Cut Throat Dene: Surface water / Groundwater investigation.

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Co-funded by the European Interreg Topsoil project, the Wear Rivers Trust (WRT) and Northumbrian Water (NW) have partnered in the investigation of surface water – groundwater interactions of the Cut Throat Dene. The dene shares many characteristics with other coastal streams which are known to 'leak' downward to the underlying groundwaters. This natural permeable feature provides a relatively rapid pathway for surface water pollutants to potentially enter public water supply. This investigation seeks to confirm flow losses within the stream, identify pollution sources and level of risk (if any) to the nearby public supply.

Background and Context:

The imaginatively named Cut Throat Dene (CTD) is situated 3km north of the City of Sunderland nestled in between the towns of Cleadon, Whitburn, Seaburn and Monkwearmouth (Fig. 1). The catchment is approximately 6 km^2 and was recently added to in 2017 with the connection of the wetland at Boldon Flatts Nature Reserve. The source of the dene is located within agricultural land near the Fulwell Quarry nature reserve (SSSI) and runs for 3.3km eastward to the mouth on the beach at Seaburn.

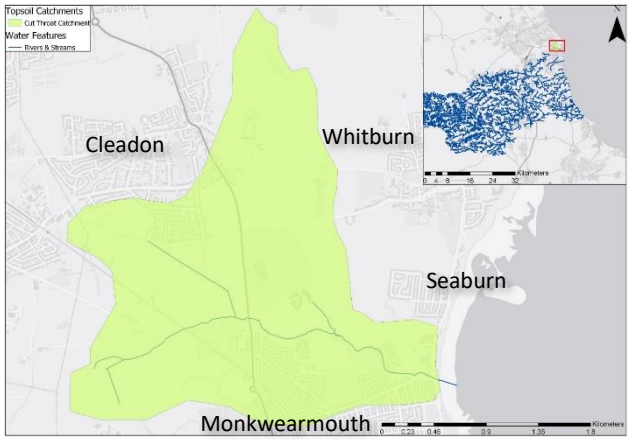

Figure 1: Cut Throat Dene catchment and location in the Wear catchment

The catchment contains several surface water features (Fig. 2) including the headwaters which form near the Fulwell Quarry in the SW, the recently connected Boldon Flatts outflow in the NW and four irrigation ponds near the football training ground which flow into the CTD north of the Monkwearmouth Cemetery. It has been reported by those with local knowledge that the stretch near the cemetery often experiences losses of flow and is home to a number of 'sink holes' which would potentially provide connections between the surface waters and the underlying groundwaters.

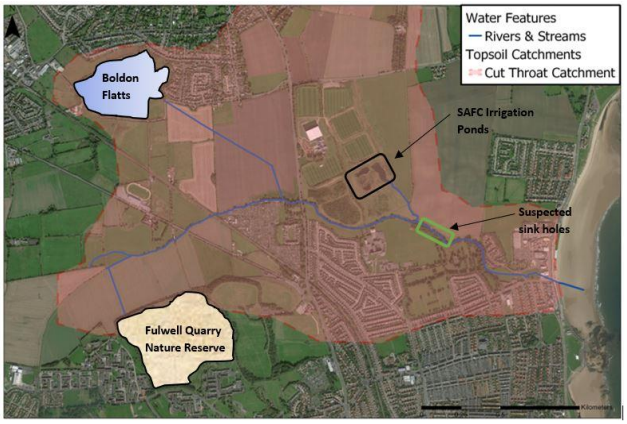

Figure 2: CTD catchment with observed surface water features

The CTD is situated on the Magnesian Limestone, a primary aquifer which is abstracted locally by Northumbrian Water for potable supply to the area of Sunderland.

Then primary aim of the investigation is to identify any risk to water quality at the nearby groundwater abstraction via hypothetical connections between the overlying surface waters and groundwaters. This was achieved via a catchment wide investigation involving, ground truthing, flow monitoring, water sampling and tracer testing.

Catchment issues & pressures

The catchment has several common water quality pressures, stemming from both agricultural and urban sources, however, in 2017 the overflows emanating from Boldon Flatts wetland were redirected into the dene. Boldon Flatts is a site of interest for migratory birds and therefore this wetland contains a dense population of avian species which produce large volumes of droppings, containing high levels of nitrates which can be flushed into the nearby surface waters (Fig. 3). The dominant land use in the catchment is arable agriculture with several land drains emptying into the dene, as well as a few sewer outfalls and urban drains.

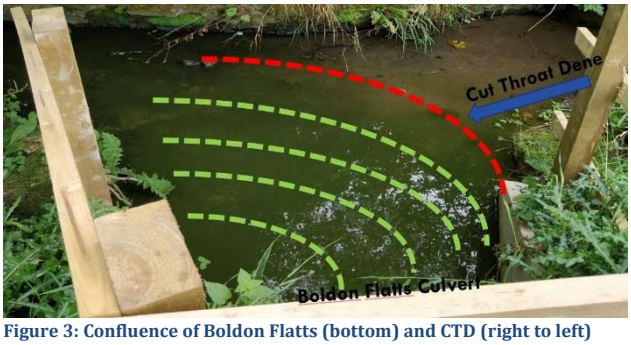

Figure 3: Confluence of Boldon Flatts (bottom) and CTD (right to left)

Topsoil CTD catchment investigation

With the inception of the Topsoil project in 2016, partners of the UK1 pilot identified the CTD as one of a number of denes that exhibited connectivity between ground and surface waters. Initial walk overs highlighted a number of issues on the catchment including; litter, algal growth, equine, canine & avian droppings, low flows (ephemerality) and evidence of sink holes (Fig. 4).

Figure 4: 'Sink hole' within CTD stream wall

Conceptualisation

The WRT, with the aid of NW and the Environment Agency (EA) collated existing information & data on the CTD's hydrological features to create a conceptual model. The EA provided access to their groundwater risk maps (Fig. 5) which highlight levels of risk of connectivity between surface and groundwaters utilising a combination of superficial type, depth and permeability. These maps act as a tool to focus our investigations on areas at greatest risk of connection (red).

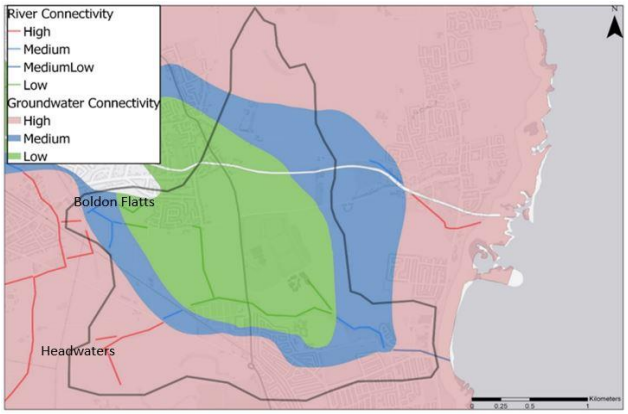

Figure 5: Groundwater risk maps of CTD catchment (provided by EA)

Additionally, complimentary postgraduate research has been graciously provided by Newcastle University MSc students and has added a great deal to this investigation. An extract of hypothetical pollution pathways between the CTD and nearby borehole can be seen below (Fig. 6).

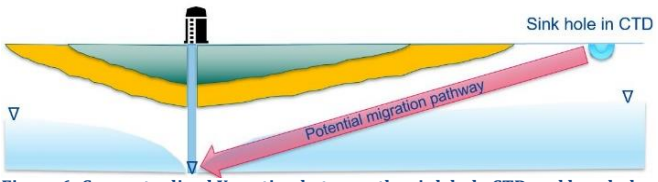

Figure 6: Conceptualised X-section between the sink hole CTD and borehole.

Results & Discussion

Flow monitoring of the dene took place monthly between Nov 17 & July 19 and results clearly demonstrate that there are losses in flow ~1000m downstream of the confluence with Boldon Flatts in the areas suspected to contain sink holes (Fig. 7).

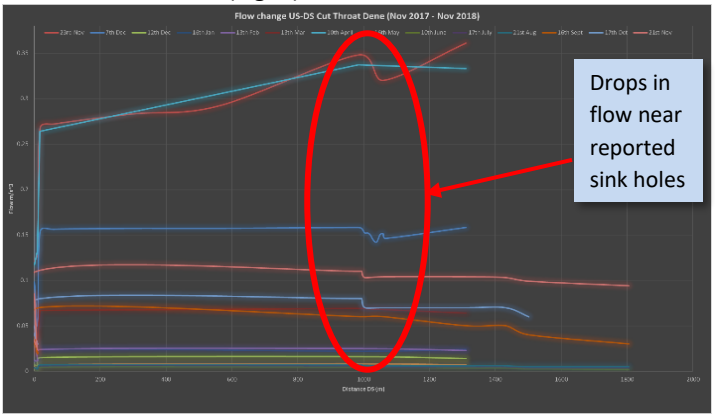

Figure 7: Flow losses within the CTD

Water chemistry exhibited in the dene was not unsimilar to any stream that flows over limestone bedrock, with relatively high levels of calcium and magnesium recorded. Iron was documented in high levels which can be attributed to the regions coal mining legacy. Additionally, high numbers of coliforms were found throughout the sampling points in the dene, with the highest values recorded at the Boldon Flatts culvert, which is to be expected considering the abundance of wildlife in the area. Samples taken from the CTD contained a plethora of Semi Volatile Organic Compounds (SVOCs) stemming from anthropogenic and natural origins. As expected for a dene sited in an agricultural landscape there was a combination of herbicides, pesticides and nitrates entering the stream. There was also an abundance of human and/or animal indicator chemicals found in the dene such as Ibuprofen, squalene (medicine) and numerous sterols which highlight potential misconnections in the nearby urban areas.

Conclusions:

During this investigation, water samples of the nearby abstraction were monitored and compared to the samples found in the CTD waters. This analysis confirmed that none of the pollutants found in the dene were migrating into the groundwater and being drawn back into public supply. This validates the initial theory that the surrounding superficial geology is acting as a protective cap against pollutants and there is no risk to public drinking water in the Sunderland area. The CTD has witnessed a spike in coliforms and algal growth since the connection of Boldon Flatts, however, this appears to have been caused by an initial flush of nutrients into the system and levels/effects have visualy waned over time.

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