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Fibre Optic Telecommunication Network in the Road Reserve

Restricted Draft

Installation Guidelines

Version: 4th Draft

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Abstract:

The development of Optic Fibre Technology has revolutionised the global telecommunication and media industries. The constantly expanding global optic fibre network has and continues to change the way the world does business and utilises resources. The extent of the new telecommunication network is almost completely superimposed on the entire available local, provincial and national road networks in South Africa.

During the past two years valuable experience has been gained with the installation of the optic fibre network with reference to civil engineering aspects, in both the planning stage and during installation.

This document appraises the different installation techniques, discuss criteria to allocate the most appropriate installation position in the road reserve and offer innovative construction measures to control erosion, manage excavated material and accommodate traffic during construction.

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DEFINITIONS OF TERMS

Fibre Optic Telecommunication: Fibre-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fibre. The light forms an electromagnetic carrier wave that is modulated to carry information. First developed in the 1970s, fibre-optic communication systems have revolutionized the telecommunications industry and have played a major role in the advent of the Information Age. Because of its advantages over electrical transmission, optical fibres have largely replaced copper wire communications in core networks in the developed world.

Conduit sleeves: Piping providing for the hauling through of telecommunication ducts e.g. in the case of embankments where long distance open trenches cannot be allowed

Telecommunication ducts: Encasements providing space for more than one fibre optic cable

Fibre optic cable: A fibre optic cable is a cable containing one or more optical fibres. The optical fibre elements are typically individually coated with plastic layers and contained in a protective tube suitable for the environment where the cable will be deployed

Engineer: Means the person appointed by the Employer to act as the Engineer for the purposes of the contract

Road Reserve: The strip of land between abutting property boundaries, specifically gazetted for the provision of public right of way. It includes the road carriageway, median (if any) as well as sidewalks and verges.

Day Time working hours: One hour after sunrise to one hour before sunset.

Wayleave: Official permission to be obtained before carrying out any work within the Road Reserve.

Soilcrete: A mixture of in-situ material or aggregate, cement and water. The consistency specification will determine whether the soilcrete is referred to as ‘dry’ or ‘wet’ soilcrete.

Embankment: A raised bank of fill material for road building purposes.

Cutting: Where soil or rock material from a hill or mountain is cut out to make way for a road.

Scubbling: Scraping of the walls of a cut-out trench.

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1 BACKGROUND

The development of Optic Fibre Technology has revolutionised the global telecommunication and media industries. The constantly expanding global optic fibre network has and continues to change the way the world does business and utilises resources. Deregulation of the South African telecommunications environment and the award of approximately 500 Electronic Communications Network Services (ECNS) licenses have resulted in major investment in the roll out of a fibre optic network across South Africa. The extent of this new telecommunication network is almost completely superimposed on the entire available local, provincial and national road networks in South Africa. During the past two years valuable experience has been gained with the installation of the optic fibre network with reference to civil engineering aspects, in both the planning stage and during installation.

This document appraises the different installation techniques, discuss criteria to allocate the most appropriate installation position in the road reserve and offer innovative construction measures to control erosion, to manage storm water, manage excavated material and accommodate traffic during construction.

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2 INTRODUCTION

South African National Roads Agency Limited (SANRAL) provisionally granted permission to telecommunication companies to install cables for fibre optic telecommunications networks within the road reserve. These cables may be installed within a defined servitude along the boundary of the road reserve.

There are however several instances where circumstances dictate that it would be impossible to stay within the aforementioned defined servitude. These instances include the occurrence of obstacles within the servitude as well as the occurrence of areas posing high risks to either the road users or the integrity of the infrastructure. Examples of obstacles and high risk areas are steep embankments, cuttings, bridges, rivers and streams, environmental sensitive areas, areas underlain by dolomites etc.

A set of detailed guidelines has been developed, with the inputs from various role players, to offer sound engineering solutions to overcome these obstacles and high risk areas.

Various other issues were also addressed which need to be handled during installation of the cables like the accommodation of traffic as well as ensuring the minimum impact on the environment.

Details in respect of the guidelines and issues are discussed in the follow-on chapters of this document:

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3 ENGINEERING DESIGN AND SUPERVISION

3.1 Introduction

Experience has shown that the design and supervision of the civil engineering components of the installation of the telecommunication cables need to be overseen by a professional civil engineer.

The agreement between SANRAL and a telecommunication company could typically stipulate that:

"The fibre optic telecommunication facilities shall at all times be installed, operated and repaired in accordance with the specifications set out in specifying schedules that form part of this agreement: (refer here to the relevant schedules) and the telecommunication company shall ensure that all work carried out be executed by or under the supervision of their own appropriately and sufficiently qualified professional employees or agents. In the event that the road carriageway would be encroached by the works and in other instances where engineering design is required due to any envisaged impact on road elements, the telecommunication company shall ensure that all work carried out be executed by or under the supervision of sufficiently qualified and competent professional civil engineers."

The agreement between SANRAL and a telecommunication company would also stipulate that the specifications of the Committee of Land Transport Officials (COLTO) will apply.

3.2 Design criteria

The completed and reinstated trench (1) must be able to resist a load of 70 kPa i.e. equivalent to the load affected by a tractor pulling a grass-cutting machine or (2) it must have a bearing strength equivalent or better than the adjacent virgin soil.

Exceptions to the above criteria will apply in the case of a trench in steep slopes either in fill or cut, marshy clayey areas or in the vicinity of structural elements like road signs, fence lines, telephone poles etc. The specific details for reinstatement that will apply in these cases are as illustrated on the designs indicated on the drawings of this document.

In general care must be taken to ensure that, the existing stormwater and other drainage systems or any other structures in the road reserve, will not be compromised by the installation of the telecommunication cables.

3.3 Typical failure mechanisms

Typical failure mechanisms associated with the installation of telecommunication cables must be taken into account when designing for the laying of such cables. Problems that could occur are mainly related to either stormwater management, slope instabilities or an impact upon the functionality of the road verge including the road furniture. These problems will be discussed in more detail below:

3.3.1 Stormwater management

Trenching for the installation of the telecommunication cables is typically done parallel to the carriageway and would thus cut through all constructed drainage elements in its way *albeit* mitre drains, earth and concrete channels, culvert outlets etc.

If the stormwater are not well-managed during installations, the open trench and even a completed and reinstated trench, will be prone to severe erosion. In cases where the backfilling is eroded by stormwater, this would result in serious environmental damage like the silting of downstream dams, blocking of drainage structures etc. Stormwater management during execution of the works and thereafter is thus of great importance.

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The completed works will remain prone to erosion until vegetation has re-established. Failure to do proper stormwater management throughout the works could result in severe erosion as indicated in Figure 1 below.

Erosion may also manifest in cases where the bundle of telecommunication ducts or conduit sleeves act as a conduit to subsurface stormwater. This will result in scouring or piping of the backfilling around the ducts or sleeves as displayed on Figure 2 below.

Installation details are proposed in this document to contain the risk of erosion during the works as well as afterwards. Refer to Drawing: Detail 006.

Figure 1 Typical failure mechanisms: Stormwater management: Erosion

Figure 2 Typical failure mechanisms: Stormwater management: Piping

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3.3.2 Slope instabilities

The trench with the bedding, padding and the cavity created in a bundle of sleeves could be considered a water bearing conduit. This conduit might drain in areas where slope stabilities (in fill or cut) could be compromised. The proper installations procedures must be followed to prevent this from happening. Failing to adhere to this could result in slope failures as displayed by Figure 3 below:

Figure 3 Typical failure mechanisms: Slope instabilities

3.3.3 Effect on functionality of road verge

The functionality of road reserve can also be severely affected by the trench in that a weak link could be created in the recovery area of the road cross-section. In such cases severe vehicular damage and/or injuries to road users could result when drivers lose control. This could cause vehicles to spin from the carriageway and get trapped in the trench. In addition, maintenance vehicles and in particular grass cutting tractors may get stuck if the trenches are not finished off and compacted correctly.

The trench could also interfere with the structural elements of road signs, fence poles, telephone poles, power masts, trees and other infrastructure as illustrated on Figure 4 below:

3.4 Drawing requirements

There are specific requirements to be adhered to in respect of drawings to be provided for evaluation/approval purposes when applying for the installation of telecommunication cables inside the road reserve. These specifications are detailed in Appendix A.

Figure 4 Typical failure mechanisms: Effect on functionality of road verge

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4 TYPICAL ROUTING DETAILS

4.1 Background

In the follow-on sections typical details for the routing of the telecommunication ducts for cable installations are described. Directives are also provided for the installation of conduit sleeves as needed. Each conduit sleeve could contain a number of telecommunication ducts as needed for the specific circumstances.

Telecommunication ducts are installed from reels over long distances and need to be continuous for lengths up to one kilometre. However, in certain problematic environments this procedure would necessitate for trenches to be left open for longer than the allowable time periods. In these cases i.e. for example through high risk areas, steep embankments etc. conduit sleeves need to be installed over short sections. The ducts could then be pulled through the installed sleeves at a later stage.

All the drawings that will be referred to below have been included in Appendix C. Note that the configuration and alignment of the conduit sleeves, telecommunication ducts and fibre optic cables as indicated on these drawings may differ from project to project.

The different elements of a typical fibre optic telecommunication duct and associated cables are illustrated on Figure 5 below:

Figure 5 Typical fibre optic telecommunication duct

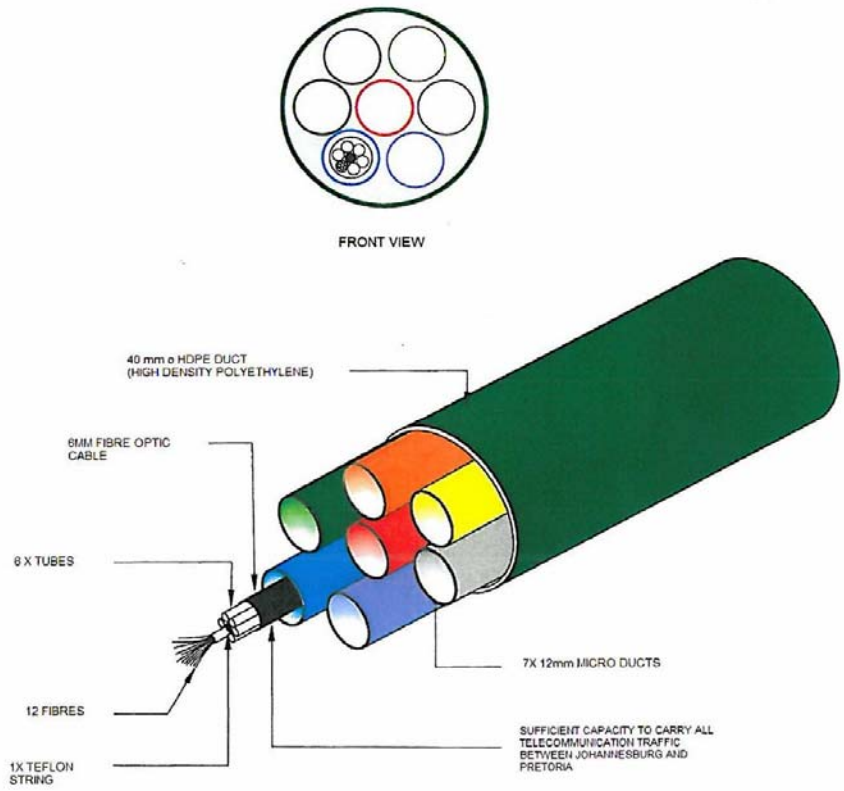
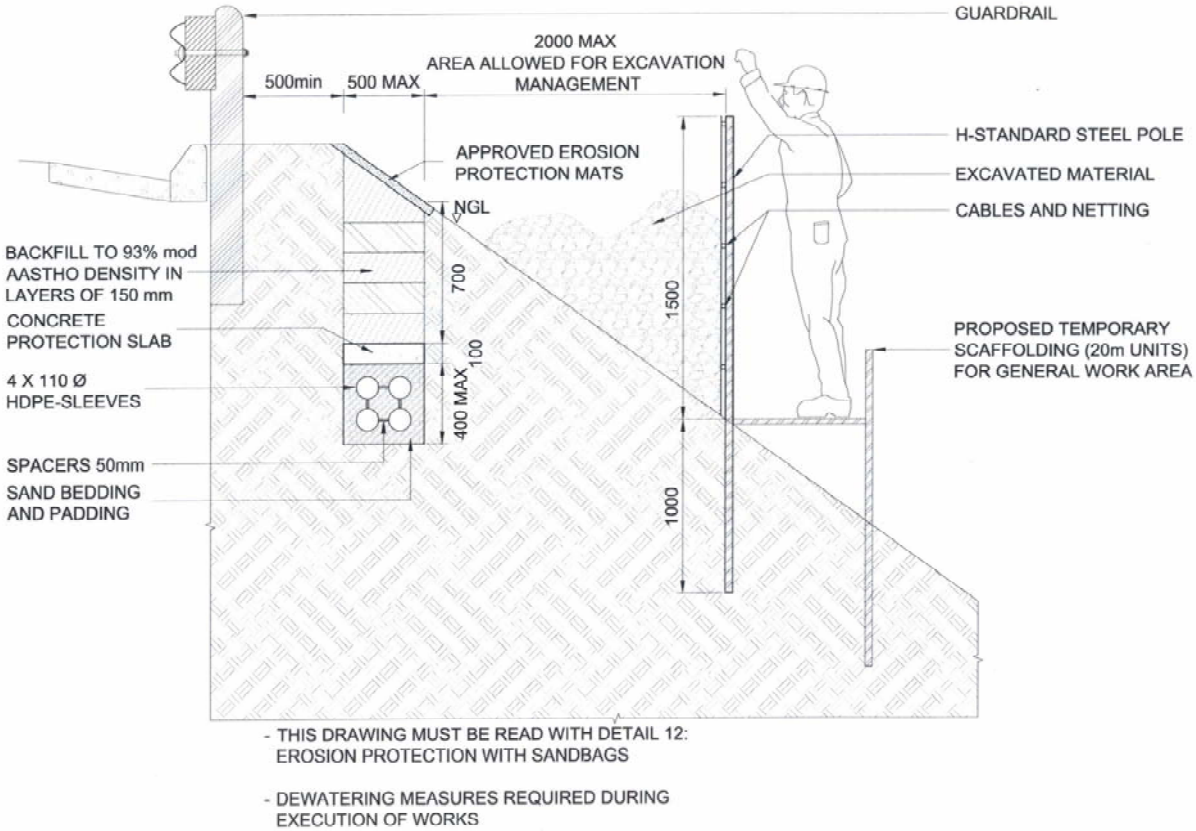


FIG 2.1: OPTIC FIBRE TECHNOLOGY:
7 - WAY DUCT

A typical application where conduit sleeves are specified is as illustrated in Figure 6 below. Each sleeve, 4 in number in this case, would contain a number of telecommunication ducts each whilst each duct would contain a number of fibre optic cables:

Figure 6 Typical usage of conduit sleeves



4.2 Telecommunication duct installation

The bulk of the telecommunication duct installation is normally installed from reels over distances up to one kilometre in length. The ducts can be installed either (1) through conduit sleeves i.e. a trenchless installation by means of Horizontal Directional Drilling or (2) in excavated trenches, as would be applicable for each specific case.

4.2.1 Standard installation along road reserve boundary

Refer to Drawing: Standard 001 and Standard 003

As indicated before approval is given for laying the ducts within a specified servitude along the road reserve boundary. The ducts must be laid to a sufficient depth that will ensure a minimum cover of 800mm or the cover as specified in the wayleave conditions. The trench must be positioned far enough from the fence line to reduce the risk of damage to the latter.

In the vicinity of embankments or cut slopes the trench must be positioned at least 1 (one) meter away from the toe as per Drawing: Standard 003.

The anchor poles of the fence need to be protected as per Drawing: Detail 005.

4.2.2 Crossings underneath roadway

Refer to Drawing: Standard 002

This type of installation makes provision for crossing the roadway. The minimum cover of the telecommunication ducts under the road carriageway must be 1200mm whilst the minimum cover in the verge must be 800mm or as specified in the wayleave conditions.

4.2.3 Crossings at interchanges

The details below refer to telecommunication cable installations at diamond interchanges. Details for installations at other types of interchanges must be directed by sufficiently qualified and competent professional civil engineers.

a) **Road over/under freeway:** Refer to Drawing: Layout 001

b) **Freeway Ramps:** Refer to Drawing: Layout 002

4.2.4 Crossings other than at interchanges

Cross road under or over freeway: Refer to Drawing: Layout 003

4.3 Telecommunication conduit sleeve installation

Where the environmental conditions do not allow the installation of the telecommunication ducts over a long enough length, conduit sleeves need to be used. The sleeves could be installed either by (1) trenchless installation i.e. by means of Horizontal Directional Drilling or (2) in excavated trenches. The specific means of cable laying must be decided upon on a case-to-case basis as would be dictated by the specific circumstances.

4.3.1 Trenchless installation

The following general directives must be adhered to:

1. A 110mm diameter conduit sleeve (or a set of conduit sleeves) for hauling through of telecommunication ducts must be installed by means of Horizontal Directional Drilling underneath the cross road.
2. The Horizontal Directional Drilling must be done perpendicular to the centre line of the road.
3. The minimum cover over the conduit sleeve under the carriageway must be 1200mm.
4. The minimum cover over the conduit sleeve in the road verge must be 800mm.

4.3.2 Trench installation

The conditions will require that the following general directives be adhered to:

1. Installation must be done in short sections e.g. in 20m lengths.
2. Trenches must be opened and closed on the same day i.e. no open trenches will be allowed after Day Time working hours.
3. Trenches must be kept dewatered at all times.

Details for installations at any other types of road crossings, than described above, must be directed by a sufficiently qualified and competent professional civil engineer.

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4.4 Other determining circumstances

4.4.1 Embankments and cuttings

Refer to Drawing: Standard 003

No trenching will be allowed within 1 (one) meter of the toe of an embankment or the face of a cutting, except if the design is specifically approved by a sufficiently qualified and competent professional civil engineer. For further details refer to Chapter 5 below.

4.4.2 Environmental sensitive areas

The directives provided in the chapter on 'Procedures for Environmental Investigations' must in all cases be adhered to in the case of environmental sensitive areas.

Furthermore, the relevant environmental specialist through the appointed Environmental Assessment Practitioner (EAP) must be consulted in respect of special directives for cabling in the case of a specific environmental sensitive area.

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5 INSTALLATION DETAILS IN SPECIAL CASES

5.1 Background

Details are provided below for the installation of telecommunication cables under special conditions i.e. where the general directives cannot be used. These conditions include embankments or cuttings as well as special soil conditions. Details are also provided for the protection of road related and other infrastructure like telephone lines making use of sand bags as well as for erosion protection as needed.

All the drawings that will be referred to below have been included in Appendix C. Note that the configuration and alignment of the conduit sleeves, telecommunication ducts and fibre optic cables as indicated on these drawings may differ from project to project.

5.2 Conduit sleeves along fill embankments

Refer to Drawing: Detail 001

This detail allows for the installation of a set of 110mm diameter conduit sleeves along short sections in the road embankment behind the guardrail. The following directives must be adhered to during installations:

- The maximum length of open trench behind the guardrail must be limited to 20m at a time. The trenches shall be opened and closed within one working day.
- The trench must be excavated to a depth of 500mm below the lower end of the guardrail posts. The trench must also be at least 500mm away from any guardrail posts.
- The conduit sleeves must be placed at the bottom of the trench and be covered by a 100mm concrete slab to the full width of the trench. This measure is needed to protect the telecommunication ducts should future maintenance to the guardrails would be needed. The concrete used must have a strength of 15 MPa and backfilling must be done to a 93% mod AASHTO density.
- Sand bags must be installed along the length of the trench following the vertical alignment thereof in accordance to drawing “Erosion Protection with Sandbags” (Drawing: Detail 006).
- Strict management of excavated material against the embankment must be ensured by providing safety nets for preventing the excavated material to fall onto the roadway.
- Continuous dewatering of the trench during excavation shall apply at any time during the installation.

The reinstatement of disturbed vegetation must be overseen by an environmental specialist.

Traffic accommodation must entail a slow lane closure during Day Time working hours the latter as defined under the ‘Definitions of Terms’. Further details are provided in the chapter below on Accommodation of Traffic. Any work and traffic accommodation measures will only be allowed during the Day Time working hours.

5.3 Conduit sleeves along the face of cuttings

Refer to Drawing: Detail 002

These details concern installations in the face of cuttings where the management of excavated material could be a risk factor:

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The same directives shall apply as for a 'Conduit sleeves along embankments' as described in the previous section.

5.4 Telecommunication ducts along a concrete side drain

Refer to Drawing: Detail 003

These details make provision for the installation of telecommunication cable under or at the outer edge of a concrete side drain:

A neat 175mm wide slot must be cut through the concrete drain to a depth of 350mm below the drain for accommodating the telecommunication ducts. Care must be taken not to disturb the underlying subsoil drain.

Soilcrete (4% cement with crusher sand) must be used to place the telecommunication ducts in pairs whilst mild poker vibration is applied during the process.

The trench containing the telecommunication ducts must be drained into an existing subsurface drain where (1) a change in grade from steep to flat occurs or (2) at a minimum of 300m intervals. The concrete of the side drain that has been cut out must be reinstated using a wet-to-dry epoxy or scubbling of the trench walls.

5.5 Concrete encasement in hard material

Refer to Drawing: Detail 004

This drawing makes provision for the case that hard natural materials are encountered which would make it impractical to apply the directives of the "Standard Duct Installation" as per Drawing: Standard 001)

A trench must be excavated in the hard material to the depth and width as indicated in Drawing: Detail 004.

Conduit sleeves must be installed prior to concrete encasement. Alternatively split-sleeves may be installed after installation of the telecommunication ducts but prior to concrete encasement.

5.6 Soilcrete reinforcement at telephone or other poles

Refer to Drawing: Detail 005

This drawing provides details for the prevention of telephone poles falling over after excavation at or near its base. This type of safeguarding could also be applied in the case of other roadside furniture.

Soilcrete reinforcement of the bases of telephone poles and anchor poles must be done as indicated on the drawing. The described reinforcement must be done at least 7 days before any excavation for the installation of cables.

5.7 Erosion protection with sandbags

Refer to Drawing: Detail 006

These details make provision for the installation of sandbags to prevent erosion during construction and along steep slopes:

Bio-degeneradable sandbags must be used to prevent erosion during construction whilst geo-fabric bags are to be used at high risk areas to create a permanent solution.

Sandbags must be installed as indicated on the drawing. The spacing of the sandbags is a function

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of the slope of the trench and the features of the catchment area as indicated on the drawing.

5.8 Details for manholes in active slopes

Refer to Drawing: Detail 007

These details make provision for manholes to be installed in the case of active clayey conditions.

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6 SPECIAL INSTALLATION AT BRIDGES

Refer to Drawings: Layout 004: Typical bridge attachments

Attachments to a bridge structure will not be allowed unless exceptional conditions warrant a grant to this effect. The aforementioned grant for each individual case must be obtained from the relevant Regional Manager of SANRAL and must be obtained as a written permission.

Examples of specific obstacles qualifying as exceptional conditions as mentioned above are:

- Large perennial rivers like the Orange River, Vaal River, Tugela River, Berg River.
- Long deep valleys.
- Deep river and other gorges.
- River beds that consist of rock/soil types that are not drillable by using Horizontal Directional Drilling e.g. natural soil consisting of cobble stones.
- Over and under passes in municipal areas where the cross road is not under SANRAL's jurisdiction.

In all other cases Horizontal Directional Drilling must be used to cross the obstacle.

Attachments must be implemented in accordance with specific details to be provided to and approved by the Bridge Network Manager of SANRAL. The design and supervision during installation thereof must be executed by a professional bridge engineer.

No separate structures will be allowed for the accommodation of any telecommunication cables unless authorised by SANRAL's Regional Manager and in compliance with the Environment Impact Assessment (EIA) requirements.

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7 INSTALLATIONS AT OTHER ROAD FURNITURE

7.1 Introduction

In this chapter details are provided for taking proper care of existing roadside furniture as well as other installations and infrastructure during cable installations. If however any of these elements were damaged during cable installations it must be reinstated to its original condition.

The contractor must beforehand take photographs of any items mentioned below i.e. those that could be affected or damaged during installations. This would enable the contractor to reinstate the items to its original status after completion of the works.

7.2 Fencing

In general care must be taken not to damage the existing fence along the road reserve boundary. The choice of the proper excavation equipment and other machinery must thus receive special attention. In general the use of back-actors and large excavators would pose a high damage risk to fences and the use of these should be avoided.

Should the need arise to dismantle a fence e.g. to be reinstated at the correct coordinates, this must be verbally communicated and followed-up in writing with the relevant land owner. The correct coordinates must in all cases be obtained from SANRAL.

7.3 Road signs and telephone poles

In general care must be taken not to damage road signs and telephone poles. If need be these installation must be safeguarded against possible damage as described in the section above on ‘Soilcrete reinforcement at telephone poles’.

7.4 Open drains

The different drainage types are as follows:

- Gravel drains
- Drains lined with stone-pitching
- Concrete lined drains

Care must be taken by the contractor that the stormwater management instilled by the constructed drainage systems not to be tampered with during the works.

7.5 Traffic survey stations

Special care must be taken not to damage any traffic counting and survey installations. The contractor must contact SANRAL and/or its service provider responsible for traffic surveys in respect of the general layout of cabling at traffic survey stations.

The contractor must confirm the positions of the cabling by means of hand excavations. If any doubt would exist about the positions of cables etc., the inputs of the service provider responsible for traffic surveys must be sought.

7.6 Toll plazas

The contractor must inform the toll operator in writing of the intention of laying cables past or through a toll plaza area. The routing to be followed would require a detailed layout and separate approval from the toll operator as well as SANRAL must be obtained.

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8 HORIZONTAL DIRECTIONAL DRILLING

8.1 Introduction

The purpose of this chapter is to provide the minimum requirements in respect of the planning and execution of Horizontal Direction Drilling (HDD) operations as may be needed for the installation of the telecommunication ducts.

Horizontal Direction Drilling is a technique during which a drilling machine pushes a steerable drill head, while being rotated, through the natural soil. At completion of the pilot hole thus created, the hole is enlarged to the required diameter by pulling a reamer backwards towards the drilling machine. Afterwards the conduit sleeve is pulled through and thus put into place.

To ensure a well designed and smooth drilling operation, the drilling contractor needs to submit the necessary documentation as part of a prescribed Drill Plan.

HDD in embankments is considered a high risk operation and must be avoided.

8.2 Competence

The actual drilling and monitoring of the drilling operation must be supervised and undertaken by individuals fully competent with this type of work. Certification of operators and proof of competency must be supplied and kept available on site at all times.

8.3 Minimum requirements during planning

8.3.1 Site Investigation

a) Environmental Impact Assessment (EIA)

The drilling contractor must compile an Obstacle Register (OR) of all obstacles that need to be addressed during the necessary Environmental Impact Assessment(s). These obstacles could include wetlands, perennial and non-perennial streams, drainage structures etc.

b) Verification of existing services

The drilling contractor must locate, identify and mark any subsurface services that run close to and/or across the intended drilling path. All the services that were thus identified must also be listed on the Obstacle Register. Where subsurface services are to be crossed, the drilling contractor must open pilot inspection holes to establish a safe drill depth and these holes must stay open during drilling operations to ensure that the drill actually pass over or under the service as planned.

c) Environmental impact

All products used during drilling operations must have no environmental or Safety Health and Environment (SHE) impact and Material Safety Data Sheets (MSDS) sheets must be provided by the drilling contractor.

d) Accommodation of traffic

Traffic accommodation during drilling operations must be done in accordance with Chapter 13 of the South African Road Traffic Signs Manual (SARTSM) Volume 2 and approved by the Engineer.

e) Fluid disposal plan

The catchment pits that would contain the slurry created during the boring operations must be reflected in the Drill Plan. These pits must be of sufficient capacity to accommodate the mixture of slurry/cuttings created during the drilling operation. The drilling contractor must ensure that the further

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disposal of the clay (bentonite) used never enter any waterways (rivers and streams), dams or water bearing structures like drains and culverts.

8.3.2 Planning for operations

a) Drilling path

HDD must be done perpendicular to the road centre line. The intended path of the drill must be indicated on the Drill Plan as well as the planned depth of the hole. The depth below ground level must be a minimum of 20% more than that was specified by SANRAL. This would accommodate possible deviations from the drill path e.g. through 'snaking' of the drill head.

b) Permits

The drilling contractor must always have the necessary documentation i.e. wayleaves and official approvals available as well as the applicable construction drawings on site during the operation. The construction drawings are in some cases generally referred to as Base Line 1 (BL1) drawings).

8.3.3 Geotechnical Report

a) Preparation of a Geotechnical report

The drilling contractor must submit a Geotechnical Report to be compiled by a professional geotechnical engineer. The purpose of this soil investigation is to provide information based upon which a decision can be made whether firstly HDD is feasible and secondly to provide sufficient information to be able to decide upon the appropriate drilling method.

The geotechnical engineer must ensure that all soil conditions have been recorded and that all best practices have been applied to ensure the undertaking of proper procedures during drilling operations.

A risk assessment of all areas of contaminated and potentially contaminated land should be thoroughly investigated and taken into account during the design of the drilling operation.

b) Soil Type Identification

The Geotechnical Report must be used to determine the details of the Drill Plan and specifically the appropriate equipment that would be needed.

HDD can be used successfully in a wide range of soft to hard soils, dry and saturated clays, silts, sands, mudstones and soft rocks.

However, difficulties may be suspected e.g. when (1) drilling through loose gravel and cobbles where creating a stable drilling operation may not be possible or (2) where glacial till boulders may cause the drill to deviate which would make it difficult to keep to the planned alignment of the drill path. In all such cases the proper procedures must be motivated, planned for and recorded in the Drill Plan.

8.3.4 Drill Plan

Based upon the data provided by proper surveys that must be executed beforehand, the drilling contractor must prepare a Drill Plan as well as supporting drawings. The Drill Plan must indicate the entrance and exit angles and the drilling radius based upon the possible curvature of the type of conduit sleeve that will be used. This will dictate the depth that needs to be achieved and also the length of the drill that must be used.

The Drill Plan must also indicate any services that were found by the drilling contractor and the details of the deviation to avoid contact with such a service.

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When the Drill Plan is completed it must be presented to the Engineer for approval. Only after such approval was granted, the HDD operations may be proceeded with.

The following specific items must be addressed in the Drill Plan:

- Equipment selection
- Drilling fluid design
- Drill path (Side and top view)
- Product Installation
- Equipment Selection

8.4 Minimum requirements during drilling operations

8.4.1 Site preparation

An all weather access to the sites at the entrance and exit positions of the HDD operations must be established. Catchment pits must be excavated at the entrance and exit points before drilling operations are commenced with. These pits must allow for the drilling residue to be collected and reclaimed thus preventing excessive wastage. The sizes of these excavation pits must be at least 1m in length x 1m in width x 1.5m in depth. Should drilling not commence immediately after the opening of the pits, barricading must be placed around the pits and the necessary signage must be erected to ensure that the excavations are visible.

a) Availability of water

The drilling contractor must identify a suitable water source or provide a water-bowser suitable to maintain a sufficient supply of water during the drilling operation.

b) Safety Measures

The drilling team of the drilling contractor must be inducted on the site rules, method statements and risk assessments prior to commencement of any work. This must take the form of toolbox talks to be provided by the drilling contractor. All safety and traffic regulations pertaining to the site must be adapted and adhered to by the drilling contractor.

8.4.2 Execution Process

The drilling contractor must ensure that the following items form part of the required minimum actions during operations:

- That the initial cleaning out of the drill hole is carried out by injecting drilling-fluid under high-pressure through drill rods: The rotating drill action loosens and brake the soil thus the high-pressure drilling-fluid initially removes the material from the drill hole. The drill hole is finally cleared by the reaming action described below.
- That a cutting head and transmitter are attached to the front of the rods which could be controlled by a locator to achieve the correct line and level required.
- That the drill rods pass through the natural soil while mixing soil with the drilling-fluid causing a small grout filled tunnel and that at no time a cavity is formed.
- That the above operation be done by removing the securing collar and unscrewing the cutting head.

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- That a reamer is attached which contains multiple jets for drilling-fluid and a cutting face.
- That the passing of different size reamers, mixing natural soil with the mud on a continual rotating system, is carried out until a grout filled tunnel is ready to receive the pipe (conduit sleeve).
- That the final reamer is attached to a towing head that is inserted and expanded in the pipe to be installed.
- That the method statement include the following details in respect of proper drilling-fluids be used to ensure good drilling practices:
    - Remove cuttings from the bit and transport it to the surface
    - Cart the cuttings away at the surface
    - Stabilize and support the wellbore
    - Protect the formation with a filter cake
    - Insure reliable geologic information by analyzing the cuttings
    - Control sub-surface pressures
    - Cool and lubricate the bit, reamer, sonde and drill string
    - Transmission of hydraulic energy to the bit
- That the grout from the tunnel or from any blow-outs be removed by means of an excavator or gully sucker by the drilling contractor and disposed of in a way that will prevent environmental contamination.

8.4.3 As Built documentation

a) As Built drawings

The drilling contractor must prepare and provide As Built drawings of the drilling operations. These drawing must include details of the installed conduit, temporary works, permanent structures and back-filling.

b) Remedial Work

The drilling contractor must record and provide the Engineer with details of any problems and difficulties encountered during the drilling and associated operations as well as the procedures used to address and/or correct these. These records must also be substantiated by appropriate photographs.

The drilling contractor must notify the Engineer of any failed drill attempts and record it on the As Built drawings. The redundant drill hole must be pressure grouted with a soilcrete.

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9 CHOICE OF TRENCHING TECHNIQUES

9.1 Introduction

A pre-condition for the choice of cable laying techniques to be used is the assurance of the minimum footprint to be left after the works. The appropriate trenching and other re-instating equipment as would be needed must thus be carefully chosen before any works are commenced with.

A basic guiding principle is the use of the smallest type of equipment that could be applied under any encountered circumstances. The choice of equipment must thus leave the smallest imprint on the environment i.e. for example the width in tracks left as well as the prevention of a swinging boom-and-cab of e.g. a big back-actor that could damage fencing, telephone lines, vegetation etc.

The final choice of equipment will mainly be dictated by the terrain type and accessibility of the working area. In special cases excavation by hand could even be needed and should be thus specified.

In summary the clear and grub operations, stripping of topsoil and the creation of a working platform or area as well as the actual excavations may have detrimental consequences in respect of the resulting environmental footprint and the risks of erosion during construction. The choice of the appropriate equipment as well as proper trenching techniques must thus be carefully made to be the most applicable for the various terrain types that will be encountered.

9.2 Flat terrain

The appropriate equipment to be used for trenching, placing of cables, backfilling and compaction as well as the rehabilitation method must be designed by the contractor and be approved by the Engineer.

A 5 (five) meter wide footprint is specified in all cases. Typical activities during installations could be the following:

- Use a trenching machine that could work in close proximity to the fence line;
- Spray water in front of the trenching machine using a water-bowser to minify dust;
- Dump the excavated material right next to the trench;
- Do backfilling with manual labour;
- Do compaction with a hand held vibratory roller;
- Apply the appropriate environment rehabilitation as specified by the environmental specialist.

Some typical activities are illustrated on Figures 7 to 9 below. Note the position of the trench relative to the fence as well as the protection of vegetation on Figure 8.

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Figure 7 Example of a trenching operation in flat terrain

Figure 8 Example of excavated trench in flat terrain

Figure 9 Example of completed works in flat terrain (limited impact on vegetation)

9.3 Rolling and mountainous terrain

The appropriate trenching, backfilling and rehabilitation method and specific equipment to be used must be designed by the contractor to be approved by the Engineer. Excavated material must be properly managed to avoid debris spillage onto the carriageway.

9.4 Environmental sensitive areas

The directives provided in the chapter on Procedures for Environmental Investigations must in all cases be adhered to.

The relevant environmental specialist through the appointed Environmental Assessment Practitioner (EAP) must be consulted in respect of special directives for the laying of telecommunication ducts in the case of specific environmental sensitive areas. Excavation of trenches by hand could in these cases be the first choice of operation.

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10 ACCOMMODATION OF TRAFFIC

10.1 Introduction

Traffic accommodation during the installation of the telecommunication ducts must be done in accordance with the most recent version of the South African Road Traffic Signs Manual (SARTSM) Volume 2 Chapter 13 and as approved by the Engineer. All these actions resorts to the contractor's responsibilities as indicated in the Safety Health and Environment (SHE) directives.

Items to be taken into account for the design for each operation to be approved by the Engineer for e.g. the closure of the shoulder or even a lane closure are:

- The prevailing speed limit;
- Whether workers will have to operate within the area;
- Working along the fence line – in which case a shoulder closure is specified;
- Working nearer than the fence line – in which case a shoulder and adjacent lane closure is specified;
- The possibility would exist that debris may fall on the road surface – in which case a shoulder and adjacent lane closure is specified.

10.2 Single carriageway roads

Refer to Drawing: Accommodation of Traffic: Single carriageway roads: These details make provision for the accommodation of traffic during the installation of cables along single carriageway roads.

As per the abovementioned drawing the following road signage shall be provided on a single carriageway road with one lane per direction requiring short term lane closure (for a few hours only):

- For a partial lane closure, where two way traffic flow can be maintained, refer to SARTSM Volume 2 Section 13.8.8 Short Term Lane Closure, Figure 13.37.1. Traffic should be separated by cones or delineators at a 10m spacing. The taper should be at a rate of 1:20 with a spacing of 5m between cones/delineators.
- For a full lane closure, STOP/GO control should be implemented as per SARTSM Volume 2 section 13.8.11. Traffic signage should be in accordance with SARTSM Volume 2 Section 13.8.8, Short Term Lane Closure, Figure 13.37.2 and should be separated by cones or delineators at a 10 m spacing. The taper should be at a rate of 1:20 with a spacing of 5m between cones/delineators.
- If for any of the above cases the lane closure extends through an intersection, additional flagmen should be placed at each intersection. It is also recommended that the assistance of traffic police be requested to do point duty at such locations.

10.3 Dual carriageway roads

Refer to Drawing: Accommodation of Traffic: Dual carriageway roads: These details make provision for the accommodation of traffic during the installation of cables along dual carriageway roads.

As per the abovementioned drawing the following road signage shall be provided on a dual carriageway road with two or more lanes per direction requiring short term lane closure (for a few hours only):

- Where short term lane closures (for a few hours) of a single lane on a dual carriageway road

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or roads with more than one lane per direction is required, traffic shall be accommodated as per Section 13.8.9 of SARTSM Volume 2, Short Term Lane Drop within Deviations, Figure 13.38.

- Traffic shall be separated by cones or delineators at 10 m spacing. The taper should be at a rate of 1:20 with a spacing of 5m between cones/delineators.
- Where such lane closures extend through an intersection the provisions of Section 13.10.6 of SARTSM Volume 2, Lane Closed Beyond a Junction shall be adhered too.

10.4 Construction within the road reserve - outside the roadway

Construction activities such as the construction of manholes might take place within the road reserve adjacent to the roadway. In these cases traffic should be managed in accordance with section 13.8.6 of SARTSM Volume 2: Fixed Site - Work on Shoulder.

If any such road work obstructs the side walk in such a manner that pedestrians cannot utilize the sidewalk anymore, then the road signage as in section 13.10.4, Sidewalk Deviation of SARTSM Volume 2 should be implemented.

10.5 Work within intersections.

Where construction work would take place through an intersection, it is recommended that sufficient flagmen be used to control traffic in the intersection.

At all signal-controlled intersections (traffic lights), the traffic police should be requested to do point duty within the intersection.

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11 PROCEDURES FOR ENVIRONMENTAL INVESTIGATIONS

11.1 Applicable environmental legislation

The applicant needs to comply with the legislation listed in Table 1 below prior to the commencement of the proposed project:

Table 1 Applicable environmental legislation

Title of Legislation, policy or guideline		Administrating authority	Type of approval
1	National Environmental Management Act, 1998 (Act No 107 of 1998) and the Environmental Impact Assessment Regulations, 2010	Department of Environmental Affairs (DEA)	Environmental Authorisation
2	National Environmental Management: Biodiversity Act, 2004 (Act No 10 of 2004)	Department of Environmental Affairs (DEA)	Environmental Authorisation, or Permit for the removal of protected plant species
3	National Water Act, 1998 (Act No 36 of 1998)	Department of Water Affairs (DWA)	Water Use License, or General Authorisation
4	National Heritage Resources Act (Act No 25, 1999)	South African Heritage Resources Agency (SAHRA)	SAHRA Permit
5	Mineral and Petroleum Resources Development Act, 2002 (Act No 28 of 2002)	Department of Mineral Resources (DMR)	Mining Permit, or Mining Right
6	National Environmental Management: Waste Act, Act No 59 of 2008	Department of Environmental Affairs – Directorate Waste Management	Waste Management License
7	Approved: Environmental Management Plan	Department of Environmental Affairs (DEA), and Environmental Control Officer (ECO)	Environmental Audit Report
8	All provincial and local authority by-laws	Local Authority	Way leave

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11.2 Required environmental procedures

The following environmental procedures need to be followed prior to the commencement of the proposed project:

11.2.1 Responsibilities of the applicant

- Identify preferred and alternative route and/or methodology options with regard to the project.
- Formulate clear motivation for the project and have technical specifications ready prior to environmental assessment.
- Identify and inform the land owner of the proposed project.
- Eight to ten months prior to anticipated commencement date of the proposed project, appoint an Environmental Consultant to commence with the EIA process:
  - To ensure compliance in terms of the National Environmental Management Act, 1998 (Act No 107 of 1998)
  - To ensure compliance in terms of the Environmental Impact Assessment Regulations, 2010
- Conduct initial site inspection with EAP.
- Finalise the preferred route as soon as possible after the initial inspection.

  Note: Changes to the route after application has been made to the Department prolong the Environmental Impact Assessment Process (EIA).
- Appoint an Environmental Consultant to commence with the Water Use Application process:
  - To ensure compliance in terms of the National Water Act, 1998 (Act No. 36 of 1998).
    - (i) Approval for a Water Use Licenses takes approximately two years.
    - (ii) DWA might require that the 1:100 year flood line be determined for each Water Use License Application. Time and financial budget have to include this item.
    - (iii) Approval for a General Authorisation takes approximately 3 – 6 months.
    - (iv) The water quality of all water courses needs to be determined before and after construction. Budget must allow for this activity.
- Consider the availability of backfill material (sand, gravel or any other mineral required) in the area. If backfill material cannot be sourced from an already permitted site, authorization is needed from the Department of Mineral Resources before any other suitable source is used for this purpose.
  - If needed, appoint a consultant to commence with the Mining Permit/Right Application process: To ensure compliance in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002),
  - No material may be removed from a farm or any other property, prior to receipt of a valid Mining Permit or Mining Right.
- Ensure provision in the budget for the appointment of an Environmental Control Officer (ECO) during the construction phase.

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11.2.2 Environmental Assessment Practitioner (EAP)'s responsibilities

- Conduct initial site inspection to identify environmental sensitivities, no-go areas, and do a holistic assessment of the area.
- Identification of specialists that is required.
- Draw up terms of reference for specialists and initiate specialist investigation of the proposed area.

  Depending on the area, the following specialists may be required:

  (i) Archaeologist;

  (ii) Botanical Specialist;

  (iii) Wetland Specialist.
- Initiate and drive the Environmental Impact Assessment (EIA) process.

11.2.3 Aspects to be addressed in the Environmental Management Plan

The following generic aspects need to be addressed in the construction phase of the Environmental Management Plan (EMP) of the proposed project. This is not an exhaustive list but can serve as a quick reference aid:

- Site layout and management of contractor's camp;
- Fencing off and securing access to contractor's camp and construction sites;
- Specification and management of access routes to contractor's camp and construction sites;
- Specification and management of construction footprint;
- Proof of authorised sites for the sourcing of backfill material;
- Handling of topsoil and overburden;
- Prevention of soil erosion;
- Management and prevention of loss of vegetation;
- Management and prevention of loss of riparian vegetation;
- Management and protection of fauna;
- Management and prevention of pollution of watercourse by effluents;
- Protection of surface and ground water;
- Waste handling;
- Handling of hazardous substances and procedures for handling of hazardous substance spillages;
- Health and safety provisions (to be complemented by the Health and Safety Officer);
- Air quality management;
- Fire prevention;
- Noise handling.

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11.3 Conclusion and recommendations

In conclusion, to ensure a successful process the following recommendations are made:

- It is vital that the land owners are informed of the project, by the applicant, prior to the start of the investigations as this helps prevent problems during the Public Participation Process (PPP).
- Alternatives must be identified and assessed. This can already be done during the planning phase.
- If the route is not finalised before commencement of the PPP and keeps on changing, the application will have to be amended after every change. This prolongs the approval processes.
- The EMP must form part of the legally binding contractual agreement between the applicant and the contractor. The contactor needs to include this item in his budget.
- The applicant/contractor needs to confirm that backfill material is available from suppliers with valid mining licenses.
- The contractor needs to be informed of the importance of environmental instructions.
- It is recommended that the ECO be empowered to stop construction works, if the contractor does not adhere to the conditions stipulated in the Environmental Authorisation (EA) and Environmental Management Plan (EMP). This will prevent later delays as the rectification measures will be done immediately.

  Note: The Departmental Environmental Monitoring Inspectors (DEA – Green Scorpions, DWA- Blue Scorpions) have been appointed and do compliance monitoring audits to ensure compliance with the conditions as stipulated in the EA and EMP and the Water Authorisations.
- Clear lines of communication must be established from the on-set of the project to avoid any delays in information exchange and proper project management.

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12 REFERENCES

1. PH Bagale, 2010, Requirements for the Design and Planning of Horizontal Directional Drilling Operations, Fairland

2. National Department of Transport, 2004, Committee of Land Transport Officials (COLTO), South African Road Traffic Signs Manual (SARTSM)

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APPENDIX A: Drawing requirements

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There are specific requirements in respect of drawings for evaluation/approval purposes for the provision of optic fibre infrastructure inside road reserves that must be adhered to. These are indicated below:

- Coordinates of road reserve boundaries obtained from MANCO-AURECON Joint Venture.
- Applications must be made per route section e.g. N2/1.
- Where available the 1:1000 layout plans of SANRAL must be utilised to show the position of the cables.
- Where the said drawings are not available, layout plans drawn at a scale of 1:5000 are required including enlargements at deviations.
- A way leave application form must accompany each application. A copy of the Application Form is attached as Appendix B.

Elements that must be shown on the plans are:

- Each drawing shall have a unique sequenced drawing number.
- Drawing scale and scale bar, north point, major destinations.
- Aerial photography background.
- The proposed optic fibre cable route shown in relation to road reserve boundaries.
- Posted kilometre distance at regular intervals and on either side of proposed deviations.
- Co-ordinates must be provided at bending points.
- All other services that will be affected.

As Built drawings must be submitted on completion of construction and shall be similar to the plans referred to above including the optic fibre route coordinates in WGS84 South African Grid (WGS) format.

As Built drawings must be submitted within 3 months after completion of the works.

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APPENDIX B: SANRAL Wayleave application form

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WAYLEAVE / ENCROACHMENT APPLICATION

APPLICATION AND CONSENT IN TERMS OF SECTION 48 OF THE SA NATIONAL ROADS AGENCY AND NATIONAL ROADS ACT, ACT 7 OF 1998 TO ENCROACH ON THE NATIONAL ROAD RESERVE BOUNDARY OR WITHIN THE BUILDING RESTRICTION AREA

SERVICE OWNER: *(*Please note that SANRAL is not the service owner)*	APPLICANT:
Address:	Address:
Contact Person:	Contact Person:
Telephone:	Telephone:
Cell Phone:	Cell Phone:
Facsimile:	Facsimile:
E-mail:	E-mail:
Contractor Contact Details:	Telephone:

PURPOSE OF APPLICATION

1. To install a new optic fibre cable for (Dark Fibre Africa)
2. To repair, replace an existing Dark Fibre Africa optic fibre
3. To occupy or perform other operations
4. New optic fibre cable in existing Ducts/re-route cable
5. Install optic fibre cable on existing Pole Route

Mark with X

SERVICE DETAILS AND REQUIRED DRAWINGS TO ACCOMPANY THE APPLICATION

FULLY DESCRIBE, TYPE OF SERVICE, AND WORK TO BE UNDERTAKEN IN THE ROAD RESERVE INDICATING CLEARLY THE LOCATION AND POSITION RELATED TO THE BLUE NATIONAL ROAD MARKER BOARDS AND ROAD RESERVE BOUNDARY. DRAWINGS REQUIRED: (CROSS SECTIONS AND REINSTATEMENT DRAWINGS AT HOR 1: 500 VERT 1: 50) (DETAIL LAYOUT AT 1:1000) (LOCALITY PLAN 1: 10000) AND ANY OTHER SPECIAL DRAWING WHICH THE SANRAL MAY REQUIRE

INFORMATION COMPULSORY

EXAMPLE

NATIONAL ROADS MARKER BOARDS AT 200 M INTERVALS

ROUTE AND SECTION -

CROSSING AT KILOMETRE

PARALLEL FROM KILOMETRE

BETWEEN LANDMARKS/ INTERCHANGES TO

And

DESCRIPTION

Your Reference: Your Drawing No's:

GENERAL INFORMATION [mark with X]

IN CASE OF AN OVERHEAD/UNDERGROUND SERVICE OR CROSSING IN BRIDGE OR OTHER STRUCTURE ATTACH THREE COPIES OF A CROSS-SECTIONAL DIAGRAM SHOWING THE POSITION OF THE SERVICE/STRUCTURE IN RELATION TO THE ROAD AND ROAD RESERVE AND HEIGHT ABOVE OR DEPTH BELOW THE ROADWAY AS WELL AS THREE COPIES OF THE LAYOUT PLAN.

OPTIC FIBRE
CABLE ☐

Crossing under/in road [ ]
In existing Duct [ ]
Through Structure [ ]

Jacking Under Road [ ]
Auger Under Ramps [ ]

Crossing Overhead [ ]
Parallel Underground [ ]
Parallel Overhead [ ]

GENERAL INFORMATION continued.....[Mark with X]

CABLE PARALLEL TO NAT ROAD: EACH DEVIATION IN EXCESS OF 2M FROM ROAD RESERVE BOUNDARY

From Marker Board km. Point	To Marker Board km. Point	Distance within ☐ Reserve Boundary (left or right) North Bound being left	Buried ☐	Overhead ☐
			Depth / Height	Size & Type of Ducts

SERVICE CROSSING NATIONAL ROAD/NATIONAL ROAD RESERVE

Km Point	Buried ☐ Overhead ☐			Size, Type & class of sleeve/ duct	THROUGH CULVERT	
	Depth below or height in meters above Roadway	Size & type Or Voltage	Dist of structures from Road Reserve Boundary Left &Right North being left		Cross-Sectional Area of Structure	Cross-Sectional Area of Encroachment

LOCATION OF SERVICE IN BRIDGE STRUCTURE

Km Point	Bridge Number	Interchange/Bridge Name

***PLEASE NOTE: CONSENT VALID FOR TWELVE MONTHS FROM APPROVAL**

DECLARATION BY DARK FIBRE AFRICA:

I ACCEPT ALL CONDITIONS IMPOSED IN TERMS OF ANY AGREEMENT BETWEEN THE SA NATIONAL ROADS AGENCY AND DARK FIBRE AFRICA OR ITS SUCESSOR AND ALL CONDITIONS IMPOSED ON THIS APPLICATION. THIS INCLUDES PAYMENT OF A FEE AS DESCRIBED IN CLAUSE 7 OF THE AGREEMENT SIGNED ON 27 MAY 2008. I AM AUTHORISED TO SIGN ON BEHALF OF (DARK FIBRE AFRICA) AND INCLUDE A POWER OF ATTORNEY IN THIS REGARD

PRINT NAME	SIGNATURE	DATE

COMPLETED FORM TO BE RETURN TO:
REGIONAL MANAGER
SA NATIONAL ROADS AGENCY LTD
PRIVATE BAG X19, BELLVILLE, 7535
FOR ATTENTION: STATUTORY CONTROL SECTION
TEL: +27(21) 957 4600
FAX: +27(21) 946 1630

FOR SOUTH AFRICAN NATIONAL ROADS AGENCY USE

COMPLETION DATE	FILE REFERENCE	CONSENT NUMBER

REGIONAL MANAGER	DATE APPROVED

APPENDIX C: Drawings of typical routing details

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Figure C1 Standard 001: Installation along road reserve boundary

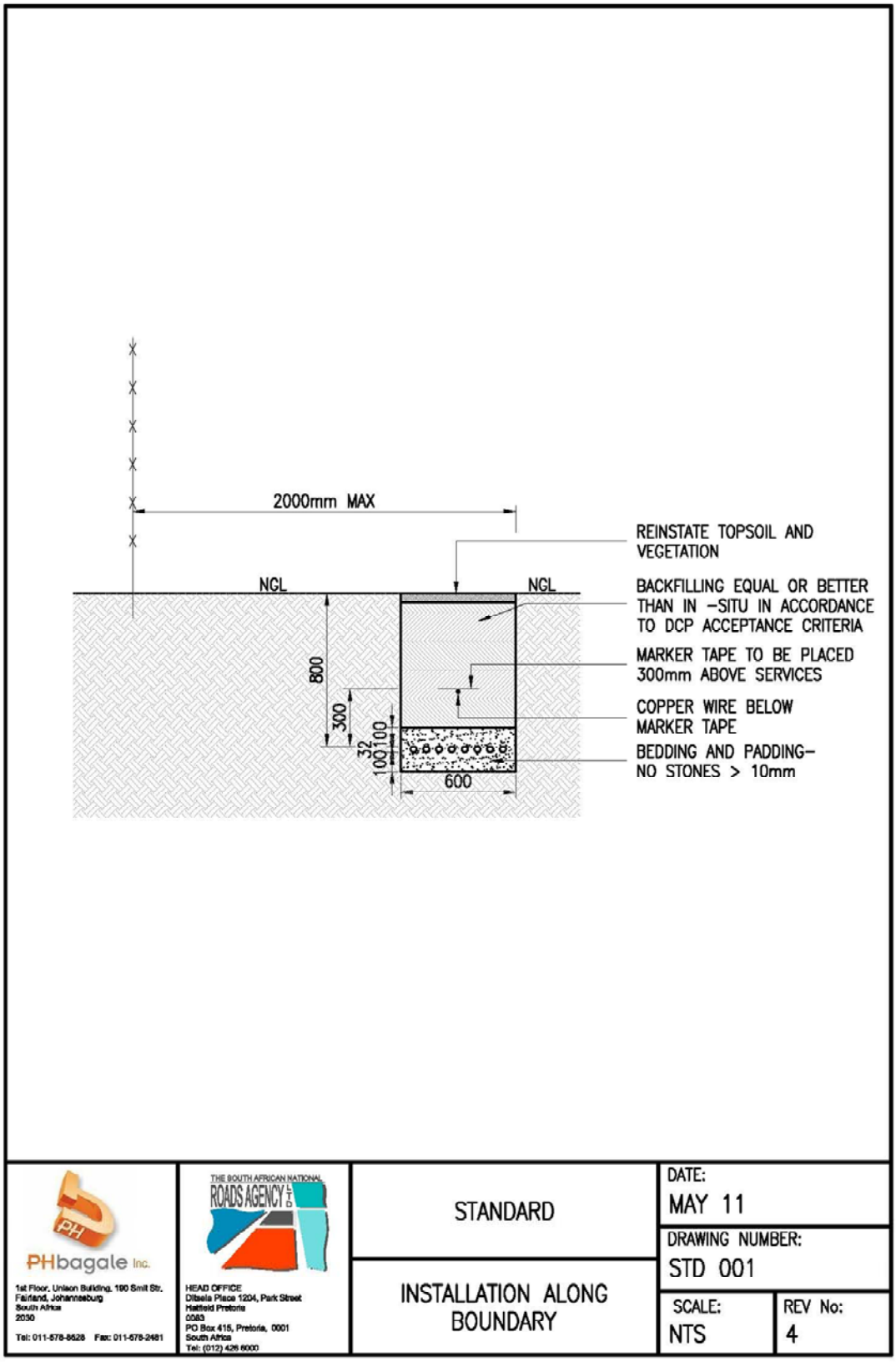


Figure C2 Standard 002: Horizontal Directional Drilling

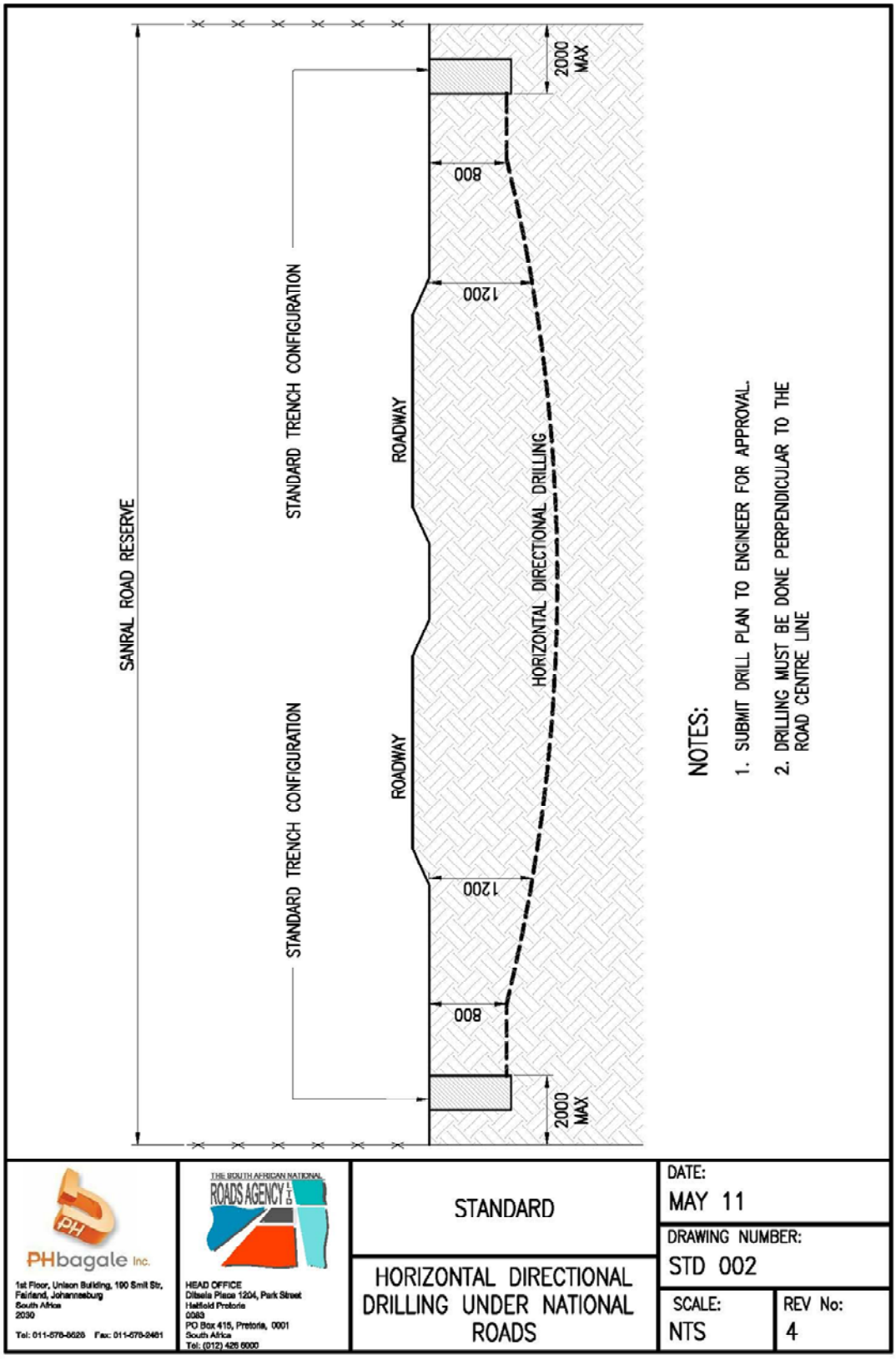


Figure C3 Standard 003: Trench at toe of embankment

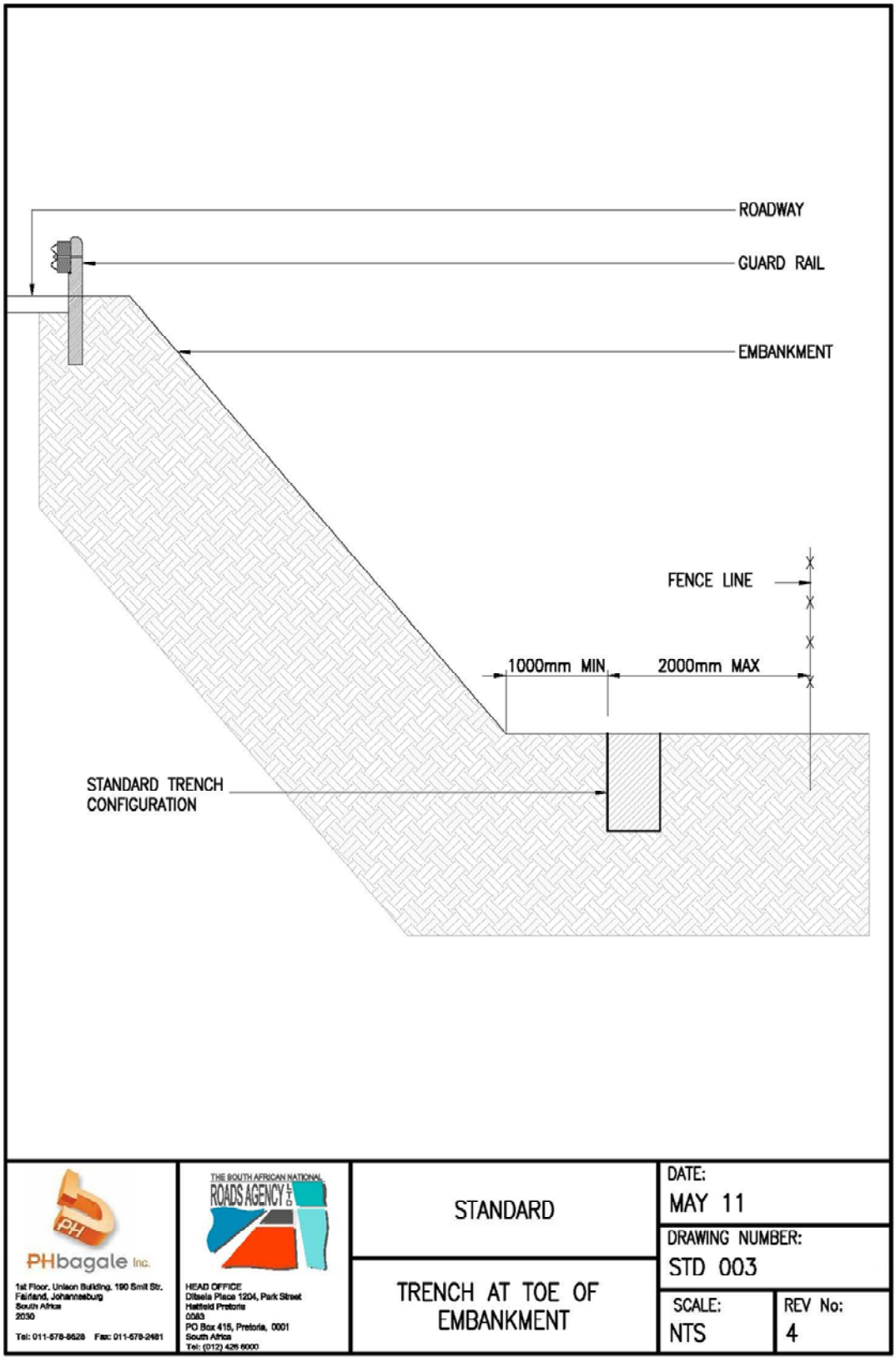


Figure C4 Layout 001: Crossing at interchanges: Cross road over / under freeway

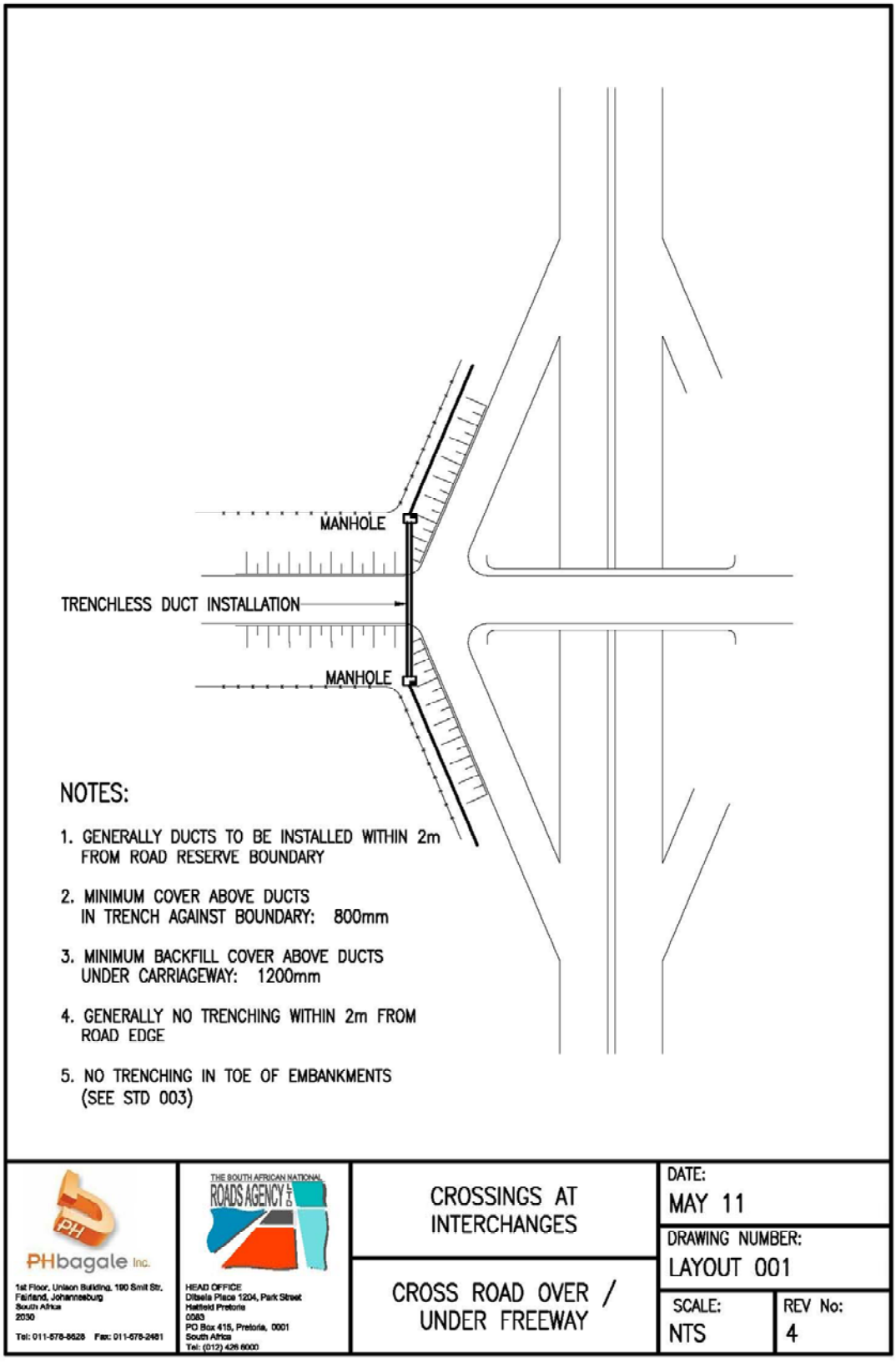


Figure C5 Layout 002: Crossing at interchanges: Cross at ramps

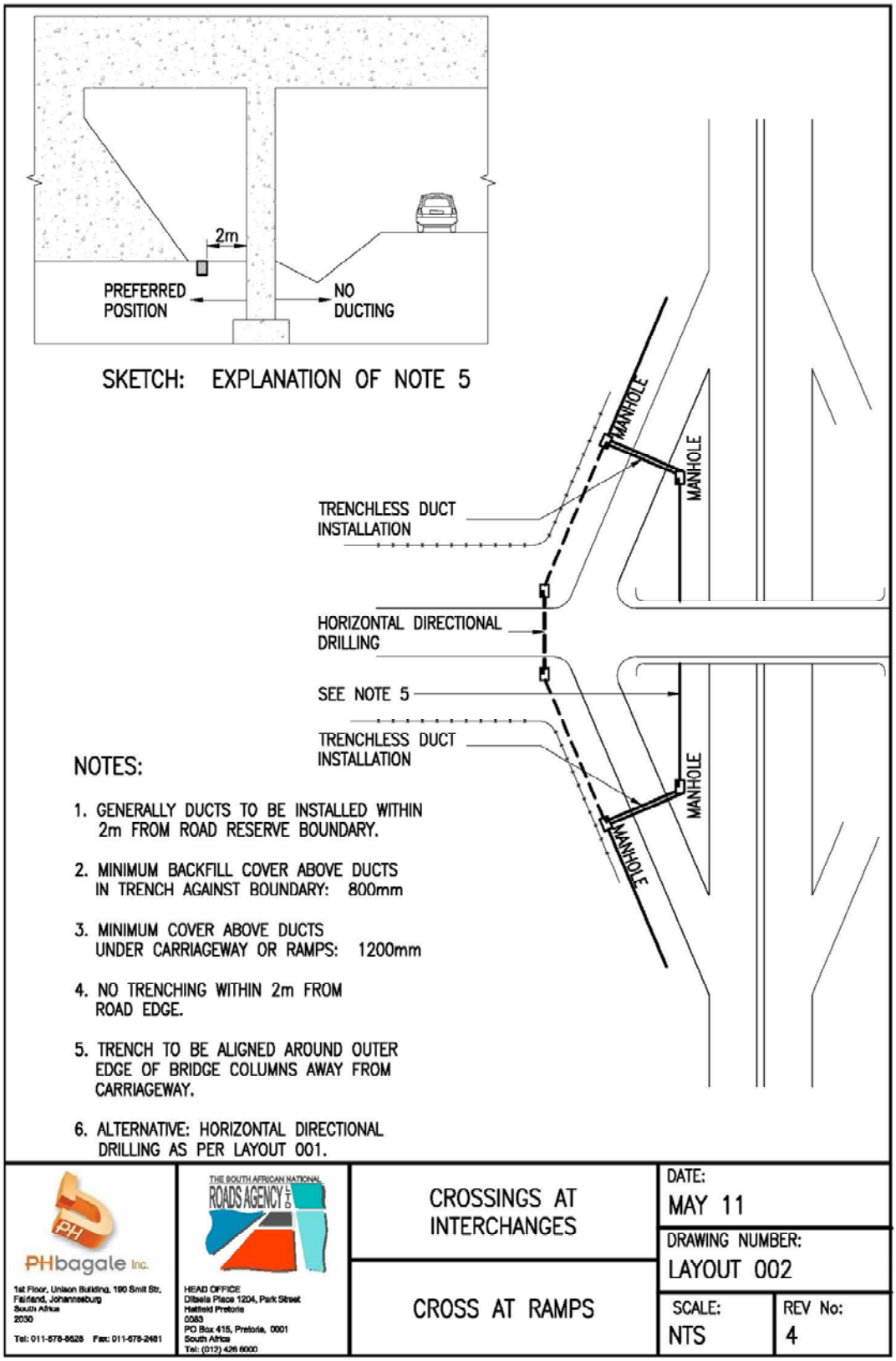


Figure C6 Standard 003: General road crossing: Trench at toe of embankment

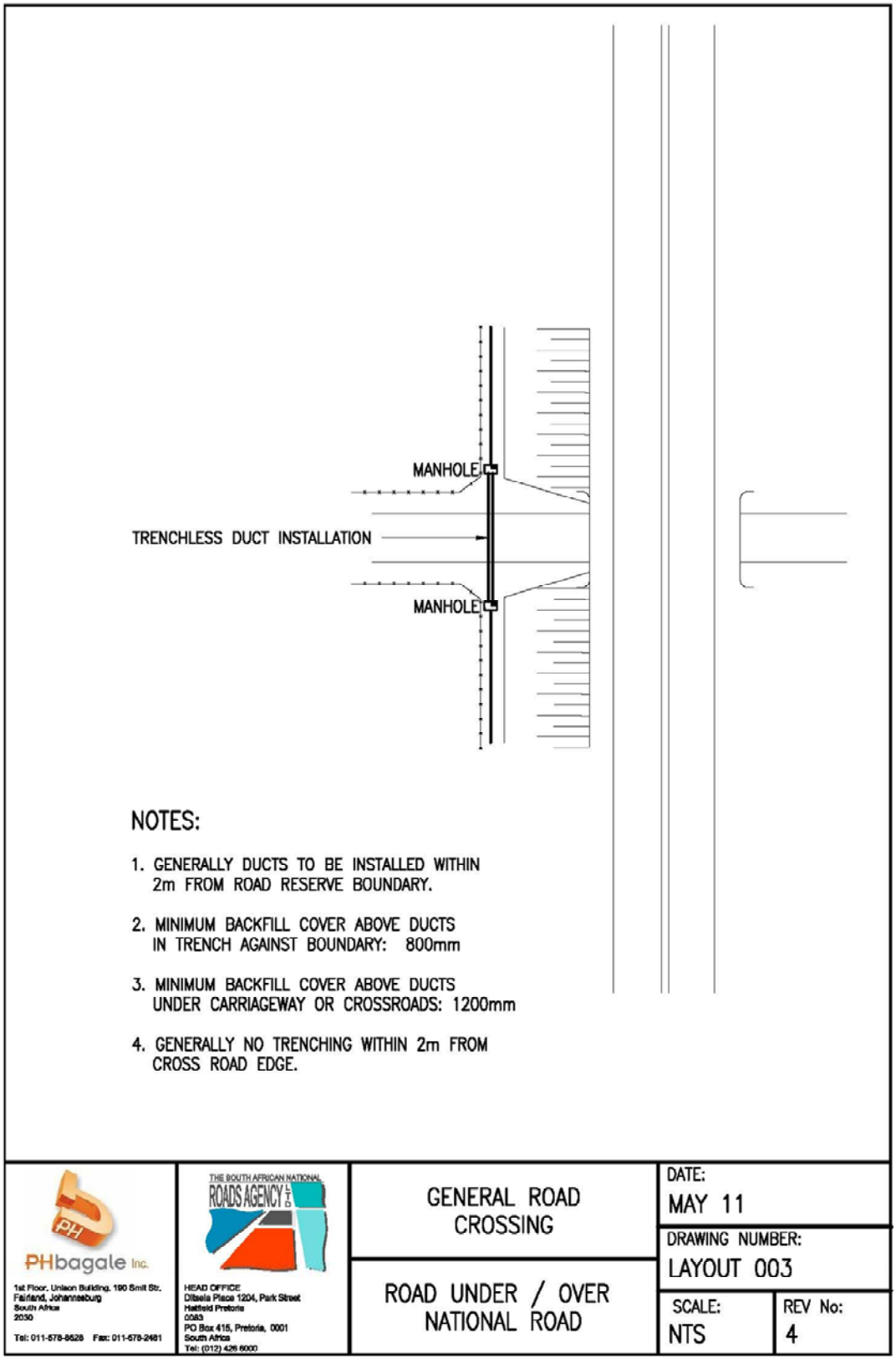


Figure C7 Standard 004: Bridges: Bridge attachment

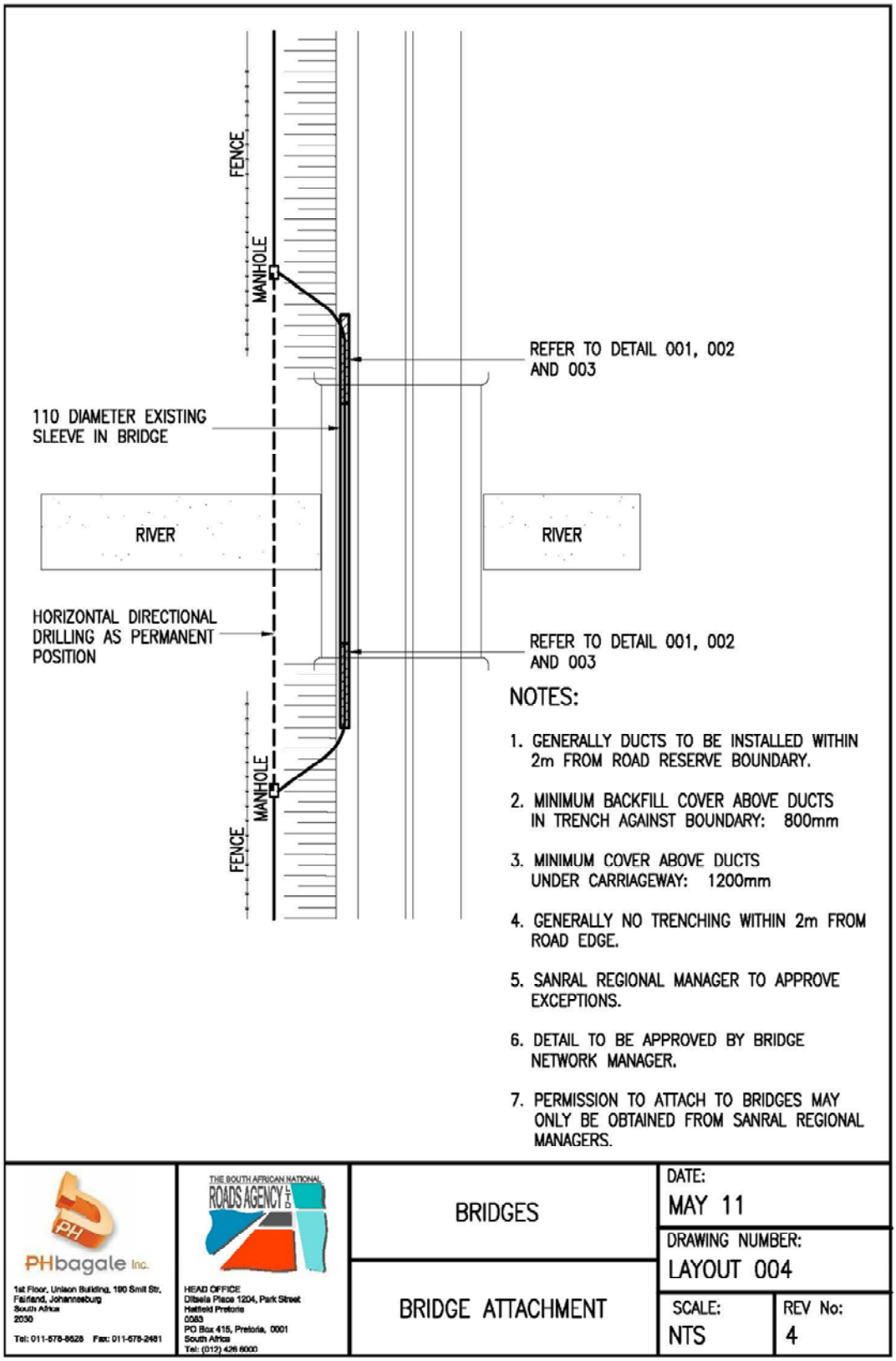


Figure C8 Detail 001: Conduit sleeves at fill embankment

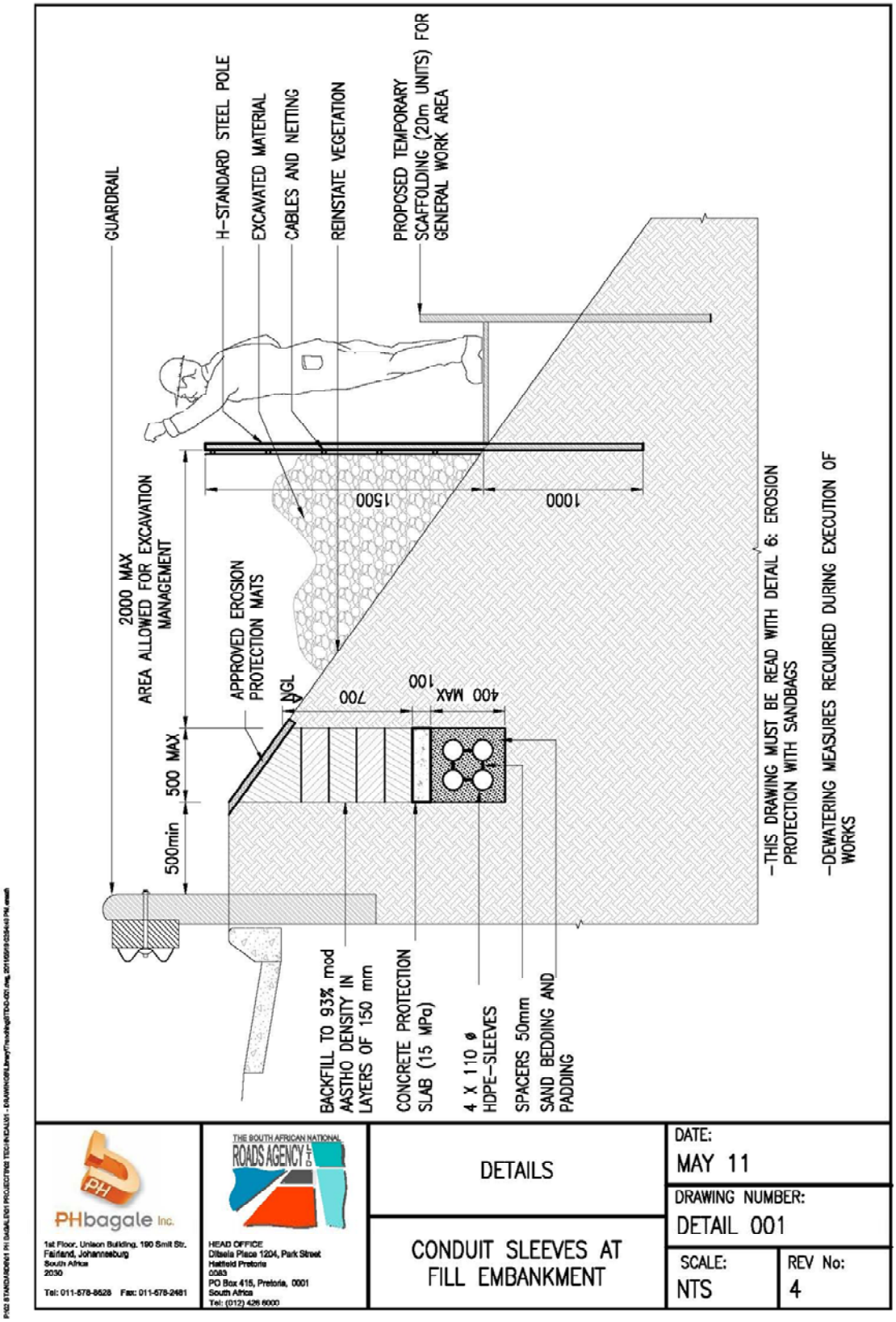


Figure C9 Detail 002: Conduit sleeves at steep cut faces

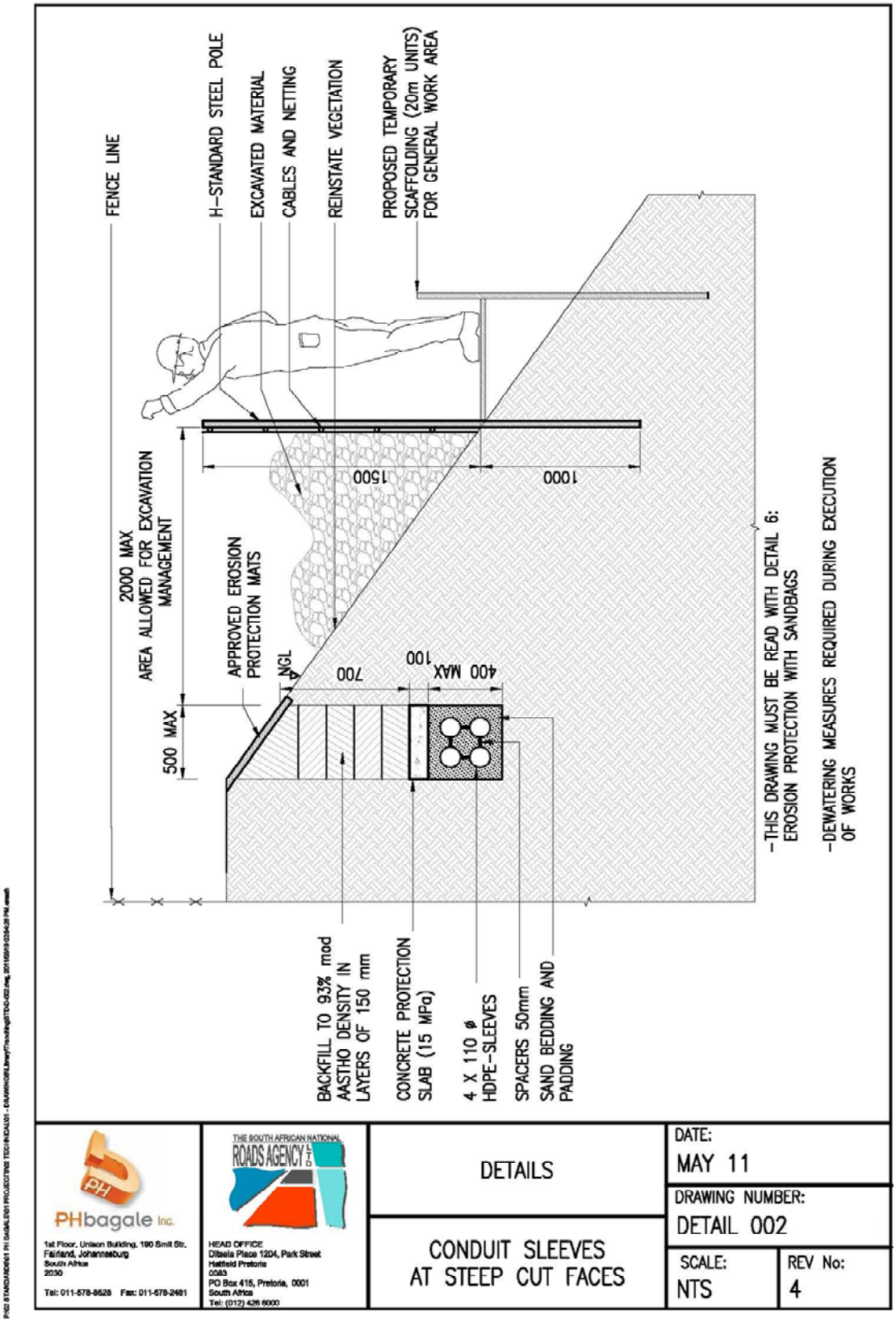


Figure C10 Detail 003: Sleeves in or at outer edge of concrete side drain

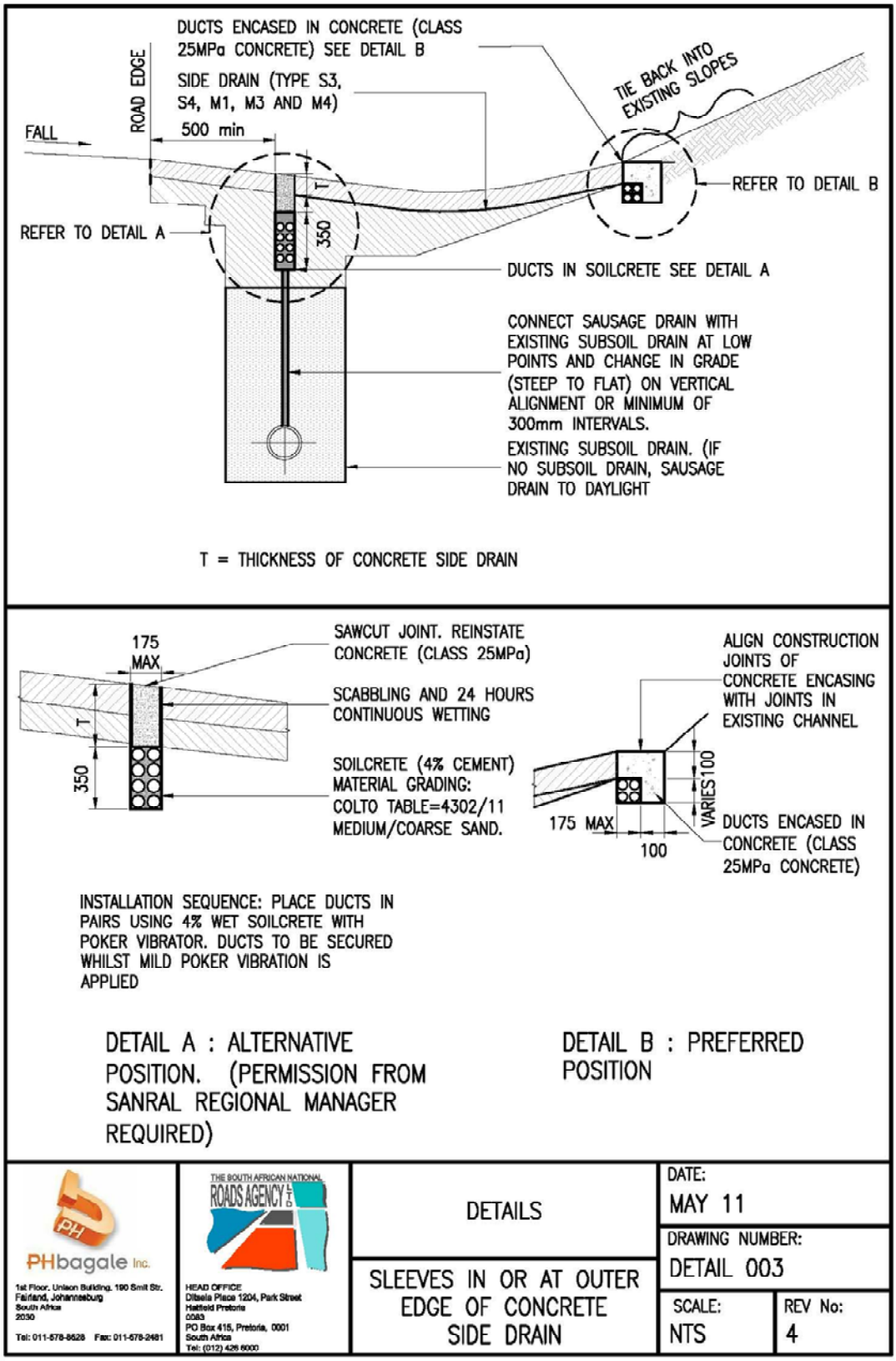
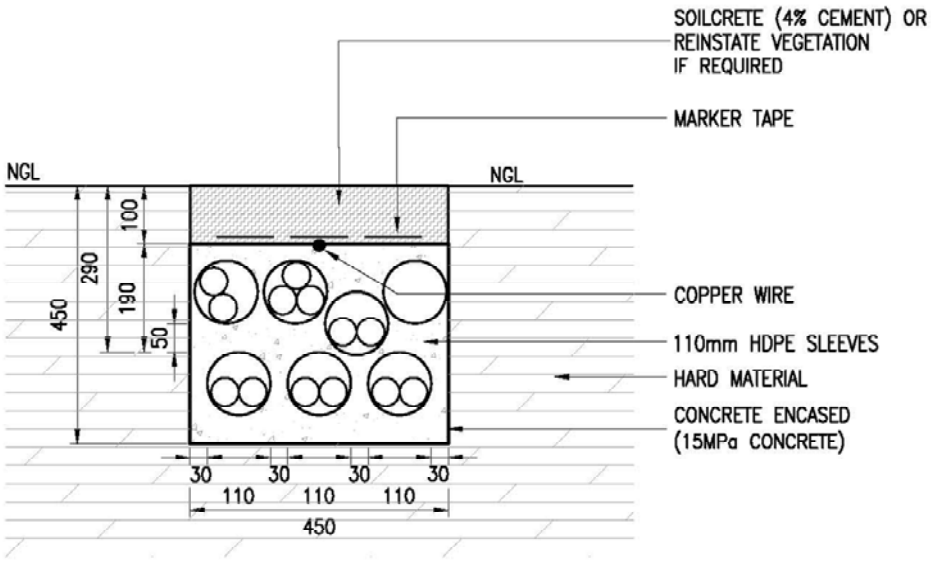


Figure C11 Detail 004: Standard concrete encasement in hard excavation



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DETAILS

STANDARD CONCRETE ENCASEMENT IN HARD EXCAVATION

DATE: MAY 11

DRAWING NUMBER: DETAIL 004

SCALE: NTS

REV No: 4

Figure C12 Detail 005: Soilcrete reinforcement at existing poles

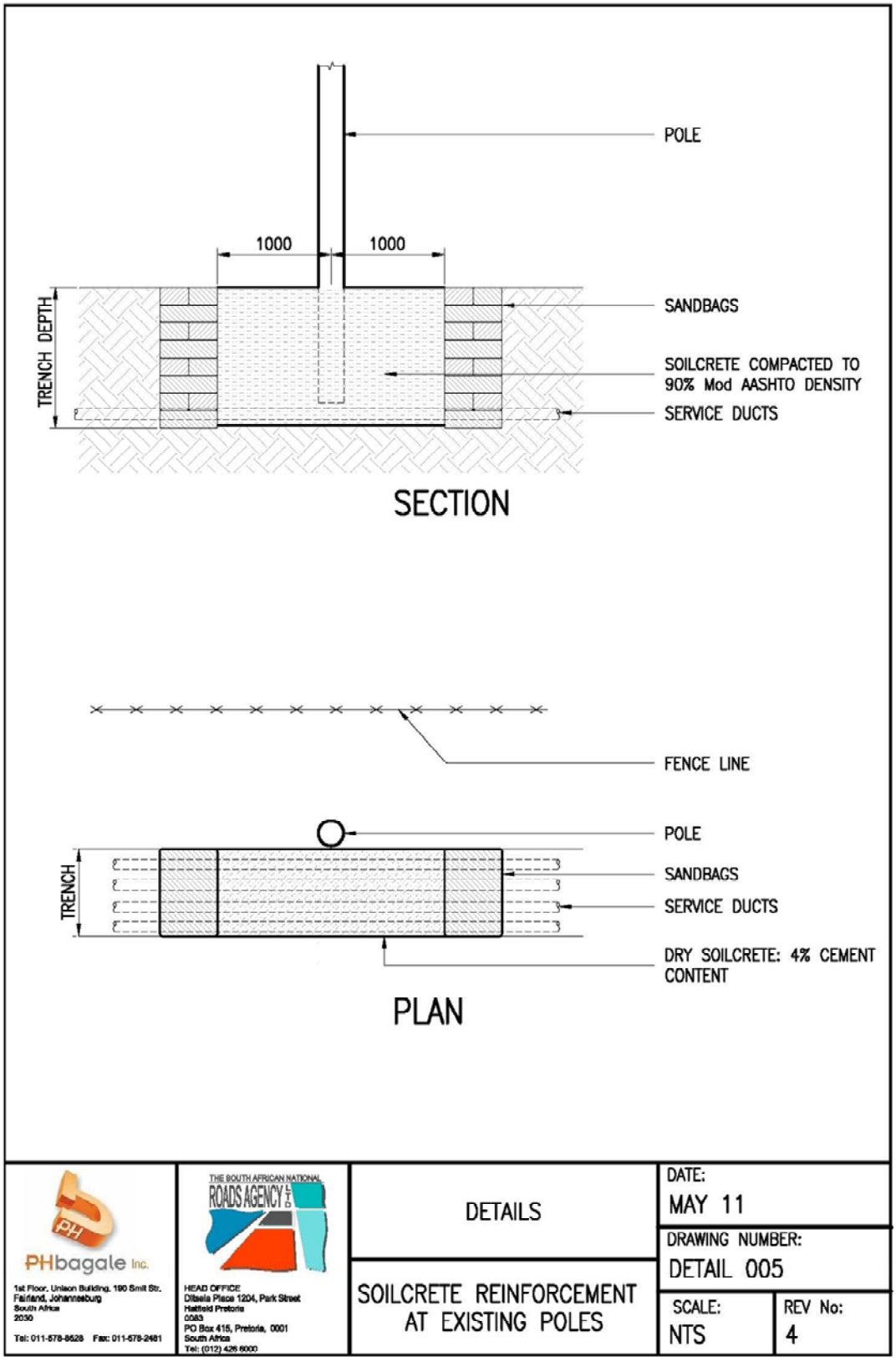

Figure C13 Detail 006: Erosion protection with sandbags

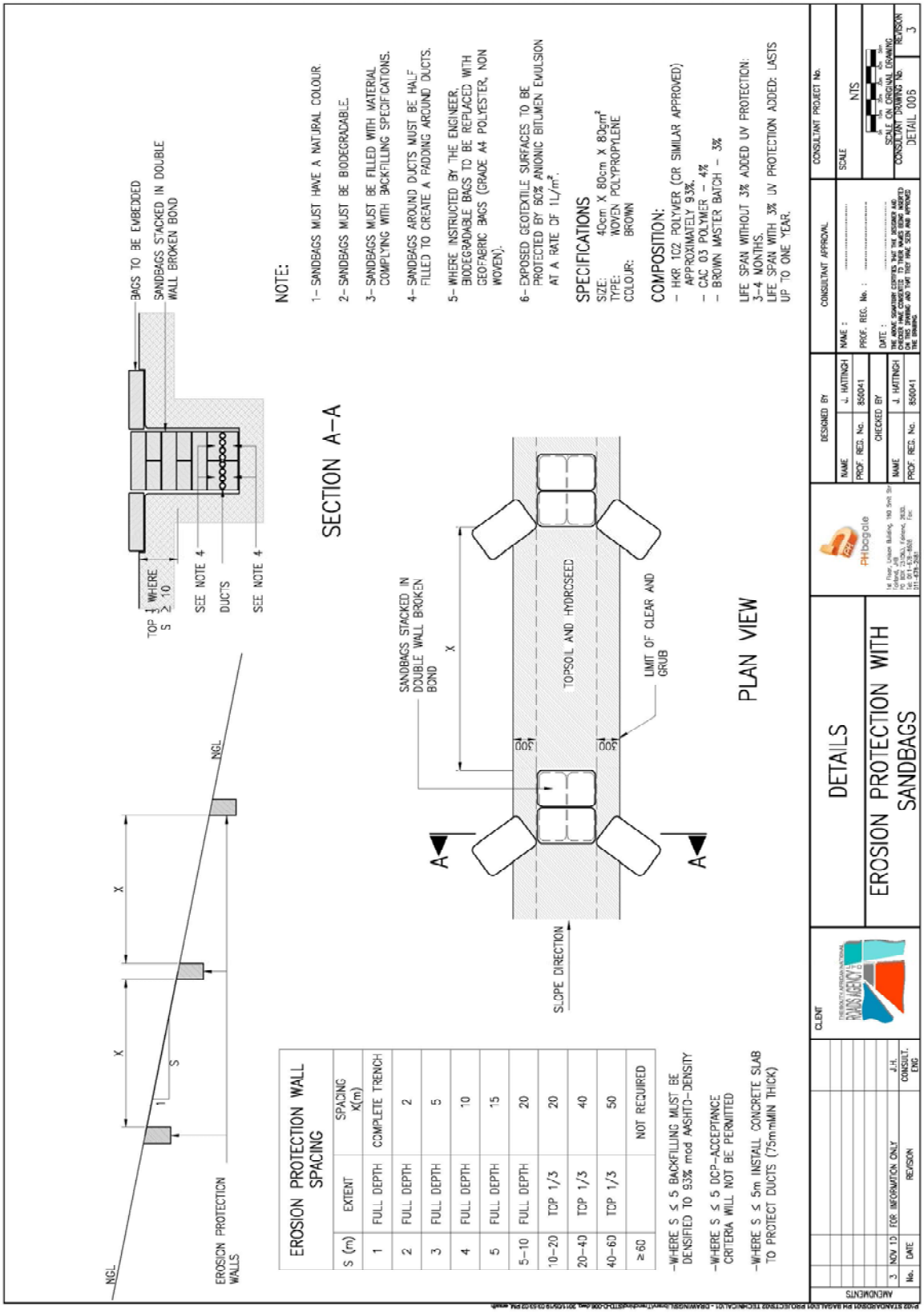
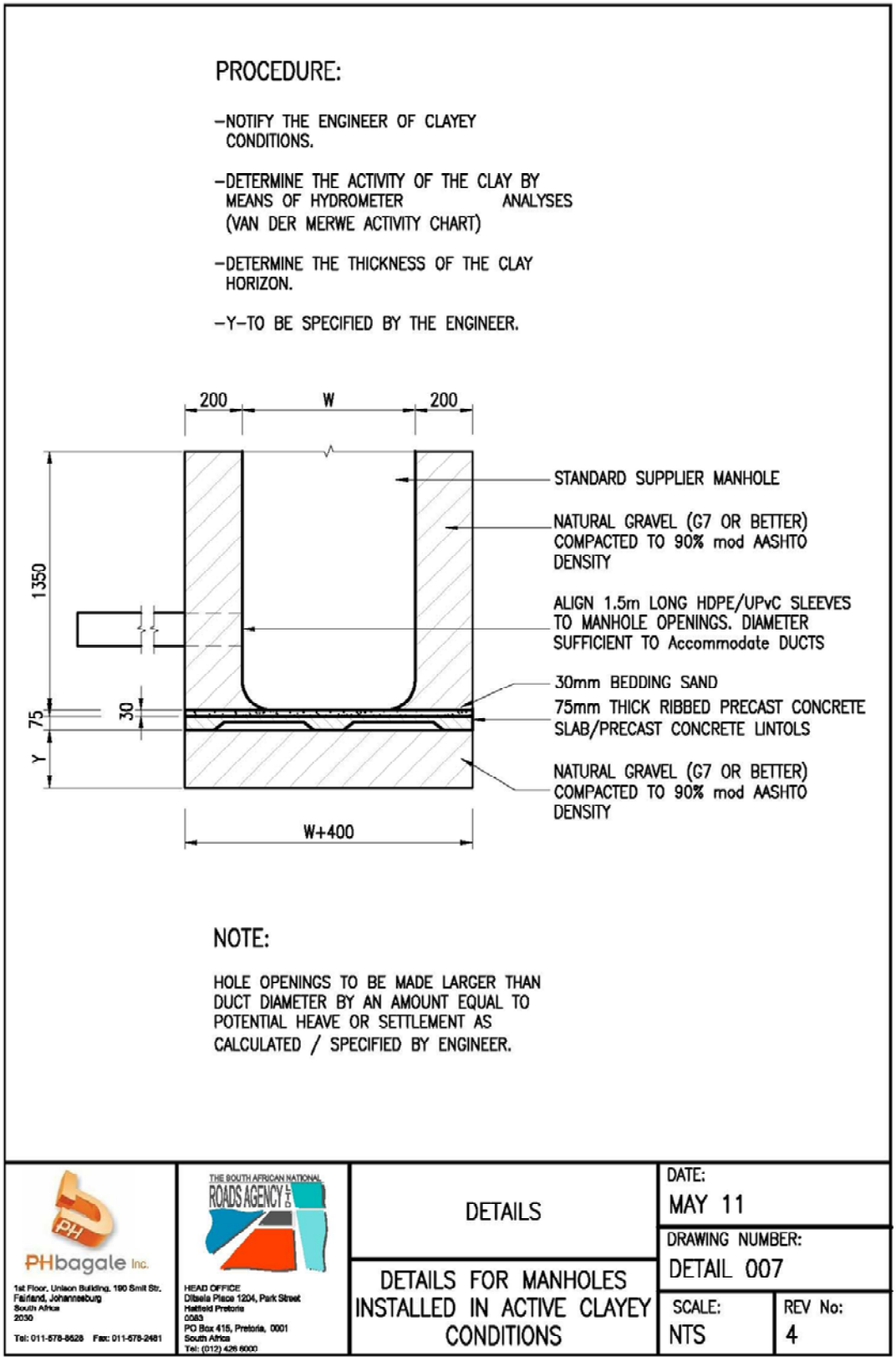
Figure C14 Detail 007: Details for manholes installed in active clayey conditions