Control of rain water run off during the construction of cross country pipelines

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In March 2006 National Grid began constructing a pipeline stretching 316km from Milford Haven on the Welsh coast, to Tirley in Gloucestershire, with a planned completion date of October 2007. Due to the size of the project, deadlines are tight, and agreements were made with the authorities that some winter working would be take place. This is unusual since cross country pipelines are normally only constructed during the drier months of March to October.

I joined the Milford Haven pipeline project in November 2006 as a Project Engineer working with the Environment team on site. It was immediately clear that the biggest challenge the team were facing was based around the wet weather conditions during winter working. It has been part of my role to help communicate the importance of implementing and maintaining winter working mitigation measures to the construction teams and senior managers on the project.

South Wales is a particularly rainy part of Britain. With reference to the average rainfall graphs below, Rhoose in South Wales has 11mm more rain each month than Manchester in North West England .

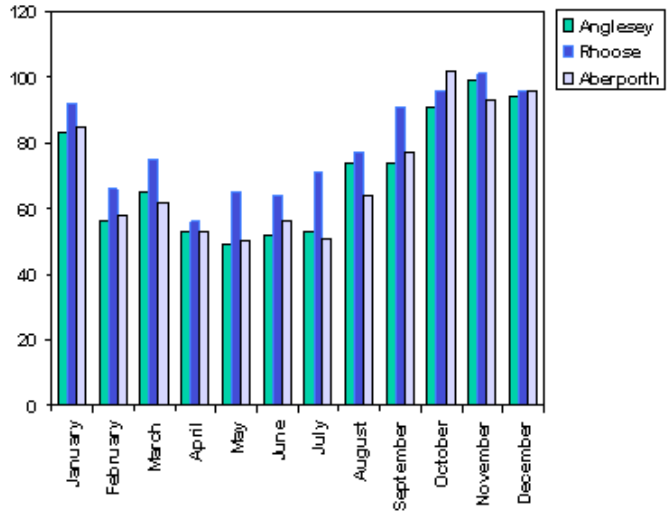

Figure 1: showing average rainfall in Wales

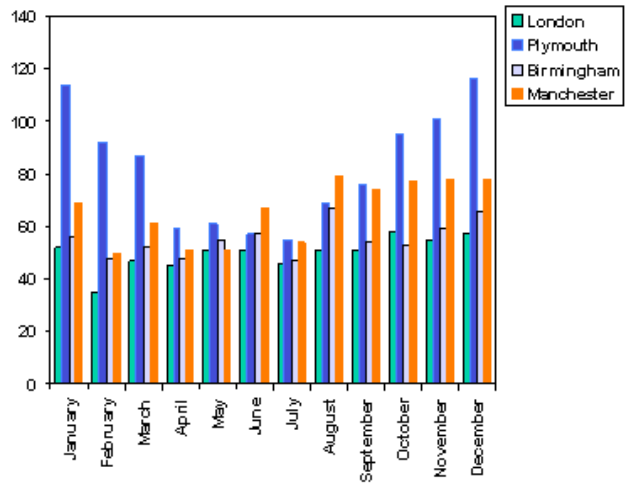

Figure 2: showing average rainfall in England

From October to December 2006 The Met Office recorded above, well above, or in some areas double the average rainfall across the UK. All this rain lead to extremely difficult conditions for the construction teams to work in and the route encounters some extreme gradients, compounding issues surrounding rain water run off. The Environment team had to be highly organised to control the rain water streaming over the easement.

The right of way on a National Grid pipeline construction project is 44m wide for most of its length. During construction, the 44m width is stripped of vegetation and top soil, exposing the sub soil to the elements. This working area is known as the “spread” and represents a large surface area where rain can flow down hill eroding soil, and potentially entering water courses. Over the 2006/7 winter, 70km of the spread was backfilled but not reinstated with vegetation on the Milford Haven project. Winterisation measures were put in place over this area in order to manage the rain water run off. In some areas winter working took place. Managing site conditions effectively required good communication and coordination between the Environment teams and construction.

During heavy rainfall streams of water known as “run off” may flow down the spread. As the run off flows down hill, it picks up soil particles which will be deposited in ditches and watercourses if not controlled. Allowing silt laden run off to enter a watercourse is pollution. The Environment Agency police watercourses, and if they suspect that more than 35mg/litre of suspended solids are entering a watercourse they could take samples and potentially prosecute under the Water Resources Act 1991. This could lead to fines of up to £20,000 or a custodial sentence of 2 years.

Silt from run off has a number of significant negative effects on a watercourse. It can clog fish gills causing them to suffocate, and cover aquatic plants preventing them from photosynthesising. The prevention of photosynthesis

will have a knock on effect for the other aquatic life since oxygen levels will be disrupted. Large amounts of sediment can also destroy the habitat of benthic organisms such as shrimp or caddis fly. The abundance of bottom dwelling organisms is key to the food chain and therefore the biodiversity of the habitat. In addition, sediment can affect spawning grounds for fish which need gravel to lay eggs on. Because silt affects the ecology of ecosystems so dramatically, it is essential that silt laden run off is controlled.

Once the spread has been reinstated, further care must be taken to ensure that run off does not cause damage by eroding the top soil. If top soil enters watercourses there is a risk that eutrophication will occur.

Eutrophication is caused when a sudden influx of nutrients enter water and is likely to cause a reduction in water quality, decrease biodiversity, change species composition and dominance, and can lead to toxicity. The toxicity of watercourses is caused by an increase in harmful algae which work their way into the food chain, resulting in the death of animals and harm to humans. In extreme cases, anaerobic conditions ensue, allowing a bacterium which is toxic to mammals and birds to grow (*Chlostridium botulinum)*. This results in the death of the river.

To ensure that silt laden run off does not enter watercourses during construction a number of mitigation measures and education programmes were employed.

On sloping ground grips and sumps were installed across the spread. Grips are open drains which capture run off, directing it off the spread into sumps. A berm of soil can be installed behind the grip to make it more robust. Sumps act as a settling device, and whilst water is retained in sumps any sediment drops out of the water column. From the sump the water slowly seeps out into vegetation on the side of the spread

where it is naturally filtered as it flows down hill. The sump should be surrounded by straw bales and geotextile to prevent the water forming fast flowing streams if it over flows the sump pit. Straw bales capture the water, and filter it through onto the surrounding ground where it will seep away slowly.

When installing grips it is important to consider the gradient of the slope, the angle of instalment, and how many grips are needed. The more grips there are the better since there is less chance for the run off to pick up particulates whilst flowing down the slope.

Heavy vehicle movements can damage the grips making them ineffective at capturing run off. Where grips traverse the vehicle track it is important to ensure that they are maintained. Where traffic is particularly frequent it's recommended that French drains are installed. This is where geotextile is placed in the base of the grip across the running track and then layered up with gravel and rocks and then covered over with a layer of gravel. This allows run off to flow through the French drain and vehicles to pass over the grip without destroying it.

Silt fences, made from technical filter fabric, were used as physical barriers, capturing run off from the slope. They work by slowing the flow and enabling it to filter through the silt fence or seep naturally into the ground. The angle of installation is critical to ensure that water is held within the fence's half moon shape, and doesn't flow out around the edges.

Run off can enter watercourses where temporary vehicle bridges have been installed. Sand bag head walls were constructed to prevent this.

Sediment traps, sediment tanks and filtration lagoons were used to release silt from pumped water. For fine sediment, large sediment traps and lagoons were used to allow the flow of water to slow down and the solids to drop out of suspension.

Siltbuster mobile silt traps have been one of the most effective silt mitigation measures used on the project. Provided that the rate of flow into the mobile silt traps is correct, and that they are maintained on a regular basis, they can be hugely successful at removing fine particles from water.

In one area which has a lot of clay in the soil there is difficulty in getting the solid matter to drop out of the water column. Two new technologies were investigated to help with this problem. The first was to use a centrifuge machine. However, in order to be effective a chemical flocculent was required prior to centrifuge. The Environment Agency prohibited the project from using this since polymers such as this are very toxic to aquatic systems and difficult to detect. The second apparatus is an electro-flocculating unit. This works by inducing an electrical charge through the solution which ionises the clay particles enabling them to coagulate and fall out of solution. This machine has not yet arrived on site but proved very successful during bench trials.

Where the spread has been reinstated specialised matting can be used to protect top soil from erosion on sloping ground. The Milford Haven to Aberdulais pipeline has carried out field trials using this biodegradable matting and it is likely to use more on the next phase of the project.

Toolbox talks and presentations dedicated to control of run off were used over the winter months to educated key personnel on site. These proved invaluable tools by spreading knowledge and understanding of control measures.

In conclusion, the team form phase one has learnt some significant lessons about planning for adverse weather conditions, the best mitigation methods for controlling run off, and the importance of maintaining mitigation. We have already shared this learning with other National Grid construction projects. The amount of work put in to control the run off on this project has been recognised both by the Environment Agency Wales and by National Grid's UK Construction Director who gave the project and Environment Award for best practice.

References

- http://en.wikipedia.org/wiki/Eutrophication
- www.siltbuster.co.uk
- www.hy-tex.co.uk

Figures

- Figure 1 Rainfall chart of Wales from the Met Office http://www.metoffice.gov.uk/climate/uk/location/wales/rainfall.html
- Figure 2 Rainfall chart of England from the Met Office www.metoffice.gov.uk/climate/uk/location/england/rainfall.html