# MASTERARBEIT | MASTER'S THESIS

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Understanding river dynamics and lotic habitats based on fluvial geomorphology, water quality and human impact of two river system sections (Alsbach and Eckbach) in the Vienna Woods (Vienna, Austria)

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## Abstract

Watercourses are important ecosystems that are coming under increasing pressure due to various stressors. Human influence in particular is leading to changes in river morphology and having a negative impact on biological communities in the waterways.

In this context, the following study examines two parallel streams (Alsbach and Eckbach) in the Vienna Woods (Vienna, Austria). The results show a comparison of the two rivers in terms of their fluvial morphological processes and units. Subsequently, data on deadwood deposits were recorded in order to investigate their impact on river morphology. In addition, an analysis of the dynamics along the Alsbach stream after the 2024 flood of the century was carried out using existing data. Due to the immediate proximity to the Vienna city area, another focus is on human influence, which was determined on the one hand by structural changes along the streams and on the other hand by measuring water parameters. In addition, this work addresses the ecology of both river sections by sampling and analysing limnic habitats with occurring macrozoobenthos.

Overall, this work takes an interdisciplinary approach, providing a comprehensive overview of the study region.

Keywords: fluvial morphology and large wood, human impact on streams, limnic habitats and macrozoobenthos, water quality, Vienna Woods

# Kurzfassung

Fließgewässer stellen wichtige Ökosysteme dar, die aufgrund unterschiedlicher Stressoren immer mehr unter Druck geraten. Besonders menschlicher Einfluss führt zu Änderungen in der Flussmorphologie und wirkt sich negativ auf biologische Lebensgemeinschaften in den Gewässern aus.

Im Zuge dessen beschäftigt sich die folgende Arbeit mit zwei parallel verlaufenden Bächen (Als- und Eckbach) im Wienerwald (Wien, Österreich). Die Ergebnisse zeigen einen Vergleich der beiden Flüsse in Hinblick auf deren fluvial morphologische Prozesse und Einheiten. In weiterer Folge wurden Daten zu Totholzablagerungen aufgenommen, um zu untersuchen, welche Auswirkungen diese auf die Flussmorphologie haben. Darüber hinaus erfolgte eine Analyse deren Dynamik entlang des Alsbachs nach dem Jahrhunderthochwasser 2024 durch bereits bestehende Daten. Aufgrund der unmittelbaren Nähe zum Wiener Stadtgebiet liegt ein weiterer Schwerpunkt auf dem menschlichen Einfluss, der einerseits anhand von strukturellen Änderungen entlang der Bäche als auch durch die Messung von Wasserparametern ermittelt wurde. Darüber hinaus widmet sich diese Arbeit auch der Ökologie beider Flussabschnitte, indem limnische Habitate mit vorkommenden Makrozoobenthos beprobt und analysiert wurden.

Insgesamt verfolgt diese Arbeit einen interdisziplinären Ansatz, wodurch ein vielseitiger Überblick über die Untersuchungsregion gegeben wird.

Stichworte: Flussmorphologie und Totholz, menschlicher Einfluss auf Flüsse, Lebensräume und Makrozoobenthos, Wasserqualität, Wienerwald

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# 1. Introduction

This chapter outlines the problems, the current state of research, the objectives, the research questions and hypotheses.

## 1.1 Problem definition and relevance

The importance of river systems extends far back into history with the sedentarisation of humans (= Neolithic Revolution), as first settlements were established along them. In the past as well as today, rivers are therefore decisive for the development and existence of society, economy and ecology. Problems such as water scarcity, pollution and ecological degradation arise with the utilisation of water bodies (Wang & He 2022). Progressive urbanisation in particular is changing rivers, causing them to lose most of their natural character, especially in industrialised countries. Dominant regulation of water bodies includes canalisation as well as the construction of concrete structures, such as transverse structures, which influence the sediment balance and water flow (Hohensinner et al. 2018; Gruber et al. 2022; Wang & He 2022; Náduvari et al. 2023; Yan et al. 2023).

Land-use changes lead to deforestation, especially riparian forests, which is why a low supply of large wood (LW) is recorded in fluvial systems. In addition, wood inputs from beavers are reduced, as the rodents are hunted as long as they are not protected. Although LW has positive properties for the ecology and morphology of the river, it is removed due to flood management, so that flood control is achieved (Gurnell et al. 2002; Wohl et al. 2016). However, the quantity and thickness of deadwood is decisive for the scale at which it acts (Wohl et al. 2016).

Anthropogenic influences such as chemical waste or fertilisers pollute water resources as well. Added to this are natural factors such as changes in precipitation patterns or snowmelt, which indirectly affect water quality as a result of anthropogenic climate change. However, it should be noted that there are regional differences depending on the area (Kumar et al. 2023).

With regard to the study region (see Chapter 3), rivers of the Vienna Woods are considered important tributaries of the Danube and water sources for the city of Vienna, which are significant for the urban development of the federal capital. Due to seasonal fluctuations in precipitation and heavy rainfall events, smaller streams can dry out and water levels can suddenly rise within a short period of time (Haidvogl et al. 2018).

For this reason, it is important to examine the streams of the Vienna Woods from an ecological and hydromorphological perspective in order to gain an impression of their dynamics. The comparison of two watercourses should provide insight into the differences and similarities between a near-natural river and one influenced by human intervention. The aim of this work is to develop an understanding of the water structure, including deadwood in the Flysch zone (see Chapter 3), and of the structural human influence in urban areas (= City of Vienna). In addition, the water quality at various locations will be determined and potential stress factors discussed. With regard to biodiversity in the water bodies, the composition of macrozoobenthos (at the order level) is to be recorded with the aim to evaluate the ecological role of large wood in flowing waters as well as general habitat structures.

### 1.2 State of Research

Fluvial geomorphology, which deals with the shape of rivers, has seen a continuous growth in literature since 1975 and has become increasingly important in North America, Europe and Australia since the 1990s (García et al. 2021). The same has been true of research into large wood in river systems, which focuses in particular on the hydraulic effect and impact on the morphology of the river. In recent years, changes in wood dynamics caused by humans have become apparent, as riparian vegetation is being reduced and deadwood is being removed from river systems for flood management purposes (Gurnell et al. 2002).

Advances in technology over the years are improving the level of detail in this field of research (Thorndycraft et al. 2008; García et al. 2021). Through the use of remote sensing, such as LiDAR (Light Detection and Ranging), it is possible to carry out topographical analyses by specifically recording data and subsequently carrying out modelling or analyses with this data (Thorndycraft et al. 2008; Yan et al. 2023).

In the past as well as today, humans are considered actors for rivers, as they either use or control them (García et al. 2021). While human interventions used to be local and short-lived, today they are large-scale and long-lasting, including the construction of dams, urbanisation and general land-use changes. As a result, geomorphological and social systems are now considered coupled in some cases (Poeppl et al. 2017). Chovanec et al. (2000) describe that urbanised watercourses in particular face (ecological) challenges. This is because watercourse management has the side effect of a loss of river dynamics, which, however, has an influence on the formation of so-called geomorphological units (see Chapter 2.1) and habitats at the same time, resulting in a loss of biodiversity of aquatic fauna or flora (Chovanec at al. 2000). For this reason, interdisciplinary and multidisciplinary approaches are being pursued in which biological/ecological, geological and engineering elements are taken into account (Thorndycraft et al. 2008; García et al. 2021).

A comparable observation can be made in Austria as well, where the federal capital of Vienna is particularly noteworthy. Since the 19th century, watercourses there have been structurally altered, banks built up and partially channelled underground (Oberhofer & Katzmann 1997; Gruber et al. 2022). The Vienna River, the main artery of the Vienna Woods, and the Danube have received the most attention in the German- and English-language literature with regard to fluvial morphology, anthropogenic influence and ecology (Oberhofer & Katzmann 1997; Chovanec et al. 2000; Wolfram & Humpesch 2005; Haidvogl et al. 2018; Gruber et al. 2022). Small tributaries which flow into the Vienna River and then into the Danube, and which are responsible for the sediment and water balance of the large river systems, are thus relegated to the background. This creates a need to examine small streams in the Vienna Woods more closely in the context of fluvial morphology and ecology.

Gaps in research are to be closed by comparing watercourses from small catchment areas near Vienna with regard to various aspects. The research aims to compare processes and morphology, taking human influence into account. Since research on large wood in Europe still needs to be further established, this thesis will examine the ecological aspect in more detail and analyse its dynamics following the floods in Austria in autumn 2024. It will be shown that, even in the case of small tributaries, the pressure of human use, especially in urban areas, will have to be addressed in the future. The collection of water samples will reveal the status quo of the two streams of the Vienna Woods under different conditions (hypotheses, see next chapter). Finally, the ecological relevance of fluvial morphological units (pools and riffles) and deadwood will be considered by examining the composition and diversity (order level) of benthic organisms.

### 1.3 Objectives, Research Questions and Hypotheses

Based on the problem definition and the state of research, the following work focusses on (i) fluvial morphology, large wood and human impact (ii) habitats and macrozoobenthos as well as (iii) water quality of the parallel flowing streams of the Vienna Woods (Als- and Eckbach).

(i) With regard to fluvial morphology, the natural processes of erosion and deposition, geomorphological units (= potential habitats) as well as structural changes caused by humans and their extent will be investigated. It will be evaluated whether there are differences in a near-natural (= Alsbach) and an anthropogenically influenced (= Eckbach) river course. The role of large wood in the formation of natural structures is discussed, as well as the changes that can be observed in large wood dynamics after a hundred-year flood.

(ii) The ecological aspect of large wood is placed in the context of macrozoobenthos as well, whereby the presence of fauna is investigated in geomorphological units.

(iii) Due to the intensity of human utilisation of the Vienna Woods, a further focus of investigation is on the water quality of selected sites, which is measured using chemical and physical parameters.

Taking this context into account, the following research questions (RQ) and hypotheses (H) were derived.

### (i) Fluvial morphology, large wood and human impact

**RQ 1.1** How does the river morphology of the streams Alsbach and Eckbach differ in terms of geomorphological units and potential habitats?

**H 1.1** Due to the fact the two streams have the same initial conditions in the Vienna Woods, they show a similar pattern.

**RQ 1.2** How does large wood influence the river morphology of the Alsbach and Eckbach stream?

**H 1.2** Large wood provides ecological added value by providing limnic habitat structures.

**RQ 1.3** How did the flooding in autumn 2024 affect the accumulation of large wood at the Alsbach stream?

**H 1.3** Based on data already recorded, large wood dynamics can be identified.

**RQ 1.4** Where and which forms of human influence can be identified?

**H 1.4** Structural impact can be identified on both river sections primarily at the lower reaches.

### (ii) Habitats and macrozoobenthos

**RQ 2.1** Which macrozoobenthos taxa can be found in selected geomorphological units in the Alsbach and Eckbach stream?

**H 2.1** A high diversity of macrozoobenthos taxa inhabit the selected river sections.

**RQ 2.2** To what extent does large wood in the Vienna Woods play a role in regard to habitats of macrozoobenthos?

**H 2.2** The number of macrozoobenthos is higher in large wood areas.

### (iii) Water quality

**RQ 3.1** How does the water quality of the Alsbach and Eckbach stream differ at selected sites?

**H 3.1.1** The water quality of the Eckbach is lower than that of the Alsbach at the upper reaches.

**H 3.1.2** In the proximity of leisure areas, the water quality of both rivers is similarly affected.

**H 3.1.3** The water quality is degraded after ponds (Hanslteich and Parapluiteich).

## 2. Thematic introduction

For a better understanding of the objectives, research questions and hypotheses, this chapter provides a basic explanation of the respective focal points.

### 2.1 Fluvial geomorphology and large wood

The classification of fluvial systems is crucial for understanding the river ecosystem. A distinction is made between two approaches. (i) Process-based classification focuses on geomorphological processes. (ii) Form-based classification focuses on diverse river forms. It should be noted that both classifications are linked, as processes give rise to forms and vice versa, as forms can favour new processes (Bañales-Seguel et al. 2024).

(i) The dominant processes in watercourses are erosion, transport and deposition/sedimentation (Buffington & Montgomery 2013). Erosion occurs mainly in the upper reaches and is dependent on the gradient of the flow section. Energy from the water dissolves sediments, causing erosion on the river bed or banks. As a result, rivers become deeper and wider. Sediments can dissolve chemically, which is called corrosion. Removed sediments are transported depending on their sediment size. Fine sediments such as clay or silt are transported through the water without touching the bottom (= suspension). Gravel, on the other hand, moves by saltation or rolling (= traction) due to its size and weight (Matsuda 2001). If the flow velocity is reduced or the gradient decreases, fine to coarse material is deposited in the riverbed or on the banks (Charlton 2008).

(ii) Based on the explanatory processes, the river is shaped by sediment and water transport. In particular, floods and heavy rainfall events affect the shape of the river (Charlton 2008; Belletti et al. 2017). Furthermore, river systems are hierarchically organised (Buffington & Montgomery 2013; Belletti et al. 2017). As a result, processes and forms at larger scales (101 km$^2$ - 105 km$^2$) influence smaller scales (100 m$^2$ - 101 m$^2$) (Belletti et al. 2017).

> *Example based on explanations in the literature (Belletti et al. 2017): If a catchment is cleared over a large area and becomes agricultural land, soil erosion processes can influence the sediment budget of the river, which in turn influences geomorphological units.*

Geomorphological units (GU) are the smallest spatial units. On the one hand, these can be found within the riverbed, on the other hand, they exist along the bank (Belletti et al. 2017). In addition to sediment and water flow, natural (rocks or dead wood) and anthropogenic structures, such as dams, are responsible for the formation of GU as well (Wheaton et al. 2015). Wheaton et al. (2015) describe the following GUs: pools, riffles, boulders, islands and cascades/steps (Tab 1).

*Tab. 1: Description and visualization of different geomorphological units, based on Hawkins et al. (1993), Charlton (2008) and Wheaton et al. (2015) (own illustrations)*

| | | |
|---|---|---|
| **Pools** | Pools (= scour pools) are formed by erosion processes, can be deeper than the usual channel and are characterised by a low flow velocity. In addition, the existing substrate at the bottom is predominantly uniform to fine. A formation by large wood or rocks (= dammed pool) contains mainly fine sediment, which is backed up like the water. |  Pool |
| **Riffles** | Riffles are shallow, fast-flowing and often lie between pools. The sediment is described as coarse. |  Riffle |
| **Boulders** | Boulders are larger than 25 cm and in some cases contribute to the formation of pools and riffles. |  |
| **Islands** | Islands are found within the riverbed due to the accumulation of (coarse) sediment, which causes them to protrude from the water like islands. |  |

| | | |
|---|---|---|
| **Cascades/Steps** | Cascades/steps are characterised by a high current speed, obstacles and stair-like formations. Pool sequences can be found after steps. |  |

In addition to the processes already mentioned, large wood affects the hydraulic complexity of the river and is therefore important for river morphology (Osei et al. 2015; Wohl et al. 2019). On the one hand, it contributes to the formation of LW-associated landscapes, such as pools, riffles, islands or morphologically complex side channels, and on the other hand, it stabilises the banks and the channel. Furthermore, the ecological added value through the promotion of biodiversity should not be ignored (Osei et al. 2015; Wohl et al. 2019; Poledniková & Galia 2021; Poeppl et al. 2024).
Depending on the LW type, the longitudinal, vertical and lateral connectivity and thus the sediment transport are influenced. In particular, a dense accumulation of LW (= jam) retains fine sediment and leads to deposition (Osei et al. 2015; Wohl et al. 2019; Poeppl et al. 2024).
The transport of woody debris depends on the flow conditions, velocity and depth of the watercourse. It is worth noting that woody debris is often mobilised by flood events, as this is when the energy and velocity of the water is at its highest. The first flood event after the LW is first recruited to the river is the most crucial (Wohl et al. 2019).
Poeppl et al. (2024) describe four types of large wood (Fig. 1), which are classified below (Table 2).

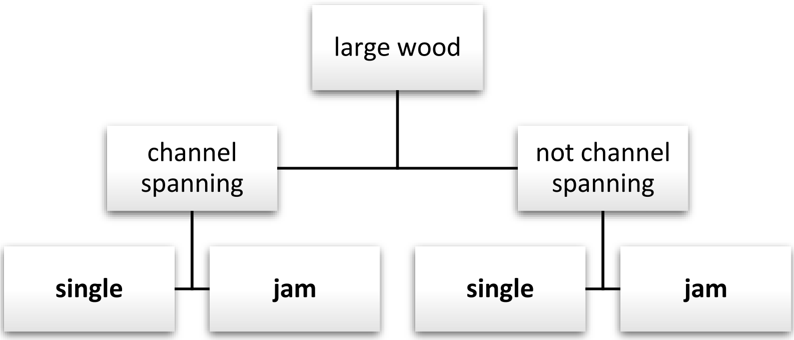


*Fig. 1: Classification of LW into channel spanning or not channel spanning single LW or jams (at least three wood pieces) (illustration based on content by Poeppl et al. 2024)*

Depending on the characteristics of the LW (Tab. 2), they have an effect on the sediment balance and on the water flow by slowing it down. (Collapsed) bridges and partial logsteps, ramps and underflow jams show a low tendency to retain sediment, as there are always gaps for flow. Dam jams, on the other hand, act like dams in the river and retain both sediment and water (= backwater) (Poeppl et al. 2024).

*Tab. 2: Description and classification of the LW-types according to Poeppl et al. 2024*

| Type | Class | Description |
|---|---|---|
| Channel spanning single | Bridge | A bridge has no contact with the river bed. Both ends span the canal. |
| | Collapsed bridge | The description is the same as for 'Bridge', however the trunk is broken in the centre. |
| | Log step | LW (a single piece) is partially buried in the riverbed and forms a step. |
| Not channel-spanning single | Ramp | One end of a ramp is in the canal, while the other is at the edge of the bank. |
| | Partial log step | The description is the same as for 'log step', however a partial log step does not cover the entire channel width. |
| Channel-spanning jam | Underflow jam | An underflow jam is an accumulation of at least three LWs that span the channel, however the water can still flow through. |
| | Dam jam | The description is similar to 'underflow jam', nevertheless in a dam jam there is contact with the river bed, so that water and sediments can back up. |
| Not channel-spanning jam | Partial dam jam | The description is the same as 'underflow jam' and 'dam jam', nonetheless the entire channel width is not spanned. |

## 2.2 Macrozoobenthos

Macrozoobenthos refers to invertebrates (= evertebrates) that are recognisable to the naked eye. The term 'benthos' stands for 'bottom' and indicates that the animals colonise the substrate of water bodies (Hussain & Pandit 2012).

Basically, macrozoobenthos can be divided into functional groups, all of which play a special role in the stream ecosystem. Filterers (= collectors) filter nutrients from the water, scrapers sit on stones and scrape off organic material, shredders decompose leaves or other biomass and predators hunt other macrozoobenthos (Herman & Nejadhashemi 2015).

The focus of this study is on insects, molluscs and crustaceans. Due to Austria's central location in Europe, representatives of the Ephemeroptera (= mayflies), Odonata (= dragonflies), Plecoptera (= stoneflies), Heteroptera (= bugs), Coleoptera (= beetles), Trichoptera (= caddisflies), Diptera (= dipterans), Gastropoda (= snails) and Crustacea can be expected in the study area (see Tab. 3) (Kriska 2013).

*Tab. 3: Overview of the expected representatives of macrozoobenthos in the selected study area based on Kriska 2013*

| **Insects** | |
|---|---|
| Ephemeroptera | The eggs of the mayflies are laid in the water, whereupon the larvae spend most of their lives (0.5 - 3 years). The size varies between 3 and 35 mm. Ephemeroptera usually have three abdominal appendages, which serve as a distinguishing feature of this order. The food spectrum ranges from organic material and microalgae to algae. |
| Odonata | Dragonflies are divided into two suborders. Zygoptera (= small dragonflies) have a delicate body structure and can be clearly recognised by their three ‘rudder blades’. Anisoptera (= large dragonflies) have a plump, cylindrical body structure and densely set compound eyes. Typical of their habitus is a capture mask to hold the prey. In general, dragonfly larvae are predatory and can be up to 55 mm in size. |
| Plecoptera | Stonefly larvae develop in water for one to three years and favour waters that are rich in oxygen. The larvae can be recognised by their long antennae (compared to their body) and have two cerci (= appendages) on their abdomen. They can grow up to 28 mm in size. Some representatives live on organic material, while others feed predatorily. |
| Heteroptera | Heteroptera live either on or under the water. At first glance, they resemble beetles, however they have stinging mouthparts and a scutellum (= small dorsal shield) on their backs. The shape of the aquatic bugs varies and depends on their way of life. They are often predatory. |
| Coleoptera | Similar to bugs, beetles have different shapes. However, the biting mouthparts are a clearly recognisable feature. Coleoptera, which live in water, feed on everything from organic material to other living creatures. |

| | |
|---|---|
| Trichoptera | Caddisfly larvae are best recognised by their caddis made of mud and small stones, although not all representatives form one. They have two noticeable claws on their abdomen. Trichoptera are scrapers and feed on organic material. |
| Diptera | Larvae of the Diptera can be cylindrical to slenderly elongated, whereby the legs are partially regressed (= stubby feet). The length can be up to 30 mm. |
| **Molluska** | |
| Gastropoda | Snails have only one shell in which the soft body is located and they grate off their food. |
| **Crustacea** | |
| The appearance of Crustacea varies depending on their way of life. What they all have in common, however, is that they have an exoskeleton and, unlike insects, more than six legs. | |
| **Collembola** | |
| Springtails prefer dead plant material and are characterised by a fork at the back (= furca), with which they can move by jumping. | |
| **Annelida** | |
| Annelida are worms that are segmented and have different habitats. Their lifestyle ranges from detritus-feeding to parasitism. | |

information according to Kriska (2013)

## 2.3 Water quality parameters

The primary aim of measuring water quality is to define the natural state of a body of water. It assesses whether there is any human influence as well.

In nature, the condition of water bodies is determined by the climate, geology, vegetation and aquatic fauna (Meybeck 2002). The water quality of water bodies can be measured or determined physico-chemically using devices in the field or laboratory, as well as biologically using indicator organisms (Rolauffs et al. 2004). In the course of this work, the water quality is measured directly in the field on the basis of physico-chemical parameters using a portable photometer and a multi-probe (see Methods chapter).

The analysed chemical parameters ammonium ($NH_3$), phosphorus ($P_4^{3-}$), nitrate ($NO_3^-$) and nitrite ($NO_2^-$) measure the human influence in the context of this work. Physical factors for determining quality include temperature (in °C), pH, colour, conductivity (µS/cm) and dissolved oxygen (DO in mg/l) (Meybeck 2002).

| | |
|---|---|
| | **Physico-chemical parameters (natural)** |
| **conductivity** | Conductivity can be used to determine the ionic concentration of salt (Sagar et al. 2015). |
| **DO (in mg/l)** | Dissolved oxygen is a key indicator of water quality in an aquatic ecosystem. It shows the result between the balance of production by aquatic flora and consumption by animals (Hess & Härtling 2000; Meybeck 2002; Sagar et al. 2015). Warm water from industrial wastewater as well as warming due to climate change can reduce DO (Sagar et al. 2015). |
| **temperature (in °C)** | Temperature is important for the survival of species in water bodies. It has an influence on chemical processes and their reaction rates in the water (Hess & Härtling 2000). |
| **pH** | The pH value indicates the concentration of hydrogen ions ($H^+$ ions) and has a scale from 0 to 14: 7 ... neutral, 7 > ... acidic, 7 < ... alkaline. Acid rain or other pH values in surface runoff can influence the pH in water bodies (Hess & Härtling 2000; Sagar et al. 2015). |
| | **Chemical parameters (human impact)** |
| **$NH_4^+$ (in mg/l)** | Ammonium usually enters bodies of water via wastewater or fertiliser runoff and has a toxic effect on living organisms at high concentrations (> 1 mg/l). For aquatic plants, the substance serves as |
| **$NO_3^-$ (in mg/l)** | a source of nitrogen, which is why eutrophication of the water is possible. |
| **$P_4^{3-}$ (in mg/l)** | Similarly, phosphate and nitrate promote algae growth (Hess & Härtling 2000); both have a negative effect on aquatic organisms. Biochemical processes (nitrification) can additionally produce toxic nitrite from the nitrogen compound ammonium, which is further |
| **$NO_2^-$ (in mg/l)** | converted to nitrate (Aissa-Grouz et al. 2015). |

## 2.4 Human impact on rivers

The influence of humans on rivers can primarily be narrowed down to three points with the focus of this work: (i) structural influence, (ii) influence on water quality and (iii) renaturalisation.

(i) Structural influence

The main reason for human intervention in rivers is to control them. Longitudinally, these are channelised or the banks are stabilised (= fortification of the banks with stone or concrete) (Grizzetti et al. 2017). To protect against washed-up deadwood, so-called wildwood rakes are erected transversely to prevent log jams (BMLFUW 2014). Land use plays a role in this respect as well (Grizzetti et al. 2017; Szatten et al. 2019). In this context, bridges are used to cross rivers. However, piers of these structures influence hydraulic properties as they disrupt the water flow. In addition, the channel width is narrowed so that damming is possible during high water flows. As a result, localised erosion zones are possible (Szatten et al. 2019). Dams and transverse structures in general are widespread structures (Waterstraat 2000; Grizzetti et al. 2017). Depending on the length and width of the watercourse, this includes dams, sluices, weirs, barrages or pipework. Although there are differences in the dimensions of the structures, they all pursue the same goal, namely to regulate the flow. This results in disrupted sediment transport on the one hand and habitat disruption on the other, which poses a challenge for migratory biota in particular (Waterstraat 2000).

(ii) Influence on the water quality

As already mentioned in Chapter 2.3, the water quality of water bodies is determined by the catchment area. However, human activities influence physico-chemical and biological parameters through land use (Igwe et al. 2017; Kanownik et al. 2020). Parameters that indicate human influence are phosphate, ammonium and nitrate or nitrite. Waters in areas where intensive land use is practised often show increased levels of nutrient inputs. In urban or industrial areas, surface runoff from rainwater in turn leads to a deterioration in water quality as nutrients and pollutants are transported (Kanownik et al. 2020).

Climate change should not be ignored as well (Kanownik et al. 2020; van Vliet et al. 2023). It is known that there is a trend towards extreme precipitation events due to the warming of the climate, which increases surface runoff, and that existing heat waves in the summer months have an impact on dissolved oxygen (DO) and at the same time lead to a warming of the water bodies, resulting in increased algae growth.

(iii) Renaturalisation

In contrast to the points mentioned above, the renaturalisation of rivers reflects a positive influence by humans.

The term renaturalisation refers to the restoration of a natural river (section) and its conditions. After renaturalisation, the human influence should be as low as possible (Muhar et al. 2018). The natural restoration of the system includes hydrology, morphology and ecology (Wohl et al. 2015). Rivers with natural or restored status are known to have better water quality, harbour greater biodiversity and provide natural flood protection (Guimarães et al. 2021). Measures taken usually only cover rivers on a small scale (Muhar et al. 2018). The aim is to establish lateral and longitudinal connectivity so that the sediment balance is restored. Attempts are being made to restore sufficient space to the river system (= river widening) and to make the course of the river more natural (= meandering). Conventional bank protection is removed and, at the same time, riparian vegetation is planted for further stabilisation, which serves as a buffer in the event of flooding (Muhar et al. 2018). In terms of ecology, habitats are created by designing riffles and pools and providing deadwood and boulders (Wohl et al. 2015; Muhar et al. 2018).

The topic of renaturalisation is being discussed both socio-economically and politically, as the project is always associated with high costs. An example from Switzerland, where the costs amounted to around €2,500/m, serves as a guide. The payment varies depending on the service and location (urban vs. rural area). However, the benefits of renaturalisation should be taken into account, particularly with regard to flooding and the resulting potential damage costs (Guimarães et al. 2021).

## 3. Research Area

The catchment areas of both rivers are located in the Vienna Woods, one of the largest deciduous forest areas in Europe (Drozdowski & Mrkvicka 2014). In terms of area, the catchment covers around 1,250 $km^2$ across 51 municipalities in Lower Austria and seven districts in Vienna, although only two catchment areas in Hernals (17th district, Vienna) are discussed in this study (Egger & Wessely 2014; Drozdowski & Mrkvicka 2014). Based on the GIS data, the catchment area of the Alsbach stream covers 242.68 ha and that of the Eckbach stream 127.06 ha (data.gv.at 2024).

From a morphological point of view, this is a pre-Alpine low mountain range landscape characterised by gentle hills. Nevertheless, there are deeply incised ditches and valleys (V-shape). It is worth noting that the Vienna Woods represent the easternmost foothills of the Alps. Furthermore, the landscape can be divided into two geological units. The south of the Vienna Woods is part of the Northern Limestone Alps, which is why the dominant rock is carbonate rock. In contrast, the study area of the two river systems is located in the Flysch zone, where sandstone and clayey sediments dominate (Egger & Wessely 2014; Drozdowski & Mrkvicka 2014; Waringer & Waringer 2014).

Due to the soil composition of the Flysch, little water is absorbed during precipitation and the majority flows off above ground. As a result, water-bearing streams in the Flysch-Vienna Woods can swell quickly and take on the character of torrents. The same applies to the runoff maxima, which occur mainly in March due to the snow melt (Drozdowski & Mrkvicka 2014; Waringer & Waringer 2014; Stadt Wien n.d.).

A total of around 50 streams flow through the city of Vienna, $^2/_3$ of which are largely canalised. Those that run on the surface are partly influenced by human activity (Stadt Wien n.d.).

The two rivers Alsbach and Eckbach run through two neighbouring catchment areas; both have their sources in Lower Austria (see Fig. 2, next page). It should be noted that the Alsbach is the longest stream of the Vienna Wood after the Vienna River. The first human modifications by means of arching already took place in the 19th century (Stadt Wien 2024). The Eckbach stream experienced a similar fate, although it should be emphasised that a 200 m section in the Schwarzenbergpark area was renaturalised in 2013 by widening the stream bed (Stadt Wien n.d.). In general, the river sections to be analysed extend from the Vienna city limits to the flood retention basin near Neuwaldegg. This is where the Alsbach and Eckbach streams meet (Stadt Wien n.d.). Accordingly, the sections to be analysed have a length of 2.4 km (Alsbach) and 1.8 km (Eckbach) (data.gv.at 2024).

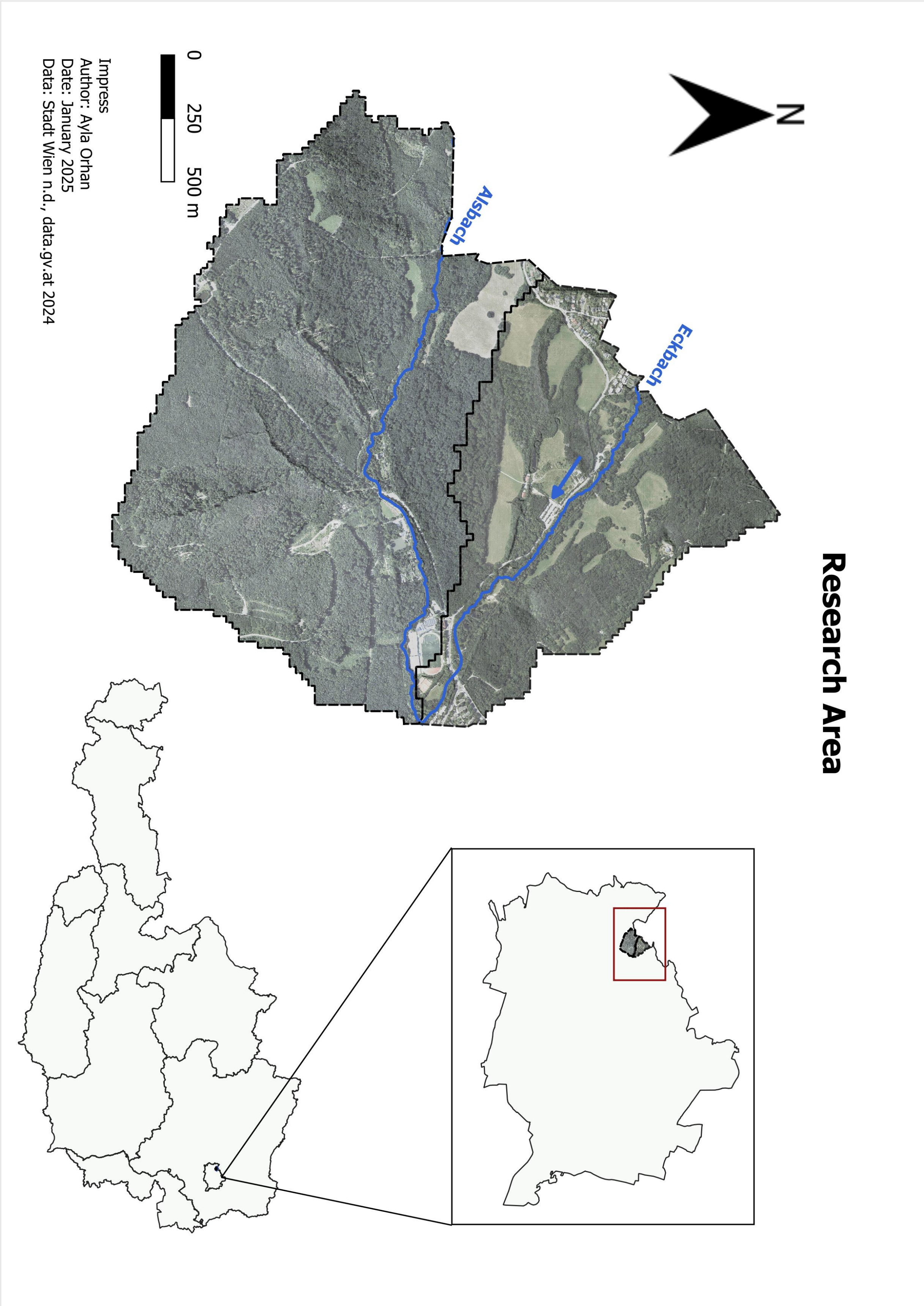


*Fig. 2: Overview of the research area as well as the location and river course of the streams (own illustration, data: Stadt Wien n.d.; data.gv.at 2024)*

In terms of climate (Fig. 3), the two catchment areas are characterised by a continental influence with warm summers and cold winters. The average annual precipitation is about 670 mm (Biosphärenpark Wienerwald Management GmbH 2024; HISTALP 2024). Based on the climate data from 1990 to 2020, the average annual temperature is almost 11°C (HISTALP 2024).

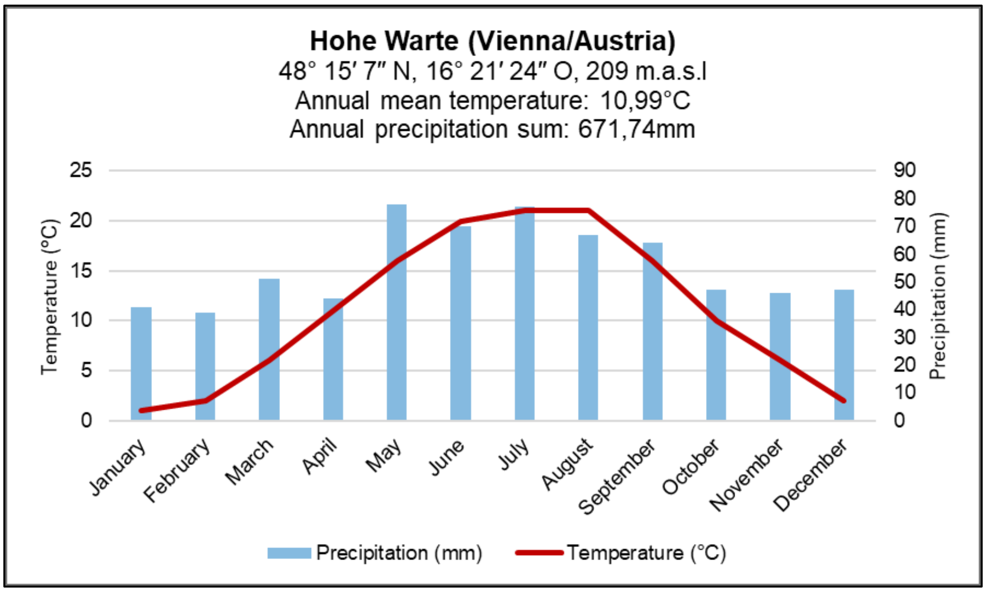


*Fig. 3: Climate graph of "Hohe Warte" in the Vienna Woods from 1990-2020 (own illustration, data: HISTALP 2024)*

Due to its close proximity to the city of Vienna, the Vienna Woods are a popular area for local recreation. Since 2005, the Vienna Woods have been a UNESCO Biosphere Reserve, as they have special natural and cultural values. Both the fauna and flora are characterised by diversity. In fact, 33 different forest types and more than 2000 plant species have been identified and mapped, with deciduous forests dominating in the Flysch-Vienna Woods (Drozdowski & Mrkvicka 2014; Stadt Wien n.d.). However, the diversity of fauna is recognizable as well, since the Vienna Woods are home to more than 5000 animal species (Stadt Wien n.d.).

# 4. Data and Methods

The data and methods for each research focus can be divided into two parts - data collection and data processing. During fieldwork in the study area, primary data were recorded, which were subsequently analysed or presented using a GIS programme or statistically. The map bases used (orthophoto and hillshade) were obtained from ViennaGIS and processed (Stadt Wien 2025). The data of the catchment areas and the river network were obtained from the open data provided by the Austrian Federal Chancellery (data.gv.at 2025).

General German- and English-language literature was consulted using keywords from literature databases and the departmental libraries ‘Geography and Regional Research’ and ‘Biology and Botany’ (see Fig 4).


*Fig. 4: Visualization of the literature search and the number of references used*

## 4.1 Geomorphological units/potential habitats, large wood and human impact

The mapping of the respective focal points was carried out at the beginning of March 2025 on two consecutive weekends in order to minimise temporal changes in the river courses and to ensure comparability.

### 4.1.1 Data collection

Data collection was carried out using traditional fieldwork, although mobile technology was used (Kingston et al. 2011; Zangana et al. 2023). The mapping sheets explained below are labelled with IDs (identification numbers). In addition, these IDs were recorded with GuruMaps (paid GPS app) by setting points, so-called ‘markers’. This is necessary in order to be able to assign the points of interest during subsequent data processing. However, it should be noted that mapping was carried out with a maximum resolution of 20 metres, which may result in inaccuracies.

### (i) Geomorphological Units and potential habitats

Since geomorphological processes and shapes are closely related, two mapping sheets were created for this purpose (Fig. 5 and 6). Figure 5 records information on erosion and deposition and their approximate surface dimensions in centimetres (cm).

River section:
Date:

| Erosion (E) | | | | Deposition (D) | | | |
|---|---|---|---|---|---|---|---|
| ID | Laterial erosion (x) | Bank erosion (x) | Size (cm) | ID | Sediment | Length (cm) | Width (cm) |
| E1 | | | L =<br>W = | D1 | O fine<br>O coarse<br>O mix | | |
| E2 | | | L =<br>W = | D2 | O fine<br>O coarse<br>O mix | | |
| E3 | | | L =<br>W = | D3 | O fine<br>O coarse<br>O mix | | |

*Fig. 5: Field mapping form of geomorphological processes and their size (in cm)*

The data collection of the geomorphological units includes riverine habitats, as these are closely linked (Hawkins et al. 1993). Based on Wheaton et al. (2015), the units were selected and subsequently processed (Fig. 6). In the course of this work, pools and riffles are determined purely by their morphology and sediments (as described in Chapter 2). So-called 'dammed pools' are referred to as "backwater" in the next subchapter ('Large Wood').

River section:
Date:

| Geomorphological Units (GU) | | | | | | | Habitats (GU ID) | | | | LW in proximity | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flood Plain | | Island | Cascade | Boulder | Pool / Riffle | | Still water zone | Fast flowing zone | Substrate-based zone | Structurally rich zone | GU ID | Before / after LW |
| ID | Size | ID | ID | ID | ID | Pool / Riffle | | | | | | |
| Fp1 | L<br>W | I1 | C1 | B1 | Pr1 | O Pool<br>O Riffle | | | | | | O before<br>O after |
| Fp2 | L<br>W | I2 | C2 | B2 | Pr2 | O Pool<br>O Riffle | | | | | | O before<br>O after |
| Fp3 | L<br>W | I3 | C3 | B3 | Pr3 | O Pool<br>O Riffle | | | | | | O before<br>O after |

*Fig. 6: Field mapping form of geomorphological untis and habitats*

In addition to the mapping sheets and a mobile terminal device, a measuring tape and a laser distance measuring device were used to record the sizes.

### (ii) Large Wood

An existing mapping sheet (Fig. 7) by Chmela & Diem (2024, unpublished), which is based on Poeppl et al. (2024), was used to collect data on large wood. Based on the research questions, the focus of the data collection was on the formation of GU or habitats (backwater) by LW as well as the LW types in the two river sections, nevertheless the mapping sheet was processed holistically. A sharpened and measured wooden stick was used to measure sediment behind LW accumulations.

| LW Types / Indices / Sediment Retention | | | | | | | | | | | | | | | | | | | | other jams: - Deflector jam (D) - Bar top jam (BT) - Bar apex jam (BA) - Meander jam (M) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LABEL | CHANNEL SPANNING | | SINGLE PIECES | | | | | JAMS | | | | WATER RETENTION | | | SEDIMENT RETENTION (MEASUREMENTS) | | | | | |
| ID | yes | no | bridge | col-laps. bridge | ramp | log step | partial log step | under-flow jam | dam jam | partial dam jam | other jams | poros. (%) | backwa-ter (yes/no) | bed contact (yes/no) | length (cm) | width (cm) | lowest point (cm) | highest point (cm) | height (cm) | coarse fine |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

*Fig. 7: Field mapping form for LW by Chmela & Diem (2024, not published)*

### (iii) Human impact

In the mapping, human influence mainly refers to created anthropogenic structures, which have an influence on the fluvial morphology in various ways (Fig. 8) (Szatten et al. 2019). The heading 'Other HI' refers, for example, to mechanical influence (initiated erosion).

River:
Date:

| Human Impact (HI) | | | | | |
|---|---|---|---|---|---|
| | Structural HI | | | | |
| ID | Bridge | dam / dam like structure | Bank reinforcement | Other structures | Other HI |
| H1 | | | | | |
| H2 | | | | | |
| H3 | | | | | |

*Fig. 8: Field mapping form of human impact*

### 4.1.2 Data processing

The data processing was generally carried out using the GIS programme 'QGIS 3.34 Prizren' and the data preparation with Excel (.xlsx and .csv); raw data and calculations are attached in the Appendix.

### (i) Geomorphological units and potential habitats

Geomorphological units and potential habitats as well as processes were graphically processed in the form of a map and their frequency subsequently analysed.

### (ii) Large wood

In large wood, the types of LW occurrences were worked out and visualised. In addition, the morphologies before and after LW were visualised on the map and in tabular form. The blockage by LW in the channel was determined using the $ID_{LW}$ (LW disconnectivity index), which is calculated as follows according to Poeppl et al. (2024).

$$ID_{LW} = \frac{\Sigma A_{LW}}{l\ (m)}$$

$A_{LW}$…porosity, l…length of the river (section) in meters

The large wood sediment retention potential index ($IR_{LW}$) was used by Poeppl et al. (2024) to discuss the sediment retention potential associated with the blockage.

$$IR_{LW\,(f)} = \frac{\Sigma RP_{LW\,(f)}}{l\ (m)}$$

$RP_{LW}$…sum of the sediment retention potential, l…length of the river (section) in meters

To compare the LW dynamics after the flood of the century in September 2024, the data provided by Chmela (2024, unpublished) for the Alsbach stream were compared with the current data and only those that could be clearly allocated were used. The dynamics of the LW type were worked out and presented in tabular form as well as in a map.

**(iii) Human impact**

The recorded data was visualised using QGIS, whereby the objects and human influence were listed in point data. Frequencies of building structures were visualised using bar charts.

## 4.2 Macrozoobenthos

Macrozoobenthos was sampled at both river sections in mid April 2025, immediately after the water quality measurements.

### 4.2.1 Data collection

A form (see Appendix) was created and used for the macrozoobenthos survey (MZB), in which abiotic habitat parameters were noted, basing on the BMNT (2019) guidelines. For each watercourse, 15 samples were taken from three different habitats (= multi-habitat sampling), which are composed as follows (Table 4) (Bezmaternykh & Shcherbina 2017; BMNT 2019).

*Tab. 4: Overview of the Multi-Habitat-Sampling (MHS) of the Alsbach and Eckbach stream*

| Alsbach | Eckbach |
|---|---|
| 5 Pools | 5 Pools |
| 5 Riffles | 5 Riffles |
| 5 Large Wood | 5 Large Wood |

Pools and riffles, as defined in Chapter 4.1, were sampled using a Hess sampler (Fig. 9) (Alonso & Camargo 2010; Sepulveda et al. 2019). The Hess sampler was pushed and rotated into the riverbed to seal off a specific area of 491 $cm^2$. The operator then dislodges organisms from the substrate within the sealed area using a screwdriver to stir up the bottom allowing a current to wash them through a downstream net and into a collection bucket, yielding a quantitative sample of macroinvertebrates from a known surface area (Fig 9). Additionally larger stones within the sampler were cleaned off with a brush (Fig 9). Each sampling point was processed for two minutes.

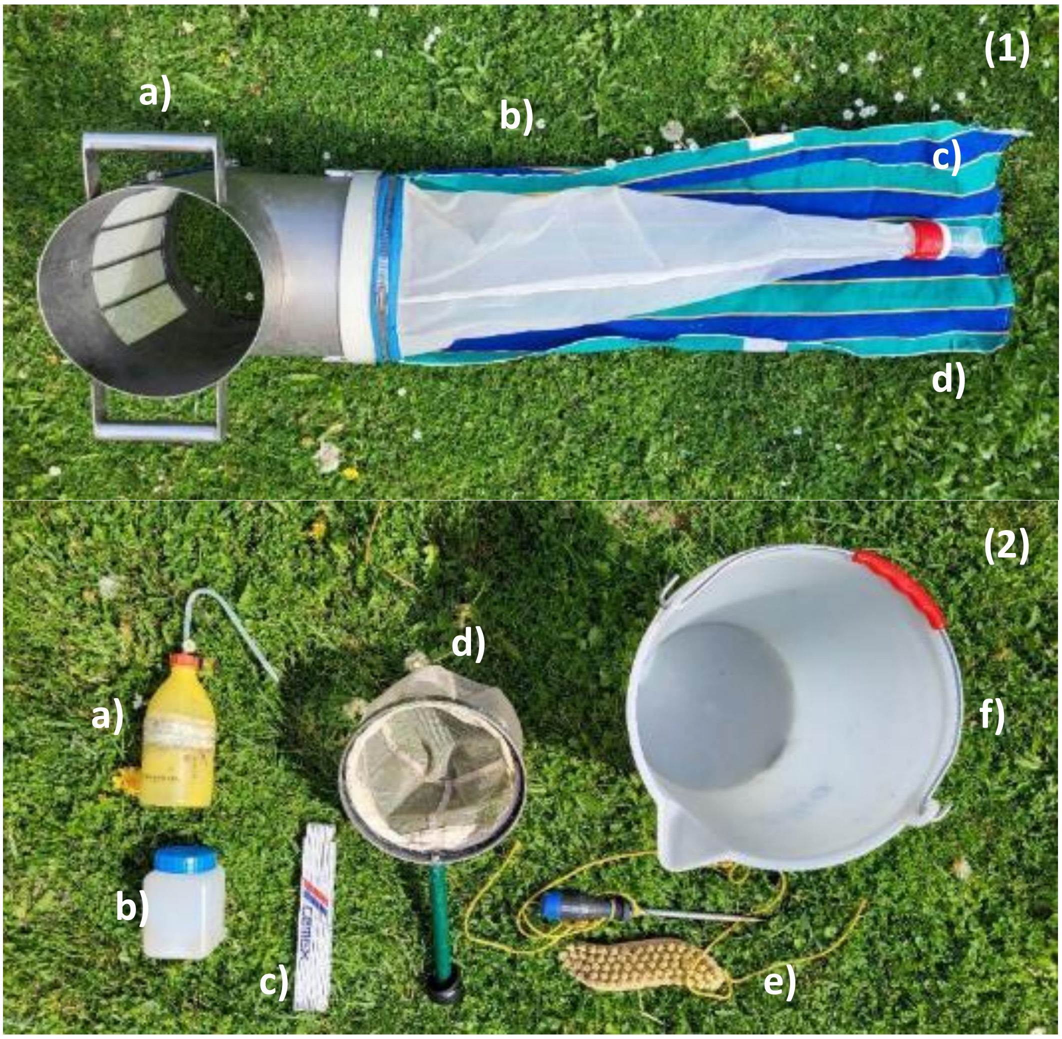


*Fig. 9: (1) Hess sampler: a) metal ring with handles and fine-meshed net so that water flows through the sampled area b) fine-meshed downstream net (50µm) c) Collection cup for MZB d) Protection for fine-meshed net (2) Other items in the field: a) Ethanol b) Plastic cup for storing the MZB c) Scale for measuring the water depth d) Fine-mesh landing net for LW sampling e) Brush and vice f) Bucket for LW sampling (own illustration)*

The contents of the collection cup were then tipped into a plastic bucket (Fig. 9, 2b) and fixed with 96% ethanol. The approach to sampling large wood was different. Here, a defined area of 0.5×0.5m was systematically sampled (right, centre, left) with a fine-meshed landing net in a figure-eight motion for two minutes and the contents (mainly leaves) were filled into the bucket (Tronstad et al. 2020). If the wood could be lifted, it was cleaned in the bucket with a brush. The bucket was then filled with water and the leaves were washed in order to remove the macrozoobenthos from the organic material. When selecting the leaves, individual macrozoobenthos that did not detach during rinsing were manually added to the plastic cup (Fig. 9, 2b). As soon as the leaves were removed from the water mixture, it was sieved through the collection container of the Hess sampler. The remaining animals were placed in the plastic storage unit and fixed with ethanol.

The macrozoobenthos was analysed with using a stereomicroscope (Nikon, 544417). Samples were presorted by first sieving the sample and then fixing it in a container with alcohol (96%) and distilled water. Portions of the samples were systematically analysed in a petri dish (Fig. 10) and organisms were placed in alcohol-filled glass vials (Fig. 10) after sorting with spring tweezers. After a subsequent count of the macrozoobenthos, these were stored in 75% ethanol (Fig. 10). The count was recorded in an Excel spreadsheet (.xlsx document); the raw data are attached to the Appendix.

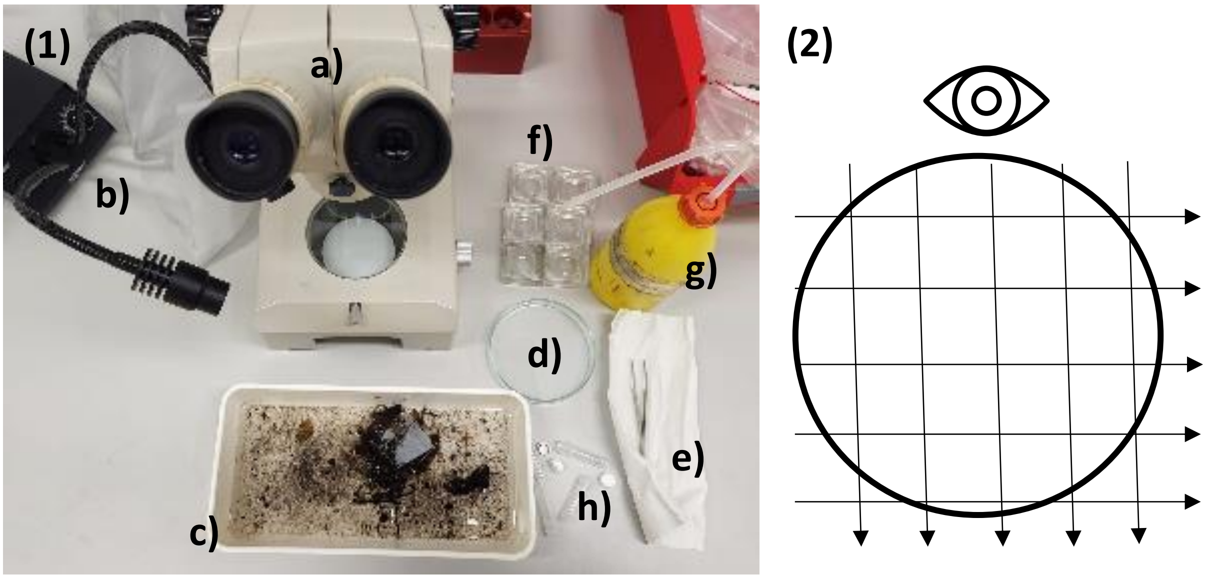


*Fig. 10: (1): a) Stereomicroscope b) Light source c) Sample d) Petri dish e) Spring tweezers f) Glass container g) Ethanol h) Plastic tubes (2) Systematics when searching the Petri dish (own illustration)*

#### 4.2.2 Data processing

In order to enable comparability within the habitats, the values of the samples first had to be extrapolated linearly to an area of 1 $m^2$. Based on the research questions, the percentages of the orders were determined. Predominantly represented macrozoobenthos (EPT-taxa and Diptera) were visualised in a boxplot with RStudio for better comparison between the habitats.

The Kruskal-Wallis test was used to calculate whether there is a difference between the diversity (order level) or number of individuals of the macrozoobenthos and the respective habitats. This is suitable for testing data that is not normally distributed. With the help of RStudio (script template in Appendix), the values (p-value, $Chi^2$) were calculated and then presented in tabular form. If there was a significant difference ($p < 0.05$), the post-hoc test was then carried out to find out between which habitats there were significant differences. Based on this, an alternative or null hypothesis could be assumed (Ostergová et al. 2014; Kuhlenkasper & Handl 2019).

## 4.3 Water quality

The parameters of the water from the Alsbach and Eckbach streams were measured on two consecutive days.

### 4.3.1 Data collection

Prior to the field work, a form (see Appendix) was created to record the data. In addition, the four sampling sites per water body had to be determined in advance, which, based on the research questions and hypotheses, included sites (i) in the headwaters, (ii+iii) upstream and downstream of a pond and (iv) sites used by people for recreational purposes.

The pH value, conductivity, temperature and dissolved oxygen were measured using a multiparameter probe (WTW, Multi 3420) (Fig. 11). When measuring the four parameters, the 'AutoRead' function was activated so that stable measured values are recorded for reproducibility (Xylem Analytics Germany GmbH 2021).

Subsequently, the chemical parameters ammonium ($NH_3$), phosphate ($PO_4^{3-}$), nitrate ($NO_3^-$) and nitrite ($NO_2^-$) were determined. A portable spectrophotometer (Hach, DR 1900) was used for this purpose (Fig. 11). This device measures the parameters with a xenon flash in a range from 340 to 800 nm (± 2 nm) (Hach 2025). Spectroscopy can be used to analyse chemical substances in the ultraviolet to infrared spectrum by determining the concentration of the substances through absorption or emission of the light source (Guo et al. 2020).


*Fig. 11: (1): a) specific probes b) buffer solutions c) deionised water for cleaning the probes d) measuring device (2) a) portable photometer b) 10 ml cuvettes for sample liquid (own illustration)*

Using the manufacturer's test kits (= powder pillows), the chemical parameters were measured in the following measuring range.

| Parameter (test kit) | Measuring range according to manufacturer | Measured wavelength |
|---|---|---|
| **$NH_3$** (Ammonia Salicylate Reagent Powder Pillows, 10ml & Ammonia Cyanurate Reagent Powder Pillows, 10ml ) | 0.00 – 0.60 mg/l | 655 nm |
| **$PO_4^{3-}$** (PhosVer® 3, 10ml) | 0.00 – 2.50 mg/l | 710 nm |
| **$NO_{3^-}$** (NitraVer® 5, 10ml) | 0.00 – 30.0 mg/l | 500 nm |
| **$NO_{2^-}$** (NitriVer® 2, 10ml) | 0.00 – 250 mg/l | 585 nm |

**4.3.2 Data processing**

The results of the water samples were then presented in tabular form and a discussion on the reference values of the EU Water Framework Directive (EU WFD) was established.

## 5. Results

This chapter presents the results based on research questions.

### 5.1 Geomorphological units/potential habitats, large wood and human impact

The following data were recorded at the beginning of March 2025. The weather was stable and dry on all three days. It should be noted that the water level of both rivers was low (<15 cm). Vegetation was not yet present at this time. However, as the two rivers largely flow through Vienna Woods (= deciduous forest), the ground was covered with a continuous layer of foliage.

#### (i) Geomorphological units and potential habitats

The recorded geomorphological units (n=103) result in a density of around 43 GU per kilometer along the length of the Alsbach stream. As can be seen in Fig. 12, pools (still water habitats) dominate and occur regularly along the entire stretch. Around 40% fast flowing zones were identified. There were no island-like structures.

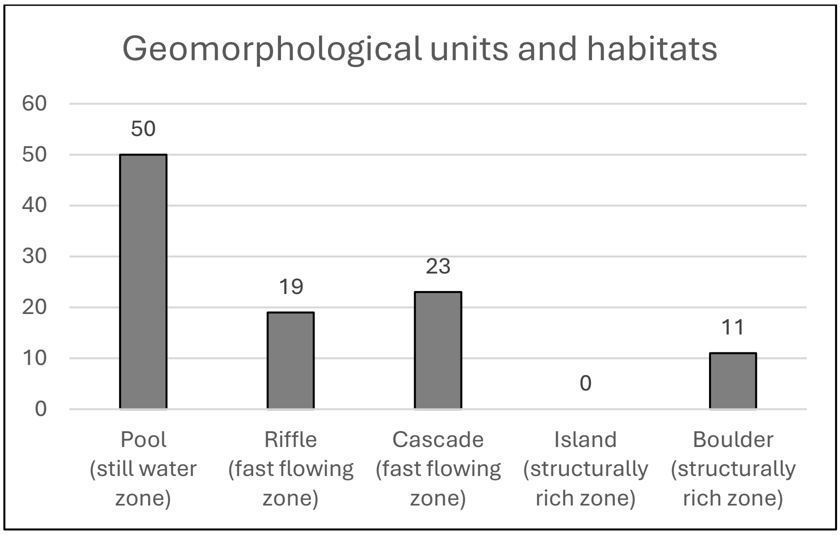


*Fig. 12: Overview of GU and potential habitats of the Alsbach stream*

Erosion processes, in which bank erosion predominates, take place particularly in the upper reaches (Fig. 13 and Appendix). Deposits (n=19) can be found around the lower reaches. In terms of the sediment composition of the deposition, these largely (n=12) consist of coarse material.

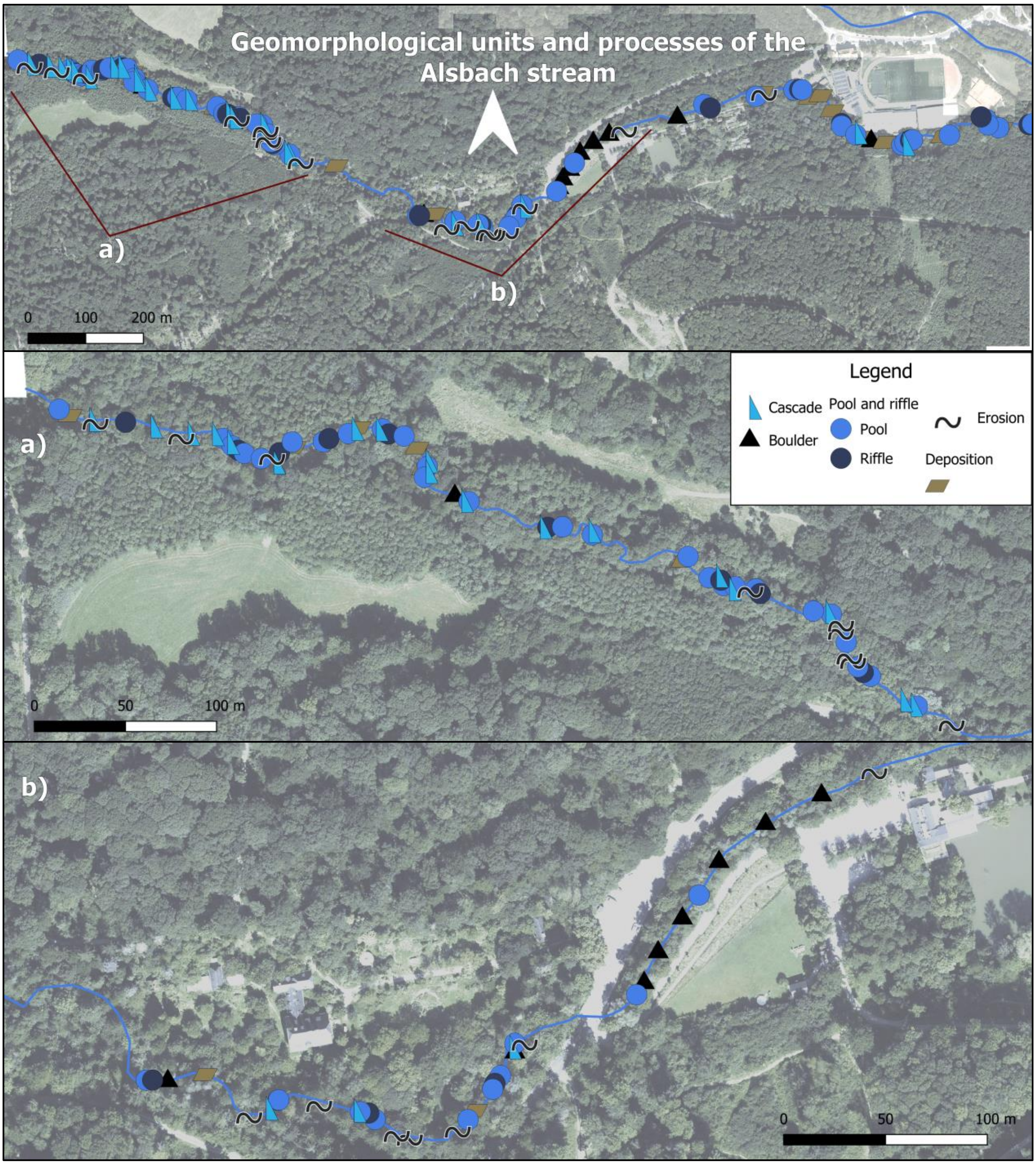


*Fig. 13: GU and potential habitats of the Alsbach stream; own illustration (orthophoto and line shapefile based on open data from Stadt Wien n.d. & data.gv.at 2024)*

A total of 54 geomorphological units were recorded on the Eckbach stream, with pools accounting for almost half (n=25). Riffles and cascades represent almost 30% of the GU. On average, around 30 geomorphological units can be found per river kilometre. In terms of potential habitats, still water zones and fast flowing zones dominate (see Fig. 14).

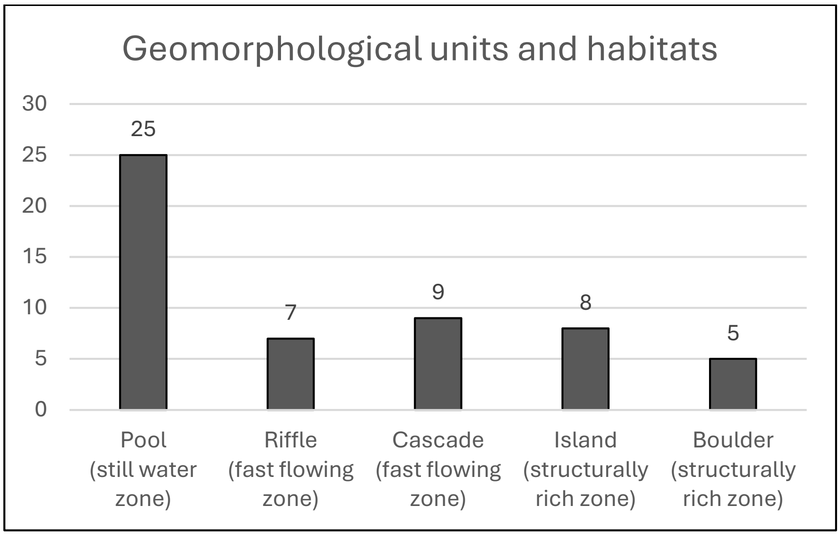


*Fig. 14: Overview of GU and potential habitats of the Eckbach stream*

Their distribution shows that GU occur in a high density in the upper to middle section of the Eckbach stream (Fig. 15). Similarly, erosion processes (n=21) can be recognised above all in the upper section. As can be seen from the map (Fig. 15), deposition takes place in the lower reaches.

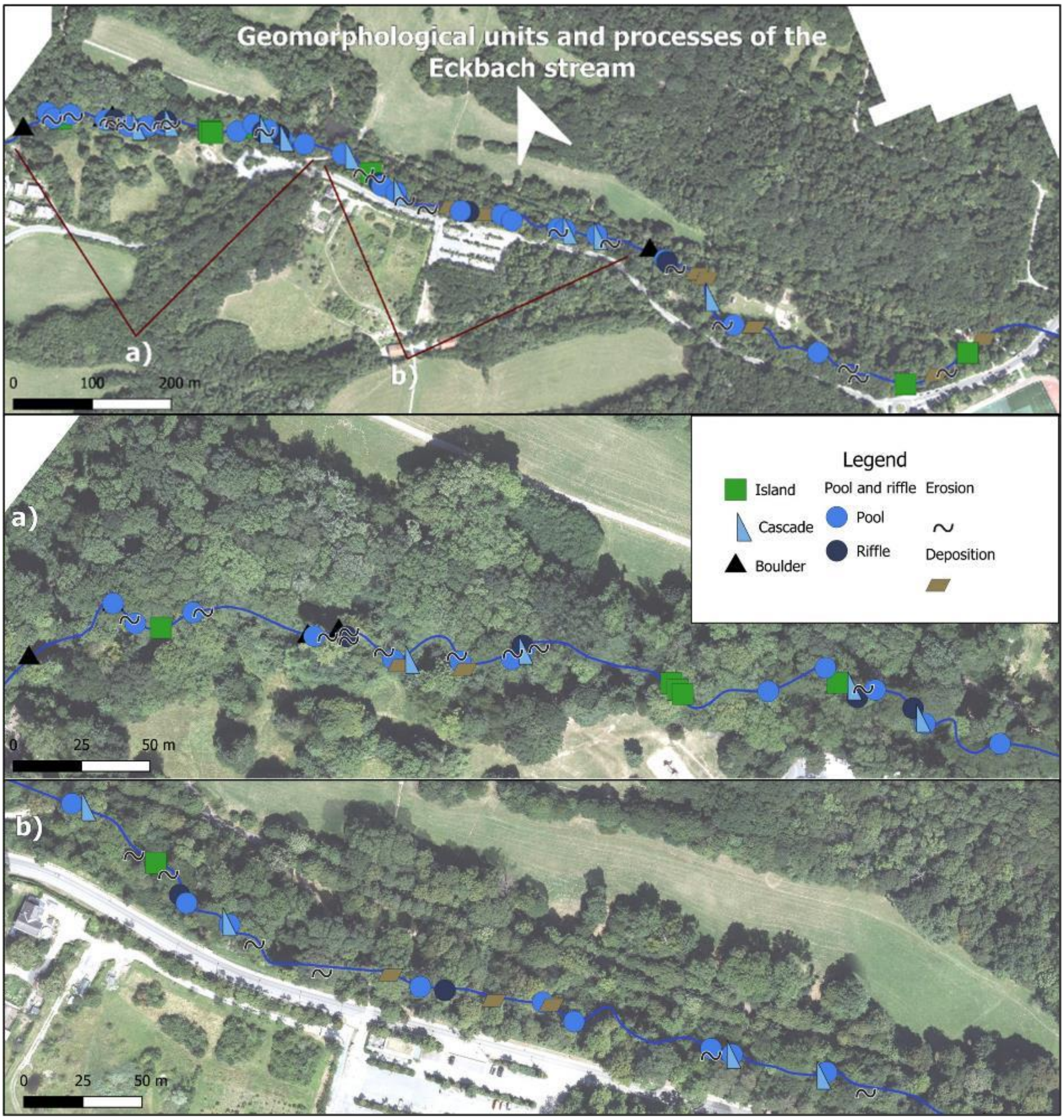


*Fig. 15: GU and potential habitats of the Eckbach stream; own illustration (orthophoto and line shapefile based on open data from Stadt Wien n.d. & data.gv.at 2024)*

### (ii) Large wood

Along the Alsbach stream, 43 pieces of large wood were recorded (Fig. 16 and Tab. 5). Single pieces (n=22) and jams (n=21) are in equal proportion, with bridges accounting for almost 40% of all types. A backwatering effect of the water is predominantly caused by dam jams, although it should be noted that not-channel-spanning LW is capable of this as well. After LW (mainly dam jams), pools were identified at six LW sites and one island (Tab. 5).

Due to the dimension of the large wood accumulation in the channel cross-section, a porosity mean value of 60 and an $ID_{LW}$=0.783 results. The index for sediment $IR_{LW}$, which can potentially be retained, is 0.040 (see Appendix).

*Tab. 5: Overview of the large wood at the Alsbach stream (C-S = channel spanning, N-C-S = not-channel-spanning)*

Alsbach stream

| | | **LW type** | **n** | **Backwater** | **Morphological formation** |
|---|---|---|---|---|---|
| Single pieces | C-S | **Bridge** | 17 | 0 | 0 |
| | N-C-S | **Ramp** | 3 | 0 | 0 |
| | | **Log step** | 1 | 1 | 0 |
| | | **Collapsed bridge** | 1 | 0 | 0 |
| Jams | N-C-S | **Partial dam jam** | 8 | 2 | 2 pools |
| | C-S | **Underflow jam** | 7 | 0 | 1 pool |
| | | **Dam jam** | 6 | 6 | 3 pools, 1 island |
| | | **Total** | **43** | **9** | **7** |

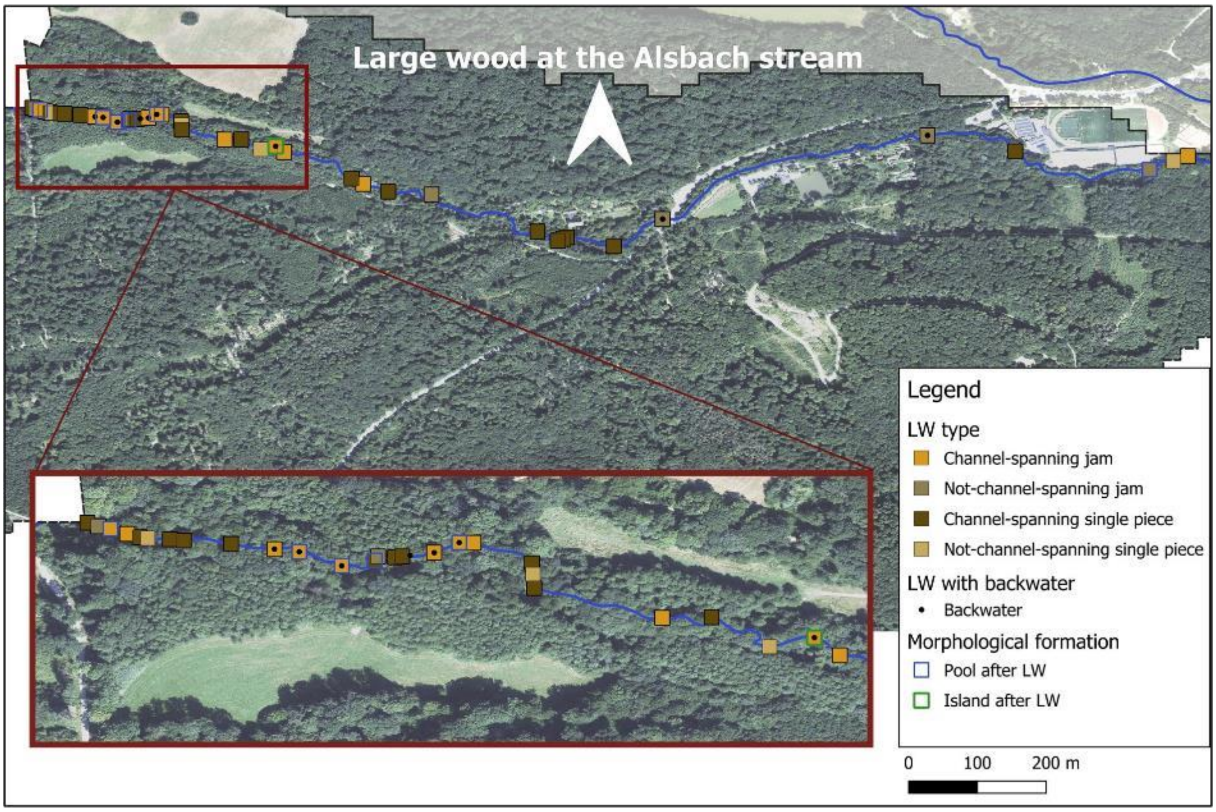


*Fig. 16: Recorded LW types with backwater and morphological formations at the Alsbach stream; own illustration (orthophoto and line shapefile based on open data from Stadt Wien n.d. & data.gv.at 2024)*

A total of 16 large wood (see Fig. 17 and Tab. 6) were recorded at Eckbach stream, with channel-spanning LW dominating with 14 pieces. Jams (n=10) occur most frequently, followed by six single pieces. Backwater due to wood accumulation was recorded at two dam jams. Morphological formations shortly after LW on the Eckbach stream are pools (n=6), which occur particularly after jams (Table 6).

Due to the thickness of the large wood, the average porosity is 43.02; based on the porosity, the $ID_{LW}$ is 0.536. The potential sediment retention ($IR_{LW}$) at Eckbach stream is 0.019 (data in Appendix).

*Tab. 6: Overview of the large wood at the Eckbach stream (C-S = channel spanning, N-C-S = not-channel-spanning)*

Eckbach stream

| LW type | | | n | Backwater | Morphological formation |
|---|---|---|---|---|---|
| Single pieces | C-S | **Bridge** | 5 | 0 | 0 |
| | N-C-S | **Log step** | 1 | 0 | 1 pool |
| Jams | N-C-S | **Partial dam jam** | 1 | 0 | 0 |
| | C-S | **Underflow jam** | 6 | 0 | 4 pools |
| | | **Dam jam** | 3 | 2 | 1 pool |
| | | **Total** | **16** | **2** | **6** |

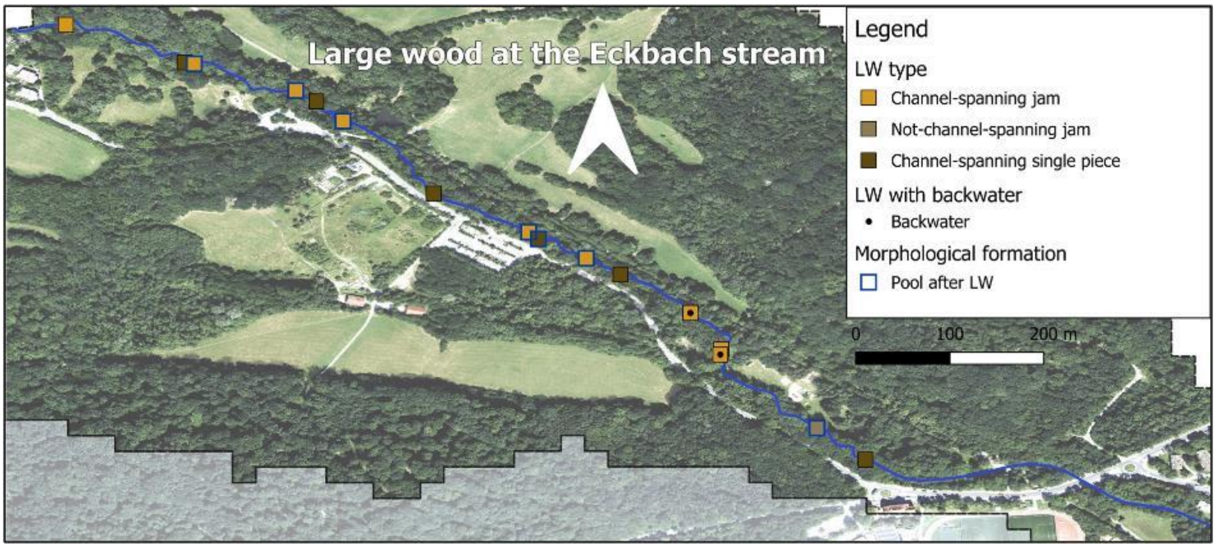


*Fig. 17: Recorded LW types with backwater and morphological formations at the Eckbach stream; own illustration (orthophoto and line shapefile based on open data from Stadt Wien n.d. & data.gv.at 2024)*

The data recorded by LW in spring 2024 and 2025 show some differences. It can be seen that before the flood event (September 2024) in spring of the same year, more wood was stored in the lower reaches (Fig. 18a). In spring 2025, on the other hand, new LW points were registered in the upper reaches of the Alsbach stream (Fig. 18b).

Excluded from the comparison are the LW accumulations in the private property of Villa Kraus, as these were recorded for the first time after the flood (Fig. 18).
Based on the data collected in 2024, exactly 14 LW GPS points could be identified after the flood event, which show a change.

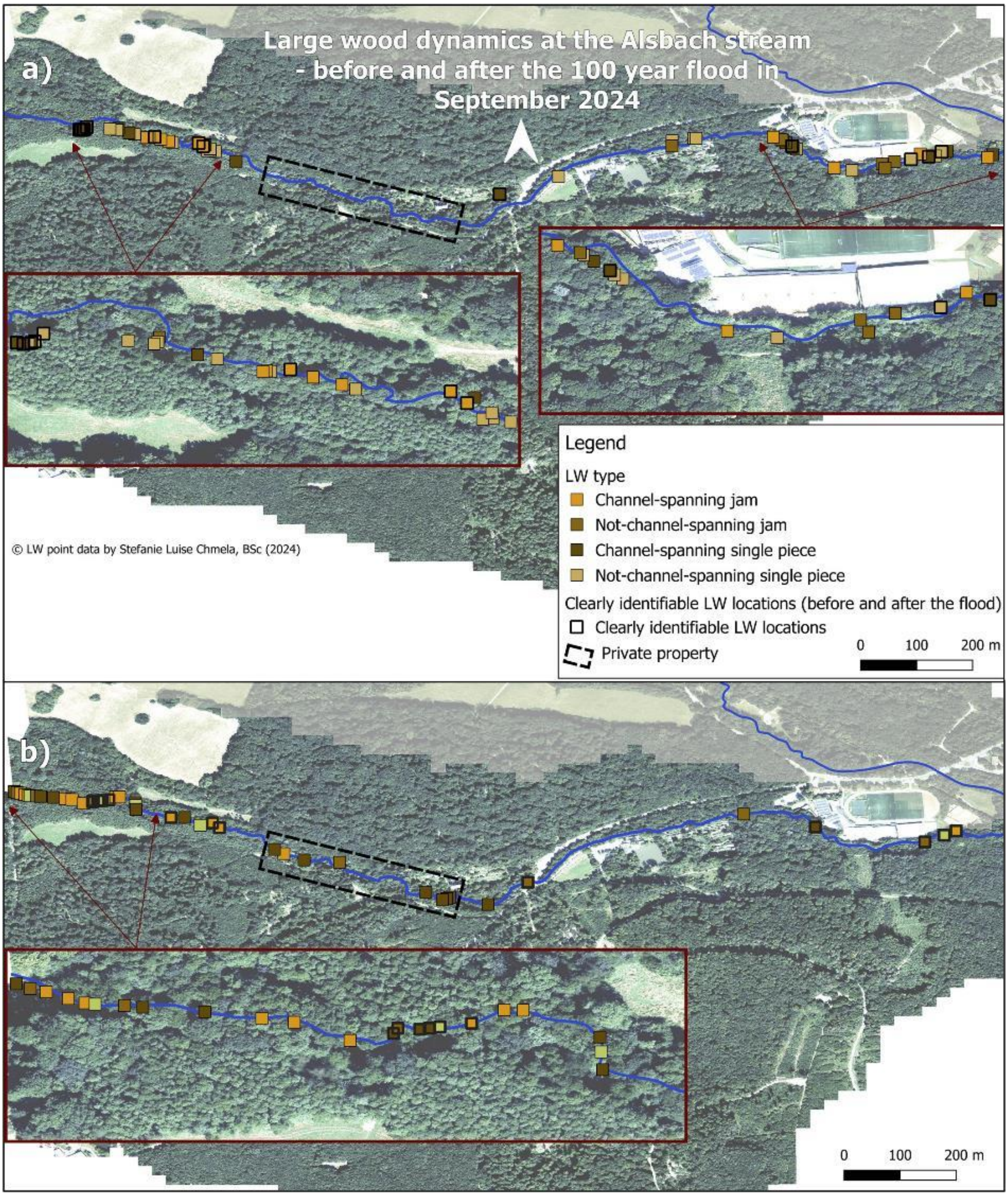


*Fig. 18: Dynamics of LW before and after the flood in autumn 2024; own illustration (orthophoto and line shapefile based on open data from Stadt Wien n.d. & data.gv.at 2024)*

It can be seen that jams and bridges have predominantly retained their LW type. However, single pieces (n=5) that were not-channel-spanning or had contact with the river bed show a dynamic in that they have grown into jams (Tab. 7).

*Tab. 7: Dynamics of identifiable LW before and after the flood in September 2024*

| | ID | 2024 | ID | 2025 |
|---|---|---|---|---|
| **Initial situation: jam** | LW35 | Dam jam | LW27 | Dam jam |
| | LW36 | Underflow jam | LW28 | Underflow jam |
| | LW40 | Dam jam | LW24 | Underflow jam |
| **Initial situation: single piece** | LW5 | Ramp | LW31 | Partial dam jam |
| | LW7 | Bridge | LW32 | Ramp |
| | LW9 | Ramp | LW31 | Partial dam jam |
| | LW18 | Bridge | LW30 | Bridge |
| | LW28 | Log step | LW34 | Partial log step |
| | LW50 | Ramp | LW18 | Dam jam |
| | LW51 | Log step | LW17 | Log step |
| | LW52 | Bridge | LW16 | Bridge |
| | LW54 | Bridge | LW15 | Bridge |
| | LW55 | Bridge | LW13 | Bridge |
| | LW56 | Ramp | LW14 | Partial dam jam |

### (iii) Human impact

Over a length of around 2.4 kilometres along the Alsbach stream, 20 structural changes caused by humans have been recorded. This results in around eight interventions per kilometre of river. Most of the influence can be seen around the former landscape garden of Villa Kraus (now privately owned) to the south-west of the map (Fig. 19). The structures are dominated by transverse structures, followed by bridges and artificial cascades. Only once along the entire length the bank was stabilised with stones (Fig. 20).

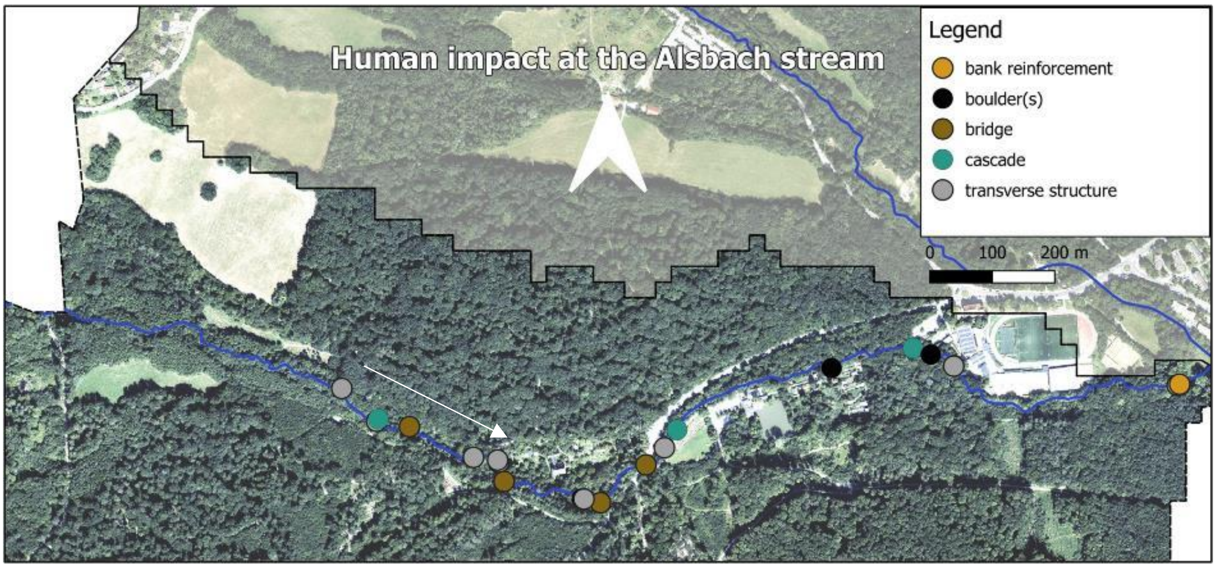


*Fig. 19: Visualization of the human impact at the Alsbach stream; own illustration (orthophoto and line shapefile based on open data from Stadt Wien n.d. & data.gv.at 2024)*

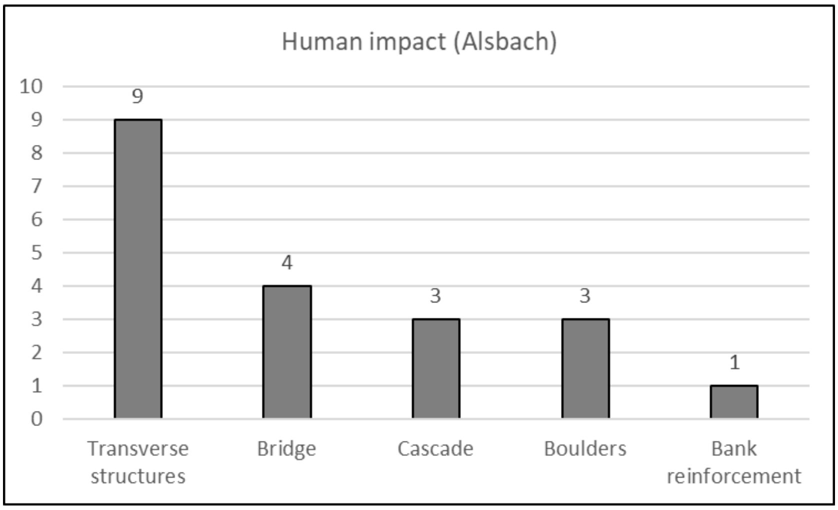


*Fig. 20: Frequency of structural human impact along the Alsbach stream (own illustration)*

The recorded data (Fig. 21) show that the Eckbach stream has already been affected by human activity in the upper reaches after the Vienna city boundary. A total of 25 structures were built along a river length of around 1.8 km, resulting in an average density of almost 14 structures per kilometre. As can be seen in Figure 22, bridges and transverse structures predominate at the Eckbach stream.

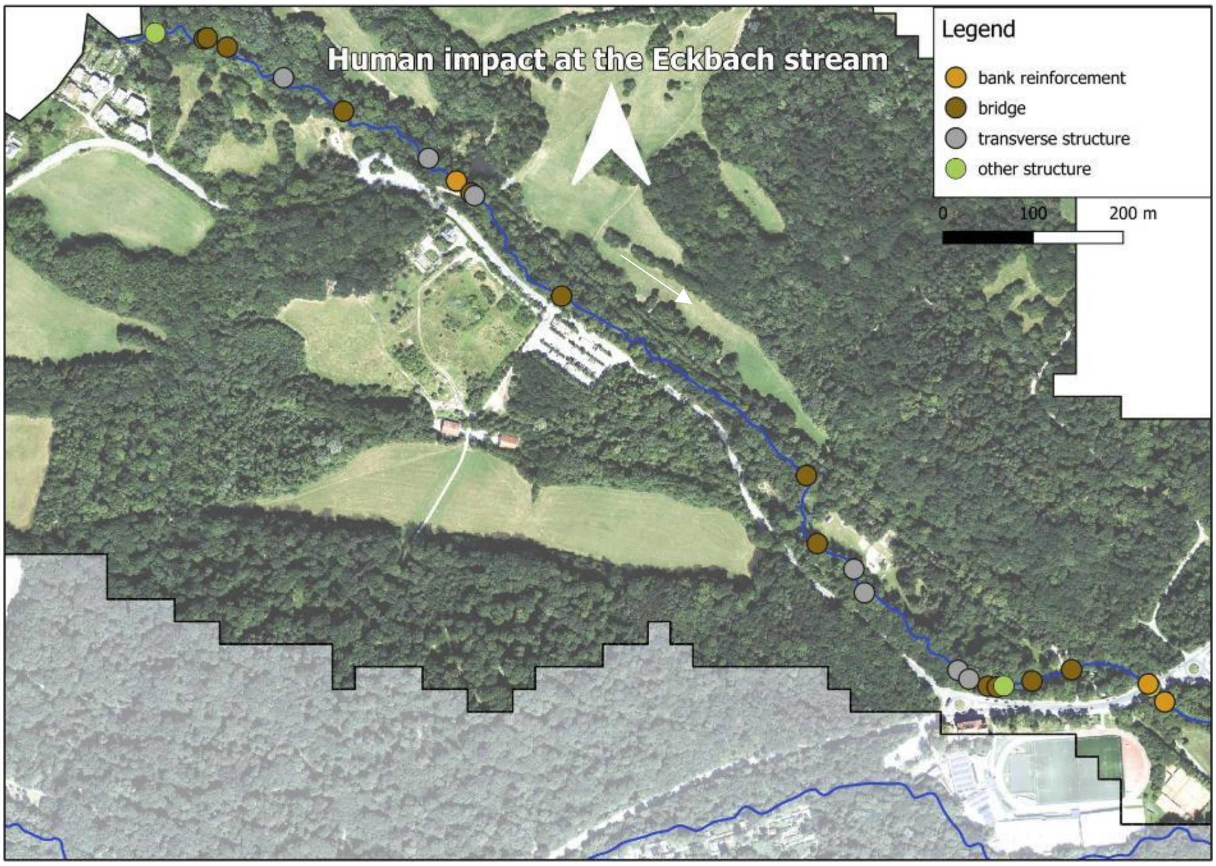


*Fig. 21: Visualization of the human impact at the Eckbach stream; own illustration (orthophoto and line shapefile based on open data from Stadt Wien n.d. & data.gv.at 2024)*

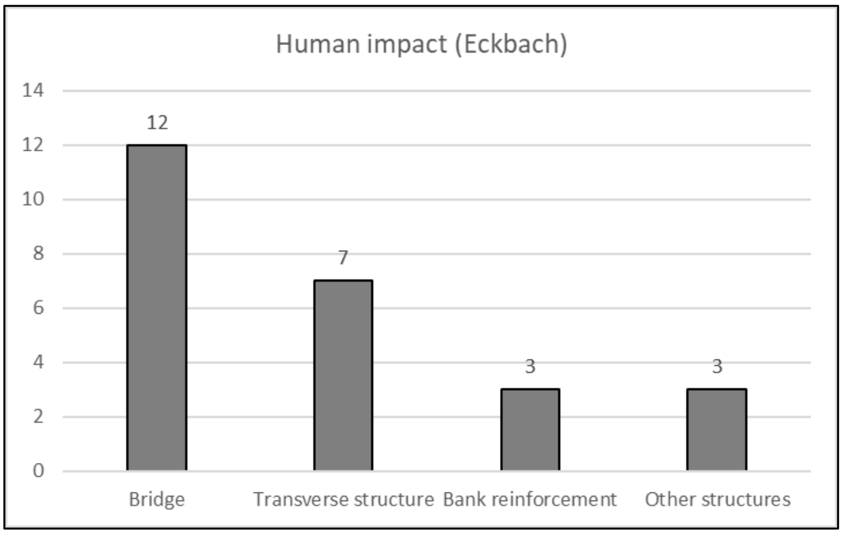


*Fig. 22: Frequency of structural human impact along the Eckbach stream (own illustration)*

## 5.2 Macrozoobenthos

The macrozoobenthos was sampled in mid-April 2025 at a total of 15 sites (Fig. 23) per river (see methods). Selected habitats on the Alsbach stream had an average water depth of 21.7 cm (pools), 10 cm (riffles) and 16.6 cm (LW). At the Eckbach stream, the pools had the highest water level with an average of 13.7 cm, followed by riffles (11.5 cm) and LW (17 cm).

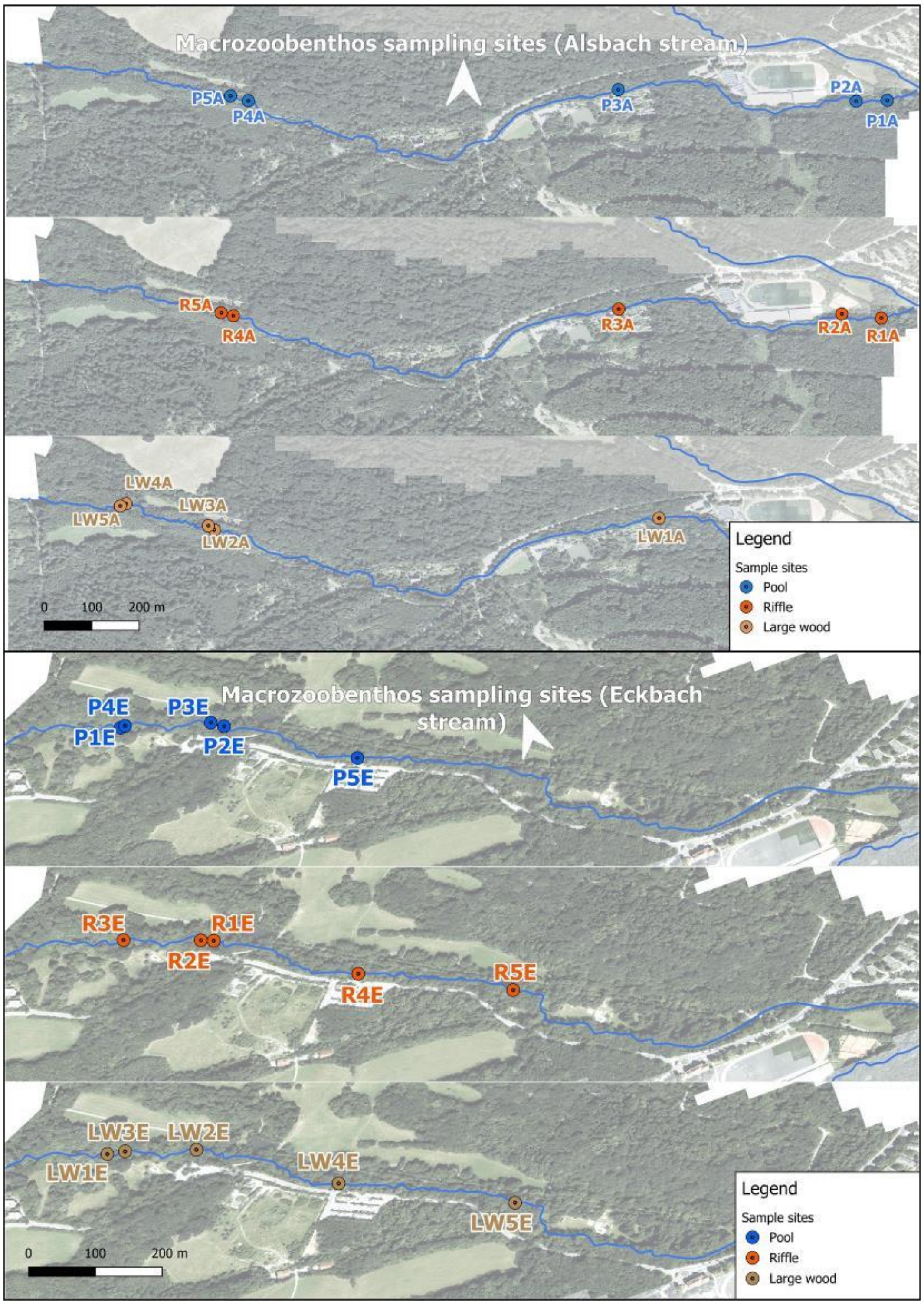


*Fig. 23: Sampling sites of the macrozoobenthos at the Alsbach and Eckbach stream; own illustration (orthophoto and line shapefile based on open data from Stadt Wien n.d. & data.gv.at 2024)*

A total of 3816 macrozoobenthos taxa were collected and analysed, with 2061 specimens from the Alsbach stream and 1755 from the Eckbach stream. Frequently occurring orders can be seen in Fig. 24.

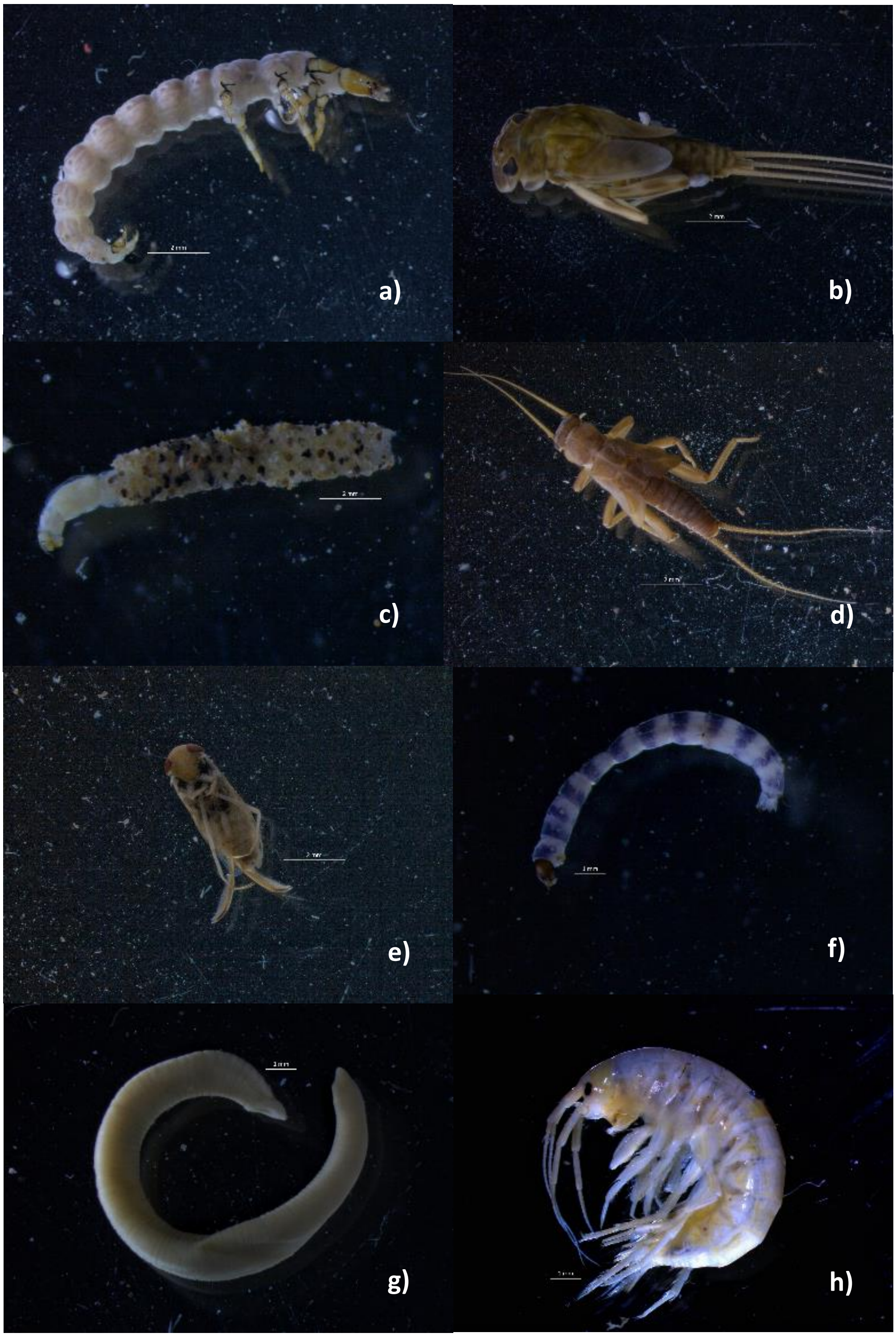


*Fig. 24: a) Trichoptera without case b) Ephemeroptera c) Trichoptera with case d) Plecoptera e) Heteroptera f) Diptera g) Oligocheta h) Amphipoda (own illustration)*

As can be seen from Table 8, representatives of the EPT order (Ephemeroptera, Plecoptera, Trichoptera) and Diptera were most frequently collected in the Alsbach stream.

*Tab. 8: Macrozoobenthos orders of the Alsbach stream (n= 2061) (* released due to its protected status)*

| **% of orders per habitat** | P_A (n=366) | R_A (n=518) | LW_A (n=1177) | Total (n=2061) |
|---|---|---|---|---|
| Amphipoda | 1.09% | 10.02% | 0.41% | 3.06% |
| Coleoptera | 0.00% | 0.74% | 0.25% | 0.34% |
| Collembola | 0.00% | 0.37% | 0.17% | 0.19% |
| Diptera | 25.14% | 28.87% | 25.91% | 27.07% |
| Ephemeroptera | 65.57% | 41.74% | 62.62% | 57.30% |
| Heteroptera | 0.00% | 0.00% | 0.08% | 0.05% |
| Isopoda | 0.27% | 0.00% | 0.42% | 0.29% |
| Odonata* | 0.00% | 0.19% | 0.00% | 0.05% |
| Oligocheta | 1.37% | 0.37% | 0.17% | 0.44% |
| Plecoptera | 5.46% | 11.50% | 7.31% | 8.15% |
| Salamandra s. larvae * | 0.00% | 0.00% | 0.93% | 0.53% |
| Trichoptera | 1.09% | 5.20% | 1.70% | 2.52% |
| | 100.00% | 100.00% | 100.00% | 100.00% |

Figure 25 (next page) shows the number of the most common orders, including EPT and Diptera, in the different habitat types along the Alsbach stream. When the EPT orders are split up, it is evident that Ephemeroptera larvae (N=12,421 ind/m²) occur most frequently in all habitat types. Overall, EPT, Ephemeroptera, Plecoptera (N=2,014 ind/m²) and Trichoptera (N=731 ind/m²), show the highest number of individuals per square meter, particularly in the 'riffle' habitat type. Diptera (N=6,374 ind/m²) show low abundance, although the values are homogeneous, as reflected in the narrow box plots; the outlier (maximum) in the riffles is an exception.

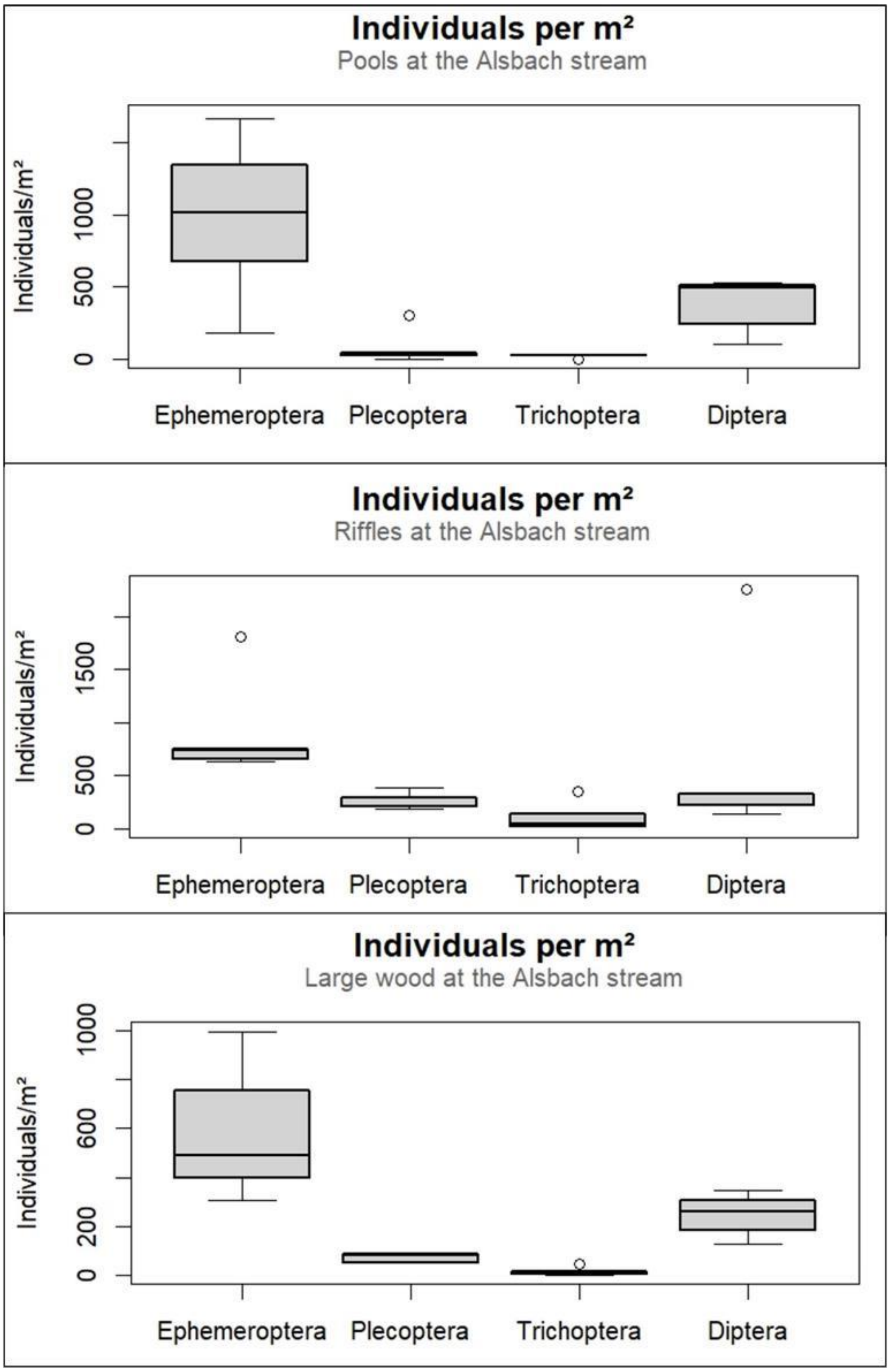


*Fig. 25: Boxplots of individuals per m² of the EPT-taxa and Diptera (Alsbach stream)*

The samples taken from the Eckbach stream show that the orders Diptera and Ephemeroptera dominate in all types of habitats as well. Individuals of the EPT always account for around a quarter of the total number. In addition, there is a high occurrence of Amphipoda (Crustaceae) this time (Table 9).

*Tab. 9: Macrozoobenthos orders of the Eckbach stream (n=1755) (* released due to its protected status)*

| **% of orders per habitat** | P_E (n=326) | R_E (n=730) | LW_E (n=699) | Total (n=1755) |
|---|---|---|---|---|
| Amphipoda | 9.20% | 34.79% | 44.06% | 33.73% |
| Coleoptera | 0.00% | 0.00% | 0.00% | 0.00% |
| Collembola | 0.00% | 0.00% | 0.00% | 0.00% |
| Diptera | 60.43% | 37.26% | 26.18% | 37.15% |
| Ephemeroptera | 23.93% | 23.01% | 20.60% | 22.22% |
| Heteroptera | 0.31% | 0.00% | 0.00% | 0.06% |
| Isopoda | 0.00% | 0.14% | 0.00% | 0.06% |
| Odonata * | 0.31% | 0.14% | 0.00% | 0.11% |
| Oligocheta | 1.84% | 1.78% | 0.14% | 1.14% |
| Plecoptera | 3.99% | 2.47% | 7.87% | 4.90% |
| Salamandra s. larvae * | 0.00% | 0.00% | 0.77% | 0.34% |
| Trichoptera | 0.00% | 0.41% | 0.29% | 0.28% |
| | 100.00% | 100.00% | 100.00% | 100.00% |

In contrast to the Alsbach, Diptera (N=10,286 ind/m²) are more abundant per square meter in the Eckbach stream, although the values vary widely. EPT taxa, especially Ephemeroptera (N=5,587 ind/m²), occur most frequently in riffles (Fig. 26).

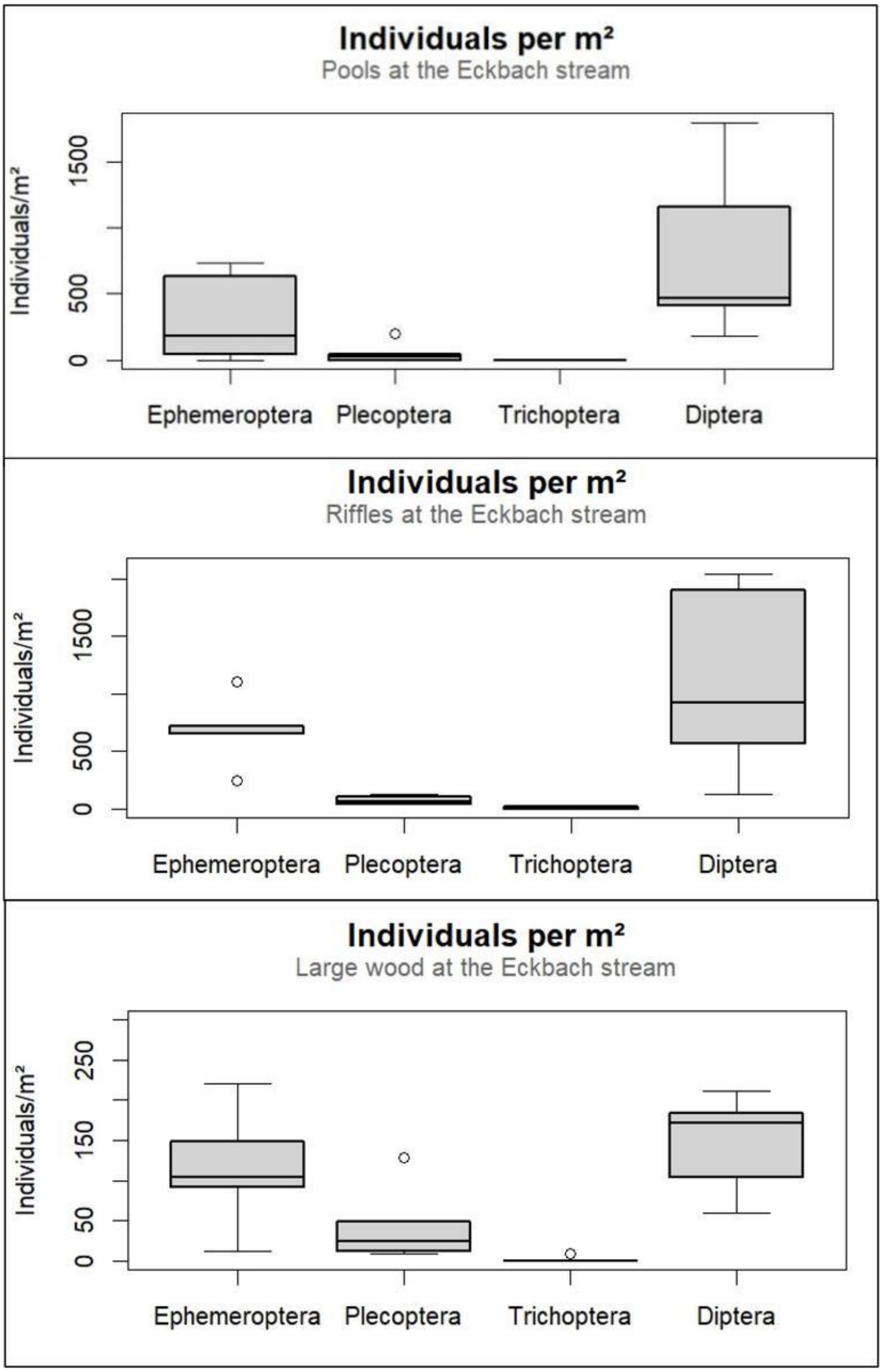


*Fig. 26: Boxplots of individuals per m² of the EPT-taxa and Diptera (Eckbach stream)*

For the Kruskal-Wallis test, the following simplified hypotheses were tested for diversity of orders and number of individuals in the habitats:

$H_1$: There is a difference in the number of individuals or diversity (order level) of macrozoobenthos in the respective habitats.
$H_0$: There is no difference in the number of individuals or diversity (order level) of macrozoobenthos in the respective habitats.

With regard to the diversity of macrozoobenthos at the order level, there is no significant difference between the habitats in both the Alsbach and Eckbach streams, which is why the null hypothesis can be accepted (Table 10).

*Tab. 10: Kruskal-Wallis-Test of the diversity (order level) of macrozoobenthos*

| River | $Chi^2$ | df | p-value |
|---|---|---|---|
| Alsbach stream | 2.1526 | 2 | 0.3409 |
| Eckbach stream | 2.0167 | 2 | 0.3648 |

As shown in Table 11, there is a significant difference between different habitats in the Alsbach stream (p=0.009) as well as in the Eckbach stream (p=0.038). The subsequent post-hoc tests (Table 12) showed that there are differences in the number of individuals in large wood and riffles in both rivers. The same can be seen in the Alsbach stream between large wood and pools. There is no significant difference between the number of individuals in pools and riffles in the two streams. Based on this, the alternative hypothesis that there is a difference in the number of macrozoobenthos individuals in the respective habitats can therefore be assumed.

*Tab. 11: Kruskal-Wallis-Test of the number of individuals of macrozoobenthos*

| River | $Chi^2$ | df | p-value |
|---|---|---|---|
| Alsbach stream | 9.4118 | 2 | 0.009042 |
| Eckbach stream | 6.54 | 2 | 0.03801 |

*Tab. 12: Post-Hoc-Test of the number of individuals of macrozoobenthos*

| | Comparison | Z-value | p-value (unadj.) | p-value (adj.) |
|---|---|---|---|---|
| Alsbach | LW – Pool | -2.5832473 | 0.009787515 | 0.02936255 |
| | LW – Riffle | -2.7247950 | 0.006434141 | 0.01930242 |
| | Pool – Riffle | -0.1415478 | 0.887437205 | 1.00000000 |
| Eckbach | LW – Pool | -1.060660 | 0.2888444 | 0.8665331 |
| | LW – Riffle | -2.545584 | 0.0109095 | 0.0327285 |
| | Pool – Riffle | -1.484924 | 0.1375639 | 0.4126917 |

## 5.3 Water quality

The Alsbach stream was sampled on 13 April 2025 in the morning. Site A1 is a near-natural upper course, A2 and A3 are located before and after the Hanslteich pond and A4 is located in a park (Schwarzenbergpark, 1170 Vienna) (see Fig. 27).

The water samples from the Eckbach stream were analysed at the same time the day before. Similar locations were selected for comparability, whereby the upper reaches are characterised by anthropogenic influences (E1). E2 and E3 included a pond (Parapluiteich) again and A4 was located next to a children's playground (Fig. 28).

The headwaters of the two rivers differ in particular in terms of dissolved oxygen, which is higher in the Alsbach stream, and conductivity, which is lower in the Eckbach stream. With the exception of nitrate, the chemical parameters are roughly the same; the Eckbach stream has a surplus of 0.9 mg/l nitrate (Table 13+14).

With regard to the ponds, a change in the DO and conductivity values can be seen in the Alsbach stream. In addition, both nitrate values at A2 and A3 are higher than at the upper reaches and an increase in phosphorus (at A3) can be observed (Table 13). At both sites (E2 and E3) along the Eckbach stream, in contrast to A2 and A3, no major changes in the chemical and physical water parameters are recognisable (Tab. 14).

With regard to the recreationally utilised area, A4 shows a clear decrease in DO and E4 shows an increase in phosphate (Tables 13 and 14).

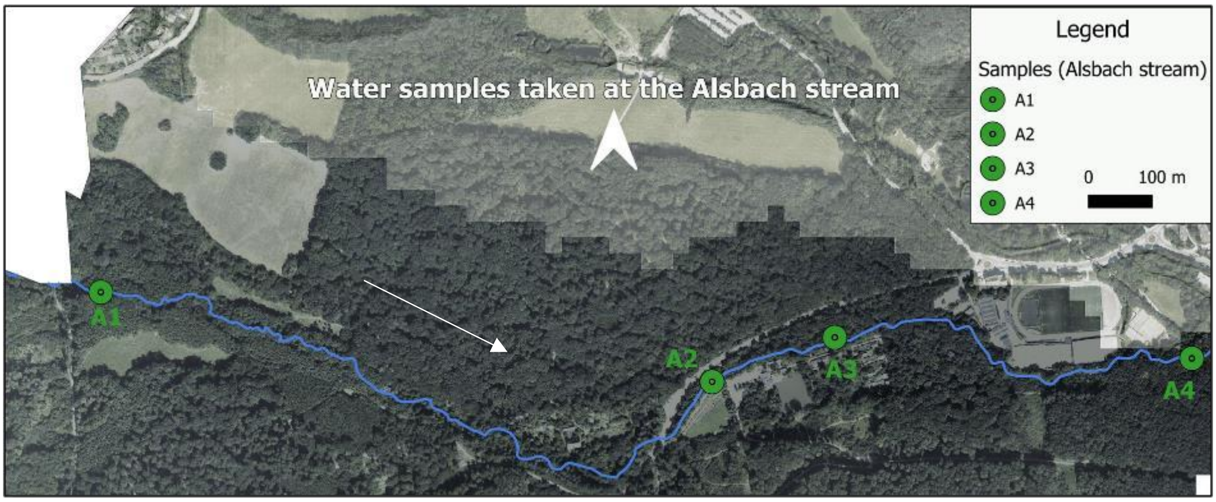


*Fig. 27: Overview of the taken samples along the Alsbach stream: upper reach (A1), before and after the Hanslteich pond (A2 and A3), Schwarzenbergpark (A4); own illustration (orthophoto and line shapefile based on open data from Stadt Wien n.d. & data.gv.at 2024)*

*Tab. 13: Physical and chemical water parameters measured at the Alsbach stream on 13 April 2025*

| | Temperature (°C) | pH | DO (mg/l) | DO (%) | Conductivity (µS/cm) | $NH_4^+$ (mg/l) | $NO_3^-$ (mg/l) | $NO_2^-$ (mg/l) | $PO_4^{3-}$ (mg/l) |
|---|---|---|---|---|---|---|---|---|---|
| **A1** | 11 | 8.3 | 10.42 | 99.3 | 775 | 0.02 | 0.2 | 9 | 0.14 |
| **A2** | 8.9 | 8.5 | 11.41 | 103.1 | 857 | 0.07 | 2.8 | 10 | 0.08 |
| **A3** | 9.4 | 8.4 | 11.27 | 102.6 | 875 | 0.08 | 2.1 | 10 | 0.43 |
| **A4** | 9.5 | 8.2 | 9.73 | 88.7 | 865 | 0.02 | 0.8 | 14 | 0.14 |

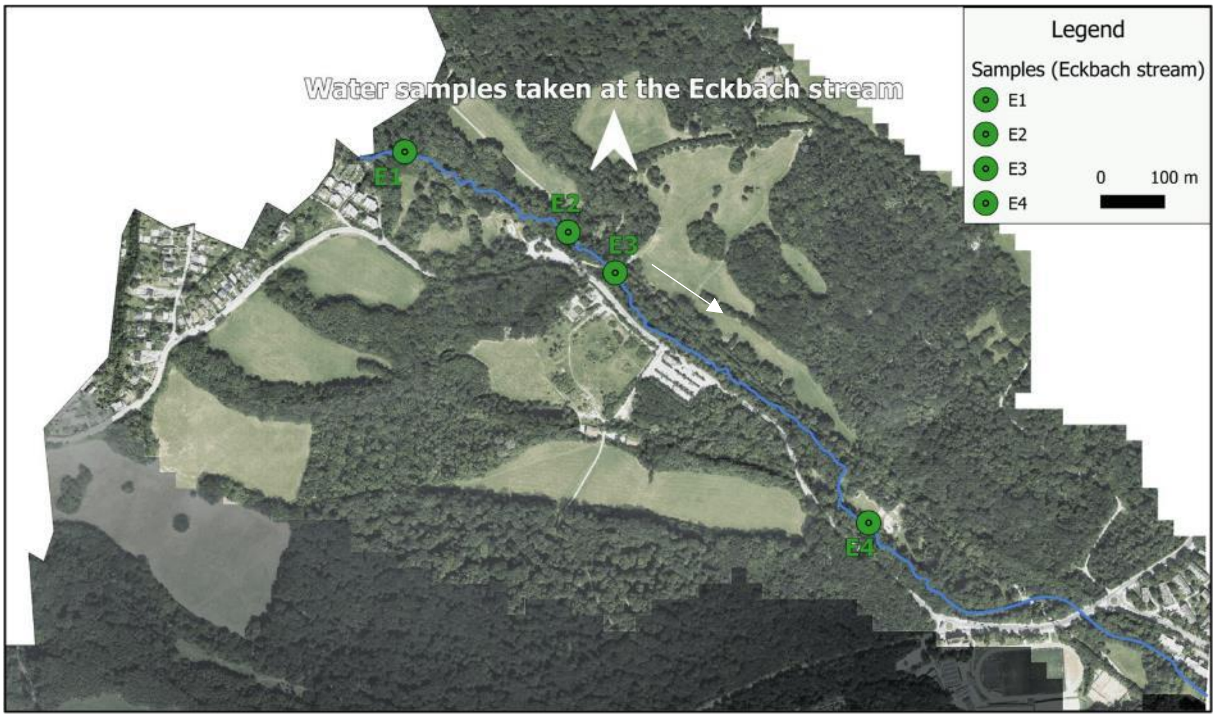

*Fig. 28: Overview of the taken samples along the Eckbach stream: upper reach (E1), before and after the Parapluiteich pond (E2 and E3), play ground (E4); own illustration (orthophoto and line shapefile based on open data from Stadt Wien n.d. & data.gv.at 2024)*

*Tab. 14: Physical and chemical water parameters measured at the Eckbach stream on 12 April 2025*

| | Temperature (°C) | pH | DO (mg/l) | DO (%) | Conductivity (µS/cm) | $NH_4^+$ (mg/l) | $NO_3^-$ (mg/l) | $NO_2^-$ (mg/l) | $PO_4^{3-}$ (mg/l) |
|---|---|---|---|---|---|---|---|---|---|
| **E1** | 8 | 8.2 | 11.15 | 98 | 753 | 0.01 | 0.9 | 9 | 0.14 |
| **E2** | 9.2 | 7.9 | 10.43 | 95 | 754 | 0.01 | 0.9 | 11 | 0.07 |
| **E3** | 10.5 | 8.1 | 10.56 | 97.9 | 737 | 0.01 | 0.9 | 2 | 0.07 |
| **E4** | 10.5 | 8.3 | 10.63 | 98.6 | 835 | 0.00 | 0.5 | 9 | 0.25 |

# 6. Discussion

In this chapter, the results obtained are compared with existing research and subsequently discussed.

## 6.1 Geomorphological units/potential habitats, large wood and human impact

Based on the number and shapes of geomorphological units, heterogeneity can clearly be observed (Scott et al. 2022). Although pools and fast-flowing zones (riffles and cascades) predominate, the ratio between the two is balanced. According to Buffington & Montgomery (2022), the dominance of different GUs in rivers cannot be determined, as several factors, such as geology, climate or human influence, are decisive. Mountain rivers often have pool-cascade/riffle sequences due to their gradient, which is why this is most likely to apply to the two pre-Alpine streams in the Vienna Woods (Buffington & Montgomery 2022). However, due to the low water levels of the Alsbach and Eckbach streams, it was difficult to clearly identify riffles, as some GU are only recognisable above a certain water level (Philips 2017). The formation of fast-flowing zones and still water zones is essential for habitat quality (='structure richness') in order to meet the preferences of the respective organisms (Muhar et al. 2000).

With regard to the processes taking place, the same pattern can be clearly seen in both the Alsbach and Eckbach stream, namely that the sediment-producing zone (= erosion) is located in the upper reaches and deposition occurs in the lowlands (Buffington & Montgomery 2022). Furthermore, it is noteworthy that the foliage of the trees in the Vienna Woods protects the riparian strips from erosion and covers areas that have already been eroded (Wiśniewsky & Märker 2019; Katayama et al. 2023). Based on the results and comparative literature, the hypothesis (H 1.1) can be accepted, as the Alsbach and Eckbach streams show both the same pattern of erosion and deposition processes and similar GU.

In contrast to the Eckbach stream, there is more LW along the Alsbach stream. Single pieces and jams dominate here. LW shows increased stability, especially in small streams, as the wood drifts less at average flow rates (Elosegi et al. 2017). It is noteworthy that there is a low density of LW both on the Alsbach stream in its lower reaches and along the entire Eckbach stream (n=16). In anthropogenically influenced rivers or river sections, large wood is primarily removed for flood protection, and it can be assumed that this applies to the study area as well (Gurnell et al. 2002). With regard to the formation of geomorphological units or habitats, the results show a tendency towards pools (including backwater) and islands, as well as the deadwood area itself. The roughness of the LW influences the hydraulics, which in turn changes the morphology of the river, creating new GU (Gurnell et al. 2002; Elosegi et al. 2017; Danhoff & Huckins 2022; Campagnolo et al. 2024). In addition to a backwater effect, fine sediments are partially retained (Elosegi et al. 2017). Organic material (leaves) has accumulated in

the backwater areas as well, which, from an ecological point of view, represents a food source for aquatic organisms (Gurnell et al. 2002).
Based on the results, the hypothesis (H 1.2) can be accepted, as large wood plays an ecologically significant role in flowing waters by forming habitats and providing food sources for decomposers through organic material. However, it should be noted that due to the dynamics of dead wood (see H 1.3), morphologies cannot always be attributed to them.

Following the hundred-year flood in September 2024, dynamic behaviour can be observed in 14 LW accumulations along the Alsbach stream. It can be seen that some LWs have accumulated (''jam''), which is typical of large wood dynamics after flooding (Gregory et al. 2024). When wood is transported by floating or rolling/sliding, it easily becomes wedged in narrow passages or at obstacles, such as existing LW (Gurnell et al. 2002; Ruíz-Villanueva et al. 2014; Piton et al. 2024; Zischg et al. 2018). In the upper reaches of the Alsbach stream, new LW GPS points can be observed, which can be interpreted as recruitment. Due to the location of the stream in the Vienna Woods, exposed pieces of wood serve as a source for further transport (Zischg et al. 2018). Gregory et al. (2024) describe storms with extreme precipitation in particular as decisive for the dynamics of large wood. Due to the geological conditions in the study area, the Vienna Woods streams can swell rapidly within a short period of time, which favours the dynamics of large wood. With regard to management, it is necessary to consider whether there is sufficient distance from critical areas (= infrastructure) (Zischg et al. 2018). Applied to the study region, this means that LW can certainly be preserved in upper reaches, nonetheless from the settlement area onwards, it must be assessed whether the ecological advantage or the risk of flood damage prevails (Zischg et al. 2018). Based on these results, the hypothesis (H 1.3) can be accepted. Observation over a period of several years would provide further insights.

When comparing the number of human impacts between the Alsbach and Eckbach streams, it is clear that these predominate on the Eckbach stream. Furthermore, the impact differs based on land use in the respective catchment areas (Grizzetti et al. 2023). In some sections of the upper reaches of the Alsbach, no human impact can be identified. From the beginning of the grounds of the former Villa Kraus (private property), there are mainly transverse structures, which are assumed to have been built to regulate water masses during flood events (Wolf et al. 2021; Grizzetti et al. 2017). In contrast, bridges are primarily found along the Eckbach stream, as the section of the river under investigation mainly flows through Schwarzenbergpark, which is used by people as a place of recreation, and the bridges serve to improve the infrastructure (Szatten et al. 2019).
With regard to the hypothesis (H 1.4), this must be differentiated, as there is no recognisable influence in the upper reaches of the Alsbach stream, however this becomes increasingly dense towards the

lower reaches, which is why the hypothesis can be accepted. In contrast, at the Eckbach stream the first structural influences can already be found in the upper reaches, as there is a residential area in the immediate vicinity of the Eckbach stream.

### 6.2 Macrozoobenthos

The data collected shows that the number of MZB individuals is highest in the Alsbach stream. Representatives of Diptera and EPT taxa predominate in both water bodies. Large quantities of amphipods were found in the samples from the Eckbach stream as well. Other representatives of MZB orders occur only in low percentages. Similar results are shown by Waringer & Waringer (2014), who studied streams in the Vienna Woods as well. The occurrence of the animals is strongly influenced by the conditions of the catchment area, which is why a comparison of results is only plausible with similar habitats (Graf et al. 2024). Due to leaf accumulations (partial blockages) in both watercourses caused by the surrounding forest, amphipods (= shredders) in particular were often present in large numbers (Waringer & Waringer 2014). In both the Alsbach and Eckbach streams, Ephemeroptera account for the largest proportion of EPT taxa (Waringer & Waringer 2014). Their presence, as well as that of the other EPT orders, is an indicator of good water quality and reflects the stability of an ecosystem (Tubić et al. 2024). An analysis of their occurrence between Alsbach and Eckbach stream shows that EPT taxa occur significantly more frequently in the Alsbach stream. Possible reasons for this are that stressors, such as human influence, impact the Eckbach stream, significantly reducing the number of sensitive taxa, such as those of the EPT (Leitner et al. 2021). Since the Eckbach stream is located in the middle of a recreational area used by humans (=Schwarzenbergpark), it can be assumed that this represents a stressor for the ecosystem and, as a result, for macrozoobenthos (Graf et al. 2024).
Based on the results, the hypothesis (H 2.1) that a large number of macrozoobenthos colonise the two river systems can be supported. However, for more precise results, it is recommended that further studies determine the orders of the respective MZB at least at the family level, which would allow for better measurement of habitat and water quality.

When analysing the results regarding the occurrence of macrozoobenthos in LW, it can be seen that there is no higher number of individuals per square metre compared to pools and riffles. On the contrary, the number per square metre is significantly lower at LW. However, since the percentage of MZB at LW appears comparable and plausible with that of the other two habitats, it can be assumed that this is an error in the field data collection. Pools and riffles were sampled using the Hess sampler, which defined an exact area and provided a barrier so that the animals could not escape. The approach to sampling LW was a defined area as well, which, however, could not be precisely delimited as with the Hess sampler. In addition, the animals had the opportunity to flee as soon as they became aware

of the disturbance. Furthermore, the substrate was not loosened by the vice, which is why it can be assumed that a certain number of individuals remained there. It should be noted, however, that habitat specialists such as fire salamander larvae (Salamandra salamandra) occur. Dead wood is their preferred habitat, as it is both structurally rich and protective (Waringer & Waringer 2014).
Based on the available data and further analysis, the hypothesis (H 2.2) cannot be supported in this study. For further sampling, it is recommended that three uniform methods are used to ensure comparability.

### 6.3 Water quality

Based on the results, the values of the chemical parameters are always below the critical threshold value (Table 15). However, this does not apply to the nitrite measurements, which are predominantly 100 times higher than the threshold value (0.09 mg/l), which is why a measurement error by the device can be assumed (BMLRT 2020).

*Tab. 15: Threshold values of the measured chemical parameters (based on BMLRT 2020)*

| | **Nitrate** | **Nitrite** | **Ammonium** | **Phosphorus** |
|---|---|---|---|---|
| **Threshold value** | 10 mg/l | 0.09 mg/l | 0.45 mg/l | 0.3 mg/l |

According to Umweltbundesamt (2003), the measured pH values are within the reference range of ≥ 8, as alkaline water is typical for the Flysch zone. The amount of dissolved oxygen at all measured locations is noteworthy, as a dissolved DO of > 8 mg/l corresponds to water quality class 1 (Umweltbundesamt 2003). The Flysch zone is characterised by mineralisation, which is why the conductivity in this area usually shows high values > 500 µS/cm (Umweltbundesamt 2003; Waringer & Waringer 2014).
The first hypothesis (H 3.1.1) must be rejected, as no significant deviations, especially outside the reference range, can be identified despite the proximity to a residential area. Hypothesis (H 3.1.2) can be supported, as both river sections show parameter values below critical thresholds. The third hypothesis (H 3.1.3) can be partially accepted, as elevated levels of nitrate and phosphorus were measured in the Alsbach stream around the Hanslteich pond, however these are still within the reference range. This is probably due to the use of the pond (= fish pond), as nutrients enter the pond mainly through feeding and then enter the Alsbach stream through the pond's feed. The influence on

the nutrient cycle and the potential for chemical changes in the substances, which can damage the underwater ecology, should not be underestimated (Bai et al. 2023).
Furthermore, it should be noted that the measurement of chemical-physical parameters only represents a snapshot of the water bodies. Long-term monitoring or the supporting measurement of biological parameters, such as macrozoobenthos, would provide even more meaningful results (Meybeck 2002).

## 6.4 Synthesis of the research

The following subchapter will take an integrative look at the results of this work and discuss potential connections between the individual focal points.
Here, humans can be viewed as the central actors who influence the environment (Gibling 2018) (see Fig. 29).

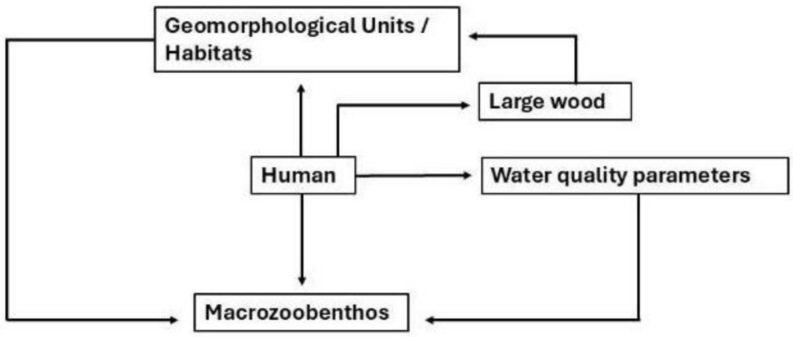


*Fig. 29: Synthesis of the thematic focal points (own illustration)*

Figure 29 shows how human impact affects individual areas. Although deadwood accumulations were recorded in both river sections, their number and occurrence vary. A pattern can be seen whereby few pieces were found near areas used by humans (private property, park) (Wohl et al. 2016). Fundamentally, the presence of LW pieces has an influence on the formation of GU and thus potential habitats. However, if there is little LW in a river, this can have a negative effect on geomorphological structure richness (Kasprak et al. 2016; Buffington & Montgomery 2022). Similarly, the number of man-made structures determines the formation of GU by creating homogeneity in river sections (Buffington & Montgomery 2022). With regard to water quality parameters, both the Alsbach and Eckbach streams show values that are within the reference framework. Nevertheless, it can be seen that in this case, human land use (fish pond) has had a degrading effect on the river section (Kumar et al. 2023; Mogane et al. 2023). Essentially, the occurrence of specific macrozoobenthos is related to the quality of the water bodies. In the study region, both the parameter values and the predominant occurrence of EPT taxa, especially in the Alsbach stream, indicate favourable conditions in the watercourses. However, to obtain clear results, the macrozoobenthos would have to be evaluated at least at the family level

(Leitner et al. 2021). Furthermore, the results show that the composition of macrozoobenthos depends on the GU (pools and riffles) (Graf et al. 2024). However, these results did not prove a connection between LW and macrozoobenthos.

## 7. Conclusion and outlook

In summary, it can be said that flowing waters are influenced both by natural conditions and by humans. This makes it all the more important to monitor rivers regularly. The results of this study have shown that there are noticeable differences between two parallel streams in the Vienna Woods due to different starting conditions.

It is clear that the Alsbach stream has a greater structural diversity of GU, which has a positive effect on habitat quality. In contrast, there are significantly more structural features on the Eckbach stream. Large wood dominates especially in the upper reaches, although this is greatly reduced at the Eckbach stream. Autumn 2024 showed that LW dynamics occur during flood events and that there is a tendency for jams to form when wedges occur. Here, the risk of damage and the ecological advantage must be weighed up.

With regard to the water quality of the two rivers, the results for both river sections are within a reference framework, with the Alsbach stream showing the better parameter values.

In terms of macrozoobenthos, more individuals were found in the Alsbach stream. Both rivers show a dominance of Diptera and EPT taxa, which is typical for the region. However, in the course of this work, no correlation between high numbers of individuals and large wood could be established.

In addition to these findings, which provide an interdisciplinary cross-section of the study region, regular observation of the fluvial processes and LW dynamics of the two Vienna Woods streams could be carried out in the future, including with extended methodology such as LiDAR, as the Flysch zone tends to undergo rapid changes during extreme weather events. In order to interpret the macrozoobenthos in greater depth, it is advisable to determine it at least at the family level or even at the species level in the further course of the study. With these findings, even more precise results regarding habitat quality could be obtained. In addition, the biological water quality could be assessed, which represents an integrative indicator for water quality.

Since pollution from waste was repeatedly observed during mapping and sampling of the MZB, particularly along the Eckbach stream (photo in Appendix), the human impact on the two river systems could be clearly highlighted by microplastics as well.

Adaptations and further investigations in form of monitoring would help to ensure that negative changes can be responded to in good time in order to guarantee and maintain the stability of river systems.

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# Appendix

Appendix 1

**Sampling protocol for macrozoobenthos**

| General information | |
|---|---|
| ID | |
| River | |
| Sampling site | O Pool O Riffle O LW |
| Date and time | |
| Coordinates | O taken |
| **Ground** | |
| sediment | O fine O coarse O mixed |
| leaves | O yes O no |
| **Weather** | |
| Weather conditions before sampling | O dry period O changeable<br>O rain periods O thunderstorm O frost<br>O snow fall O snow melt |
| Weather conditions during sampling | O windy O precipitation O sunny<br>O cloudy O foggy |
| **Morphology** | |
| Average water depth (cm) | |
| Channel width (cm) | |
| Flow velocity (m/s, estimated value with an orange) | |
| Bank strcuture (right) | O natural O close to nature<br>O engineered |
| Bank structure (left) | O natural O close to nature<br>O engineered |
| Bank vegetation (right) | O no vegetation O ruderal O grass<br>O trees/shrubs |
| Bank vegetation (left) | O no vegetation O ruderal O grass<br>O trees/shrubs |
| **Photos** | |
| Photos taken | O yes |

orientated to "Leitfaden zur Erhebung der biologischen Qualitätselemente Teil A – Makrozoobenthos", BMNT (2019)

Appendix 2

River:

**Protocol of the water sample**

date:

time:

sampling location (description):

recording of the coordinates: ☐

weather conditions:

| **multi-sensor-device (WTW Multi 3420)** | |
|---|---|
| water temperature | °C |
| pH | |
| DO | % mg / l |
| conductivity | µS/cm |
| **portable spectrophotometer (Hach, DR 1900)** | |
| Ammonium ($NH_4^+$.) | mg / l |
| Nitrate ($NO_3^-$) | mg / l |
| Nitrite ($NO_2^-$) | mg / l |
| Phosphate ($PO_4^{3-}$) | mg / l |

Appendix 3 (Data)

Note: ID numbers beginning with 51 are located on the private property along the Alsbach stream

Alsbach

| Date | ID | Potential Habitat | Place | x | y |
|---|---|---|---|---|---|
| 08.03.2025 08:34:19,938 | c1 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25708467 | 48,23977092 |
| 08.03.2025 08:45:34,226 | c2 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25753687 | 48,23973949 |
| 08.03.2025 08:51:47,057 | c3 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25781155 | 48,23970308 |
| 08.03.2025 08:55:54,397 | c4 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25799143 | 48,23970132 |
| 08.03.2025 09:02:52,958 | c5 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25810494 | 48,23965868 |
| 08.03.2025 09:12:03,413 | c6 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25844531 | 48,2395611 |
| 08.03.2025 09:36:33,776 | c7 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,25902399 | 48,23972768 |
| 08.03.2025 09:43:56,257 | c8 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25920372 | 48,239725 |
| 08.03.2025 09:52:42,254 | c9 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25957184 | 48,23956828 |
| 08.03.2025 09:59:30,085 | c10 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25957163 | 48,2395163 |
| 08.03.2025 10:16:28,096 | c11 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25983404 | 48,23937299 |
| 08.03.2025 10:23:48,014 | c12 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,2604159 | 48,23924298 |
| 08.03.2025 10:30:51,980 | c13 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,26077538 | 48,23922612 |
| 08.03.2025 10:56:05,819 | c14 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26171742 | 48,23900411 |
| 08.03.2025 10:58:00,552 | c15 | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,26181389 | 48,23893899 |
| 08.03.2025 11:06:53,928 | c16 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26252607 | 48,23882644 |
| 08.03.2025 12:40:00,167 | c17 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,27640045 | 48,23871079 |
| 08.03.2025 13:01:47,681 | c18 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,27751917 | 48,23853011 |
| 09.03.2025 07:57:05,024 | c51 | Fast flowing zone | Wien, KG Neuwaldegg, Hernals | 16,26859311 | 48,23755471 |
| 09.03.2025 08:22:21,322 | c52 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26756653 | 48,23727451 |
| 09.03.2025 08:37:19,002 | c53 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26698339 | 48,23728368 |
| 09.03.2025 09:28:11,245 | c54 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26315754 | 48,23836827 |
| 09.03.2025 09:29:46,810 | c55 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26308078 | 48,23839254 |

Alsbach

| Date | ID | Place | x | y |
|---|---|---|---|---|
| 08.03.2025 10:15:53,772 | b1 | KG Hadersdorf, Penzing, Wien | 16,25978383 | 48,23939634 |
| 08.03.2025 11:27:53,108 | b2 | Wien, KG Neuwaldegg, Hernals | 16,26948263 | 48,23783842 |
| 08.03.2025 11:29:50,992 | b3 | Wien, KG Neuwaldegg, Hernals | 16,26957485 | 48,2379746 |
| 08.03.2025 11:31:04,987 | b4 | Wien, KG Neuwaldegg, Hernals | 16,26973476 | 48,23812434 |
| 08.03.2025 11:35:43,157 | b5 | Wien, KG Neuwaldegg, Hernals | 16,26997711 | 48,23837405 |
| 08.03.2025 11:36:47,550 | b6 | Wien, KG Neuwaldegg, Hernals | 16,2702849 | 48,23854187 |
| 08.03.2025 11:37:40,215 | b7 | Amundsenstraße, 10, Wien | 16,27065515 | 48,23866857 |
| 08.03.2025 12:03:34,440 | b8 | KLG Hanslteich-Hofwiese, 1, Wien | 16,27224893 | 48,2389354 |
| 08.03.2025 12:48:04,794 | b9 | KG Dornbach, Hernals, Wien | 16,27677299 | 48,23857181 |
| 09.03.2025 07:58:15,211 | b51 | Wien, KG Neuwaldegg, Hernals | 16,26862854 | 48,23753086 |
| 09.03.2025 08:48:19,413 | b52 | KG Hadersdorf, Penzing, Wien | 16,26633205 | 48,23740337 |

Alsbach

| Date | ID | Sediment | Length (cm) | Width (cm) | Area (~;cm2) | Area (~;m2) | Place | x | y |
|---|---|---|---|---|---|---|---|---|---|
| 27:16,4 | d1 | fine | 300 | 100 | 30000 | 3 | KG Hadersdor | 16,2569394 | 48,2397904 |
| 23:20,0 | d2 | fine | 200 | 70 | 21000 | 2,1 | KG Hadersdor | 16,2585972 | 48,2396345 |
| 41:22,1 | d3 | mix | 130 | 50 | 15000 | 1,5 | KG Neuwalde | 16,2590748 | 48,2397318 |
| 50:06,6 | d4 | coarse | 150 | 70 | 21000 | 2,1 | KG Hadersdor | 16,2595057 | 48,2396317 |
| 56:06,4 | d5 | coarse | 300 | 120 | 36000 | 3,6 | KG Hadersdor | 16,2595534 | 48,2395286 |
| 26:45,2 | d6 | mix | 170 | 60 | 18000 | 1,8 | KG Neuwalde | 16,2605304 | 48,2392487 |
| 50:04,7 | d7 | coarse | 300 | 100 | 30000 | 3 | KG Neuwalde | 16,2614719 | 48,2390745 |
| 12:27,5 | d8 | coarse | 1000 | 150 | 45000 | 4,5 | KLG Hanslteic | 16,2742167 | 48,2393271 |
| 26:59,6 | d9 | coarse | 200 | 300 | 90000 | 9 | KG Dornbach, | 16,2753488 | 48,2392383 |
| 30:07,2 | d10 | mix | 500 | 100 | 30000 | 3 | Neuwaldegge | 16,2755942 | 48,2392754 |
| 32:51,1 | d11 | coarse | 1500 | 300 | 90000 | 9 | KG Neuwalde | 16,2758601 | 48,239042 |
| 45:57,4 | d12 | coarse | 200 | 100 | 30000 | 3 | KG Dornbach, | 16,2764513 | 48,2386337 |
| 50:57,3 | d13 | coarse | 200 | 100 | 30000 | 3 | KG Dornbach, | 16,277095 | 48,238552 |
| 16:23,2 | d14 | coarse | 500 | 150 | 45000 | 4,5 | KG Dornbach, | 16,2784435 | 48,2386431 |
| 28:46,7 | d15 | mix | 1000 | 150 | 45000 | 4,5 | KG Neuwalde | 16,2793887 | 48,2389297 |
| 35:30,7 | d16 | coarse | 1000 | 150 | 45000 | 4,5 | KG Dornbach, | 16,2797981 | 48,2387674 |
| 07:56,5 | d51 | fine | 200 | 100 | 30000 | 3 | KG Hadersdor | 16,2683679 | 48,2372746 |
| 44:13,1 | d52 | coarse | 1500 | 150 | 45000 | 4,5 | KG Neuwalde | 16,2665798 | 48,2374319 |
| 17:53,4 | d53 | coarse | 1000 | 200 | 60000 | 6 | KG Neuwalde | 16,2642865 | 48,23818 |

| Date | ID | Pool/Riffle | Potential Habitat | Place | x | y |
|---|---|---|---|---|---|---|
| 08.03.2025 08:22:20,861 | pr1 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,25685876 | 48,23982094 |
| 08.03.2025 08:42:50,591 | pr2 | Riffle | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25734995 | 48,23975722 |
| 08.03.2025 09:01:25,293 | pr3 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,25807208 | 48,23967828 |
| 08.03.2025 09:03:06,579 | pr4 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,25813711 | 48,23964161 |
| 08.03.2025 09:04:36,639 | pr5 | Riffle | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25818259 | 48,23961972 |
| 08.03.2025 09:06:01,417 | pr6 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,25822684 | 48,2396048 |
| 08.03.2025 09:09:38,290 | pr7 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,25835383 | 48,23957923 |
| 08.03.2025 09:16:25,162 | pr8 | Riffle | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25848713 | 48,23960774 |
| 08.03.2025 09:21:53,660 | pr9 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,25858277 | 48,23966113 |
| 08.03.2025 09:30:26,591 | pr10 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,25881133 | 48,23966229 |
| 08.03.2025 09:31:08,097 | pr11 | Riffle | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,25885293 | 48,23967794 |
| 08.03.2025 09:35:57,643 | pr12 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,2589965 | 48,23970289 |
| 08.03.2025 09:45:40 | pr13 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,25924821 | 48,23972544 |
| 08.03.2025 09:46:28,970 | pr14 | Riffle | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,25929357 | 48,2397007 |
| 08.03.2025 09:48:07,770 | pr15 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,2594077 | 48,23969096 |
| 08.03.2025 09:52:23,301 | pr16 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,25957995 | 48,23954025 |
| 08.03.2025 09:58:55,517 | pr17 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,25955809 | 48,23948763 |
| 08.03.2025 10:17:03,848 | pr18 | Pool | Still water zone | KG Hadersdorf, Hernals, Wien | 16,25988877 | 48,23936727 |
| 08.03.2025 10:27:17,906 | pr19 | Riffle | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26047092 | 48,23924101 |
| 08.03.2025 10:28:09,385 | pr20 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,26057944 | 48,23924353 |
| 08.03.2025 10:31:11,308 | pr21 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,26080095 | 48,23920481 |
| 08.03.2025 10:51:28,109 | pr22 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26150774 | 48,23909788 |
| 08.03.2025 10:55:27,691 | pr23 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,26166327 | 48,23899312 |
| 08.03.2025 10:57:08,718 | pr24 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,2617707 | 48,23895474 |
| 08.03.2025 10:58:25,757 | pr25 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,26185549 | 48,23894933 |
| 08.03.2025 11:02:57,577 | pr26 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26201025 | 48,23893808 |
| 08.03.2025 11:03:13,689 | pr27 | Riffle | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26204166 | 48,23891518 |
| 08.03.2025 11:08:51,164 | pr28 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26256773 | 48,2388134 |
| 08.03.2025 11:27:16,313 | pr29 | Pool | Still water zone | Wien, KG Neuwaldegg, Hernals | 16,26943295 | 48,23778652 |
| 08.03.2025 11:33:50,661 | pr30 | Pool | Still water zone | Wien, KG Neuwaldegg, Hernals | 16,26984521 | 48,23822678 |
| 08.03.2025 12:07:03,452 | pr31 | Pool | Still water zone | KLG Hanslteich-Hofwiese, 2, Wier | 16,27286139 | 48,23913758 |
| 08.03.2025 12:10:48,628 | pr32 | Pool | Still water zone | KLG Hanslteich-Hofwiese, 4, Wier | 16,27408484 | 48,23926729 |
| 08.03.2025 12:22:13,199 | pr33 | Pool | Still water zone | KLG Hanslteich-Hofwiese, 4, Wier | 16,27496718 | 48,2393659 |
| 08.03.2025 12:23:47,593 | pr34 | Riffle | Fast flowing zone | KG Dornbach, Hernals, Wien | 16,27510203 | 48,23937514 |
| 08.03.2025 12:24:17,628 | pr35 | Pool | Still water zone | KG Dornbach, Hernals, Wien | 16,27515681 | 48,2393693 |
| 08.03.2025 12:38:24,777 | pr36 | Riffle | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,27607626 | 48,23884373 |
| 08.03.2025 12:39:04,246 | pr37 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,27608041 | 48,23880834 |
| 08.03.2025 12:40:24,482 | pr38 | Pool | Still water zone | KG Dornbach, Hernals, Wien | 16,27641247 | 48,23866833 |
| 08.03.2025 13:01:13,230 | pr39 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,27748664 | 48,23851202 |
| 08.03.2025 13:02:20,633 | pr40 | Pool | Still water zone | KG Dornbach, Hernals, Wien | 16,27755923 | 48,23855024 |
| 08.03.2025 13:06:11,900 | pr41 | Riffle | Fast flowing zone | KG Dornbach, Hernals, Wien | 16,27768981 | 48,2385866 |
| 08.03.2025 13:06:37,165 | pr42 | Pool | Still water zone | KG Dornbach, Hernals, Wien | 16,277734 | 48,23859047 |
| 08.03.2025 13:23:15,891 | pr43 | Pool | Still water zone | KG Dornbach, Hernals, Wien | 16,27859649 | 48,23866667 |
| 08.03.2025 13:28:56,932 | pr44 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,27945793 | 48,23890948 |
| 08.03.2025 13:35:57,027 | pr45 | Pool | Still water zone | KG Dornbach, Hernals, Wien | 16,27974883 | 48,2387808 |
| 08.03.2025 13:36:50,587 | pr46 | Pool | Still water zone | KG Dornbach, Hernals, Wien | 16,27949866 | 48,23882614 |
| 09.03.2025 07:56:23,227 | pr51 | Pool | Still water zone | Wien, KG Neuwaldegg, Hernals | 16,26862806 | 48,23757161 |
| 09.03.2025 08:05:24,656 | pr52 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,26853276 | 48,23742876 |
| 09.03.2025 08:05:52,308 | pr53 | Riffle | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,26849622 | 48,23739393 |
| 09.03.2025 08:07:17,718 | pr54 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,26848141 | 48,2373681 |
| 09.03.2025 08:09:25,861 | pr55 | Pool | Still water zone | KG Hadersdorf, Penzing, Wien | 16,26831863 | 48,23723352 |
| 09.03.2025 08:20:04,917 | pr56 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26770437 | 48,23723414 |
| 09.03.2025 08:20:49,836 | pr57 | Riffle | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26766195 | 48,23726244 |
| 09.03.2025 08:21:45,583 | pr58 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26760602 | 48,2372676 |
| 09.03.2025 08:35:37,140 | pr59 | Riffle | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26706236 | 48,23731869 |
| 09.03.2025 08:36:05,012 | pr60 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26706572 | 48,23732003 |
| 09.03.2025 08:47:26,907 | pr61 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,2661893 | 48,23740687 |
| 09.03.2025 08:47:59,485 | pr62 | Riffle | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26623183 | 48,23740746 |
| 09.03.2025 09:27:38,202 | pr63 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26320379 | 48,2383603 |
| 09.03.2025 09:34:18,575 | pr64 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26285725 | 48,23850795 |
| 09.03.2025 09:35:12,642 | pr65 | Riffle | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26280344 | 48,2385264 |
| 09.03.2025 09:36:03,849 | pr66 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26276331 | 48,23855384 |
| 09.03.2025 09:41:20,064 | pr67 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26267757 | 48,23867519 |
| 14.04.2025 07:07:28,820 | pr68 | Riffle | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,27933628 | 48,23894972 |
| 14.04.2025 07:38:33,243 | pr69 | Riffle | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,28045468 | 48,23882819 |
| 14.04.2025 07:47:01,151 | pr70 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,28053083 | 48,23884183 |
| 14.04.2025 08:26:50,080 | pr71 | Riffle | Fast flowing zone | KLG Hanslteich-Hofwiese, 2, Wier | 16,27301625 | 48,23908457 |
| 14.04.2025 10:26:09,263 | pr72 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26243389 | 48,23882936 |
| 14.04.2025 11:56:33,084 | pr73 | Riffle | Fast flowing zone | KG Hadersdorf, Penzing, Wien | 16,26175012 | 48,23898118 |

Alsbach

| Date | ID | Lateral Erosion | Bank Erosion | Length (cm) | Width (cm) | Area (~;cm2) | Area (~;m2) | Place | x | y |
|---|---|---|---|---|---|---|---|---|---|---|
| 08.03.2025 08:37:02,749 | e1 | 1 | | 200 | 50 | 10000 | 1 | KG Hadersdorf, Penzing, Wien | 16,2571276 | 48,23977026 |
| 08.03.2025 08:49:10,876 | e2 | 1 | | 130 | 50 | 6500 | 0,65 | KG Hadersdorf, Penzing, Wien | 16,25776176 | 48,23969759 |
| 08.03.2025 09:14:59,396 | e3 | | 1 | | | 0 | 0 | KG Hadersdorf, Penzing, Wien | 16,25843357 | 48,23959772 |
| 08.03.2025 11:01:26,069 | e4 | 1 | | 1000 | 100 | 100000 | 10 | KG Neuwaldegg, Hernals, Wien | 16,26196837 | 48,23894515 |
| 08.03.2025 11:39:42,016 | e5 | 1 | | 600 | 200 | 120000 | 12 | Amundsenstraße, 10, Wien | 16,27100343 | 48,23878438 |
| 08.03.2025 12:19:02,675 | e6 | | 1 | | | 0 | 0 | KLG Hanslteich-Hofwiese, 4, Wie | 16,27426914 | 48,23935618 |
| 09.03.2025 07:59:09,461 | e51 | | 1 | | | 0 | 0 | Wien, KG Neuwaldegg, Hernals | 16,26869259 | 48,23758417 |
| 09.03.2025 08:10:54,119 | e52 | | 1 | | | 0 | 0 | KG Hadersdorf, Penzing, Wien | 16,26825066 | 48,23719942 |
| 09.03.2025 08:14:21,248 | e53 | | 1 | 1000 | 40 | 40000 | 4 | KG Hadersdorf, Penzing, Wien | 16,26793344 | 48,237164 |
| 09.03.2025 08:16:18,076 | e54 | | 1 | | | 0 | 0 | KG Hadersdorf, Penzing, Wien | 16,26784711 | 48,23718029 |
| 09.03.2025 08:29:04,518 | e55 | | 1 | | | 0 | 0 | KG Neuwaldegg, Hernals, Wien | 16,26733372 | 48,23731273 |
| 09.03.2025 08:42:05,676 | e56 | | 1 | | | 0 | 0 | KG Neuwaldegg, Hernals, Wien | 16,26687066 | 48,23726145 |
| 09.03.2025 09:23:48,018 | e57 | | 1 | | | 0 | 0 | KG Neuwaldegg, Hernals, Wien | 16,26345674 | 48,2382868 |
| 09.03.2025 09:38:16,025 | e58 | | 1 | 200 | 50 | 10000 | 1 | KG Neuwaldegg, Hernals, Wien | 16,26272816 | 48,23859483 |
| 09.03.2025 09:39:43,032 | e59 | | 1 | 200 | 30 | 6000 | 0,6 | KG Neuwaldegg, Hernals, Wien | 16,26270147 | 48,23861655 |
| 09.03.2025 09:43:13,268 | e60 | | 1 | 150 | 40 | 6000 | 0,6 | KG Hadersdorf, Penzing, Wien | 16,26263828 | 48,23873811 |
| 09.03.2025 09:44:30,998 | e61 | | 1 | 1000 | 120 | 120000 | 12 | KG Neuwaldegg, Hernals, Wien | 16,26263896 | 48,23877802 |

Eckbach

| Date | ID | Potential Habitat | Place | x | y |
|---|---|---|---|---|---|
| 02.03.2025 09:47:53,909 | c1 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26568134 | 48,24642485 |
| 02.03.2025 10:08:17,409 | c2 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26622331 | 48,24632694 |
| 02.03.2025 10:40:23,442 | c3 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26768629 | 48,24584708 |
| 02.03.2025 10:48:52,994 | c4 | Fast flowing zone | Wien, KG Neuwaldegg, Hernals | 16,26795111 | 48,24566936 |
| 02.03.2025 11:10:23,073 | c5 | Fast flowing zone | Wien, KG Neuwaldegg, Hernals | 16,26887843 | 48,24520722 |
| 02.03.2025 11:35:56,671 | c6 | Fast flowing zone | Wien, KG Neuwaldegg, Hernals | 16,26940897 | 48,24461403 |
| 02.03.2025 12:23:45,961 | c7 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,27184589 | 48,2434862 |
| 02.03.2025 12:27:46,211 | c8 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,27228686 | 48,24329534 |
| 02.03.2025 12:49:13,131 | c9 | Fast flowing zone | KG Neuwaldegg, Hernals, Wien | 16,27367197 | 48,24217059 |

Eckbach

| Date | ID | Place | x | y |
|---|---|---|---|---|
| 02.03.2025 09:15:11,103 | i1 | Wien, KG Neuwaldegg, Hernals | 16,26460182 | 48,24679833 |
| 02.03.2025 10:21:04,071 | i2 | KG Neuwaldegg, Hernals, Wien | 16,2668729 | 48,24605318 |
| 02.03.2025 10:22:02,951 | i3 | KG Neuwaldegg, Hernals, Wien | 16,26689248 | 48,24602491 |
| 02.03.2025 10:22:32,319 | i4 | KG Neuwaldegg, Hernals, Wien | 16,26690722 | 48,2460066 |
| 02.03.2025 10:38:54,942 | i5 | KG Neuwaldegg, Hernals, Wien | 16,26764422 | 48,2458674 |
| 02.03.2025 11:21:08,429 | i6 | Wien, KG Neuwaldegg, Hernals | 16,26916409 | 48,2449103 |
| 02.03.2025 13:28:33,141 | i7 | Neuwaldegger Straße, 57a, Wien | 16,2762727 | 48,24039238 |
| 02.03.2025 13:39:06,529 | i8 | Schwarzenbergallee, 40, Wien | 16,27745739 | 48,24045909 |

Eckbach

| Date | ID | Potential Habitat | Place | x | y |
|---|---|---|---|---|---|
| 02.03.2025 08:51:55,459 | B1 | Structurally rich zone | Wien, KG Neuwaldegg, Hernals | 16,26393928 | 48,24685249 |
| 02.03.2025 09:08:06,111 | B2 | Structurally rich zone | KG Neuwaldegg, Hernals, Wien | 16,26441841 | 48,24692458 |
| 02.03.2025 09:29:11,049 | B3 | Structurally rich zone | KG Neuwaldegg, Hernals, Wien | 16,26526733 | 48,24660614 |
| 02.03.2025 09:38:33,178 | B4 | Structurally rich zone | KG Neuwaldegg, Hernals, Wien | 16,26542023 | 48,24658786 |
| 02.03.2025 12:31:33,548 | B5 | Structurally rich zone | KG Neuwaldegg, Hernals, Wien | 16,27308439 | 48,24290075 |

Eckbach

| Date | ID | Sediment | Length (~; cm) | Width (~;cm) | Area (cm2) | Area (m2) | Place | x | y |
|---|---|---|---|---|---|---|---|---|---|
| 02.03.2025 09:50:19,827 | d1 | coarse | 500 | 150 | 75000 | 7,5 | KG Neuwaldegg, Hernals, Wien | 16,26564371 | 48,24641319 |
| 02.03.2025 10:01:56,205 | d2 | mix | 800 | 150 | 120000 | 12 | KG Neuwaldegg, Hernals, Wien | 16,26593786 | 48,24632837 |
| 02.03.2025 11:49:06,410 | d3 | fine | 300 | 50 | 15000 | 1,5 | Exelbergstraße, 32, Wien | 16,27020088 | 48,24420514 |
| 02.03.2025 11:52:34,324 | d4 | coarse | 500 | 100 | 50000 | 5 | Exelbergstraße, 32, Wien | 16,27070367 | 48,24397999 |
| 02.03.2025 11:59:29,284 | d5 | mix | 400 | 100 | 40000 | 4 | Exelbergstraße, 32, Wien | 16,2710036 | 48,24389024 |
| 02.03.2025 12:40:06,687 | d6 | mix | 900 | 150 | 135000 | 13,5 | KG Neuwaldegg, Hernals, Wien | 16,27367943 | 48,24244994 |
| 02.03.2025 12:44:19,696 | d7 | mix | 300 | 100 | 30000 | 3 | KG Neuwaldegg, Hernals, Wien | 16,273797 | 48,24236392 |
| 02.03.2025 13:11:21,688 | d8 | mix | 500 | 150 | 75000 | 7,5 | KG Neuwaldegg, Hernals, Wien | 16,27424074 | 48,24164333 |
| 02.03.2025 13:33:09,795 | d9 | coarse | 200 | 100 | 20000 | 2 | Neuwaldegger Straße, 57a, Wien | 16,27682215 | 48,24036506 |
| 02.03.2025 13:46:58,433 | d10 | coarse | 500 | 200 | 100000 | 10 | Schwarzenbergallee, 40, Wien | 16,27779888 | 48,24054228 |

Eckbach

| Date | ID | Lateral erosion | Bank erosion | Length (~;cm) | Width (~;cm) | Area (cm2) | Area (m2) | Place | x | y |
|---|---|---|---|---|---|---|---|---|---|---|
| 02.03.2025 09:10:50,856 | e1 | | 1 | 150 | 30 | 4500 | 0,45 | Wien, KG Neuwaldegg, Hernals | 16,26447592 | 48,24686918 |
| 02.03.2025 09:22:07,082 | e2 | | 1 | 500 | 50 | 25000 | 2,5 | KG Neuwaldegg, Hernals, Wien | 16,26482944 | 48,24680872 |
| 02.03.2025 09:32:00,855 | e3 | | 1 | 150 | 30 | 4500 | 0,45 | KG Neuwaldegg, Hernals, Wien | 16,26536507 | 48,2465923 |
| 02.03.2025 09:34:37,891 | e4 | 1 | | 220 | 30 | 6600 | 0,66 | KG Neuwaldegg, Hernals, Wien | 16,26547155 | 48,24658384 |
| 02.03.2025 09:40:40,001 | e5 | | 1 | 150 | 30 | 4500 | 0,45 | KG Neuwaldegg, Hernals, Wien | 16,26545722 | 48,24655867 |
| 02.03.2025 09:47:17,379 | e5 | | 1 | 100 | 30 | 3000 | 0,3 | KG Neuwaldegg, Hernals, Wien | 16,26559973 | 48,24648223 |
| 02.03.2025 09:58:13,329 | e7 | | 1 | 150 | 25 | 3750 | 0,375 | KG Neuwaldegg, Hernals, Wien | 16,26593079 | 48,24638868 |
| 02.03.2025 10:10:42,024 | e8 | 1 | | 10000 | 100 | 1000000 | 100 | KG Neuwaldegg, Hernals, Wien | 16,26619478 | 48,24633352 |
| 02.03.2025 10:14:49,476 | e9 | | | | | 0 | 0 | KG Neuwaldegg, Hernals, Wien | 16,26632376 | 48,24632042 |
| 02.03.2025 10:43:53,866 | e10 | 1 | | 300 | 30 | 9000 | 0,9 | KG Neuwaldegg, Hernals, Wien | 16,26775907 | 48,24583007 |
| 02.03.2025 11:18:05,394 | e11 | 1 | | 150 | 20 | 3000 | 0,3 | Wien, KG Neuwaldegg, Hernals | 16,26906892 | 48,24497706 |
| 02.03.2025 11:23:35,107 | e12 | | 1 | 500 | 30 | 15000 | 1,5 | Wien, KG Neuwaldegg, Hernals | 16,26921565 | 48,2448649 |
| 02.03.2025 11:39:32,977 | e13 | 1 | | 200 | 40 | 8000 | 0,8 | Exelbergstraße, 32, Wien | 16,26954062 | 48,24450321 |
| 02.03.2025 11:41:25,751 | e14 | 1 | | 10000 | 100 | 1000000 | 100 | Exelbergstraße, 32, Wien | 16,26984555 | 48,24431399 |
| 02.03.2025 12:22:25,672 | e15 | 1 | | 1000 | 100 | 100000 | 10 | KG Neuwaldegg, Hernals, Wien | 16,27176497 | 48,24351493 |
| 02.03.2025 12:30:30,353 | e16 | 1 | | 2000 | 100 | 200000 | 20 | KG Neuwaldegg, Hernals, Wien | 16,27251978 | 48,24318043 |
| 02.03.2025 12:37:00,492 | e17 | | 1 | 500 | 100 | 50000 | 5 | KG Neuwaldegg, Hernals, Wien | 16,27338988 | 48,24262862 |
| 02.03.2025 12:52:06,718 | e18 | 1 | | 500 | 50 | 25000 | 2,5 | KG Neuwaldegg, Hernals, Wien | 16,27377467 | 48,24183655 |
| 02.03.2025 13:19:51,599 | e19 | 1 | | 250 | 100 | 25000 | 2,5 | KG Neuwaldegg, Hernals, Wien | 16,27548741 | 48,24083823 |
| 02.03.2025 13:21:47,801 | e20 | | 1 | 1500 | 150 | 225000 | 22,5 | Neuwaldegger Straße, 59, Wien | 16,27558911 | 48,24069223 |
| 02.03.2025 13:35:24,827 | e21 | 1 | | 1000 | 50 | 50000 | 5 | Neuwaldegger Straße, 57a, Wien | 16,27702728 | 48,24037728 |

Eckbach

| Date | ID | Pool / Riffle | Potential Habitat | Place | x | y |
|---|---|---|---|---|---|---|
| 02.03.2025 09:06:56,377 | pr1 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26442055 | 48,24692754 |
| 02.03.2025 09:11:50,544 | pr2 | Pool | Still water zone | Wien, KG Neuwaldegg, Hernals | 16,26448998 | 48,24684023 |
| 02.03.2025 09:18:41,031 | Pr3 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26477618 | 48,24680931 |
| 02.03.2025 09:29:27,516 | pr4 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26529731 | 48,24659973 |
| 02.03.2025 09:39:12,501 | pr5 | Riffle | Fast Flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26544628 | 48,24656302 |
| 02.03.2025 09:47:41,222 | pr6 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26562284 | 48,24643845 |
| 02.03.2025 09:57:26,941 | pr7 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26593236 | 48,2463561 |
| 02.03.2025 10:06:52,071 | pr8 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26617408 | 48,24630622 |
| 02.03.2025 10:09:00,168 | pr9 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26624949 | 48,24632668 |
| 02.03.2025 10:27:07,052 | pr10 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26730794 | 48,24591895 |
| 02.03.2025 10:38:11,003 | pr11 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26761311 | 48,24592709 |
| 02.03.2025 10:49:22,735 | pr12 | Pool | Still water zone | Wien, KG Neuwaldegg, Hernals | 16,26798041 | 48,24564261 |
| 02.03.2025 10:58:07,757 | pr13 | Pool | Still water zone | Wien, KG Neuwaldegg, Hernals | 16,26829394 | 48,245496 |
| 02.03.2025 11:10:07,449 | pr14 | Pool | Still water zone | Wien, KG Neuwaldegg, Hernals | 16,26883033 | 48,24523058 |
| 02.03.2025 11:29:21,295 | pr15 | Riffle | Fast Flowing zone | Wien, KG Neuwaldegg, Hernals | 16,2692293 | 48,24476542 |
| 02.03.2025 11:29:58,072 | pr16 | Pool | Still water zone | Wien, KG Neuwaldegg, Hernals | 16,26925057 | 48,24472701 |
| 02.03.2025 11:36:13,389 | pr17 | Pool | Still water zone | Wien, KG Neuwaldegg, Hernals | 16,26943805 | 48,24459493 |
| 02.03.2025 11:55:14,541 | pr18 | Pool | Still water zone | Exelbergstraße, 32, Wien | 16,27096223 | 48,24391093 |
| 02.03.2025 12:02:53,069 | pr19 | Pool | Still water zone | Exelbergstraße, 32, Wien | 16,27109165 | 48,24380137 |
| 02.03.2025 12:21:10,944 | pr20 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,27177074 | 48,24352658 |
| 02.03.2025 12:23:28,048 | pr21 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,27187281 | 48,24347884 |
| 02.03.2025 12:28:09,695 | pr22 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,27234313 | 48,24329227 |
| 02.03.2025 12:35:10,687 | pr23 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,27326173 | 48,24273991 |
| 02.03.2025 12:54:09,136 | pr24 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,27393432 | 48,2417546 |
| 02.03.2025 13:17:29,848 | pr25 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,27509121 | 48,24110355 |
| 02.03.2025 12:35:10,685 | pr26 | Riffle | Fast Flowing zone | Wien, KG Neuwaldegg, Hernals | 16,26795087 | 48,2457043 |
| 02.03.2025 12:35:10,685 | pr27 | Riffle | Fast Flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26771115 | 48,24580054 |
| 02.03.2025 12:35:10,685 | pr28 | Riffle | Fast Flowing zone | KG Neuwaldegg, Hernals, Wien | 16,26624728 | 48,24633739 |
| 02.03.2025 12:35:10,685 | pr29 | Riffle | Fast Flowing zone | Exelbergstraße, 32, Wien | 16,27046212 | 48,24408079 |
| 02.03.2025 12:35:10,685 | pr30 | Riffle | Fast Flowing zone | KG Neuwaldegg, Hernals, Wien | 16,27328169 | 48,24270515 |
| 15.04.2025 07:46:27,000 | p31 | Pool | Still water zone | KG Neuwaldegg, Hernals, Wien | 16,26780648 | 48,24580324 |
| 15.04.2025 11:03:59,352 | p32 | Pool | Still water zone | Exelbergstraße, 32, Wien | 16,27033749 | 48,24412438 |

## Aisbach stream

| | | | LW TYPE | | | | | WATER RETENTION | | | SEDIMENT RETENTION (cm) | | | | | COORDINATES | | MORPHOLOGICAL FORMATION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LW/MR | Max_ID | ID | channel sp | single piec | jams | type | type spanning | porosity | backwater | bed contac | length | width | height | volume (m³ | material | x | y | pool | bar/island | after LW | RP_lw |
| LW | 1 | LW1 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,25664 | 48,23988 | | | | 2 |
| LW | 2 | LW2 | y | | partial dam | jam | not-channel-spanning jam | 65 | 0 | 1 | 130 | 80 | 5 | | c | 16,25671 | 48,23985 | | | | 3 |
| LW | 3 | LW3 | y | | underflow j | jam | channel-spanning jam | 85 | 0 | 0 | | | | | | 16,25679 | 48,23984 | 1 | | 1 | 2 |
| LW | 4 | LW4 | y | | underflow j | jam | channel-spanning jam | 80 | 0 | 0 | | | | | | 16,2569 | 48,2398 | | | | 2 |
| LW | 5 | LW5 | y | | partial dam | jam | channel-spanning single piece | 55 | 0 | 0 | | | | | | 16,25698 | 48,23978 | | | | 1 |
| LW | 6 | LW6 | y | collapsed bridge | | single piece | not-channel-spanning single piece | 20 | 0 | 1 | 90 | 70 | 20 | | f | 16,25703 | 48,23977 | | | | 3 |
| LW | 7 | LW7 | n | | partial dam | jam | channel-spanning single piece | 60 | 0 | 1 | 120 | 100 | 30 | | c | 16,25718 | 48,23977 | | | | 1 |
| LW | 8 | LW8 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,25727 | 48,23976 | | | | 2 |
| LW | 9 | LW9 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,25758 | 48,23974 | | | | 1 |
| LW | 10 | LW10 | y | | dam jam | jam | channel-spanning jam | 100 | 1 | 1 | 120 | 100 | 40 | | c | 16,25788 | 48,2397 | | | | 3 |
| LW | 11 | LW11 | y | | dam jam | jam | channel-spanning jam | 100 | 1 | 1 | 200 | 75 | 30 | | m | 16,25802 | 48,23968 | 1 | | 1 | 3 |
| LW | 12 | LW12 | y | | dam jam | jam | channel-spanning jam | 100 | 1 | 1 | 150 | 80 | 20 | | c | 16,2583 | 48,23959 | 1 | | 1 | 3 |
| LW | 13 | LW13 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,25852 | 48,23963 | | | | 2 |
| LW | 14 | LW14 | n | | partial dam | jam | not-channel-spanning jam | 60 | 0 | 1 | 150 | 80 | 10 | | c | 16,25854 | 48,23965 | 1 | | 1 | 1 |
| LW | 15 | LW15 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,25865 | 48,23965 | | | | 2 |
| LW | 16 | LW16 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,2587 | 48,23965 | | | | 2 |
| LW | 17 | LW17 | y | log step | | single piece | | 90 | 1 | 1 | 100 | 50 | 5 | | f | 16,25875 | 48,23966 | | | | 3 |
| LW | 18 | LW18 | y | | dam jam | jam | channel-spanning jam | 100 | 1 | 1 | 130 | 100 | 20 | | c | 16,25891 | 48,23968 | | | | 3 |
| LW | 19 | LW19 | y | | dam jam | jam | channel-spanning jam | 100 | 1 | 1 | | | | | | 16,25907 | 48,23974 | 1 | | 1 | 3 |
| LW | 20 | LW20 | y | | underflow j | jam | channel-spanning jam | 90 | 0 | 1 | | | | | | 16,25917 | 48,23974 | | | | 3 |
| LW | 21 | LW21 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,25955 | 48,23961 | | | | 2 |
| LW | 22 | LW22 | n | ramp | | single piece | not-channel-spanning single piece | 15 | 0 | 1 | | | | | | 16,25958 | 48,23954 | | | | 1 |
| LW | 23 | LW23 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,25956 | 48,23945 | | | | 2 |
| LW | 24 | LW24 | y | | underflow j | jam | channel-spanning jam | 85 | 0 | 0 | | | | | | 16,2604 | 48,23925 | | | | 2 |
| LW | 25 | LW25 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,26073 | 48,23825 | | | | 2 |
| LW | 26 | LW26 | y | ramp | | single piece | not-channel-spanning single piece | 20 | 0 | 1 | | | | | | 16,26111 | 48,23806 | | | | 3 |
| LW | 27 | LW27 | y | | dam jam | jam | channel-spanning jam | 100 | 1 | 1 | 120 | 90 | 10 | | f | 16,2614 | 48,23812 | | 1 | 1 | 3 |
| LW | 28 | LW28 | y | | underflow j | jam | channel-spanning jam | 75 | 0 | 0 | | | | | | 16,26157 | 48,239 | | | | 2 |
| LW | 29 | LW29 | y | | partial dam | jam | not-channel-spanning jam | 60 | 1 | 1 | 110 | 80 | 10 | | c | 16,27417 | 48,23933 | | | | 3 |
| LW | 30 | LW30 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,27589 | 48,23902 | | | | 2 |
| LW | 31 | LW31 | y | | partial dam | jam | not-channel-spanning jam | 65 | 0 | 1 | 120 | 100 | 10 | | c | 16,27852 | 48,23888 | 1 | | 1 | 3 |
| LW | 32 | LW32 | n | ramp | | single piece | not-channel-spanning single piece | 15 | 0 | 1 | | | | | | 16,27899 | 48,23883 | | | | 1 |
| LW | 33 | LW33 | y | | underflow j | jam | channel-spanning jam | 80 | 0 | 1 | | | | | | 16,27927 | 48,23893 | | | | 3 |
| LW | 51 | LW51 | y | | partial dam | jam | not-channel-spanning jam | 60 | 1 | 1 | 900 | 120 | 10 | | c | 16,26898 | 48,23789 | | | | 3 |
| LW | 52 | LW52 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,26803 | 48,23716 | | | | 2 |
| LW | 53 | LW53 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,2671 | 48,23733 | | | | 2 |
| LW | 54 | LW54 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,26703 | 48,2373 | | | | 2 |
| LW | 55 | LW55 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,26693 | 48,23727 | | | | 2 |
| LW | 56 | LW56 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,26653 | 48,23745 | | | | 2 |
| LW | 57 | LW57 | y | | partial dam | jam | not-channel-spanning jam | 70 | 0 | 0 | | | | | | 16,26446 | 48,23817 | | | | 2 |
| LW | 58 | LW58 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,26361 | 48,23823 | | | | 2 |
| LW | 59 | LW59 | y | | underflow j | jam | channel-spanning jam | 90 | 0 | 0 | | | | | | 16,26312 | 48,23838 | | | | 2 |
| LW | 60 | LW60 | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,26289 | 48,23848 | | | | 2 |
| LW | | | | | | | | 1850 | | | | | | | | | | | | | 95 |

| | | | |
|---|---|---|---|
| Länge A | 2361 m | Länge A | 2361 m |
| Summe Alw | 1850 | Summe RPlw | 95 |
| IDlw | 0,78356629 | IRlw | 0,0402 |

| | | | |
|---|---|---|---|
| Länge E | 1788 m | Länge E | 1788 m |
| Summe Alw | 960 | Summe RPlw | 35 |
| IDlw | 0,53691275 | IRlw | 0,0196 |

Eckbach Stream

| LABEL | | | | LW TYPE | | | | | WATER RETENTION | | | SEDIMENT RETENTION [cm] | | | | | COORDINATES | | MORPHOLOGICAL FORMATION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LW/MR | Max_ID | ID | photo | channel spani | single pieces | jams | type | type spanning | porosity | backwater | bed contact | length | width | height | volume [m³] | material | x | y | pool | secondary ch: | after LW | RP_lw |
| LW | 1 | LW1 | | y | | underflow jam | jam | channel-spanning jam | 100 | 0 | 0 | | | | | | 16,2642788 | 48,246873 | 0 | 0 | | 2 |
| LW | 2 | LW2 | | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,2659809 | 48,2463345 | 0 | 0 | | 2 |
| LW | 3 | LW3 | | y | | underflow jam | jam | channel-spanning jam | 80 | 0 | 0 | | | | | | 16,2661203 | 48,2463149 | 1 | 0 | 1 | 2 |
| LW | 4 | LW4 | | y | | underflow jam | jam | channel-spanning jam | 80 | 0 | 1 | | | | | | 16,2675745 | 48,2459307 | 1 | 0 | 1 | 3 |
| LW | 5 | LW5 | | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,2678717 | 48,2457777 | 0 | 0 | | 2 |
| LW | 6 | LW6 | | y | | underflow jam | jam | channel-spanning jam | 80 | 0 | 1 | | | | | | 16,268252 | 48,2454949 | 1 | 0 | 1 | 3 |
| LW | 7 | LW7 | | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,2695516 | 48,2444564 | 0 | 0 | | 2 |
| LW | 8 | LW8 | | y | | underflow jam | jam | channel-spanning jam | 80 | 0 | 0 | | | | | | 16,2709152 | 48,2439066 | 1 | 0 | 1 | 2 |
| LW | 9 | LW9 | | y | log step | | single piece | channel-spanning single piece | 90 | 0 | 0 | | | | | | 16,2710526 | 48,2438091 | 1 | 0 | 1 | 2 |
| LW | 10 | LW10 | | y | | dam jam | jam | channel-spanning jam | 100 | 0 | 0 | | | | | | 16,2717389 | 48,2435316 | 1 | 0 | 1 | 2 |
| LW | 11 | LW11 | | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,2722315 | 48,2432979 | 0 | 0 | | 2 |
| LW | 12 | LW12 | | y | | dam jam | jam | channel-spanning jam | 100 | 1 | 1 | | | | | | 16,2732322 | 48,2427481 | 0 | 0 | | 3 |
| LW | 13 | LW13 | | y | | underflow jam | jam | channel-spanning jam | 80 | 0 | 0 | | | | | | 16,2736754 | 48,242225 | 0 | 0 | | 2 |
| LW | 14 | LW14 | | y | | dam jam | jam | channel-spanning jam | 100 | 1 | 1 | | | | | | 16,2738624 | 48,2421526 | 0 | 0 | | 3 |
| LW | 15 | LW15 | | n | | partial dam jai | jam | not-channel-spanning jam | 70 | 0 | 1 | | | | | | 16,2750476 | 48,2411035 | 1 | 0 | | 1 |
| LW | 16 | LW16 | | y | bridge | | single piece | channel-spanning single piece | 0 | 0 | 0 | | | | | | 16,2757413 | 48,2406483 | 0 | 0 | 1 | 2 |
| LW | | | | | | | | | | | | | | | | | | | | | | |
| LW | | | | | | | | | 960 | | | | | | | | | | | | | |
| LW | | | | | | | | | | | | | | | | | | | | | | 35 |
| LW | | | | | | | | | | | | | | | | | | | | | | |

Eckbach stream

| ID | HI | Place | x | y |
|---|---|---|---|---|
| HI1 | other structure | Wien, KG Neuwaldegg, Hernals | 16,2640108 | 48,2468681 |
| HI2 | bridge | KG Neuwaldegg, Hernals, Wien | 16,2647431 | 48,246809 |
| HI3 | bridge | KG Neuwaldegg, Hernals, Wien | 16,2647879 | 48,2468189 |
| HI4 | bridge | KG Neuwaldegg, Hernals, Wien | 16,2650873 | 48,2467279 |
| HI5 | transverse structure | KG Neuwaldegg, Hernals, Wien | 16,2659286 | 48,2464222 |
| HI6 | bridge | KG Neuwaldegg, Hernals, Wien | 16,2668271 | 48,2460884 |
| HI7 | transverse structure | Wien, KG Neuwaldegg, Hernals | 16,2680958 | 48,2456194 |
| HI8 | bank reinforcement | Wien, KG Neuwaldegg, Hernals | 16,268514 | 48,2453937 |
| HI9 | bridge | Wien, KG Neuwaldegg, Hernals | 16,2687335 | 48,2452726 |
| HI10 | transverse structure | Wien, KG Neuwaldegg, Hernals | 16,2687842 | 48,2452469 |
| HI11 | bridge | Exelbergstraße, 32, Wien | 16,2700869 | 48,244245 |
| HI12 | bridge | KG Neuwaldegg, Hernals, Wien | 16,2737458 | 48,2424558 |
| HI13 | bridge | KG Neuwaldegg, Hernals, Wien | 16,2739102 | 48,2417767 |
| HI14 | transverse structure | KG Neuwaldegg, Hernals, Wien | 16,2744575 | 48,241522 |
| HI15 | transverse structure | KG Neuwaldegg, Hernals, Wien | 16,274615 | 48,2412867 |
| HI16 | transverse structure | Neuwaldegger Straße, 59, Wien | 16,2760128 | 48,2405128 |
| HI17 | transverse structure | Neuwaldegger Straße, 57a, Wien | 16,2761778 | 48,2404249 |
| HI18 | bridge | Neuwaldegger Straße, 57a, Wien | 16,2764615 | 48,2403541 |
| HI19 | bridge | Neuwaldegger Straße, 57a, Wien | 16,2765985 | 48,2403457 |
| HI20 | other structure | Neuwaldegger Straße, 57a, Wien | 16,2766976 | 48,2403574 |
| HI21 | bridge | Schwarzenbergallee, 40, Wien | 16,2771199 | 48,2404058 |
| HI22 | bridge | Schwarzenbergallee, 40, Wien | 16,2777113 | 48,2405201 |
| HI23 | other structure | KG Neuwaldegg, Hernals, Wien | 16,2788905 | 48,2403507 |
| HI24 | bank reinforcement | Schwarzenbergallee, 40, Wien | 16,2788563 | 48,2403781 |
| HI25 | bank reinforcement | Wien, KG Neuwaldegg, Hernals | 16,2791028 | 48,2401994 |

Alsbach stream

| ID | HI | Place | x | y |
|---|---|---|---|---|
| HI1 | transverse structure | KG Neuwaldegg, Hernals, Wien | 16,262591 | 48,2387868 |
| HI2 | bridge | Wien, KG Neuwaldegg, Hernals | 16,2691561 | 48,237692 |
| HI3 | transverse structure | Wien, KG Neuwaldegg, Hernals | 16,2695528 | 48,2379375 |
| HI4 | cascade | Wien, KG Neuwaldegg, Hernals | 16,2698271 | 48,2381954 |
| HI5 | boulders | KLG Hanslteich-Hofwiese, 6, Wien | 16,2731584 | 48,2390875 |
| HI6 | cascade | KLG Hanslteich-Hofwiese, 4, Wien | 16,2749168 | 48,2393742 |
| HI7 | boulders | Neuwaldegger Straße, 59, Wien | 16,2752989 | 48,2392822 |
| HI8 | transverse structure | Neuwaldegger Straße, 59, Wien | 16,2757948 | 48,2391146 |
| HI9 | transverse structure | KG Neuwaldegg, Hernals, Wien | 16,2806171 | 48,2388438 |
| HI10 | bank reinforcement | Wien, KG Neuwaldegg, Hernals | 16,2806692 | 48,2388574 |
| HI11 | bridge | KG Hadersdorf, Penzing, Wien | 16,2681746 | 48,2371469 |
| HI12 | boulders | KG Hadersdorf, Penzing, Wien | 16,267775 | 48,2372078 |
| HI13 | transverse structure | KG Hadersdorf, Penzing, Wien | 16,2678173 | 48,2371991 |
| HI14 | bridge | KG Neuwaldegg, Hernals, Wien | 16,266095 | 48,2374518 |
| HI15 | transverse structure | KG Neuwaldegg, Hernals, Wien | 16,2659792 | 48,2377277 |
| HI16 | transverse structure | KG Neuwaldegg, Hernals, Wien | 16,2659549 | 48,2377587 |
| HI17 | transverse structure | KG Hadersdorf, Penzing, Wien | 16,2654335 | 48,2377966 |
| HI18 | bridge | KG Hadersdorf, Penzing, Wien | 16,2640504 | 48,2382375 |
| HI19 | transverse structure | KG Neuwaldegg, Hernals, Wien | 16,2633436 | 48,2383147 |
| HI20 | cascade | KG Neuwaldegg, Hernals, Wien | 16,2633799 | 48,2383465 |

| Date | ID | Place | x | y | Sampling side | Sediment | Weather cond. | Weather before sampling | Water depth (cm) | Leaves | Channel width (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14.04.2025 00:00:00,000 | R1A | KG Neuwaldegg, Hernals, Wien | 16,27933628 | 48,23894972 | Riffle | coarse | sunny, cloudy | changeable | 11 | no | 230 |
| 14.04.2025 00:00:00,000 | P1A | KG Dornbach, Hernals, Wien | 16,27964826 | 48,23881567 | Pool | fine | sunny, cloudy | changeable | 31 | no | 410 |
| 14.04.2025 00:00:00,000 | R2A | KG Neuwaldegg, Hernals, Wien | 16,28045468 | 48,23882819 | Riffle | coarse | sunny, cloudy | changeable | 11 | no | 120 |
| 14.04.2025 00:00:00,000 | P2A | KG Neuwaldegg, Hernals, Wien | 16,28053083 | 48,23884183 | Pool | coarse | sunny, cloudy | changeable | 20,5 | no | 180 |
| 14.04.2025 00:00:00,000 | R3A | KLG Hanslteich-Hofwiese, 2, Wien | 16,27301625 | 48,23908457 | Riffle | coarse | sunny, cloudy | changeable | 10 | no | 90 |
| 14.04.2025 00:00:00,000 | P3A | KLG Hanslteich-Hofwiese, 2, Wien | 16,27291273 | 48,23914355 | Pool | fine | sunny, cloudy | changeable | 28 | no | 287 |
| 14.04.2025 00:00:00,000 | LW1A | KLG Hanslteich-Hofwiese Wien | 16,27417249 | 48,23933398 | Large wood | fine | sunny, cloudy | changeable | 25 | yes | 150 |
| 14.04.2025 00:00:00,000 | P4A | KG Neuwaldegg, Hernals, Wien | 16,26243389 | 48,23882936 | Pool | mixed | sunny, cloudy | changeable | 17 | no | 196 |
| 14.04.2025 00:00:00,000 | R4A | KG Neuwaldegg, Hernals, Wien | 16,26209431 | 48,23889516 | Riffle | coarse | sunny, cloudy | changeable | 8 | no | 90 |
| 14.04.2025 00:00:00,000 | P5A | KG Neuwaldegg, Hernals, Wien | 16,26193035 | 48,23896724 | Pool | mixed | sunny, cloudy | changeable | 12 | no | 150 |
| 14.04.2025 00:00:00,000 | LW2A | KG Neuwaldegg, Hernals, Wien | 16,26156959 | 48,2390043 | Large wood | mixed | sunny, cloudy | changeable | 21 | yes | 120 |
| 14.04.2025 00:00:00,000 | R5A | KG Hadersdorf, Penzing, Wien | 16,26175012 | 48,23898118 | Riffle | coarse | sunny, cloudy | changeable | 10 | no | 110 |
| 14.04.2025 00:00:00,000 | LW3A | KG Neuwaldegg, Hernals, Wien | 16,26140277 | 48,23912004 | Large wood | mixed | sunny, cloudy | changeable | 10 | yes | 100 |
| 14.04.2025 00:00:00,000 | LW4A | KG Neuwaldegg, Hernals, Wien | 16,2590739 | 48,23974455 | Large wood | coarse | sunny, cloudy | changeable | 14 | yes | 120 |
| 14.04.2025 00:00:00,000 | LW5A | KG Hadersdorf, Penzing, Wien | 16,25890989 | 48,23967815 | Large wood | coarse | sunny, cloudy | changeable | 13 | yes | 140 |
| | | | | | | | | | | | |
| | | | | | | | | | Pool average | | 166,2 |
| | | | | | | | | | 21,7 | | average |
| | | | | | | | | | | | |
| | | | | | | | | | Riffle average | | |
| | | | | | | | | | 10 | | |
| | | | | | | | | | | | |
| | | | | | | | | | LW average | | |
| | | | | | | | | | 16,6 | | |

| Date | ID | Place | x | y | Sampling site | Sediment | Weather cond. | Weather before sampling | Water depth (cm) | Leaves | Channel width (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Testing day, 07 | P1E | KG Neuwaldeg | 16,2661741 | 48,2463062 | Pool | mixed | windy, cloudy | changeable | 11 | no | 100 |
| 00:00,0 | P2E | Wien, KG Neu | 16,2680312 | 48,2456419 | Pool | mixed | windy, cloudy | changeable | 15,5 | no | 232 |
| 00:00,0 | P3E | KG Neuwaldeg | 16,2678065 | 48,2458032 | Pool | mixed | windy, cloudy | changeable | 13 | no | 140 |
| 00:00,0 | P4E | KG Neuwaldeg | 16,2661605 | 48,2463333 | Pool | coarse | windy, cloudy | changeable | 18 | no | 161 |
| 00:00,0 | P5E | Exelbergstraß | 16,2703375 | 48,2441244 | Pool | coarse | windy, cloudy | changeable | 11 | no | 200 |
| 00:00,0 | R1E | Wien, KG Neu | 16,2679509 | 48,2457043 | Riffle | coarse | windy, cloudy | changeable | 11 | no | 146 |
| 00:00,0 | R2E | KG Neuwaldeg | 16,2677112 | 48,2458005 | Riffle | mixed | windy, cloudy | changeable | 15,5 | no | 180 |
| 00:00,0 | R3E | KG Neuwaldeg | 16,2662473 | 48,2463374 | Riffle | coarse | windy, cloudy | changeable | 11 | no | 155 |
| 00:00,0 | R4E | Exelbergstraß | 16,2704621 | 48,2440808 | Riffle | coarse | windy, cloudy | changeable | 10 | no | 200 |
| 20:54,0 | R5E | KG Neuwaldeg | 16,2732817 | 48,2427052 | Riffle | coarse | windy, cloudy | changeable | 10 | no | 200 |
| Testing day, 07 | LW1E | KG Neuwaldeg | 16,2659274 | 48,2464047 | Large wood | fine | windy, cloudy | changeable | 12 | yes | 100 |
| 17:00,5 | LW2E | KG Neuwaldeg | 16,2676426 | 48,245873 | Large wood | coarse | windy, cloudy | changeable | 25 | yes | 165 |
| 38:25,1 | LW3E | KG Neuwaldeg | 16,2662803 | 48,2463333 | Large wood | coarse | windy, cloudy | changeable | 18 | yes | 150 |
| 00:00,0 | LW4E | Exelbergstraß | 16,2701036 | 48,2442556 | Large wood | coarse | windy, cloudy | changeable | 10 | yes | 250 |
| 06:16,0 | LW5E | KG Neuwaldeg | 16,2733097 | 48,2426741 | Large wood | mixed | windy, cloudy | changeable | 20 | yes | 250 |
| | | | | | | | | | | | |
| | | | | | | | | | Pool | | 175,2666667 |
| | | | | | | | | | 13,7 | | |
| | | | | | | | | | Riffle | | |
| | | | | | | | | | 11,5 | | |
| | | | | | | | | | LW | | |
| | | | | | | | | | 17 | | |

| d=25cm | 0,049087 m² | | | | | | |
|---|---|---|---|---|---|---|---|
| Order | R1A | R2A | R3A | R4A | R5A | *sum* | |
| Ephemeroptera L | 31 | 10 | 77 | 25 | 31 | **174** | **204** |
| Ephemeroptera L wwp | 0 | 5 | 12 | 7 | 6 | **30** | |
| Plecoptera | 19 | 14 | 10 | 9 | 10 | **62** | |
| Trichoptera mK | 0 | 0 | 0 | 0 | 0 | **0** | **28** |
| Trichoperta oK | 1 | 17 | 1 | 7 | 2 | **28** | |
| Coleoptera | 0 | 4 | 0 | 0 | 0 | **4** | |
| Diptera | 16 | 7 | 11 | 111 | 16 | **161** | |
| Odonata*** | 0 | 0 | 0 | 0 | 1 | **1** | |
| Amphipoda | 1 | 32 | 21 | 0 | 0 | **54** | |
| Collembola | 0 | 0 | 1 | 0 | 1 | **2** | |
| Oligocheta | 0 | 0 | 0 | 2 | 0 | **2** | |
| **sum** | **68** | **89** | **133** | **161** | **67** | **518** | |

wwp = with wing pads

| 1m² | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Order** | **R1A** | **R2A** | **R3A** | **R4A** | **R5A** | ***sum*** | | **%** |
| Ephemeroptera L | 631,53 | 631,53 | 1568,64 | 509,30 | 631,53 | **3972,54** | **4583,70** | 41,74% |
| Ephemeroptera L wwp | 0,00 | 101,86 | 244,46 | 142,60 | 122,23 | **611,16** | | |
| Plecoptera | 387,07 | 285,21 | 203,72 | 183,35 | 203,72 | **1263,06** | | 11,50% |
| Trichoptera mK | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | **570,47** | 5,20% |
| Trichoperta oK | 20,37 | 346,32 | 20,37 | 142,60 | 40,74 | **570,42** | | |
| Coleoptera | 0,00 | 81,49 | 0,00 | 0,00 | 0,00 | **81,49** | | 0,74% |
| Diptera | 325,95 | 142,60 | 224,09 | 2261,29 | 325,95 | **3279,89** | | 29,87% |
| Odonata | 0,00 | 0,00 | 0,00 | 0,00 | 20,37 | **20,37** | | 0,19% |
| Amphipoda | 20,37 | 651,90 | 427,81 | 0,00 | 0,00 | **1100,09** | | 10,02% |
| Collembola | 0,00 | 0,00 | 20,37 | 0,00 | 20,37 | **40,74** | | 0,37% |
| Oligocheta | 0,00 | 0,00 | 0,00 | 40,74 | 0,00 | **40,74** | | 0,37% |
| sum | **1385,30** | **2240,92** | **2709,48** | **3279,89** | **1364,92** | **10980,504** | | 100,00% |
| **order diversity** | **6,00** | **6,00** | **7,00** | **5,00** | **7,00** | | | |

| ~ ▭ | 0,5x0.5 | 0,5x0,5 | 0,5x0,5 | 0,5x0,5 | 0,5x0,5 | | |
|---|---|---|---|---|---|---|---|
| qm | 0,25 | 0,25 | 0,25 | 0,25 | 0,25 | | |
| **Order** | **LW1A** | **LW2A** | **LW3A** | **LW4A** | **LW5A** | ***sum*** | |
| Ephemeroptera L wwp | 0 | 44 | 0 | 22 | 21 | **87** | **737** |
| Ephemeroptera L | 189 | 205 | 77 | 101 | 78 | **650** | |
| Plecoptera | 21 | 12 | 20 | 12 | 21 | **86** | |
| Trichoptera mK | 0 | 3 | 0 | 0 | 1 | **4** | **20** |
| Trichoperta oK | 1 | 1 | 11 | 0 | 3 | **16** | |
| Coleoptera | 0 | 0 | 1 | 2 | 0 | **3** | |
| Diptera | 31 | 65 | 76 | 46 | 87 | **305** | |
| Odonata *** | 0 | 0 | 0 | 0 | 0 | **0** | |
| Amphipoda | 4 | 0 | 0 | 0 | 1 | **5** | |
| Collembola | 0 | 1 | 1 | 0 | 0 | **2** | |
| Oligocheta | 0 | 0 | 0 | 2 | 0 | **2** | |
| Isopoda | 2 | 1 | 1 | 1 | 0 | **5** | |
| Heteroptera | 0 | 1 | 0 | 0 | 0 | **1** | |
| Salamandra s. larvae *** | 0 | 2 | 2 | 3 | 4 | **11** | |
| **sum** | **248** | **335** | **189** | **189** | **216** | **1177** | |

*** released due to its protected status

| 1qm | | | | | |
|---|---|---|---|---|---|
| **Order** | **LW1A** | **LW2A** | **LW3A** | **LW4A** | **LW5A** |
| Ephemeroptera L wwp | 0 | 176 | 0 | 88 | 84 |
| Ephemeroptera L | 756 | 820 | 308 | 404 | 312 |
| Plecoptera | 84 | 48 | 80 | 48 | 84 |
| Trichoptera mK | 0 | 12 | 0 | 0 | 4 |
| Trichoperta oK | 4 | 4 | 44 | 0 | 12 |
| Coleoptera | 0 | 0 | 4 | 8 | 0 |
| Diptera | 124 | 260 | 304 | 184 | 348 |
| Odonata *** | 0 | 0 | 0 | 0 | 0 |
| Amphipoda | 16 | 0 | 0 | 0 | 4 |
| Collembola | 0 | 4 | 4 | 0 | 0 |
| Oligocheta | 0 | 0 | 0 | 8 | 0 |
| Isopoda | 8 | 4 | 4 | 4 | 0 |
| Heteroptera | 0 | 4 | 0 | 0 | 0 |
| Salamandra s. larvae *** | 0 | 8 | 8 | 12 | 16 |
| **sum** | **992** | **1340** | **756** | **756** | **864** |
| **order diversity** | **6** | **9** | **9** | **8** | **5** |

*** released due to its protected status

| d=25cm | 0,049087 m² | | | | | | |
|---|---|---|---|---|---|---|---|
| **Order** | **P1A** | **P2A** | **P3A** | **P4A** | **P5A** | ***sum*** | |
| Ephemeroptera L wwp | 10 | 3 | 6 | 1 | 7 | **27** | **240** |
| Ephemeroptera L | 40 | 6 | 76 | 32 | 59 | **213** | |
| Plecoptera | 15 | 1 | 2 | 0 | 2 | **20** | |
| Trichoptera mK | 1 | 0 | 0 | 0 | 0 | **1** | **4** |
| Trichoperta oK | 0 | 0 | 1 | 1 | 1 | **3** | |
| Coleoptera | 0 | 0 | 0 | 0 | 0 | **0** | |
| Diptera | 24 | 5 | 12 | 25 | 26 | **92** | |
| Gastropoda | 0 | 0 | 0 | 0 | 0 | **0** | |
| Odonata*** | 0 | 0 | 0 | 0 | 0 | **0** | |
| Amphipoda | 2 | 0 | 1 | 0 | 1 | **4** | |
| Collembola | 0 | 0 | 0 | 0 | 0 | **0** | |
| Oligocheta | 0 | 0 | 0 | 2 | 3 | **5** | |
| Isopoda | 0 | 0 | 0 | 1 | 0 | **1** | |
| Heteroptera | 0 | 0 | 0 | 0 | 0 | **0** | |
| Salamandra s. larvae *** | 0 | 0 | 0 | 0 | 0 | **0** | |
| **sum** | **92** | **15** | **98** | **62** | **99** | **366** | |

| 1m² | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Order** | **P1A** | **P2A** | **P3A** | **P4A** | **P5A** | **sum** | | |
| Ephemeroptera L wwp | 203,72 | 61,12 | 122,23 | 20,37 | 142,60 | **550,04** | **4889,28** | 65,57% |
| Ephemeroptera L | 814,88 | 122,23 | 1548,27 | 651,90 | 1201,95 | **4339,23** | | |
| Plecoptera | 305,58 | 20,37 | 40,74 | 0,00 | 40,74 | **407,44** | | 5,46% |
| Trichoptera mK | 20,37 | 0,00 | 0,00 | 0,00 | 0,00 | **20,37** | **81,49** | 1,09% |
| Trichoperta oK | 0,00 | 0,00 | 20,37 | 20,37 | 20,37 | **61,12** | | |
| Coleoptera | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0 |
| Diptera | 488,93 | 101,86 | 244,46 | 509,30 | 529,67 | **1874,22** | | 25,14% |
| Gastropoda | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| Odonata | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| Amphipoda | 40,74 | 0,00 | 20,37 | 0,00 | 20,37 | **81,49** | | 1,09% |
| Collembola | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| Oligocheta | 0,00 | 0,00 | 0,00 | 40,74 | 61,12 | **101,86** | | 1,37% |
| Isopoda | 0,00 | 0,00 | 0,00 | 20,37 | 0,00 | **20,37** | | 0,27% |
| Heteroptera | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| Salamandra s. larvae *** | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| **sum** | **1874,22** | **305,58** | **1996,46** | **1263,06** | **2016,83** | **7456,15** | | 100,00% |
| **order diversity** | **6** | **4** | **6** | **6** | **7** | | | |

| d=25cm | 0,049087 m² | | | | | | |
|---|---|---|---|---|---|---|---|
| Order | R1E | R2E | R3E | R4E | R5E | sum | |
| Ephemeroptera L wwp | 28 | 41 | 27 | 7 | 18 | **121** | **168** |
| Ephemeroptera L | 4 | 13 | 8 | 5 | 17 | **47** | |
| Plecoptera | 2 | 5 | 3 | 2 | 6 | **18** | |
| Trichoptera mK | 0 | 0 | 0 | 0 | 0 | **0** | **3** |
| Trichoperta oK | 1 | 0 | 0 | 1 | 1 | **3** | |
| Coleoptera | 0 | 0 | 0 | 0 | 0 | **0** | |
| Diptera | 45 | 93 | 28 | 6 | 100 | **272** | |
| Odonata (Zyg) | 0 | 0 | 0 | 0 | 0 | **0** | **1** |
| Odonata (Anis) | 1 | 0 | 0 | 0 | 0 | **1** | |
| Amphipoda | 5 | 11 | 27 | 13 | 198 | **254** | |
| Collembola | 0 | 0 | 0 | 0 | 0 | **0** | |
| Oligocheta | 2 | 1 | 0 | 10 | 0 | **13** | |
| Isopoda | 0 | 0 | 1 | 0 | 0 | **1** | |
| Heteroptera | 0 | 0 | 0 | 0 | 0 | **0** | |
| Salamandra s. larvae ** | 0 | 0 | 0 | 0 | 0 | **0** | |
| **sum** | **88** | **164** | **94** | **44** | **340** | <u>**730**</u> | |

| 1m² | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Order** | **R1E** | **R2E** | **R3E** | **R4E** | **R5E** | ***sum*** | | |
| Ephemeroptera wwp | 570,42 | 835,25 | 550,04 | 142,60 | 366,70 | **2465,01** | **3422,49** | 23,01% |
| Ephemeroptera L | 81,49 | 264,84 | 162,98 | 101,86 | 346,32 | **957,48** | | |
| Plecoptera | 40,74 | 101,86 | 61,12 | 40,74 | 122,23 | **366,70** | | 2,47% |
| Trichoptera mK | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | **61,12** | 0,41% |
| Trichoperta oK | 20,37 | 0,00 | 0,00 | 20,37 | 20,37 | **61,12** | | |
| Coleoptera | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0 |
| Diptera | 916,74 | 1894,60 | 570,42 | 122,23 | 2037,20 | **5541,18** | | 37,26% |
| Odonata (Zyg) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| Odonata (Anis) | 20,37 | 0,00 | 0,00 | 0,00 | 0,00 | **20,37** | **20,37** | 0,14% |
| Amphipoda | 101,86 | 224,09 | 550,04 | 264,84 | 4033,65 | **5174,49** | | 34,79% |
| Collembola | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| Oligocheta | 40,74 | 20,37 | 0,00 | 203,72 | 0,00 | **264,84** | | 1,78% |
| Isopoda | 0,00 | 0,00 | 20,37 | 0,00 | 0,00 | **20,37** | | 0,14% |
| Heteroptera | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| Salamandra s. larvae | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| **sum** | **1792,74** | **3341,01** | **1914,97** | **896,37** | **6926,48** | **14871,55** | | 100,00% |
| **order diversity** | **7** | **6** | **5** | **6** | **5** | | | |

| ~ □ | 0,5x0,5 | m | | | | | |
|---|---|---|---|---|---|---|---|
| qm | 0,25 | | | | | | |
| **Order** | **LW1E** | **LW2E** | **LW3E** | **LW4E** | **LW5E** | ***sum*** | |
| Ephemeroptera L wwp | 29 | 18 | 50 | 3 | 15 | **115** | **144** |
| Ephemeroptera L | 8 | 8 | 5 | 0 | 8 | **29** | |
| Plecoptera | 32 | 3 | 6 | 2 | 12 | **55** | |
| Trichoptera mK | 0 | 0 | 0 | 0 | 0 | **0** | **2** |
| Trichoperta oK | 0 | 2 | 0 | 0 | 0 | **2** | |
| Coleoptera | 0 | 0 | 0 | 0 | 0 | **0** | |
| Diptera | 43 | 46 | 26 | 15 | 53 | **183** | |
| Odonata (Zyg)*** | 0 | 0 | 0 | 0 | 0 | **0** | **0** |
| Odonata (Anis) | 0 | 0 | 0 | 0 | 0 | **0** | |
| Amphipoda | 13 | 135 | 19 | 65 | 76 | **308** | |
| Collembola | 0 | 0 | 0 | 0 | 0 | **0** | |
| Oligocheta | 0 | 0 | 1 | 0 | 0 | **1** | |
| Isopoda | 0 | 0 | 0 | 0 | 0 | **0** | |
| Heteroptera | 0 | 0 | 0 | 0 | 0 | **0** | |
| Salamandra s. larvae *** | 0 | 2 | 3 | 0 | 1 | **6** | |
| **sum** | **125** | **214** | **110** | **85** | **165** | <u>**699**</u> | |

| 1qm | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Order** | **LW1E** | **LW2E** | **LW3E** | **LW4E** | **LW5E** | ***sum*** | | % | |
| Ephemeroptera L wwp | 116 | 72 | 200 | 12 | 60 | **460** | **576** | | |
| Ephemeroptera L | 32 | 32 | 20 | 0 | 32 | **116** | | | |
| Plecoptera | 128 | 12 | 24 | 8 | 48 | **220** | | 20,60% | 7,87% |
| Trichoptera mK | 0 | 0 | 0 | 0 | 0 | **0** | **8** | | |
| Trichoperta oK | 0 | 8 | 0 | 0 | 0 | **8** | | | 0,29% |
| Coleoptera | 0 | 0 | 0 | 0 | 0 | **0** | | 0 | |
| Diptera | 172 | 184 | 104 | 60 | 212 | **732** | | 26,18% | |
| Odonata (Zyg) | 0 | 0 | 0 | 0 | 0 | **0** | **0** | 0,00% | |
| Odonata (Anis) | 0 | 0 | 0 | 0 | 0 | **0** | | 0,00% | |
| Amphipoda | 52 | 540 | 76 | 260 | 304 | **1232** | | 44,06% | |
| Collembola | 0 | 0 | 0 | 0 | 0 | **0** | | 0,00% | |
| Oligocheta | 0 | 0 | 4 | 0 | 0 | **4** | | 0,14% | |
| Isopoda | 0 | 0 | 0 | 0 | 0 | **0** | | 0,00% | |
| Heteroptera | 0 | 0 | 0 | 0 | 0 | **0** | | 0,00% | |
| Salamandra s. larvae *** | 0 | 8 | 12 | 0 | 4 | **24** | | 0,86% | |
| **sum** | **500** | **856** | **440** | **340** | **660** | **2796** | | | |
| **o.div** | **5** | **6** | **7** | **5** | **6** | | | | |
| | | | | | | | | | 100,00% |

| d=25cm | 0,049087 m² | | | | | | |
|---|---|---|---|---|---|---|---|
| **Order** | **P1E** | **P2E** | **P3E** | **P4E** | **P5E** | ***sum*** | |
| Ephemeroptera L wwp | 7 | 1 | 15 | 22 | 0 | **45** | **78** |
| Ephemeroptera L | 2 | 1 | 16 | 14 | 0 | **33** | |
| Plecoptera | 0 | 1 | 2 | 10 | 0 | **13** | |
| Trichoptera mK | 0 | 0 | 0 | 0 | 0 | **0** | **0** |
| Trichoperta oK | 0 | 0 | 0 | 0 | 0 | **0** | |
| Coleoptera | 0 | 0 | 0 | 0 | 0 | **0** | |
| Diptera | 20 | 23 | 88 | 57 | 9 | **197** | |
| Odonata (Zyg) | 0 | 1 | 0 | 0 | 0 | **1** | **1** |
| Amphipoda | 1 | 0 | 12 | 16 | 1 | **30** | |
| Collembola | 0 | 0 | 0 | 0 | 0 | **0** | |
| Oligocheta | 0 | 5 | 1 | 0 | 0 | **6** | |
| Isopoda | 0 | 0 | 0 | 0 | 0 | **0** | |
| Heteroptera | 0 | 1 | 0 | 0 | 0 | **1** | |
| Salamandra s. larvae *** | 0 | 0 | 0 | 0 | 0 | **0** | |
| | | | | | 0 | | |
| **sum** | **30** | **33** | **134** | **119** | **10** | <u>**326**</u> | |

| 1m² | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Order** | **P1E** | **P2E** | **P3E** | **P4E** | **P5E** | ***sum*** | | |
| Ephemeroptera L wwp | 142,60 | 20,37 | 305,58 | 448,18 | 0,00 | **916,74** | **1589,02** | 23,93% |
| Ephemeroptera L | 40,74 | 20,37 | 325,95 | 285,21 | 0,00 | **672,28** | | |
| Plecoptera | 0,00 | 20,37 | 40,74 | 203,72 | 0,00 | **264,84** | | 3,99% |
| Trichoptera mK | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | **0** | 0% |
| Trichoperta oK | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | |
| Coleoptera | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0 |
| Diptera | 407,44 | 468,56 | 1792,74 | 1161,20 | 183,35 | **4013,28** | | 60,43% |
| Odonata (Zyg) | 0,00 | 20,37 | 0,00 | 0,00 | 0,00 | **20,37** | 20,37 | 0,31% |
| Amphipoda | 20,37 | 0,00 | 244,46 | 325,95 | 20,37 | **611,16** | | 9,20% |
| Collembola | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| Oligocheta | 0,00 | 101,86 | 20,37 | 0,00 | 0,00 | **122,23** | | 1,84% |
| Isopoda | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| Heteroptera | 0,00 | 20,37 | 0,00 | 0,00 | 0,00 | **20,37** | | 0,31% |
| Salamandra s. larvae *** | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** | | 0,00% |
| **sum** | **611,16** | **672,28** | **2729,85** | **2424,27** | **203,72** | **6641,27** | | 100% |
| **order diversity** | **4** | **6** | **6** | **5** | **3** | | | |

Appendix 4 (R Skript)

Boxplots (template)

```
# Data
daten <- data.frame(
  EPT = c(1038.97, 1364.72, 2037.20, 977.85, 998.22),
  Diptera = c(325.95, 142.60, 224.09, 2261.29, 325.95)
)

par(mar = c(5, 4, 6, 2) + 0.1)

# Boxplot
boxplot(daten,
        ylab = "Individuals/m²",
        col = c("lightgrey", "lightgrey"),
        ylim = c(0, 2700), # Example
        border = "black",
        whisklty = 1,
        whisklwd = 2,
        staplewex = 0.5,
        boxlwd = 2,
        medlwd = 2)

# Titel + Subtitle
mtext("Individuals per m²", side = 3, line = 4, cex = 1.3, font = 2)
mtext("*habitat* at the *name* stream", side = 3, line = 3, cex = 1,
col = "gray40")
}
```

Diversity of MZB orders (template)

```
# „Kruskal-Walis-Test‟ template

diversity <- c(
  4, 6, 6, 5, 3,        # Pool
  7, 6, 5, 6, 5,           # Riffle
  5, 6, 7, 5, 6             # Large Wood
)

# Assignment of habitats
habitat <- rep(c("Pool", "Riffle", "LargeWood"), each = 5)

# combination of data
df <- data.frame(Diversity = diversity, Habitat = habitat)

# data print
print(df)


# data overview
head(df)
str(df)
```

```
# testing of normal distribution
# Pool
qqnorm(df[df$Habitat %in% "Pool" , ]$Diversity)
qqline(df[df$Habitat %in% "Pool" , ]$Diversity)
# Riffle
qqnorm(df[df$Habitat %in% "Riffle" , ]$Diversity)
qqline(df[df$Habitat %in% "Riffle" , ]$Diversity)
# LargeWood
qqnorm(df[df$Habitat %in% "LargeWood" , ]$Diversity)
qqline(df[df$Habitat %in% "LargeWood" , ]$Diversity)

#### Kruskal-Wallis-Test ####

kruskal.test(Diversity ~ habitat, data = df)
```

Number of individuals (template)

```
# Kruskal-Walis-Test" (template)

mzb.number <- c(
  2872.45, 2485.38, 3015.05, 1364.92, 2098.32,       # Pool
  1548.27, 2240.92, 3015.05, 3279.89, 1426.04,       # Riffle
  1248, 1364, 760, 788, 864                            # Large Wood
)

# Habitats
habitat <- rep(c("Pool", "Riffle", "LargeWood"), each = 5)

# combination of data
df <- data.frame(Mzb.number = mzb.number, Habitat = habitat)

# print data
print(df)


# data overview
head(df)
str(df)
# testing of normal distribution
# Pool
qqnorm(df[df$Habitat %in% "Pool" , ]$Mzb.number)
qqline(df[df$Habitat %in% "Pool" , ]$Mzb.number)
# Riffle
qqnorm(df[df$Habitat %in% "Riffle" , ]$Mzb.number)
qqline(df[df$Habitat %in% "Riffle" , ]$Mzb.number)
# LargeWood
qqnorm(df[df$Habitat %in% "LargeWood" , ]$Mzb.number)
qqline(df[df$Habitat %in% "LargeWood" , ]$Mzb.number)

#### 3. Kruskal-Wallis-Test ####
kruskal.test(Mzb.number ~ habitat, data = df)
```

```
# 4. Post-hoc-Test

install.packages("FSA")
library(FSA)

dunnTest(mzb.number ~ Habitat, data = df, method = "bonferroni")
```

Appendix 5 (pollution at the Eckbach stream)