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**TECHNICAL SPECIFICATION**



## HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

# BACKFILLING

JUNE 2021



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# Table of Contents

# 1. SCOPE

The Scope of this project is to define the minimum requirements for the backfilling works of the following:

- Backfilling works for the construction of the natural gas pipeline comprising of bedding, padding and backfilling of the trench, as well as installation of HDPE conduits and warning tape along the pipeline route in cross country and urban areas, steep slopes, including pipelines laid by or under road surfaces.

- For backfilling at pipeline crossings with roads, railways, water courses, drains, pipes, cables, etc. this specification is applicable unless otherwise specified.

# 2. REFERENCES

## 2.1 REFERENCE DOCUMENTS AND DRAWINGS

- Tech. Spec. DSF-SPC-CIV-017 [Fibre Optic Conduit Installation]
- Tech. Spec. DSF-SPC-CIV-003 [Trenching and Excavation]
- Tech. Spec. DSF-SPC-CIV-011 [ Paving]
- Tech. Spec. DSF-SPC-CIV-014 [Reinstatement]
- Tech. Spec. DSF-SPC-CIV-023 [Application of Erosion Protection Measures]
- STD-2-41-03 [Top Soil Erosion Protection for Pipeline]
- STD-2-41-04 [Erosion Protection Ditch Breakers with Sand Bags / cement - sand bags for Pipelines]
- STD-1-41-08 [Surface Drainage & Erosion Protection with Diversion Berms]
- STD-00-41-11 [River, Stream /Torrent Bed Protection with Gabion Boxes for Pipelines]
- STD-1-41-14 [Water Collector Pit Plan Sections and Details]
- STD-0-41-15 [Typical R.O.W. Configuration and Typical Trenches for 42", 36", 30", 24", 20", 14",10" dia N.G. Pipeline in Open Country and Road Crossings]
- STD-1-41-18 [Typical Pipeline Construction Details – Ravine Crossing – Bed Erosion Protection with Rip –Rap]
- STD-1-41-19 [Pipeline Backfill Protection with Curb]
- STD-1-41-21 [Surface Drainage & Erosion Protection of Backfilling Material with Rock Fill and galvanized wire mesh]

### 2.2 REFERENCE CODES AND STANDARDS

The latest issue of the following standards shall be considered for the backfilling works of this project:

- EN 1594- [Gas Infrastructure - Pipelines for maximum operating pressure over 16 bar – Functional Requirements]
- EN 932- [Tests for general properties of aggregates]
- EN 933- [Tests for geometrical properties of aggregates]
- EN 1097- [Tests for mechanical and physical properties of aggregates]
- EN 1367- [Tests for thermal and weathering properties of aggregates]
- EN 1744- [Tests for chemical properties of aggregates]
- EN 13242+A1- [Aggregates for unbound and hydraulically bound materials foruse in civil engineering work and road construction]
- EN 13286- [Unbound and hydraulically bound mixtures. Test methods.]
- EN ISO/IEC 17025- [General requirements for the competence of testing and calibration laboratories]
- ΠΕΤΕΠ.05.03.03.00/ΠΑΡΑΡΤΗΜΑ Α27-[Temporary National Technical Specification - Road Base Courses of Unbound Aggregates]
- ΠΔ. 1073/1981- [Safety measures for construction works in building construction and civil works. (ΦΕΚ 260/Α/1981)]
- ΠΔ. 305/1996- [Health and Safety specifications for temporary or mobile construction sites in compliance with EC directive 92/57 (ΦΕΚ 212/Α/1996)]
- ΥΑ ΒΜ5/30058/1983- [Technical Specification for safety signs and measures for roadworks in urban areas (ΦΕΚ 121/Β/1983)]
- ΠΤΠ-Ο150 (Ministry of Public Works)- [Standard Technical Specification]
- ΠΤΠ-Ο155 (Ministry of Public Works)- [Standard Technical Specification]
- ΠΤΠ Α-201 (Ministry of Public Works)- [Standard Technical Specification]
- ΠΤΠ-Α203 (Ministry of Public Works)- [Standard Technical Specification]
- ΠΤΠ-Α265 (Ministry of Public Works)- [Standard Technical Specification]

## 3. ACRONYMS

| | |
|---|---|
| DN | Nominal Diameter |
| NG | Natural Gas |
| HDPE | High-Density Polyethylene |

# 4. BACKFILLING WORKS FOR NG ABBAS PIPELINE CONSTRUCTION

## 4.1 GENERAL

The backfilling works shall be carried out in three main stages:

- Bedding
- Padding, which consists of two main parts:
  i. Middle padding
  ii. Top padding
- Backfilling

Pipeline lowering in activities shall not take place before the OWNER's Representative inspection of the trench bottom and permission to proceed to lowering in.

## 4.2 BEDDING

**Bedding** is the trench bottom preparation, in order to provide a continuous and even support to the pipeline to be laid. It shall also be free of organic or other substances. The filling material shall be quarry sand or river sand, free of any object or stones that may impinge the pipe. The thickness of bedding shall be at least 200 mm.

When laid, the pipeline must be free of stresses in order to avoid any deformation. If the bottom of the excavated trench does not assure the above conditions, then a layer of suitable material mentioned above should be provided.

Without reducing the requirements for minimum cover specified in the relevant Standard drawings, a trench bottom bedding of sand, at least 20 cm thickness, shall be provided below the pipeline in all types of soil, including:

- the trench bottom is rocky or semi-rocky,
- the excavated material mainly consists of stony material, including semi-rock materials,
- Low-strength soil is encountered at the bottom of the trench (e.g. clays, silty soils, muds, etc.), as will be shown on the longitudinal sections,
- chemically polluted soil (particularly organic dissolvent) is struck on all rivers, streams, torrents and ravine crossings at steep slopes

The bedding material shall be clean river sand or quarry sand according to EN 13242 and it shall be properly watered, lightly compacted and shaped.
Alternatively, in any case the excavation products used for bedding shall be mainly sand or silty sand. The use of organic soils or soils with clay content more than 15% is not allowed. Bedding material shall be free of construction waste, roots, wood, scrap material, vegetation, refuse, soft unsound particles and other deleterious or objectionable materials. Bedding material shall be stockpiled separately from any other materials and not to be mixed with other materials.

Prior to lowering in activity the bedding must be checked by the OWNER's Representative and lowering in activity may start only after the approval of OWNER's Representative.

In case of over – excavation the bottom of the excavation shall be restored to the required level, to ensure that the pipeline is properly supported and stress free by filling with sand. This material shall be compacted in layers not exceeding 20 cm.

As bedding on sloping ground, sandbags may be used under the following conditions:

- The filling material of the sandbags is quarry or river sand.
- The height of the sandbags ensures a min distance of the bottom of the lowered pipeline from the trench bottom at least 20cm.
- The distance between sequential sandbags does not exceed five (5) m.
- The bags are of clothing material and not nylon or plastic.
- At vertical sag bends, sandbags should be avoided and continuous bedding layer as described above should be performed.
- After lowering in, the space between the sandbags should be filled with sand or suitable screened excavated material, provided that by cutting out sandbags by knife. The bedding material shall be properly pushed and compacted by means of suitable equipment beneath the pipeline in order to assure an even and continuous support to the pipeline.

At watery terrain, the trench shall be kept free of water and the pipe shall be lowered in immediately after bedding completion, in order to prevent damage of bedding material.

Immediately after lowering in and since the trench is kept continuously free of water, padding and backfilling of the coated pipeline portions shall be performed in order to prevent floating of the pipeline. For trench de-watering wells, drainage pipes, well point equipment and open sump pumping shall be used. Contractor shall proceed with all required arrangements with landowners and/or authorities for the disposal of the pumped water at locations where relevant license is obtained

### 4.3 PADDING

Prior to padding execution, the trench shall be carefully cleaned by any falling stones, rocks, boulders, routes, debris, electrodes, rubbish etc. Padding shall be performed in two stages:

- **Middle padding** which is the backfilling of the trench up to the top level of the pipe.
- **Top padding** which is the backfilling of the trench up to 200 mm above the top level.

Padding shall be carried out carefully so that the pipeline's coating will not be damaged. In that case, special care shall be taken by the Contractor, so that the padding material fall from the lowest possible height in order to avoid any damage of it.
The padding material shall be clean river or quarry sand according to EN 13242, properly watered after its installation and lightly compacted in a way that the pipeline's coating will not be damaged and the pipeline will not be displaced or stressed.
If this is not possible using mechanical means, padding shall be carried out carefully by hand.

If the excavation material meets the requirement described above, this material may be used for padding. In any case, the used excavation products shall be mainly sand or silty sand. Organic soils or soils with clay content more than 15% shall not be allowed.

If the backfilling material consist only of round shaped stones not larger than 15 cm, then there is an option of wrapping the pipe with one layer of protective fabric (rock shield) can substitute (after OWNER's Representative approval), for padding with sand. It is flexible, heavy duty, plastic mesh that used for pipelines to replace the traditional thick sand collar that acts as a cushion for the pipe's coating. Rock shield is significantly easier to install than sand, which is difficult to place consistently around pipes. The mesh prevents stone from damaging the pipe's coating. Wrapping material shall be approved by the OWNER's Representative approval prior its application. Wrapping shall ensure an overlap of at least 150 mm and wrapping material shall be approved by the OWNER's Representative.
Where the pipeline it is not continuously supported on the bedding, the space between the top of the bedding and the bottom of pipeline shall be filled with clean river or quarry sand, which will be adequately watered in order to be compacted. Only sand will be used for restoration of bedding to the required height. Warning mesh shall be placed over the entire length of the pipeline (urban and non-urban areas). The mesh shall be approximately 600 mm wide and shall be made of yellow PVC or PE. Warning mesh shall also be used where isolated cables are laid away from the pipe. Mesh shall be laid by the Contractor without extra charge to the Owner.

During padding, Contractor shall push by hands and not mechanically the padding material around and below the pipe, in order to cover all holes and depressions within the trench.
Where concrete protecting slabs are to be laid above the pipe, these shall be separated from the pipe by a layer of at least 20 cm compacted sand.
It is Contractor's responsibility to ensure that settlements will not occur at a later stage, either in the backfilling material or in the material beneath the pipe.

### 4.4 BACKFILLING OF THE TRENCH

**Backfilling** is the filling of trench above the top padding material.

After completion of padding and installation of the warning tape, the excavated material shall be used for backfilling provided that:

- stones larger than 15 cm diameter shall be separated and driven away
- soil boulders shall be broken prior to backfilling
- Backfilling material shall be free of any debris, bushes, waste materials, electrodes, organic substances, etc.

Backfilling shall be performed without causing any displacement or overstress application to the pipeline. For this reason, backfilling shall be done in layers, which will be lightly compacted and the unloading equipment must release the material at a small height. Compaction will be performed by a small roller and/or by construction equipment (e.g. using the backside of a backhoe). Contractor shall ensure that settlements of the backfilled material or the material beneath the pipeline shall not occur at a later stage.

The Contractor shall ensure that all dewatering and well point equipment has been removed before starting backfilling. Backfilling shall commence immediately after removal of well point equipment, in order to ensure that satisfactory compaction can be achieved.

Any excess material, which is not used for backfilling or is not suitable, shall be removed by Contractor or spread over the ROW if the landowner agrees.

At locations, where the excavated material is not suitable for backfilling (e.g. large stones in big amount) the Contractor shall provide suitable backfilling material.

Any propping or shoring used to hold the trench open shall be removed as soon as the trench is sufficiently backfilled and compacted, so as to prevent any falls of earth, which may damage the pipeline or coating.

Where the trench crosses drainage installations, these shall be re-instated during backfilling works according to Technical Specification No. DSF-SPC-PIP-016 and OWNER's requirements. Horizontal drains used for dewatering during construction shall be cut and sealed, at a level below the normal ground water level.

Backfilling below the gabion boxes on all major rivers, streams and torrent crossings shall be compacted quarry sand or river sand.

### 4.5 PADDING AND BACKFILLING AT STEEP SLOPES

At steep slopes (i.e. with inclination greater than 36% or greater than 20% when artesian water is present), padding and backfilling shall be performed from the bottom to the top of

the slope. The entire length of the pipeline shall be wrapped with one layer of protective geotextile, while the part of the pipe being inside the ditch breakers shall be wrapped with two layers of protective geotextile.

Specifications for the protective geotextile are given in project specification DSF-SPC-CIV-023 “Application of Erosion Protection Measures”.

At steep slopes, padding shall be performed by sand (either river or quarry sand) and the backfilling shall be suitable excavated material. At steep slopes, erosion protection beams (ditch breakers) shall be constructed within the trench at a distance of 20m between them. The first ditch breaker must be constructed at a length of 5 meters from the bottom of the slope. At intermediate positions between ditch breakers the pipeline shall be supported on sandbags placed under the pipeline and extending over the entire trench width at intervals not exceeding 4m. Between these sand bags supports pipeline bedding material shall consist of clean river or quarry sand complying to EN 13242.

Erosion ditch breakers and sandbag supports shall be constructed as per relevant standard drawings prior to bedding, padding and backfilling works.

Backfilling works shall be executed part by part between the completed ditch breakers. In case of beams made of concrete the procedure may be changed, subject to OWNER’s Representative's agreement, so that a number of beams may be cast before backfilling works between them are executed.

Perforated drainpipes wrapped with filter cloth shall be installed at either side of the pipeline, within the trench and at the whole length of the slope. At the bottom of the slope, the drainpipes shall be driven outside the trench in order to release their water at the surrounding area, as per relevant standard drawings

## 5. BEDDING, PADDING AND BACKFILLING FOR PIPELINES LAID BY OR UNDER ROAD SURFACES

The following procedure shall be applied where pipelines are laid by or under road surfaces of any kind urban or any other areas. Backfilling materials shall be transferred in such a way that pedestrians and vehicular traffic are not obstructed using risk free equipment and work method according to the law and Regulations of relevant Authorities.

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### 5.1 SAFETY MEASURES

Safety measures are very important for the acceptable execution of works. These measures consist of but are not limited to:

Marking of the working area according to law Π.Δ. 1073/1981 (ΦΕΚ 260/Α/16.9.1981) – "Safety measures for civil engineering works", ΥΑ ΒΜΠ/30058/1983 (ΦΕΚ 121/Β/23-3-1983) – "Technical standard for safety measures to be taken for works in urban areas".

Apply any possible means to ensure safe move of people and vehicles such as:

- Protective barriers, fences and signals for pedestrians
- Traffic signs for vehicles
- Traffic lights and reflective signs
- Deviation of roads
- Safety barriers, signals, traffic arrangement study
- Illumination

### 5.2 SURFACE CUTTING

Special care shall be taken of cutting of all types of surface i.e. asphalt or cement slabs, pavement, concrete lining etc., and their subbases. Every material that could possibly be reused should be cleared and transported to appropriate place.

Discarded material shall be removed by Contractor to locations designated by the relevant Authorities.
Cutting works must be done carefully, using a proper asphalt-cutting machine in order to obtain a neat and orderly layout of excavation.

Walkway slabs should be removed in individual pieces. The temporary placing of the excavated surface materials must be done properly without causing:

- Damages in urban areas.
- Obstructions during the pipe transportation and installation.
- Problems to pedestrians and traffic.
- Danger to personnel.
- Problems to surplus material removal.
- Damage to reusable slabs.

In case that there is no place on site for placing excavation materials that will be reused, Contractor will transport them to an appropriate place and then transport them back to site, at his own expense.

### 5.3 EXCAVATIONS

Trenches and excavations of any shape must be undertaken according to relevant standards and specifications, following the rules of good engineering practice. Sides and bottom leveling shall be performed for any type of soil, even if water is accumulating. Isolated boulders may be removed manually. Uprooting and removal of plants shall be done only as appropriately, and relevant permits shall be obtained, if required, from the
Forestall Authorities.
At areas where machinery cannot be used, works shall be done manually, regardless of the amount of work required.
Use of explosives shall be avoided, except at rare cases where Contractor shall get special permit issued by the relevant Authorities and OWNER. Such permit is issued after submission of relevant report by Contractor, which shall indicate measures to be taken for safety of the public and adjacent structures. The permit is copied for information to the local police station, who shall also be informed about intended safety measures to be taken.
In case of existing pipeline in site, the use of explosives are forbidden.
Contractor shall inform the Supervisor beforehand about the type of pneumatic drill point and the safe distance (for vibrations) of the plant to be used, according to manufacturer’s specifications.

### 5.3.1 Dewatering

If water is accumulating in the trench, it must be drained or pumped to a location approved by the relevant Authorities or the landowner.

If special permission is required, Contractor is responsible for obtaining it. Any problem relating to water existence, which may appear at any time before the delivery of works, shall be resolved by Contractor at his own expense.

### 5.3.2 Existing Installations

It is necessary to support properly and protect every pipe, duct or other existing installation, which may be revealed during excavation works.

Contractor is responsible to restore, at his own expense, any damage caused to underground installations. Supporting works shall be performed in a way approved by the owner of the revealed installations, who must be informed by Contractor in time about the incident.

## 5.4 BEDDING

The bottom of the trench shall be sufficiently cleaned from any object which may damage the pipe during lowering-in. If the bottom is not at the appropriate depth due to over-excavation, then it shall be filled with sand up to the required level.

Bedding layer shall be 20 cm thick, made of clean quarry sand complying with EN 13242 free of organic or other substances. This bedding layer shall be extended up to the side slopes of the road.

The lowering - in of the pipe shall be carried out, after approval of the OWNER's Representative.

## 5.5 PADDING

The padding layer shall be strictly consisted of the same material as the bedding material and it shall be placed according to the relevant standard drawings. The use of sand with salt residues is not allowed.

The padding layer shall surround the pipe and cover it for an additional 20 cm thickness.

### 5.6 BACKFILLING

There are two categories of backfilling compaction, according to the size of imposed ground loads:

a. For footways, rural roads or other secondary roads and fire break zones, backfilling material consists of appropriate excavated soil, which is laid and compacted 95% Proctor Density to EN 13286.02 in 20 cm thick layers. Compaction shall be performed by vibrator and soaking in parallel, until the required degree of compaction is achieved.

b. For major roads, asphalt roads, pavements, concrete surfaces, road shoulders, backfilling material consists of crushed aggregate according to ΠΤΠ Ο-150, which is laid and compacted in 20 cm thick layers. In particular, from top to bottom the following courses shall be constructed:

- Base Course, compacted to 98% Proctor Density to EN 13286.02.
- Sub-Base Course, compacted to 98% Proctor Density to EN 13286.02, which shall extend to the top of the pipeline padding layer. Contractor is responsible for handling backfilling materials in such a way, so that no obstacle, nor danger is created for the pedestrians and the traffic either.

Contractor shall remove and dispose of any excess material after backfilling in a way meeting all Local and National Authority regulations.

In any case, backfilling of the upper part of the trench, will be performed as follows:

- For rocky ground, the upper part of trench backfill shall be replaced by a lean concrete layer, grade C12/15 150 mm thick. The top surface shall be curved outwards from the trench to facilitate drainage of surface water flow.

- For semi-rocky ground the upper part of trench backfill shall be replaced by cement stabilised aggregates consisting of sub-base course material and 100kg/m3 of cement. The mixture will be laid in a single course 30cm thick and shall be uniformly mixed and soaked in place. The top surface shall be curved outwards from the trench to facilitate drainage of surface water flow.

- In all other cases, the upper part of trench backfill shall be replaced by a 300 mm thick layer of crushed gravel with grading 16/32mm, compacted to refusal.

All work shall be performed according to the law and the regulations of local Authorities.

### 5.7 TEMPORARY REINSTATEMENT OF PAVED ROADS

Temporary reinstatement of roads, if required, shall be performed with suitable excavated material free of stones larger than 3 cm. This will be placed on the top of the second backfilling layer, up to 5 cm above the paved level. Its purpose is to facilitate traffic flow until the proper reinstatement of the road surface.

### 5.8 REINSTATEMENT OF ASPHALT ROAD SURFACES

Sequence of works is as follows:

1. Removal of the asphalt pieces over areas where the subbase has cracked and disturbed. Asphalt pieces are removed manually or with machinery in such a way, that the scar layout consists of straight lines parallel or perpendicular or perpendicular to the trench axis.

2. Filling up with aggregate to ΠΤΠ Ο-150 and ΠΤΠ Ο-155 for the upper 200 mm and compaction with soaking in parallel, by vibrator, up to the point when the density is at least the same as of the adjacent material of the road.

3. Top surface of the compacted aggregate is cleared from any loose material and covered with emulsion type ΚΕ-S of ΠΤΠ Α203, or emulsions ΜΕ-Ο or ΜΕ-1 of ΠΤΠ Α201, according to Supervisor's instructions.

4. The required layers of asphalt grout to ΠΤΠ Α265 are laid, each 50mm thick in order to reinstate the total thickness of existing asphalt road. Between these layers, adhesive layer type ΚΕ-1 of ΠΤΠ Α203 is applied. The appropriate temperature for laying asphalt grout is 120-130°C. Asphalt grout laying is not allowed if weather conditions are cold or windy (to be judged by Supervisor), or if the temperature is below 10°C. Asphalt grout laying shall be performed by experienced crew and compaction will be done using appropriate plant vibrators and rollers.

5. Road surface is cleaned (with brooms, pressure water) of any residues of material and then it shall be open to traffic.

Following OWNER's Representative instruction for reinstatement of major roads and fast completion of works (to avoid accidents etc), Bitumix binder may be used and Contractor will be reimbursed with the difference in price of the new binder.

### 5.9 CONDUITS OF FIBRE OPTIC CABLE

Two HDPE conduits shall be laid in the pipeline trench, as shown in the relevant standard drawings. Installation of conduits shall be carried out after the completion of the middle padding of the trench, in compliance with the requirements of project specification DSF-SPC-CIV-017 "Fibre Optic Conduit Installation".

### 5.10 WARNING MESH

The warning mesh shall be purpose made and shall consist of two meshes, heat welded on one edge along their length. Both constituent meshes shall have the following characteristics:

- Material shall be HDPE
- Width of mesh shall be 600±10 mm

- Weight of mesh shall be 140±10 gr/m
- Yellow Colour
- Sheets of 200-300m length

The mesh shall be net-like, except for a continuous solid strip at the centre of the mesh, 7±1 cm wide. On either side of the central strip, the mesh shall be net like with 7 to 8 openings, size 4x4 cm each. A solid ending strip, at least 1 cm wide, shall be provided at mesh edges.

At the middle strip of the mesh the following marking shall be printed, with dark fadeless characters, "**ΔΕΣΦΑ ΑΓΩΓΟΣ ΦΥΣΙΚΟΥ ΑΕΡΙΟΥ ΥΨΗΛΗΣ ΠΙΕΣΗΣ**". Characters shall be approximately 5cm high.

## 6. QUALITY ASSURANCE

It is the Contractor's responsibility to properly complete quality forms, which are applicable for the execution of backfilling works, in accordance with the specifications and codes.
After completion of works, the relevant quality forms and material – laboratory certificates shall be submitted to the Client representative for approval and acceptance of the works.
Client representatives shall have the right to review all the relevant documentation and audit the relevant quality procedures, as considered necessary, in order to ensure that the quality system is actually functioning satisfactorily.
The whole package of quality records shall be part of the final documentation package of this project and shall be checked by the Supervising Engineer.

## 7. ATTACHMENTS

Q.A. Form No.: DSF-SPC-CIV-005/F1 "Permit for Backfilling"

| | | |
|---|---|---|
| DESFA<br>Hellenic Gas Transmission System Operator<br>**CONTRACTOR'S LOGO** | **CLIENT**:<br>**PROJECT**:<br>**CONTRACTOR**: | **FORM**:<br>**REV**.:<br>**PAGE**: |

| | | |
|---|---|---|
| ***PERMIT FOR BACKFILLING*** | | |
| **SUPERVISION** : | **SECTION**: …….<br>**REF. DWGS:** …….<br>**PREPARED BY:** …….<br>**LOCATION:** From K ……..<br>to K ……. | **REPORT No:**<br>**ISSUE DATE:**<br>**SHEET No:** ……. of …… |
| **Prior to backfilling the following points have been checked:** | | |

| | |
|---|---|
| AS BUILT PIPE SURVEYING COMPLETED | ☐ |
| PIPE AND FITTINGS LOG INFORMATION COMPLETED | ☐ |
| WELDING RECORDS COMPLETED | ☐ |
| NDT RECORDS COMPLETED | ☐ |
| JOINTS & FITTINGS COATING / WRAPPING COMPLETED | ☐ |
| HDPE CONDUITS INSTALLED | ☐ |
| WARNING TAPE INSTALLED | ☐ |
| CATHODIC PROTECTION (CONNECTIONS) COMPLETED | ☐ |

**COMMENTS:**

**BACKFILLING IS PERMITTED**

**CONTRACTOR** **ENGINEER**