



CANADIAN SHIELD

SPECIFICATION SHEET
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THE UNDERGROUND FAMILY

AQUIFER CS-411

THE CIVIL LONG-BORE COILED-TUBING PLANT

The CS-410 plant sent to utility and aquifer ground: a steerable coiled-tubing bore in three sizes that installs conduit, characterizes the ground and leaves a completion in place.



Ø85–Ø149 mm

PILOT BORE ACROSS THE
THREE SIZES

34.3–237.3 kN

DESIGN PUSH, HALF THE HELIX
YIELD CAP

15.5–27.6

TRIPS OF TUBE LIFE, AGAINST
15.0 REQUIRED

1.79–3.49 m

FREE SPAN AT THE ENTRY
GUIDE

AT A GLANCE

ONE PLANT ABOVE THE GROUND LINE. THREE SIZES BELOW IT.

Four figures that size the family, and four reasons a utility, civil or water buyer puts it on an alignment.

ONE MACHINE

THE CS-410 PLANT ON CIVIL WORK

Reel, straightener, clamp-and-push injector and entry guide are the CS-410's. The civil job changes the head kit, the fluid package and the article left in the ground, and a spare on the shelf serves both applications.

THREE SIZES

NAMED BY THE HOLE THEY CUT

Pilot bores of Ø85, Ø108 and Ø149 mm, with the push, the reel and the completion following from each, from a 57 mm service completion to DN140.

WHAT GOES IN

A SHORT LIST AND A MEASURED LOSS

Water, bentonite and a pH buffer, nothing unlisted in the tank, and the loss to the formation measured on every bore by two flowmeters.

NOBODY IN THE BORE

THE PLANT STAYS ON THE SURFACE

A person at the console steers every bore and nobody enters it. There is no radio and no GPS aboard, and on loss of the data path to the head, advance stops.

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01 · SPECIFICATION

EVERY FIGURE ACROSS THE THREE SIZES. EACH WITH THE BASIS IT RESTS ON.

Values run CS-411A, CS-411B, CS-411C, grouped as the family, tube and bore, push, downhole, the drilling fluid, the reel and tube life, entry, reaction and transport, and guidance and safety.

01 THE FAMILY

PARAMETER	VALUE	BASIS
Sizes	CS-411A micro · CS-411B utility · CS-411C industrial	design value, the three-size ladder
Plant	The CS-410 surface plant: reel, straightener, clamp-and-push injector and entry guide	design value; one machine in its civil application
What changes from CS-410	Head kit, fluid package and completion goods	design value
Injector	Dual-clamp continuous advance	design value, the advance subsystem
What enters the ground	The string and its bottom-hole assembly; nobody enters the bore	design value; the plant stays on the surface
Design case	Freeze-thaw ground, to -40 °C	design case for the Underground family

02 TUBE AND BORE

PARAMETER	VALUE	BASIS
Coiled tubing	38.10 × 3.18 mm · 60.33 × 4.78 mm · 88.90 × 6.35 mm	design value, CT-80 grade in every size
Tube yield strength	552 MPa	design value, CT-80 grade
Tube bore	31.74 mm · 50.77 mm · 76.20 mm	calculated from the tube sections
Tube axial yield	192.6 kN · 460.5 kN · 909.0 kN	calculated
Pilot bore	Ø85 mm · Ø108 mm · Ø149 mm	calculated; the pilot is sized by hole cleaning alone
Radial annulus, pilot bore	23.45 mm · 23.84 mm · 30.05 mm	calculated
Ream pass	Ø96 mm · Ø149 mm · Ø216 mm	design value; the completion is cut by a separate reaming pass, permitted separately
Service completion	57 mm · DN90 · DN140	design value; DN90 and DN140 fixed by owner decision

03 PUSH

PARAMETER	VALUE	BASIS
Design push	34.3 kN · 110.3 kN · 237.3 kN	calculated: the helix yield cap divided by 2.0

PARAMETER	VALUE	BASIS
Governing push limit	The tube yielding inside its own helix	calculated; the clamp does not govern in any size

04 DOWNHOLE

PARAMETER	VALUE	BASIS
Bottom-hole assembly	Positive-displacement mud motor with a bent housing	design value, all three sizes
Jetting-only string	Kept for loose to medium sand and silt	design value; a site decision taken against a geotechnical report
Toolface	Electrically driven orienting sub, closed loop on a downhole toolface measurement	design value; nothing at surface rotates the string
Survey instrument	Gyro, continuous, with stationary north-seeking re-references	design value; a gyro needs no non-magnetic spacing
Downhole power	Turbine-alternator in the mud stream	design value; tool power is generated downhole
On loss of the data path to the head	Advance stops and the string is pulled back	design rule
Release sub	In the string on every bore, in every size	design rule; a string that cannot be rotated cannot be backed off
Recovery means	Overpull, then a deliberate release	design value; the string cannot be rotated, backed off or jarred

05 DRILLING FLUID

PARAMETER	VALUE	BASIS
Formulation	Water, sodium bentonite and a soda-ash pH buffer	design rule; nothing else enters the tank in aquifer contact unless it carries a third-party drinking-water listing
Maximum mud density	SG 1.05	operating limit, held by mud balance on site
Circulation	Never stopped with the string in an open lateral	operating limit
Loss to the formation	Measured on every bore by delivery and return flowmeters	design value, the instrument schedule
Surface expression of fluid	Zero; the inadvertent-returns response starts immediately	operating limit

06 REEL AND TUBE LIFE

PARAMETER	VALUE	BASIS
Reel core radius	1.00 m · 1.20 m · 1.70 m	calculated
Reel outside diameter, layers	2.50 m, 5 · 3.18 m, 5 · 4.73 m, 6	calculated

PARAMETER	VALUE	BASIS
Bend strain across the drum	1.91 % · 2.51 % · 2.61 %	calculated at the inner wrap
Tube life available	27.6 · 16.7 · 15.5 trips	calculated, full trips
Tube life required	15.0 trips	design requirement, every size
Tube record	A fatigue ledger that belongs to the tube and follows it between jobs	design value; the tube is a tracked consumable
Reel module	Integrated · Integrated · Demountable	design value

07 ENTRY, REACTION AND TRANSPORT

PARAMETER	VALUE	BASIS
Conductor bore at the entry guide	Capped at the pilot bore: Ø85 mm · Ø108 mm · Ø149 mm	interface requirement at the entry guide
Lateral support pitch, oversize conductor	1.26 m · 1.73 m · 2.46 m	calculated: Euler half-wave at twice the design push; supports built into the entry module
Free span at the design push	1.79 m · 2.45 m · 3.49 m	calculated, Euler pinned-pinned
Reaction anchors	2 at 25 kN · 6 at 25 kN · 6 at 100 kN	design value, anchor points on the frame
Transport	Single load · Single load · Three-load spread	design value
CS-411C reel on the road	Over-height at a 4.73 m outside diameter; travels as its own module	design value, the over-height route
CS-411C reaction	The demounted reel is not counted as sliding resistance	design rule at the anchor interface

08 GUIDANCE AND SAFETY

PARAMETER	VALUE	BASIS
Emissions	No radio and no GPS aboard	design value, in any size
Operator	A person at the console steers every bore	design value

02 · ONE MACHINE

THE SAME PLANT. A DIFFERENT JOB IN THE GROUND.

CS-410 and Aquifer CS-411 are one machine in two applications. Above the ground line the hardware is shared; below it the head, the fluid and the article left behind belong to the civil job.

**SHARED****REEL, STRAIGHTENER, INJECTOR, ENTRY GUIDE**

One rig, one drive and one console. The commonality is mechanical, down to the spares on the shelf.

THE HEAD KIT**A MUD MOTOR AND A BIT**

A positive-displacement motor with a bent housing turns the bit, and an orienting sub sets toolface at the head. A jetting-only string is kept for loose sand and silt.

THE FLUID AND THE ARTICLE**CUTTINGS OUT, A COMPLETION IN**

The drilling fluid carries cuttings back along the annulus to surface settlement, and the service completion goes into a bore opened by a separate reaming pass.

A long civil bore asks the drive for endurance and an accurate stroke count rather than more force, so the injector advances continuously on two clamps, one holding the load while the other resets. Everything above the ground line is the machine on the CS-410 sheet. Everything below it is on this one.

03 · THE SIZES

**BUILT IN THREE SIZES.
NAMED BY THE HOLE EACH ONE CUTS.**

The pilot bore names the size, and the tube, the push, the reel and the completion follow from it.

	CS-411A MICRO	CS-411B UTILITY	CS-411C INDUSTRIAL
Coiled tubing, CT-80	38.10 × 3.18 mm	60.33 × 4.78 mm	88.90 × 6.35 mm
Pilot bore	Ø85 mm	Ø108 mm	Ø149 mm
Ream pass, separately permitted	Ø96 mm	Ø149 mm	Ø216 mm
Service completion	57 mm	DN90	DN140
Design push	34.3 kN	110.3 kN	237.3 kN
Reel outside diameter, layers	2.50 m, 5	3.18 m, 5	4.73 m, 6
Reel module	Integrated	Integrated	Demountable
Transport	Single load	Single load	Three-load spread

One tube grade runs through the ladder. What moves with size is the push the tube can carry inside its helix, the reel its fatigue demands, and the way the plant travels: the largest size carries its reel as a demountable module and moves as three loads.

04 · THE PUSH

**THE CLAMP DOES NOT SET THE PUSH.
THE TUBE INSIDE ITS HELIX DOES.**

Push a coiled tube along a horizontal hole and it goes sinusoidal, then helical. The tube yielding inside its own helix is the limit, and the design push is half of it.



SIZE	TUBE AXIAL YIELD	DESIGN PUSH
CS-411A	192.6 kN	34.3 kN
CS-411B	460.5 kN	110.3 kN
CS-411C	909.0 kN	237.3 kN

A tube bent into a helix carries bending stress on top of its axial load, and the tube is not empty: on the smallest size, internal pressure alone adds enough effective force to buckle the string from the toe before any push is applied at surface. The helix cap is solved with that pressure-induced effective force in the bending term.

The clamp does not govern in any size, and its conforming dies are retained for tube life, not for capacity.

05 · THE BORE

A PILOT BORE FOR HOLE CLEANING.
A SEPARATE PASS FOR THE COMPLETION.

The pilot is sized by hole cleaning alone. The service completion follows on a separate reaming pass, with its own permit and its own fluid.

A completion article does not travel down the tube. The tube bores are 31.74, 50.77 and 76.20 mm and the service completions are 57 mm, DN90 and DN140, so the completion goes into the ground behind the string, after the reaming pass has opened the bore to Ø96, Ø149 or Ø216 mm.

In the pilot bore the fluid carries cuttings back along the annulus to surface settlement, and the annulus at the entry guide is the only place the returns can be observed.

THE PILOT

SET BY THE HOLE IT CLEANS

Each pilot bore is sized to keep its own hole clean, not to fit the completion that follows it.

THE REAM

ITS OWN PASS, ITS OWN PERMIT

Cut separately and permitted separately, so the fluid each pass puts into the ground is reported on its own.

06 · THE FLUID

A SHORT LIST IN THE TANK. A MEASURED LOSS IN THE GROUND.

The drilling fluid is written as an exclusion rule, not a recipe: water, sodium bentonite and a soda-ash pH buffer, and nothing else in aquifer contact unless it carries a third-party drinking-water listing.



- ✓ Mixed density held at SG 1.05 by mud balance on site; density is the controlled property.
- ✓ Circulation is never stopped with the string in an open lateral.
- ✓ Delivery and return flowmeters measure the loss to the formation on every bore.
- ✓ An unlisted additive does not enter the tank.
- ✓ Any surface expression of drilling fluid starts the inadvertent-returns response at once.

Fifteen classes of additive are assessed against aquifer contact and eight are excluded outright, and the exclusions are written down so that the fluid actually mixed can be audited against them. The rate of penetration is treated as an environmental control as well as a hydraulic one: at a fixed loss fraction, the volume lost is proportional to the hours the string spends in the hole.

07 · DOWNHOLE

NOTHING AT SURFACE TURNS THE BIT. THE HEAD HOLDS ITS OWN TOOLFACE.

A coiled tube transmits no controlled rotation, and a long string winds up under torque. So the motor, the toolface control and the power all sit at the head.

A positive-displacement mud motor with a bent housing turns the bit in all three sizes, and its reactive torque twists the string. Toolface is set by an electrically driven orienting sub that closes its loop on a downhole toolface measurement, because the string would absorb any reference taken at surface. Power for the tools is generated at the head by a turbine-alternator in the mud stream.

FORMATION	JETTING-ONLY STRING
Loose to medium sand, silt	Adequate: the jet erodes and the string is advanced by push alone
Soft to firm clay	Marginal: it erodes slowly and the cuttings ball
Stiff clay, glacial till	Inadequate: the matrix erodes and the clasts stay
Cobbles, boulders	Inadequate and hazardous: the string stops
Bedrock	Impossible

08 · SURVEY AND CONTROL

A GYRO RIDES IN THE STRING. A PERSON STEERS FROM THE CONSOLE.

The survey instrument travels with the bottom-hole assembly, and a person at the console steers every bore. When the data path to the head is lost, the bore stops.

THE GYRO

NO NON-MAGNETIC SPACING

A continuous gyro with stationary north-seeking re-references, which needs no run of non-magnetic material around the sensor.

THE STOP RULE

NO DATA PATH, NO ADVANCE

On loss of the data path to the head, advance stops and the string is pulled back. A bore advanced blind past its allowance has an unknown cover.

DOCTRINE

NO RADIO. NO GPS. A PERSON AT THE CONSOLE.

There is no radio and no GPS aboard, in any size. The plant stays on the surface and nobody enters the bore.

09 · THE TUBE

EVERY PASS ACROSS THE DRUM IS PLASTIC.
THE TUBE KEEPS ITS OWN COUNT.

The tube bends onto the drum at far more than its yield strain on every pass, so it is a tracked consumable and its life is counted in trips.



	CS-411A	CS-411B	CS-411C
Reel core radius	1.00 m	1.20 m	1.70 m
Bend strain across the drum, inner wrap	1.91 %	2.51 %	2.61 %
Trips available	27.6	16.7	15.5
Trips required	15.0	15.0	15.0

The largest size clears its requirement by a narrow margin, so the fatigue ledger is load-bearing rather than a record-keeping convenience: the count belongs to the tube, follows it between jobs and is signed off by someone other than the person running the machine. A completion left in the ground spends about one deployment of tube life, and every re-entry to develop a lateral or service a sensor string is charged to the same ledger.

10 · ENTRY, REACTION AND RECOVERY

THE ENTRY GUIDE IS CAPPED.
THE ANCHORS CARRY THE PUSH.

The conductor at the entry guide is capped at the pilot bore, the push goes into the ground through anchors, and a release sub in every string decides what happens if the string will not come back.

	CS-411A	CS-411B	CS-411C
Conductor bore at the entry guide	Ø85 mm	Ø108 mm	Ø149 mm
Support pitch, oversize conductor	1.26 m	1.73 m	2.46 m
Free span at the design push	1.79 m	2.45 m	3.49 m
Reaction anchors	2 at 25 kN	6 at 25 kN	6 at 100 kN

Where site conditions force an oversize conductor, lateral supports at the stated pitch are part of the entry module, never a field practice. On CS-411C the reel leaves the machine as its own module, and its mass is not counted as sliding resistance at the anchors.

The string cannot be rotated, backed off or jarred, so recovery rests on overpull and a deliberate release. The release sub is in the string on every bore in every size: when it fires, the tools stay at the toe and the tube comes back. Without it, a string that cannot be pulled free is abandoned in the hole whole.

11 · FIT

THE WORK THIS GEOMETRY CLOSES.
AND THE WORK IT LEAVES TO A CAISSON.

A surface-launched lateral has nowhere to house a pump, so the work that suits the plant is the work that needs none.

Where it earns its place.

- Dewatering laterals and horizontal drains under excavations, slopes and working faces, flowing to a sump by gravity
- Utility, pipeline and telecommunications conduit along a planned alignment, with no trench
- Water-table and subsurface characterization, with the ground logged along a line rather than at a point
- Managed aquifer recharge, the same lateral in reverse duty, under its own licensing regime

What it is not.

- Not a pumped production well on its own geometry; that mission takes a vertical caisson with laterals kicked off below the water table
- Not a machine that goes into the ground; nothing enters the bore but the string
- Not a munition or a component of one
- No radio and no GPS aboard, in any size

12 · CONFIGURATIONS

THREE SIZES ON ONE ARCHITECTURE. THE ALIGNMENT DECIDES WHICH.

What differs between the sizes, from the tube and the completion to the way the plant travels.

CS-411A · MICRO**Ø85 MM PILOT ON 38.10 MM TUBE**

34.3 kN design push and a 57 mm service completion after a reaming pass to Ø96 mm. The reel is integrated and the plant travels as a single load.

CS-411B · UTILITY**Ø108 MM PILOT ON 60.33 MM TUBE**

110.3 kN design push and a DN90 completion after a reaming pass to Ø149 mm. Integrated reel, single load.

CS-411C · INDUSTRIAL**Ø149 MM PILOT ON 88.90 MM TUBE**

237.3 kN design push and a DN140 completion after a reaming pass to Ø216 mm. The reel is a demountable module and the plant moves as a three-load spread.

13 · DOCTRINE AND SAFETY

A BORING PLANT, NEVER A MUNITION. NOBODY GOES INTO THE BORE.

The lines that hold on every size and for every customer.

- ✓ Carriers, not munitions: a boring and conduit plant with no warhead, no fuze and no energetic material in any size.
- ✓ No radio and no GPS aboard, in any size: a person at the console steers every bore.
- ✓ Human safety comes first: the plant stays on the surface, nobody enters the bore, and on loss of the data path to the head, advance stops.

THE CONVERSATION

BRING THE ALIGNMENT.
WE BRING THE SIZE THAT SUITS IT.

A first conversation needs the alignment, the ground it runs through, the cover available and the article to be left in it.

Start a screened enquiry at cdnshield.ca/enquiries.

DOCUMENT	CDN-PROD-SPC-011 · Aquifer CS-411 · Specification sheet
REVISION	R1.0 · issued 2026-09-10
WEB VERSION	cdnshield.ca/systems/underground/spec-sheets/cs-411 · carries the current revision
RELATED SHEETS	CS-410 · CS-425 · CS-430 · Trembler Line CS-435 · CS-460
ISSUED BY	Canadian Shield · cdnshield.ca

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