Typology 2 a: water supply and transport

Operations and systems for the movement of water masses in the transport of drinking and non-drinking water as well as in the creation of hydraulic engineering works.
With the onset of inhabited and agricultural centres, came the need to no longer exclusively rely on water from natural sources, with its variable quantity, excesses and shortages. A relatively simple but functional system was the creation of large brick basins or basins excavated in the rocky ground, which are gradually filled with rainwater during the year. Storage, including underground storage systems were created in anticipation of dry spells. The water could be easily lifted and distributed: The five primary issues associated with modern-day water supply that is its collection, lifting, transport, storage and distribution were already studied and resolved thousands of years ago. Water generally was and continues to be used for various purposes:
- for drinking water;
- for agricultural use;
- for industrial use;
- for the operation of sewer system;
- for defence purposes;
- for roadways.

It should not be forgotten that a continuous supply of water, such as that from the capture of perennial water streams involved and still involves a second factor: drainage. This task is fulfilled by sewers, which collect water discarded by consumers.

Aqueduct
Complex of hydraulic works for the capture of water and its transport from the point of origin to the consumers.
The term 'aqueduct' refers to a system, whether simple or complex, which allows the transfer of water from the point of supply to the point of use. The first distinction is between drinking and non-drinking water. Channelled drinking water acquires social and political connotations as well as financial connotations. When the community exceeds a certain population threshold, the continual intake of a significant amount of water becomes necessary. At least in the past, exceeding a certain population threshold could be directly linked to the possibility of increasing water intake.

The main works required in the creation of an aqueduct are the following:
water capture works: for water capture in places where water is naturally available;
supply conduit (or supply channel): this is needed to transport water from the point of capture to that of use, where "conduit" refers to generally cylindrical piping and "channel" refers to the closed channel or *specus*, with free surface water flow; an earthenware, *eternit* (made of asbestos and Portland cement fibres) or other type of conuduit is sometimes positioned in the *specus*; water is channelled through this to ensure quality and prevent pollution;
reservoir or storage works: used in the storage of water when consumption is inferior to supply and in the supply of water when the situation is reversed;
distribution network (network conduits): complex of small conduits or pipes for the transport of water to the supply points;
private installations: network of small channels or more commonly piping, linked to the distribution network and which directly supplies private consumers.

Artificial underground canal
Canal, either underground or through a relief.

An underground canal is a work normally cut into the rock or at any rate, directly into the soil. Canals for hydroelectric and industrial use were built both by underground excavation and by the cut and cover method (artificial vaulted canals).

Forced channel: used for its driving force, this type of canal can sometimes be cut into the rock or consist of pipes placed inside the tunnel.

Water diversion: this type of work is used to divert a watercourse. For example, in Italy sometime around the VI century B.C., the Etruscans built the Ponte Sodo near Veii (Rome). This tunnel was cut into the rock to channel and divert the watercourse.

Levada: type of irrigation canal found on the island of Madeira, predominantly excavated from the XV century onwards.

Artificial vaulted canal
Artificial vaulted canal – created either during construction of the canal or subsequently.
The floor and banks of an artificial canal constructed by surface excavation can be either natural or masonry-lined. There are many types of canal, due to different needs and purposes. Over time a canal may be provided with a vaulted covering, although there are many examples of these being created at the same time as the canal is built. An artificial vaulted canal may consist of large surface or underground water conduits.

Discharge channel (or discharge tunnel): this work helps keep certain works dry, such as certain fortification moats for example. At Fort Demonte in Valle Stura (Cuneo - Italy), an underground, XVIII century brick installation serves as a drain for rainwater and ice water, which would otherwise stagnate in the ditch surrounding Bastion of Saint Ignatius. 23.1 m of this is still practicable and leads to a circular chamber with three small drainage conduits. At approximately half-way is the floodgate housing, which can be actioned by an overlying countermine system.

Connecting shaft
Vertical structure for the passage of water.
Despite the attempts of our ancestors to avoid the flow of large masses of water through masonry wells or wells cut into the rock or through highly inclined channels of either material, certain hydraulic works for these very purposes have been found. One example can be seen at the San Cosimato rock on the River Aniene (Rome - Italy): the connecting channel between two aqueducts, the *aqua Claudia* and *aqua Marcia*, which supplied ancient Rome.

Drainage channel
Group of structures, in this case underground works, which drain and improve land subject to regular flooding and prone to water stagnation, for both production and sanitation purposes.
In central Italy, various underground structures were created for the drainage of land prone to water stagnation. Not always easy to comprehend, such installations consisted of one or more wells for the collection and removal of water. They were connected by underground passages, whose job it was to transport the liquid elsewhere. In Lalibela in Ethiopia, underground tunnels, cut into the rock, connected the ditches surrounding the monolithic churches to ensure the flow of meteoric water.

Filtering gallery
Hydraulic work for the collection and supply of infiltration water.
Masonry, tunnel-shaped structure located on one or more flood plain depressions where underground filaments of water merge. The side of the structure is equipped with weepholes, for the

capture of even modest amounts of groundwater. It can be used for drainage purposes or for the supply of water where water is scarce.

Under-river drainage tunnel: this is a specific work generally utilised for the capture of fluvial water, from beneath the riverbed.

Underground emissarium

Canal or channel which drains water into a drainage basin, channels river-water or connects two basins.

The territory's control and hydraulic works include underground man-made emissarii for the natural basins. In central Italy and particularly in the Colli Albani area in Latium (Italy) there are a high number of underground passages plus documented evidence of at least two effluents, probably created by the Etruscan and Latin civilisations.

The precise purpose of the artificial emissariums created in antiquity is debatable. Some believe that these were used for the drainage of lake basins, while others believe that they served to regulate or simply limit water level fluctuations during rainfall: as the basins had no natural effluents, flooding within the troughs would not have been infrequent. Given the range of hydraulic works known today, it cannot be excluded that some may have been drained intentionally; however, such cases only go to confirm that ancient populations were far more aware of the territory's ecological structure than we are today. It should be taken into account that a basin was primarily an immediate source of available water, however, through fishing, it also provided a source of food, and this was not to be underestimated. For these very reasons, even smaller basins may have been retained and not drained and would have been easily regulated by a spillway. In addition, this was an excellent source of irrigation water for cultivations situated beyond the confines of the water: passages and tunnels may thus have been designed with irrigation in mind and not solely for the regulation of water levels. On the other hand, the rise or persistence of malaria or the urgent need to cultivate land may have led to the basins being drained. An extended basin was difficult to regulate and even more difficult to drain, at least when using underground tunnels despite the fact that this may have been attempted by means of the Fucino (Italy) in Roman times. The modern emissary (or rather the discharge or drainage tunnel) had a drastic environmental impact and the Fucino plain suffered from the lack of water; this inconvenience was foreseeable and would not have been unknown to ancient civilisations. In order to avoid assessment errors, each and every emissary must be considered on its own right.

Vaulted, natural watercourse

Natural watercourse with subsequent addition of masonry banks and vaulted covering.

Over time and due to the intervention of man, a watercourse, be it a river or a stream, may change in appearance and move underground. This is especially true where urban settlements develop along its banks. Part of its natural bed may be replaced by an artificial canal or its banks may be reinforced with brickwork and covered to meet various requirements. In time it will become in all effects, subterranean.