# Chapter 5: Project Description

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# 5 Project Description

## 5.1 Introduction

This chapter describes the design philosophy of the Project, the construction schedules and the characteristics of the Construction and Pre-Commissioning, Operational and Decommissioning Phases. It describes the principal materials, wastes and emissions associated with the Project and anticipated labour requirements. Finally, it describes how material changes to the Project, and any consequent changes to the assessment and management of environmental and social impacts will be managed.

## 5.2 The Project

As described in **Chapter 1 Introduction**, the Project is the Turkish Sector of the South Stream Offshore Pipeline, which itself, is the offshore component of the South Stream Pipeline System that will deliver natural gas from Russia to the countries of Central and South-Eastern Europe.

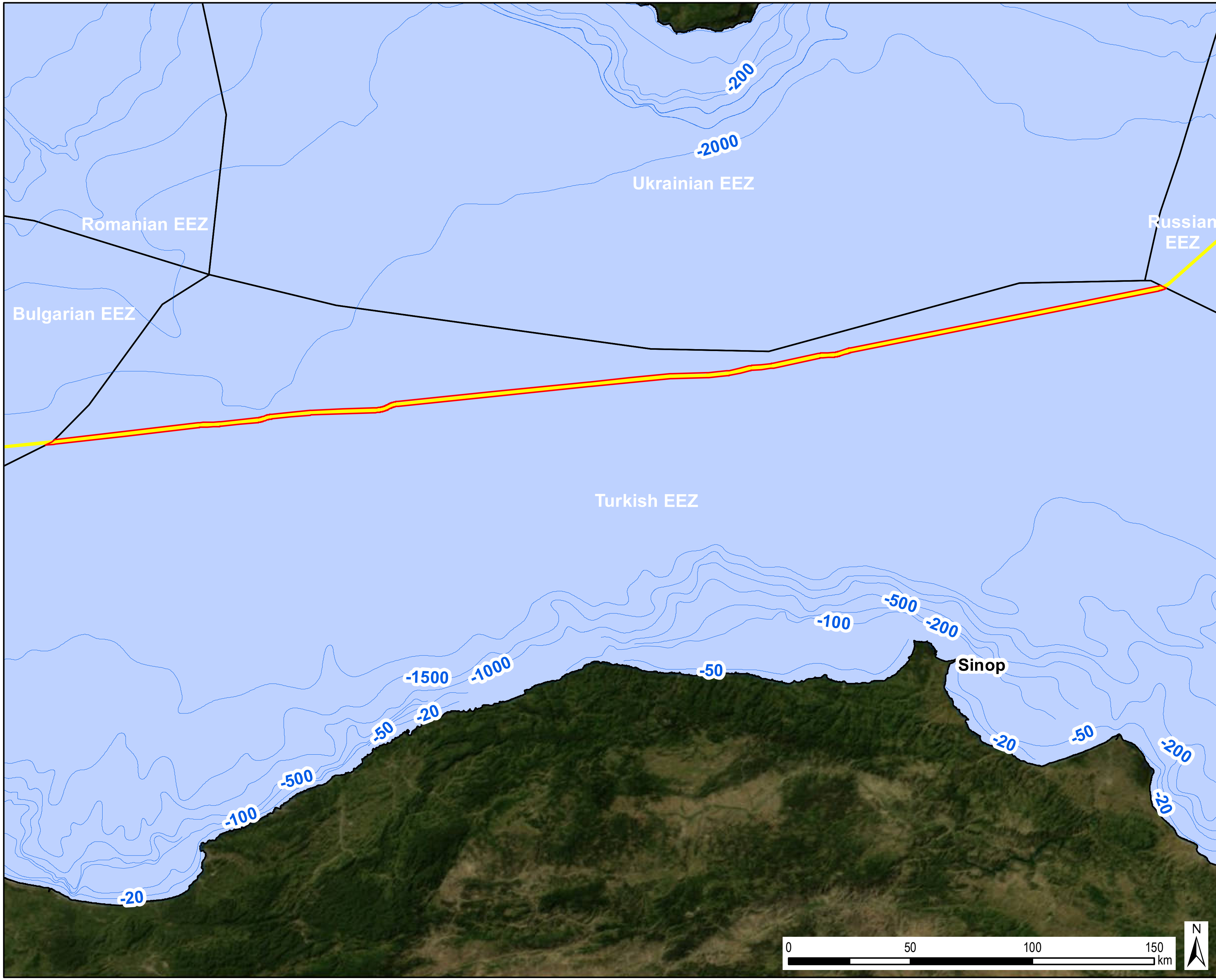
The Project is approximately 470 kilometres (km) in length and extends through the Black Sea from the border of the Russian EEZ in the east to the border of the Bulgarian EEZ in the west (Figure 5.1). The Project will comprise the construction and commissioning, operation and decommissioning of four 32-inch diameter (813 millimetres (mm)) pipelines within the Turkish EEZ.

The four pipelines will be laid directly on the seabed. No seabed intervention works are anticipated either before or after pipe-lay. There will be no landfall facilities within the Turkish Sector.

At maximum capacity the South Stream Offshore Pipeline will be able to transport up to 63 billion cubic metres (bcm) of natural gas per year from Russia to Bulgaria. Each of the four Project pipelines will have a maximum flow rate of approximately 47.9 million standard cubic metres (MMSCM) per day (approximately 15.75 bcm per year), and a maximum design pressure of 300 bar.

The proposed route of the Project was selected following an Analysis of Alternatives as described in **Chapter 4 Analysis of Alternatives**. Final Pipeline route alignments may be further optimised during the detailed design phase; however any such changes are not anticipated to result in changes to the impact assessments presented in technical Chapters 7 to 12 of this ESIA Report.

During detailed design, Construction and Pre-Commissioning and Operational Phases of the Project, there may be a requirement to amend design elements or processes which results in a deviation from that presented in this project description. The Project has a management of change process to manage and track any such amendments. Further information is set out in Section 5.12.




**LEGEND**

**Turkish Sector of South Stream Offshore Pipeline**

- Proposed offshore pipelines
- Turkish Project Area
- Exclusive Economic Zones
- Isobaths

Projection: Lambert Conformal Conic

Purpose of Issue
For Information

Client
South Stream Offshore Pipeline – Energising Europe

Project Title
SOUTH STREAM OFFSHORE PIPELINE

Drawing Title
TURKISH PROJECT AREA

| Drawn | Checked | Approved | Date |
|---|---|---|---|
| AH | RW | MW | 23/04/2014 |

| URS Internal Project No. | Scale @ A4 |
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| 46369082 | 1:2,000,000 |



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www.ursglobal.com

Drawing Number
Figure 5.1

Rev

Plot Date: 23 Apr 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Turkey\Tukey ESIA\Chapter 5\Figure 5.1 Turkish Project Area_Layout.mxd

It is proposed that the pipelines will be laid within a 420 metre (m) corridor, in agreement with the relevant Turkish authorities. This corridor accommodates the four pipelines and a safety zone either side of the outermost pipelines. In general, the four pipelines will be laid in parallel 100 m apart, although this may change in response to specific seabed conditions.

## 5.3 Design Philosophy

The overall design philosophy is to ensure compliance with internationally recognised standards for the design, material use, fabrication, installation, testing, commissioning, operation, maintenance and environmental and social management of pipeline systems. Specific considerations which have informed the approach to and eventual design are discussed below.

### 5.3.1 Pipeline System Design Codes and Standards

The Project will comply with applicable Turkish regulations, construction permit and other related permits. The Project will be designed in accordance with recognised and respected pipeline industry standards.

The pipeline will be designed and constructed in compliance with the internationally-recognised offshore design code Det Norske Veritas (DNV) Offshore Standard DNV-OS-F101 Submarine Pipeline Systems (DNV, October 2010), which is harmonised with International Organisation for Standardisation (ISO) 13623:2009 and other relevant ISO standards. This design code has been used for 65% of offshore pipelines worldwide, including Blue Stream that connects Russia with Turkey across the Black Sea, and Nord Stream, which is the only high pressure offshore pipeline constructed in the Baltic Sea.

DNV will certify compliance with the above referenced standard.

### 5.3.2 Pipeline Design Parameters and Gas Properties

#### 5.3.2.1 System Export Capacity

The South Stream Offshore Pipeline has a design life of 50 years. When fully operational, it will have a design export capacity of 63 bcm per year. Each of the four pipelines will have an export capacity of 15.75 bcm and a daily flow rate of approximately 47.9 MMSCM per day (MMSCM/day).

The entire South Stream Offshore Pipeline, including the Turkish Sector, will have a design pressure of 300 bar although the expected maximum operating pressure is anticipated to be approximately 284 bar.

#### 5.3.2.2 Gas Composition and Properties

The gas will consist of approximately 97 mol%[1] of methane and 0.41 mol% carbon dioxide. The gas density is anticipated to vary between approximately 60 and 250 kilograms per cubic metre (kg/m$^3$).

Table 5.1 provides a summary of the likely composition of the gas. These gas properties apply as design values only and the properties of the processed natural gas provided to the South Stream Offshore Pipeline may vary slightly from those identified in Table 5.1. However, any changes will be very small deviations around the design natural gas parameters and will not result in changes to the size and design of the main Project components.

**Table 5.1 Gas Composition**

| Component | Mol% | Component | Mol% |
|---|---|---|---|
| Methane | 97.5389 | n-pentane | 0.0171 |
| Nitrogen ($N_2$) | 0.9305 | Hexane | 0.0205 |
| Carbon Dioxide ($CO_2$) | 0.4101 | Heptane | 0.0033 |
| Ethane | 0.8800 | Octane | 0.0004 |
| Propane | 0.1399 | Nonane | 0.0001 |
| i-butane | 0.0150 | Water | 0.0014 |
| n-butane | 0.0249 | Methanol | 0.0005 |
| i-pentane | 0.0171 | Hydrogen sulphide ($H_2S$) | 0.0003 |

#### 5.3.2.3 Resource Efficiency

Resource efficiency measures will form part of South Stream Transport's Environmental and Social Management Plan (ESMP). Examples of such measures in Turkey include:

- Appropriate vessels will be chosen and maintained correctly; and
- Systematic monitoring of the condition and the adjustment of the fuel systems of ship equipment to ensure efficient use of fuel.

[1] Mol% describes the percentage of moles (or molecules) within a given mixture.

## 5.4 Pipeline Description

### 5.4.1 Pipeline Overview

The pipelines will be constructed of steel in 12 m sections. The pipe sections will be coated both inside and outside prior to delivery. The internal coating will be an epoxy paint which improves internal cleanliness and gas flow, whilst the external coating will be made of three-layer-polypropylene (3LPP) to protect the pipelines from corrosion.

In addition, the pipelines will also be protected against corrosion by a cathodic protection system consisting of sacrificial anodes. Further details are presented below.

### 5.4.2 Pipe Dimensional Data

The properties of the steel pipe are summarised in Table 5.2.

**Table 5.2 Pipeline Dimensional Data of 32-inch Pipe**

| Parameter | 32-inch Pipe |
|---|---|
| Pipe nominal outside diameter | 812.8 mm |
| Pipe nominal inside diameter | 734.8 mm |
| Wall thickness | 39 mm |
| Internal or external corrosion allowance | 0 mm |
| Wall thickness fabrication tolerance | ±1 mm |

### 5.4.3 Buckle Arrestors

Buckle arrestors, i.e. pipe reinforcement, are used in the pipeline to avoid buckle propagation in the event of local buckling by placing arrestors at regular intervals and/or in susceptible areas along the length of the pipeline. The buckle arrestors will be welded into the pipelines in those areas that are susceptible to collapse, local buckling or propagation buckling.

Buckle arrestors are manufactured from the same steel grade as the pipes and essentially act as a reinforcing ring placed around the outside of the pipe.

An integral ring buckle arrestor is considered to be the most effective type of arrestor for deep water pipeline projects. As such, an integral ring buckle arrestor approximately 4.1 m long with wall thickness of 74 mm (tapering down to 39 mm) is proposed. Buckle arrestors will be required throughout the Project (i.e. the Turkish Sector) and it is proposed that a buckle arrestor spacing of 2,000 m is used. As the exact spacing of arrestors will depend on the pipe-lay installation methodology, the final spacing of the arrestors will be determined in consultation with the appointed construction contractor.

#### 5.4.3.1 Welding

Line pipe sections will be welded to form the four pipelines. Each weld will be subject to visual inspection and non-destructive examination (NDE) to ensure it meets the required specification. The weld specification will be agreed with the installation contractor in compliance with design standards prior to construction and supported by an Engineering Critical Assessment. The weld specification will be produced to complement the NDE procedures.

Critical processes such as welding will be inspected by the contractor's quality assurance crew, and thereafter inspected by DNV and South Stream Transport.

#### 5.4.3.2 Corrosion Protection, Internal and External Coatings

**Corrosion Protection System**

Corrosion protection will be achieved through a combination of an external anti-corrosion coating with associated field joint coatings, and cathodic protection.

**Anti-Corrosion Coating**

A three-Layer-Polypropylene (3LPP) external coating will be applied to protect the steel line pipe from external corrosion. The 3LPP coating combines excellent mechanical properties and heat resistance (up to 105ºC) with a high degree of resistance to chemical attack and cathodic disbondment. The external coating is selected to provide additional mechanical strength for handling (given the heavy weight of pipe joints) and high reliability protection against a severe environment in combination with a long lifetime.

**Internal Flow Coating**

An internal coating will be applied to the pipelines to improve the flow efficiency. An internal flow coating will also assist in maintaining a dry internal pipe surface as less water will be absorbed by the coating compared to the steel. Furthermore, the smooth internal surface will reduce wear of pigging instruments during pre-commissioning tests and inspections. The proposed internal flow coating is two component epoxy paint with a thickness of minimum 100 micrometres (µm).

**Field Joint Coating**

The application of the external anti-corrosion coating on the line pipe leaves the pipe ends exposed for welding during installation. Coating of the girth weld area after completion of welding is an integral component of the pipeline protection system. Such a coating system is called the field joint coating.

Field joint coating needs to ensure a good corrosion protection in the weld area. Given the particular chemical characteristics of the Black Sea, which is anoxic and saturated with $H_2S$ at a water depth below 150 m, it is particularly important to protect the weld area with a highly reliable field joint coating. This is in addition to the normal functions of field joint coating, which are to provide protection from impacts and against corrosion.

The selected field joint coating system is injection moulded polypropylene coating on top of a fusion bonded epoxy layer. The field joint coating will consist of a heat shrink sleeve applied directly over the joint. The thickness will be 5 mm minimum over the weld and 8 mm minimum on the pipe body.

**Cathodic Protection**

Cathodic protection will be provided by sacrificial anodes developed in accordance with the recommended practice design code DNV-RP-F103.

The anodes will consist of a zinc alloy half-shell bracelet that will be attached to the pipeline at intervals of up to 300 m along each pipeline. Approximately 1,650 zinc alloy bracelets are anticipated in the Turkish Sector, equivalent to a total anode mass of 620 tonnes.

## 5.5 Construction Phase

This section describes the activities that will take place during construction of the Project.

### 5.5.1 Indicative Construction Schedule

The overall South Stream Offshore Pipeline phases and timeline is provided in **Chapter 1 Introduction**. The base case construction schedule for the Project is summarised in Table 5.3. Pipe-laying is programmed for early 2015, with first gas from Pipeline 1 scheduled for late 2015, and all four pipelines fully operational by the end of 2017.

As with all large construction projects there may be some changes made to the schedule, during the Construction and Pre-commissioning Phase, as a result of unforeseen delays such as weather conditions, logistics, geological conditions or administrative procedures with national governments. Should there be any material change to the construction schedule, which may affect the results of the ESIA Report; the management of change process described in Section 5.12 will be followed.

Two main methods of pipe-lay are generally employed; J-Lay and S-Lay (refer to Section 5.5.3.5). The construction schedule presented in Table 5.3 assumes a J-Lay method, in which the pipeline vessel moves more slowly than in S-Lay, and is therefore a more conservative assumption in identifying and assessing environmental and social effects.

Table 5.3 indicates the sequence of Pipeline construction. Pipelines would be laid in an east to west direction, and from north (Pipeline 1 being most northerly) to south. There are no plans for there to be two construction spreads in Turkish waters at the same time. Given the construction spreads will be travelling at approximately the same speed, there will also be at least 470 km between the spreads at any given time.

**Table 5.3 Indicative Construction Schedule (All Four Pipelines)**

| | Nov-14 | Dec-14 | Jan-15 | Feb-15 | Mar-15 | Apr-15 | May-15 | Jun-15 | Jul-15 | Aug-15 | Sep-15 | Oct-15 | Nov-15 | Dec-15 | Jan-16 | Feb-16 | Mar-16 | Apr-16 | May-16 | Jun-16 | Jul-16 | Aug-16 | Sep-16 | Oct-16 | Nov-16 | Dec-16 | Jan-17 | Feb-17 | Mar-17 | Apr-17 | May-17 | Jun-17 | Jul-17 | Aug-17 | Sep-17 | Oct-17 | Nov-17 | Dec-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pre-Lay Surveys(in Turkish Waters)* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| All | ■ | ■ | | | | | | | | | | | ■ | | | | | ■ | ■ | | | | | ■ | ■ | | | | | | | | | | | | | |
| *Pipe-Laying (in Turkish Waters)* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | | | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | |
| *Pre-Commissioning* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ |
| *Commissioning and First Gas* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ |

### 5.5.2 Logistics and Material Supply

The Project will require the procurement of materials, equipment and labour from locations both within and outside of the European Union (EU). The steel line pipe is anticipated to come from pipe mills located in Europe, Russia, Japan, and/or India.

It is currently anticipated that all of the pipe required to construct the Project will arrive at marshalling yards in Bulgaria via sea.

#### 5.5.2.1 Marshalling Yards

Large scale pipeline construction work requires considerable support from onshore support facilities, known as marshalling yards, for the delivery, storage and load out of pipe, plant and equipment. The marshalling yards will also provide support facilities, which will provide general storage for supply of consumables to the offshore fleet, and managerial support for South Stream Transport and its contractors.

Marshalling yards for the construction of pipelines 1 and 2 will be located at the ports of Varna East, Varna West and Burgas in Bulgaria. The impacts of the development and use of these marshalling yards are assessed in the South Stream Offshore Pipeline – Bulgarian Sector: ESIA Report. The Project is committed to using these marshalling yards for construction of pipelines 1 and 2, including construction of the landfall (onshore) components in Russia and in Bulgaria. The location of marshalling yards for the construction of pipelines 3 and 4 will be determined as construction contracts for these lines are determined.

There will be no marshalling yards located in Turkey.

### 5.5.3 Construction Phase

#### 5.5.3.1 General Overview

The main construction activities to be undertaken within the Project Area include:

- Surveys of the Pipeline route prior to, during and after the pipe-laying process; and
- Offshore pipe-laying.

#### 5.5.3.2 Construction Vessel Spread

The number, types and technical specifications of vessels associated with the pipe-lay, and the associated requirements for the transport of personnel (via vessel or helicopter) will be determined by the principal construction contractors. For the purposes of this ESIA Report, a typical array of construction vessels, machinery and equipment has been assumed; details are provided in Table 5.4 and illustrated in the schematic in Figure 5.2.

**Table 5.4 Typical Offshore Construction Vessel Spread per Pipeline**

| Construction Activity | Type of Vessel | Task | Number of Vessels | Duration (days) per vessel | Indicative Vessels | Power Rating in kilowatts (kW) | Persons on Board | Utilisation (%) |
|---|---|---|---|---|---|---|---|---|
| Offshore Pipe-laying | Deep water pipe-lay vessel | Deep water pipe-laying | 1 | 170 (470 km at 2.75 km per day) | Saipem 7000 Castorone | 70,000 | 725 | 40 |
| | Tug | General support | 1 | As above | Normand Neptun | 13,880 | 40 | 60 |
| | Pipe Supply Vessel (PSV) | Supplying pipe to pipe-lay vessel | 5* | As above | Normand Flipper | 7,160 | 16 | 60 |
| | Survey vessel | Surveying the sea floor in front and behind the pipe-lay vessel | 2 | As above | GSP Prince | 7,604 | 62 | 60 |
| | Multi Service Vessel (MSV) | ROV support<br>Diving support<br>Consumables supply<br>Bunker supply<br>Provisions supply<br>Water supply | 2 | As above | Normand Mermaid | 10,000 | 70 | 60 |
| | Fast supply vessels | Crew changes | 1 | 5 (i.e. 10 half day trips) | GSP Lyra | 2,520 | 70 | 60 |

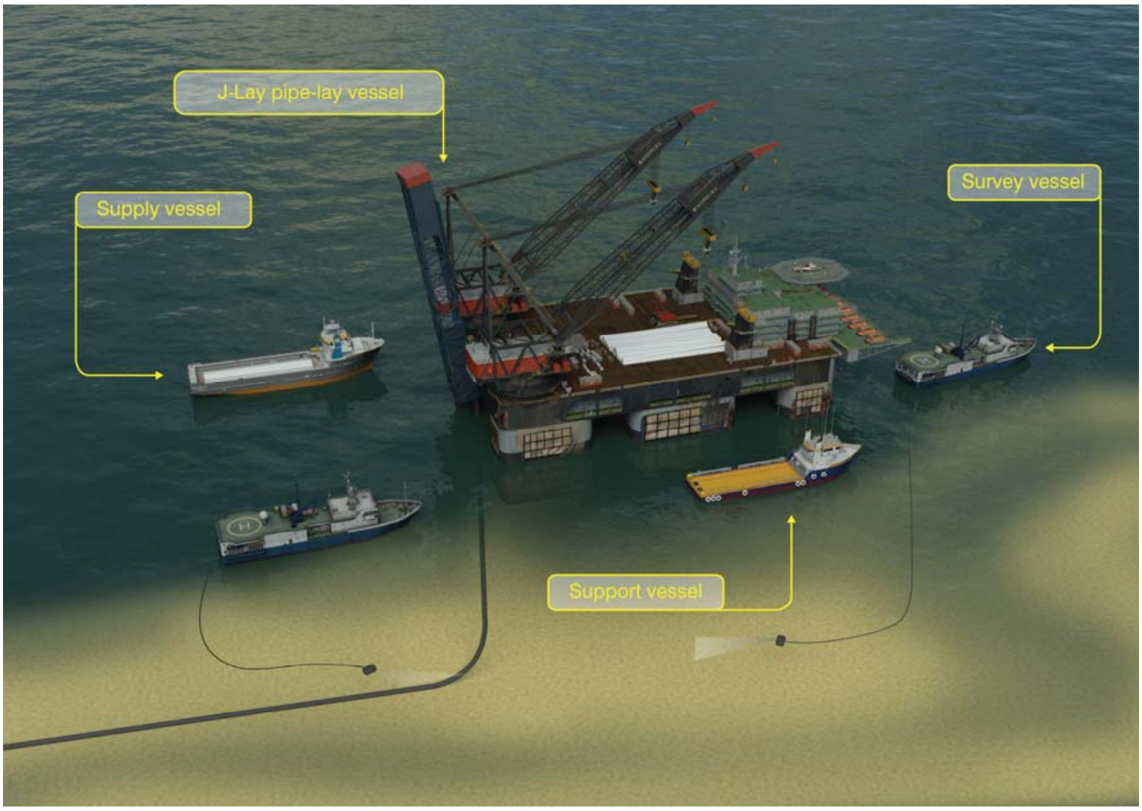
*Continued…*

| Construction Activity | Type of Vessel | Task | Number of Vessels | Duration (days) per vessel | Indicative Vessels | Power Rating in kilowatts (kW) | Persons on Board | Utilisation (%) |
|---|---|---|---|---|---|---|---|---|
| Offshore Pipe-laying | Helicopter | Crew changes | 1 | 9 (i.e. 18 half day trips) | Super Puma | 1,200 | 10 | 60 |
| | Maintenance vessel | Delivery of spare parts / equipment | 1 | 9 | Normand Flipper | 7,160 | 16 | 60 |
| | Fuel / waste water collection vessel | Bilge and waste water gathering | 1 | 9 | Bryansk | 610 | 5 | 60 |
| | Rescue vessel | Safety and rescue operations | 1 | Only required in case of emergency | GSP Vega | 9,548 | 23 | 60 |

* This indicative number only accounts for the anticipated maximum number of PSVs that would be present inside the Turkish EEZ at any one time to supply the spread whilst pipe-laying is undertaken in Turkey. PSVs will also pass through the Turkish EEZ to reach the construction spread when pipe-laying is occurring in Russia. These additional PSV movements are accounted for in the estimated fuel use (Table 5.6) and $CO_2$ emissions estimates (Table 5.10).

*Complete.*

**Figure 5.2 Typical Offshore Pipeline Construction Spread**




Note: Not to scale, water depth greater than 2,000 m.

### 5.5.3.3 Surveying

The design and routing of the pipelines has been informed by a number of studies as outlined in the baseline data sections of Chapters 7 to 12 of this ESIA Report. However, a number of further surveys will be required before, during and after installation of the pipelines to ensure they avoid any obstacles, are laid along the correct route and are laid without defect.

**Pre-Construction Surveys**

Pre-lay surveys will be carried out along each pipeline route prior to commencement of the pipe-lay works to confirm the previous route surveys undertaken during the Feasibility and Development Phases, and to help to finalise any minor re-routing of the pipelines. The survey will include a range of geophysical survey techniques and/or visual surveys using, where necessary, a Remotely Operated Vehicle (ROV) and confirm the absence of any obstructions along the route (to be avoided by minor re-routing).

An unexploded ordnance (UXO) survey may be carried out along each pipeline route well in advance of pipe-laying. A UXO clearance plan (if required) will be developed by South Stream Transport in close conjunction with relevant national authorities at the appropriate time. Survey results will be submitted to the Ministry of Foreign Affairs (MoFA) as appropriate.

**Touch-Down Monitoring and As-Laid Surveys**

During pipe-laying, touch-down monitoring will be conducted in real-time to ensure correct installation of each pipeline on alignment and with respect to lateral separation criteria for adjacent pipelines, and avoidance of obstacles (against minimum offset criteria). An as-laid survey will be performed once each pipeline has been laid on the seabed. The surveys will establish the as-laid position (horizontal and vertical) and condition of the pipelines and would comprise bathymetry and other survey sensors in conjunction with visual inspection by ROV.

**As-Built Survey**

After completion of pipe-laying, an as-built survey will be conducted to ensure the Pipeline has been installed correctly, to document the condition and to ensure the integrity of the installed pipelines. The survey would comprise the integration of as-laid survey results from pipe-lay installation operations with the post-installation rectification/acceptance surveys for specific construction activities.

#### 5.5.3.4 Pipe-Laying Process

The following is a general description of typical pipeline laying arrangements.

Offshore pipe-laying is accomplished by the sequential alignment, welding and lowering of pipe segments from a pipe-laying vessel. Pipe-laying may be performed by the S-lay or J-lay technique; the method to be employed is yet to be confirmed. The final choice will be defined after award of the construction contracts.

Line pipe sections are transported to the pipe-lay vessel by supply vessels, from which they are lifted and stacked on board the pipe-lay vessel. Pipe sections are then transported using conveyor systems to the pipe bevelling station where the pipes are made ready for welding. The bevelling process produces scrap metal which will be required to be stored in containers for collection and disposal onshore.

The pipe segments are moved to the first welding station where they are clamped and welded. The welded pipe segment is moved to the inspection station where the weld is subject to Non-Destructive Examination (NDE), performed by visual inspection and Automated Ultrasonic Testing (AUT), to ensure the weld meets the required specification. Any welds not meeting the specification are removed by cutting out the cylinder of pipe containing the weld. The pipe is then re-welded and subject to another full NDE. Following successful weld testing, the pipe segments move along to the coating stations. The number of coating stations depends on the pipe-lay vessel used. In the coating stations, a field joint coating is applied to the welds for corrosion protection.

The pipe-lay vessel utilises dynamic positioning (DP), a computer controlled system that drives the vessel's thrusters (directional propellers) to maintain position or move the vessel forward. Once the pipe segments have exited the pipe-lay vessel, the vessel stops forward motion, and work commences on welding the next pipe segments together.

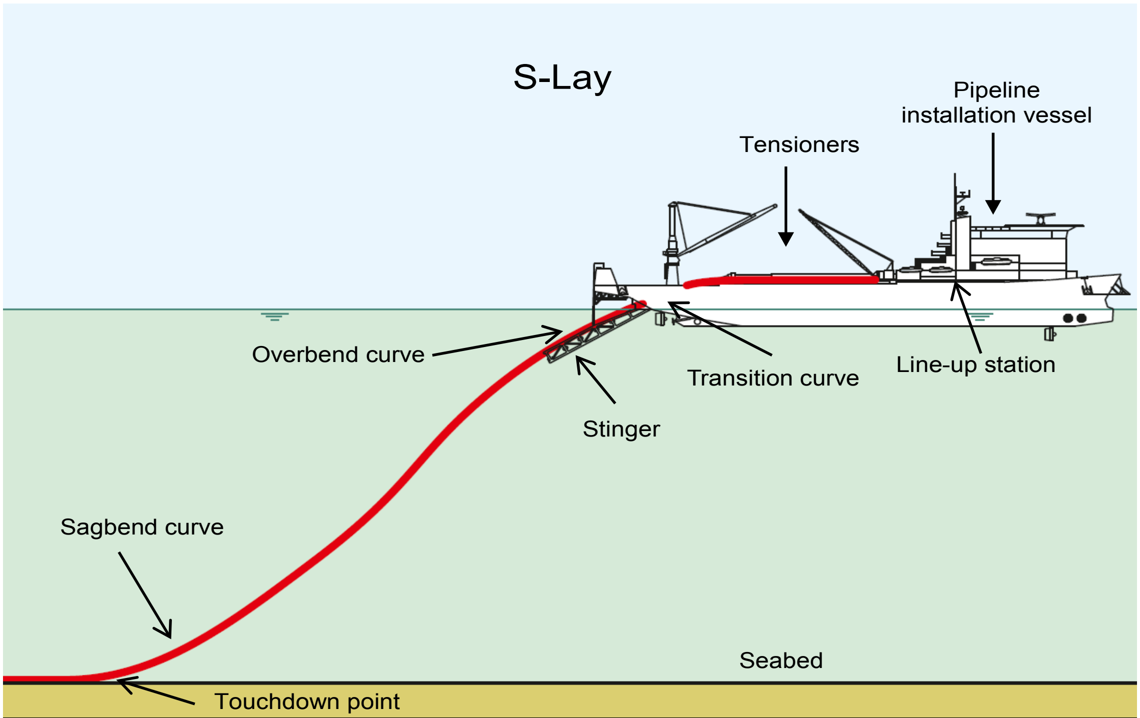
During the pipe-lay process, a navigational Safety Exclusion Zone is proposed of 2 km radius (1.1 nautical miles (NM)) centred on the pipe-lay vessel. The navigational Safety Exclusion Zone will be agreed with the relevant maritime authorities who will, in turn, ensure that it is communicated to vessels in passage in the vicinity of the pipe-lay vessel. The pipe-lay vessel will be equipped with navigation lights, radar and radio communications. Due to the construction spread advancing along the Pipeline route as the pipe is laid, regular consultation will be undertaken by the contractor with the appropriate marine authorities to inform them of the location of the construction spread. The marine authorities will then be responsible for informing marine traffic of the location of the pipe-laying activities and the position of the associated navigational Safety Exclusion Zone.

#### 5.5.3.5 Pipe-Lay Techniques

As indicated above, two pipe-lay techniques may be employed for projects of this nature.

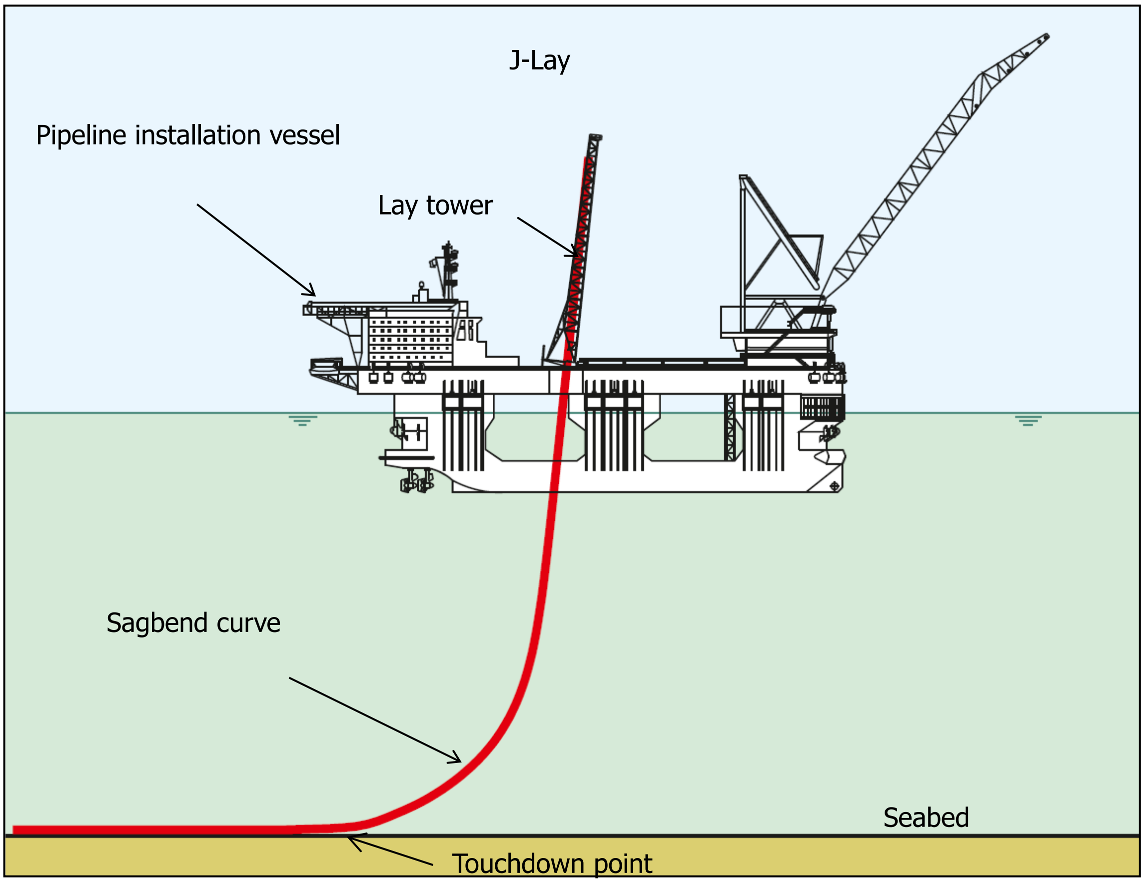
The S-Lay technique (Figure 5.3) requires the load out of single 12 m pipe segments to the pipe-lay vessel and welding the pipe segments together horizontally. The pipe segments are continuously 'fed' over the vessel's pipe-laying stinger from the stern of the vessel as the vessel moves forward in such a way that the pipeline forms an "S" shape from the vessel's exit point to the touchdown point on the seafloor. Sufficient tension is required during the S-Lay process to avoid overstressing the pipeline. This tension is maintained via tensioning rollers and a controlled forward thrust to prevent the pipeline from buckling. The average pipe-lay rate for S-Lay technique is expected to be approximately 3.5 km per day (24 hour period), depending on weather conditions.

**Figure 5.3 Schematic of S-Lay Pipe-Lay Method**



J-lay pipeline installation (Figure 5.4) was developed for laying pipe in deep waters (over 600 m) as it puts less stress on the pipeline at these depths. In the J-Lay method, the pipeline segments are quad or double jointed i.e. 48 m or 24 m long sections onshore at the marshalling yards. Pipe segments are then transported to the pipe-lay vessel where they are assembled and welded vertically in a tower erected on the centre or side of the pipe-lay vessel. A pipe tensioner or support frame is used to lower the pipeline through the tower. As the pipe-lay vessel moves forward, the pipeline is lowered in a "J" shape down to the seafloor. The average pipe-lay rate using J-Lay technique is expected to be in the order of 2.75 km per day (24 hour period), depending on weather conditions.

**Figure 5.4 Schematic of J-Lay Pipe-Lay Method**




Under both techniques, the weight of the pipeline will cause it to sink to the seabed, and settle on the bottom sediment. There will be no fixing mechanisms required to secure the pipeline on the seabed. No excavation and no fill materials are expected to be required to create a level platform for the pipelines. Based on bathymetry data presented in **Chapter 7 Physical and Geophysical Environment**, the seabed through the Project Area is understood to be essentially flat. The intention therefore is to lay the pipelines directly on the seabed. Figure 5.5 shows a typical S-Lay vessel and Figure 5.6 shows a typical J-Lay pipe-lay vessel.

## Figure 5.5 Typical Deep Water S-Lay Vessel


Image supplied courtesy of Allseas, Switzerland

## Figure 5.6 Typical Deep Water J-Lay Vessel


Image supplied courtesy of Saipem

#### 5.5.3.6 Pipeline Flood Protection during Installation

A flood prevention device will be developed by the appointed pipe-lay contractor for installation within the Pipeline during construction. Possible methods are listed below:

- Air pressure from a start-up head;
- Control umbilical connected to the pipe-lay vessel; and
- A battery powered drive unit.

In the event that there is a loss of tension or loss of vessel position during pipe-laying causing the Pipeline to become overstressed to the point where it ruptures and floods, then the flood prevention device will detect the change in pressure, will activate and seal the Pipeline, thus preventing untreated seawater from flooding the Pipeline. The damaged section of the Pipeline between the flood prevention device and the pipe-lay vessel will then be removed and the undamaged pipeline section (protected by the flood prevention device) will be recovered back to the pipe-lay vessel and pipe-laying will resume.

#### 5.5.3.7 Construction Material Use

**Use of Resources**

*Materials*

During construction of the Project, a variety of materials will be required. An estimate of the quantities of the main materials to be consumed is shown in Table 5.5. Quantities are approximate and subject to final optimisation.

**Table 5.5 Material Consumption**

| Material | Quantity per Pipeline | Total (all four pipelines) |
|---|---|---|
| Steel (pipelines) | 345,483 tonnes | 1,381,932 tonnes |
| Coating (3LPP) | 4,565 tonnes | 18,260 tonnes |
| Coating (Field Joint) | 308 tonnes | 1,232 tonnes |
| Weld Material | 339 tonnes | 1,356 tonnes |

*Fuel*

Where possible, vessel bunkering will be undertaken at support ports in Russia and Bulgaria. However, when this is not practicable (i.e., for vessels located continually at sea or at large distances from the coast), the bunker will be pumped into the ships' tanks by the bunkering tanker. All bunkering activities will be undertaken in accordance with the Vessels and Marine Transport Construction Management Plan (CMP), which will be developed as part of South Stream Transport's Environmental and Social Management Plan (ESMP). The CMP will contain activity-specific requirements, to be met by both South Stream Transport and the appointed contractors (and sub-contractors). All bunkering activities at sea will be undertaken by designated persons with appropriate training. Further details on the Vessels and Marine Transport CMP and South Stream Transport's ESMP are described in **Chapter 16 Environmental and Social Management.**

Estimates of the average daily fuel consumption during the Construction and Pre-Commissioning Phase are provided in Table 5.6.

**Table 5.6 Estimated Fuel Consumption**

| Fuel | Use | Average Quantity per Day (tonnes) |
|---|---|---|
| MGO/MDO | Vessels | 241 |
| Diesel | On board Equipment | Included within MGO/MDO calculation |

*Water Consumption*

During construction of the Project water will be required for domestic purposes on-board the vessels (this includes drinking water, washing, cooking, laundry and general vessel cleaning) and industrial use (various uses during pipeline fabrication process). Although some of the vessels listed in Table 5.7 may possess desalination equipment (distillation or reverse osmosis) to produce fresh water, it is assumed for the purposes of the ESIA Report that fresh water may be supplied by tankers. Bottled water may be provided for drinking purposes.

**Table 5.7 Estimated Water Consumption during Construction**

| Water Type | Details | Maximum Consumption per day during Peak of Construction (cubic metres - $m^3$) |
|---|---|---|
| Freshwater | 200 litres per person per day | 240 |

### 5.5.3.8 Summary of Waste Generated during Construction

There are a number of activities during the Construction and Pre-Commissioning Phase that have the potential to generate waste. Table 5.8 indicates the waste types and approximately quantities anticipated to be generated. A more detailed breakdown of the waste generated during construction is presented in **Chapter 12 Waste Management**.

### Table 5.8 Estimated Types of Waste Generated during Construction

| Code | European Waste Catalogue (EWC) Description | Estimated Quantity |
|---|---|---|
| 12 01 | Wastes from Shaping (including forgoing, welding, pressing, drawing, turning, cutting and filing) and Surface Treatment of Metals and Plastics | 120 – 1,200 tonnes |
| 13 01* | Waste Hydraulic Oils | 1 to 10 tonnes |
| 13 02* | Waste Engine, Gear and Lubricating Oils | 1 to 10 tonnes |
| 13 04* | Bilge Oils | 10 to 100 tonnes |
| 13 07* | Wastes of Liquid Fuels | 1,000 to 2,000 tonnes |
| 15 01 | Packaging | 15 to 140 tonnes |
| 15 02* | Absorbents, Filter Materials, Wiping Cloths and Protective Clothing | Less than 1 tonne |
| 16 05 | Chemicals and Gases in Containers | Less than 1 tonne |
| 17 02 | Wood, Glass and Plastic | Less than 1 tonne |
| 17 09 | Other Construction and Demolition Wastes | 100 to 1,000 tonnes |
| 18 01* | Wastes from Natal Care, Diagnosis, Treatment or Prevention of Disease in Humans | Less than 1 tonne |
| 20 01* | Separately Controlled Fractions (except 15 01) | 100 to 1,000 tonnes |
| 20 03 | Other Municipal Waste | 100 to 1,000 tonnes |

* Contains hazardous wastes

The estimated generation of sanitary waste (black water) and wash water (grey water) during construction is provided in Table 5.9.

### Table 5.9 Estimated Volumes of Grey and Black Water Generated

| Waste Type | Details | Average Quantity Produced per Day ($m^3$) |
|---|---|---|
| Wash (Grey) Water | 180 litres per person per day | 216 |
| Sewage | 12 litres per person per day | 14.4 |

All vessel discharges and wastes will be compliant with International Convention for the Prevention of Pollution from Ships (MARPOL) and national regulations. Sewage (sanitary waste or black water) will be treated to applicable standards as set out in *MARPOL Annex IV* prior to discharge. Discharge of sewage into the sea is prohibited, except when:

*"…the ship is discharging comminuted and disinfected sewage at a distance of more than three nautical miles from the nearest land, or sewage which is not comminuted or disinfected at a distance of more than 12 nautical miles from the nearest land, provided that in any case, the sewage that has been stored in holding tanks shall not be discharged instantaneously but at a moderate rate when the ship is en route and proceeding at not less than four knots; or the ship has in operation an approved sewage treatment plant."*

There are no prohibitions under MARPOL on the discharge of wash (grey) water. All other liquid wastes such as sewage sludge, oily bilge water, tank sludges, untreated oily water and waste oil will be shipped to shore for disposal, or otherwise managed in accordance with the applicable MARPOL requirements.

Within 12 nautical miles of the coastline there will be no discharge of food wastes. Outside 12 nautical miles, vessel maceration units used that are designed to treat food wastes to applicable MARPOL standards for particle size will be used prior to discharge to sea. Discharge will only be permitted from vessels travelling at speeds in excess of four knots. Given that the pipe-lay vessels will not be travelling at this speed, they will be required to transfer their food wastes to another vessel for discharge at sea or transfer to ports in Russia or Bulgaria for disposal onshore. Non-putrescible galley waste will be collected and transported onshore to Russia or Bulgaria for disposal via licensed contractors.

Should any of the vessels use desalination equipment to produce freshwater, the waste brine solution will be discharged to sea. Brine from the distillation and reverse osmosis processes must not contain or come in contact with machinery or industrial equipment, toxic or hazardous materials, or wastes. If brine does become contaminated by such materials, the brine will be transferred to a support vessel and disposed of properly onshore in Russia or Bulgaria.

All wastes generated will be handled and disposed of in accordance with applicable Turkish national waste policy and MARPOL requirements. Waste disposal facilities for waste generated by the Project at sea that needs to be taken ashore for disposal will be located in Russia and/or Bulgaria. No waste generated by construction of the Project will be transported and disposed of onshore in Turkey. It should be noted, however, that no decision has been taken at this time as to which potential waste facility sites in Russia and Bulgaria will be used and will be subject to further investigation. Further information on waste generation and management is described in **Chapter 12 Waste Management**.

### 5.5.3.9 Summary of Emissions to Atmosphere

Table 5.10 presents the annual greenhouse gas (GHG) (i.e. $CO_2$) and non-GHG emissions predicted to be generated from the construction of all four pipelines, based on the expected vessels and number of days of operation outlined in Table 5.4. Further information on emissions to atmosphere is provided in **Chapter 7 Physical and Geophysical Environment**.

**Table 5.10 Atmospheric Emissions from Construction Vessels for all 4 pipelines (tonnes)**

| Carbon Dioxide ($CO_2$) | Nitrogen Oxide ($NO_X$) | Carbon Monoxide (CO) | Particulate Matter (PM) | Sulphur Dioxide ($SO_2$) | Non-Methane Volatile Organic Compounds (NMVOC) |
|---|---|---|---|---|---|
| 91,913 | 2,283 | 215 | 44 | 873 | 81 |

### 5.5.3.10 Summary of Total GHG Emissions to Atmosphere

Table 5.11 provides the total GHG emissions for the Project and the Russian and Bulgarian Sectors of the South Stream Offshore Pipeline. The total GHG emissions for the entire South Stream Offshore Pipeline are also shown. The methodology used to estimate these GHG emissions is contained within Appendix 7.1: Atmospheric Emissions of the South Stream Offshore Pipeline – Turkish Sector: Construction and Pre-Commissioning Phase.

**Table 5.11 Total Greenhouse Gas Emissions during Construction and Pre-Commissioning Phase for all 4 pipelines (tonnes $CO_2$ equivalent)**

| Russian Sector | Turkish Sector | Bulgarian Sector | Total South Stream Offshore Pipeline System |
|---|---|---|---|
| 674,853 | 94,061 | 1,003,787 | 1,772,701 |

## 5.6 Pre-Commissioning Phase

Pre-commissioning will follow Pipeline installation. Pipeline pre-commissioning activities typically involve hydrotesting, cleaning, gauging and drying. However, the pipelines within the Turkish Sector will not be hydrotested. Waiving of the hydrostatic test for the South Stream Offshore Pipeline presents various environmental and technical benefits, as follows:

- Costly and time consuming effects of pipeline flooding and dewatering operations are eliminated and any adverse environmental effects associated with the discharge of the test water after the hydrotest test has been completed will be avoided;
- The construction schedule is shortened thereby reducing the duration of disturbance and temporary land use requirements; and
- Absence of flooding, dewatering and hydrostatic testing minimises the volumes of water, fuel and chemicals required and associated emissions and discharges to the environment.

Hydrotesting has been thoroughly investigated and discussed with DNV (DNV is contracted by South Stream Transport for the Verification of Front End Engineering and Design (FEED) and pre-qualification test of line pipe, buckle arrestors, coating and anodes for the Project) during the FEED design stage in 2012. The hydrotest for the pipelines in more than 345 m water depth is allowed to be waived according to DNV-OS-F101 (2010), Section B204.

As a result of the receipt of the DNV waiver, the only pre-commissioning activities to be undertaken for the Project pipelines are cleaning, gauging and drying. These activities are undertaken using pipeline inspection gauges (PIGs) inserted at the Russian landfall facilities and received at the Bulgarian landfall facilities.

Cleaning, gauging and drying of the South Stream Offshore Pipeline will be undertaken between a temporary PIG launcher/receiver at the fence of the landfall facilities in Russia and a temporary PIG launcher/receiver located at the fence of the landfall facilities in Bulgaria, and will include the Turkish Sector. This cleaning, gauging and drying will be undertaken following completion of the pre-commissioning tests of the landfall facilities and pipelines to 30 m water depth in Russia and approximately 36 m water depth in Bulgaria, and completion of all pipeline tie-ins between the landfall facilities in Russia and Bulgaria. It should be noted that all wastes and discharges associated with cleaning, gauging and drying of the pipelines between Russia and Bulgaria will be collected and disposed of in Bulgaria and/or Russia.

Temporary PIG stations will be established at the two landfalls, and PIG trains will be deployed through the full length of the pipelines (including the Turkish Sector) to remove debris from the construction process. Pipelines will be dried using Monoethylene Glycol (MEG) deployed via the PIG trains.

The water, MEG and debris arising from the pigging process will be captured in temporary tanks located at the PIG launcher/receiver in Bulgaria, to allow the debris to separate from the water and MEG for local disposal.

Following drying, the pipelines will be purged with nitrogen prior to gas filling. Purging is to prevent the formation of a potentially explosive gas/air mixture during gas filling.

## 5.7 Commissioning

Commissioning will involve gas filling, quality testing to ensure the gas meets appropriate export specification, pressurisation to seasonal operational pressure and pressure and safety valve testing to ensure pipeline integrity and the correct operation of all metering and safety equipment and systems. Commissioning activities are anticipated to take approximately 14 days per pipeline (including 10 days for gas filling). Each pipeline will be commissioned separately as illustrated in the schedule in Table 5.3.

## 5.8 Operational Phase

### 5.8.1 South Stream Offshore Pipeline Operating Philosophy

The South Stream Offshore Pipeline will have a maximum operating pressure of approximately 284 bar at the inlet to the landfall facilities in Russia, falling to between 65 and 87 bar at the Bulgarian landfall. The maximum daily capacity of each pipeline at normal conditions will be 47.9 MMSCM per day and a maximum of 63 bcm of gas will be transported by all four pipelines each year. The pipelines will be operated seven days a week, 24 hours per day.

The South Stream Offshore Pipeline will operate on the principle of a constant gas inventory (i.e. there is always gas stored in the pipelines). Based on the daily capacity indicated above, this will equate to between 104 and 111 MMSCM. This range varies in relation to winter and summer operating conditions.

The flow, pressure and temperature of the gas in the South Stream Offshore Pipeline will be controlled by the Russkaya Compressor Station in Russia and the Receiving Terminal in Bulgaria. The four pipelines will be operated as a single system.

#### 5.8.1.1 South Stream Offshore Pipeline Parameter Monitoring

Flow, inventory and pressure will be managed remotely. Inventory, pressure, temperature, flow, and gas composition (including water and hydrocarbon dew point) will be monitored at the landfall facilities and remotely in the Central Control Room (CCR) and a Back Up Control Room (BUCR) by continuous real time monitoring of process conditions via the Supervisory Control and Data Acquisition (SCADA) system. Automatic shutdown systems will be initiated if parameters deviate from defined limits, and emergency shut-down valves located at the landfall facilities will be deployed. Alarms will also be installed to detect changes in the gas pressures and temperatures. Vent systems will be deployed to depressurise the pipelines for routine maintenance. Leak detection systems will be capable of detecting leaks equivalent to 1 to 2% of throughput.

### 5.8.2 Maintenance

#### 5.8.2.1 External Pipeline Surveillance

The external condition of the subsea pipeline, including the condition of the cathodic protection system, will be monitored on a regular basis as set out in Table 5.12 using ROV or Autonomous Underwater Vehicles (AUV) and inspection technologies including sonar scans to visual (camera) inspections.

An initial ROV subsea leak inspection survey will be carried out along the pipelines as soon as practicable once the pipelines become operational and sufficient gas flow rates, for the detection of leaks, are achieved.

Critical sections of the Pipeline route will be surveyed at more frequent intervals, initially on an annual basis and subsequently more or less frequently, depending on actual findings (e.g. growth of free span due to sediment dispersing from underneath the pipelines). Critical sections of the Pipeline route may include any areas where seabed anomalies may occur (based upon earlier inspections).

#### 5.8.2.2 Internal Pipeline Surveillance

Following the completion of pipeline gauging during pre-commissioning, further internal inspections of the pipelines using PIGs are not expected to be required until approximately five years after initial start-up and operation. The frequency of testing can be increased or decreased depending on the results of previous inspection runs, survey information and regulatory requirements. The proposed frequency of internal pipeline inspections is shown in Table 5.13.

### Table 5.12 Proposed External Inspection Surveys for Turkish Sector Pipelines

| External Inspection | Inspection Method | Proposed Frequency of Inspection | Survey Duration per Pipeline |
|---|---|---|---|
| Critical Pipeline Sections Survey (if necessary) | ROV | Annually | Approximately 10 days (allows for operational downtime and weather standby etc.) |
| Entire Pipeline Route Survey | ROV | Before start up or within one year of operation commencing | Approximately 60 days (allows for operational downtime and weather standby etc.) |
| | AUV | Every five years thereafter | Approximately 23 days (allows for operational downtime and weather standby etc.) |
| Cathodic Protection Survey | ROV | Before start up or within one year of operation commencing<br>After five years of operation<br>Every ten years thereafter | Approximately 60 days (allows for operational downtime and weather standby etc.) |

### Table 5.13 Proposed Internal Pipeline Inspection Surveys

| Internal Inspection | Inspection Method | Proposed Frequency of Inspection |
|---|---|---|
| Wall thickness measurement | Intelligent PIG | Before start up or within one year of operation commencing<br>Every five years thereafter |
| Pipeline position | XYZ Mapping PIG | Before start up or within one year of operation commencing<br>Every five years thereafter |
| Pipeline geometry | Gauging PIG | Before start up<br>Prior to running calliper or intelligent pigs |
| | Calliper PIG | Before start up<br>Every five years thereafter |

Internal pipeline cleaning is not anticipated to be required due to the composition of the dry gas that will be transported through the pipelines. However, any cleaning that may be required will be undertaken using cleaning PIGs transported using gas. Gas flow rates in the Pipeline will be reduced to approximately 60% of the maximum flow rate during pigging activities. Furthermore, a Pipeline Integrity Management System (PIMS) will be developed to control on-going monitoring and maintenance during system operation, with a specific focus on corrosion control.

### 5.8.3 Emergency Pipeline Repair

Although the probability of failure of a properly designed and installed deep-water pipeline is negligible, South Stream Transport will employ an Emergency Pipeline Repair Strategy (EPRS) for the South Stream Offshore Pipeline to be utilised in the event of damage to any of the pipelines.

A key objective of the EPRS is to have a Repair Plan in place, which, reinstates the pipeline’s integrity and ensures the earliest possible and safe commencement of gas throughput. The Repair Plan has been prepared to provide a high level overview into recommended repair procedures and the relevant hardware and tools.

In the unlikely event of a loss of pipeline integrity, there are parts where the external pressure around the pipeline (i.e. the pressure of the seawater) is greater than the pressure of the gas within the pipeline, specifically along approximately one third of the (western) extent of the pipeline in the Turkish EEZ.

For different types of damage, different types of repair and re-commissioning methods are applicable. Preparation of a pipeline for repair will be aimed at minimising or avoiding any impact on pipeline integrity, therefore avoiding water ingress. If water ingress is inevitable, or has already occurred, then dewatering and replacing salt or contaminated water with chemically treated water will be essential to stabilise the pipeline condition and to minimise corrosion whilst a case specific repair plan is developed and executed. The preferred approach will be to isolate the damaged area (using plugs if pigging is feasible) and create a safe work environment for repair. Prior to re-commissioning a repaired pipeline, the pipeline must be cleaned, dewatered and/or conditioned to ensure the pipeline is clean, without defect and free of water. After a repair is made, the pipeline will be commissioned through pigging and drying and then gas can be re-introduced into the pipeline, thereafter resuming normal operating conditions.

The unplanned events and potential associated damage, which may occur to the pipelines, are described in more detail in **Chapter 13 Unplanned Events.**

### 5.8.4 Operational Safety Zone

Article 60, Paragraph 5 of the United Nations Convention on the Law of the Sea (UNCLOS) provides for the agreement of safety zones around installations on the sea bed. As indicated in Section 5.2, it is proposed that the pipelines will be laid within a 420 m wide corridor, in agreement with the relevant Turkish authorities. This corridor accommodates the four pipelines and an operational safety zone, either side of the outermost pipelines, and precludes any third party seabed activities within this zone across the entire pipeline route in the Turkish EEZ.

## 5.9 Pipeline Design Safety and Risk Assessment

An integrated Health, Safety, Security and Environment – Integrated Management System (HSSE-IMS) has been developed in accordance with Good International Industry Practise (GIIP) and in line with the requirements of ISO 14001:2004 (environmental management system) and OHSAS 18001:2007 (health & safety management system), as well as the Environmental and Social Management System requirements of the Project standards (principally the Equator Principles (EPs) and the International Finance Corporation (IFC) Performance Standards). The main objective of the HSSE-IMS is to provide a robust framework for meeting the Project's Health, Safety, Security and Environment (HSSE) objectives during the entire Project lifecycle. The following section describes the approach to safety issues, a key component of the HSSE-IMS relating to the installation and operation of the South Stream Offshore Pipeline.

Safety is a key priority for the Project during construction, installation and operation. Accordingly, a Safety Management Plan will be prepared in order to reduce all risks to "as low as reasonably practicable" (ALARP).

Design hazards have been identified and assessed using internationally recognized tools throughout the FEED process. These tools include:

- Hazard Identification (HAZID);
- Environmental Impact Identification (ENVIID);
- Quantified Risk Assessment (QRA);
- Hazard and Operability (HAZOP);
- Hazard Construction (HAZCON); and
- Bowtie Analysis.

HAZID is a tool for safety hazard analysis used at an early stage of the Project to inform the FEED study. Risk workshops and HAZID studies have been held covering different aspects of the Project. The risks that have been identified have been addressed through design measures aimed at reducing either the likelihood or the consequences (or both) of the risks. Such measures have been developed during FEED and will be further developed during the detailed design phase of the Project. The HAZID is updated as the design evolves and develops, and when key design decisions are made and/or technology is selected. The risks identified as a result of the workshops and studies have been assessed qualitatively and this assessment will be followed by an overall risk assessment that will cover design, construction, installation, operations and simultaneous operations (SIMOPS), as required.

ENVIID is a tool for environmental impact identification and analysis used at an early stage of the Project to inform the FEED study. The ENVIID process aids the FEED study in identifying any significant impacts of the Project and the associated design controls and mitigation measures to be implemented into the design to remove or reduce the impact.

QRA is a tool for calculating the individual and societal/group risks from major accidents or adverse events. QRA is used to establish the potential consequences of catastrophic events, such as fires, explosions and gas releases.

HAZOP is a tool for the identification of process hazards in the design and operation of a facility or infrastructure. The HAZOP process comprises the systematic application of combinations of parameters (e.g. flow, pressure, temperature) and guide words (e.g. no, more, less) to produce deviations (no flow, less pressure) from the design intent or intended operational mode of the installation. Credible causes of these deviations are identified for each process section (node) and consequences of the deviations are assessed. The assessment consists of an examination of the pipeline design to determine whether the safety measures included in the design are sufficient to ensure that the pipelines are safe to operate, even under extreme or unusual conditions.

HAZCON is a safety study to identify and assess hazards before start of construction works. HAZCON 1 is generally carried out early in the project, prior to construction, to identify major hazards to client and contractor personnel, site visitors or the general public. HAZCON 2 is carried out to provide a detailed assessment of construction hazards, based on a significant completion of engineering design, engineering drawings, construction implementation plan, and details of the marine spread.

Bowtie analysis is part of the identification and management of key risks, and is used to identify risk controls, their effectiveness and corrective actions required. Before defining where to focus effort within the analysis, key risk areas are identified via other risk assessments and risk registers. The understanding of key risks highlights areas for which Bowtie analysis will be developed.

During the FEED process, design approaches and methods that minimise risk to personnel (construction, installation and operations personnel) have been developed based on the results of the various risk assessment studies.

A FEED/Technical Risk Register is used to record all significant design HSSE risks, as well as technical risks related to construction and operations identified by the FEED study. The FEED/Technical Risk Register is established, managed and maintained by South Stream Transport, utilising inputs related to FEED risks from the FEED contractor, and forms part of the overall Project Risk Register.

Major accident hazards (MAHs) during construction, installation and operation of the Project, in relation to users of the Black Sea (i.e. fishing industry) are addressed in **Chapter 13 Unplanned Events**. Plans for dealing with the effects on Black Sea marine users of construction, installation and operation of the Project such as increased marine traffic, transportation of hazardous substances, waste water discharge, solid waste disposal etc. will be managed by South Stream Transport and their respective contractors through a number of CMPs and Operational Management Plans (OMPs). Further information on the various Project CMPs and OMPs to be implemented can be seen in **Chapter 16 Environmental and Social Management**.

# 5.10 Labour

## 5.10.1 Construction Phase

The number of workers that will be employed during the construction of the Project are not known at this stage. This information will become available when the detailed design of the Project has been completed. However, based on the anticipated construction vessel spread and deployment, the workforce is expected to be up to approximately 1,100 during the peak of construction activity.

The majority of the construction work force required will be highly skilled and are anticipated to come from outside Turkey. Employees will work in rotations offshore and shift patterns, depending on their roles, when offshore. The largest workforce will be based with the pipe-lay vessel. No onshore residential accommodation will be provided by the Project. Employees are anticipated to commute between home and the port from which they will be transferred to the Project, whichever is appropriate at the time.

### 5.10.1.1 Hours of Working

For construction and installation of the pipelines, it is anticipated that work will be carried out 24 hours per day, seven days per week.

### 5.10.1.2 Worker Health and Safety

Occupational Health and Safety (OH&S) for procurement, construction, installation and operations will be managed by South Stream Transport and their respective contractors. Internationally recognised procedures to assure the OH&S of the workforce will be adopted along with the necessary equipment and training to make these effective.

The health risks to which workers are exposed are determined by a Health Risk Assessment (HRA). The HRA is the Hazards and Effects Management Process (HEMP) for health hazards, and identifies the health hazards and risks (physical, chemical, biological, ergonomic and psychological) in the workplace, and facilitates an occupational health needs analysis. The HRA determines if medical health surveillance is required for a job position that includes exposure to potentially harmful conditions or risks.

OH&S procedures to be adopted by the Project include:

- Fitness-to-work Assessment;
- Management procedures; and
- First aid and medical emergency response.

Further information on OH&S of the workforce is provided in Appendix 9.2: Occupational Health and Safety.

### 5.10.2 Operational Phase

There will be no full time workers employed for the Project during the Operational Phase of the Project other than a workforce stationed permanently at the CCR and BUCR to operate the South Stream Offshore Pipeline. The operational performance of the South Stream Offshore Pipeline (including the pipelines and landfall facilities in Russia and Bulgaria) will be monitored in real-time using SCADA from the CCR and BUCR in Amsterdam as described in Section 5.8.1.1.

## 5.11 Decommissioning

The expected service lifetime of the South Stream Offshore Pipeline is 50 years. The decommissioning program will be developed during the Operational Phase of the Project. It is likely that the technological options and preferred methods for decommissioning of such gas transportation systems as the South Stream Offshore Pipeline will be different in 50 years' time. The status of the South Stream Offshore Pipeline at the time of decommissioning will also impact on the chosen decommissioning methods.

Under all circumstances, decommissioning activities will be undertaken in accordance with the international and national legislation and regulations prevailing at that time, and in liaison with the relevant regulatory authorities.

A review, and relevant studies if necessary, will be undertaken during the Operational Phase to confirm that the planned decommissioning activities utilise GIIP and are the most appropriate to the prevailing circumstances. The review will outline management controls and demonstrate that the decommissioning activities will not cause unacceptable environmental and social impacts. The decommissioning activities will also require all relevant approvals and authorisations from the Turkish government departments responsible at the time.

### 5.11.1 Decommissioning of the Project

Current practices for the decommissioning of subsea pipelines involve either removing the Pipeline or leaving the Pipeline on the seabed after cleaning and filling it with water in combination with a program of planned monitoring to ensure safety for other users of the sea. The prevailing opinion is that leaving the Pipeline in place results in the least environmental impact as over time the pipelines will become integrated within the seabed environment and their removal would disturb the habitats that have generated in the vicinity of the pipelines. A summary of the activities involved with the two options are described below.

Leaving the pipelines on the seabed will typically involve the following types of activities:

- Filling the Pipeline with water;
- Pipeline cleaning by flushing with water and associated water displacement, collection and disposal;
- Sealing of the Pipeline ends; and
- Monitoring surveys following decommissioning.

Removal of the pipelines from the seabed will typically involve the following types of activities:

- Vessel operations similar in nature to those required for construction of the Pipeline;
- Seabed intervention works;
- Pipeline removal, recycling and disposal;
- Disturbance of the seabed as the Pipeline is recovered; and
- Logistics support offshore and onshore.

Factors to be considered when taking the decision on decommissioning methods for the Project include:

- The potential for re-use of the pipeline in connection with further developments will be considered before decommissioning, together with other existing projects (such as hydrocarbon storage, water outfall). If re-use is considered viable, suitable and sufficient maintenance of the pipeline will be investigated and ensured;
- All feasible decommissioning options shall be considered and a comparative assessment made;
- Any removal or partial removal of a pipeline shall be performed in such a way as to minimise the potential for any significant adverse effects on the marine environment;
- Any decision that a pipeline may be left in place should have regard to the likely deterioration of the material involved and its present and possible future effect on the marine environment; and
- Account shall be taken of other users of the sea.

Where it is proposed that a pipeline should be decommissioned by leaving it on the seabed for natural degradation (referred to as in situ decommissioning), either wholly or in part, the decommissioning program will be supported by a suitable study that addresses the degree of past and likely future burial or exposure of the Pipeline and any potential effect on the marine environment and other users of the sea. The study will include the survey history of the Pipeline, using appropriate data to confirm the current status of the Pipeline, including the extent and depth of burial, trenching, spanning and exposure.

Determination of any potential effect on the marine environment at the time of decommissioning will be based upon scientific evidence. The factors to be taken into account will include the effect on water quality and geological and hydrographical characteristics, the presence of endangered or threatened species, fishery resources and the potential for pollution or contamination by residual products from, or deterioration of, the Pipeline.

The above serves as an example of general principles that should be applied during the decommissioning options decision-making process. It is foreseen that more directly applicable international or national guidelines are likely to be developed before the end of the lifetime of the Project (approximately 50 years) and that these will specify additional options that may need to be considered.

### 5.11.2 Decommissioning Planning

It is envisaged that the process of developing detailed decommissioning management plans may be staged, initially outlining potential options and studies required for discussion with the regulatory authorities, and finally leading to agreed plans prior to the commencement of decommissioning. The plans are expected to include methods and activities associated with the decommissioning of the offshore pipelines, including the transportation and final disposal or re-use strategy for Project components and wastes. Completion criteria can be detailed in the management plans and determined in consultation with the respective national and local authorities.

Documentation or processes addressing the issues outlined below would further support the implementation of detailed decommissioning management documentation:

- Incident reporting, recording and investigation;
- Chemical and hazardous substance management;
- Waste management;
- Health and safety; and
- Spill contingency.

## 5.12 Management of Change Process

During the detailed design, Construction and Pre-commissioning and Operational Phases of the Project, there may be a requirement to amend design elements or processes which results in a deviation from that presented in this chapter. The Project has a management of change process to manage and track any such amendments, and to:

- Assess their potential consequences with respect to environmental and social impact; and
- In cases where a significant impact is likely to arise as a consequence of the amendment or change, to inform and consult with relevant parties on the nature of the impact and on proposed mitigation measures, where practical and appropriate.

All design changes will be added to a register of changes, which will summarise the change, the assessment, and the justification for South Stream Transport's actions.

The management of change process will be incorporated into the HSSE management of change procedure, which is an integral part of the HSSE-IMS described in more detail in **Chapter 16 Environmental and Social Management**.