DOCUMENT 6.3.2

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Crossing Methods

The Yorkshire and Humber (CCS Cross Country Pipeline) Development Consent Order

Under Regulation 5(2)(a) of the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Application Reference: EN070001

June 2014

APPENDIX 6.3.2 – CROSSING METHODS

1.1 OPEN CUT CROSSINGS

Watercourses – Dry Open Cut

1.1.1 Most minor watercourse/ditch crossings will be carried out using a dry open cut trench methodology. In dry open cut methods water flow is maintained by damming and over pumping or using temporary “flume” pipes installed in the bed of the watercourse. Details of these methods are outlined below.

1.1.2 The site is first prepared by stripping the topsoil from the banks and areas adjacent to the river at the crossing point and storing it separately within the working area. If practicable the bed material and a selection of vegetation is stored, for replacement after the pipe has been laid. A flume pipe bridge will be installed, during the preparation of the working width, adjacent to the trenchline flume in order to enable passage of plant and materials along the pipeline route.

1.1.3 For dry open cut watercourses / ditch crossings a suitably sized flume pipe will be installed over the point of the proposed crossing ensuring that it extends on each side of the trenchline crossing point for a suitable distance. The flume pipe will then be bedded and packed or surrounded with soil filled sandbags to create a seal or dam across the watercourse, so that the flume pipes take all the flow.

1.1.4 Excavation of the watercourse then proceeds beneath the trenchline flume pipe. The excavated material will be stored within the working width separately from the bank material. Trench supports may be used to facilitate safe excavation.

1.1.5 If damming and over pumping methodology is adopted then soil filled sandbags are still used to create a seal or dam across the watercourse. However, flume pipes are not installed in the riverbed. Pumps are set up to take the flow from upstream to downstream of the crossing point. The discharge hose(s) will be directed through a filtering medium to limit silt carry over or bed disturbance, before the pumped water is returned to the watercourse.

1.1.6 The prefabricated pipeline section is then installed in the trench and checked to ensure that a minimum cover of 2 m (rivers) and 1.7 m (ditches) exists below the true clean bottom of the watercourse and the top of the pipe. Thicker walled pipe may be used. In some circumstances the pipeline may be further protected by installing it at a greater depth or installation of a thick concrete protection slab over the pipe.

1.1.7 Initial backfilling will take place using excavated subsoil free of large stones or other deleterious material. Final reinstatement will use the stored river bed materials.

1.1.8 The banks are then reformed to their original profile in accordance with both the Environment Agency / Internal Drainage Board (IDB)/ Local Lead Flood Authority (LLFA) and the landowners' requirements.

1.1.9 The flume pipe and packing or bags are removed once the bed materials and bank profile is reinstated. Final bank reinstatement may require further measures to stabilise the banks and prevent erosion. Geotextiles such as geojute may be used in conjunction with seeding of an appropriate grass mix. Heavier solutions such as the importation of locally sourced large stones or rocks may also be used. Bank stabilisation works will be discussed with the Environment Agency/ IDB / LLFA to ensure that suitable materials and methodologies are being used.

1.1.10 Any bank protection, where it is required, will be adequately keyed into both the bed and banks. Materials and methods employed will be in keeping with the surrounding environment, and will be in line with consent requirements.

Roads – Open Cut

1.1.11 Minor roads may also be open cut, involving the excavation of the trench across the road. The method is likely to be applied to small single track roads which will typically require a temporary road closure during the crossing works.

1.1.12 Where required traffic lights or signals may be used to allow work on alternate halves of the road while maintaining the flow of traffic. After excavating the first half, steel plates are placed across the trench for traffic to pass while the second half of the road is excavated. A prefabricated section of pipe is then threaded through the trench under the steel plates. The trench is then backfilled and the road re-surfaced.

1.2 NON OPEN CUT (TRENCHLESS) CROSSINGS

1.2.1 There are several non-excavation construction techniques. These include auger boring, grundoram, tunnelling including pipe-jacks, microtunnelling, and horizontal directional drilling. These techniques vary in the method used to install the pipeline without disturbing the surface. Generally, all non-open cut crossings are constructed at a minimum depth of 1.7 m under small watercourses and ditches, 2 m below roads and main rivers and 4.3 m below railways. However, the actual design will be submitted to the appropriate body for approval prior to construction.

Auger Boring

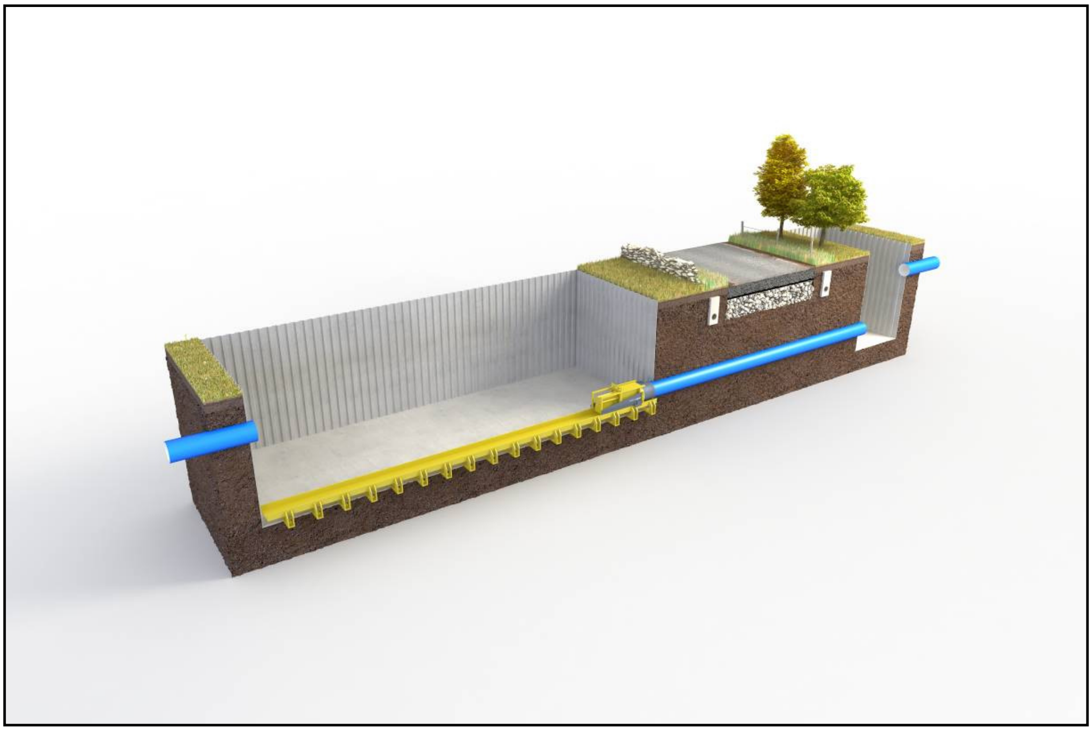
1.2.2 The auger bore is a well proven technique that can be utilised for short and medium length crossings of up to 120 m.

1.2.3 The technique requires the excavation of pits on either side of the crossing to aid the installation of the pipeline. The depth of the pits depends on the nature of the crossing and the local ground conditions. De-watering and sheet piling etc may be utilised if required to ensure a safe crossing design.

1.2.4 A launch pit is excavated on one side of the crossing, following this a smaller reception pit is excavated on the opposite side of the crossing to receive the bore. Additional land is required on both sides of the crossing to accommodate the excavated material from the pits and the pipe, and to allow for the construction plant associated with the crossing.

1.2.5 For auger bore, a pipe string is welded above ground and an auger drill inserted into it. A 'cutting head' is fixed to the auger drill at the front of the pipe string and rails installed in the floor of the pit for the unit to run on. Power is transmitted to the auger drill via a power unit that is temporarily fastened to the rear of the pipe string and attached on to the rails. This pipe string is lowered into the thrust pit and is supported by crane-type side booms. Surveyors then line and level the pipe string to ensure it is installed in the correct location and at the correct depth.

1.2.6 A combination of the rotation of the auger drill within the pipe string and a hydraulic thrust located on the power unit installs the pipe string. The excavated material is drawn from the cutting head, down the auger drill flutes exiting from the rear of the pipe string adjacent to the power unit.



1.2.7 Depending on the ground conditions and length of crossing the auger bore crossing technique is used for non-major highway crossings, ditch crossings, minor river and canal crossings. Ground conditions dictate where this technique can be best utilised. Should ground conditions not be suitable an alternative for short crossings is the Grundoram crossing technique.

Grundoram

1.2.8 The Grundoram crossing technique is utilised on short crossings such as minor roads, drains and services. This technique is more suited to soft ground conditions.

1.2.9 A pneumatic piston drives the pipe from one pit to a receiving pit at the other side of the crossing. The risk of settlement is low as there is no overcutting of the tunnel when installing the pipeline.

Tunnelling

<u>Pipe- Jack</u>

1.2.10 Pipe-jacking uses a hydraulic ram or jack to thrust an open-ended pipe under the obstacle. Miners or mechanical methods are used to remove the soil as the pipe is thrust forward. Closed face, unmanned operations are the preferred methods; manned excavations are avoided as far as possible. The excavated material is removed via the exposed end of the pipe. As each pipe progresses forward then another is welded on and in this manner the pipe is installed. This construction method is generally used on large diameter pipes or to install a concrete carrier sleeve under the obstacle. The concrete tunnel will be of a larger diameter than the pipe (typically 1.5m or 1.8m). The pipe is then welded and installed within the concrete sleeve. Once the pipe has been installed and tested the annulus between the pipe and the tunnel sleeve will be filled with cement grout. Alternatively the annulus may be filled with crushed glass or flooded with water.

<u>Microtunnelling</u>

1.2.11 Microtunnelling is a broadly similar technique to pipe-jacking. The method involves the use of steerable remote control pipe-jacking. As with previous methods it requires additional temporary land take for launch and reception pits, drilling fluid management and to accommodate associated equipment.

1.2.12 Pre-cast concrete jacking pipes are placed behind a microtunnelling machine with a cutting head lubricated with water or a mud mix. Small quantities of bentonite may also be used to reduce friction. The excavated material is removed with the drill fluid and is returned to the surface via a slurry pipe through the tunnel entrance where the fluid is filtered to remove the cuttings and returned to temporary mud storage tanks for re-use. A thrust wall is constructed at the launch pit from which to jack the pipe forward. As the tunnel progresses new segments of pipe are attached at the launch pit until the microtunnel reaches the reception pit, where the drill bit is detached from the tunnel and removed. The jacked pipe can be the final pipe itself or a sleeve through which a smaller pipe is then threaded. Shafts are often required in place of pits when the pipe is situated at depth.

1.2.13 Equipment associated with microtunnelling will include power units, slurry separation plant and a control cabin (see Tunnel Option Section 5.5, Landfall Construction).

1.2.14 Commonly the microtunnel crossing technique is used to cross infrastructure such as railway lines, major rivers and major highways such as motorways. The microtunnel is a crossing technique that performs well in a variety of ground conditions and gives the best guarantee of little or no settlement. The technique is very accurate and by increasing the depth of such high risk crossings the possibility of settlement is reduced even further.

Direct Pipe

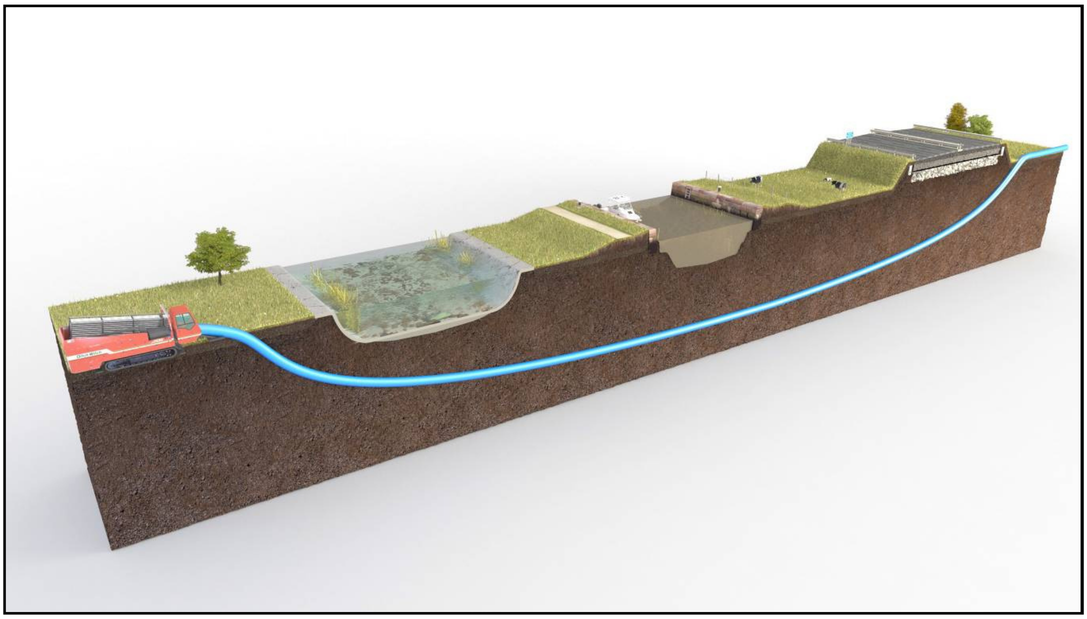
1.2.15 The direct pipe technique can be utilised as an alternative to the HDD and microtunnel crossing techniques. This method uses the product pipe directly (rather than a concrete carrier sleeve) which is welded to the end of the microtunnelling machine. It is pushed forward by rams which push the pipe and the microtunelling machine forward together. The microtunnelling machine has interchangeable cutting bits so it can deal with a variety of ground conditions. This technique tends to be used on longer crossings where there may be a number of obstacles to navigate.

Horizontal Directional Drilling (HDD)

1.2.16 With horizontal directional drilling (HDD) the pipeline is bored under the crossing to emerge at a target point on the opposite side. A large area of temporary land take is required on either side of the proposed crossing to accommodate the equipment, drilling fluid management system and laydown area for the pipe.

1.2.17 The directional drilling unit is placed at the start location and is elevated at the rear to the correct entrance angle. The rig is then anchored in position. The drilling operation begins by drilling a pilot hole using the drill bit, the drill head and the pressure injection of drilling fluid. The drilling is carried out continuously in intervals equivalent to one length of drill pipe.

1.2.18 Location of the drill bit is monitored using the HDD locating system. An electronic transmitter in the drill head sends information to the locator operator's receiver. As each drill rod is drilled into the ground the locator operator takes a reading from his equipment and informs the drill operator of the location, pitch and roll of the drill head. From this information the operator knows the location of the drill head at all times. The operator uses the information to maintain the pre-planned path of the bore. The accuracy of the drilling is verified by comparing the co-ordinates of the actual location of the drill bit against the planned drill profile. If there is a major difference between the actual and planned location of the drill bit, the operator is able to correct the actual profile by pulling back to a correct position of the planned profile and begin re-drilling.



1.2.19 The hole is then enlarged by a back reamer. When the bore hole has been reamed out to the correct diameter the back reamer is typically sent back down the bore one or two more times and swabbed in both directions to ensure that the hole is clear of any large objects. The pipe is laid out on the opposite side of the obstacle to the drill rig and welded to form a length long enough to cross the full length of the drill. Once the driller is satisfied that the hole is clear and ready for the pipe, the pull head is connected to the drill string via a swivel. The pipe is then pulled back toward the exit area by the drill rig.

1.2.20 All drilling fluids used for HDD will be sampled, analysed and disposed of in accordance with duty of care requirements of the Environmental Protection Act, 1990.

1.2.21 The HDD crossing technique can be used for long crossings such as rivers and multiple crossings where trenching or open excavation is not feasible. It gives a good degree of accuracy but due to over cutting of the tunnel a small amount of settlement can be experienced.