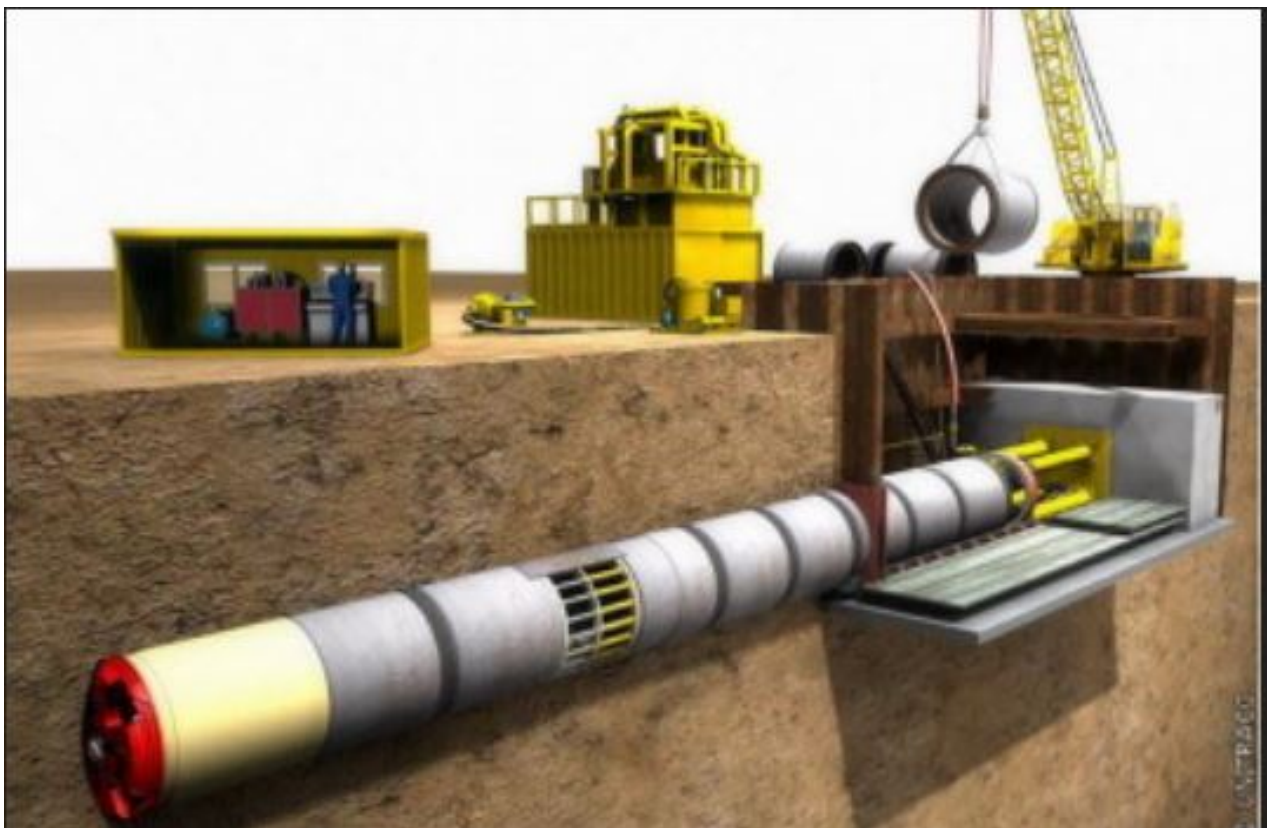


PIPE RAMMING

The pipe ramming process has been successfully used to install steel casing in close proximity to sensitive structures for more than thirty years. When project specifications call for little to no soil displacement, as is the case for railway culverts, pipe ramming is the cost-effective alternative to other methods such as auger boring, open cutting and micro-tunneling.

Drainage culverts throughout North America are currently an urgent concern, no less for railroads than for state and local transportation agencies. The pipe ramming method often provides the most cost-effective and least intrusive means of replacing or relocating these culverts. It is generally less expensive as it entails fewer personnel to complete, yet it can be completed in a fraction of the time of open cut technique. It requires less setup and restoration time, avoiding their consequent costs. Additionally, pipe ramming operations most often can be conducted without shutting disrupting road traffic.

For these reasons pipe ramming can be considered the preferred method for installing or replacing drainage culverts in the sensitive structures under roadbeds.



PIPE RAMMING CULVERT INSTALLATION REPLACING OLD CULVERTS

Replacing culverts with pipe ramming technique begins with excavation of two pits: the insertion pit and the receiving pit. An appropriately sized pneumatic ramming tool is attached to the rear of a steel pipe in the entry pit. Once properly aligned, the front of the steel pipe, which remains open-ended, is driven into the ground with repeated percussive blows from the hammer similar to the way vertical piles are driven. The pipe can be installed as an entire length or, to accommodate confined spaces and restrictive ground conditions, it may be installed in shorter segments connected one at a time in a series of rams. Each time a shorter pipe segment has been rammed its full length into the ground, the hammer is returned to its initial position behind a new pipe segment, which has been welded or mechanically attached to those already driven into the ground.

The installed pipe usually has an open end that allows the soil to enter the pipe during the installation. The spoils that accumulate inside the pipe can be removed either during or after the installation. The same tools used to clean old culvert prior to inspections can be utilized to remove spoils during installations. Such techniques include directional drilling fitted with auger fighting, auguring, using compressed air, and water jetting. As soon as installation is complete, the pipe is immediately ready for use.

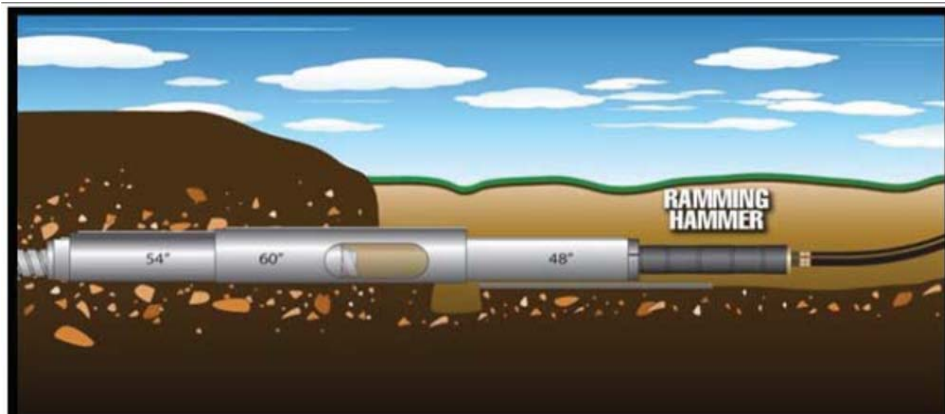
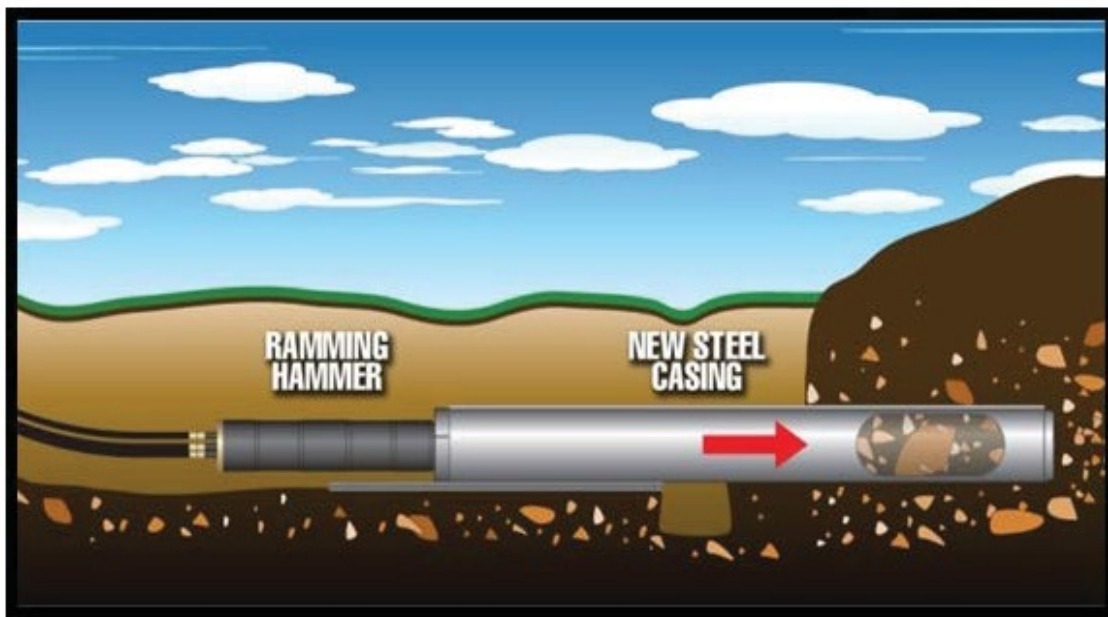


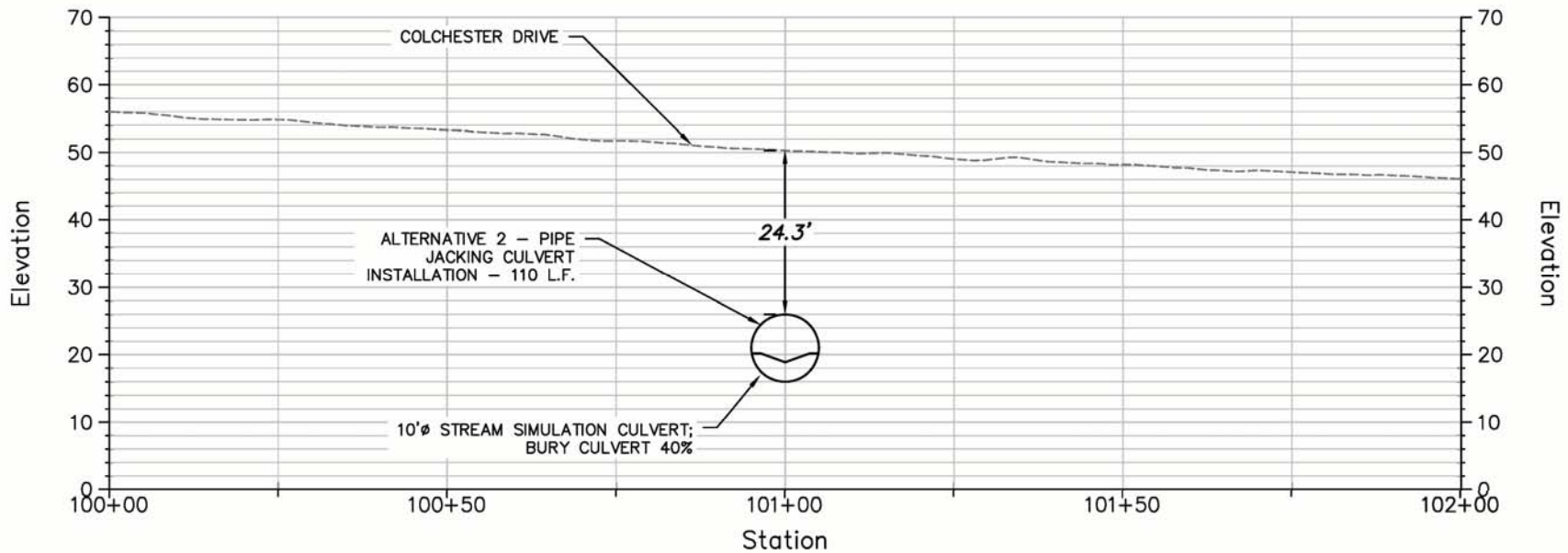
Figure 5: The telescoping method allows for longer distance ramming projects by first ramming larger diameter pipes, cleaning them out and then ramming further out with smaller diameter

Duncan Creek Culvert Installation Options

Preferred Option No. 1

Pipe Jacking

This method would require pushing a 10' - 12' diameter culvert pipe directly through the Colchester Drive road bed. The pipe would need to be pushed approximately 110 lineal feet. There is possibility that obstructions might be encountered that would make pushing the pipe through impossible. There could be large boulders, stumps, or other material used as fill when Colchester Drive was constructed.



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DUNCAN CREEK ALTERNATIVES

PROPOSED CULVERT - JACKING ALTERNATIVE
SECTION VIEW

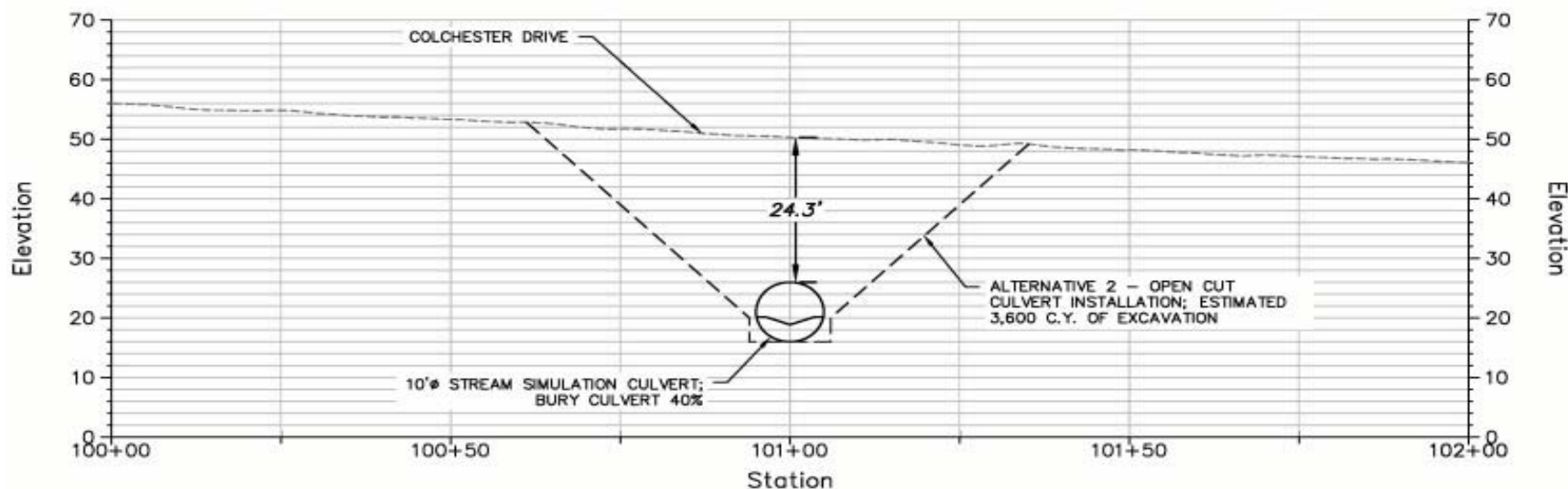
FIGURE A3

Duncan Creek Culvert Installation Options

Culvert Replacement Option No. 2

Open Cut

This method would require cutting a 24 foot wedge down through Colchester Drive to the level of the current streambed. This method would involve excavating approximately 3,600 cubic yards of material. Doing the "cut an fill" method would necessitate closing Colchester Drive between the North end of Puget Drive to Hemlock Street. The cost could be considerably more than Pipe Jacking (option No. 1).



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DUNCAN CREEK ALTERNATIVES

PROPOSED CULVERT - OPEN CUT ALTERNATIVE
SECTION VIEW

FIGURE A2

Duncan Creek Culvert Replacement Proposed Plan & Profile

