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POLLUTION OF THE PICHNA RIVER IN LIGHT OF THE REVALORISATION OF TOWN PARK IN ZDUŃSKA WOLA

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ABSTRACT

The historic town park in Zduńska Wola in its central and northern part is a designated conservation area pending on the local spatial development plan and the Registry of Historical Monuments. The composition of the park is diversified, with the highest elevation point in its northern part, sloping to the south towards the valley of the Pichna River which feeds two park ponds, including the bigger one with an island, which closes a compositional axis, and the smaller one – a remnant of a long gone fire-fighting reservoir. The area holds considerable natural values, because of an old-growth forest and the described water system. Extensive research and numerous analyses were conducted in the course of the preparations for the park revalorisation. They included an assessment of the sanitary condition of the Pichna River waters, which flow through the park and feed the ponds. It turned out that the level of contamination (caused, among others, by discharges of untreated water from the nearby traffic routes) made it impossible to carry out the revalorisation, while letting for the ponds to be further fed with the river waters. In order to ensure a satisfactory level of water quality and clearness in both ponds, a decision was made to introduce complex and advanced technology to renovate the water system. The introduced solutions gained recognition from the Provincial Fund for Environmental Protection and Water Management, which granted considerable funding and an award in the contest 'Natural treasures of the Łódzkie Voivodeship – program for the revitalisation of historical parks'.

Keywords: ponds, historic water system, park revalorisation, urban park, river pollution

INTRODUCTION

The town park – the subject of the paper – is located in the very centre of the Zduńska Wola, and its total area is about 9.5 ha. It includes buildings of historical significance and the park itself is partly protected by provisions in the municipal plan for spatial development. The premises are irregularly shaped, presenting diverse landforms. The highest point of the area is in the northern part and declines to the south on artificially formed slopes, towards the pond situated at the close of the historic part of the park. The area unprotected by the spatial development plan is a contemporary park with a smaller pond and the Pichna River flowing through it in a regulated channel.

Due to the old-growth forest and water system, which comprises of two park ponds fed by the Pichna, the terrain has significant natural values (see: Fig. 1–4). Unfortunately, numerous problems arose as to the area's functioning, which at the stage of preparing the revalorisation project required broader analyses and propositions of specific solutions. Quite diversified terrain of the park requires rainwater management, which after heavy precipitation deposit to its area a number of pollutants from roads, parking lots or buildings' roofs within the river's basin, entering its waters, and consequently – the ponds.

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ANALYSIS OF FORMAL AND LEGAL CONDITIONS

The project documentation was consulted and adjusted to the provisions of the strategic programs of higher order, at the level of spatial policy for the voivodeship and the county. In particular, it complies with the provisions of the Environmental Protection Program of Łódzkie Voivodeship adopted in 2012 (along with the Waste Management Plan) (Program… 2012), which was compiled on the basis of Environmental Protection Law and Development Strategy for the Łódzkie Voivodeship (2007–2020) and Regional Urban Development of the Łódzkie Voivodeship (2017). Its primary objective is "to ensure broadly understood ecological security by an implementation of sustainable development that enables effective regulation and the control of usage of the environment in the optimum way that does not pose threats to the quality and durability of natural resources" (Program... 2004).

The park revalorisation project (Milecka et al. 2014), together with the extremely important for the terrain's composition water system, has been adapted to the Environmental Protection Program with its integral part, i.e. the Waste Management Plan for the county of Zduńska Wola (Uchwała... 2004). The environmental part of the program settles that one of the strategic objectives is to improve the natural environment condition in the county and to preserve its natural values. Also, in the Study of Conditions and Directions of Urban Spatial Development of Zduńska Wola (Studium… 2012) important accounts on water protection can be found.

When referring to these documents, it is worth paying attention to how **water consumption is rationalised** and to not too fortunate wording, calling the Pichna River "a channel", which unfortunately translates into its "ameliorative" treatment by the town's spatial policy, ignoring completely its biocenotic values. This has a significant impact on current sanitary conditions of the river itself and two park ponds fed by it that are the subject of this study. Another issue is that the "river-channel" receives waters largely untreated, obviously affecting the sanitary conditions and the water quality in park ponds.

THE GROUND AND WATER CONDITIONS

For the purpose of this study a geotechnical opinion for a rainwater project management and water reservoirs renovation in the Town Park of Zduńska Wola, area of Parkowa Street, was made (Sternicki 2015), the annex no. 1 to the documentation. The geotechnical research included five test holes made to a depth between 2.5–4 m, macroscopic analysis of soil samples collected during drilling and hydrological measurements.

The ground conditions there were plain. The park surfaces consist of humus banks with an admixture of debris. The thickness of embankments is 1–2 m. Below them lie medium- and fine-grained fluvio-glacial light-grey and yellow sands. Sandy sediments occur to a depth of 2–3 m. Their deposition is grey silty clay.

The free groundwater table was drilled in June 2015, at a depth of 1.2–1.5 m on the ordinates of 171.1–171.4 m a.s.l. It is a seasonally low water level. A rich surface supply will increase water levels. Considering the weather anomalies in recent years, it is difficult to forecast the maximum water level.

The aquifer is composed of medium- and fine-grained sands with average water permeability (*co. k* = ca 5–10 m/d). The surface embankments contain a significant admixture of humus, therefore their water permeability is much smaller (Sternicki 2015).

THREAT ANALYSIS FOR WATER SANITARY CONDITIONS

The research on the quality of surface water carried out by the State Environmental Monitoring has shown that the Pichna near Zduńska Wola is a heavily modified unit. The river passes through Zduńska Wola and then flows into fields and forests. The city discharges into the Pichna its municipal sewage and rinsing waters from a knitting factory and cooling water from a heat and power plant. Municipal sewage from Zadzim municipality is also discharged to these waters. Through the right-side tributary – the Pichna Szadkowicka – sewage from the town and municipality of Szadek flows into the main course (Sobczak and Kaczor 2013). Water conditions can change drastically, which is precisely illustrated by the compilation of archival (see: Fig. 1) and contemporary images (see: Fig. 2).

Both the ponds and the river at the end of 20th century were strengthened to a water height 10% with reinforced concrete slabs 2,0 × 1,0 × 0,125 m of "Jeziorsko" type, whereas above the reinforced concrete stands with openwork plates. An earlier study of the ameliorative project (Regulation of the Pichna River and Modernization of the Park Ponds) from 1998 suggests a thorough maintenance of the river, involving manual desludging and removal of the spoil and impurities (Kołomak 1998), which indicates a significant pollution already 17 years ago.

Another arduous problem is the management of precipitation. Rainwater is absorbed into an underground rainwater drainage system, so it is drained to

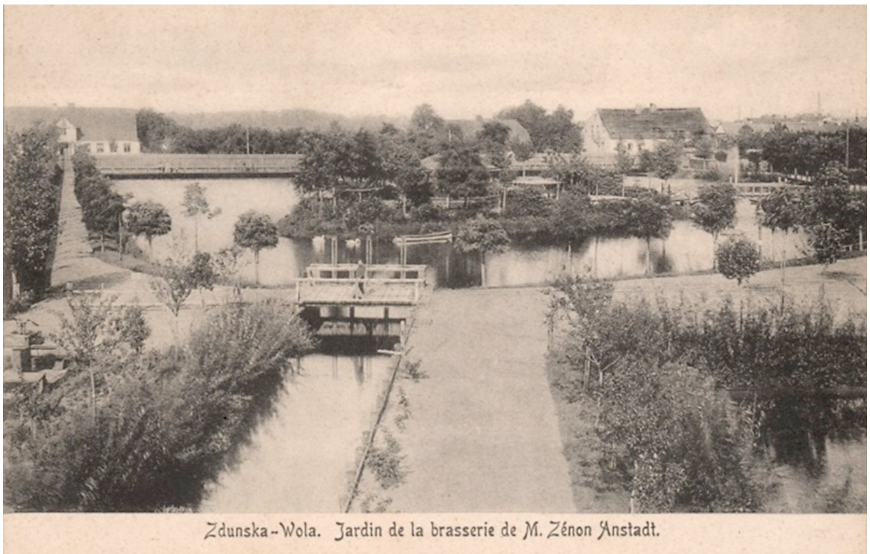

Fig. 1. Undated picture of the park, most probably from the middle 19th. View on the ponds from the east

Fig. 2. Regulated channel of the Pichna River – a contemporary photo. View from the west (photo by M. Milecka)

a sewage plant as soon as possible, and then to the main receiver. Among the environmental effects of an implementation of a rapid rainwater drainage system is a reduction of groundwater levels in aquifers that directly adjoin the surface and a disturbance of the natural water conditions. It also affects soil degradation, which follows its drying out.

Increase in flooding of small courses of surface water and drainage channels that function as sewage and precipitation receivers from rainwater drainage system is often the result of ignoring the problem of so-called rainwater runoff. Morphological changes, even small watercourses ecosystem degradation, resulting from an uncontrolled drainage of surface runoff from areas with high surface pollution can lead to contamination of river, less frequently lakes. All this is caused by storm discharges – precisely speaking, discharges of municipal sewage without purification during heavy precipitation (Brankiewicz and Widelska 2012).

The outlet of rainwater channels on the section were the Pichna is regulated, flowing through the Town Park in Zduńska Wola is discharged through the W-3 drainage outlet, and in the case of existing prefabricated abutments through the P-2/60 culvert. There are four outlets with a diameter of 40 and 30 cm on this section, two for each type, and moreover there is an outlet from a rainwater collector with a diameter of 100 cm (Kołomak 1998). Rainwater is often discharged from the park or the adjacent area of road development, without any prior treatment. This deepens the already difficult sanitary situation of the described watercourse.

VARIANTS OF SOLVING THE PROBLEM OF SURFACE RUNOFF MANAGEMENT WITH GUIDELINES FOR EXECUTIVE PROJECT

One of the reasons for the Pichna's pollution is the uncontrolled surface runoff from the catchment area, covering a significant part of the town. With rainwater, the river gets a lot of pollution from traffic routes, including pollution from vehicles, petroleum derivatives and waters containing dust pollution from the roofs of buildings near the riverbed. To reduce these uncontrolled discharges of pollutants surface runoff management needs to be rationalised, however not by "traditional" means, draining the water into the rain-

Fig. 3. Hydrotechnical devices in the smaller pond. View from the north (photo by M. Milecka)

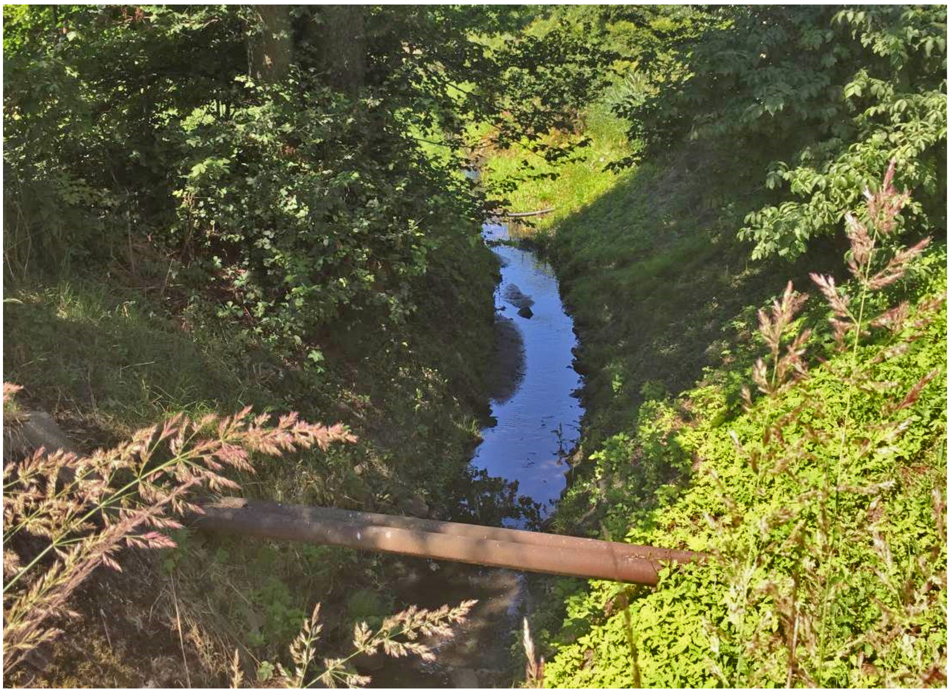

Fig. 4. The Pichna riverbed above the Town Park (July 2015, photo by M. Milecka)

water drainage system, but by its management at the place of precipitation, in order to avoid desiccation and degradation of soil, and disturbances in the hydrological cycle.

Rainwater quantity calculations

For the proper rainwater management the following should be taken into account:
- drainage surfaces with division into catchments;
- permeability of native soil layers;
- total amount of rainwater for each catchment.

Data for calculation of rainwater management in the historic town park were adopted on the basis of the development plan.

The areal balance for the entire park:
- designed development area with small architecture 96 m^2
- designed hardening (upgrading and construction of park alleys and squares) 27,420 m^2
- green areas 59,156 m^2
- waters 9,040 m^2
- **total area: 95,712 m^2**

The areal balance for the historic park – summary (current state):
- area of the historic park 20,606 m^2

including:
- concrete slab pavement on a sand-cement bedding 977 m^2
- asphalt pavement 389 m^2
- permeable ground and gravel surface 4,169 m^2

Current trends in drainage systems favour a technical solution, capable of keeping water in a closed circuit within a given catchment, mainly through discharging rainwater to the ground. This way not only temporary flow rates are reduced, but also the volume of surface runoff discharged directly to receivers and the load of most pollution indicators.

Atmospheric precipitation occur both in liquid form – rain or drizzle, as well as solid – snow or hail. Usually, because of its largest temporary outflows rainfall is used to measure the drainage rate of an area. The phenomenon of rainfall is characterised by three parameters: the intensity of rain I (or alternatively, the rate q), duration of the rain t and territorial range F. The intensity of the infiltration process of rainwater to ground environment is primarily influenced by geological and soil conditions. In dimensioning and selection of devices for infiltration of rainwater it is crucial to know the hydrogeological parameters of soil. The following calculations allow to determine the necessary area to hold, retain and control "in situ" the rainwater there were it actually rained.

Due to the fact that research on rainwater management within public areas applies patterns used in Germany, the calculations were based on less popular in Poland Reinhold coefficient. The runoff coefficient was thus calculated according to Reinhold formula. It determines the rate of calculated flow in the rainwater management system. It is a ratio of the part of precipitation which fell to the catchment area. Its rate depends on:

- type of surface coverage of a catchment area,
- type of development of a catchment area,
- buildings' roof angles,
- duration and frequency of precipitation,
- rain intensity,
- fall in a catchment area,
- geological structure of top soil layers,
- initial soil moisture level of surface,
- surface temperature.

T – 123 minutes – duration of rain calculated according to Reinhold,
A_{RED} – 850 m^2 (catchment area),
A_S – 130 m^2 (infiltration area),
k_f – 5 × 10^{-6} soil filtration coefficient,
V_S – 32,8 m^3 – volume of a basin,
$r_{15;1}$ – 150 (calculated precipitation according to Reinhold).

$$T = \sqrt{\frac{3{,}85 \cdot 10^{-5} \cdot (A_{RED} + A_S) \cdot r_{15;1}}{A_S \cdot \frac{k_f}{2}}} - 9$$

$$T = \sqrt{\frac{3{,}85 \cdot 0{,}00001 \cdot (850 + 130) \cdot 150}{130 \cdot 0{,}0000025}} - 9$$

$$T = \sqrt{\frac{5{,}66}{0{,}000325}} - 9$$

$$T = \sqrt{17415} - 9$$

$$\mathrm{T} = 131{,}97 - 9$$

$$\mathrm{T} \approx 123 \text{ min}$$

$$V_S = \frac{2{,}57 \cdot 10^{-4} \cdot (A_{RED} + A_S) \cdot r_{15;1} \cdot T}{T + 9} - A_S \cdot T \cdot 60 \cdot \frac{k_f}{2}$$

$$V_S = \frac{2{,}57 \cdot 0{,}0001 \cdot (850 + 130) \cdot 150 \cdot 123}{123 + 9} - \\ - 130 \cdot 123 \cdot 60 \cdot 0{,}0000025$$

$$V_S = \frac{4646{,}82}{132} - 2{,}4$$

$$V_S = 35{,}2 - 2{,}4$$

$$V_S = 32{,}8$$

At 130 m^2 of the surface of infiltration basin, water will raise about 25 cm.

T – 124 minutes – duration of rain calculated according to Reinhold,
A_{RED} – 3,600 m^2 (area of asphalt road with parking),
A_S – 540 m^2 (infiltration area),
k_f – 5 × 10^{-6} – soil filtration coefficient,
V_S – 140 m^3 – volume of a basin,
$r_{15;1}$ – 150 (calculated precipitation according to Reinhold).

$$T = \sqrt{\frac{3{,}85 \cdot 10^{-5} \cdot (A_{RED} + A_S) \cdot r_{15;1}}{A_S \cdot \frac{k_f}{2}}} - 9$$

$$T = \sqrt{\frac{3{,}85 \cdot 0{,}00001 \cdot (3600 + 540) \cdot 150}{540 \cdot 0{,}0000025}} - 9$$

$$T = \sqrt{\frac{23{,}91}{0{,}00135}} - 9$$

$$T = \sqrt{17711} - 9$$

$$T = 133{,}08 - 9$$

$$T = 124{,}08$$

$$V_S = \frac{2,57 \cdot 10^{-4} \cdot (A_{RED} + A_S) \cdot r_{15;1} \cdot T}{T+9} - A_S \cdot T \cdot 60 \cdot \frac{k_f}{2}$$

$$V_S = \frac{2,57 \cdot 0,0001 \cdot (3600 + 540) \cdot 150 \cdot 124}{124+9} - \\ - 540 \cdot 124 \cdot 60 \cdot 0,0000025$$

$$V_S = \frac{19790}{133} - 10,04$$

$$V_S = 148,8 - 10,04$$

$$V_S = 138,76$$

At 540 m^2 of the surface of infiltration basin, water will raise about 26 cm.

Description of proposed solutions

Solutions proposed in the project (Milecka et al. 2014) include an application of a system which distributes and infiltrates rainwater. The highest point is located in the northern part, on the highest terrace of the historic park. Water from the roofs of buildings and paved, impermeable surfaces can be collected there. Due to used mineral surfaces, 100% water-permeable, part of the precipitation will permeate directly through these surfaces. In addition, slopes were utilised – transversal towards green areas and longitudinal towards lower areas. In places that are also exposed to erosion (slope crown), linear drainage was used (see: Fig. 5), routed in the direction of underground sewage pipe (DN 160), which functions as a receiver of higher intensity rainwater. The pipe will run parallel to the main traffic route with a granite pavement, where a gutter with a depth of 2.5 cm and a 15% slope drop was set, which according to calculations will receive rainwater during intensive rains. While water from the gutter will be collected by a (cast-iron) rain drain connected to a sewage pipe that discharged water to a infiltration basin with an area of 130 m^2 and depth of backwater 25 cm.

Infiltration basins are a type of surface installations, whose task is to distribute backwater. It is integrated with the rest of the system and with green areas. Water can be stored there for a longer period, but maximum is only 2 days (see: Fig. 6–7). However, a special mix of moisture-loving plants that provide appropriate hydrological performance should be used. Proposed mix (7301 type) contains plants such as: *Agrostis capillaris*, *Agrostis stolonifera*, *Festuca rubra communata*, *Festuca rubra rubra*, *Festuca trachyphylla*, *Lolium perenne*, *Poa pratensis.*

The second infiltration basin, located in the modern part of the park, will receive a storm runoff from local roads with a rather large slope, directly adjacent to the park. Rainwater will reach a separator of oil impurities through a drain, and then to the basin, in which a plant filter will play an important role, especially due to possible contamination. Proposed mix of plants (type 9430) includes: *Agrostis canina*, *Agrostis gigantea*, *Alopecurus pratensis*, *Anthoxanthum odoratum*, *Bromus racemosus*, *Bromus mollis*, *Desampchsia caespitosa*, *Festuca arundinacea*, *Festuca gigantea, Holcus lanatus*, *Phalaris arundinacea*, *Poa palustris*, *Poa trivialis.* It may turn out that it is reasonable to use a stone filter for water distribution, which will reduce excessive pressure.

The described basin with an area of 540 m^2 in which water will be able to raise to the height of 26 cm, will also fulfil the second important function. It will be capable of receiving waters from the Pichna River in case of their high levels. This can be done in two ways – the easiest is to construct an emergency overflow (bellows), or – second – by means of sewage pipe with a valve.

The basic task of the presented concept is the management of rainwater for the Town Park in Zduńska Wola. The benefits of the proposed solutions are primarily:

- ecological use and distribution of rainwater in the place of their precipitation by a system of so-called small retention and infiltration into the soil,
- improvement of ground and water conditions in the catchment by draining rainwater from impermeable surfaces towards green lands and distributing them to depressions (infiltration basins),
- reduction of surface runoff contaminating the ponds and at the same time deteriorating water relations in the upper part of the park.

It should be noted that an additional advantage of using retention devices involves increasing of groundwater resources, as well as local restoration of the natural water circuit, characterised by a balance between precipitation and runoff processes, infiltration and transpiration of rainwater.

Fig. 5. The use of drainage channels for stairs

Source: Aco Drain Multiline

Fig. 6. Meadow for infiltration – Type 7301 (photo by M. Gąsiorowski)

PRELIMINARY VARIANTS FOR SOLVING THE PROBLEMS WITH RENOVATION OF WATER RESERVOIRS IN THE PARK WITH THE GUIDELINES FOR EXECUTION PROJECT

The basis for the study of renovation and renaturalisation of water reservoirs in the Town Park in Zduńska Wola was geotechnical research, field observation, as well as consultations on water reservoir design, inventory work and planning. The direct practice related to design, construction and maintenance of water reservoirs was of particular importance for this paper. As a final result, the study presents a project for reconstructing both the ponds and their surroundings.

The concept of reconstruction of the ponds

The project assumed the reconstruction of both municipal ponds and its surroundings, which would serve as a recreational and leisure sites for town's residents, with emphasis on the optimal solution for sealing, fill-

Fig. 7. Mixture for the banks of reservoirs and floodplains – Type 9430 (photo by M. Gąsiorowski)

ing and cleaning water in the ponds, so that having a rest there becomes a pleasure, and the reservoirs come to be a showcase of the town. The area in the vicinity of the ponds as a place of passive and active recreation was developed according to its purpose.

The shape of the ponds (especially the one with an island), due to its historical value was not modified, so the edges of both ponds were mildly formed and the basin deepened (see: Fig. 8–9). The pond basin was deepened to approximately 2 m (so that appropriate drops to bottom outflows and appropriate level of water surface can be maintained). Swamp filter areas (rushes) in the smaller pond have a depth of about 1–1.2 m and are completely filled with filtration material. The depth > 2 m of the pond is dictated by recommendations for swimming ponds, which directly relates to preventing an excessive growth of filamentous algae (that prefer shallow and warm waters).

The soil needed for filling and forming of embankments was used for deepening the pond. The shape of the piers in proposed solutions has been adapted for other pieces of equipment and small architecture. Especially important was to isolate the pond from the road, with groups of trees, shrubs and perennials, and planting around the reservoir for additional isolation from the negative impact of traffic. The selection of vegetation both around and inside the reservoir was based on the biocenotic principles, i.e. taking into account terrain features, soil conditions and the role the reservoir is to play.

Description of designed water circulation in the pond

The designed object (the set of two ponds with different functions) is equipped with a circulation pump, skimmers, bottom outflows, mechanical-mineral filter, swamp filter (mineral deposit planted with vegetation).

Water in the ponds in Zduńska Wola is introduced into circulation (see: Fig. 10) with pumps (capacity of 160 $m^3 \cdot h^{-1}$). Water in the large pond (for viewing and recreation, with an island) is collected by skimmers and bottom outflow into a filtration chamber. The skimmer is designed to collect surface debris such as leaves, algae, seeds, pollen etc. The collected sediments are captured by a sludger in the skimmer, then, water flows through a mechanical-mineral filter, filled with ion-exchange substrates (biozamonite), which due to their sorption and ion-exchange abilities provide a significant reduction of biogenic elements: nitrogen and phosphorus. These minerals also create an ideal habitat for microorganisms, forming a stable biofilter that removes colloidal (mineral and organic) particles from water, phytoplankton and pathogenic bacteria.

In a filter chamber water flows through a mechanical filter (sponge with appropriate density), a mineral filter and then is led by circulation pumps into the second (smaller) pond that functions as a mineral and vegetation filter (the core of the filtration system). Routed through the discharge pipeline water is direct-

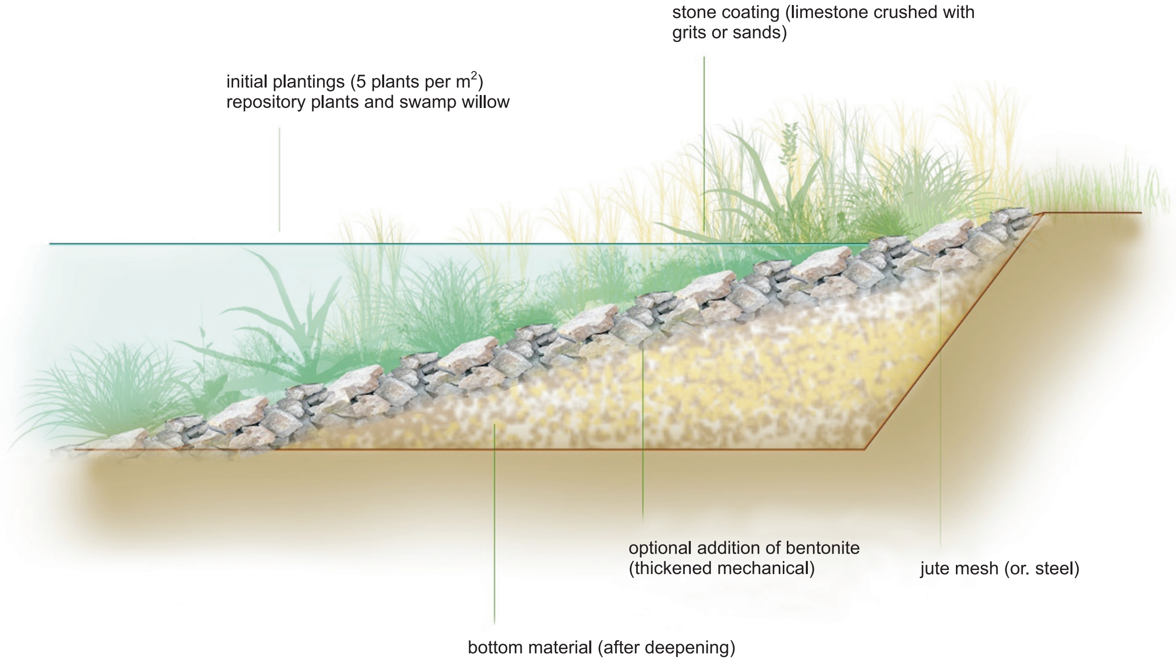

Fig. 8. The form of strengthening of the edge of a recreational pond (edited by Ewelina Widelska)

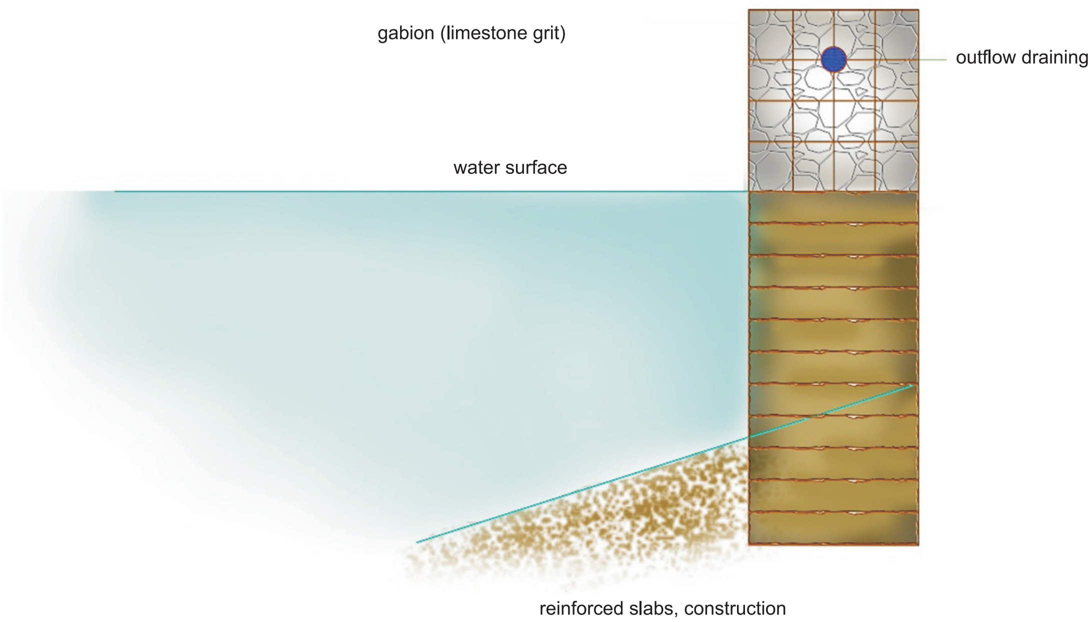

Fig. 9. The form of strengthening of the bank of a filter pond (edited by Ewelina Widelska)

ed to a filter bed overgrown with water and swamp vegetation, where a reduction of biogen takes place. Purified water is pumped into vertical flow swamp filter, which removes biogenic compounds almost completely. The smaller pond serves as a filter for the entire system. After passing through swamp filters and again through bottom outflows and skimmers, water flows into a mechanical-mineral filter with a closed circuit. Water loss from evapotranspiration is supplemented by the supply from a deep well.

The part plants have in functioning of the pond

The part that plants play in water reservoirs is directly proportional to their biomass, since it depends on how much biophilic elements plants can accumulate in their tissues, and their phenology has impact on how long they can keep them in their tissues.

Plants obtain biogenic compounds (so-called trophic effect), preventing algae growth. Biomass is accumulated in a waterside zone and mostly can be easily removed, for example by mowing. Accumulation of dead plants in the form of low peat does not threaten water quality, and is a buffer stabilising water chemistry.

The surface of the submerged plants is covered with periphyton (it is a combination of plant and animal organisms inhabiting any beddings immersed in water, e.g. diatoms, green algae, oligochaeta, small snails), including “bacterial membrane” – having a great part in the process of water self-cleaning. The larger the membrane surface, the better the cleaning effect.

It is necessary to introduce appropriate vegetation to the pond vegetation, in terms of quantity and species selection. Vegetation is not only an ally in the fight against algae, but it fills a whole range of other important functions, affecting: natural and aesthetic values by an impact it has on water quality; the spatial arrangement for animals (creating locations for settling, breeding, feeding); creating refugia (hiding places from predators); limiting the growth of mosquito populations by cutting off water surface; creating a filter that captures runoffs from the surrounding area.

CONCLUSION

The revalorisation project conducted by numerous specialists in architectural monuments and historic water systems, both public and private, was fit with the current purpose and use of the area, as well as with the provisions of the local spatial development plan. The park area, before finalising the project, has been a subject of numerous studies and analyses concerning both its natural and cultural values, because it has great importance for the quality of life and functioning of the inhabitants. Unfortunately, the degree of pollution of the Pichna has a significant impact on the natural and landscape values of the area.

For this reason, great emphasis was put on solutions that take ecology into account, so the maintenance of valuable ground and water conditions can be ensured, consequently keeping the precious tree stand in good state and enabling the restoration of proper sanitary conditions of waters in both ponds, and in future of the Pichna, too. Care for green areas should include these solutions that in a stabilized environment have a chance to maintain the relative durability of ecosystems, and lead to reducing costs of maintenance. The aim for taking these measures is to renaturalise the Pichna River in future, which should once again become town’s effi-

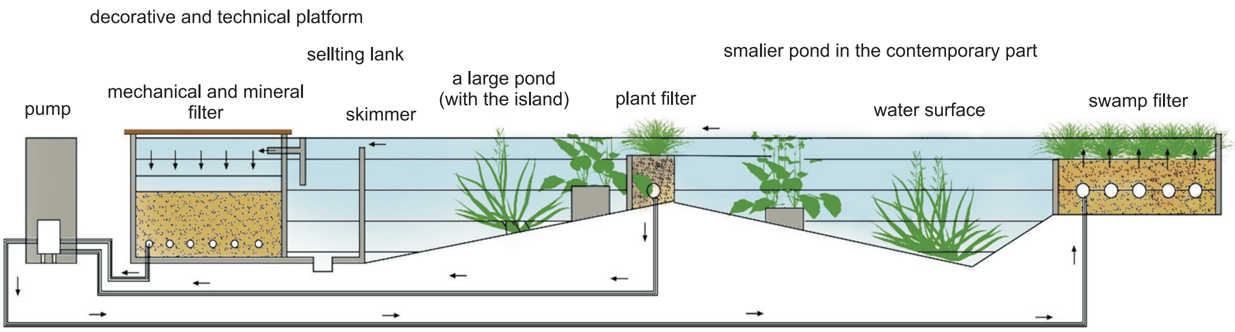

Fig. 10. The scheme of water circulation in the ponds (edited by Ewelina Widelska)

cient ecological corridor. One of the intermediate solutions, possible at the revalorisation stage of works, is to manage rainwater at places of precipitation by a retention-drainage system, which definitely can improve the condition of soils exposed in the urban environment to considerable overdrying and reduce long-term shifts in a hydrological cycle. This applies to green areas in particular, where there is no need to treat rainwater as sewage. Thus, an attempt to utilise it for supplying vegetation should be taken, due to its exposure to tough conditions for growth in urban areas.

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PROBLEM ZANIECZYSZCZENIA RZEKI PICHNY W KONTEKŚCIE REWALORYZACJI PARKU MIEJSKIEGO W ZDUŃSKIEJ WOLI

ABSTRAKT

Zabytkowy park miejski położony w Zduńskiej Woli, objęty jest w części centralnej i północnej ochroną konserwatorską na podstawie zapisu w miejscowym planie zagospodarowania przestrzennego oraz poprzez wpis do ewidencji zabytków. Park charakteryzuje się urozmaiconą rzeźbą terenu, z czego najwyższy punkt znajduje się na północy i opada skarpami ku południu, w kierunku doliny rzeki Pichny, zasilającej dwa stawy parkowe w tym: większy z wyspą, będący zamknięciem osi kompozycyjnej, oraz mniejszy – będący pozostałością po dawnym zbiorniku wodnym przeciwpożarowym. Pod względem przyrodniczym teren posiada znaczące wartości z uwagi na starodrzew oraz opisany układ wodny.

W ramach prac przygotowawczych do rewaloryzacji założenia parkowego, przeprowadzono szereg badań i analiz, w tym m.in. ocenę stanu sanitarnego wód Pichny, która zasila zbiorniki i przepływa przez park. Na tej podstawie okazało się, że stopień zanieczyszczenia (wśród przyczyn wymienić należy zrzut nieoczyszczanych wód z okolicznych ciągów komunikacyjnych) uniemożliwia rewaloryzację parku przy dalszym zasilaniu stawów wodami rzeki. W celu zapewnienia zadowalającego stopnia czystości i przejrzystości wody w obu stawach podjęto decyzję o zastosowaniu złożonych i nowoczesnych rozwiązań technologicznych, umożliwiających renowację układu wodnego. Przyjęte rozwiązania zyskały przychylność Wojewódzkiego Funduszu Ochrony Środowiska i Gospodarki Wodnej, który przyznał wysokie finansowanie i nagrodę w konkursie „Przyrodnicze perły województwa łódzkiego program rewitalizacji zabytkowych parków".

Słowa kluczowe: stawy, zabytkowy układ wodny, rewaloryzacja parku, park miejski, zanieczyszczenie rzeki