Tercial

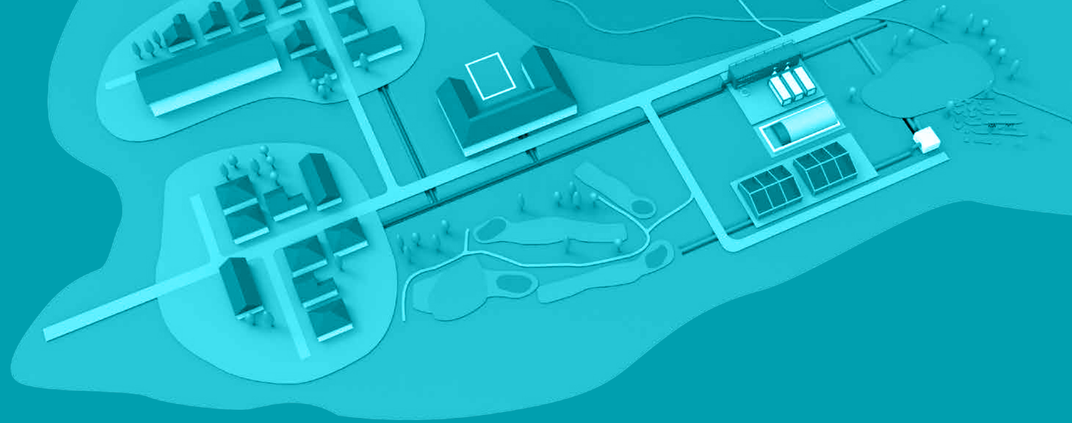
innovative wastewater treatment plants with a membrane bioreactor

Tercial

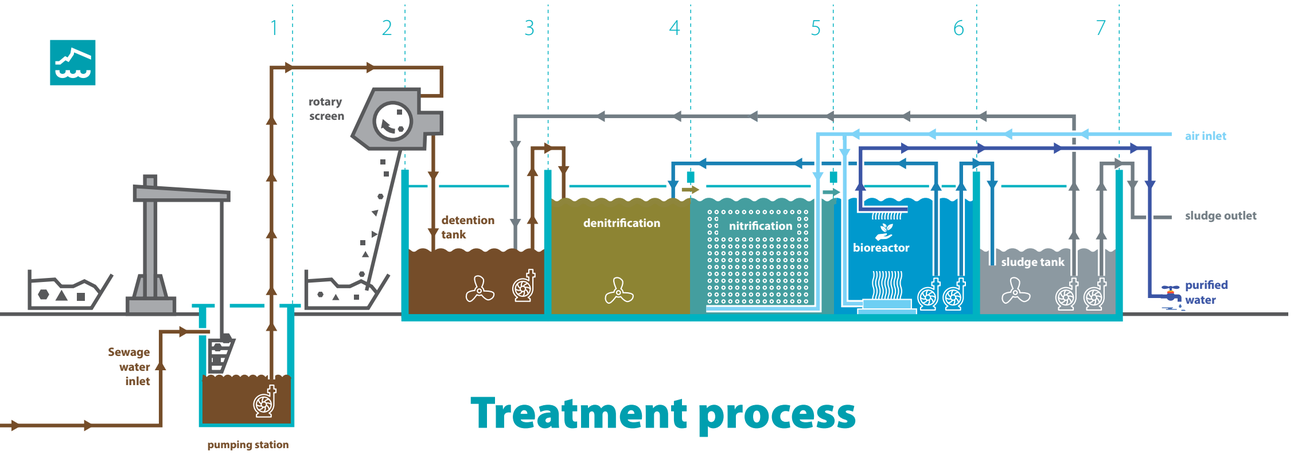
Environmental protection is one of the key values of Tercial, which is a member of BOST group. In cooperation with Slovak universities, it has developed a modern and innovative system of wastewater treatment using membrane bioreactors. Water Beast 700 is a modern container wastewater treatment plant with a treatment capacity of 100 m3/day, which is sufficient for approx. 700 PE (population equivalents).

Water Beast treatment plants achieve exceptionally high and stable treatment values over a long period. The treatment plants are suitable wherever it is too expensive to build a multi-kilometre long connection to existing sewage networks, in areas with increased environmental protection and where the construction time and the size of the built-up area play an important role.

- **municipalities**
- **industrial objects**
- **commercial objects**
- **crisis areas**
- **areas with an increased level of environmental protection**



- **1/3 built-up area compared to conventional WWTPs and low construction costs**
- **an application for remote control and for checking the condition from a PC, smartphone or tablet**
- **fully automatic and almost unattended operation**
- **a very short manufacture, installation and commissioning time, 3-6 months**
- **saving of costs related to the construction of a system of concrete tanks**
- **possibility of funding through EU funds, banks and leasing**
- **use of cleaned water as service water, the possibility of discharge into low-flow watercourses**
- **high treatment efficiency, for some indicators up to 99%**



Treatment process

Input pumping station – 1

The input pumping station is used to pump wastewater from the inflow sewerage level to the accumulation section of the process tank. The pumping station (PS) consists of a shaft with a diameter of 2-2,5m. Its depth depends on the depth of the input sewerage, inflow unevenness and is fully adapted to the local conditions. The PS includes a bar screen basket for retaining solids with gaps between individual bar screens of 20 – 25mm. When the basket is full, it is emptied into a collecting container using a bracket jib crane. Pumps in the pumping station will be designed for a maximum calculation inflow. One pump constitutes a 100% backup for the other one.

Mechanical pre-treatment – 2

The mechanical pre-treatment is provided by the bar screen basket in the input PS and subsequently by a rotary screen with openings with a diameter of 0.5mm. Here, insoluble substances of sizes larger than 0.5mm are separated from the inflow wastewater. Rotation of the drum pushes impurities into a chute and into an adjacent container. The rotary screen is located above the accumulation section of the process tank.

Biological treatment in the process container

The process container is divided into sections in which the biological treatment process takes place gradually using activated sludge (specific mixture of micro-organisms), which removes individual components of pollution during the biological treatment process. The tank consists of the following sections:

Accumulation section – 3

The accumulation tank is used to balance the inflow unevenness during the day, thus ensuring a continuous and uniform treatment process in the following sections. This section contains submersible pumps, which pump water into the next denitrification section. The pump is switched on and off depending on the setting of the level sensor and the level drop in further sections. The tank also contains a submersible propeller stirrer ensuring homogenisation of water intended for treatment. The accumulation section also receives back water returning from the sludge dewatering section.

Denitrification section – 4

The denitrification section follows the accumulation tank and is used to remove nitrogen pollution from the wastewater, namely by converting nitrate and nitrite forms of nitrogen into gaseous nitrogen. At the same time, partial degradation of carbon pollution stemming from the organic substrate takes place here. Correct functioning of the denitrification reactor requires continuous homogenisation of its content by the installed submersible propeller stirrer. The inlet of the recirculation, which ensures the return of activated sludge from the membrane bioreactor, also discharges into this section.

Nitrification section – 5

It follows the denitrification section, into which a mixture of polluted water and activated sludge flows gravitationally over an overflow edge. The nitrification section enables biological removal of carbon pollution, which reduces COD and BOD5, and, at the same time, oxidation of nitrogen pollution in the form of ammoniacal nitrogen up to nitrates takes place here. This process requires oxidation of treated water. For this purpose, fine-bubble membranes ensuring uniform airflow across the whole area of the section are located on the tank bottom. Necessary amount and pressure of air are ensured by a set of blowers located in the blowing plant.

Membrane bioreactor - MBR – 6

Treated water flows into the section by overflowing from the nitrification section. The section contains a membrane bioreactor embedded with membrane units with a total surface area of 420m2. Cleaned water rid of activated sludge and bacteria is extracted through pores in the membrane walls with a size of 0.04µm from the inside of hollow fibres into a collecting tank for cleaned water.

Cleaned water can be used for:

- Cyclical back-flushing of membranes.
- Spraying the rotary screen of mechanical pre-treatment.
- As service pressurised water for secondary use in the treatment plant.
- In the WWTP sanitary facility for flushing.

The flow of the mixture of treated water with sludge around the outer walls of the membranes is solved by an aeration system located at the bottom of the bioreactor.

The membraneless filtration process follows the following regime:

- 20-25 min. extraction of cleaned water from the membrane walls into the collecting tank.
- 5-7 min. a back-flushing of the membranes with the cleaned water from the collecting tank.
- 1 min. in the last phase of the flushing a chemical is dosed by injecting a sodium hypochlorite or citric acid solution. The whole process of cleaned water extraction and membrane module back-flushing cycles are programmatically controlled using the PLC system.

Extraction of cleaned water from the bioreactor tank causes sludge densification in the section. Submersible pumps with a backup are located in the section together with the bioreactor. These provide the following functions: the pumps provide the pumping of the returned sludge back to the treatment process in the denitrification section. The recirculation coefficient is adjustable within the range of 2–5 times the WWTP output.

An airlift pump is switched on automatically after the sludge density in the bioreactor section reaches 12-15g/l and pumps superfluous sludge into the sludge tank (sludge collector).

Sludge management – 7

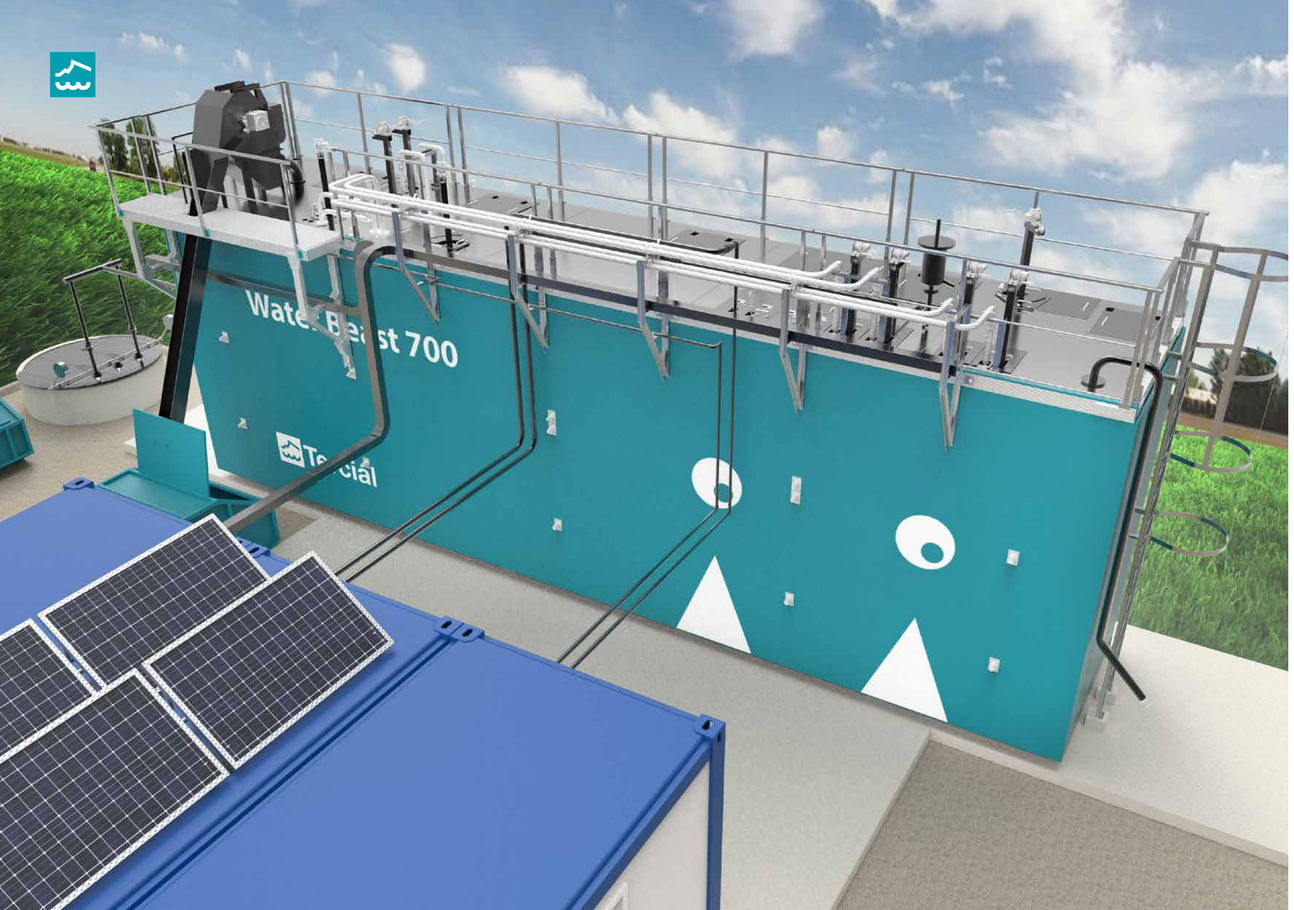
The last section in the process tank is the sludge tank, which is divided into two parts with a different volume by a dividing barrier. Superfluous sludge from the MBR section is pumped into the first part, whose volume takes up ¾ of the sludge collector, and not only gravitational densification of the sludge and the offsetting of sludge water, but also the completion of sludge stabilisation takes place here as it is provided with both a stirrer and aeration. The offset sludge water falls into the other tank part over the barrier and when it is full, it is pumped with the submersible pump into the accumulation tank. Homogenised sludge with dry matter of approx. 20-30g/l, which is monitored with a sludge probe, can be pumped out using a faecal suction truck or pumped into a sludge dewatering line.

Innovative solution

The membrane bioreactor MBR is a facility for perfect wastewater treatment.

Cleaned water is extracted through micro pores (0.04µm) in the walls of thousands of fine fibres of the membrane bioreactor.

Water thus cleaned does not contain almost any insoluble substances and most of the bacteria, which is why it can be used as service water for irrigation and for the restoration of natural water areas and wetlands.



Water Beast **700**

Container treatment plants with a membrane bioreactor

100 – 400 m³ WW/d³y designed for 700 – 2100 inhabitants

Container WWTPs are delivered pre-assembled. A very short time of delivery and putting the facility into operation from 3 to 6 months.

They consist of two basic modules, each with dimensions of a transport container for simple transport and assembly. They are equipped with the state-of-the-art treatment technology using membrane bioreactors.

The container tanks are covered. The covers are also used as service platforms for the maintenance and repairs of technological equipment. All the equipment inside the tanks (pumps, stirrers etc.) is adapted to allow its easy and quick replacement. The container tanks may be located on the surface, as half-embedded or fully embedded.

Depending on climatic conditions, the will be provided with suitable thermal insulation. Submersible equipment is already installed in the lower part. A service platform with laid segments of distribution pipelines is located in the upper part. Both parts will be joined together and sealed at the place of assembly. The inner surfaces of the tank and covers are provided with a special zinc-containing coating resistant to the water being treated.

In addition to the basic container modules, we also supply service containers containing supplementary technologies, a control centre, a blowing plant. The treatment plant is pre-assembled and during the on-site assembly it is only necessary to interconnect pipelines, electric distribution lines, process tanks and make a connection to the WW pumping station.

Water Beast **5000**

Wastewater treatment plants with a membrane bioreactor

800 – 3000 m³/day designed for 5,000 – 15,000 inhabitants

Water Beast 5000 offers a solution to minimize construction works and quickly deliver the treatment plant and put it into operation.

Process tanks are circular with inner division of individual tanks. They are made up of metal sheets enamelled on both sides, mutually screwed together and sealed. They are placed on a water-resistant reinforced concrete plate.

6m high tanks may be supplied as open or roofed, equipped with thermal insulation or without it. Auxiliary operating facilities consisting of a control room with a sanitary facility, a bioreactor and sludge dewatering control are also delivered fully assembled, at the construction site they just have to be mutually interconnected and connected to the process tanks. The technological equipment is supplemented with a sand separator and adapted to the designed output. The operation of this type of treatment plants is fully automatic with the possibility of remote control via mobile devices or PC. We give a WWTP with an output of 1000m3/day as an example. It consists of three circular tanks with the following parameters:

N1 - Accumulation tank

The accumulation tank is located in the circular tank itself with a diameter of 8.57m and height of 5.8m with a volume of 330m3. It contains a sand trap, a stirrer and pumps for pumping the treated water into biological treatment tanks. The mechanical pre-treatment and thereafter also the interception of fats and oils of plant and animal origin (if the character of mainly industrial WW requires it) takes place separately before entry into the accumulation tank.

N2 – Treatment process tanks

The treatment process tanks - they include 2 concentric circular tanks, the outer tank has a diameter of 11.14m and a height of 5.8m, the inner one 6.86m. The inner tank with a volume of 211m3 is used as a denitrification tank. The space in the annular area is divided into 3 parts with dividing walls: the anaerobic section with a volume of 71m3, the nitrification section 177m3 and the bioreactor section 106m3.

Supplementary technological equipment of the WWTP

Separation of ballast water from wastewater - OP1

This option is necessary in a place with a single-pipe system. The equipment – an overflow (OF) – is located in the preliminary shaft ahead of the inflow of the WW into the pumping station. The OF is a certified finished product allowing a WW volume of Qmax. to be conveyed into the WWTP and the WW volume to be relieved into the by-pass, thinned in a proportion required by legislation, which will flow to the recipient either through the rain tank or directly. The filling of the rain tank is enabled by a motor-operated slide, which opens and closes the entry into the rain tank from the by-pass. In the case of torrential rain, the slide opens from the by-pass into the rainwater retention tank. In normal operation, the slide is in the open position into the WWTP, closed into the by-pass. In the case of torrential rain, the inflow into the treatment plant is closed and the inflow into the by-pass or the rainwater retention tank opens simultaneously. The control may be remote or automatic via a rain sensor.

Sludge dewatering – OP2

The basic version envisages the transport of aerobically stabilised sludge, gravitationally densified to 20-25g/l using a faecal suction truck to the nearest big treatment plant for further processing. If it is not possible, we offer to add equipment for sludge dewatering by pressing using a screw press or a screen belt press. The pressed sludge cake contains 20% of dry matter and its further use must be in accordance with legislation on the handling of sewage sludge. It can be used as a garden or field fertiliser. Water from the press – the filtrate – flows into the collecting tank and returns to the accumulation section of the process tank via a pump. The equipment is located in a separate container together with a device for inserting and dosing a flocculant into the sludge before the pressing process. Composted sludge can be used as a quality garden or field fertiliser.

Reuse of the cleaned water – OP3

The quality of the cleaned WW and its wholesomeness allow its reuse for flushing the technological equipment for WW pre-treatment, sludge dewatering equipment, in sanitary facilities for flushing the toilet, the maintenance of green areas in the WWTP area etc. Further use of the cleaned WW is possible while using it as service water for agriculture, e.g. for irrigation during the growing season and other purposes. The equipment consists of a pressure water station connected to a distribution pipeline to places of its direct consumption. Cleaned WW not used for the above purposes flows into the recipient, to wetlands etc.

Removal of phosphates – OP4

This option is suitable for higher outputs and high pollution of wastewater by phosphate compounds and wherever required by environmental authorities. The treatment is done using the simultaneous coagulation technology. Phosphor is normally coagulated using ferric or ferric-aluminium coagulants, dosed into the denitrification section. The equipment consists of a separate solution reservoir and a dosing pump, which doses the chemical into the denitrification tank in a set ratio.

Solar panels – OP5

It is possible to use solar energy on the WWTP by installing photovoltaic cells. Energy gained from them is used for lighting, as a backup power supply for the control system, or to drive part of the technological equipment. The solar system contributes to the reduction of electricity running costs.

Operating facilities of the WWTP

Operating facilities are used to provide utilities, operating media and the overall operation of the treatment process in the basic configuration. These operating facilities are designed to be located in transport 20' containers with dimensions 6 x 2.4 x 2.52m and are delivered with the following equipment:

Blower operation facility – K1

The equipment in the container provides compressed air necessary for the aeration in the nitrification section, for the bioreactor and airlift pump modules. 3 pcs of Roots blowers are located here, 1 pc for nitrification, 1 pc for the bioreactor module and one backup blower with an automatic start for one or the other branch. Furthermore, distribution pipelines, a set of fittings and sensors. The operation is controlled from a central control room located in K3. The blower output is controlled using frequency converters and in the nitrification also based on oxide probe data.

Bioreactor automatic control operation facility – K2

The container contains a cleaned water balancing tank, reversing pumps for sucking off water from the bioreactor into the balancing tank. They also provide the flushing of membranes during reverse operation. The output of the pumps is controlled using frequency converters based on pressure and flow sensors. If the set membrane resistance is exceeded, they automatically switch the reverse operation to the back-flushing. If necessary, a container with the Fe-coagulant for phosphor coagulation can also be found here.

An automatic water station is also connected to the balancing tank. This automatic water station provides pressurised water for the rotary screen, a sludge dewatering line and other use of cleaned water for utility purposes.

Furthermore, chemical tanks can be found here, which are placed in safety tubs, as well as dosing pumps of chemicals, which inject a dose of a chemical (a sodium hypochlorite or citric acid solution) right at the entry of the back-flushing water into the bioreactor module at selected cycles during the membrane back-flushing.

Control room and sanitary facility – K3

Here is the room of the central electric switchgear and control system for the automatic control of the technological process of the WW treatment, the control of external lighting, heating, security cameras etc., with a direct connection to the internet network.

Another part houses a sanitary facility with a toilet, shower and a changing room for occasional operators, also a laboratory with basic equipment for taking samples and performing necessary analyses of the WW and sludge.

Remote control

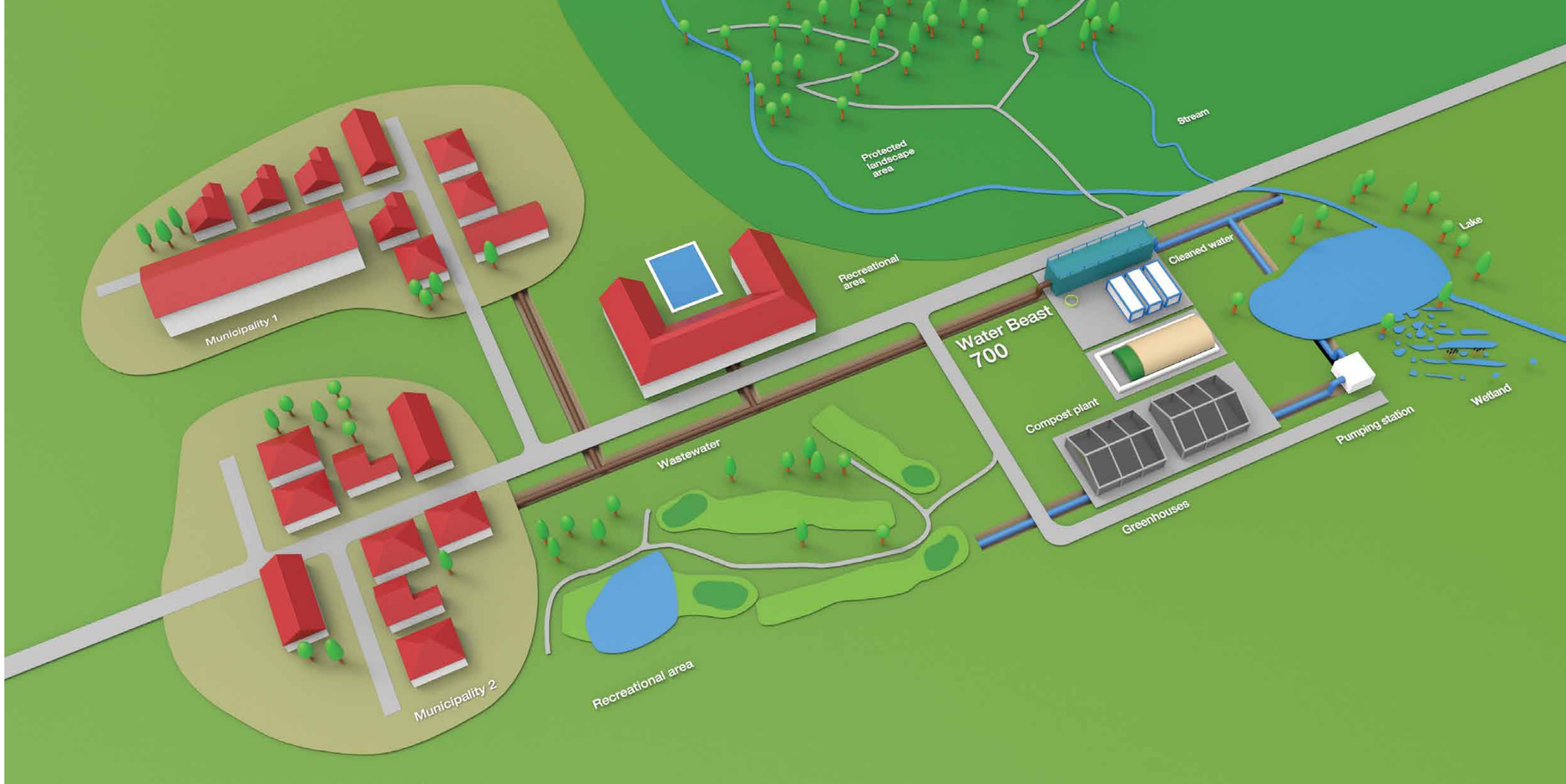
The latest generation of PLC, a database and visualisation system, works under both the Android and iOS systems. After it is connected via the internet, it is any time capable of monitoring the state, correcting the automatic WWTP control or switching the operation to the manual mode.

The visualisation system provides timely alerts to changes of process values beyond required ranges, which helps prevent emergency situations of the WWTP. For service purposes, it is possible to retrospectively monitor all states, alarms and messages. Remote diagnostics and preventive maintenance thus help you substantially reduce service costs and predict potential emergency situations. We offer the possibility to connect to the manufacturer's dispatching.

Statistical evaluation of selected process parameters representing the amount of cleaned water and energy consumption at selected time intervals goes without saying.

Proposal for the location of Water Beast **700** in the vicinity of a protected landscape area

A typical site for embedding a container WWTP with a MBR is an agglomeration of minor municipalities and settlements in mountain areas with recreational facilities with sports facilities, hotels and hostels. This is an opportunity to reuse well cleaned water and also a possibility to retain it in the area. The dewatered stabilised sludge produced from the WWTP is suitable for use in local compost plants and for agricultural purposes in plant production.



Bost group

BOST Group was founded in 1990 as BOST Vladimír Bielik based on experience in the area of automation and CNC machines. For 25 years we have been listening to and solving problems of our clients active in various industries.

In 2015, the company divided its activities into various areas according to the focus or project specialisation. Former BOST managers work as partners and executives in the management of the firms, which ensures value and knowledge continuity. During the division process, a structure was created allowing the foundation of new spin-off companies with the Group's capital and know-how support.

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