PIPELINE BURIAL & EXCAVATION OVERVIEW

PIPELINE BURIAL & EXCAVATION

- Bury or Expose > 60” Diameter Concrete Coated Pipelines
- Turbidity Mitigation
- Overcome Very High Vane Shear, Hard Pan, Glacial Till Soils, High Plasticity Clays & Sugar Sandy Conditions
- Water Depth Range – Beach to >1,000’ (0m – >300 m)
  - Bury or Expose – Single, Dual, Triple & Quad Pipeline Bundles
  - Umbilicals and Cables

PIPELINE BURIAL & EXCAVATION

- Advanced Burial & Backfill Pipeline Plough
- Pre-Trenching & Post-Trenching
- Bury or Expose Active & Inactive Pipelines
- Trenching to > -20’ (6m) Below Mud Line (BML)
- Conventional Single & Dual Stage Pull Sleds
- Self Propelled Burial Sled For “Active” Pipeline Burial
- Self Propelled Pipeline Excavation Sled
- Bi-Directional Sled Operations
- High Pressure/High Performance Portable Jet Pumps
- Successfully Excavated >100’ (30.48m) below the seafloor in Water Depths >300’ (91.4m)
- Portable Systems Deployed From Anchored or DP2 Asset of Availability

OFFSHORE SURVEY – POST BURIAL

- “As Built” Surveys
- Position and Anchor Plot Surveys
- Mapping Survey

ISO 9001:2008
ISO 14001:2004
OHSAS 18001:2007
PIPELINE BURIAL & EXCAVATION METHODS

Throughout most US Territorial Waters, US Federal and State Governmental regulations require almost all marine, offshore and subsea pipelines to be buried in water depths less than 200 feet (60.9 m). This requirement exists to assure the protection of in situ pipelines from external sources of damage (from trawling boards, commercial fishing gear, anchors and contact with vessels) and to mitigate environmental and/or safety risks generated from the impact of hydrodynamic factors including tides, waves and currents resulting in scouring and vertical and/or horizontal movement of pipelines which are simply laid on the seabed. The burial of marine, offshore and subsea pipelines can also assure “On Bottom Stability” as well as thermal resistance related to the reduction of hydrates in natural gas pipelines and paraffin wax accumulation in oil pipelines. The burial of pipelines also mitigates risks associated with free span vortex induced vibrations.

Depending on the region and the composition of the seabed, from the softest fine gained “liquefied” silts, to the stiffest clays, to large cobbles, to rock; pipeline burial presents very unique challenges. The three primary methods of pipeline burial are: Dredging, (through various methods) which mechanically cuts or digs a trench which can later be backfilled; Jetting, using high pressure water and air or water eductors to create a trench by fluidizing the seabed which is then dispersed into the water column to be carried away by the current; or Rock/Soil Dumping, a method of covering or “backfilling” a pipeline that remains above grade on the seabed or below grade down in an trench.

In harder and more stable seabeds, aside from bucket or cutterhead dredging a trench before a pipeline is laid or “pre-trenching”, an alternative method of the pre-trenching is performed using an Advanced Burial Plough. The plough can either “Pre-Trench” a trench in which a pipeline is then laid, or a plough can be placed on top of a previously laid pipeline and pulled by a DP vessel or a moored barge to bury the pipeline. To backfill a pipeline after it is lowered to a specified depth in a trench, the burial plough is either modified to “backfill” or a second backfill plough is then pulled over the pipeline which then directs the mounds of trenched spoil, back into the trench to cover the pipeline. The ploughing method can be limited, when the seabed is too fluid and lacks load bearing capacity to support the plough’s weight or conversely when the seabed is too hard to “cut”, in instances where coral, rock or boulders are prevalent.

An alternative mechanical dredging method is the “pumping” or “blowing” of soils. The pumping is primarily performed using a hydraulic submersible pump fitted with an agitator head and jetting ring. Pumping can be effective in isolated shallow areas or when there are shorter lengths of pipe to cover. The pumping method is generally slow, less efficient and can have limitations depending on the “depth of cover” requirements.

The blowing of soils is performed by Mass Flow Excavation tools using a high volume and a high flow rate of water directed through a wide diameter nozzle. This method is limited to sandy and softer seabeds when high pressure jetting is not required. Mass Excavation Tools do have difficulty “cutting” consolidated soils as explained by Bernoulli’s principle, any increases in water velocity is equals to a proportional decrease in water pressure.
The jetting method involves using a high pressure water and air or water eductor jet sled. The jet sled is placed over a previously laid pipeline or in some instances operates simultaneously while pipeline is being laid. The jetting process cuts the seabed with high volume pressurized water “jetted out” through typically 100 or more nozzles at the leading edge of the sled and across the bottom of the trench while spoil is extracted from beneath the sled via the eductor system, which then disperses the spoil into the water column. While jetting, gravity lowers the pipeline to the bottom of the jetted trench behind the sled. Jetting sleds are generally buoyant and work well in areas where the seabed is composed of the softest fine gained “fluidized” silts as well as in the stiffest clays. Jetting success is directly proportional to the output volume and pressure of the water and air relative to the type of seabed. The higher the water and/or air pressures and/or volumes, the better the jetting performance in most cases.

The jetting method is limited to favorable soil compositions which can be fluidized and pass through the eductor system. Jetting as a burial method is only commercially feasible when the backfill can occur via a natural seabed backfill process. Due to the soil fluidization during the jetting process, the trenched spoil is placed into the water column and generally “swept away” by the current and is therefore not able to be placed back in the trench on top of the pipeline.

The rock and/or soil dumping is a method of covering a pipeline on the seabed that is above or partially above the surface of the seabed or as an alternative when the seabed is too hard to dredge or jet. Rock and/or soil dumping is also an effective yet costly (specific regulations can substantially increase the complexities and expenses of post lay seabed restoration) way to cover or backfill a pipeline which is exposed on the seabed or at the bottom of an open trench.

If a pipeline must be covered or buried for “on bottom stability" purposes and/or protected from the natural metocean forces, fishing gear, mooring gear, and other marine traffic etc.; the cover and/or burial of that pipeline can be either environmentally challenging or operationally challenging or both. There is no singular best method of pipeline cover or burial. Each unique project will require an equally unique solution.

The various pipeline burial and backfill methods can be used as stand alone methods or in combination to accentuate each another. Numerous regulatory, environmental and operational factors dictate the selection of the best methods.

Because most major international pipelay contractors do not have on-board internal burial capabilities on their pipelay barges or vessels. BISSO MARINE can perform stand alone pipeline burial services as a main contractor's subcontractor to perform burial operations from small (2”Ø) to large diameter (> 60”Ø) pipeline burial operations. All of BISSO MARINE pipeline burial and excavation assets can be deployed worldwide to be used by a vessel of opportunity or used from BISSO MARINE’s own assets. In some cases the supporting asset can be either conventionally moored or dynamically positioned.
The BISSO MARINE laybarge fleet has “on-board” jetting systems for most routine burial requirements. In more challenging cases, the BISSO MARINE laybarges can be supplemented by the portable high pressure and high volume packages. For deeper waters, deeper burial, high vane sheer soils or sugar sandy conditions the BISSO MARINE portable jetting systems can supplemental the “on-board” laybarge jetting capacity.

In the most extreme cases or when turbidity is a major concern, a pipeline can be Pre-Trenched or Post-Trenched using the BISSO MARINE Advance Burial and Backfill Plough system, from depths of 0 m (ft) to 91m (300 ft). The Advance Burial and Backfill Plough can operate in air or subsea in undrained soil conditions.

Other non-pipline specific BISSO MARINE barges and vessels or third party assets can be outfitted with the portable high pressure and high volume packages, sleds, the plough or tools to support any pipeline burial or excavation project.

**US Waters Burial Depth Standards for pipelines:**
- Standard Gulf of Mexico – Depth of cover 3 feet Top of Pipe (T.O.P.)
- Standard Northeast US – Depth of cover 4 feet Top of Pipe (T.O.P.)
- Primary Deep Draft Shipping Fairways or Channels – Depth of cover 10 feet Top of Pipe (T.O.P.)
- Primary Deep Draft Anchorages – Depth of cover 16 feet Top of Pipe (T.O.P.)

**Effects Of Burial Methods On The Marine Ecosystems:**

Turbidity – Cloudiness or haziness in water caused by a large volume of particulate that are generally invisible to the naked eye, similar to smoke in air. The measurement of **turbidity** is a key test of water quality.

- Ploughing – Minimal turbidity*
- Conventional Dredging & Rock or Soil Dumping – Moderate Turbidity*
- Jetting & Pumping – Significant Turbidity*

  *The seafloor particulate size and weight are the determining factors of the concentration level of turbidity

Turbidity primarily impacts marine flora and fauna in the following Oceanic Zones:
- Pelagic – Creatures living in the open ocean in water column
- Benthopelagic – Creatures living above the seafloor near the sea floor
- Benthic creatures – Creatures living on the seafloor

Filter feeders: sponges, cnidarians (jellyfish, anemones, coral), mollusks (clams, oysters, mussels, scallops, snail, squid, octopus), arthropods (crab, shrimp, lobster) and echinoderms (starfish, urchin) are particularly susceptible to turbidity.

**BISSO MARINE** is very cognizant of the varying and vital marine ecosystems and believes in the responsible balance between operations and environmental accountability.
ADVANCED BURIAL & BACKFILL PLOUGH

The only US based, owned and operated Pipeline Burial Plough

ALL ploughing in US waters must be performed by Coastwise Eligible US Flagged assets governed by 46 U.S.C. § 55109

- Single Pass Burial Depth 6.5’ (78") (1.98m)*
  - Cover Depth 3’ (.91m) Top of Pipe - up to 42”Ø total OD – single pass**
  - Cover Depth 4’ (1.21m) Top of Pipe - up to 30” Ø total OD – single pass**
- V-Trench with 35° Slope up to 4.5’ (1.37m) & 25° Slope from 4.5’ (1.37m) to 6.5’ (1.98m)
- Designed For Glacial Till and High Vane Shear Soils
- Operational Water Depth - ~10’ (~3.04m) to 300’ (91.4m) ***
- Designed for a Pipe Range of 4” – 36” Maximum Ø
- Designed for 220sT (199.5 mT) Sustained Pull****

ADVANTAGES:
- Pre-Trenching & Post-Trenching Capabilities
- Backfill of Pre or Post-Trenched “Ditch” with Trenched Spoil
- Minimal Environmental Impact and Turbidity Mitigation
- On Board Electronic Pipe Monitoring Available
- Winch pulled or DPII towed

Maximum Operational Dimensions:
- 74’7.2” (22.73m) width (backfilling)
- 77’9.4” (23.7m) length (ploughing)
- 28’9.3” (8.77m) height (ploughing)
- 11’9”(3.58m) plough share opening
- 8’5.3”(2.57m) aft opening between backfill blades

Weight:
- 110 sT (99.7 mT) dry
- 94 sT (85.2 mT) submerged

* Can be modified for deeper burial depth
** Exact number of passes depends on seafloor composition confirmed by geotechnical survey
*** Can be modified for larger Ø pipe
**** Shallow depths are dictated by Barge/Vessel draft and access, NOT plough functionality
PIPELINE PLOUGHING

PRE & POST TRENCH PLOUGHING
SELF PROPELLED TRACK SLED

- Crawl on Pipeline Using “Tensioner” Style Pads
- Can Actively Pass Over an Anode, Will NOT Damage Coatings
- Can Bury Active Pipelines
- Bi-directional Travel at Controllable Speed
- Designed For All Types of Unconsolidated and Consolidated Soils
- Pipe Range: 4” – 30”Ø Inclusive of Coating
- Can Achieve First Pass Depth of 4 Feet T.O.P. Cover
- Can Be Adjusted For 16 Feet (4.88 meters) T.O.P. Cover
- On Board Electronic Pipe Monitoring Available
- Anchored or DPII Deployment

Specifications subject to changes without notice
CONVENTIONAL PULL SLEDS

- Designed to Deliver High Pressure Air & Water to Fluidize Seabed Soils
- Designed to Obtain the Standard Gulf of Mexico 3 Feet (1 meter) T.O.P. Cover
- Pipe Range: 2” – 12” OD, Will NOT damage FBE Pipe Coatings
- Can Be Adjusted For 16 Feet (4.88 meters) T.O.P. Cover
- Can Be Used to "Uncover" Pipelines for Removal Operations
- On Board Electronic Pipe Monitoring Available
- Dimensions and Weights vary by design

Specifications subject to changes without notice
“DUAL STAGE” PULL SLED – up to 2,500 PSI & 9,600 CFM

- Designed to Deliver 2x High Pressure Jetting & Airlifting
- Designed For Extreme Volume Output and Fast Speed for Sugar Sand Burial
- Pipe Range: 4” – > 60” OD Inclusive of Coatings
- Can Achieve First Pass Ditch Depth of 5 Feet (1.5 meters) - Depending on Soils
- Can Be Adjusted For 16 Feet (4.88 meters) T.O.P. Cover
- On Board Electronic Pipe Monitoring Available
- Narrow Version
- Wide Version

Specifications subject to changes without notice
JET PUMP PACKAGES

Portable Jet Pump Systems:

(4) 1,500 GPM @ 2,500 PSI
5,600 LPM @ 172 bar

(3) 2,800 GPM @ 1,150 PSI
10,600 LPM @ 79 bar

(2) 3,000 GPM @ 300 PSI
11,350 LMP @ 20 bar

Specifications subject to changes without notice
EXCAVATION TOOLS

Air Lifts, Jet Strings, and Pumps
Custom Engineered and Designed for Specific Project Requirements.

Designs from:
3” (76 mm) - 30” (760mm) Diameter
Up to 80’ (24.3 m) Long

Major excavations have been performed to -110’ (-33.5m) Below Mud Line @ -320’ (-97.5 m) Water Depth

Specifications subject to changes without notice.
AS-BUILTS, ANCHOR VERIFICATION & ANOMALY AVOIDANCE