Chapter 4: Analysis of Alternatives

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4.1 Introduction

The Project is the Turkish Sector of the South Stream Offshore Pipeline, which in itself is part of the larger South Stream Pipeline System. The objective of the South Stream Pipeline System is to develop a new gas supply route via the Black Sea that provides a safe and reliable means to transport Russian gas to the countries of Central and South-Eastern Europe.

This chapter examines the technically and financially feasible alternatives to achieve the Project objective, which, consistent with the objective of the overall South Stream Pipeline System, is to form a key part of the new supply route via the Black Sea. These alternatives were considered during the Feasibility and Development Phases of the Project and have led to the validation of the Project as it is described in **Chapter 5 Project Description**.

Alternatives to the overall South Stream Pipeline System have not been considered within this Environmental and Social Impact Assessment (ESIA) Report, although reference is made to decisions made for the South Stream Offshore Pipeline and the wider South Stream Pipeline System. Such reference is made to provide context, particularly where decisions were made by third parties that directly influence the design of the South Stream Offshore Pipeline, recognising that the South Stream Offshore Pipeline is an integral part of the wider South Stream Pipeline System.

Alternatives that were considered and assessed during the Feasibility Phase are referenced to the source documentation in the text. As indicated above, not all alternatives that are described in this chapter were considered and assessed during the Feasibility Phase. Some were examined later during the Development Phase, which includes the ESIA process.

The objective of this chapter is to outline how the Project represents an optimised design that is technically and financially feasible whilst minimising overall environmental and social impacts. The assessment of impacts that will arise as the result of the Project, along with the identification of appropriate mitigation measures, is contained in Chapters 7 to 12 of this ESIA Report.

This chapter starts by considering the zero alternative; it goes on to describe the high level strategic options (e.g. alternative means of gas transport) initially considered and progressively focuses in on the more detailed Project specific alternatives considered as part of the Front End Engineering and Design (FEED) process (e.g. route refinement options) (Ref. 4.1 and 4.2). Routing and siting alternatives have been analysed in the context of the engineering, environmental, socio-economic and cultural heritage optimisations that have been carried out during both the Feasibility and Development Phases of the Project.

4.2 Approach to Analysis of Alternatives

As recommended in the International Finance Corporation (IFC) Performance Standards Guidance Note 1: Assessment and Management of Environmental and Social Risks and Impacts (Ref. 4.3), the ESIA Report includes:

"An examination of technically and financially feasible alternatives to the source of such impacts, and documentation of the rationale for selecting the particular course of action proposed."

It is important to recognise that the South Stream Offshore Pipeline is the offshore component of the entire South Stream Pipeline System. Consequently, the South Stream Offshore Pipeline and the Project (Turkish Sector), which forms part of it, are significantly influenced by the route selection for the broader South Stream Pipeline System. Alternatives to the South Stream Offshore Pipeline as a whole are briefly discussed in Section 4.3 followed by the more detailed discussion of alternatives to the Project (Turkish Sector).

Decisions taken by Gazprom as part of the wider South Stream Pipeline System have significantly influenced the route selection (Ref 4.2). This chapter briefly refers to the consideration of alternatives and to these decisions which have to a large extent pre-defined the Project design i.e. the general location of landfall facilities and the routing of the offshore section of pipeline. Consequently the Analysis of Alternatives described in this chapter is structured to follow a 'narrowing approach' involving a series of logical steps, starting with the high-level alternatives (including those determined by third parties) followed by description of more detailed alternatives considered as part of the Project. Using this commonly adopted narrowing approach, the Analysis of Alternatives considers alternatives in the following sequence:

- The 'Zero' or 'No Project' alternative;
- South Stream Offshore Pipeline alternatives:
  - Alternative means of gas transportation; and
  - Offshore (macro) routing.
- Project Alternatives:
  - Route optimisation.

4.3 No Project or Zero Alternative

The 'Zero' alternative for the purposes of this ESIA Report is the situation where the Project, (i.e. the South Stream Offshore Pipeline – Turkish Sector) does not proceed. Under this scenario, there are no adverse environmental or social impacts in Turkey, as there is no construction or operation of the Pipeline in Turkey.

However, the need for the South Stream Pipeline System and therefore the Project is driven by Europe's long-term demand for natural gas; further details are provided in **Chapter 1 Introduction**. Should the Project not proceed the entire South Stream Offshore Pipeline would not proceed and therefore, the objective to provide a new supply route to the countries of Central and South-Eastern Europe via the Black Sea would not be met. This would, in turn, mean that diversifying existing supply routes to Central and South-Eastern Europe and providing additional supplies of natural gas to meet its growing energy demand would not be possible.

4.4 South Stream Offshore Pipeline Alternatives

4.4.1 Alternative Means of Gas Transportation

Based on the premise that gas will be exported via a new route across the Black Sea, consideration can be given to offshore transportation of gas by means other than pipeline systems. The main alternative to pipelines for transporting natural gas from Russia to the countries of Central and South-Eastern Europe by sea is the liquefaction of natural gas at a Black Sea port in Russia, and transportation of Liquefied Natural Gas (LNG) using LNG Carriers to either:

- A port on the Western Black Sea coast (Bulgaria or Romania); or
- A port in Southern Europe beyond the Turkish Straits.

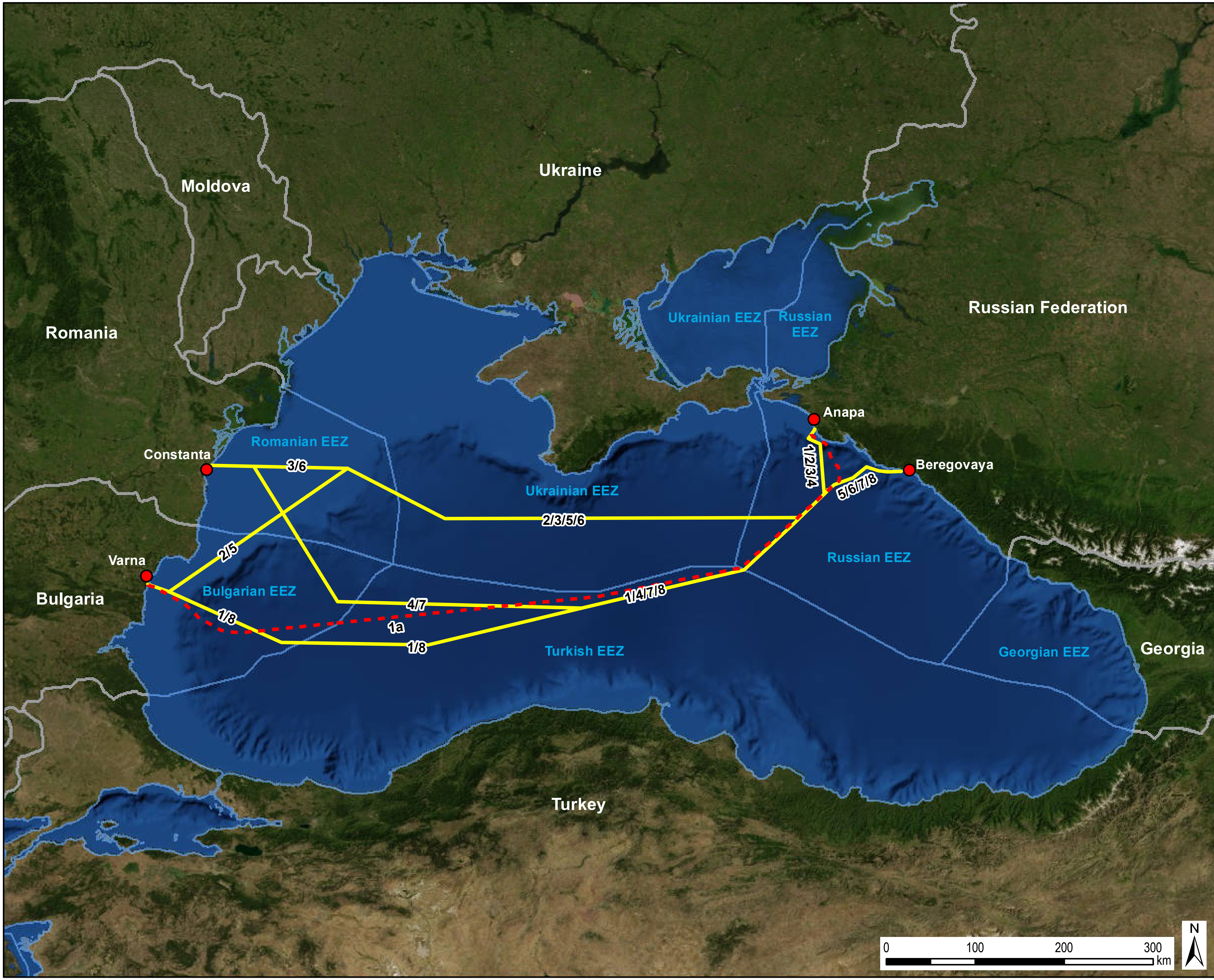
The following factors were considered in the assessment of these alternatives:

1. Liquefaction and transportation of LNG to gas markets is usually undertaken for 'stranded gas' deposits where the source of gas is so distant and isolated from its markets as to make transportation by pipeline uneconomic;
2. Liquefaction would require the construction of a liquefaction plant on the Russian coastline. The onshore environmental impacts associated with the construction and operation of an LNG plant would be greater than those of a pipeline and associated compressor station;
3. This alternative would require the presence of an unloading jetty or offshore buoy and a regasification plant on the shores of a receiving country. In view of the sensitivity and often designated protected status and recreational value of the Western Black Sea coastlines it is undesirable to develop a regasification plant on the coastal areas of the Western Black Sea. In order to avoid construction of a permanent regasification plant, export to an existing Southern European LNG regasification terminal could be considered; and
4. Transportation of LNG would require approximately 600 to 700 LNG carrier movements per year to export 63 billion cubic metres (bcm) of natural gas per year. This would equate to approximately two full LNG carrier movements per day passing through the Turkish Straits, which include the densely populated areas adjacent to the Bosphorus Strait, Istanbul. In view of the hazardous nature of the cargo, the existing high density of maritime traffic through the Turkish Straits and the population density around the Bosphorus Strait, this number of vessels movements would introduce an additional and potentially unacceptable safety risk.

On the basis of the above the LNG alternative is not considered further.

4.4.2 Offshore Routing

Eight potential offshore pipeline corridors were considered across the Black Sea; four offshore pipeline corridors from a shore crossing area near Beregovaya, and four from a shore crossing area near Anapa, both located in the Russian Federation as shown in Figure 4.1.



LEGEND

- Route alternatives
- Option 1a
- Exclusive Economic Zones

Offshore Pipeline Route Alternatives
Option 1 - Anapa to Varna (Turkish waters)
Option 1a - Anapa to Varna (Turkish waters)
Option 2 - Anapa to Varna (Ukrainian & Romanian waters)
Option 3 - Anapa to Constanta (Ukrainian waters)
Option 4 - Anapa to Constanta (Turkish & Bulgarian waters)

Discounted Offshore Pipeline Route Alternatives
Option 5 - Beregovaya to Varna (Ukrainian & Romanian waters)
Option 6 - Beregovaya to Constanta (Ukrainian waters)
Option 7 - Beregovaya to Constanta (Turkish & Bulgarian waters)
Option 8 - Beregovaya to Varna (Turkish waters)

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Purpose of Issue
For Information

Client
South Stream Offshore Pipeline
ENERGISING EUROPE

Project Title
SOUTH STREAM OFFSHORE PIPELINE

Drawing Title
PIPELINE ROUTE OPTIONS

Drawn	Checked	Approved	Date
DH	RW	MW	03/06/2014

URS Internal Project No.	Scale @ A4
46369082	1:5,500,000

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Drawing Number
Figure 4.1

Rev

Plot Date: 03 Jun 2014
File Name: I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Turkey\Turkey ESIA\Chapter 4\Figure 4-1 Pipeline Route Options.mxd

The comparative assessment of these two locations, carried out by Gazprom (Ref. 4.2), showed that the location at Anapa has less potential for environmental impacts compared to the Beregovaya location.

Following selection of Anapa as the preferred site for the Russkaya Compressor Station (CS), four offshore pipeline corridors were assessed for crossing the Black Sea to potential landfall sites in Bulgaria and Romania. Table 4.1 summarises the four offshore pipeline routes considered, which are shown on Figure 4.1.

Table 4.1 Offshore Pipeline Route Alternatives

Option	Landfall (Russia)	Landfall (West Black Sea Coast)	Transit Exclusive Economic Zones (EEZs)	Length of Assessed Route in kilometres (km)
1	Anapa	Varna	Russia, Turkey and Bulgaria	940.3
2	Anapa	Varna	Russia, Ukraine, Romania and Bulgaria	928.4
3	Anapa	Constanta	Russia, Ukraine, Romania	933.2
4	Anapa	Constanta	Russia, Turkey, Bulgaria and Romania	931.3

Of these four corridors, two cross the Turkish Exclusive Economic Zone (EEZ) (Options 1 and 4) and two cross the Ukrainian EEZ (Options 2 and 3). Options 2 and 3 could not be surveyed within the timeframe required and were therefore discarded from further consideration. Further technical investigations were performed for Option 1, landing in Bulgaria and Option 4, landing in Romania (Ref. 4.2).

Various landfall site alternatives were assessed on the Western Black Sea coast, in Bulgaria and Romania. This assessment identified two preferred sites; one near the Bulgarian port of Varna and one near the Romanian port of Constanta.

After Bulgaria and Russia signed an Intergovernmental Agreement on South Stream, the remaining Romanian landfall alternative (Option 4) was no longer considered, leaving Option 1 as the preferred option. Following this decision, shore crossing sites in the vicinity of Varna on the Bulgarian Black Sea coast were further considered.

4.5 Project Alternatives

4.5.1 Route Optimisation Across Turkish Waters

The continental slopes in Russian and Bulgarian waters are unstable regions where the depth of the sea rapidly changes and the seabed is generally characterised by unstable sediments, dynamic conditions (e.g. submarine slumps and sediment flows) and irregular morphology.

The continental slope near Anapa in Russia is characterised by an extensive network of canyons. Two stable lateral canyons running down the continental slope were identified during the survey programme. On the basis of the width of the canyons, it was established that the best technical option was to route two pipelines in each canyon.

On the Bulgarian continental slope, two submerged canyons, immediately adjacent to each other, were deemed adequate for the laying of the four Project pipelines. Given the engineering constraints and risk management benefits associated with divergent pipeline alignments, the best technical option identified involved the routing of three pipelines in the larger of the two canyons and one pipeline in the smaller, narrower canyon.

Following selection of the optimal continental slope crossing locations in the Russian and Bulgarian EEZs, it was necessary to address environmental and technical considerations for the preferred offshore route along the abyssal plain within the Turkish EEZ. This investigation formed part of the wider South Stream Offshore Pipeline survey of the abyssal plain, which also included areas in the Bulgarian and Russian EEZs. The required locations for the continental slope crossing in the Bulgarian and Russian EEZs constrain where the Pipeline in the Turkish EEZ can be laid as it has to join these two continental slope crossings.

Option 1 was subsequently subject to route optimisation with consideration of a direct route across the Turkish EEZ as opposed to an alignment to the south. Option 1 was originally proposed to avoid the potential impacts of the southern edge of the Danube Delta sediment fan[1]. Following further engineering investigation, it was concluded that due to the relatively low relief and inactive depositional nature of the outer submarine fan, the effects associated with deposition of sediment in the Danube fan system were minor. The direct approach shown as Option 1a in Figure 4.1 was therefore adopted and subjected to further consideration of environmental and cultural heritage sensitivities (**Chapter 8 Biological Environment** and **Chapter 10 Cultural Heritage**).

One of the key reasons for selecting the preferred option (Option 1a) is that it is shorter than the alternative routes. It reduces the total offshore length of the pipeline route by approximately 20 km per pipeline, and the length of the Turkish Sector by approximately 50 km per pipeline thereby minimising the Project footprint.

[1] A sediment fan is a fan- or cone-shaped deposit of sediment crossed and built up by streams. The Danube fan system is a relict sedimentary feature in the North-Western part of the bottom of the Black Sea.

In summary, the selection process for the offshore route of the South Stream Offshore Pipeline was largely constrained by engineering and environmental factors in Russian or Bulgarian waters. The landfall options and continental slope crossing significantly influenced where the EEZ border crossing with Turkey would be and as such, also determined where the Pipeline could run in the Turkish EEZ (and thus dictated the location of the Project).

No significant engineering or social constraints were identified on the Turkish abyssal plain, based on the information available on the environmental constraints (e.g. marine ecosystems) at that stage. Therefore, direct line routes were initially adopted within the preferred corridor.

The route alignments were subsequently selected on the basis of further geophysical and environmental surveys. The entire corridor was mapped and the geological, bathymetric and cultural features were recorded for further analysis.

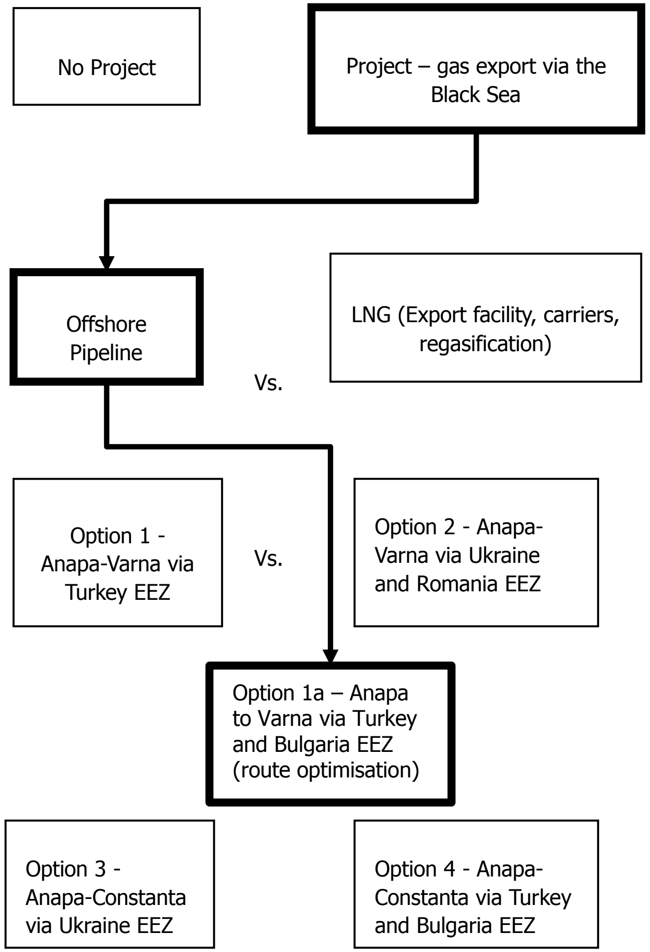
Specifically, a thorough review of the seabed features was carried out to determine the presence of features of biological importance and cultural heritage objects (CHOs). The findings of this review are included in **Chapter 7 Physical and Geophysical Environment** and **Chapter 10 Cultural Heritage**.

Whereas no significant features of biological importance were identified, two CHOs were identified on the abyssal plain within 150 metres (m) of the initial proposed Pipeline route. These CHOs were first identified in side-scan sonar images and were earmarked for visual inspection via submersible Remotely Operated Vehicles (ROVs) to determine their identity and potential cultural significance, prior to construction of the Pipeline (Ref. 4.4). As these objects were found to be of cultural heritage value, route adjustments have been made to avoid them and to maintain at least a 150 m buffer between the pipelines and any CHOs. **Chapter 10 Cultural Heritage** discusses these objects, their potential value and measures required to ensure their protection in more detail.

4.6 Summary

This chapter summarises the Analysis of Alternatives reflecting the initial design of the South Stream Pipeline System and subsequent considerations during the Feasibility and Development Phases of the South Stream Offshore Pipeline and subsequent Project. Within the Turkish Sector, the assessment was constrained by the preferred routes in Russian and Bulgarian waters where there are more constraints (such as continental slope crossings) that could impact the route. The Analysis of Alternatives reported here has adopted a typical narrowing approach, starting with high level alternatives such as means of transporting gas across the Black Sea, honing in on more detailed consideration of alternatives, such as consideration of detailed pipeline routing. Figure 4.2 summarises the analysis of alternatives process, including the rationale for discarding certain alternatives.

Figure 4.2 Summary Analysis of Alternatives (South Stream Offshore Pipeline)



Options	Outcome and rationale
The 'No Project' or 'Zero' alternative	Project Objective: *to diversify supply routes for transportation of gas from Russia to the countries of Central and South-Eastern Europe via the Black Sea, and to help meet projected increased demand for natural gas.* If the Project does not proceed: • Impacts attributed to the Project would not occur, but other impacts associated with alternative transit routes would occur; and • An opportunity to diversify gas supply routes will be missed. **The 'No Project' option was dismissed**. Refer to **Chapter 1 Introduction** for the Project need
Alternatives to cross the Black Sea	LNG could be exported beyond Central and South-Eastern Europe, however: • It is not the Project intent to export beyond Central and South-Eastern Europe; • Transit through the Turkish Straits, for example to Italy, carries higher safety and environmental risks; and • LNG would generate more greenhouse gases (GHG) emissions. **LNG dismissed on the grounds that a pipeline system was considered more safe and reliable avoiding the need to construct a new regasification plant on the Black Sea coast/ship LNG through the Turkish Straits. Also, less GHG emissions from a pipeline.**
Offshore routing (Macro alignment) based on decision to land at Varna, Bulgaria	Options 2 and 3 were dismissed because survey work would have resulted in schedule delays. Option 4, landing in Romania, was dismissed after Bulgaria and Russia signed an Intergovernmental Agreement on South Stream. Option 1 underwent further route optimisation through on-going investigations and studies. **Option 1a was the preferred alternative** selected for detailed route alignment studies

References

Number	Reference
Ref. 4.1	Giprospetzgaz, 2010. Feasibility Study for the Offshore Section of the "South Stream" Project Pipeline, Volume 17 of the Environmental Impact Assessment (Russian Sector), Second Part of the Environmental Impact Assessment on Alternative Route Options for Pipeline (land area), Archive number: 6976.101.003.11.14.17.02-1 (replacement for 6976.101.003.11.14.17.02, St. Petersburg.
Ref. 4.2	Giprospetzgaz. 2010. Feasibility Study For Construction of South Stream Gas Pipeline, Volume 9: Route Evaluation. Part 3. Route Selection Manual. Archive No 6976.101.003.11.14.09.03-1 Instead of Archive No 6976.101.003.11.14.09.03
Ref. 4.3	IFC 2012. Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts. http://www1.ifc.org. Accessed 21 January 2013.
Ref. 4.4	Seascape Consultants Ltd. 2013. Interpretation of Seabed Survey Data for the South Stream Offshore Pipeline Project, Report No 2013/07.