material in transition
The fragile mountain

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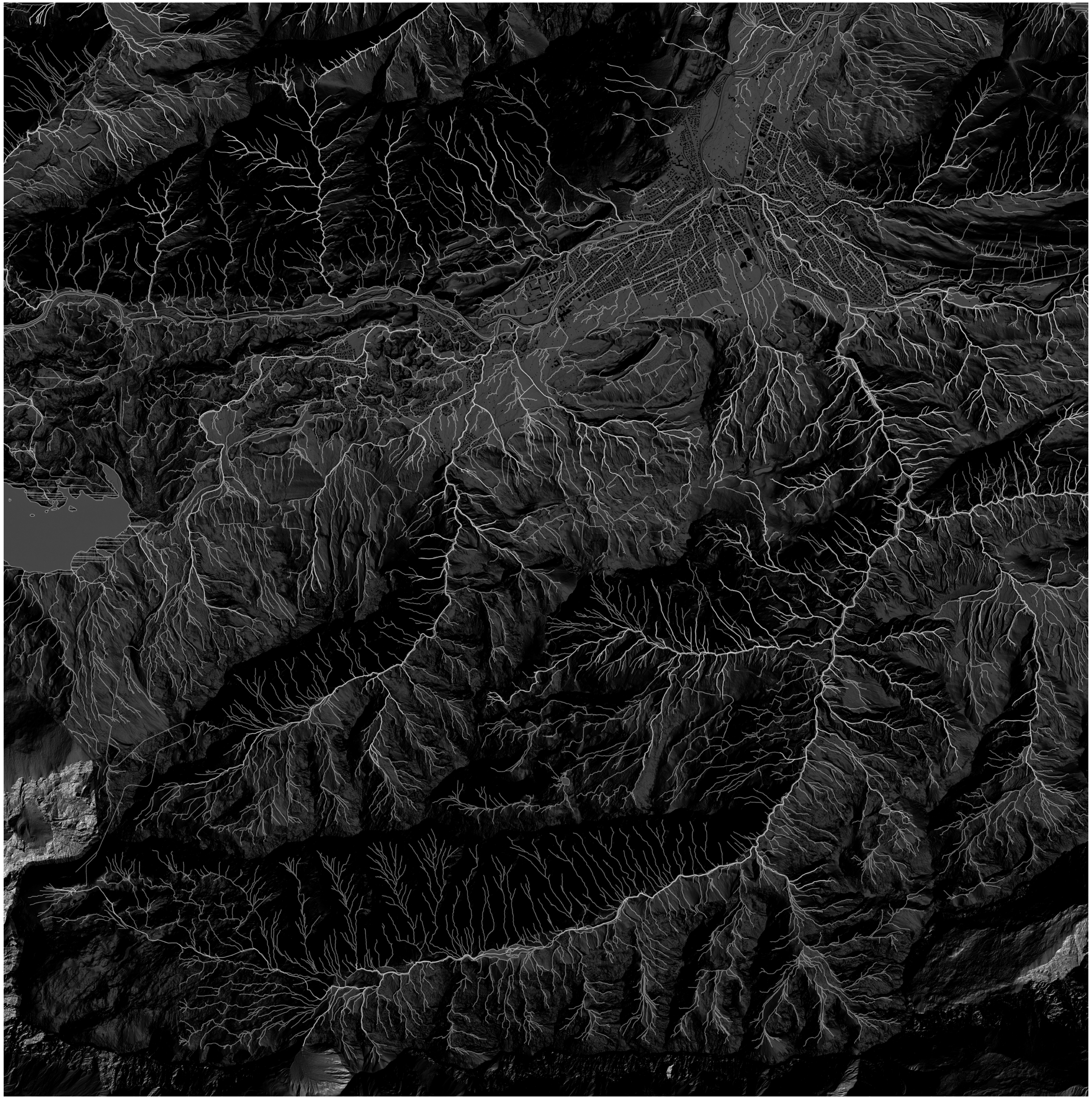
fragile rock

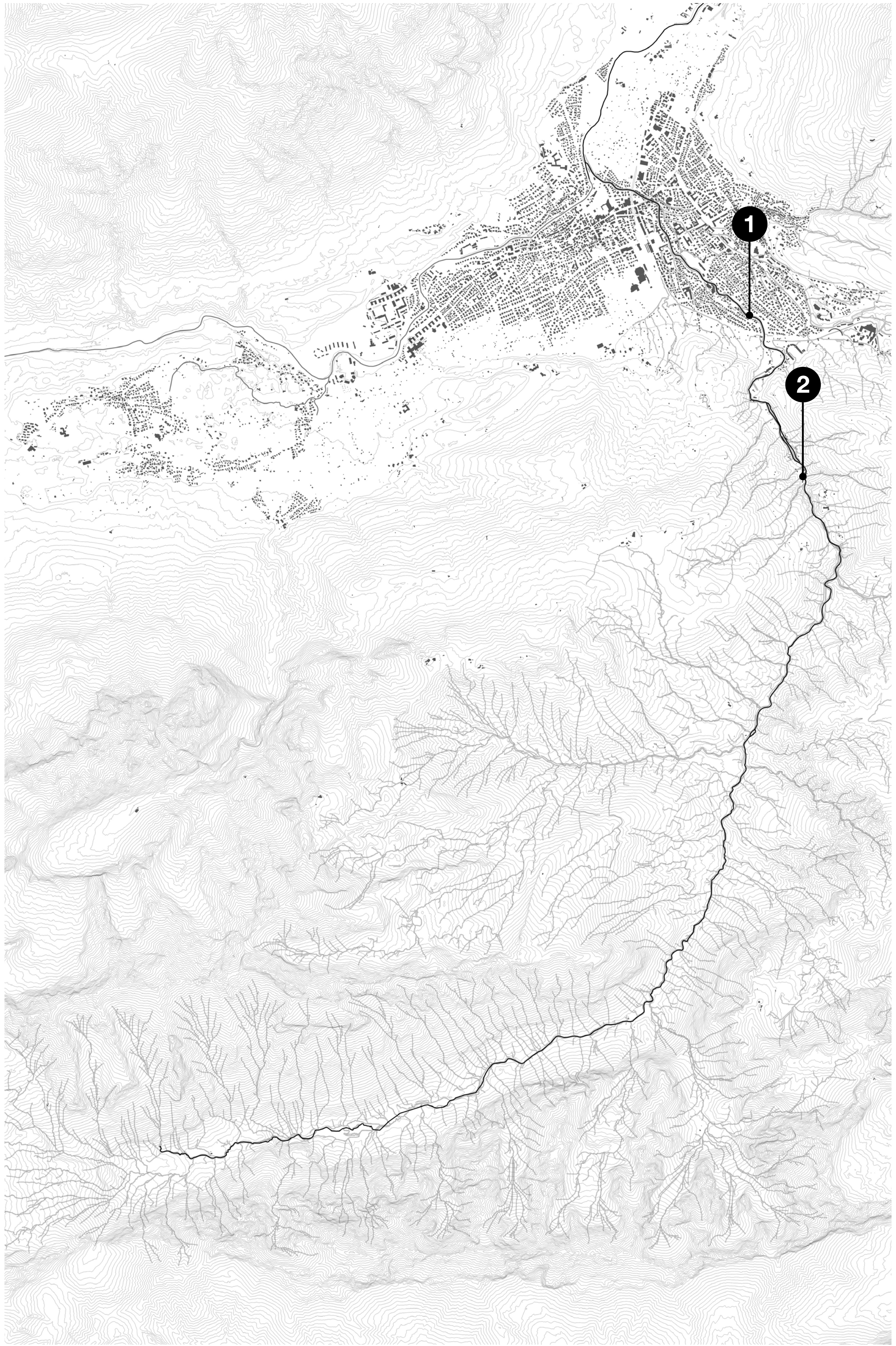


network of possible torrents during heavy rainfall

field journal

The route of water defines the trajectory of eroded rock. All the torrents that form during heavy precipitation, shape a network of material transportation. The Partnach River serves as the main channel, continuously carrying water and debris. To understand the erosional patterns of rock in the mountain, I hike upwards, facing the movement of material downwards. The short encounters with the matieral are photographed and located in plane and height.

river Partnach and its supplying torrent network

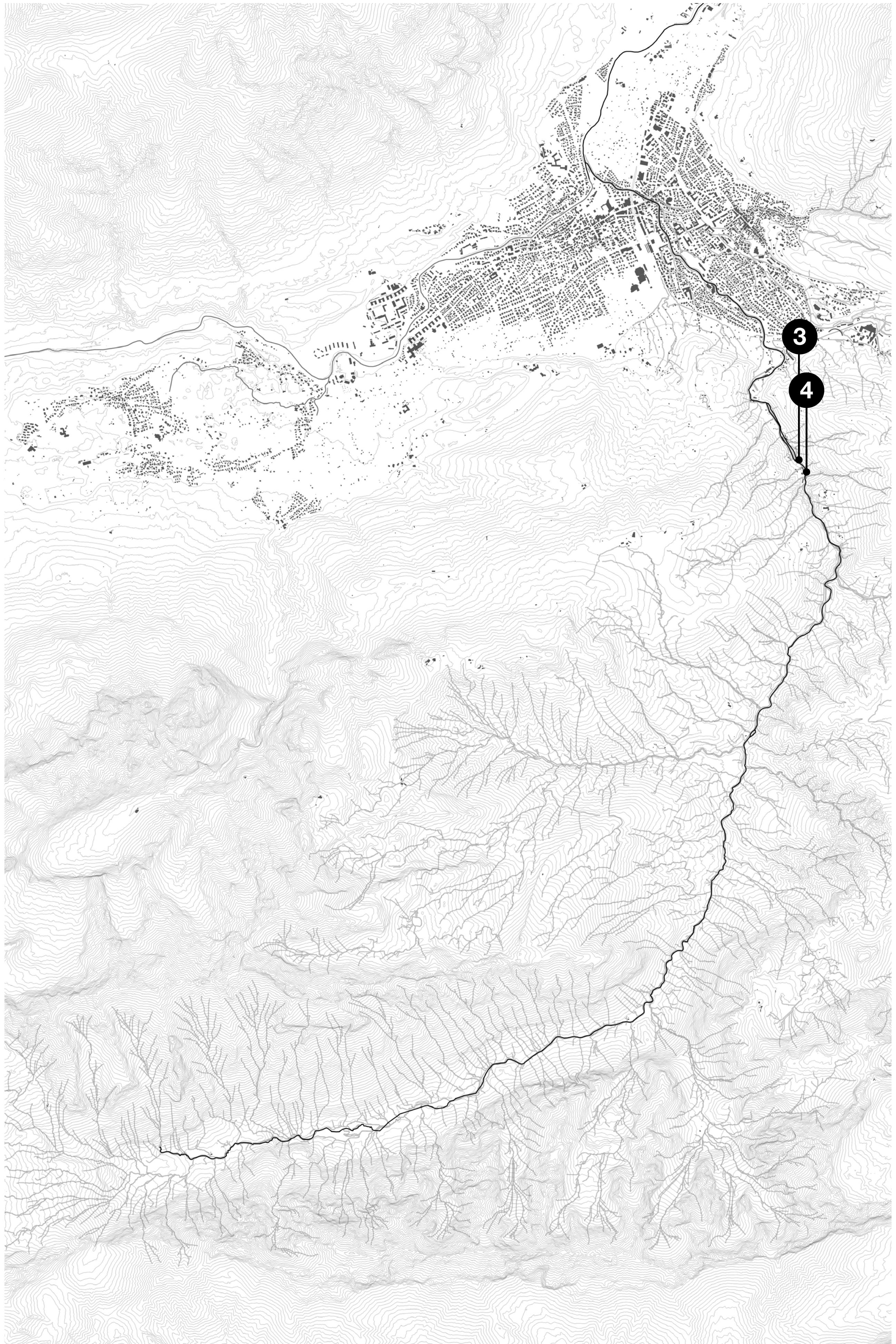


1 726 m

2 748 m

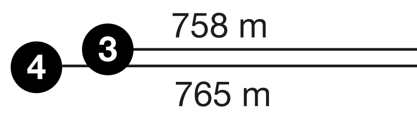
River stones from Partnach and Loisach. In Garmisch-Partenkirchen these stones are exhibited among some others along the urban trajectory of the Partnach river. Together with a information sheet they are museum pieces telling a story of their origin up in the mountains.

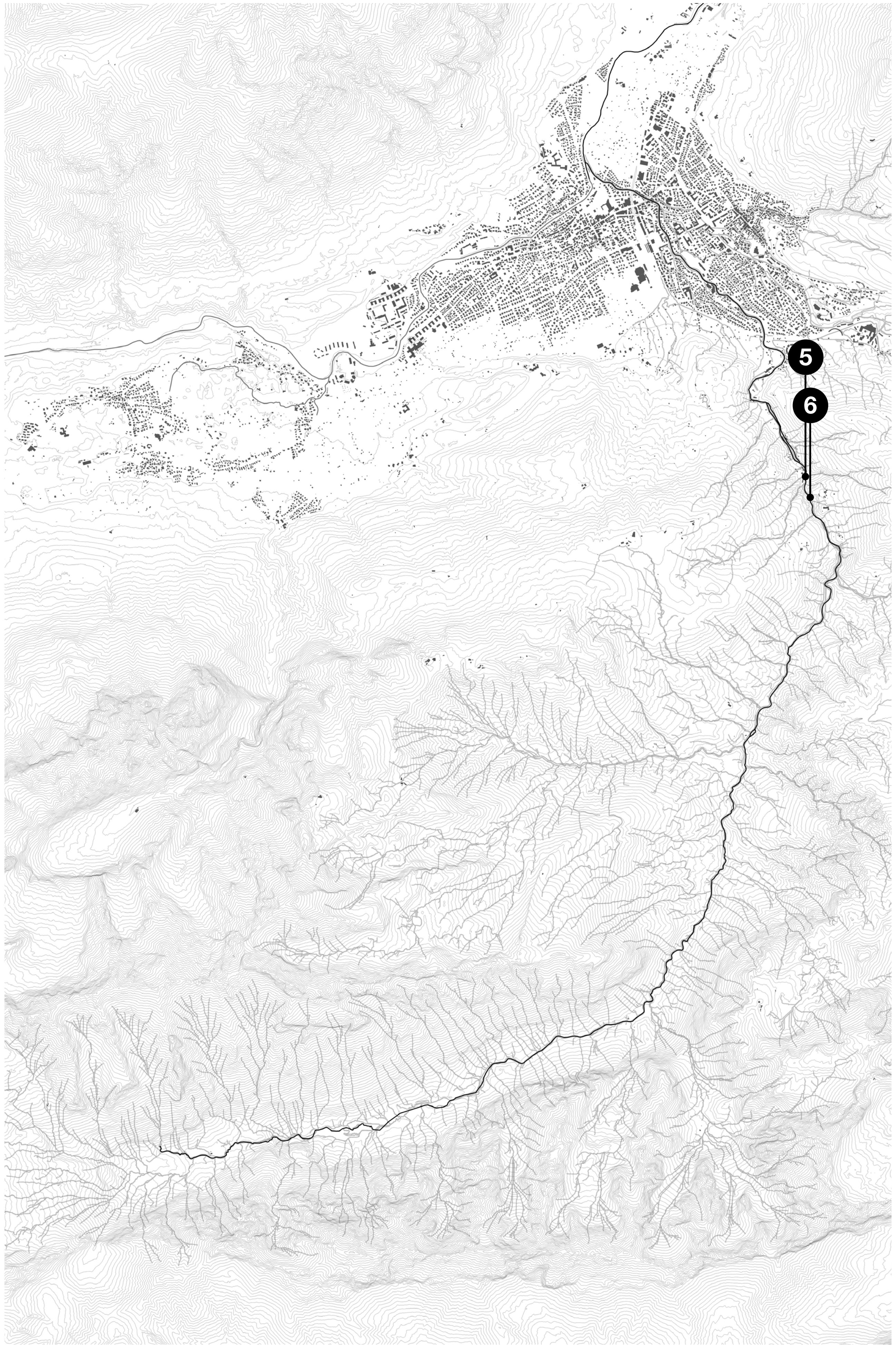
Torrent control. A torrent leading into the Partnach river is slowed down by steps that whirl up the water. This helps to prevents mud and rock forming into a debris slide.



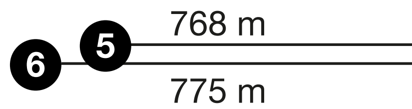
Weir. Close to the ticket booth for the Partnach gorge, this weir guides the water into a side chanel with a turbine to produce energy. According to the water management of the area, the gates need to be opened to flush along the rock material that accumulates over time. This has led to a worn down riverbed, needing rapair work.

Different grain sizes of stones. Right beneath the deep Partnach gorge outside of Garmisch-Partenkirchen different sizes of stone can be found. Grain sizes vary from particles dissolved in the clacerous blue water to bigger boulders that are also used to protect the river banks from further erosion.



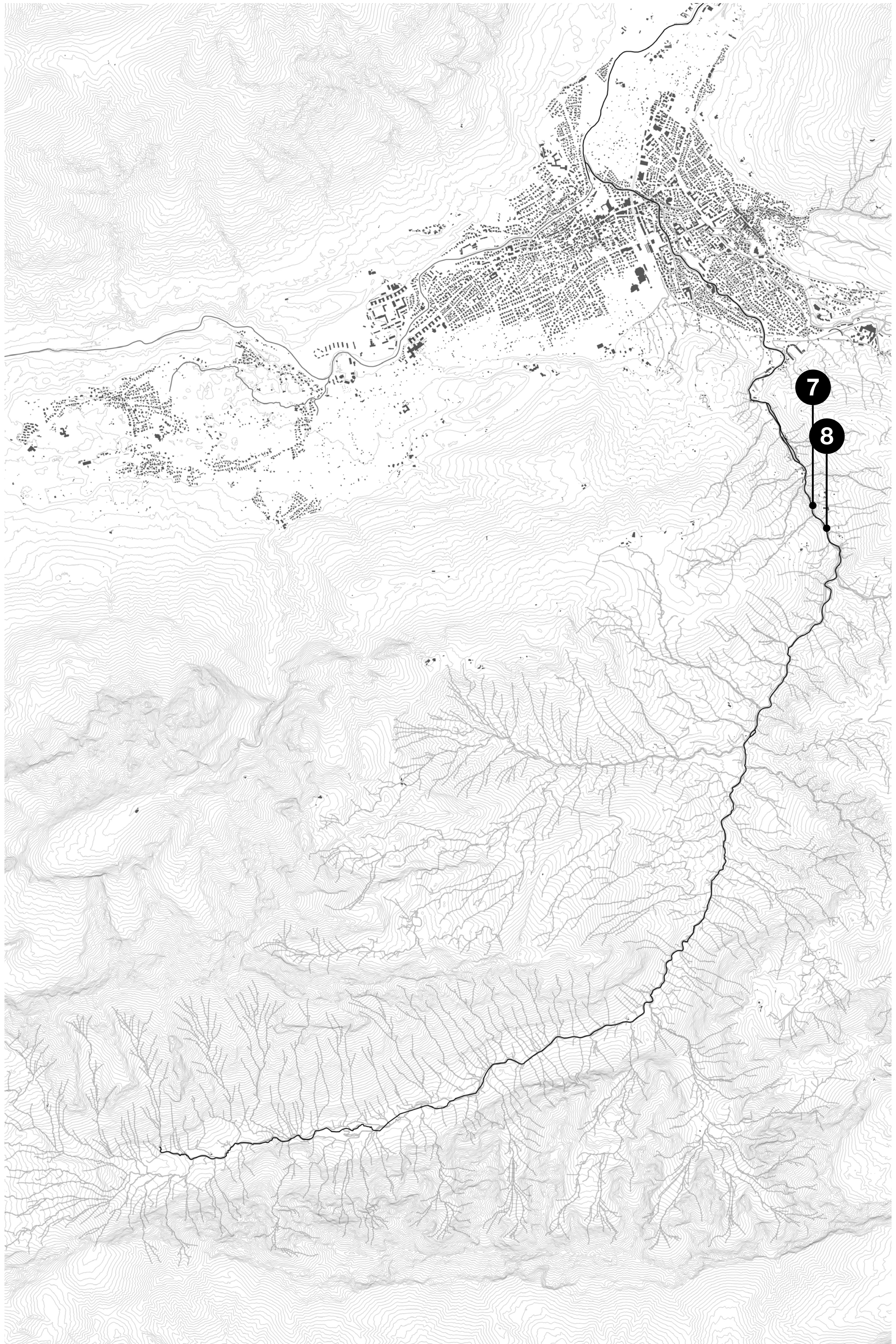


fenced rocks. Looking up the steep rockwalls, metal nets uncover the fragility of the rock. As this is a highly frequented location, they are installed to prevent injuries from rockfall.



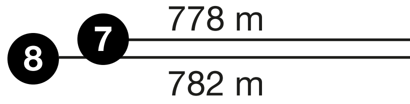
The Partnach Gorge. A layer of hard alpine shell limestone, covered with the softer calcerous mudstones from the so-called Partnach layers, created the condition for the deep gorge we see today. While the softer top layers were very quickly eroded by small rivulets, over time the Partnach, which had a completely different course before the Ice Age, deepened the harder rock layers. What we see today is a 80m deep gorge, in which the constrainted width accelerates the water until it finds the softer rock where the riverbed widens.[1]

1 Robert Pehlke, 'Die Entstehung Der Partnachklamm', Partnachklamm Info, n.d., https://www.partnachklamm-info.de/geschichte.html.

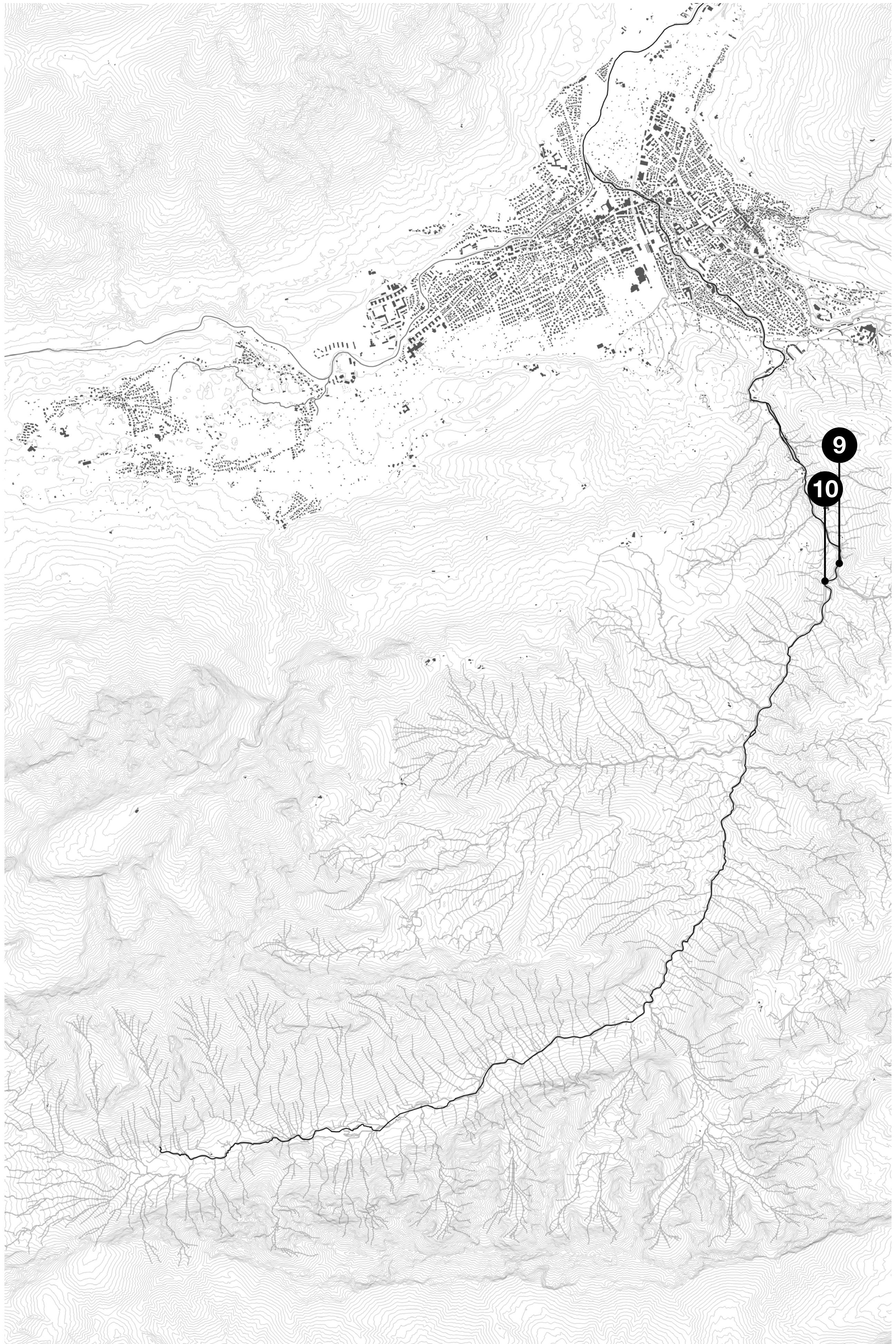


Loose rock. The steep, mostly vertical gorge walls with overhangs are prone to rockfalls. On 1 June 1991, around 10,000 cubic metres of rock broke out of the western rock face at the southern end of the gorge and formed a 15-metre-high wall. The mass of rockfall dammed up the Partnach into a lake, which soon dried up.[2]

Concrete bolts. While safety nets allow rock to fall, these bolts inside the Partnach gorge hold back possible movement, especially at overhangs. Here, the gorge becomes a hybrid of natural and human structure.

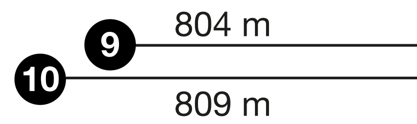


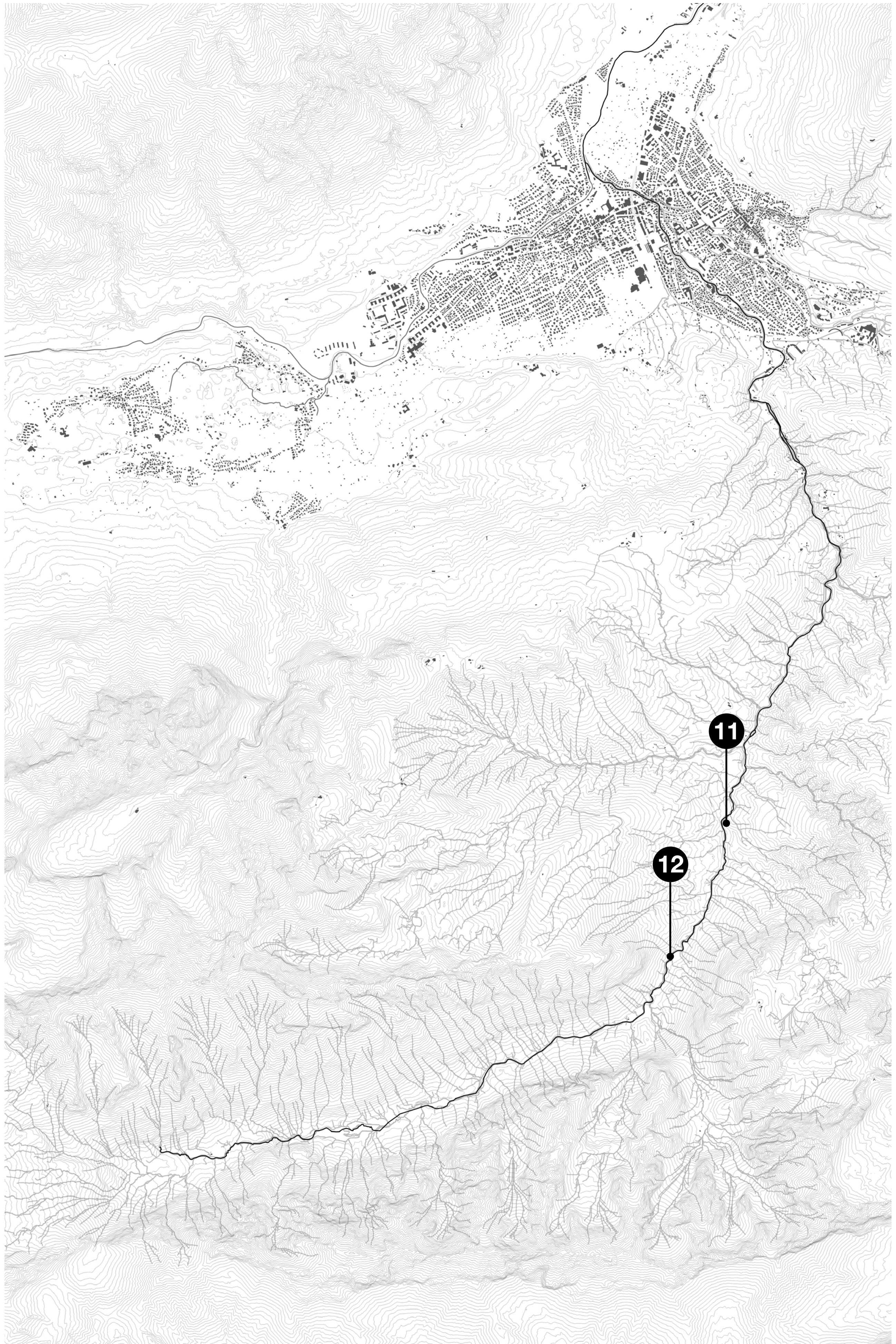
2 Joachim Götz and Lothar Schrott, eds., Das Reintal - Geomorphologischer Lehrpfad am Fuße der Zugspitze: Eine Wanderung durch Raum und Zeit mit einem Einblick in moderne geowissenschaftliche Arbeitsweisen, 1., Aufl (München: Pfeil, 2010), 17.



Debris pile. After heavy rainfall, debris is transported down the slopes, consisting of fragments of rock and wood. This pile is located just behind a barrier, meaning only smaller debris could settle here, as the larger pieces were intercepted by the barrier.

Rock sculpture. A temporary stack of found rocks, organized and balanced with care. The rocks are naturally sorted from large to small as part of the stacking process. Fragile and ephemeral, these sculptures will eventually collapse due to natural forces and continue their journey down the mountain. In a way, these small architectures reflect the human desire to leave a mark, participating in the mountain‘s system of erosion and sedimentation



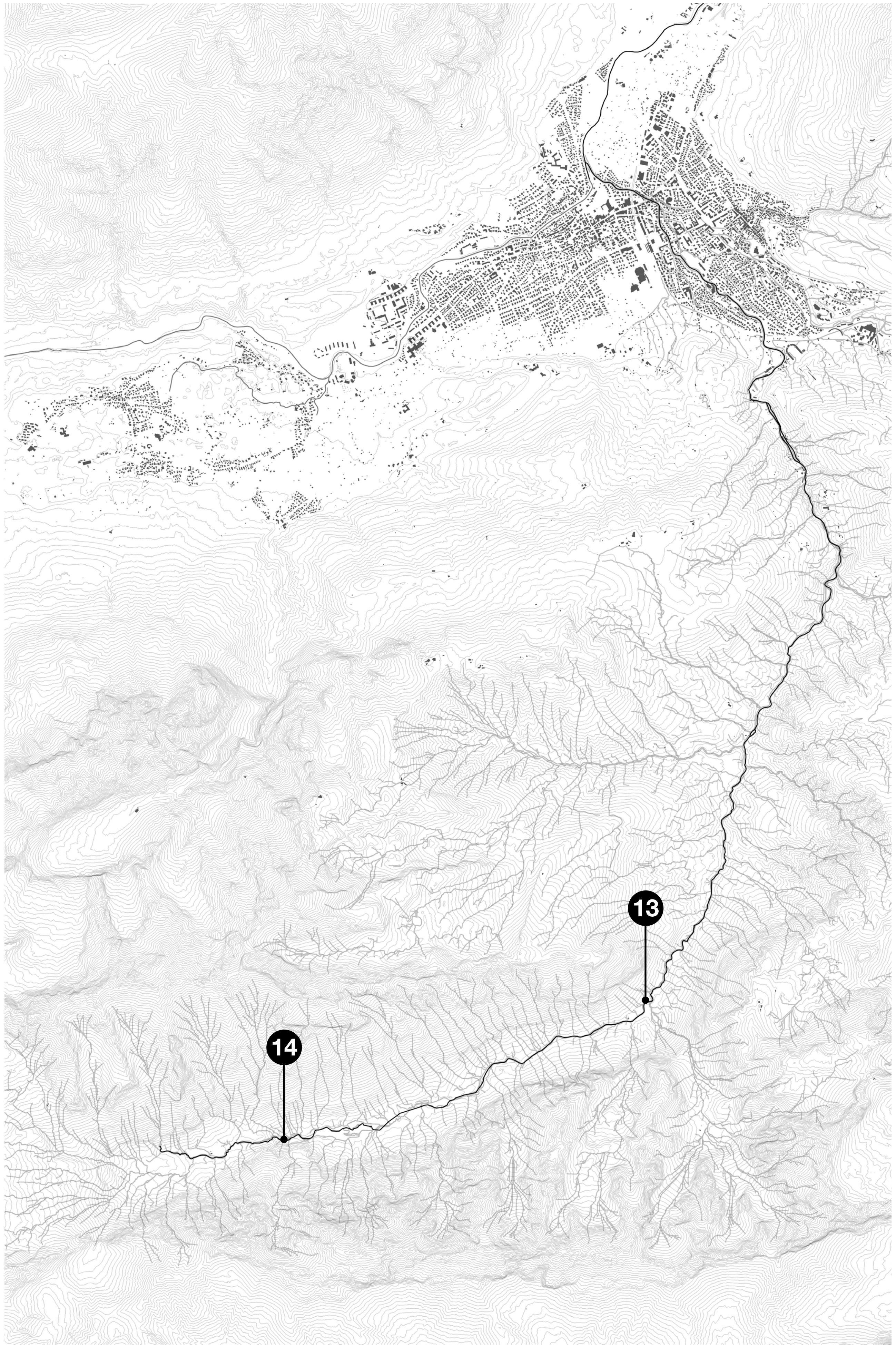


Rock gutter. A boulder becomes not only part of the façade of this storage hut, but supports the thin metal sheet guiding away the water from the building.

11 882 m

12 1.119 m

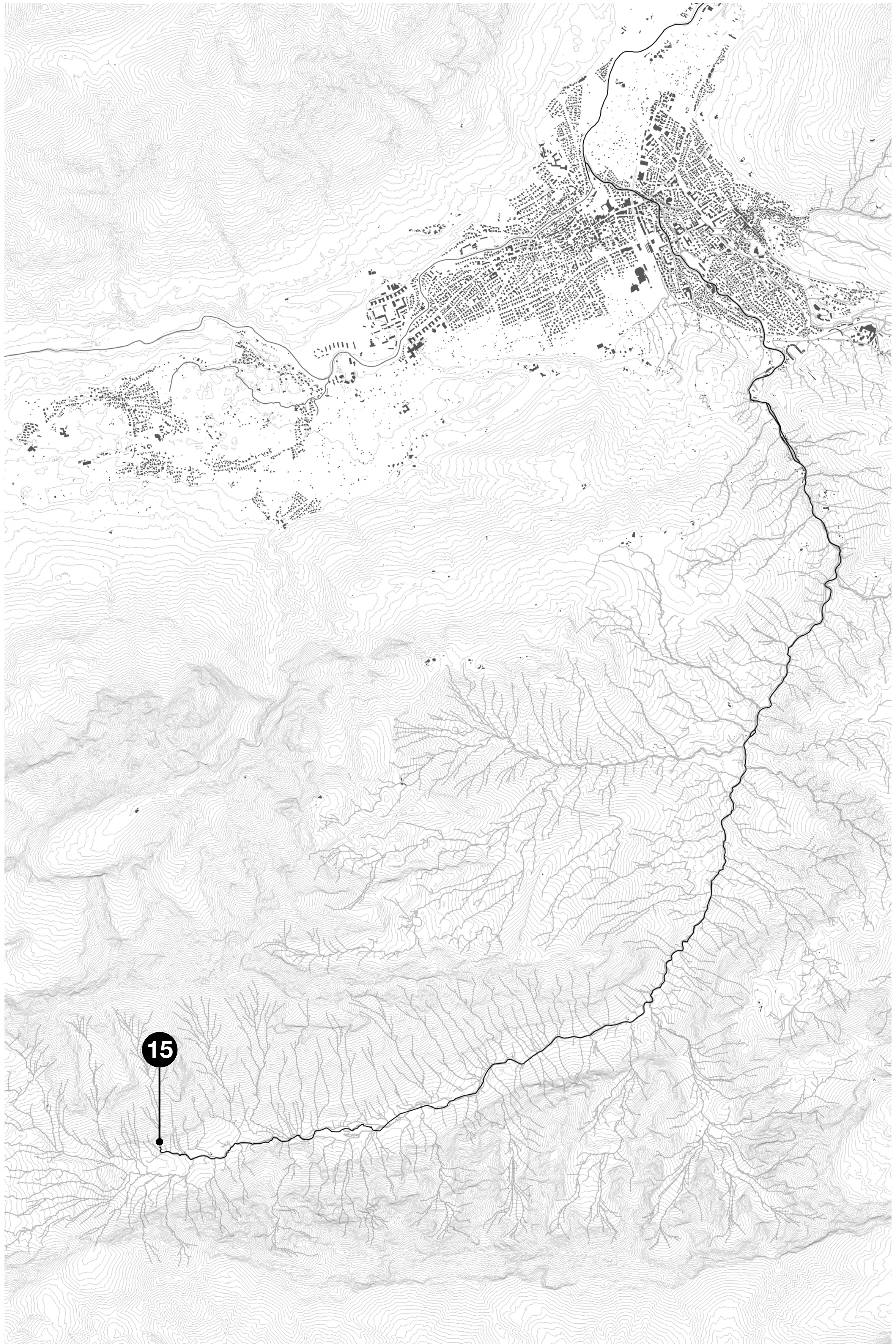
Path enforcement. Rocks sourced from the site are used to protect the steep slope below the path from erosion. Loose rocks are arranged into gabion walls, forming artificial horizontal layers within the naturally sloped landscape.



Debris cones. The conical shapes of these piles of eroded rock are typical for the Reintal valley. The darker rock shows older and therefore weathered rocks while recent activity can be distinguished by looking at the light spots.[3]

3 Götz and Schrott, Das Reintal - Geomorphologischer Lehrpfad am Fuße der Zugspitze, 27.

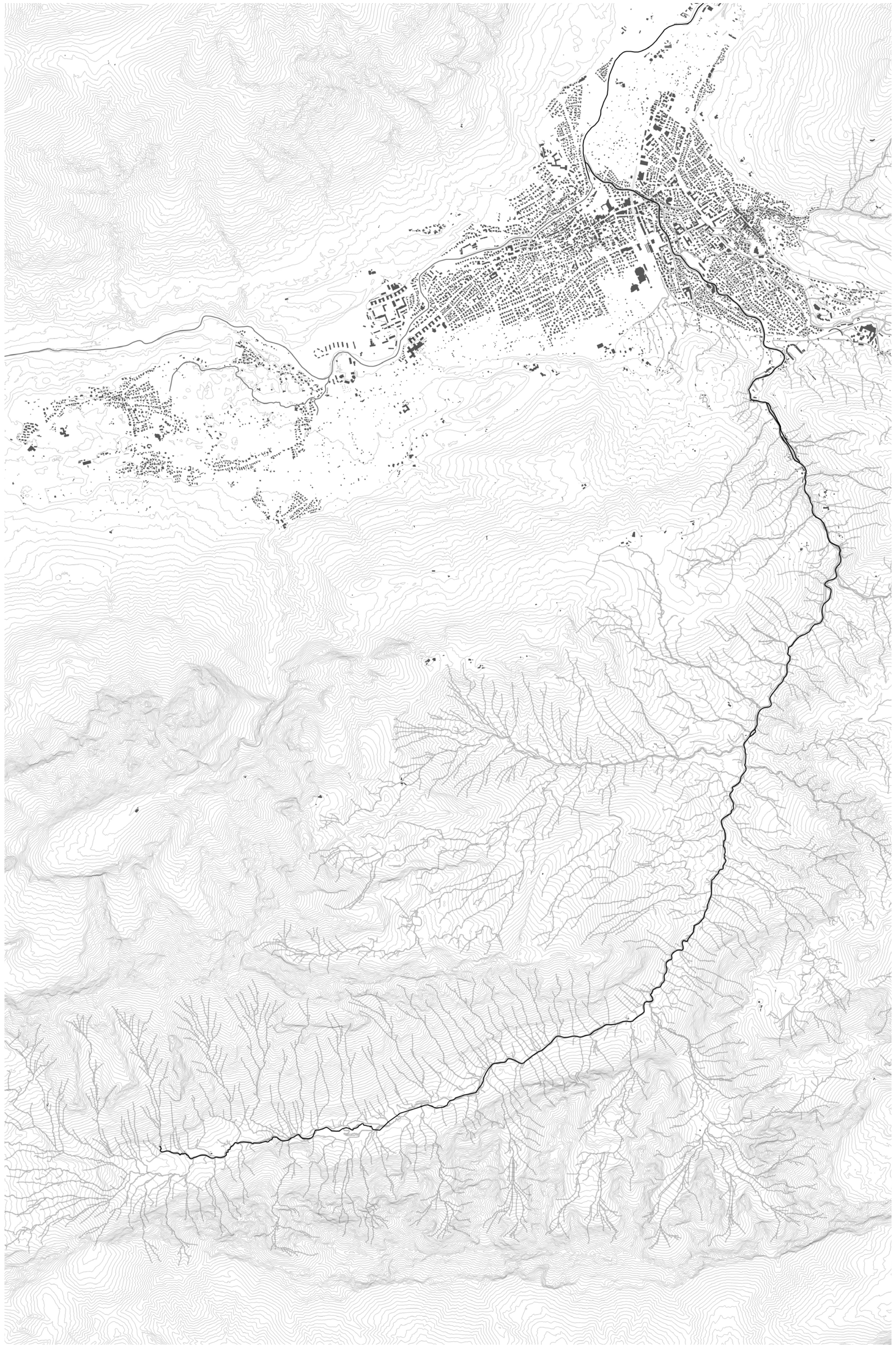
Material transport. As the Partnach river runs along the lowest parts of the valley the rock material following gravity at a certain points meets the river, with it is then transported further downwards.



The Partnach spring. Precipitation and meltwater from the glaciers in the catchment area above penetrate through numerous fissures and crevices into an underground Karst system. Fault lines in the rock delimit the karst stock and force the water to rise to the surface at the point of the spring.[4]

4 Götz and Schrott, Das Reintal - Geomorphologischer Lehrpfad am Fuße der Zugspitze, 50.

15 1.400 m



Debris island. Rockfalls, mudslides, and avalanches constantly reshape the river, making it a highly dynamic system. Here, the water has carved its way around and created an island of rocks. During heavy rainfall, the island continues to erode, with sediment being transported further downstream.

Torrent paths. Looking closely at the mountain's surface, it is etched with outflow paths following gravity downward toward the Partnach River. These paths tell a story of time, of constant change, reminding us that what we see is only temporary.

16 1.454 m

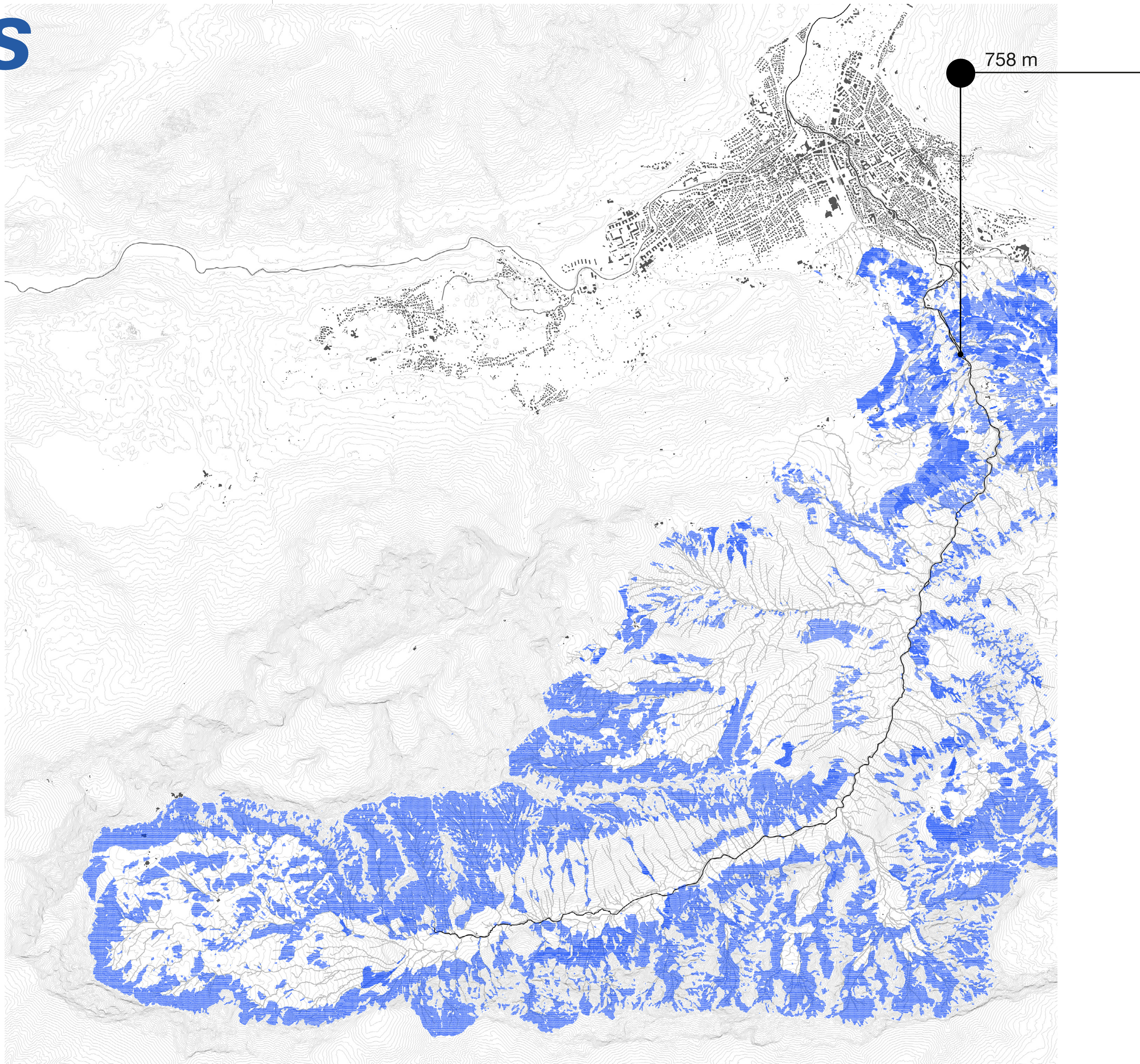
17 1.775 m

conclusions

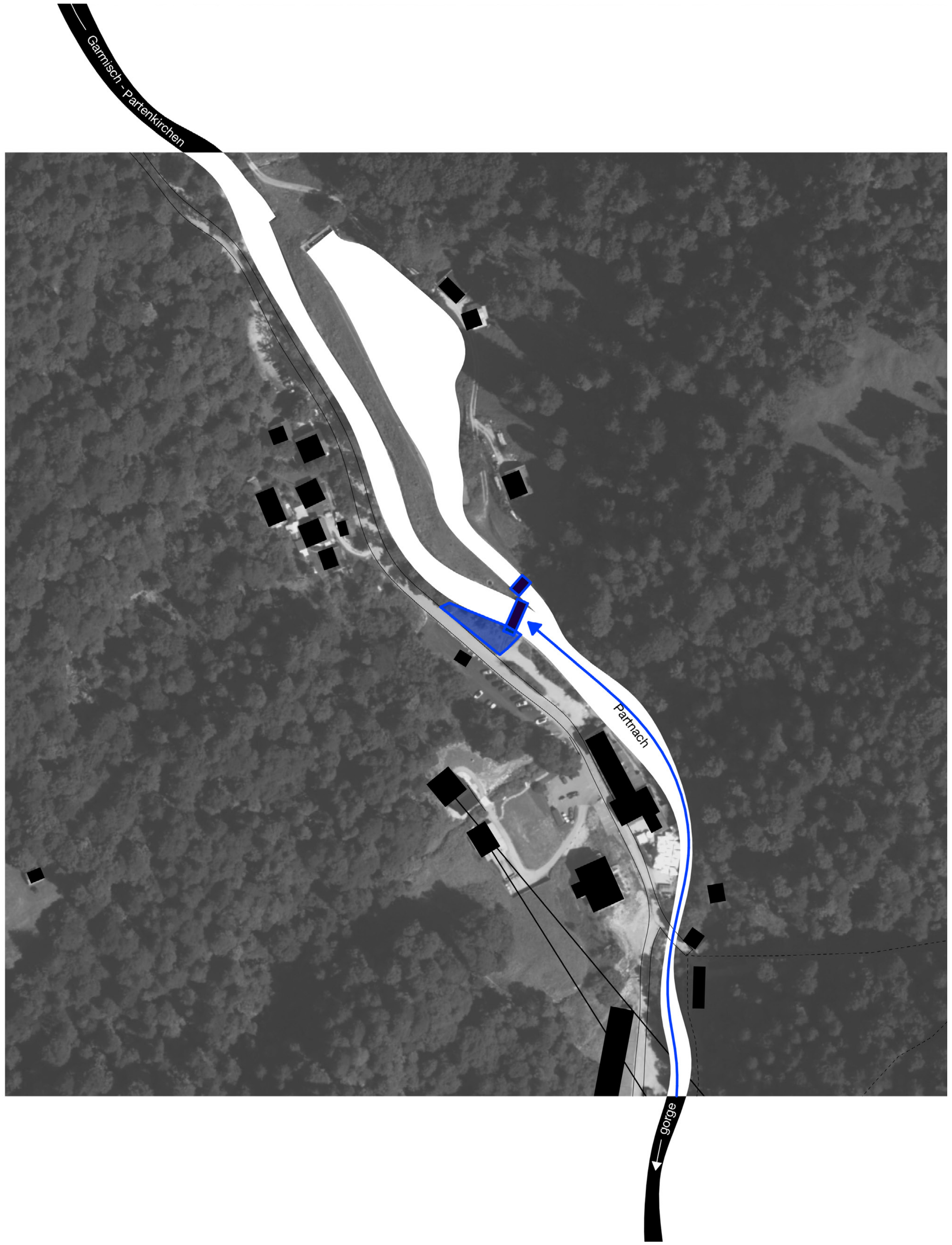
From the mountain's summit to the valley floor, the journey of rock is shaped by the persistent force of water. At every scale, the landscape bears evidence of this dynamic process. Water carves fissures, dislodges rock, and transports it downstream as bedload sediment, gradually softening and reshaping its form.

In higher altitudes, this eroded material is repurposed to stabilize trails and support built structures. Yet, as the rock descends toward inhabited areas, it transforms from a useful resource into a potential hazard. Mitigation measures, such as safety nets, rock consolidation or debris flow barriers are employed to manage this threat.

The first major alteration of the river flow, an energy-producing weir, redirects the natural stream, causing an increased accumulation of bedload rock and marking a pivotal point in the relationship between natural forces and human infrastructure. It is located at an altitude of 758m above sea leavel right below the deep Partnach gorge.



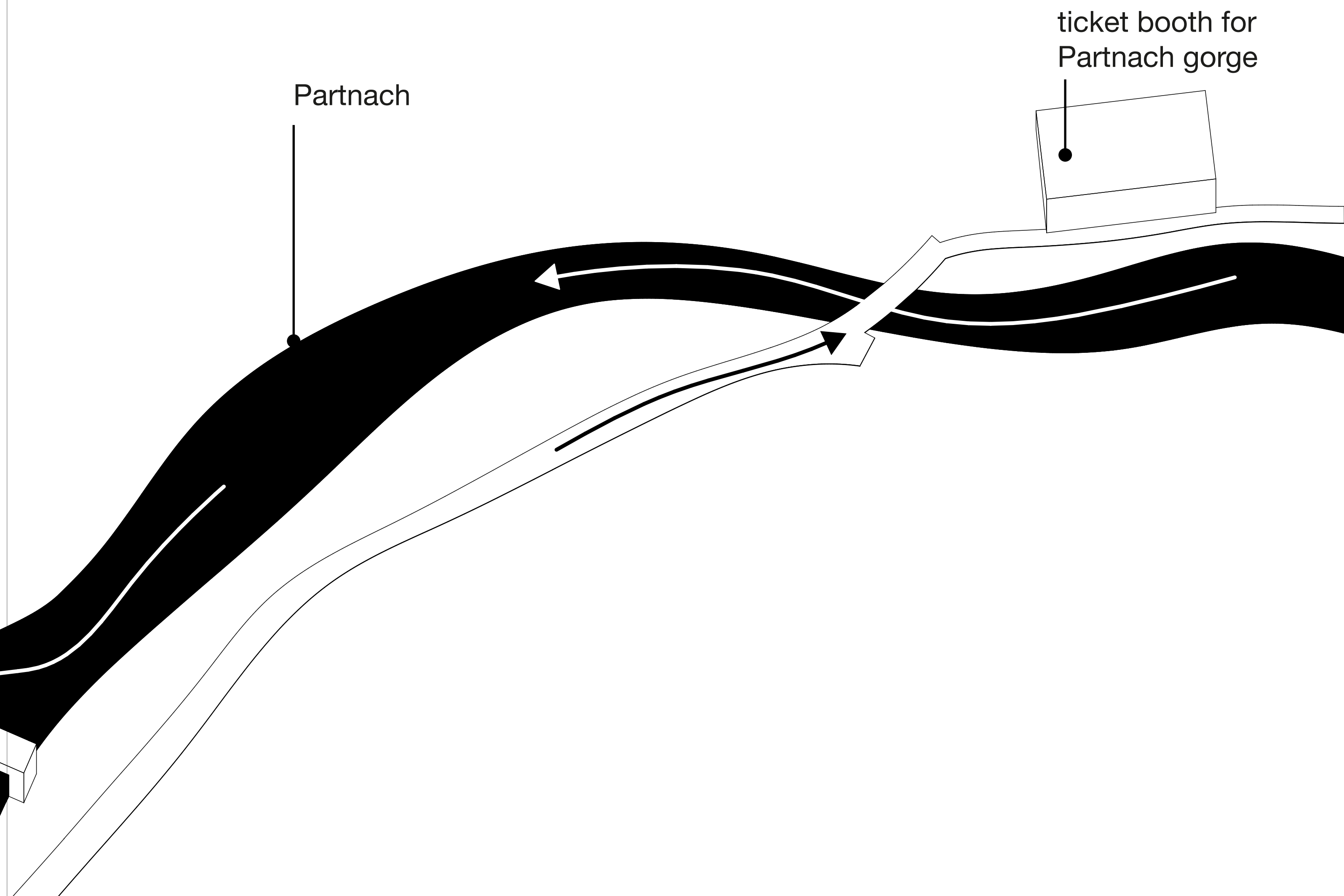
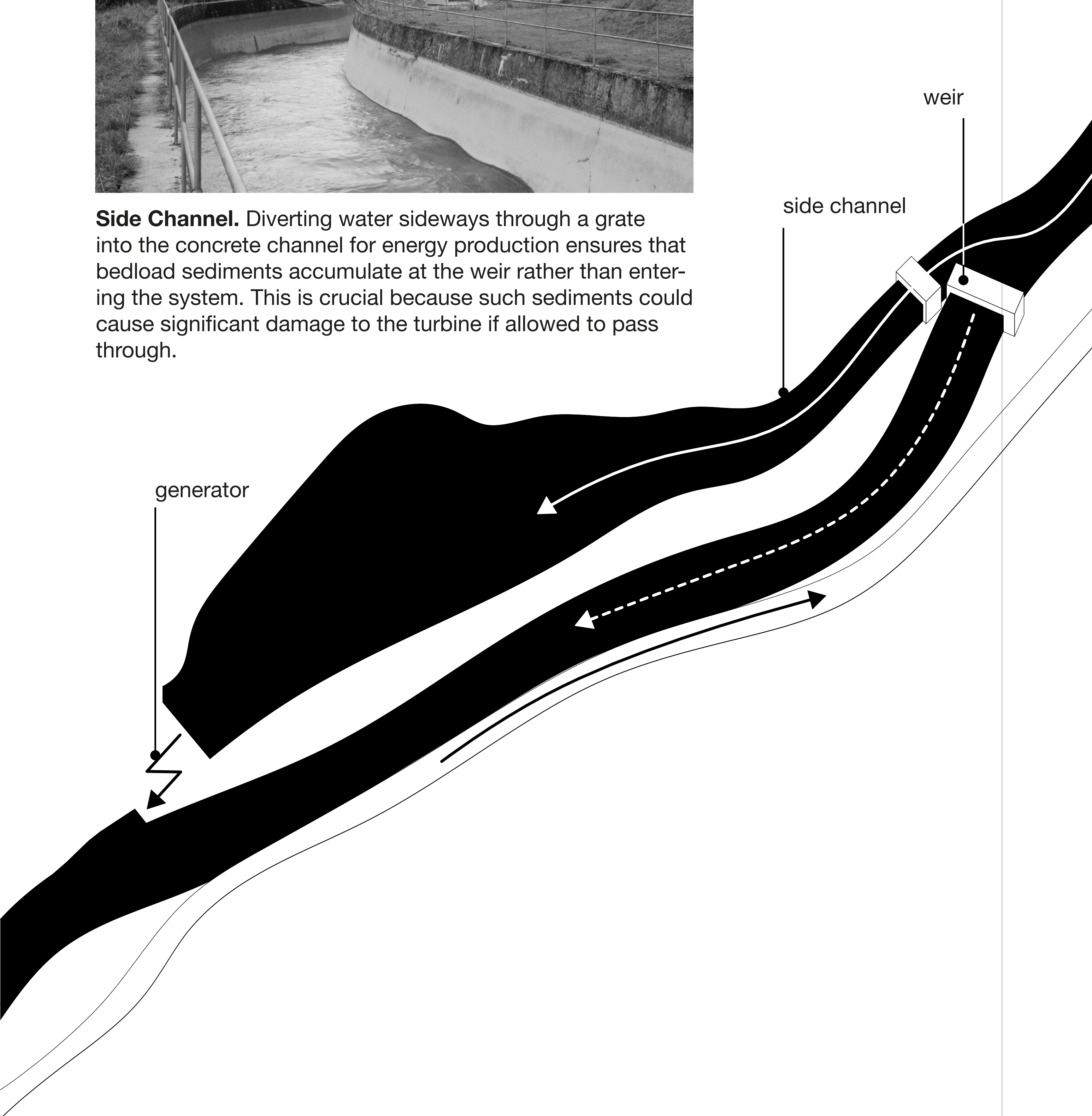
Risk of slope failure in the catchment area of river Partnach



Bedload Barrier. Several human-made barriers are positio-ned along the Partnach River, with the first being the hydro-power plant just below the Partnach Gorge. Loose rocks are continually washed down the river, accumulating where the weir blocks the water to divert it into a side channel. This channel harnesses the water's velocity for electricity genera-tion.

During periods of heavy rainfall and high discharge, even larger rocks can be transported downstream. Regular main-tenance of the riverbed is therefore crucial and is managed by the Weilheim Water Authority. Depending on the situation, accumulated rocks are either flushed further downstream or removed entirely. For example, at this hydropower plant, gates are opened to allow material to pass through, leading to sedimentation in the lower river sections. According to the water management authority, **2,000 m³** of material had to be extracted from a downstream weir just two years ago.

Side Channel. Diverting water sideways through a grate into the concrete channel for energy production ensures that bedload sediments accumulate at the weir rather than entering the system. This is crucial because such sediments could cause significant damage to the turbine if allowed to pass through.

Weir gates. These gates regulate the flow of water and manage sediment buildup. Over time, bedload accumulates until it needs to be flushed downstream. When this occurs, the lower gates are raised to allow the material to move along. The upper gates can be lowered to control the amount of water entering the side channel, diverting excess flow over the top of the gate.