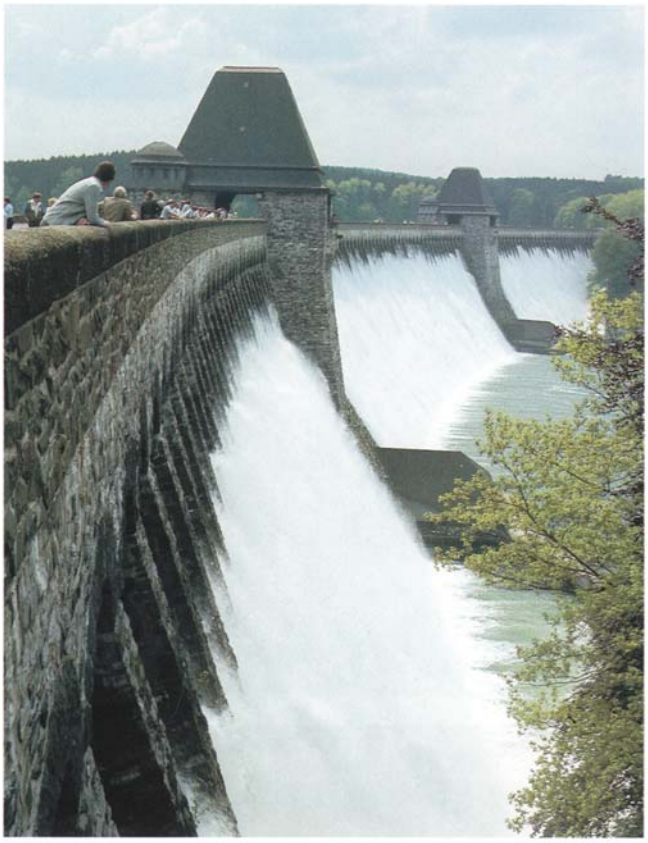
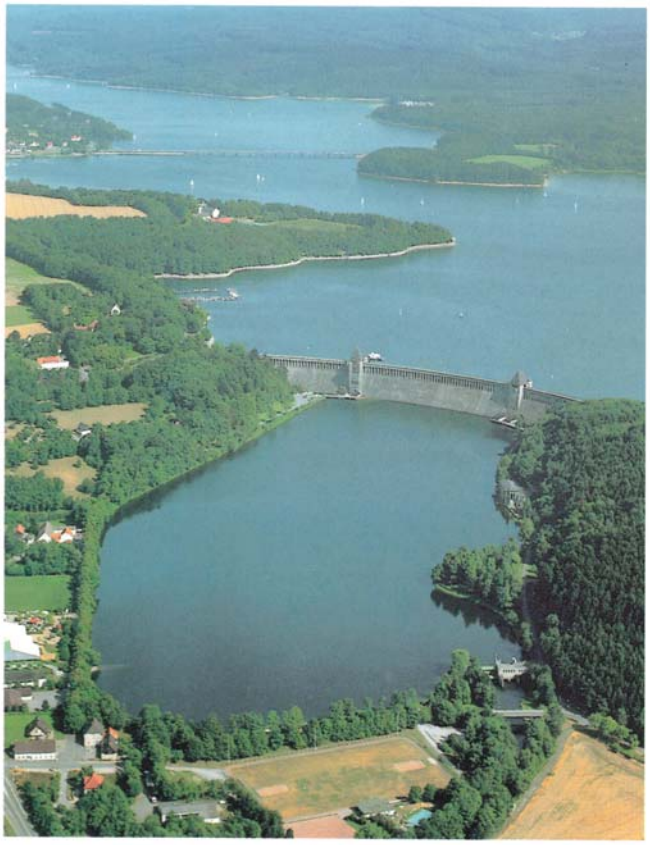
Ruhrverband





Ruhrverband

Information department
Kronprinzenstraße 37
D-45128 Essen
Phone 0201 / 178-0
Fax 0201 / 178-1425

Printed on
chlorine-free paper

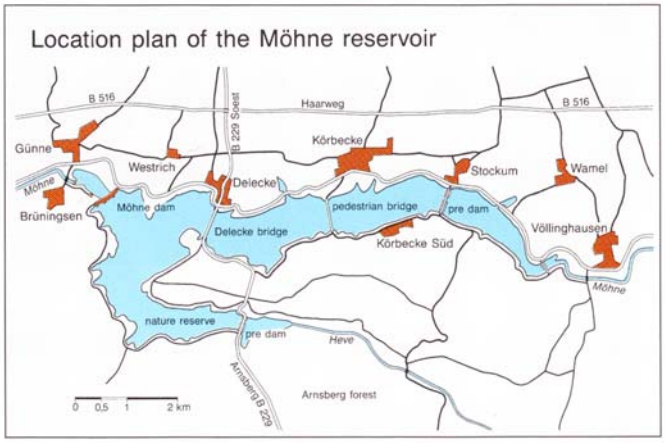
10000-9-1995

The Möhne Dam and Reservoir

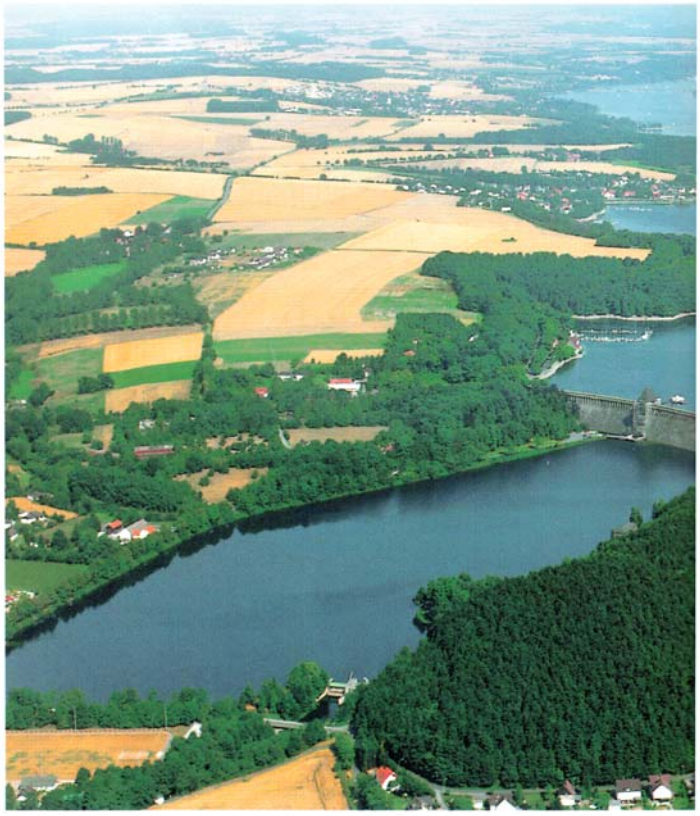
The Möhne Dam and Reservoir

The water supply for the urban conglomeration of the Ruhr District is mainly provided by abstraction of water from the Ruhr River. Due to the natural flow regime of the river and losses of water resulting from water export to adjacent river basins, the demand can only be met continually by the operation of reservoirs on the tributaries of the Ruhr River. These reservoirs store the water during times of high river flow and discharge supplemental water during times of a low natural flow. Therefore the reservoirs provide flood protection and guarantee a minimum flow in the Ruhr River during drought periods.

The Ruhr Reservoirs Association (in German: Ruhrtalsperrenverein) was founded in 1899 as an organization of civil law and was changed into a public corporation in 1913. This association built and operated a system of reservoirs in the catchment area of the Ruhr. In 1990, the Ruhr Reservoirs Association was united with the Ruhr River Association (in German: Ruhrverband), an organization responsible for water quality management. The new water association is called Ruhrverband and is responsible for both, water quantity and water quality management. Besides that the Ruhr River Association facilitates various leisure activities at the Ruhr and the reservoirs.



The Möhne dam – at that time one of the largest reservoirs in Europe – was put into operation in 1913 by the Ruhr Reservoirs Association after a construction time of only five years. It became one of the most important sources of water supply of the Ruhr area. As it covers more than 25% of the storage capacity of all reservoirs along the Ruhr it still plays an important role in controlling the water flow of the Ruhr River. The volume needed for water supply is abstracted from the "travelling wave" of the

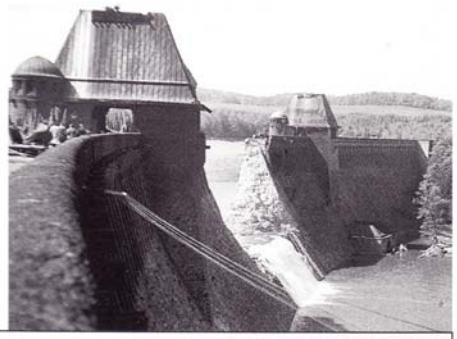


river. The reservoir with its masonry dam, which is 650 m long and up to 40 m high, has a storage capacity of 134.5 million m^3 of water. The water which is discharged from the reservoir during normal operation is used for energy production in a power station just below the dam. Nevertheless, the amount of water discharged depends on the needs of water quantity management along the river. The generation of hydro power is a side benefit. From the main power station the water flows into the compensating reservoir from which the water is steadily discharged into the Möhne River via a secondary power station. The power stations are operated by the Lister- and Lennekraftwerke GmbH in Olpe, a 100% subsidiary of the Ruhr River Association.

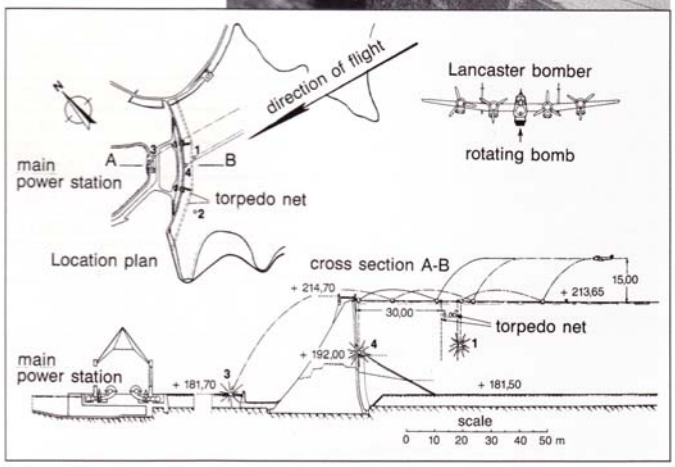
During World War II in the early morning hours of May 17th 1943, the Möhne dam was severly damaged by a bomb attack. The dam was destroyed to a height of 23 m and over a length of 77 m. The following flood wave of about 110 million m^3 of water and a height of 6 - 7 m killed more than 1,200 people and devastated the Möhne valley. It also caused serious damage at the lower reaches of the Ruhr valley. The main power station of the Möhne dam was completely destroyed and the compensating reservoir beneath the dam was swept away. Despite of all the difficulties of that time the breach in the dam was closed the same year. Thus, the reservoir could soon be used again to provide water for the Ruhr area.

In 1950 the Ruhr Reservoirs Association began to restore the power stations and the compensating reservoir. The new main power station was situated near the outlet of the former drawoff tunnel on the left slope. This tunnel got a steel lining and now serves as a penstock.

In case of a misfunction of the main power station or in case of an exceeding of its discharge capacity the water is released from the reservoir by two groups of bottom outlet systems with two independent bottom outlets each. The outlets of each group consist of an annular piston valve allowing a direct regulation of the discharge and a flat slide valve with conical jet. The four bottom outlets lead into the compensating reservoir.



The destroyed dam after the attack of British bombers



The air raid in May 1943

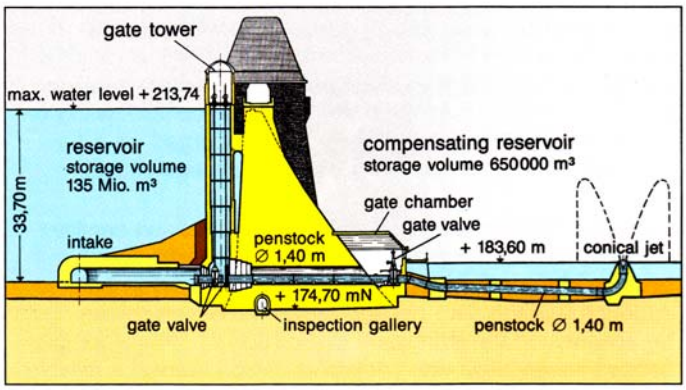
The seepage could thus be reduced to a safe level. Today the additionally constructed control and drainage system allows a permanent monitoring of the seepage.

Since 1992 the 80 year old bottom outlets inside the gate towers have been replaced and the gate towers have been sealed. Because of its importance for the water management the Möhne reservoir is in operation during the entire repair works. Therefore a great deal of the work can only be performed by divers.

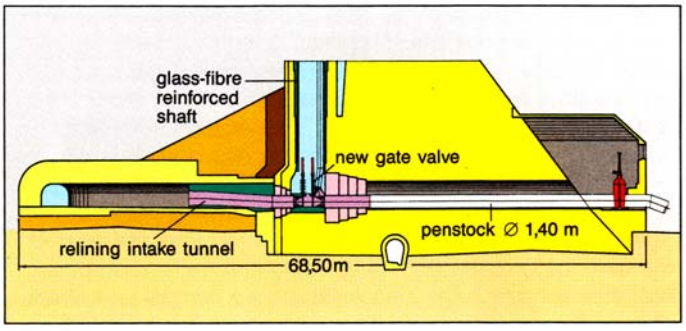
Since 1992 as well the downstream face of the dam is under reconstruction. 20,000 m² of masonry damaged by weathering have to be repaired and partly replaced.

During the time of construction of the Möhne dam two pre-reservoirs had been constructed at the tailback where the Möhne and Heve Rivers flow into the reservoir. The pre-dam "Stockum" which is 13 m high and 600 m long with a 60 m long weir stores the water at a relatively constant level. Thus, effects of swamping can be avoided in the shallow inflow area of the reservoir. In addition, the pre-reservoir has its individual

Cross section of the dam with bottom outlet (before rehabilitation)



Cross section of bottom outlet III after rehabilitation



105 outlets are located as flood spillway at the crest of the dam amounting to a total length of 262.5 m. As these outlets are well distributed over three quarters of the dam's length one gets the impression that in case of overflow the dam is entirely flooded.

The downstream side of the dam is designed in such a way that projecting blocks already ensure a considerable part of the energy dissipation of the overflowing water. The main energy dissipation takes place in the compensating reservoir which in this case works as a stilling basin. From the compensating reservoir large volumes of water can be discharged via a fish belly flap gate right next to the secondary power station.

Dams are complex technical structures which need constant maintenance and control. In the course of several decades it became obvious that due to ageing and weathering the seepage through the dam became larger. Similar processes could be observed in the foundation of the dam. In 1970 a comprehensive investigation was undertaken which allowed a reliable evaluation of the present condition of the dam and the foundation.

The internal structure of the dam and the bedrock were examined by core drillings which reached down to a depth of 60 m below the base of the dam. The results showed that considerable measures of rehabilitation had to be taken. As a first measure a gallery for working, drainage and inspection was driven through the dam in the transition zone between the dam and the underground. In 1974 this gallery was completed after two years of construction while maintaining the water at a normal reservoir level. From this gallery and from the crest of the dam the grouting of both the dam and the underground was then executed. Grouting materials like cement and elastic chemicals were injected into a complex system of boreholes.

biological conditions different from those of the main reservoir and it thus serves an important function in terms of water quality management. For the discharge of water from the pre-reservoir there are three bottom outlets integrated into the dam.

In 1982 and 1983 the pre-dam "Stockum" had to be reconstructed extensively as its stability was endangered due to erosion damages at the downstream face of the dam. The dam is now durably protected against the waves by a solid rockfill with a special wave protection at the crest of the dam.

The reservoirs are surrounded by forests which protect the stored water. These forests are being ecologically cultivated by the Ruhr River Association. In shore protection and other construction activities also ecologically sound methods are applied.

Technical data

Water management	
Storage capacity	134.5 million m³
thereof Möhne pre-reservoir	7 million m³
thereof Heve pre-reservoir	0.8 million m³
Maximum water level	213.74 m above mean sea level
Catchment area	436 km²
Average annual inflow (1968-1993)	193.6 million m³
Storage ratio	0.69
Surface area at maximum storage	1,037 hectare
Storage capacity of compensating reservoir	0.65 million m³
Maximum water level of compensating reservoir	183.60 m above mean sea level
Flood storage capacity (Nov.-April)	max. 10 million m³

Dam	
Maximum height of crest	40.3 m
Lenght of crest	650.0 m
Maximum width of dam	34.2 m
Radius of curvature	parabolic curve $y^2 = 1000\ x$
Maximum width of crest	6.25 m
Volume of dam	267,000 m³
Total overflowable length of crest	262.50 m

Bottom outlets	
Four steel tubes in tunnels, diametre arranged in two groups with two outlets each	1.40 m
Downstream outlet elements: each group 1 annular piston valve with a maximum discharge of 1 flat slide valve with conical jet with a maximum discharge of	 25 m³/s 23 m³/s

Discharge facilities of the compensating basin	
Fish belly flap gate, driven oil-hydraulically:	
Width	15.0 m
Height	3.88 m
Maximum discharge	190 m³/s
Bottom outlet:	
Width	4.60 m
Heigth	2.70 m
Maximum discharge	40 m³/s

Main power station	
Inflow via steel lined penstock:	
Diametre	3.40 m
Length	200 m
Diametre of manifold to turbines	2.30 m
2 Kaplan-turbines with vertical, synchronous AC-generators, each aggregate:	
Effective head	32.0 m
Discharge	12 m³/s
Capacity	3,500 kW
Average annual energy output	12,9 million kWh

Secondary power station	
2 Kaplan-turbines with vertical, synchronous AC-generators, each aggregate:	
Effective head	6.40 m
Discharge	6 m³/s
Capacity	300 kW
Average annual energy output	1.9 million kWh

The power stations are operated by the Lister- and Lennekraftwerke GmbH in Olpe, a 100% subsidiary of the Ruhr River Association.