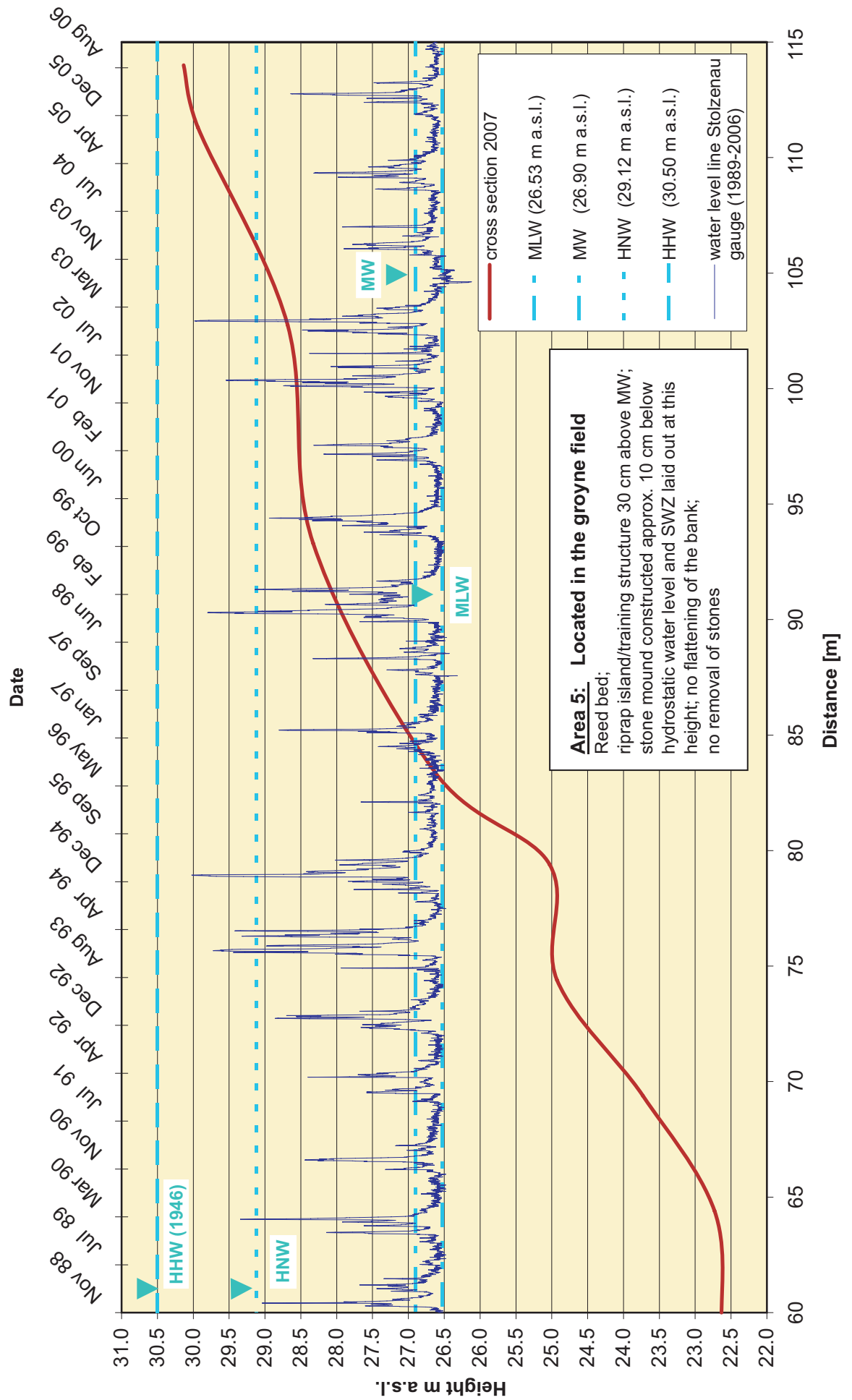
**Cross section of River Weser at Km 241.650, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 241.650, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-3

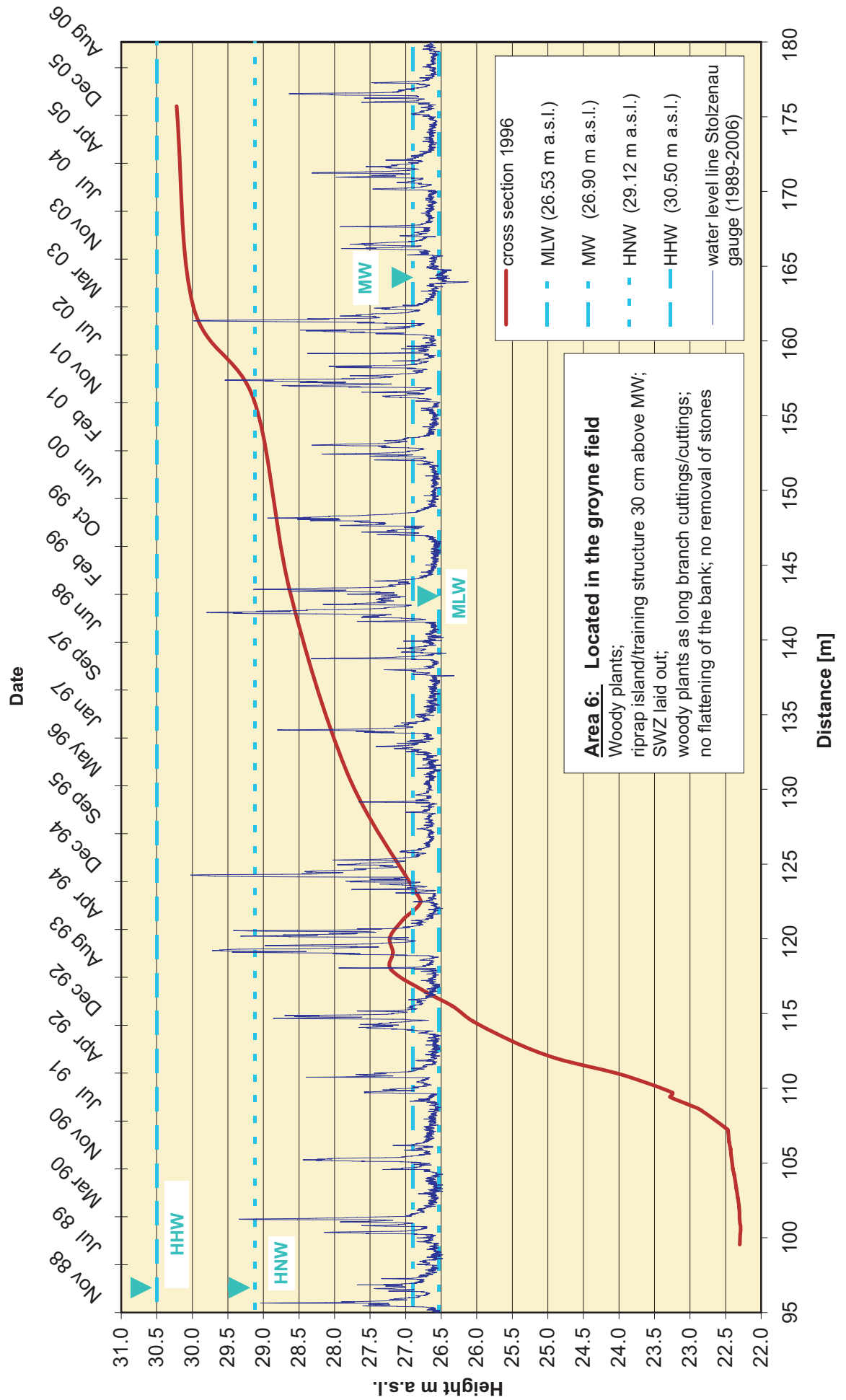
**Cross section of River Weser at Km 241.750, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 241.750, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-4

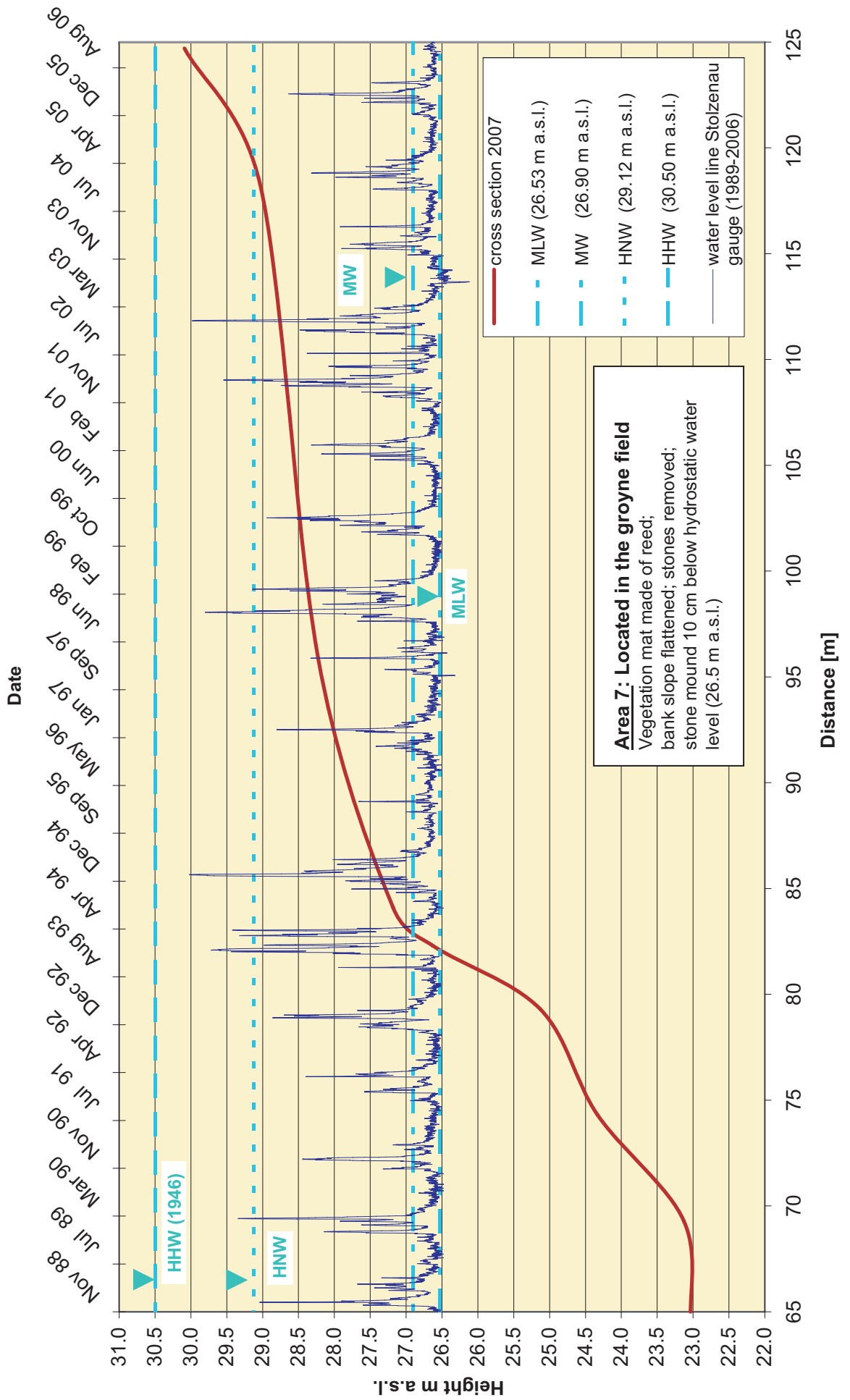
**Cross section of River Weser at Km 241.800, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 241.800, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-5

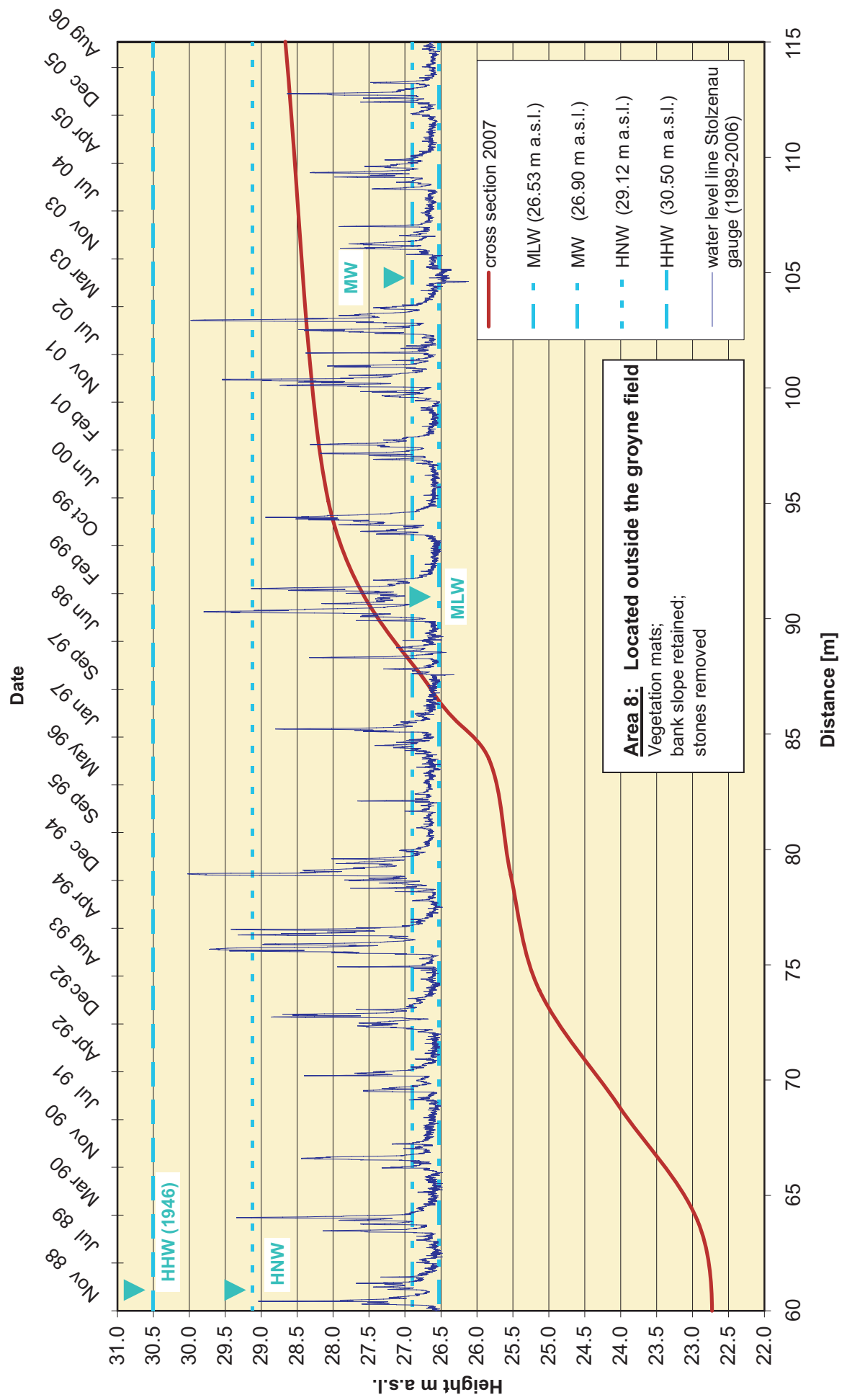
**Cross section of River Weser at Km 241.850, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 241.850, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-6

**Cross section of River Weser at Km 241.950, right bank
(water level records: Stolzenau gauge Km 243.400)**

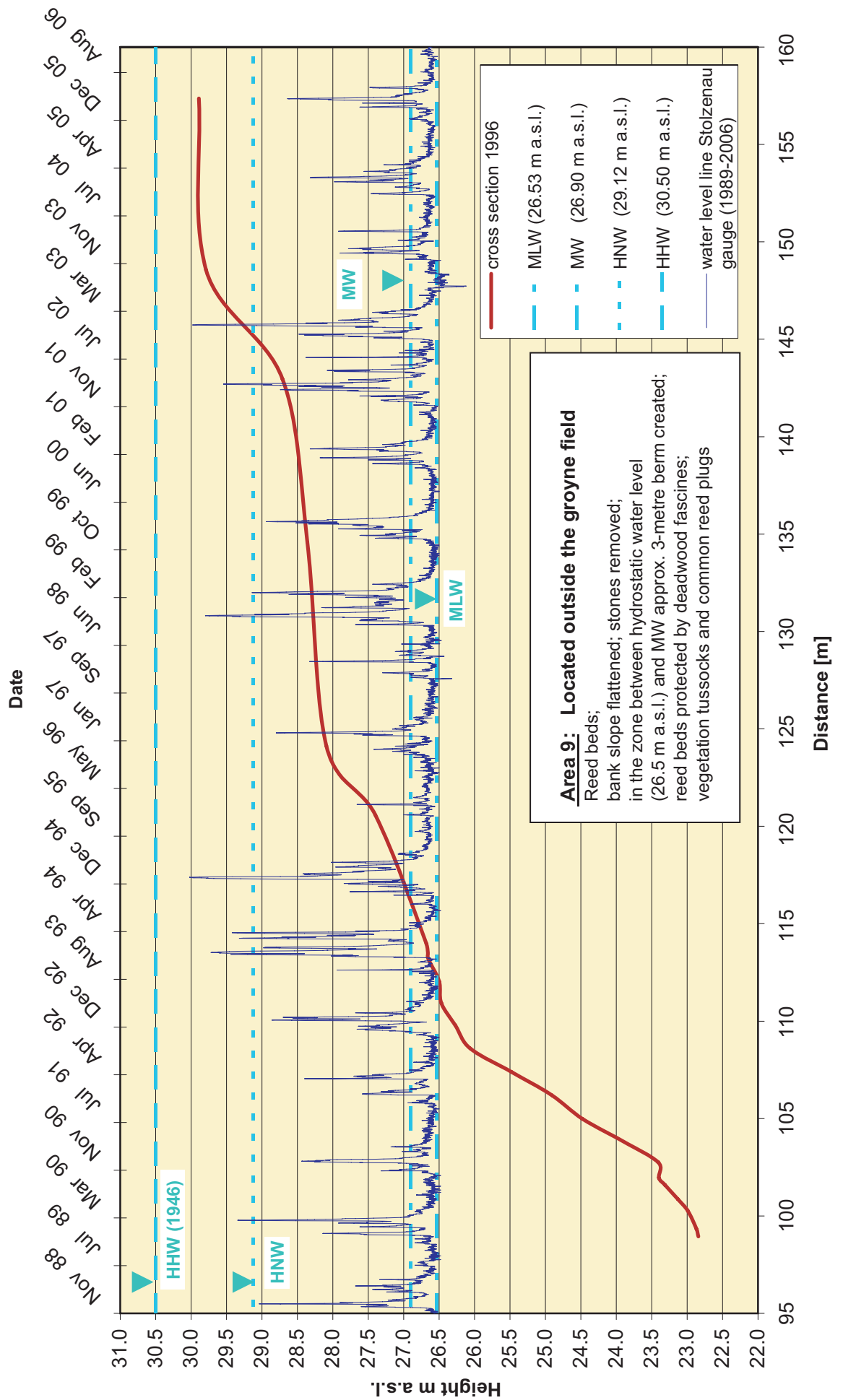


Area 8: Located outside the groyne field
 Vegetation mats;
 bank slope retained;
 stones removed

Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 241.950, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-7

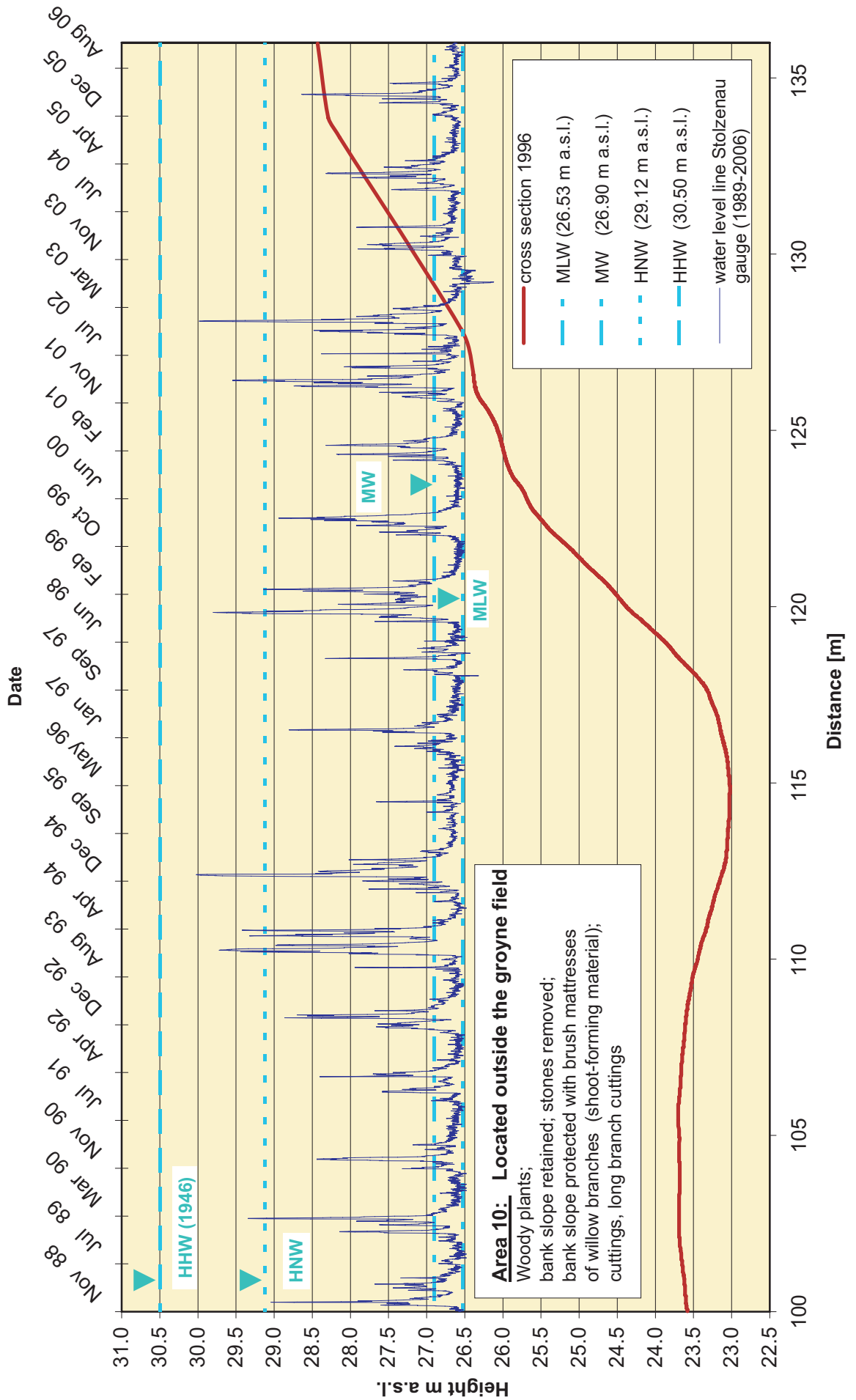
**Cross section of River Weser at Km 242.000, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 242.000, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-8

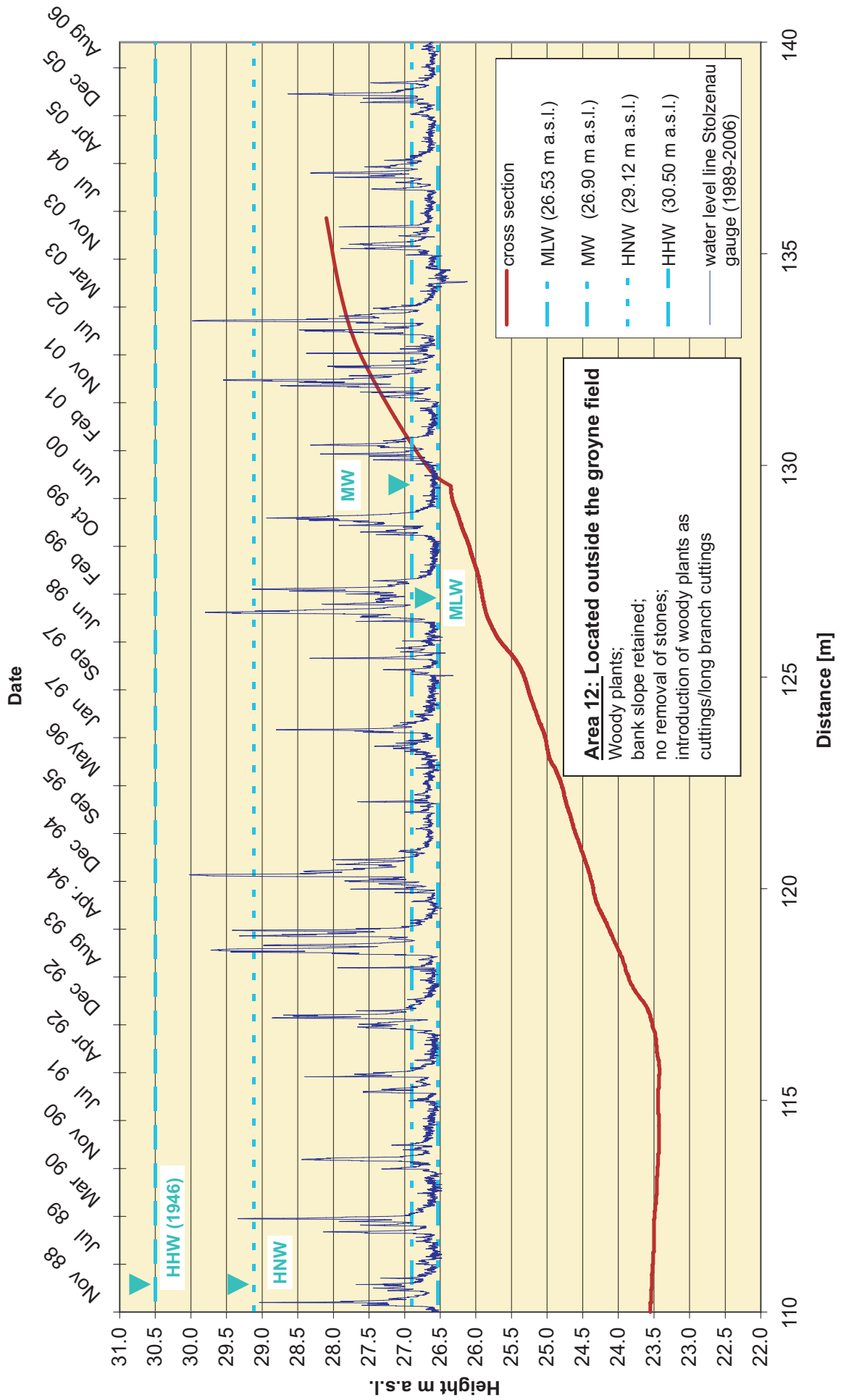
**Cross section of River Weser at Km 242.040, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 242.040, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-9

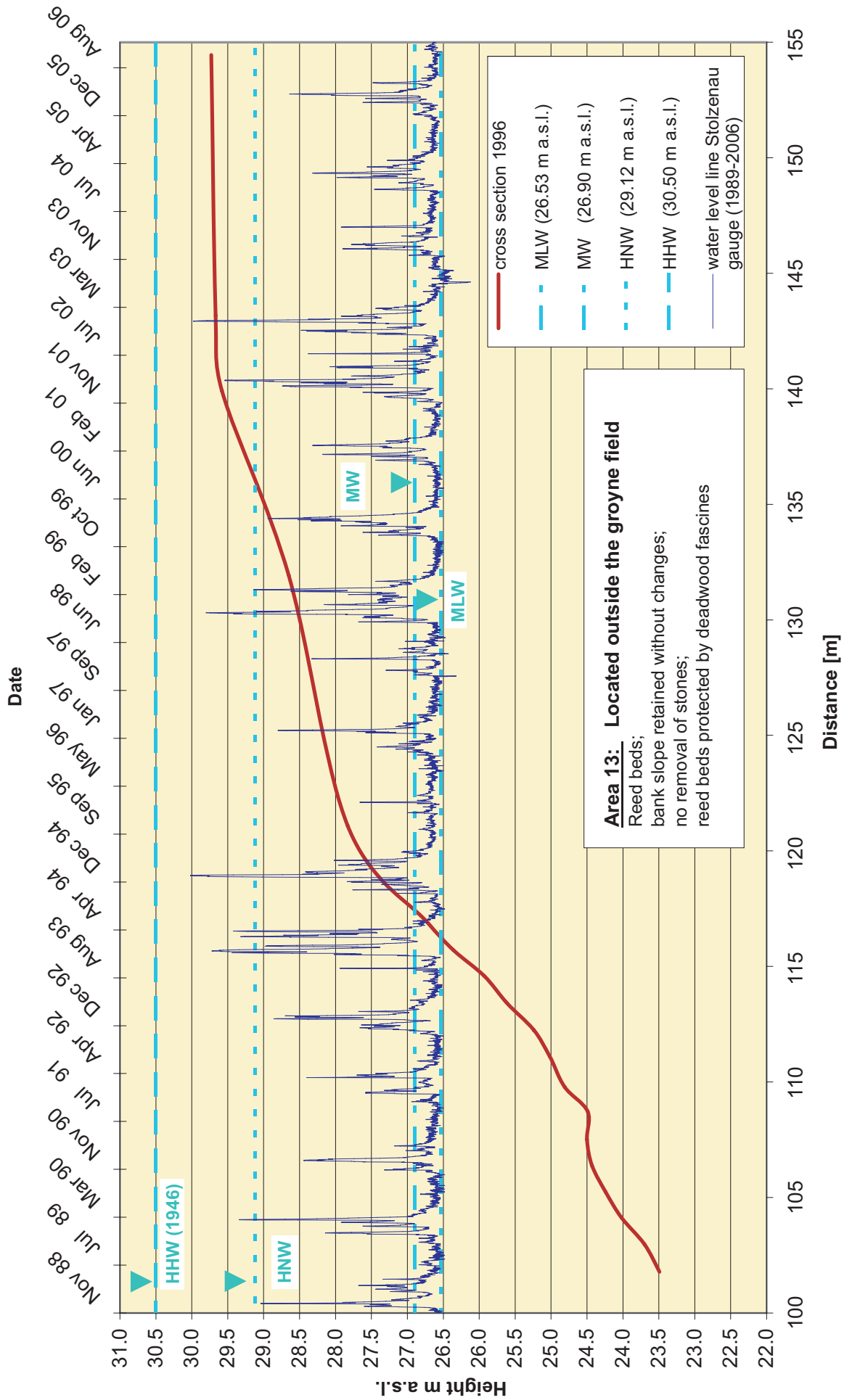
**Cross section of River Weser at Km 242.170, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 242.170, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-10

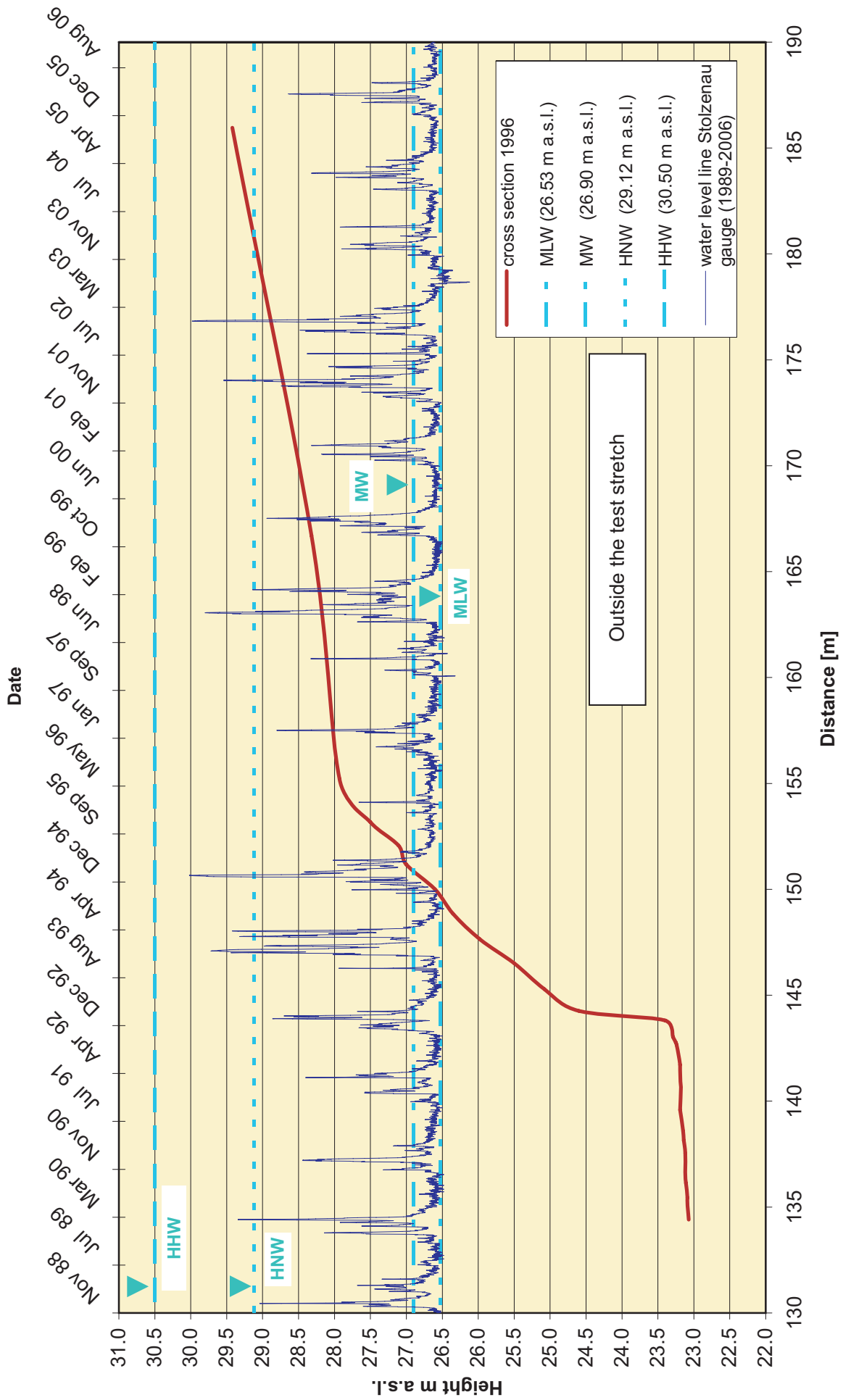
**Cross section of River Weser at Km 242.200, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
		File	A2.04.10151.00_5.6-1_13	
Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 242.200, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-11

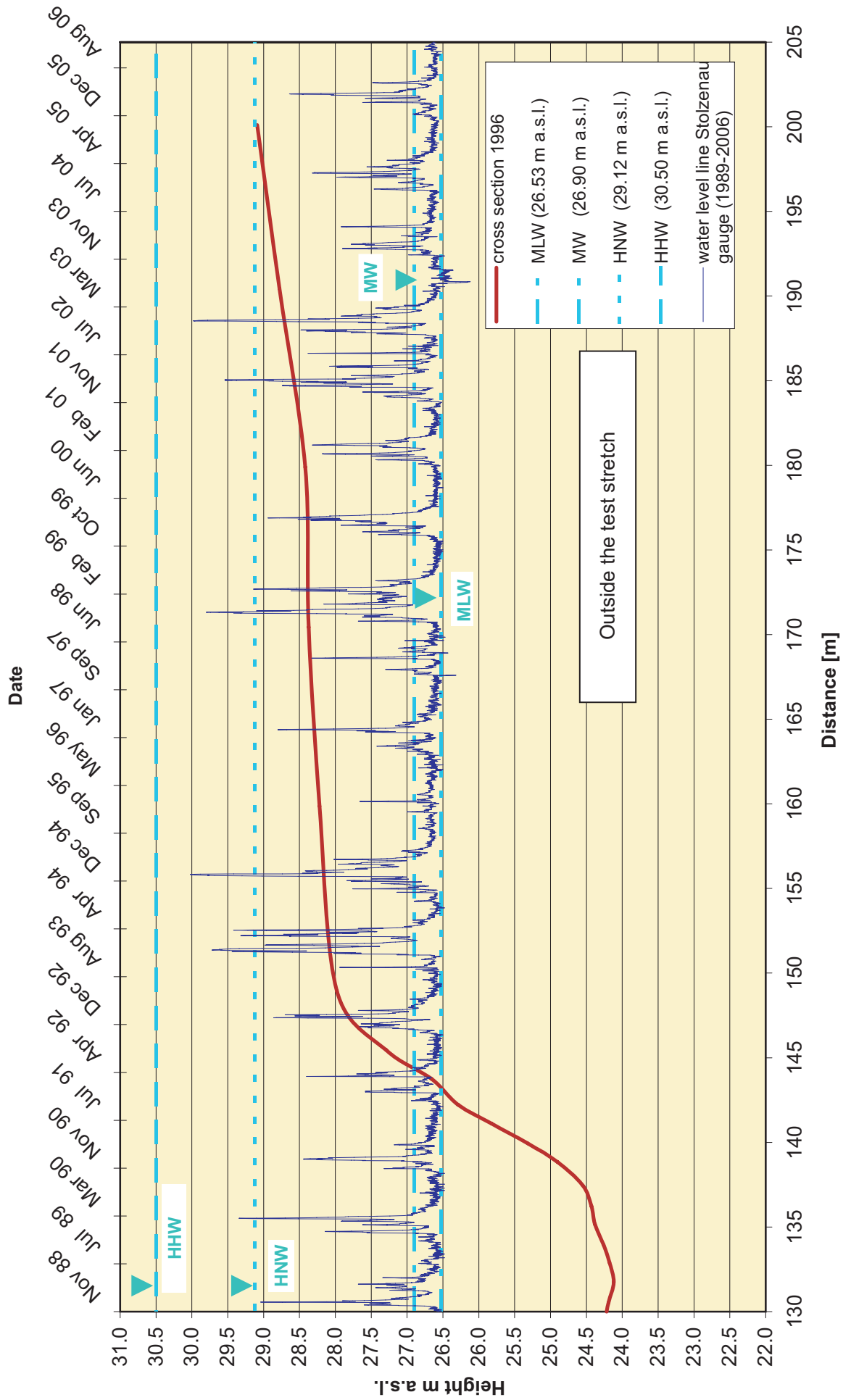
**Cross section of River Weser at Km 242.400, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 242.400, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-12

**Cross section of River Weser at Km 242.500, right bank
(water level records: Stolzenau gauge Km 243.400)**



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	27.04.08
Scale		File	A2.04.10151.00_5.6-1_13	
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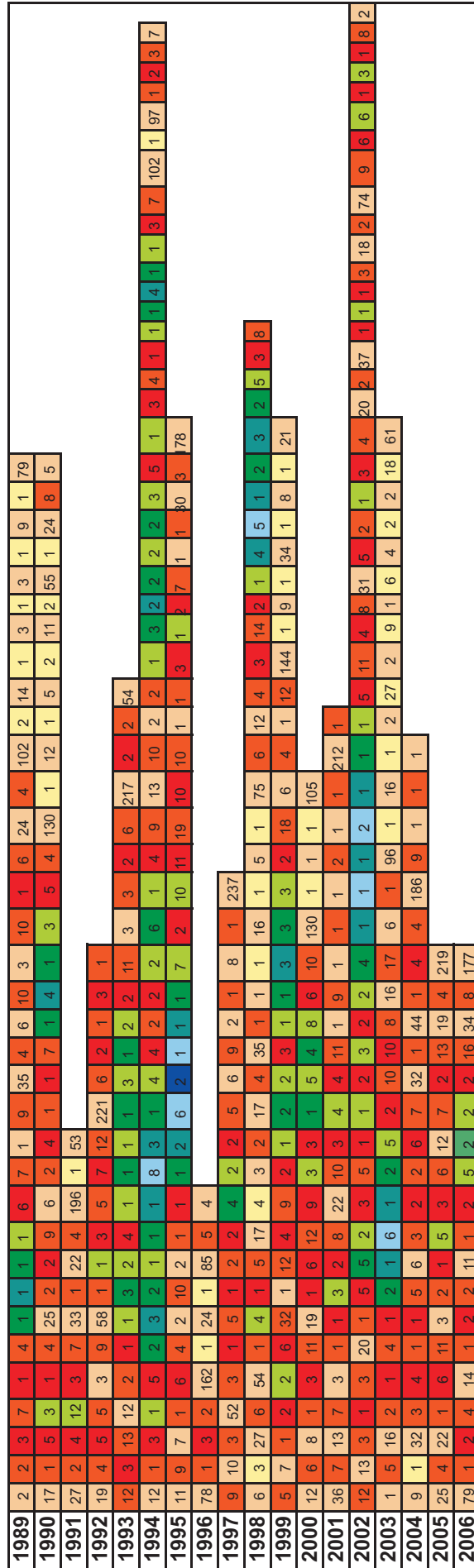
Test stretch at Stolzenau Km 241.550 - Km 242.300 cross section Km 242.500, right bank	
Order no.	2.04.10151.00
Appendix no.	5.6-13

Appendix 5.7

Days of flooding and water level frequencies at Stolzenau gauge

Appendix 5.7-0	Days of flooding
Appendix 5.7-1	Frequencies of water levels 1989/1990
Appendix 5.7-2	Frequencies of water levels 1991/1992
Appendix 5.7-3	Frequencies of water levels 1993/1994
Appendix 5.7-4	Frequencies of water levels 1995/1996
Appendix 5.7-5	Frequencies of water levels 1997/1998
Appendix 5.7-6	Frequencies of water levels 1999/2000
Appendix 5.7-7	Frequencies of water levels 2001/2002
Appendix 5.7-8	Frequencies of water levels 2003/2004
Appendix 5.7-9	Frequencies of water levels 2005/2006

Days of flooding



Key : allocation of colours to water levels m a.s.l.

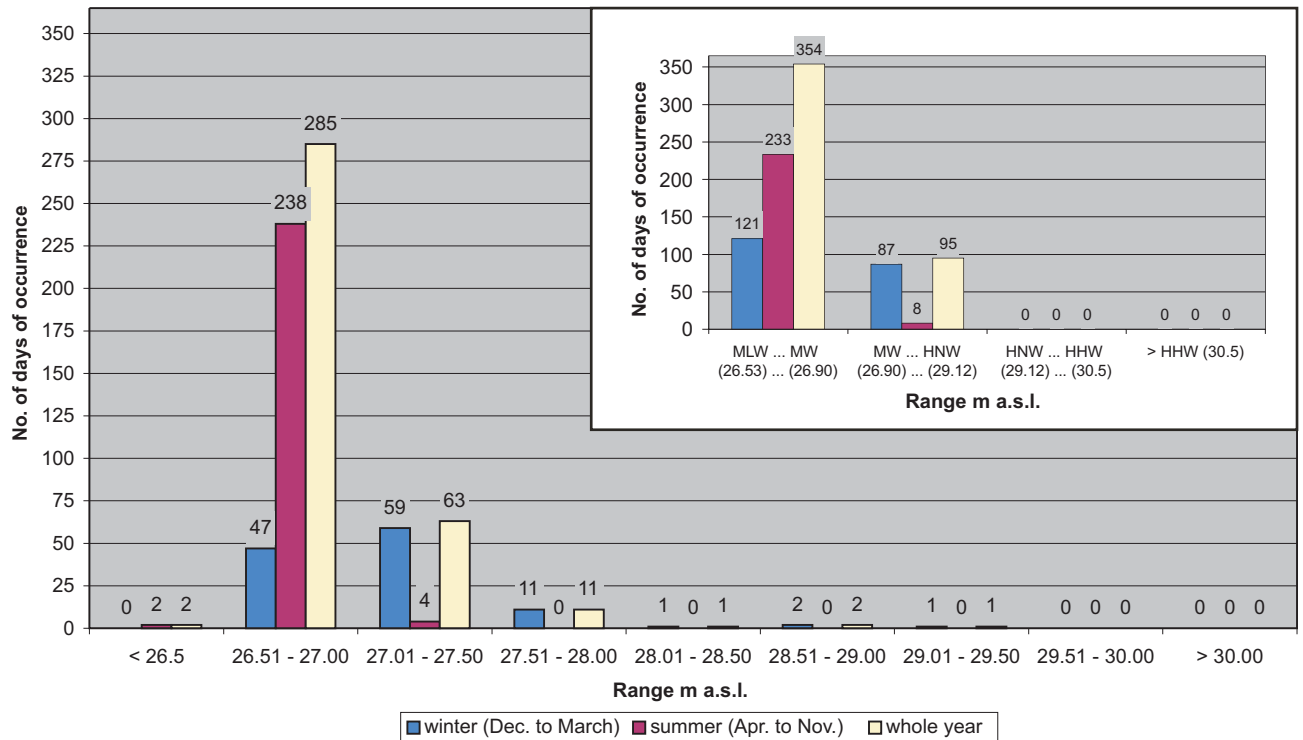


Modified	Date	Processed by	F.Fleischer	Date
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Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

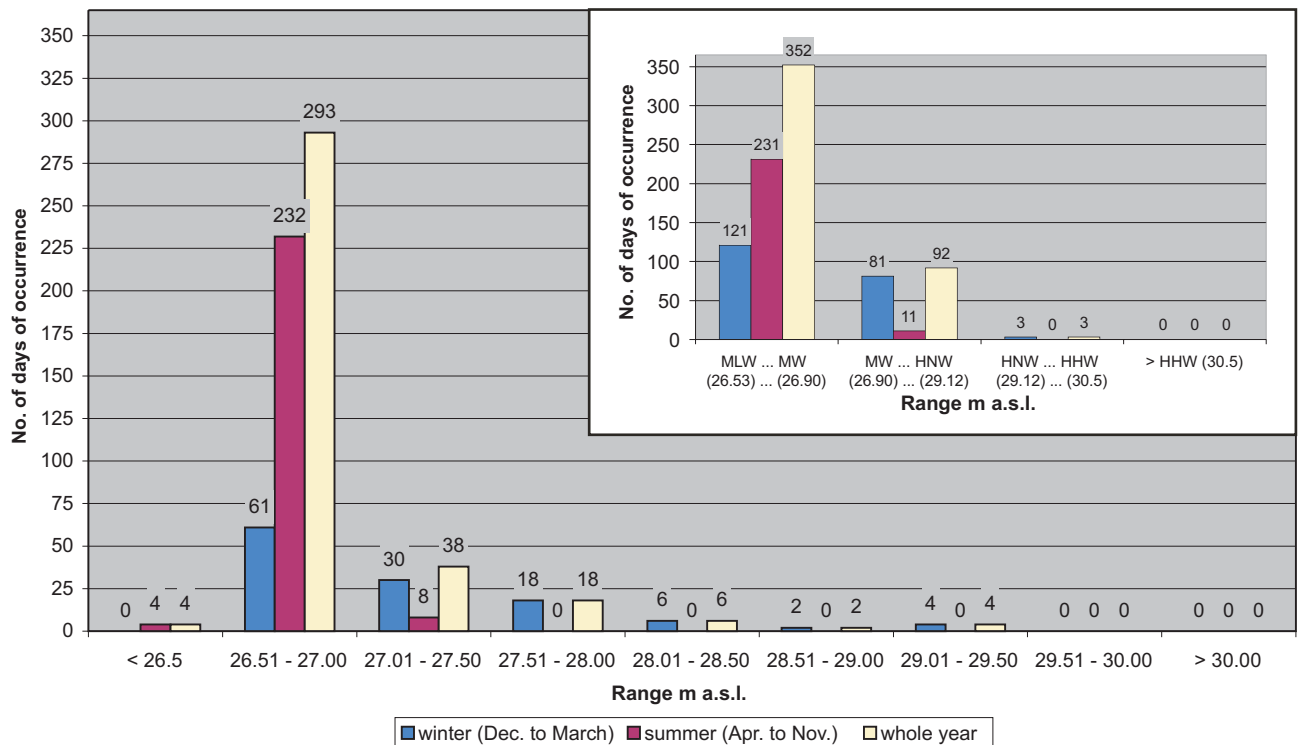
Test stretch at Stolzenau
Km 241.550 - Km 242.300
days of flooding

Order no.	2.04.10151.00	Appendix no.	5.7
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Frequencies of water levels at Stolzenau gauge (1989)



Frequencies of water levels at Stolzenau gauge (1990)



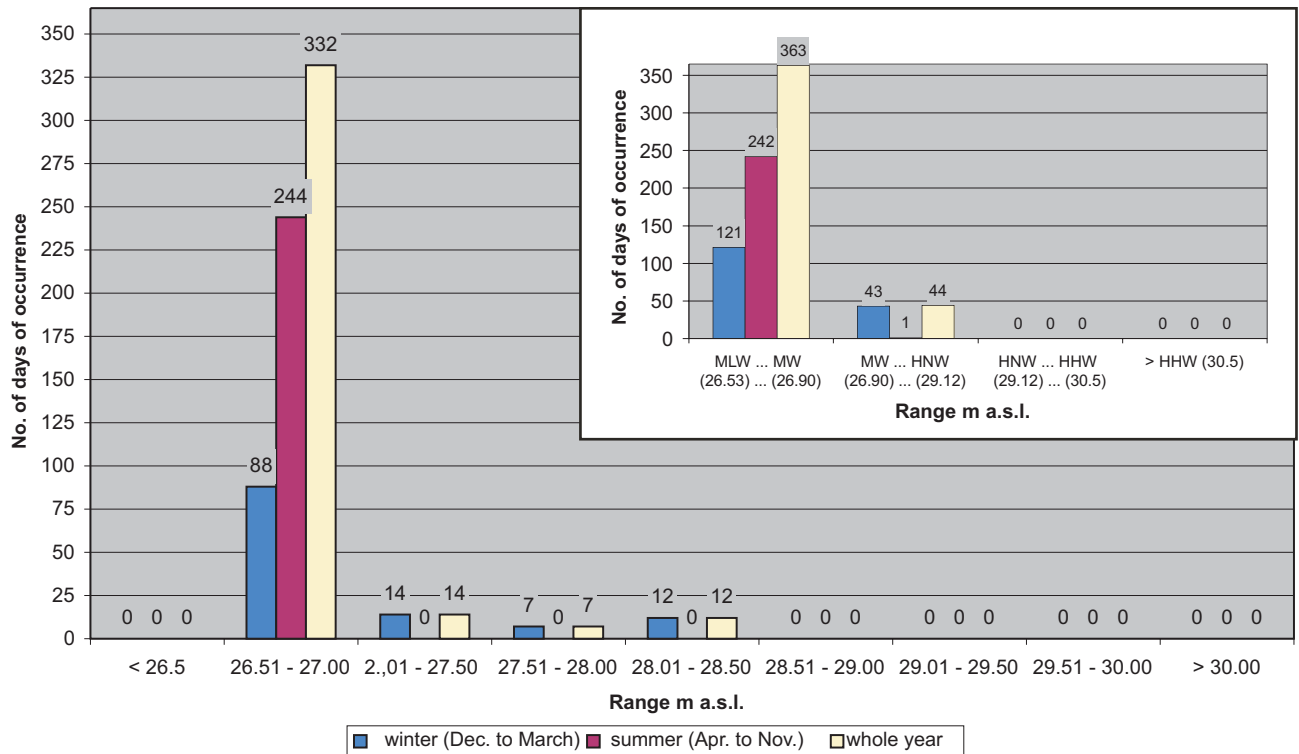
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.	.	Signed by	SH	28.04.08
		File	A2.04.10151.00_5.7-1-9	
Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau
Km 241.550 - Km 242.300
frequencies of water levels 1989/1990

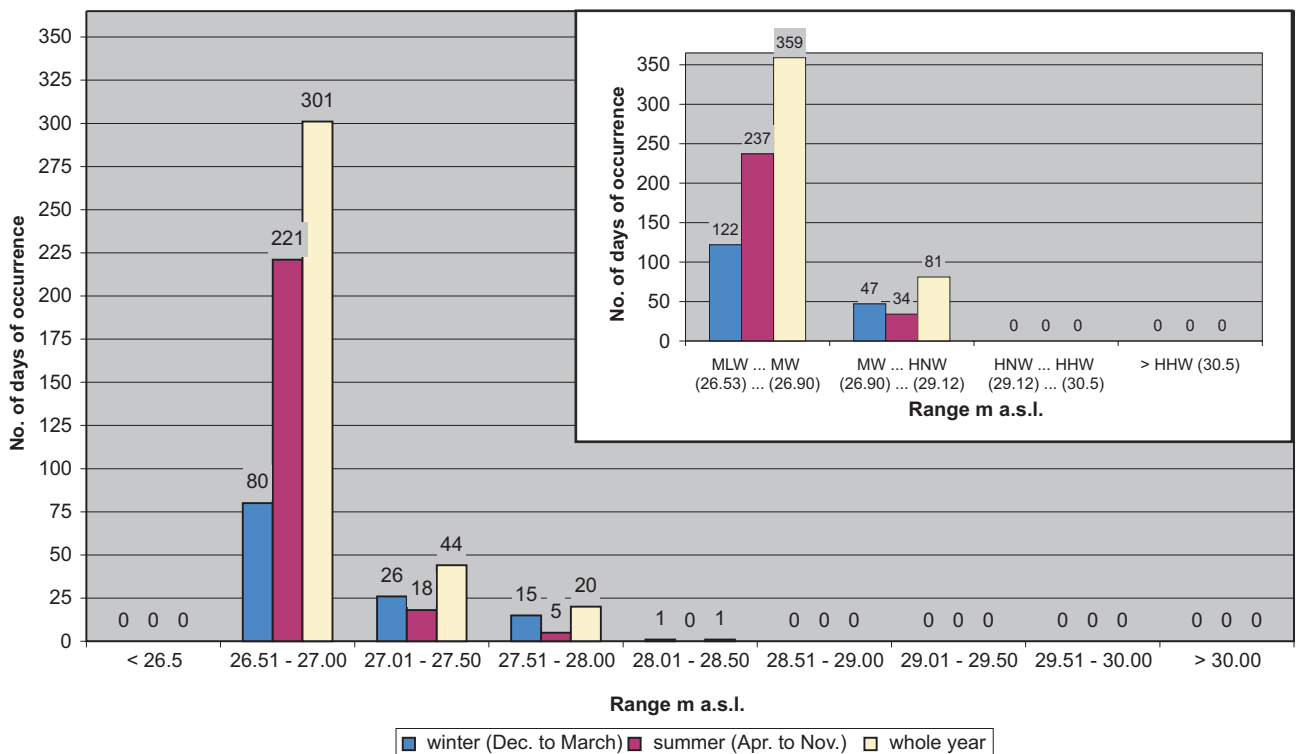
Order no. 2.04.10151.00

Appendix no. 5.7-1

Frequencies of water levels at Stolzenau gauge (1991)



Frequencies of water levels at Stolzenau gauge (1992)



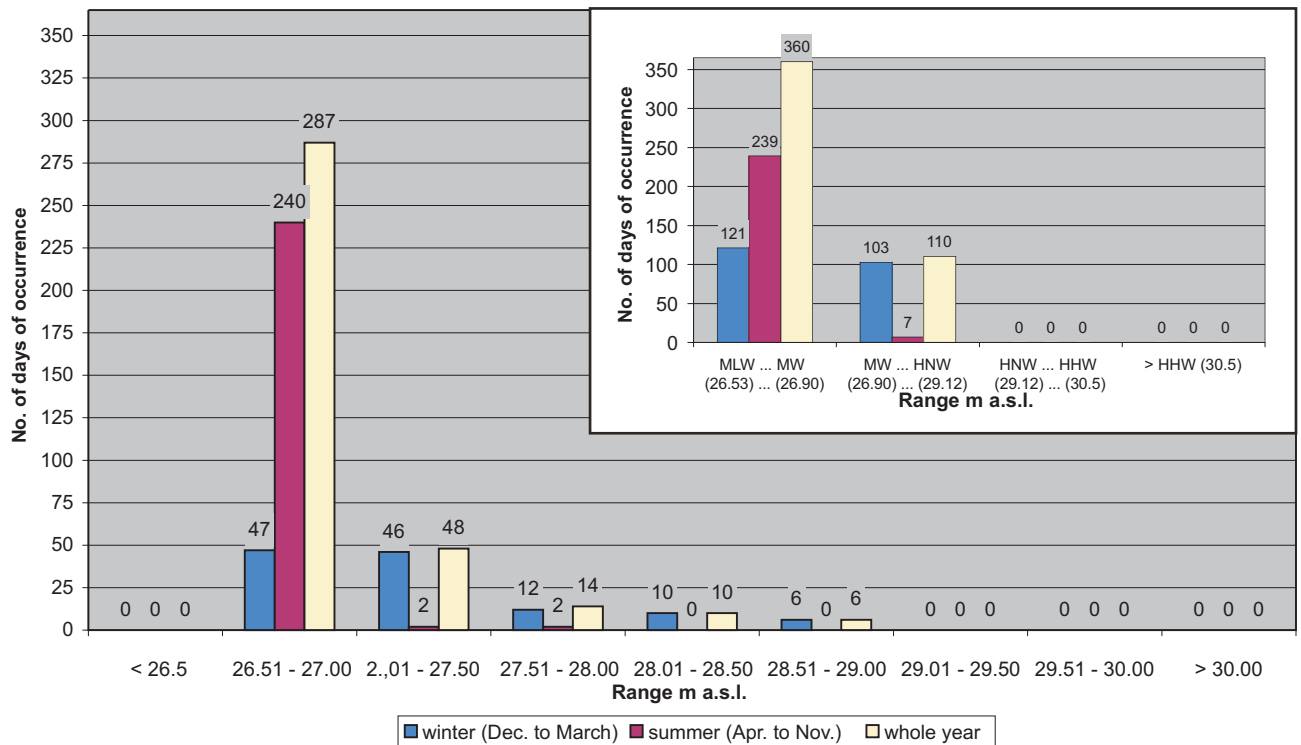
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		File	A2.04.10151.00_5.7-1-9	
Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau
Km 241.550 - Km 242.300
frequencies of water levels 1991/1992

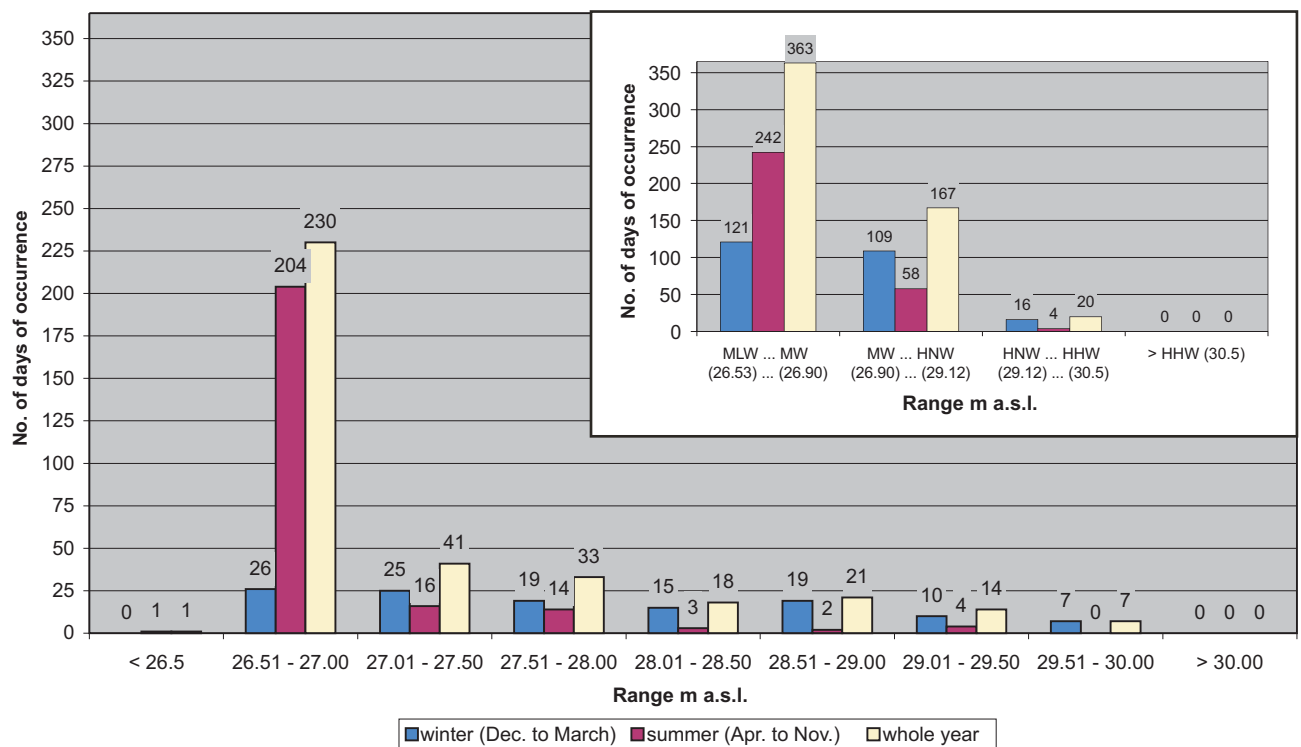
Order no. 2.04.10151.00

Appendix no. 5.7-2

Frequencies of water levels at Stolzenau gauge (1993)



Frequencies of water levels at Stolzenau gauge (1994)



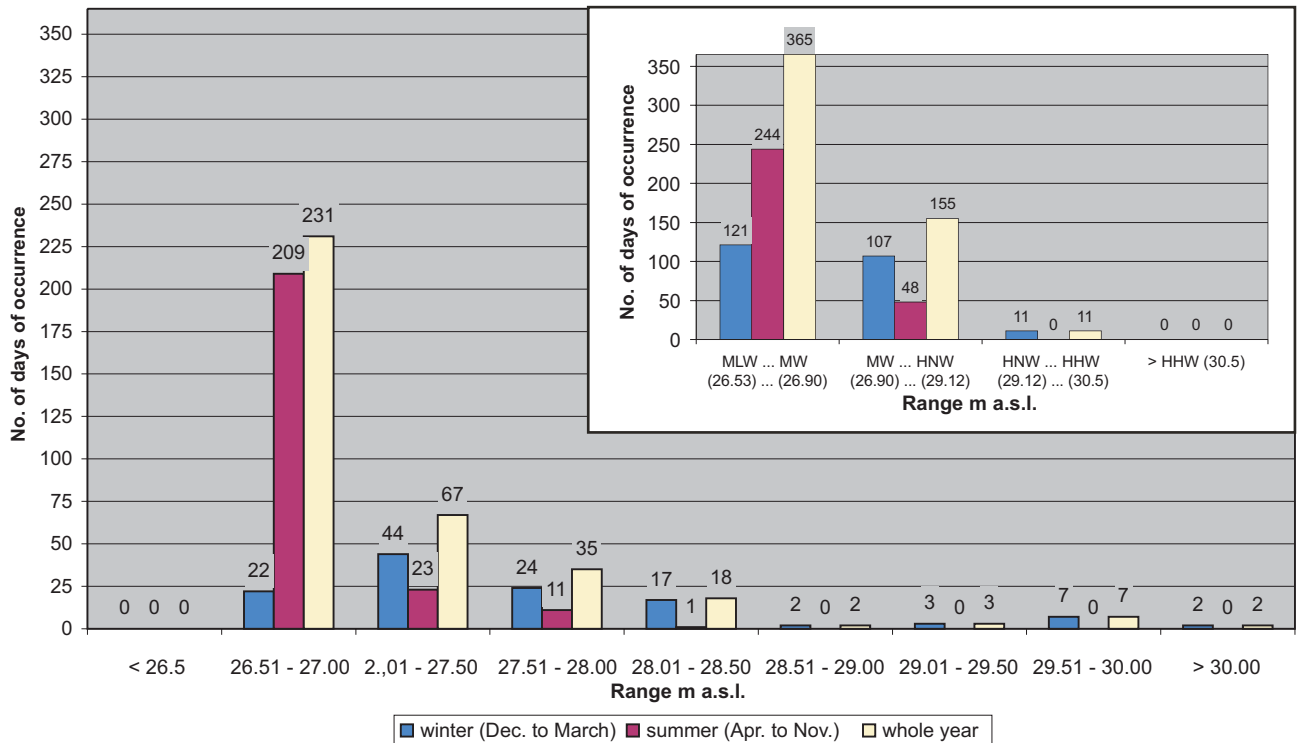
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		File	A2.04.10151.00_5.7-1-9	
Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau
Km 241.550 - Km 242.300
frequencies of water levels 1993/1994

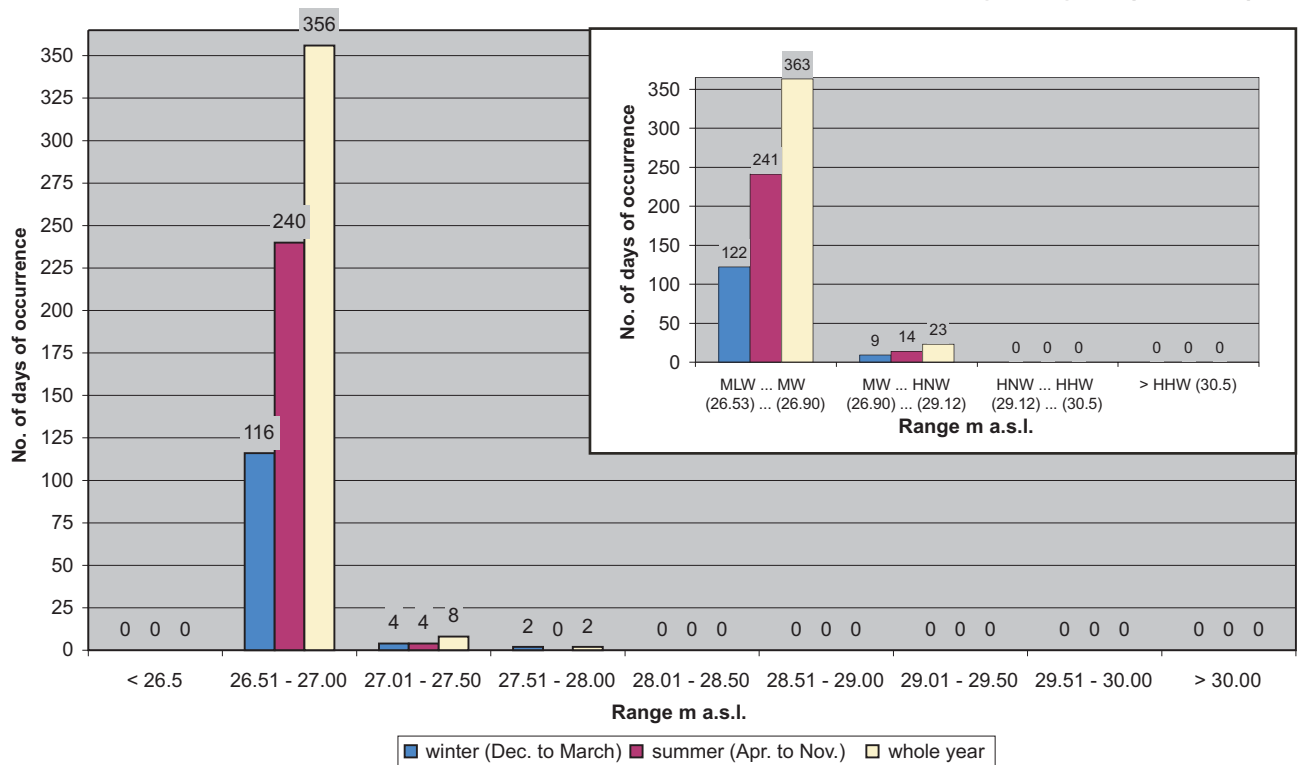
Order no. 2.04.10151.00

Appendix no. 5.7-3

Frequencies of water levels at Stolzenau gauge (1995)



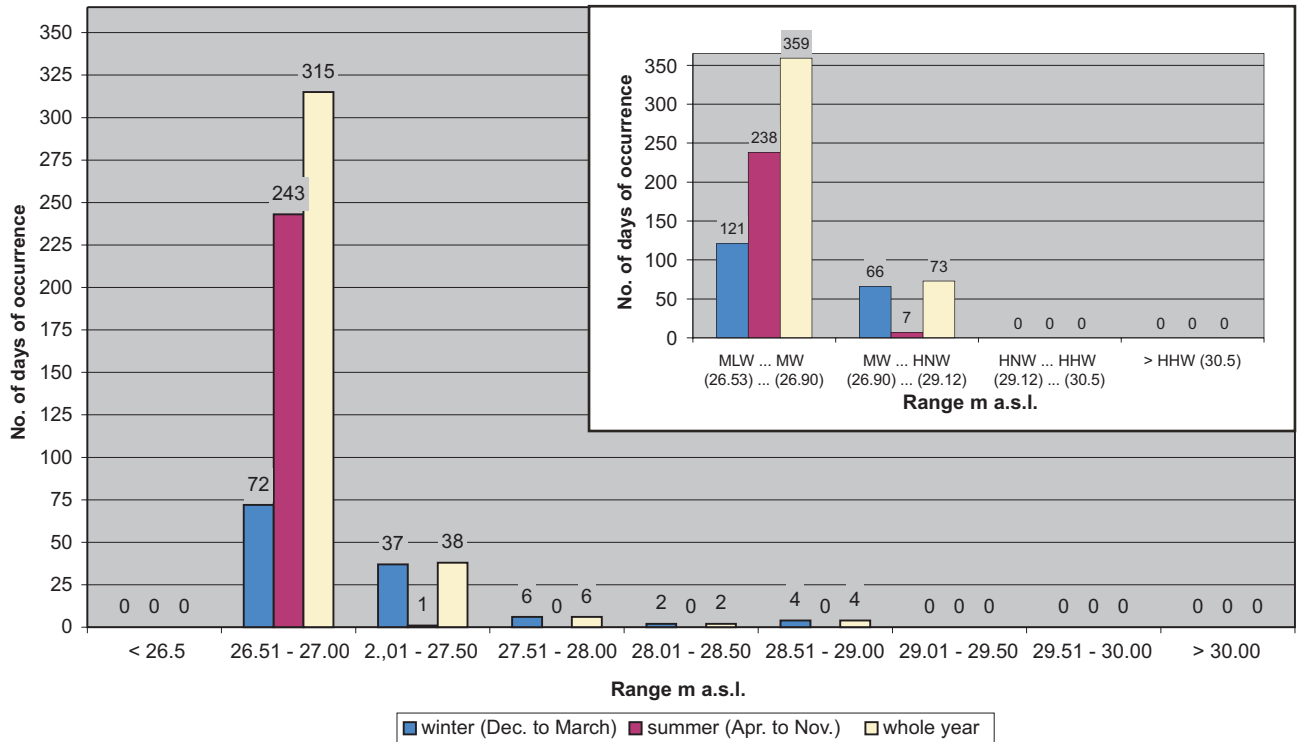
Frequencies of water levels at Stolzenau gauge (1996)



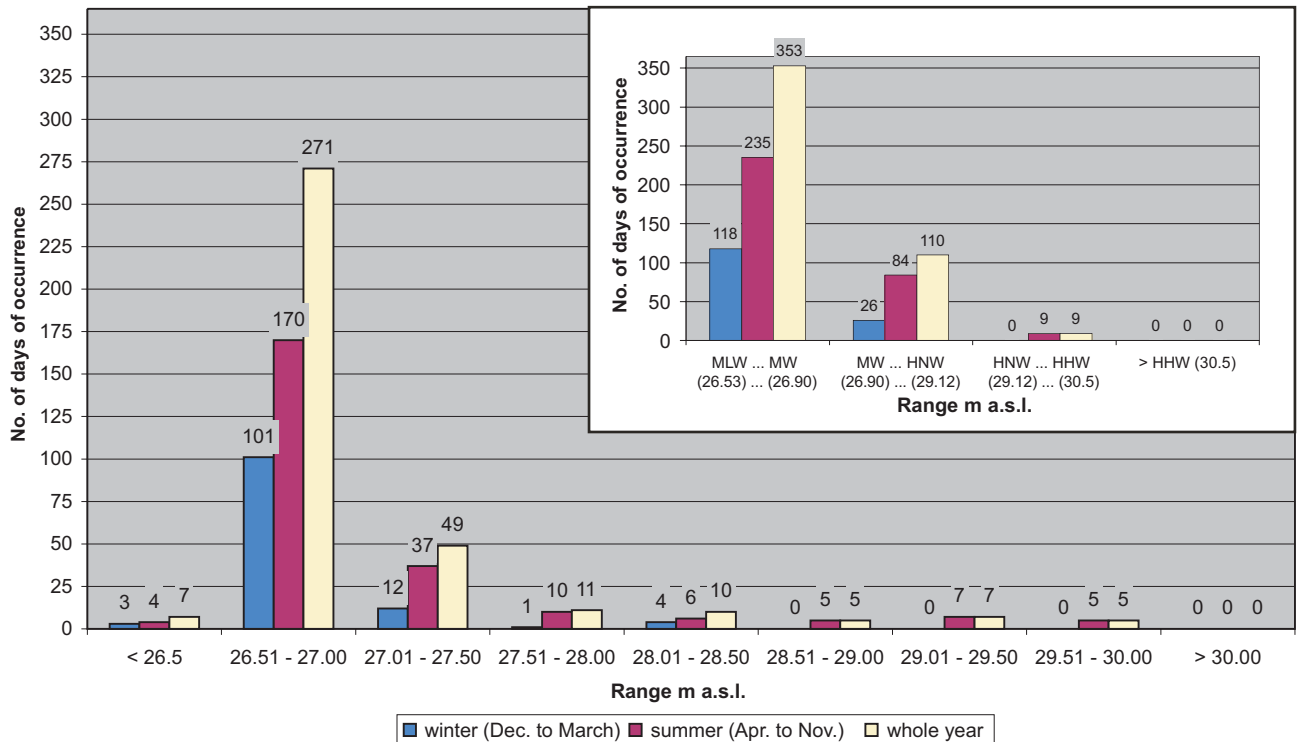
Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	28.04.08
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Scale		FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY		

Test stretch at Stolzenau Km 241.550 - Km 242.300 frequencies of water levels 1995/1996	
Order no.	2.04.10151.00
Appendix no.	5.7-4

Frequencies of water levels at Stolzenau gauge (1997)



Frequencies of water levels at Stolzenau gauge (1998)



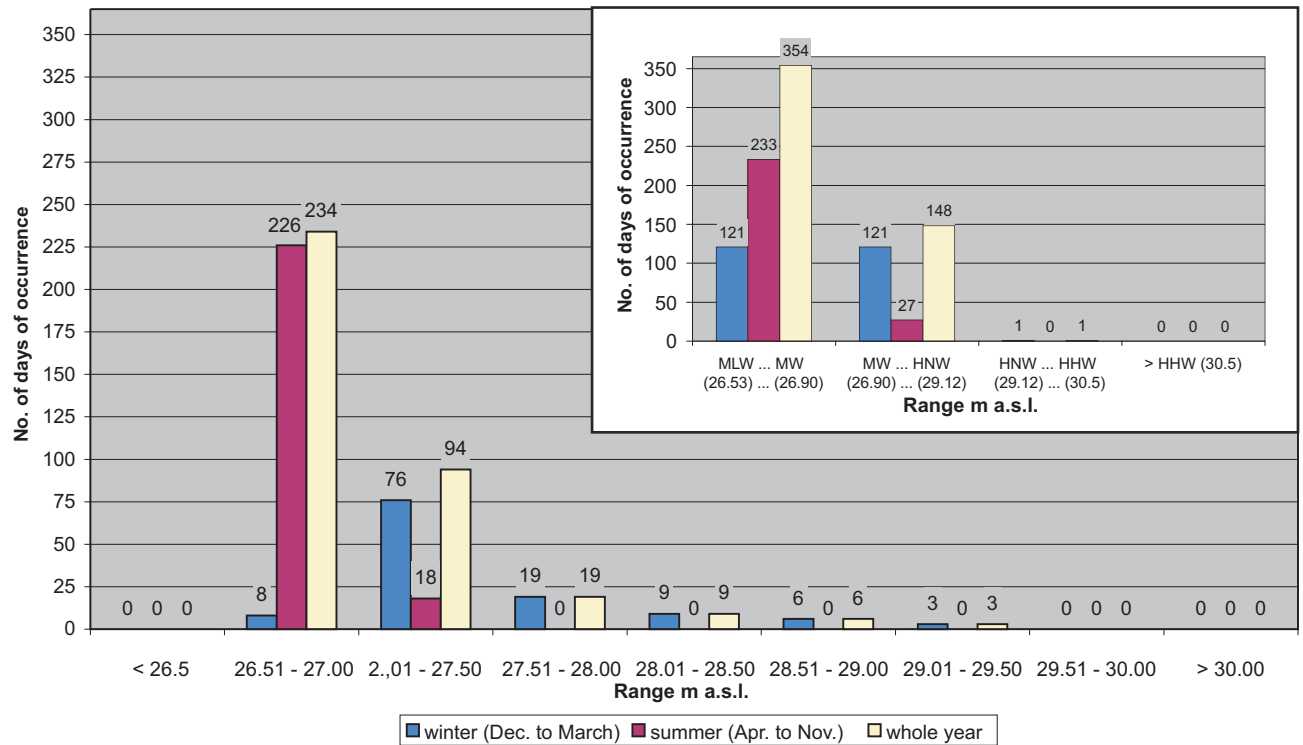
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.	.	Signed by	SH	28.04.08
		File	A2.04.10151.00_5.7-1-9	
Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau
Km 241.550 - Km 242.300
frequencies of water levels 1997/1998

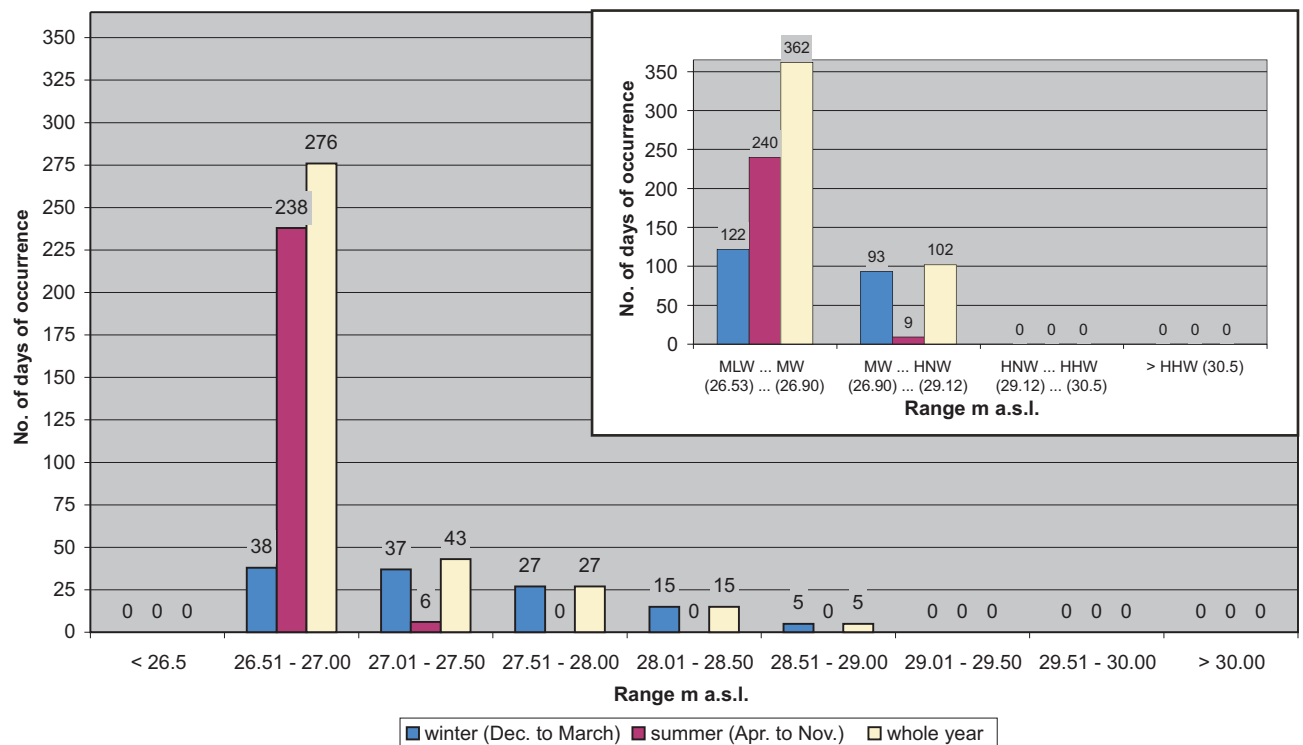
Order no. 2.04.10151.00

Appendix no. 5.7-5

Frequencies of water levels at Stolzenau gauge (1999)



Frequencies of water levels at Stolzenau gauge (2000)



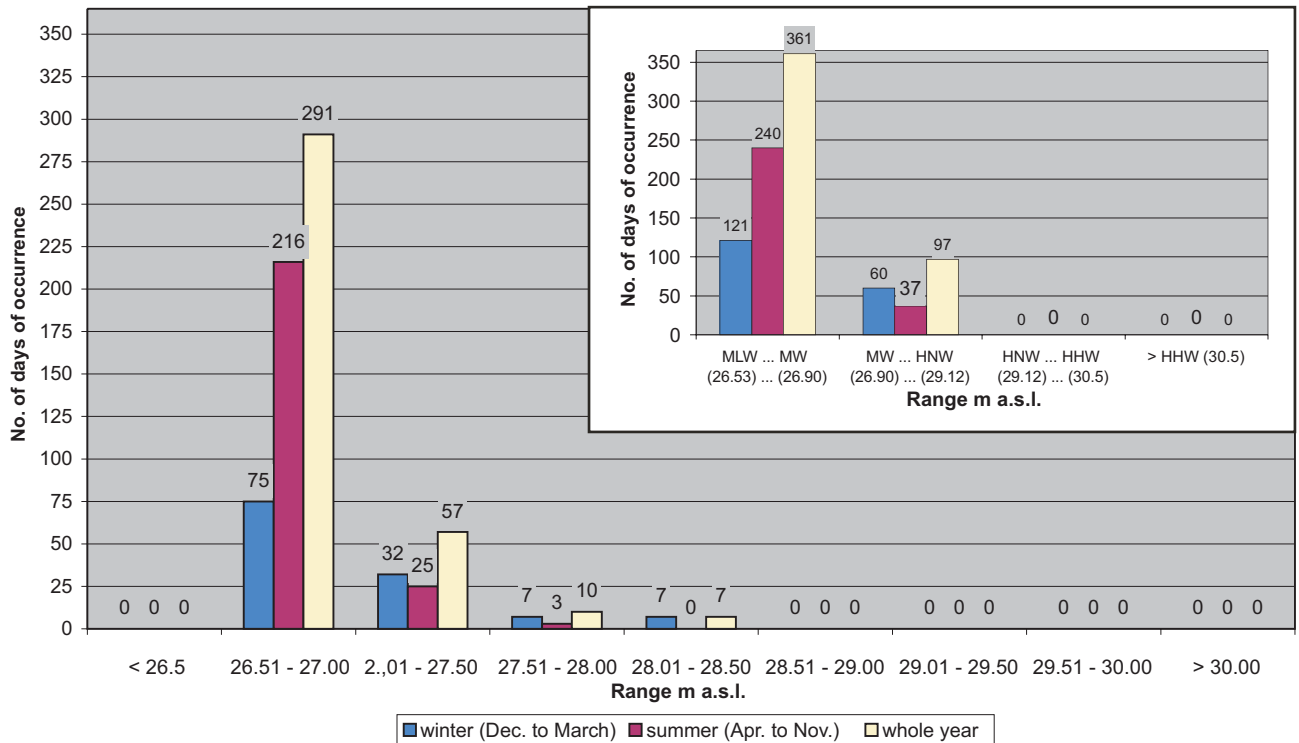
Modified	Date	Processed by	F.Fleischer	Date
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Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau
Km 241.550 - Km 242.300
frequencies of water levels 1999/2000

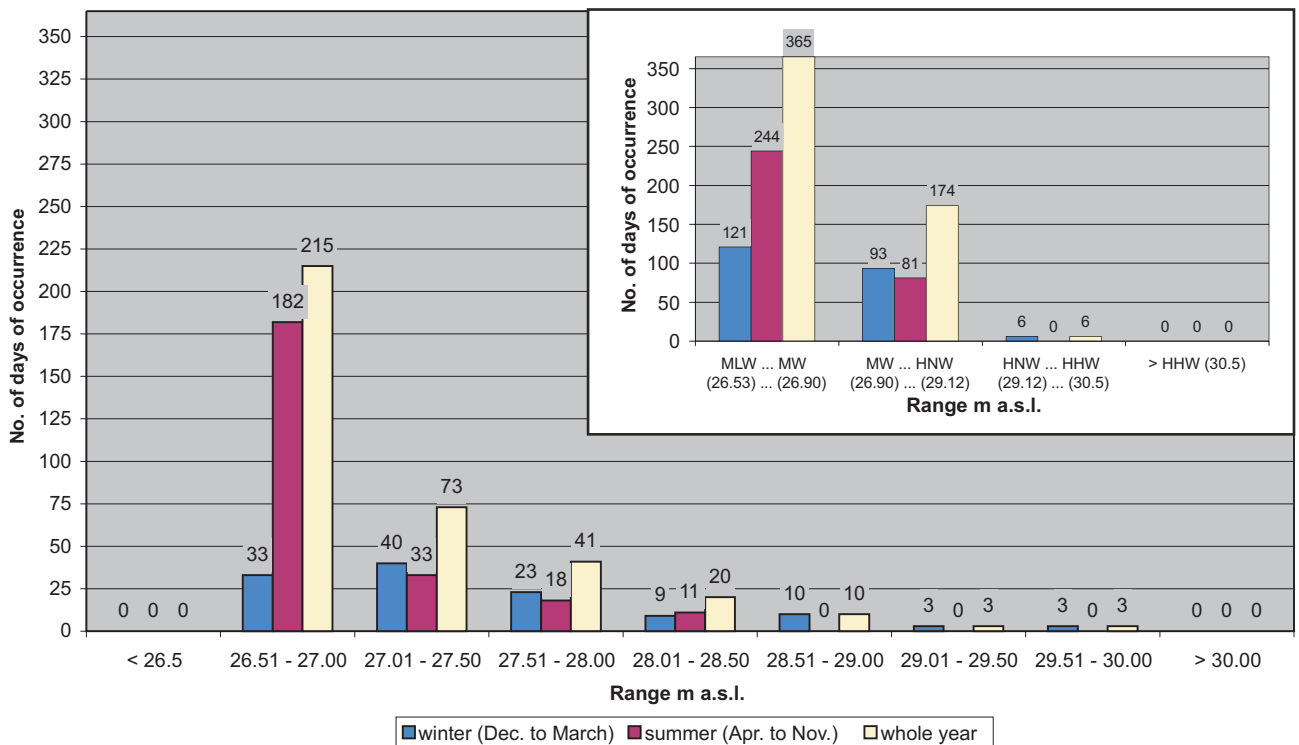
Order no. 2.04.10151.00

Appendix no. 5.7-6

Frequencies of water levels at Stolzenau gauge (2001)



Frequencies of water levels at Stolzenau gauge (2002)



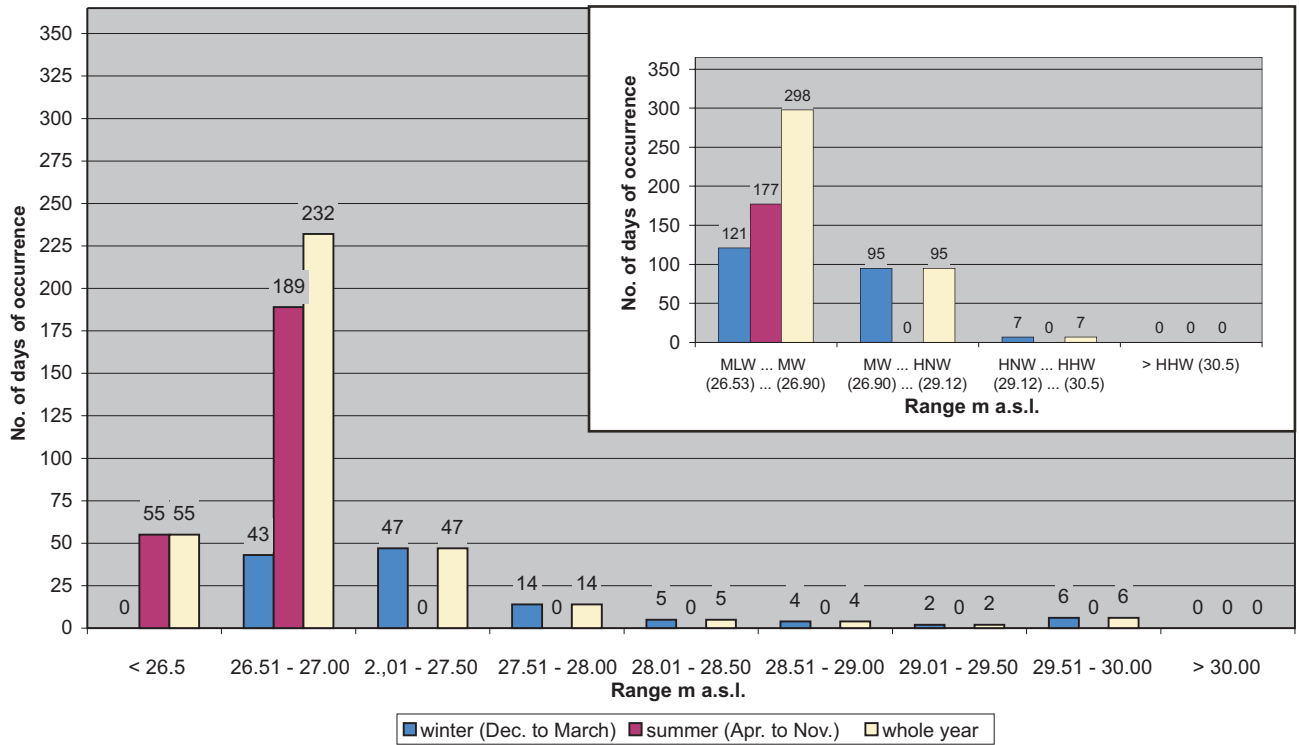
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Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau
Km 241.550 - Km 242.300
frequencies of water levels 2001/2002

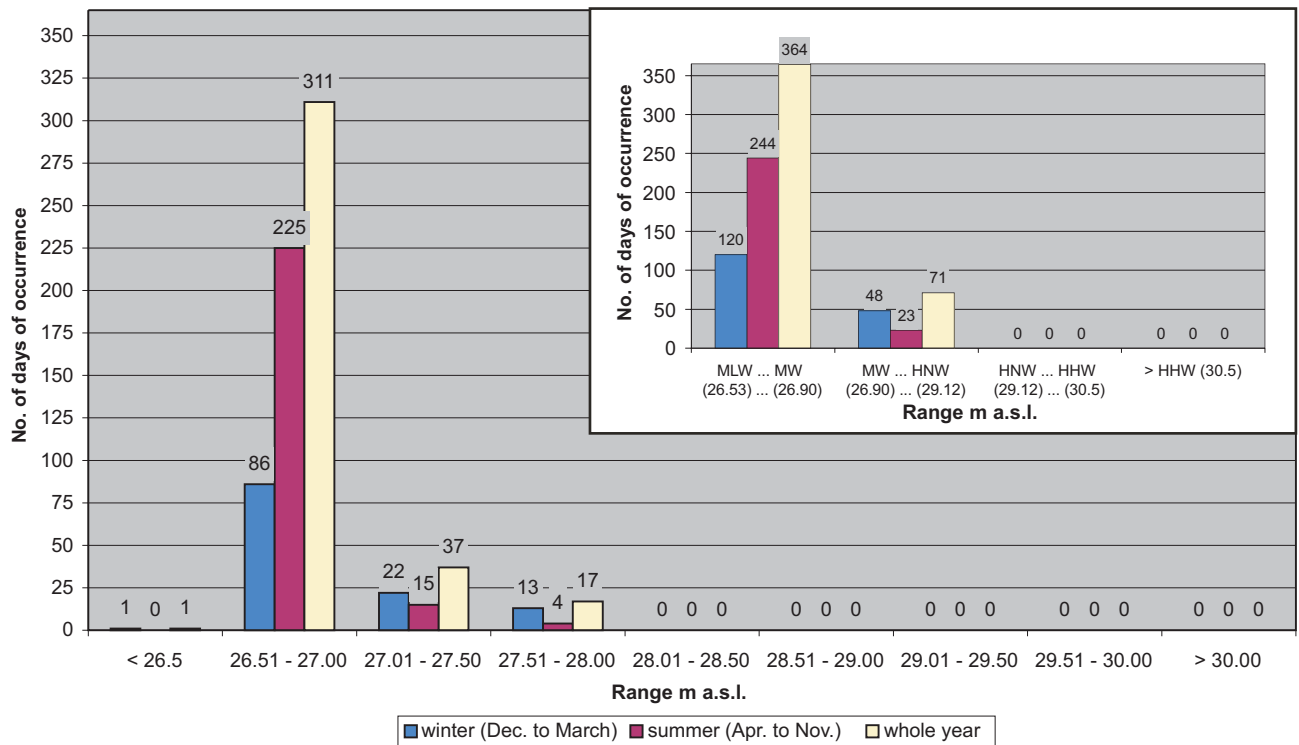
Order no. 2.04.10151.00

Appendix no. 5.7-7

Frequencies of water levels at Stolzenau gauge (2003)



Frequencies of water levels at Stolzenau gauge (2004)



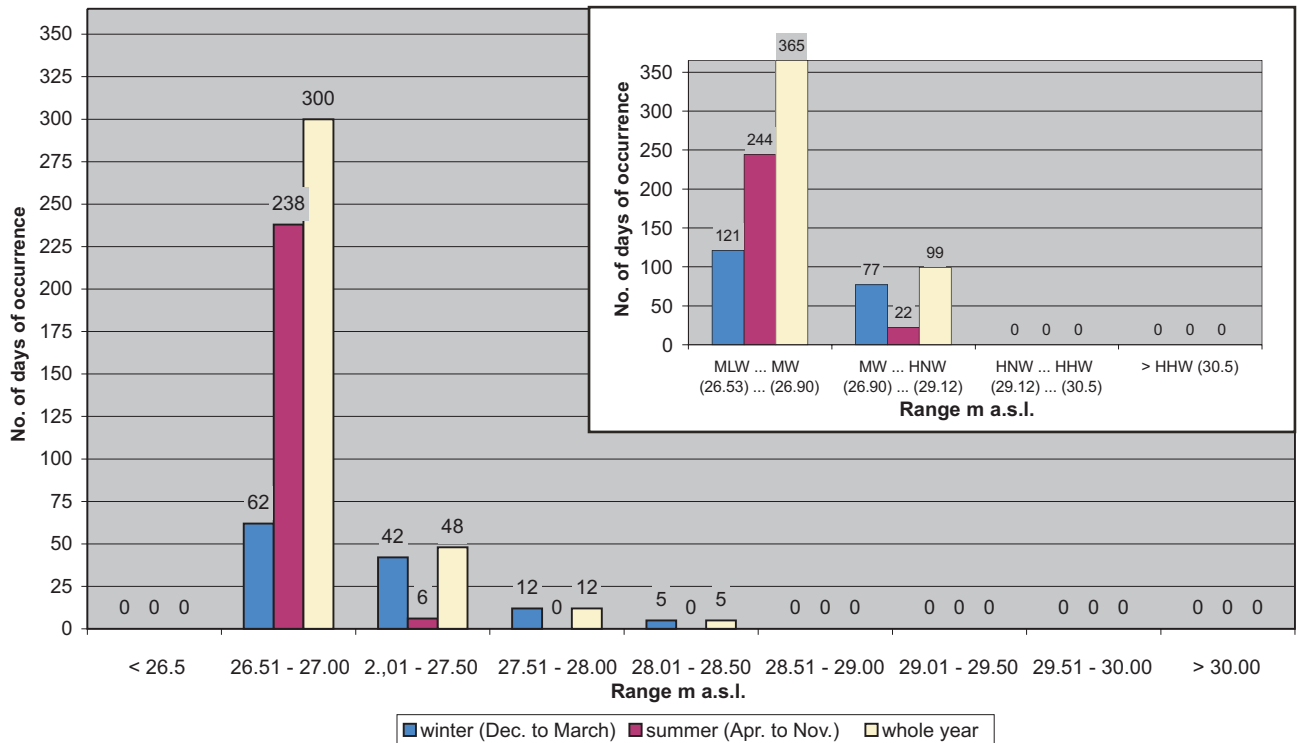
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Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau
Km 241.550 - Km 242.300
frequencies of water levels 2003/2004

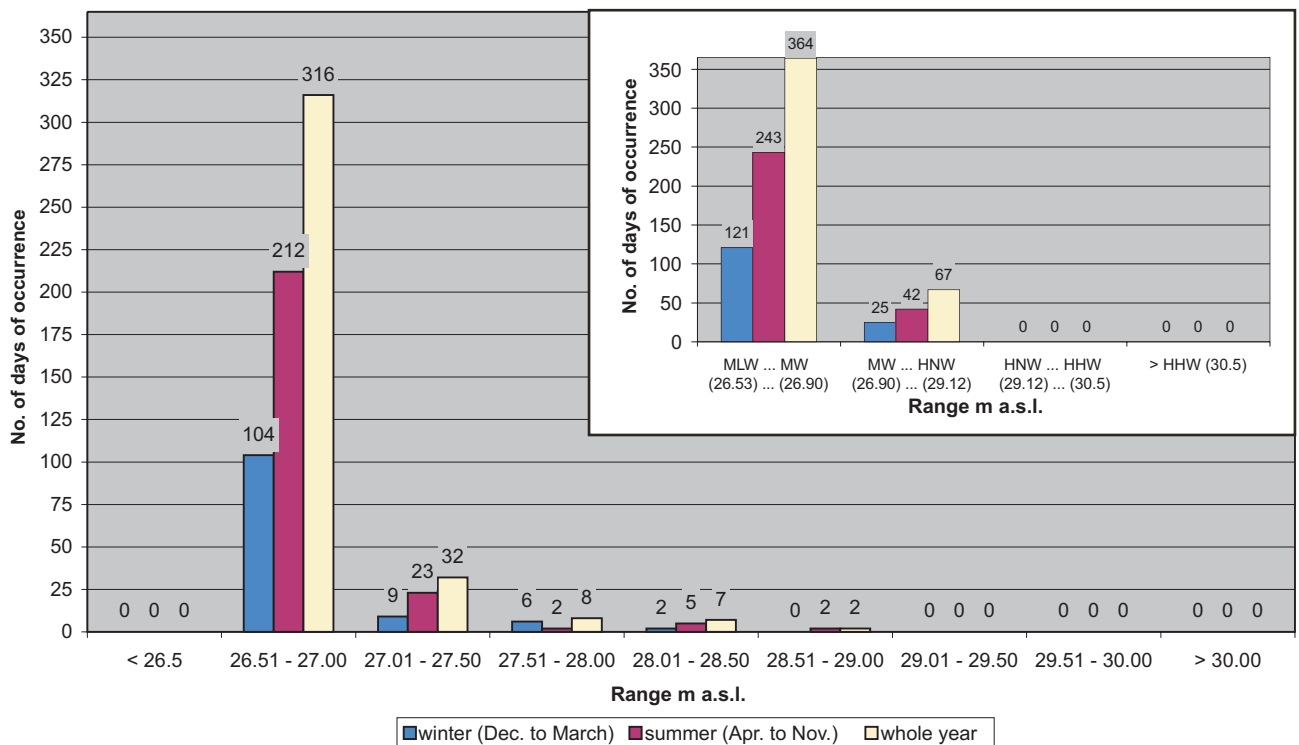
Order no. 2.04.10151.00

Appendix no. 5.7-8

Frequencies of water levels at Stolzenau gauge (2005)



Frequencies of water levels at Stolzenau gauge (2006)



Modified	Date	Processed by	F.Fleischer	Date
.	.	Signed by	SH	28.04.08
		File	A2.04.10151.00_5.7-1-9	
Scale	FEDERAL WATERWAYS ENGINEERING AND RESEARCH INSTITUTE FEDERAL INSTITUTE OF HYDROLOGY			

Test stretch at Stolzenau
Km 241.550 - Km 242.300
frequencies of water levels 2005/2006

Order no. 2.04.10151.00

Appendix no. 5.7-9



Bundesanstalt für Gewässerkunde

Bundesanstalt für Wasserbau

**Studies on alternative technical-biological bank protection measures
applied on inland waterways (R&D project)**

Part 2: Test stretch Stolzenau / Weser Km 241,550 – 242,300

BfG-Nr.:1579

BAW-Nr.: 2.04.10151.00



Appendices

to

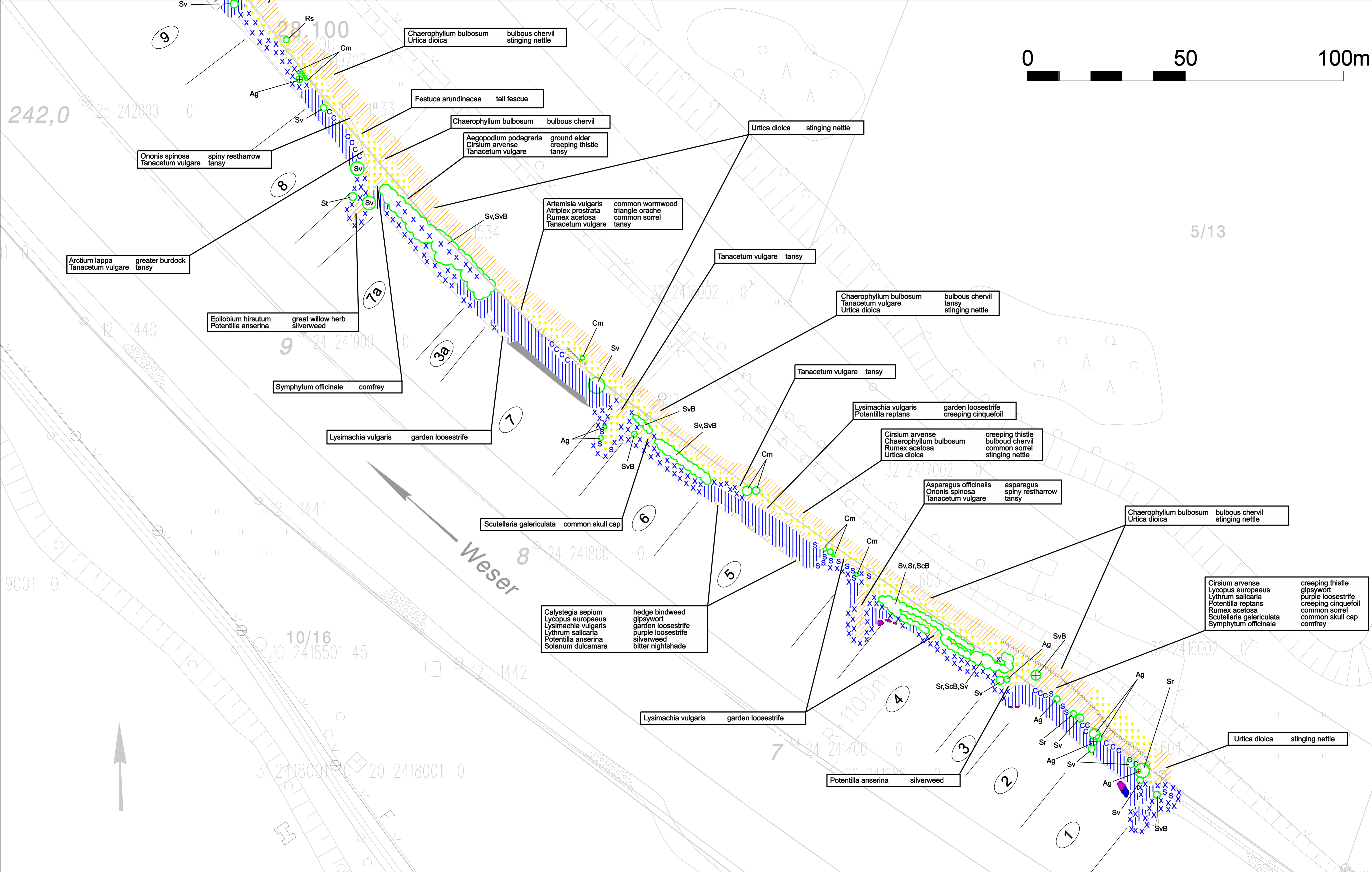
Chapter 9

Appendix 9.1

Vegetation and bank structure; survey from Sept. 1999

Appendix 9.1-1 Sections 1 - 8

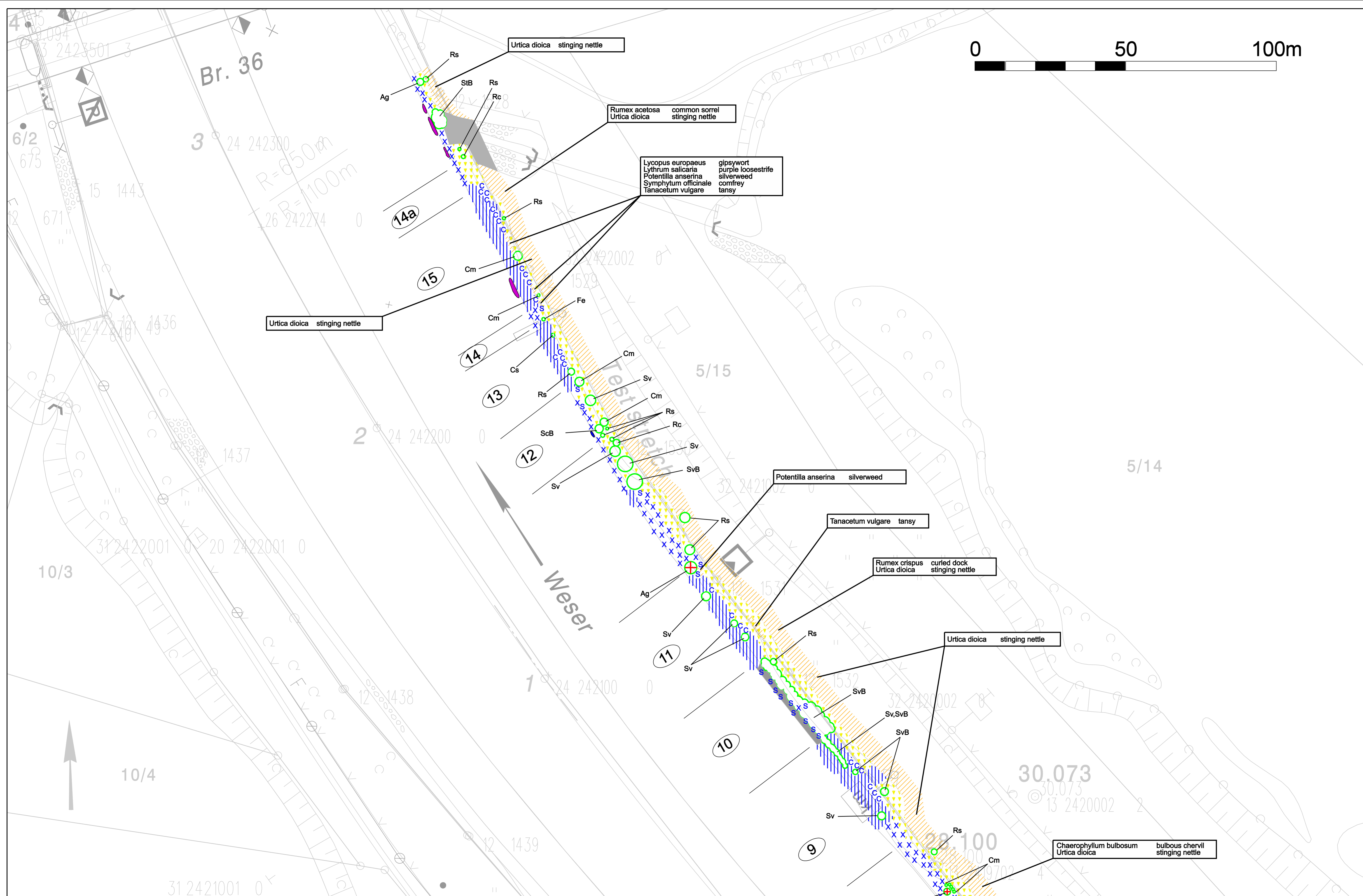
Appendix 9.1-2 Sections 9 - 15



KEY

- Woody plants**
- single plants and shrubs
 - treelike and shrub-like woody plants
- | | | |
|-----|-------------------------|------------------------------|
| Ag | Alnus glutinosa | black (European) alder |
| Cm | Crataegus monogyna | common hawthorn |
| Cs | Cornus sanguinea | common dogwood |
| Fe | Fraxinus excelsior | common ash |
| Ps | Prunus spinosa | blackthorn, sloe |
| Rc | Rhamnus cathartica | purging buckthorn |
| Rs | Rosa spp. | varieties of wild rose |
| ScB | Salix cinerea-Bastard | bastard grey willow |
| Sr | Salix x rubens | hybrid crack-willow |
| St | Salix triandra | almond-leaved willow |
| StB | Salix triandra-Bastard | bastard almond leaved willow |
| Sv | Salix viminalis | basket willow |
| SvB | Salix viminalis-Bastard | bastard basket willow |
- dead wood
 - stands of willow with undergrowth
- Tall forb meadows**
- tall forbs
- Reed beds**
- | | | |
|--|----------------------|--------------------|
| | Phragmites australis | common reed |
| | Phalaris arundinacea | reed canary grass |
| | Iris pseudacorus | yellow flag (iris) |
| | Carex spp. | varieties of sedge |
- Aquatic plants**
- | | | |
|--|------------------------|------------------------|
| | Potamogeton pectinatus | fennel pondweed |
| | Myriophyllum spicatum | Eurasian water milfoil |
- Grassland**
- Elymus repens s. str. couch grass
- Areas without vegetation cover**
- concreted area (slope etc.), stone blocks and the like
 - steep edge
 - planning section (no.)

Project:	Studies on alternative technical-biological bank protection measures applied on inland waterways (R&D project) Part 2: Test stretch Stolzenau/Weser Km 241.550 - 242.300	
Type of plan:	Vegetation and bank structure; survey from Sept. 1999	Scale: 1:500 (original) Appendix no.: 9.1-1
Prepared by:	FEDERAL INSTITUTE OF HYDROLOGY KOBLENZ	
Processed by:	Herz / Bauer	
CAD/GIS:	Meyer / Buscher / Hoppe	
Issued:	Aug. 2005	Format modified: September 2008



KEY

- Woody plants**
- single plants and shrubs
 - treelike and shrub-like woody plants
- | | | |
|-----|-------------------------|------------------------------|
| Ag | Alnus glutinosa | black (European) alder |
| Cm | Crataegus monogyna | common hawthorn |
| Cs | Cornus sanguinea | common dogwood |
| Fe | Fraxinus excelsior | common ash |
| Ps | Prunus spinosa | blackthorn, sloe |
| Rc | Rhamnus cathartica | purging buckthorn |
| Rs | Rosa spp. | varieties of wild rose |
| ScB | Salix cinerea-Bastard | bastard grey willow |
| Sr | Salix x rubens | hybrid crack-willow |
| St | Salix triandra | almond-leaved willow |
| StB | Salix triandra-Bastard | bastard almond leaved willow |
| Sv | Salix viminalis | basket willow |
| SvB | Salix viminalis-Bastard | bastard basket willow |
- dead wood
 - stands of willow with undergrowth
- Tall forb meadows**
- tall forbs
- Reed beds**
- | | | |
|--|----------------------|--------------------|
| | Phragmites australis | common reed |
| | Phalaris arundinacea | reed canary grass |
| | Iris pseudacorus | yellow flag (iris) |
| | Carex spp. | varieties of sedge |
- Aquatic plants**
- | | | |
|--|------------------------|------------------------|
| | Potamogeton pectinatus | fennel pondweed |
| | Myriophyllum spicatum | Eurasian water milfoil |
- Grassland**
- Elymus repens s. str. couch grass
- Areas without vegetation cover**
- concreted area (slope etc.), stone blocks and the like
 - steep edge
 - planning section (no.)

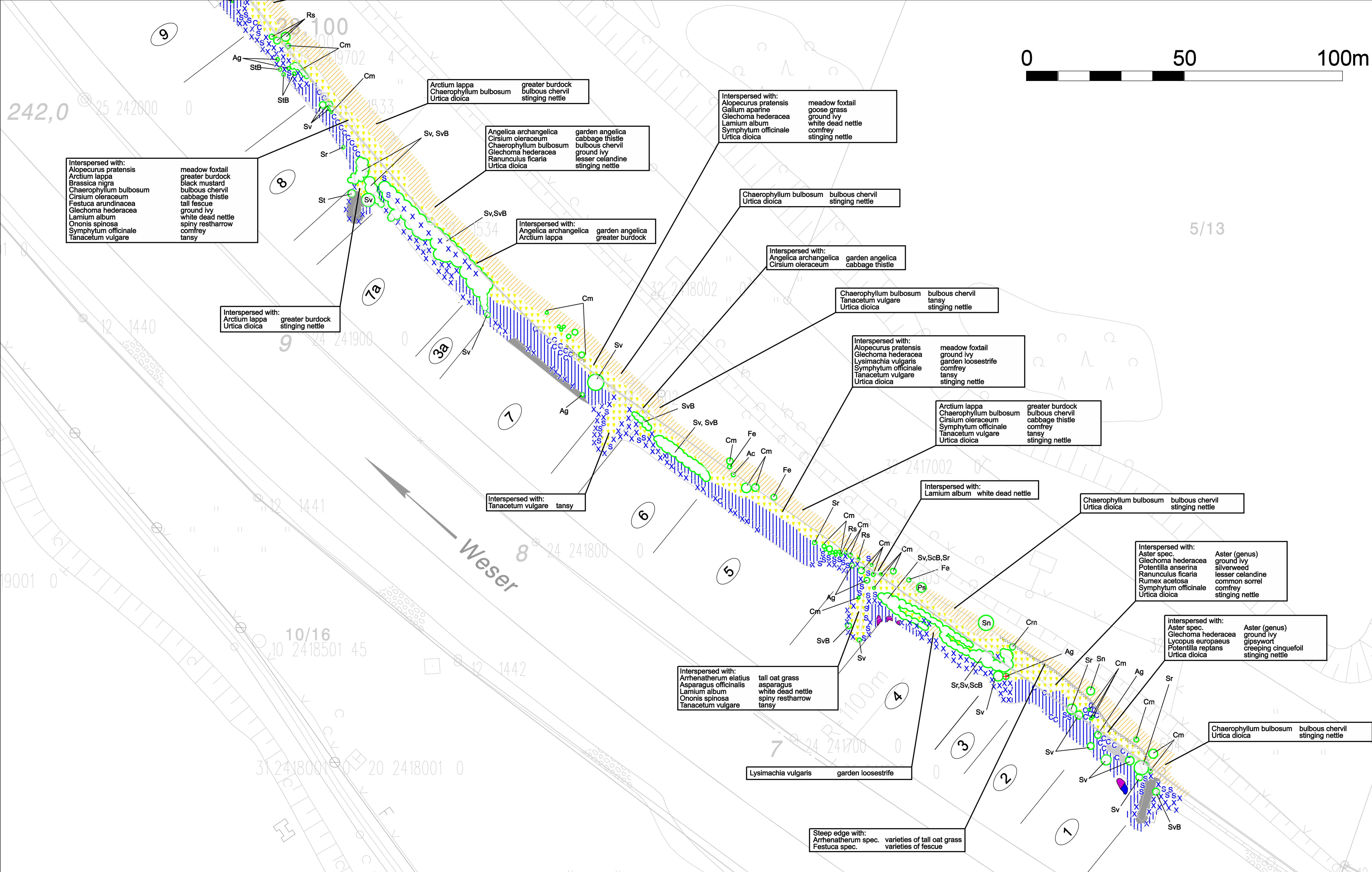
Project: Studies on alternative technical-biological bank protection measures applied on inland waterways (R&D project) Part 2: Test stretch Stolzenau/Weser Km 241.550 - 242.300		
Type of plan: Vegetation and bank structure; survey from Sept. 1999		
Prepared by: FEDERAL INSTITUTE OF HYDROLOGY KOBLENZ		Scale: 1:500 (original) Appendix no.: 9.1-2
Processed by: Herz / Bauer		
CAD/GIS: Meyer / Buscher / Hoppe		
Issued: Aug. 2005	Format modified: September 2008	

Appendix 9.2

Vegetation and bank structure; survey from April 2005

Appendix 9.2-1 Sections 1 - 8

Appendix 9.2-2 Sections 9 - 15



KEY

- Woody plants**
- single plants and shrubs
 - treelike and shrub-like woody plants
- | | | |
|-----|-------------------------|------------------------------|
| Ac | Acer campestre | field maple |
| Ag | Alnus glutinosa | black (European) alder |
| Cm | Crataegus monogyna | common hawthorn |
| Cs | Cornus sanguinea | common dogwood |
| Fe | Fraxinus excelsior | common ash |
| Ps | Prunus spinosa | blackthorn, sloe |
| Rc | Rhamnus cathartica | purging buckthorn |
| Rs | Rosa spp. | varieties of wild rose |
| ScB | Salix cinerea-Bastard | bastard grey willow |
| Sr | Salix x rubens | hybrid crack-willow |
| St | Salix triandra | almond-leaved willow |
| SIB | Salix triandra-Bastard | bastard almond leaved willow |
| Sv | Salix viminalis | basket willow |
| SvB | Salix viminalis-Bastard | bastard basket willow |
| Sn | Sambucus nigra | common elder |

- dead wood
- stands of willow with undergrowth

- Tall forb meadows**
- tall forbs

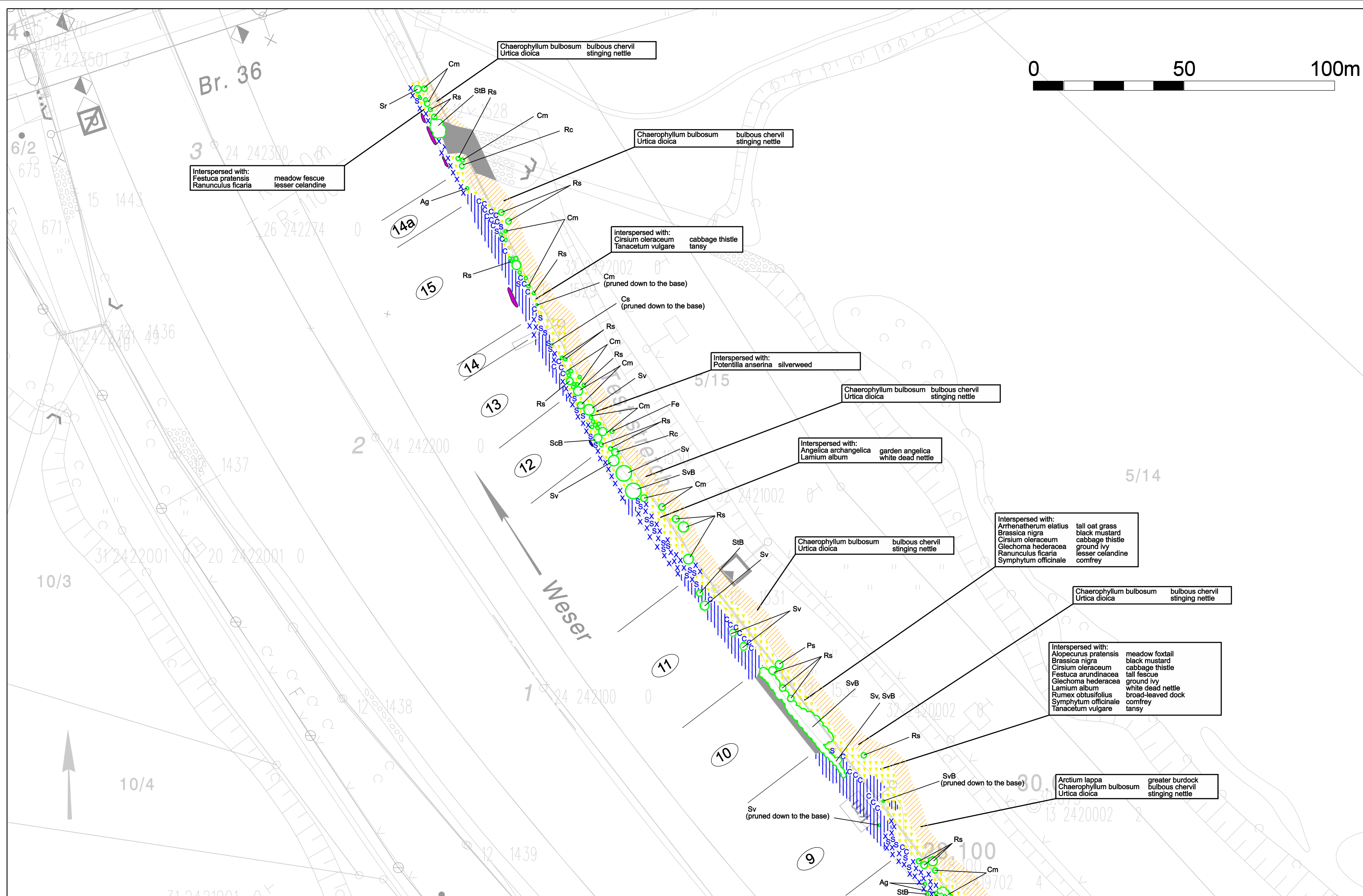
- Reed beds**
- Phragmites australis common reed
 - Phalaris arundinacea reed canary grass
 - Iris pseudacorus yellow flag (iris)
 - Carex spp. varieties of sedge

- Aquatic plants**
- Potamogeton pectinatus fennel pondweed
 - Myriophyllum spicatum Eurasian water milfoil

- Grassland**
- Elymus repens s. str. couch grass

- Areas without vegetation cover**
- concreted area (slope etc.), stone blocks and the like
 - reed mulch
 - steep edge
 - planning section (no.)

Project:	Studies on alternative technical-biological bank protection measures applied on inland waterways (R&D project) Part 2: Test stretch Stolzenau/Weser Km 241.550 - 242.300	
Type of plan:	Vegetation and bank structure; survey from April 2005	Scale: 1:500 (original) Appendix no.: 9.2.1
Prepared by:	FEDERAL INSTITUTE OF HYDROLOGY KOBLENZ	
Processed by:	Herz / Bauer	
CAD/DIGIS:	Meyer / Buscher / Hoppe	
Issued:	Dec. 2005	Format modified: September 2008



KEY

- Woody plants**
- single plants and shrubs
 - treelike and shrub-like woody plants
- | | | |
|-----|-------------------------|------------------------------|
| Ac | Acer campestre | field maple |
| Ag | Alnus glutinosa | black (European) alder |
| Cm | Crataegus monogyna | common hawthorn |
| Cs | Cornus sanguinea | common dogwood |
| Fe | Fraxinus excelsior | common ash |
| Ps | Prunus spinosa | blackthorn, sloe |
| Rc | Rhamnus cathartica | purging buckthorn |
| Rs | Rosa spp. | varieties of wild rose |
| ScB | Salix cinerea-Bastard | bastard grey willow |
| Sr | Salix x rubens | hybrid crack-willow |
| St | Salix triandra | almond-leaved willow |
| StB | Salix triandra-Bastard | bastard almond leaved willow |
| Sv | Salix viminalis | basket willow |
| SvB | Salix viminalis-Bastard | bastard basket willow |
| Sn | Sambucus nigra | common elder |

- dead wood
- stands of willow with undergrowth

- Tall forb meadows**
- tall forbs

- Reed beds**
- Phragmites australis common reed
 - Phalaris arundinacea reed canary grass
 - Iris pseudacorus yellow flag (iris)
 - Carex spp. varieties of sedge

- Aquatic plants**
- Potamogeton pectinatus fennel pondweed
 - Myriophyllum spicatum Eurasian water milfoil

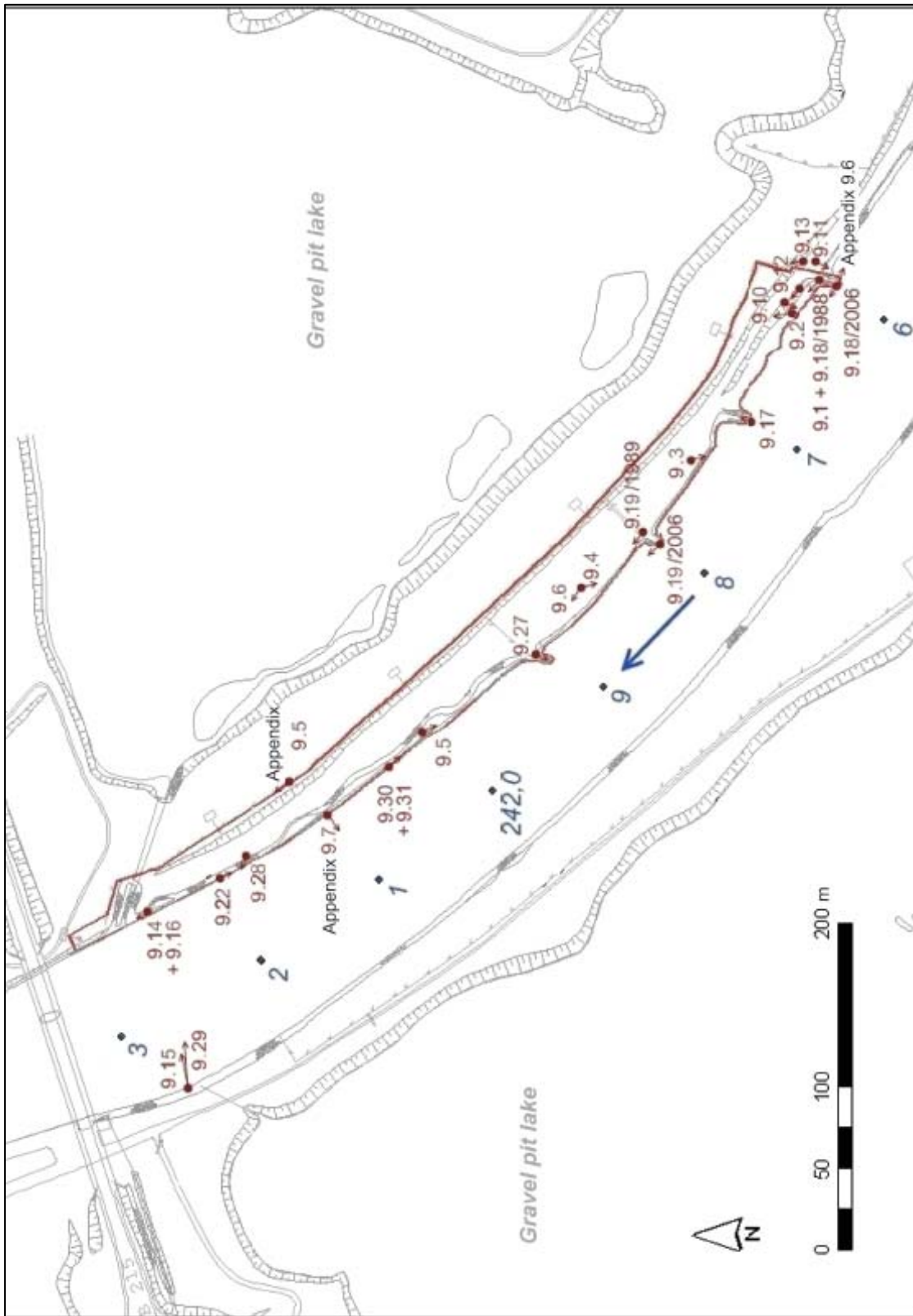
- Grassland**
- Elymus repens s. str. couch grass

- Areas without vegetation cover**
- concreted area (slope etc.), stone blocks and the like
 - reed mulch
 - steep edge
 - planning section (no.)

Project:	Studies on alternative technical-biological bank protection measures (R&D project) Part 2: Test stretch Stolzenau/Weser Km 241.550 - 242.300	
Type of plan:	Vegetation and bank structure; survey from April 2005	
Prepared by:	FEDERAL INSTITUTE OF HYDROLOGY KOBLENZ	Scale: 1:500 (original) Appendix no.: 9.2-2
Processed by:	Herz / Bauer	
CAD/GIS:	Meyer / Buscher / Hoppe	
Issued:	Dec. 2005 Format modified: September 2008	

Appendix 9.3

Location of photographs with direction of view and photograph numbers

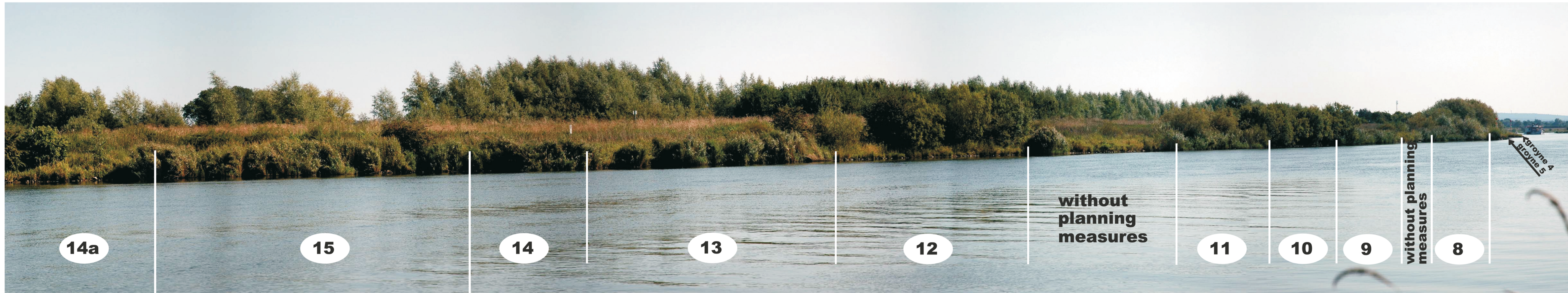


Appendix 9.3: Location of photographs with direction of view and photograph numbers



Appendix 9.4

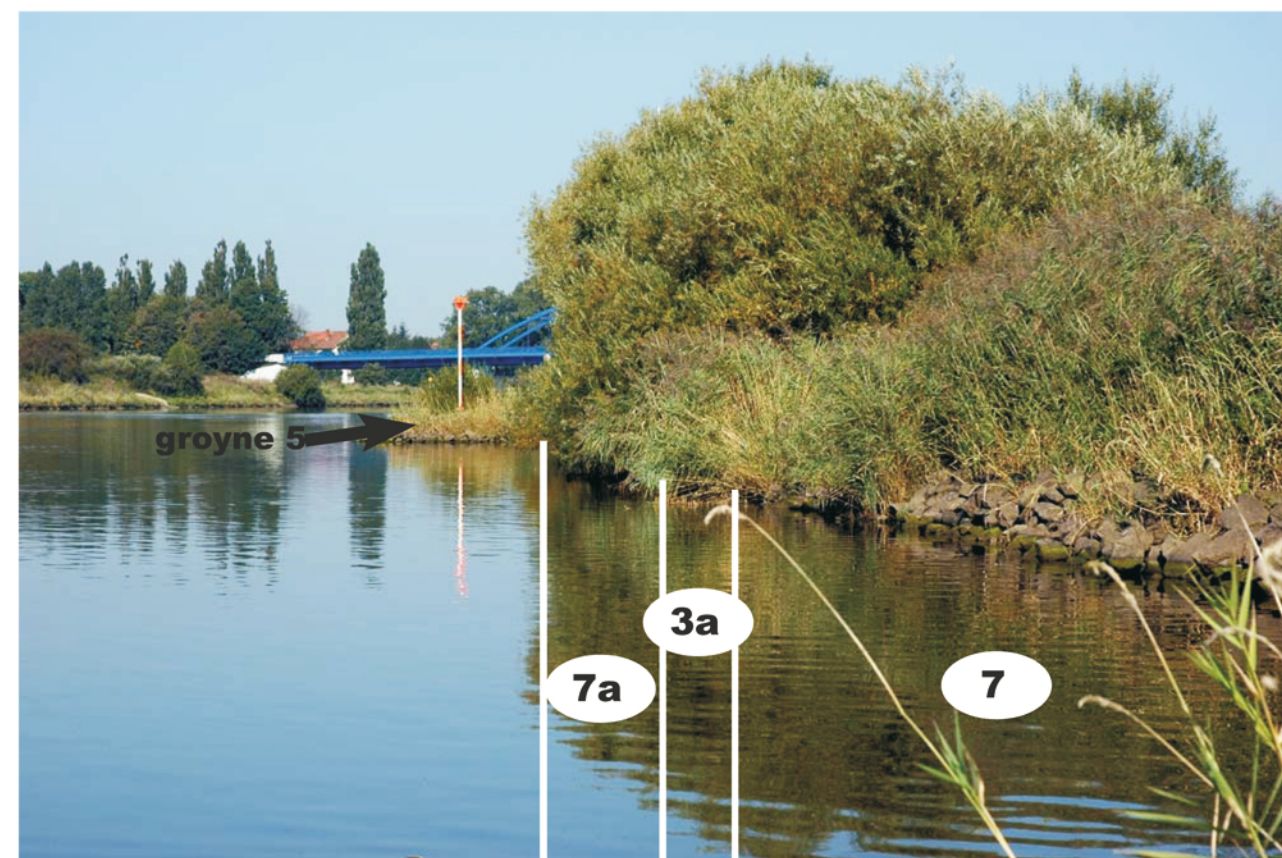
Photographic documentation



Panorama of the northern part of the test stretch; photographs taken at the left bank



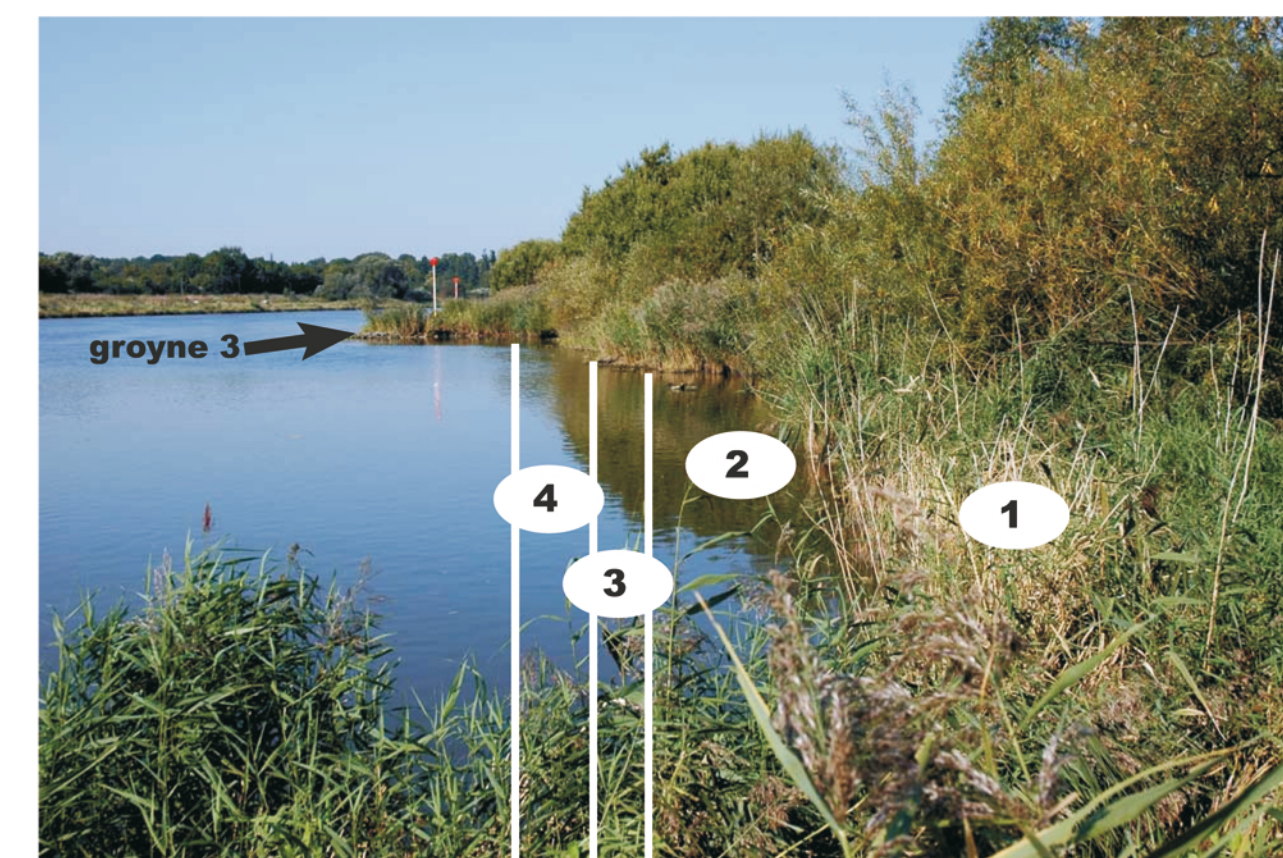
Site of photograph: groyne 5, looking downstream





Site of photograph: groyne 4, looking downstream



Site of photograph: groyne 3, looking downstream



Site of photograph: groyne 2, looking downstream

Project:	Studies on alternative bank protection measures applied on inland waterways (R&D Project) Part 2: Test stretch, Stolzenau/River Weser Km 241.550 - 242.300	
Type of plan:	Photographic documentation September 2006 at low water	
Prepared by:	Federal Institute of Hydrology Koblenz	
Processed by:	Bauer	
CAD/GIS:	Diel	
Issued:	December 2006	



Bundesanstalt für Gewässerkunde

Bundesanstalt für Wasserbau

**Studies on alternative technical-biological bank protection measures
applied on inland waterways (R&D project)**

Part 2: Test stretch Stolzenau / Weser Km 241,550 – 242,300

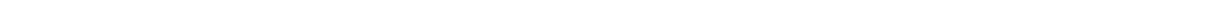
BfG-Nr.:1579

BAW-Nr.: 2.04.10151.00



Appendix 9.5

Hinterland (Km 242.100)





Appendix 9.5: Hinterland (Km 242.100): Fallow land dominated by stinging nettle (*Urtica dioica*) and bulbous chervil (*Chaerophyllum bulbosum*), landward side, adjoining cattle pasture (14.9.2006).

Appendix 9.6

Bank vegetation directly upstream from the test stretch



Appendix 9.6: Bank vegetation directly upstream from the test stretch: dominant type near the waterline is reed canary grass (*Phalaris arundinacea*) (14.9.2006, at low water).

Appendix 9.7

Bank opposite the test stretch (Km 242.100)



Appendix 9.7: Bank opposite the test stretch (Km 242.100): dominated by reed canary grass (*Phalaris arundinacea*) and tall forbs, with occasional willow shrubs (14.9.2006, at low water).

Appendix 9.8

Complete list of plant species in the test stretch

Appendix 9.8: List of all species of plants in the test stretch (April 2005 and September 2006)

	Red List Lower Saxony		Red List Lower Saxony
field maple (<i>Acer campestre</i>)	*	gipsywort (bugleweed) (<i>Lycopus europaeus</i>)	*
sneezewort (<i>Achillea ptarmica</i>)	*	garden loosestrife (<i>Lysimachia vulgaris</i>)	*
black or European alder (<i>Alnus glutinosa</i>)	*	purple loosestrife (<i>Lythrum salicaria</i>)	*
meadow foxtail (<i>Alopecurus pratensis</i>)	*	water mint (<i>Mentha aquatica</i>)	*
garden angelica (<i>Angelica archangelica</i>)	*	Eurasian water milfoil (<i>Myriophyllum spicatum</i>)	*
greater burdock (<i>Arctium lappa</i>)	*	spiny restharrow (<i>Ononis spinosa</i>)	n.s.
tall oat grass (<i>Arrhenatherum elatius</i>)	n.s.	reed canary grass (<i>Phalaris arundinacea</i>)	*
common wormwood (<i>Artemisia vulgaris</i>)	*	timothy (grass) (<i>Phleum pratense</i>)	*
asparagus (<i>Asparagus officinalis</i>)	*	common reed (<i>Phragmites australis</i>)	*
common Michaelmas daisy (<i>Aster x salignus</i>)	*	swamp meadow grass (<i>Poa palustris</i>)	*
black mustard (<i>Brassica nigra</i>)	n	smooth meadow grass (<i>Poa pratensis</i>)	*
hedge bindweed (<i>Calystegia sepium</i>)	*	fennel pondweed (<i>Potamogeton pectinatus</i>)	n.s.
welted thistle (<i>Carduus crispus</i>)	*	silverweed (<i>Potentilla anserina</i>)	*
slender-tufted sedge (<i>Carex acuta</i>)	*	creeping cinquefoil (<i>Potentilla reptans</i>)	*
lesser pond sedge (<i>Carex acutiformis</i>)	*	wild cherry (<i>Prunus avium</i>)	*
cypress-like sedge (<i>Carex pseudocyperus</i>)	*	blackthorn (sloe) (<i>Prunus spinosa</i>)	n.s.
brown knapweed (<i>Centaurea jacea</i>)	*	lesser celandine (<i>Ranunculus ficaria</i>)	*
bulbous chervil (<i>Chaerophyllum bulbosum</i>)	*	hairy buttercup (<i>Ranunculus cf. sardous</i>)	2
creeping thistle (<i>Cirsium arvense</i>)	*	purging buckthorn (<i>Rhamnus cathartica</i>)	*
cabbage thistle (<i>Cirsium oleraceum</i>)	*	dog rose (<i>rosa canina</i>)	n.s.
common dogwood (<i>Cornus sanguinea</i>)	*	sweet-briar (<i>Rosa rubiginosa</i>)	n.s.
common hawthorn (<i>Crataegus monogyna</i>)	*	common sorrel (<i>Rumex acetosa</i>)	*
orchard grass (<i>Dactylis glomerata</i>)	*	broad-leaved dock (<i>Rumex obtusifolius</i> agg.)	*
couch grass (<i>Elymus repens</i> ssp. <i>repens</i>)	*	almond-leaved willow (<i>Salix triandra</i> agg.)	n.s.
tall fescue (<i>Festuca arundinacea</i>)	*	bastard almond-leaved willow (<i>Salix triandra-</i>)	n.s.
meadow fescue (<i>Festuca pratensis</i>)	*	basket willow (<i>Salix viminalis</i>)	*
common ash (<i>Fraxinus excelsior</i>)	*	bastard basket willow (<i>Salix viminalis-</i>)	n.s.
goose grass (<i>Galium aparine</i>)	*	hybrid crack-willow (<i>Salix x rubens</i>)	*
false baby's breath (<i>Galium album</i>)	*	black elder (<i>Sambucus nigra</i>)	*
ground ivy (<i>Glechoma hederacea</i>)	n.s.	climbing nightshade (<i>Solanum dulcamara</i>)	*
common hogweed (<i>Heracleum sphondylium</i>)	n.s.	Canada golden rod (<i>Solidago canadensis</i>)	*
St. John's wort (<i>Hypericum perforatum</i>)	*	marsh woundwort (<i>Stachys palustris</i>)	*
British yellowhead (<i>Inula britannica</i>)	3	wood stitchwort (<i>Stellaria nemorum</i>)	*
yellow flag (<i>Iris pseudacorus</i>)	*	comfrey (<i>Symphytum officinale</i> s. l.)	*
white dead nettle (<i>Lamium album</i>)	*	tansy (<i>Tanacetum vulgare</i>)	*
spotted deadnettle (<i>Lamium maculatum</i>)	*	scentless false mayweed (<i>Tripleurospermum</i>)	*

	Red List Lower Saxony		Red List Lower Saxony
		<i>perforatum</i>)	
autumn hawkbit (<i>Leontodon autumnalis</i>)	*	stinging nettle (<i>Urtica dioica</i> agg.)	*
common toadflax (<i>Linaria vulgaris</i>)	*		

3: threatened

*: not threatened

n: neophyte

n.s.: non specified

The yellow flag (*iris pseudacorus*) is strictly protected under the Federal Ordinance on the Conservation of Species /BGBl/.



Appendices

to

Chapter 10

Appendix 10.1

Taxa lists MZB

River Weser at Stolzenau,

May 2006

- Appendix 10.1-1 Taxa lists of the samples W1 – W10 in the area AU1**
 - Appendix 10.1-2 Taxa lists of the samples W11 – W20 in the area AU2**
 - Appendix 10.1-3 Taxa lists of the samples W21 – W30 in the area RU**
-

Appendix 10.1-1

Taxa list MZB River Weser at Stolzenau (River Km 241.55 -242.30) - May.2006

Consecutive Nos.:	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
Substratum type:	AU1	AU1	AU1	AU1	AU1	AU1	AU1	AU1	AU1	AU1
Bank position:	rt. bank	rt. bank	rt. bank	rt. bank	rt. bank	rt. bank	rt. bank	rt. bank	rt. bank	rt. bank
Sample depth [m]:	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Sampling technique:	landing net	landing net	landing net	landing net	landing net	landing net	landing net	landing net	landing net	landing net
Area [m²]:	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Type of body of water:	river reach	river reach	river reach	river reach	river reach	river reach	river reach	river reach	river reach	river reach
Water level:	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean
Type of flow:	slow	slow	slow	slow	slow	slow	slow	slow	slow	slow
Shade:	light	light	light	light	light	light	light	light	light	light
Substratum [%]:										
Coarse stone:										
Medium stone:										
Fine stone:	30	30	30	30	30	30	30	30	30	30
Gravel:	50	50	50	50	50	50	50	50	50	50
Sand:										
Silt:	15	15	15	15	15	15	15	15	15	15
Riprap:	5	5	5	5	5	5	5	5	5	5
Thread algae:										
TAXA (individuals/m²)										
PORIFERA - sponges										
<i>Ephydatia fluviatilis</i>										
GASTROPODA - Snails and slugs										
<i>Ancylus fluviatilis</i>	8	8	32	8	8	8	16		32	80
<i>Bithynia tentaculata</i>				32	24		8		8	8
<i>Potamopyrgus antipodarum</i>			8		8		8			
<i>Radix balthica</i>										
<i>Radix sp. (juv.)</i>		16								
BIVALVIA - bi-valve molluscs										
<i>Corbicula fluminea</i>					32					
<i>Dreissena polymorpha</i>										
<i>Musculium lacustre</i>	16	8	8	8	16	8	8	8	8	32
<i>Pisidium sp.</i>	56		8	32	104	8	88	8	32	40
<i>Pisidium supinum</i>	16		8		16		16			
<i>Pisidium supinum/henslowanum</i>					16				8	16
Sphaeriidae (juv.)	8				32		40			40

Appendix 10.1-1

BAW-Nr.: 2.04.10151.00

Consecutive Nos:	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
Substratum type:	AU1	AU1	AU1	AU1	AU1	AU1	AU1	AU1	AU1	AU1
OLIGOCHAETA – worms										
<i>Criodrilus lacuum</i>										
<i>Eiseniella tetraedra</i>								8		
Enchytraeidae					24					
Naididae	8		8			8	8	8	16	24
Oligochaeta						8	8			
Tubificidae	16		32	24	64	64	8	24	24	24
POLYCHAETA - bristle worms										
<i>Hypania invalida</i>	8		16	32	48	24	40	32	48	8
HIRUDINEA - leeches										
<i>Erpobdella vilnensis</i>		8		8			8	8	8	24
<i>Helobdella stagnalis</i>					16		8			
CRUSTACEA - crustaceans										
<i>Chelicorophium curvispinum</i>		24	8	40	56	16	48	16	16	64
<i>Dikerogammarus villosus</i>	720	192	664	3360	2760	2528	2832	1416	2104	520
<i>Echinogammarus ischnus</i>	128			192	3384	232	160		64	24
<i>Echinogammarus trichiatus</i>	16		8		216	64	120	64	144	64
Gammaridae (juv.)	1024	2480	1872	8200	5952	4960	3816	1128	4576	3912
<i>Gammarus tigrinus</i>				64	688	104	48		8	8
<i>Hemimysis anomala</i>										
<i>Jaera istri</i>	8	24	80	16	56	40	352	48	112	176
<i>Neomysis integer</i>									8	
<i>Proasellus coxalis</i>				16		8	8	8		16
EPHEMEROPTERA - mayflies										
<i>Caenis macrura</i>										
ODONATA - dragon flies										
<i>Calopteryx splendens</i>										
COLEOPTERA - beetles										
<i>Anacaena bipustulata</i>		8								
<i>Cercyon tristis</i>	8									
<i>Dryops</i> sp. (Larve)		32	32		8	8	8	8		
<i>Haliplus</i> sp. (Imago W)					8				8	
<i>Hydrobius fuscipes</i>					8					
<i>Laccobius</i> sp.(Imago W)	8									
<i>Laccobius striatulus</i>	8									
<i>Noterus clavicornis</i>								8		



Appendix 10.1-1

Consecutive Nos.:	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
Substratum type:	AU1	AU1	AU1	AU1	AU1	AU1	AU1	AU1	AU1	AU1
HETEROPTERA - true bugs										
<i>Gerris lacustris</i>										
<i>Micronecta sp.</i> (Larve)										
<i>Sigara sp.</i> (Imago W)										
TRICHOPTERA - caddis flies										
<i>Hydroptila forcipata</i>										
<i>Hydroptila sp.</i>							8			
<i>Hydroptila sparsa</i>										
<i>Limnephilus lunatus</i>	8			8	24		8			
<i>Tinodes cf. pallidulus</i>		8	8							
<i>Tinodes waeneri</i>		8								
DIPTERA - true flies										
<i>Antocha sp.</i>										
Ceratopogoninae					8	8		8		
Chironomini	8	24	24	8	256	24	72	104	40	192
Orthocladiinae	8	16	8	8					8	32
<i>Stenochironomus sp.</i>										
Tabanidae										
Tanypodinae									8	
Tanytarsini		8								
BRYOZOA - moss animals										
Bryozoa										
Taxa nos.:	19	15	17	17	26	18	25	17	21	20
Nos. of individuals:	2080	2864	2824	12056	13832	8120	7744	2904	7280	5304

Consecutive Nos.	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20
Substratum type:	AU2	AU2	AU2	AU2	AU2	AU2	AU2	AU2	AU2	AU2
HETEROPTERA - true bugs										
<i>Gerris lacustris</i>	8									
<i>Micronecta</i> sp. (Larve)							8			
<i>Sigara</i> sp. (Imago W)									8	
TRICHOPTERA - caddis flies										
<i>Hydroptila forcipata</i>										
<i>Hydroptila</i> sp.			8	8				8		40
<i>Hydroptila sparsa</i>										
<i>Limnephilus lunatus</i>					8					
<i>Tinodes</i> cf. <i>pallidulus</i>			8							40
<i>Tinodes waeneri</i>										
DIPTERA - true flies										
<i>Antocha</i> sp.										
Ceratopogoninae										
Chironomini	224	784	120	112	376	592	200	56	192	40
Orthocladiinae				8		48	64	8		8
<i>Stenochironomus</i> sp.									8	
Tabanidae								8		
Tanypodinae	8	32				32	48			
Tanytarsini	8	16								
BRYOZOA - moss animals										
Bryozoa										
Taxa numbers:	23	17	20	17	21	14	20	18	17	20
Nos. of individuals:	4504	4776	4912	3256	7280	3296	5784	7712	2248	3488



Appendix 10.1-3

Consecutive Nos.:	W21	W22	W23	W24	W25	W26	W27	W28	W29	W30
Substratum type:	RU	RU	RU	RU	RU	RU	RU	RU	RU	RU
HETEROPTERA - true bugs										
<i>Gerris lacustris</i>										
<i>Micronecta</i> sp. (Larve)										
<i>Sigara</i> sp. (Imago W)										
TRICHOPTERA -caddis flies										
<i>Hydroptila forcipata</i>		8								
<i>Hydroptila</i> sp.	32	8	32	40	16	8	40	80	72	24
<i>Hydroptila sparsa</i>		8		8			16	16	8	
<i>Limnephilus lunatus</i>										
<i>Tinodes</i> cf. <i>pallidulus</i>			8			72	8			
<i>Tinodes waeneri</i>	8		48	88	8	16	16	8	80	
DIPTERA - true flies										
<i>Antocha</i> sp.	48				16					
Ceratopogoninae										
Chironomini	312	408	2208	352	456	72	680	112	144	600
Orthocladiinae	176	8	96	384	112	8	88	72	328	64
<i>Stenochironomus</i> sp.										
Tabanidae										
Tanypodinae					8				8	
Tanytarsini						8		8	8	40
BRYOZOA - moss animals										
Bryozoa			+		+		+		+	+
Taxa numbers:	15	13	15	17	20	21	23	16	19	18
Nos. of individuals:	12592	4088	10960	17120	22456	11528	12800	14648	16152	31480

Appendix 10.2

Distribution of constancy, dominance, animal groups and ecological features of the MZB River Weser at Stolzenau, May 2006

Appendix 10.2-1	Constancy distribution of the MZB
Appendix 10.2-2	Dominance distribution of the MZB
Appendix 10.2-3	Animal group distribution of the MZB
Appendix 10.2-4	Ecological features of the MZB

Appendix 10.2-1

Constancy distribution MZB, River Weser at Stolzenau, May 2006

(Shown as percentage (%) of all samples)

Taxon	AU1	AU2	RU	Taxon	AU1	AU2	RU
Gammaridae	100.00	100.00	100.00	Laccobius striatulus	10.00	0.00	0.00
Musculium lacustre	100.00	80.00	0.00	Tanypodinae	10.00	40.00	20.00
Jaera istri	100.00	100.00	100.00	Tinodes waeneri	10.00	0.00	80.00
Chironominae	100.00	100.00	100.00	Noterus clavicornis	10.00	0.00	0.00
Dikerogammarus villosus	100.00	100.00	100.00	Cercyon tristis	10.00	0.00	0.00
Hypania invalida	90.00	90.00	40.00	Hydroptila sp.	10.00	40.00	100.00
Ancylus fluviatilis	90.00	90.00	100.00	Neomysis integer	10.00	40.00	0.00
Tubificidae	90.00	100.00	10.00	Eiseniella tetraedra	10.00	10.00	0.00
Pisidium sp.	90.00	100.00	20.00	Anacaena bipustulata	10.00	0.00	0.00
Chelicorophium curvispinum	90.00	90.00	100.00	Hydrobius fuscipes	10.00	0.00	0.00
Echinogammarus trichiatus	80.00	50.00	0.00	Calopteryx splendens	0.00	20.00	0.00
Echinogammarus ischnus	70.00	60.00	50.00	Caenis macrura	0.00	10.00	0.00
Naididae	70.00	50.00	100.00	Gerris lacustris	0.00	10.00	0.00
Erpobdella vilnensis	60.00	10.00	20.00	Antocha sp.	0.00	0.00	20.00
Gammarus tigrinus	60.00	100.00	30.00	Bryozoa	0.00	0.00	50.00
Dryops sp.	60.00	10.00	10.00	Criodrilus lacuum	0.00	10.00	0.00
Orthocladinae	60.00	50.00	100.00	Ephydatia fluviatilis	0.00	0.00	90.00
Proasellus coxalis	50.00	40.00	0.00	Dreissena polymorpha	0.00	0.00	80.00
Bithynia tentaculata	50.00	30.00	70.00	Micronecta sp.	0.00	10.00	0.00
Sphaeriidae	40.00	40.00	0.00	Hydroptila sparsa	0.00	0.00	50.00
Pisidium supinum	40.00	50.00	0.00	Stenochironomus sp.	0.00	10.00	0.00
Limnephilus lunatus	40.00	10.00	0.00	Tabanidae	0.00	10.00	0.00
Potamopyrgus antipodarum	30.00	50.00	20.00	Radix balthica	0.00	0.00	30.00
Pisidium	30.00	30.00	0.00	Hemimysis anomala	0.00	30.00	0.00
Ceratopogoninae	30.00	0.00	0.00	Sigara sp.	0.00	10.00	0.00
Tinodes pallidulus	20.00	20.00	30.00	Hydroptila forcipata	0.00	0.00	10.00
Oligochaeta	20.00	10.00	0.00	Sphaerium corneum	0.00	10.00	0.00
Helobdella stagnalis	20.00	10.00	0.00				
Halipus sp.	20.00	0.00	0.00				
Radix sp.	10.00	0.00	100.00				
Enchytraeidae	10.00	0.00	0.00				
Tanytarsini	10.00	20.00	40.00				
Laccobius sp.	10.00	0.00	0.00				
Corbicula fluminea	10.00	20.00	0.00				

Appendix 10.2-2

Dominance distribution MZB, River Weser at Stolzenau, May 2006

(Shown as percentage (%) of all individuals)

Taxon	AU1	AU2	RU	Taxon	AU1	AU2	RU
Gammaridae	58.33	44.78	48.19	Laccobius striatulus	0.01	0	0
Dikerogammarus villosus	26.3	20.31	1.64	Laccobius sp.	0.01	0	0
Echinogammarus ischnus	6.44	0.68	0.06	Tanypodinae	0.01	0.25	0.01
Gammarus tigrinus	1.42	1.44	0.02	Tinodes waeneri	0.01	0	0.18
Jaera istri	1.4	1.91	1.48	Noterus clavicornis	0.01	0	0
Chironominae	1.16	5.71	3.47	Cercyon tristis	0.01	0	0
Echinogammarus trichiatus	1.07	0.81	0	Hydroptila sp.	0.01	0.14	0.23
Pisidium sp.	0.58	1.46	0.01	Neomysis integer	0.01	0.1	0
Chelicorophium curvispinum	0.44	0.51	1.8	Eiseniella tetraedra	0.01	0.02	0
Tubificidae	0.43	15.91	0.01	Anacaena bipustulata	0.01	0	0
Hypania invalida	0.39	1.02	0.05	Hydrobius fuscipes	0.01	0	0
Ancylus fluviatilis	0.31	0.88	16.39	Calopteryx splendens	0	0.03	0
Sphaeriidae	0.18	0.19	0	Caenis macrura	0	0.02	0
Musculium lacustre	0.18	0.74	0	Gerris lacustris	0	0.02	0
Dryops sp.	0.15	0.03	0.01	Antocha sp.	0	0	0.04
Orthocladinae	0.12	0.29	0.87	Bryozoa	0	0	0.01
Bithynia tentaculata	0.12	0.05	0.2	Criodrilus lacuum	0	0.03	0
Naididae	0.12	1.76	22.43	Ephydatia fluviatilis	0	0	0.01
Erpobdella vilnensis	0.1	0.03	0.03	Dreissena polymorpha	0	0	0.08
Proasellus coxalis	0.09	0.19	0	Micronecta sp.	0	0.02	0
Pisidium supinum	0.09	0.14	0	Hydroptila sparsa	0	0	0.04
Limnephilus lunatus	0.07	0.02	0	Stenochironomus sp.	0	0.02	0
Pisidium supinum/henslowanum	0.06	0.05	0	Tabanidae	0	0.02	0
Corbicula fluminea	0.05	0.03	0	Radix balthica	0	0	0.02
Helobdella stagnalis	0.04	0.02	0	Hemimysis anomala	0	0.07	0
Enchytraeidae	0.04	0	0	Sigara sp.	0	0.02	0
Potamopyrgus antipodarum	0.04	0.12	0.01	Hydroptila forcipata	0	0	0.01
Ceratopogoninae	0.04	0	0	Sphaerium corneum	0	0.02	0
Oligochaeta	0.02	0.02	0				
Tinodes pallidulus	0.02	0.1	0.06				
Halipus sp.	0.02	0	0				
Radix sp.	0.02	0	2.63				
Tanytarsini	0.01	0.05	0.04				

Appendix 10.2-3

Animal group distribution, MZB River Weser at Stolzenau, May 2006

(Shown as percentage (%) of all individuals and taxa)

Animal group density of individuals[%]	AU1	AU2	RU	Animal group number of taxa[%]	AU1	AU2	RU
GASTROPODA	0.49	1.05	19.25	GASTROPODA	9.09	6.98	16.67
BIVALVIA	1.14	2.62	0.09	BIVALVIA	13.64	16.28	6.67
OLIGOCHAETA	0.63	17.74	22.44	OLIGOCHAETA	11.36	11.63	6.67
POLYCHAETA	0.39	1.02	0.05	POLYCHAETA	2.27	2.33	3.33
HIRUDINEA	0.14	0.05	0.03	HIRUDINEA	4.55	4.65	3.33
CRUSTACEA	95.5	70.8	53.19	CRUSTACEA	20.45	23.26	20
DIPTERA	1.34	6.33	4.44	DIPTERA	11.36	13.95	16.67
EPHEMEROPTERA	0	0.02	0	EPHEMEROPTERA	0	2.33	0
ODONATA	0	0.03	0	ODONATA	0	2.33	0
HETEROPTERA	0	0.05	0	HETEROPTERA	0	6.98	0
COLEOPTERA	0.25	0.03	0.01	COLEOPTERA	18.18	2.33	3.33
TRICHOPTERA	0.12	0.25	0.5	TRICHOPTERA	9.09	6.98	16.67
PORIFERA	0	0	0.01	PORIFERA	0	0	3.33
BRYOZOA	0	0	0	BRYOZOA	0	0	3.33
EPT / CRUST	0.001	0.004	0.009	EPT / CRUST	0.444	0.4	0.833
EPT / (CRUST+BIVAL)	0.001	0.004	0.009	EPT / (CRUST+BIVAL)	0.267	0.235	0.625
rK Class 1 [Ind/m ²]	91	90	228				
rK Class 2 [Ind/m ²]	48	77	14				
rK Class 3 [Ind/m ²]	97	298	736				
rK Class 4 [Ind/m ²]	30	51	7				
rK Class 5 [Ind/m ²]	3908	2243	9941				
rK Class 6 [Ind/m ²]	1734	974	284				
rK Class 7 [Ind/m ²]	2	0	404				
rK Class 8 [Ind/m ²]	5	1	0				
rK Class 9 [Ind/m ²]	2	2	0				
rK Class 10 [Ind/m ²]	0	0	0				
rK Class 11 [Ind/m ²]	0	0	0				
Nos. of r individuals [Ind/m ²]	236	466	978				
Nos. of K individuals [Ind/m ²]	5680	3271	10636				
Nos. without classification	554	965	3490				
r dominance [%]	3.99	12.46	8.42				
Total individ. density [Ind/m ²]	6501	4726	15385				
rK diversity	0.84	1.09	0.61				



Appendices

to

Chapter 12

Appendix 12.1

Specification test stretch Stolzenau, River Weser Km 241.550 – 242.300, right bank

Annex 12.1



Bundesanstalt für Gewässerkunde / Bundesanstalt für Wasserbau



Studies on Alternative Technical-Biological Bank Protection Measures Applied on Inland Waterways

Research project

SPECIFICATION

Test section Stolzenau, River Weser Km 241.55 – 242.30, right bank
Technical-Biological Bank Protection Measures and Boundary Conditions

(1) Bank protection methods and their evaluation	Planting methods	Success of planting	Value regarding nature protection ⁷⁾
	<p>Planting common reed and sedges</p> <p>a) <u>Planting plugs and sods of common reed</u> on flattened bank slopes protected by stone mounds or berms, in some stretches additionally with fascines or vegetation fabric</p> <p>b) <u>Planting plugs and sods of common reed</u> on steep bank slopes where stones have been removed, protected by vegetation fabric</p> <p>c) <u>Planting plugs and sods of common reed</u> on unmodified bank slopes (i.e. steep and protected with armour stones) with or without protection from training structures or fascines</p> <p>d) <u>Planting plugs and sods of sedges</u>; varying topography and protection as in a) to c)</p> <p>e) <u>Reed mats</u> on flattened bank slope</p> <p>Planting woody plants</p> <p>f) <u>Willow cuttings and long branch cuttings</u> on flattened bank slopes protected by training structure or stone mound</p> <p>g) <u>Willow cuttings and long branch cuttings</u> on unmodified bank slope, if placed close to the water line and protected by stone mound</p> <p>h) <u>Brush mattresses of willows</u> on flattened as well as on steep bank slopes, if armour stones have previously been removed</p> <p>i) <u>Alder plantings</u> in the upper part of unmodified bank slopes</p> <p>j) <u>Willow cuttings and long branch cuttings</u> if placed in the upper part of the (flattened or unmodified) bank slope</p>	<p>Very good</p> <p>Good</p> <p>Good</p> <p>Good¹⁾</p> <p>Moderate²⁾</p> <p>Very good</p> <p>Very good</p> <p>Very good</p> <p>Failed³⁾</p> <p>Failed⁴⁾</p>	<p>Very high value⁵⁾</p> <p>Medium to high value⁶⁾</p> <p>Medium to high value⁶⁾</p> <p>Of medium value</p> <p>-</p> <p>Medium to high value</p> <p>Medium to high value</p> <p>Medium to high value</p> <p>-</p> <p>-</p>
	<p>¹⁾ In 2005 often still in places where originally planted, without any tendencies to spread</p> <p>²⁾ In the first years, the common reed plants of the mats showed poor growth and low vitality. The later development cannot clearly be retraced.</p> <p>³⁾ Probably dried up (due to lack of precipitation and irrigation) or affected by the lethal alder disease (phytophthora)</p> <p>⁴⁾ Presumably dried up (due to lack of precipitation and irrigation)</p> <p>⁵⁾ In 2005 wide common reed stands, i.e. also of benefit to fauna</p> <p>⁶⁾ In 2005 relatively narrow, though vital common reed stands</p> <p>⁷⁾ By 2005, the test section achieved, as a whole, a high value in terms of nature protection; this was due to its habitat diversity i.e. the way in which the planted and unplanted sections had developed.</p> <p>Note: Below the water level (mean low water) the slopes – with a continuous inclination of 1 : 3 – are protected with class III armour stones in accordance with TLW 1993 (<i>TLW – Technical supply conditions for armorstones</i>).</p>		
(2) Body responsible for project	WSA Verden, in cooperation with BfG and BAW		
(3) Start year	1988/89		
(4) Monitoring	Examined and documented between 1989 and 2007: waterway geometry, ground, ground water and river water levels, hydraulic bank load resulting from navigation and natural river flow, vegetation, birds, fish, macrozoobenthos		

(5) Bank geometry	<p>- slip-off slope - slope inclinations 1 : 3.5 to 1 : 7 (1 : 8) - partly with stone mound in front of alternative protection measures, shallow water zone, training structure or berm</p> <p>In the test section only minor changes in the slope geometry had occurred by 2007. Even relatively steep slope sections, where riprap had been replaced by live brush mattresses or reed beds, had remained stable to a very large extent.</p>																
(6) Ground	<p>In the immediate bank area, up to approx. 3 m below the upper edge of the terrain (corresponding roughly to the mean low water level) the native soil mainly consists of silts bearing sandy or clayey constituents and partly also of silty or gravelly sands. Below this, the Weser Gravel begins (intermittently to widely graded medium to coarse sandy gravel, 0.2 mm to 60 mm) with a depth of 6 to 8 m.</p>																
(7) Navigation	<p>Number of vessels (calculated from number of lockings) <u>Freighters:</u> approx. 500 / year; approx. 20 / working day <u>Recreational, passenger, other vessels:</u> approx. 100 / year (journeys within the reach are <u>not</u> recorded!)</p> <p>Dimensions (mean/maximum from down- and upstream travel taken from traffic observation)</p> <table border="0" style="width: 100%;"> <tr> <td colspan="2"><u>Freighters</u> (motor cargo and motor tank vessels, push-tow units)</td> <td colspan="2"><u>Recreational craft</u></td> </tr> <tr> <td>Length:</td> <td>76 m (max. 114 m)</td> <td>Length:</td> <td>9.1 m (max. 15 m)</td> </tr> <tr> <td>Width:</td> <td>8.5 m (max. 9.5 m)</td> <td>Width:</td> <td>3.4 m (max. 4 m)</td> </tr> <tr> <td>Draught:</td> <td>1.8 m (max. 2.5 m)</td> <td>Draught:</td> <td>1 m (max. 1.6 m)</td> </tr> </table> <p>Data on journeys (minimum/mean/maximum from down- and upstream travel taken from traffic monitoring)</p> <p><u>Freight ships</u> (motor cargo and motor tank vessels, push-tow units) Distance from the bank: 52 m (min. 38 m / max. 67 m) Vessel speed: 11.5 km/h (min. 7.0 km/h / max. 16.5 km/h)</p> <p><u>Recreational craft</u> Distance from the bank: 47 m (min. 15 m / max. 75 m) Vessel speed: 16.4 km/h (min. 7.7 km/h / max. 58 km/h)</p>	<u>Freighters</u> (motor cargo and motor tank vessels, push-tow units)		<u>Recreational craft</u>		Length:	76 m (max. 114 m)	Length:	9.1 m (max. 15 m)	Width:	8.5 m (max. 9.5 m)	Width:	3.4 m (max. 4 m)	Draught:	1.8 m (max. 2.5 m)	Draught:	1 m (max. 1.6 m)
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(8) Hydraulic loads	<p><u>Shear stress (τ):</u> $\leq 6 \text{ N/m}^2$ <u>Flow velocity (v):</u> $\leq 1 \text{ m/s}$ <u>Wave heights:</u></p> <table border="0" style="width: 100%;"> <tr> <td>Drawdown:</td> <td>0.14 m (max. 0.39 m)</td> </tr> <tr> <td>Stern waves:</td> <td>0.15 m (max. 0.64 m)</td> </tr> <tr> <td>Secondary waves:</td> <td>0.06 – 0.08 m (max. 0.41 m)</td> </tr> </table> <p>All values given here refer to the loads in the bank area by 2007. Shear stress and flow velocity values are noticeably below the load-bearing capacity limits – known from the literature – of the technical-biological bank protection measures applied here. The ship-induced waves mentioned here can be absorbed by the bank protection measures without damage. As limiting values for the capacity of bearing load resulting from ship waves are not yet known from the literature, further experience needs to be made within this research project in order to make valid statements as to whether waves higher than those measured here can be absorbed without damage.</p>	Drawdown:	0.14 m (max. 0.39 m)	Stern waves:	0.15 m (max. 0.64 m)	Secondary waves:	0.06 – 0.08 m (max. 0.41 m)										
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(9) Evaluation of fauna	<p>In spring and summer 2006 the area with alternative bank protection and, as a reference, an area of traditional bank protection were examined regarding animal ecology. For this purpose, inventories were taken of birds, fish (especially juvenile fish) and macrozoobenthos. This revealed an increased density of juvenile fish as well as a higher diversity of birds and macrozoobenthos in the alternatively protected bank section, including some Red List species. Therefore the evaluation of the alternative bank protection applied in the Stolzenau stretch has a positive result regarding animal ecology. Continued monitoring in a 5 to 10 year rhythm would be desirable.</p>																
(10) Overall result	<p>After 20 years of operation, the current state of the technical-biological bank protection measures can be estimated as being very good – with the exception of the issues stated under (1). Under the given boundary conditions, almost all planting measures could develop in a positive manner. The bank protection provides good protection from erosion. The banks are in a stable condition. From the perspective of the WSA, so far no maintenance measures have been necessary. (Future maintenance needs are referred to in the report.)</p>																
<p>Publication: Report "Studies on Alternative Technical-Biological Bank Protection Measures Applied on Inland Waterways (R&D project) Part 2: Test Section Stolzenau / River Weser km 241.55 – 242.30"; BfG-No.:1579, BAW-No.: 2.04.10151.00, Aug. 2008. (http://www.baw.de/ufersicherung/ or http://www.bafg.de/ Starting page > The BfG > Organisational structure > Department U3 > information on this topic provided in German)</p>																	
<p>Contact: BAW: Petra Fleischer, Dept. Engineering, Section G4: +49 (0)721 9726 3570 Dr Renald Soyeaux, Dept Hydraulic Engineering, Section W4 +49 (0)721 9726 3650 BfG: Hubert Liebenstein, Ecology Division, Dept. U3: +49 (0)261 1306 5445 Dr Jochen H.E. Koop, Ecology Division, Dept. U4: (0)261 1306 5404</p>																	
<p>Status: 19 August 2008</p>																	



Appendix 12.2

Recommendations for a monitoring programme

Recommendations for a monitoring programme

Objective: If bank protection along a federal waterway is implemented using alternative technical-biological measures, the following monitoring programme is recommended for documenting the success and durability of these measures.

Waterway geometry	→ Measuring of cross sections in the bank zone, including river bed and slope, using a sufficiently fine grid, before and after the measure (immediately after implementation, and subsequently once per annum).
Hydrology/ hydraulics	<ul style="list-style-type: none"> → Documentation of the water level hydrograph → Documentation of the discharge hydrograph → Measuring and documentation of flow velocities (volume, direction) in the area of the measure; the proportion of influence from shipping should also be documented as far as possible – if necessary, repeat measurements once after installation of the bank protection measures. → Measurement and documentation of water level fluctuations in the area of the measures; the proportion of influence from shipping should also be documented as far as possible
Ground	<ul style="list-style-type: none"> → Ground assessment (ground expertise or additional exploratory borings should be available.) → Documentation of the groundwater situation – documentation of ground water levels in the hinterland
Navigation	<ul style="list-style-type: none"> → Documentation of the current navigation fleet (ship types) → Recording of typical technical data of the ships (length, width, draught, type of propulsion, engine capacity) → Documentation of traffic density - traffic statistics (e.g. using lock records)
Fauna	→ Inventory / documentation: before and immediately after construction, and after 1, 3, 6 and 10 years
Vegetation	<ul style="list-style-type: none"> → Inventory / documentation: before and immediately after construction, and after 1, 3, 6 and 10 years; subsequently every 10 years, if needed → Maintenance plan (monitoring every 10 years and, if required, improvements)
General	→ Photographic documentation at suitable intervals (annually)

Contact:

BAW: Petra Fleischer, Dept. Engineering, Section G4: +49 (0)721 9726 3570

Dr Renald Soyeaux, Dept Hydraulic Engineering, Section W4 +49 (0)721 9726 3650

BfG: Hubert Liebenstein, Ecology Division, Dept. U3: +49 (0)261 1306 5445

Dr Jochen H.E. Koop, Ecology Division, Dept. U4: (0)261 1306 5404