AYGM

HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Environmental and Social Impact Assessment

70069878-ESIA
DECEMBER 2021

PUBLIC

11

SURFACE WATER

PUBLIC

11 SURFACE WATER

11.1 Introduction

11.1.1. This chapter reports the findings of the assessment of the potential effects of the Project to the surface water environment and flood risk during both the construction and operational phases. For both phases, the type, source and significance of potential effects are identified, and the measures that will be employed to minimise these described.

11.2 LEGISLATIVE FRAMEWORK, POLICY AND GUIDANCE

11.2.1. The assessment has been undertaken in line with international best practice. The Water Framework Directive (2000/60/EC) has been considered during the completion of this assessment, where appropriate, when considering the surface water environment.

11.2.2. The following national legislation has been considered during the completion of the assessment:

- The Law on the Environment (1983) – as amended in 2006 and 2018 (Law No.5491 and Law No.7153 respectively). The Law forms the basis for all major environmental regulations in Turkey, those pertinent to surface water quality are summarised below. Of relevance to this assessment the Law outlines responsibilities which sit with the Ministry of Environment regarding the use and protection of natural resources and for the prevention of water, soil, and air contamination;
- Regulation on Control of Water Pollution (2004) – as amended in 2010, 2016, 2018 and 2020. The Regulation establishes standards / limits relating to pollution discharge into waterbodies, details the permitting system for discharge activities, and outlines a classification system for waterbodies in Turkey (high-quality waters, waters with minimal pollution, polluted waters, and highly polluted waters). The Regulation used to set out four protection areas around drinking water reservoirs that comprised 'absolute, short range, medium-range and long-range' protection areas in which works that may pose risk to drinking water reservoirs were controlled. Although they are referred to in the National EIA for the Project (2017), these areas were removed from legislation following the 2018 update;
- Regulation on Environmental Permits and Licences (2014) – as amended in 2016, outlines the environmental permits and certification required (as summarised within the **ESMP**);
- Regulation on the Management of Surface Water Quality (2012) - This Regulation sets forth the rules and procedures for the determination and classification of biological, chemical, physicochemical and hydromorphological quality of surface waters, coastal waters and transitional waters. It also provides for the rules and procedures of monitoring of the water quality and quantity. The Regulation further sets out provisions concerning the sustainable use of water, and measures to be taken to maintain or achieve good surface water status;
- Regulation on Control of Waste Oils (2008) - The purpose of this Regulation is the control and management of waste oils, to protect human health and to maintain environmental protection. The Regulation lays down the principles and procedures regarding the storage, recycling, recovering, disposal, import, export and transits of waste oils;
- Regulation on Wastewater and Domestic Solid Waste Disposal Facilities (2010) - This Regulation sets our provisions on (i) establishment, maintenance, operation, tracking and termination of wastewater and domestic solid waste disposal facilities, (ii) collection, discharge and recycling of urban or industrial wastewater, (iii) collection, transport, transfer, recycling and disposal of

domestic solid waste, (iv) duties and authorities of the Ministry and environmental agencies, and (v) raising public awareness.

- Regulation on the Protection of Wetlands (2014) - this Regulation defines the principles of protection, management and development of wetlands and their habitats in Turkey's land borders and the continental shelf which includes protection of groundwaters which feed wetlands;
- Regulation on Control of Pollution Caused by Dangerous Substances in Aquatic Environment (2005) – sets forth technical and administrative standards for identifying dangerous substances that pollute surface water, estuaries, and regional waters. It also provides standards for preparing pollution reduction programs, for monitoring and preventing pollution, and for conducting inventories of dangerous substances discharged into water resources;
- Regulation regarding Protection and Management of Water Basins (2012) – This Regulation concerns the protection of surface waters and groundwater considering physical, chemical and ecological qualities, setting out the principles and procedures of management plans of water basins to ensure sustainability, rehabilitation and protection. The Regulation covers basins of coastal waters, surface waters and groundwater resources; and
- Regulation on the Quality and Treatment of Water Intended for Potable Water Supply (2019) – this regulation outlines the procedures and principles of quality standards, treatment categories and treatment efficiency of water intended for potable water supply. It also details the principles of categorization of waters and appropriate standard methods of treatment for each category, the sampling and analysis methods and frequencies of analysis of drinking water.

11.2.3. The Project will be required to comply with EBRD Performance Requirements (PRs) that cover key environmental and social issues. The objectives of PR3: Resource Efficiency and Pollution Control that have been considered in this assessment are to:

- Identify project-related opportunities for energy, water and resource efficiency improvements and waste minimisation;
- Adopt the mitigation hierarchy approach to addressing adverse impacts on human health and the environment arising from the resource use and pollution released from the project; and
- Promote the reduction of project-related greenhouse gas emissions.

11.3 ASSESSMENT METHODOLOGY

11.3.1. This Chapter qualitatively assesses the potential effects of the Project on the surrounding surface water features during both construction and operation.

11.3.2. Where appropriate this Chapter also proposes mitigation measures to minimise or control likely adverse effects on surface water receptors arising from the Project. This Chapter should be read in conjunction with the introductory chapters (**Chapter 1: Introduction** to **Chapter 5: Approach to ESIA**), **Chapter 8: Ecology**, **Chapter 12: Geology and Soils** and **Chapter 14: Climate Change**.

11.3.3. The methodology adopted in the assessment follows the principles set out in **Chapter 5: Approach to ESIA**.

11.3.4. The assessment of the Project has been undertaken primarily through a desk-based study using available information relating to existing surface water quality, location of mapped waterbodies and flood risk in combination with surface water quality sampling. Key desk-based information, included, but was not limited to:

- The National EIA for the Project (2017);

- Project design information provided by TCDD and AYGM (2020);
- Information provided by the TCDD for the Cerkezkoy to Kapikule railway section, which is currently under construction (July 2020); and
- Surface water quality sampling undertaken in January 2016 and July 2020.

11.3.5. The surface water quality sampling has been undertaken at 5 locations along the Project:

- Sample 1: Samples collected from Sazli Stream immediately upstream of the proposed tunnel of the Project (chainage 4+170).
- Sample 2: Samples collected from Camasir Creek which forms the inlet channel of Büyükçekmece Lake at the location of the proposed crossing (chainage 27+230).
- Sample 3: Samples collected from Karasu Stream immediately downstream of the proposed crossing of the watercourse (chainage 37+150).
- Sample 4: Samples collected downstream of the Project from the Azinlar Creek that is close to the western extent of the Project alignment (0.2km west of chainage 76+700).
- Sample 5: Samples collected downstream of the Project from the Corlu Creek that forms the downstream extent of the Ambar Stream that will be crossed by the Project (1.6km west of chainage 76+700).

11.3.6. The surface water sampling locations are shown in **Figure 11-1**.

11.3.7. The sampling locations provide an indication of the quality of the waterbody and a baseline against which construction impacts can be monitored, although further sampling prior to construction is recommended as summarised in **Section 11.6**. Of the 5 samples, 2 (1 and 2) were collected to inform the National EIA for the Project (2017)[174] in January 2016. The remaining 3 samples (3, 4 and 5) were collected in July 2020 to inform this assessment. The sampling was undertaken in accordance with the methodology detailed in TS EN ISO 5667[175]. Further sampling is likely to be required in close proximity to the actual location of the construction compounds / construction workers accommodation that will be selected by the contractor (noting that only indicative locations for the construction compounds was available at the time of sampling).

STUDY AREA

11.3.8. The study area for surface water characterisation and assessment is defined according to potential receptors that may be affected by the Project and the surface water catchment within which the Project is located.

11.3.9. The study area typically encompasses surface water features up to 0.5km from the Project that have the potential to be affected directly by the proposed works (i.e. associated with overland migration of pollutants directly to a surface feature). The study area also includes surface water features that are in hydraulic connectivity with the study area, such as those downstream of features that are within 5km of the Project and that may therefore be affected by indirect impacts (i.e. associated with pollutants that may be conveyed downstream via surface water features or drainage systems).

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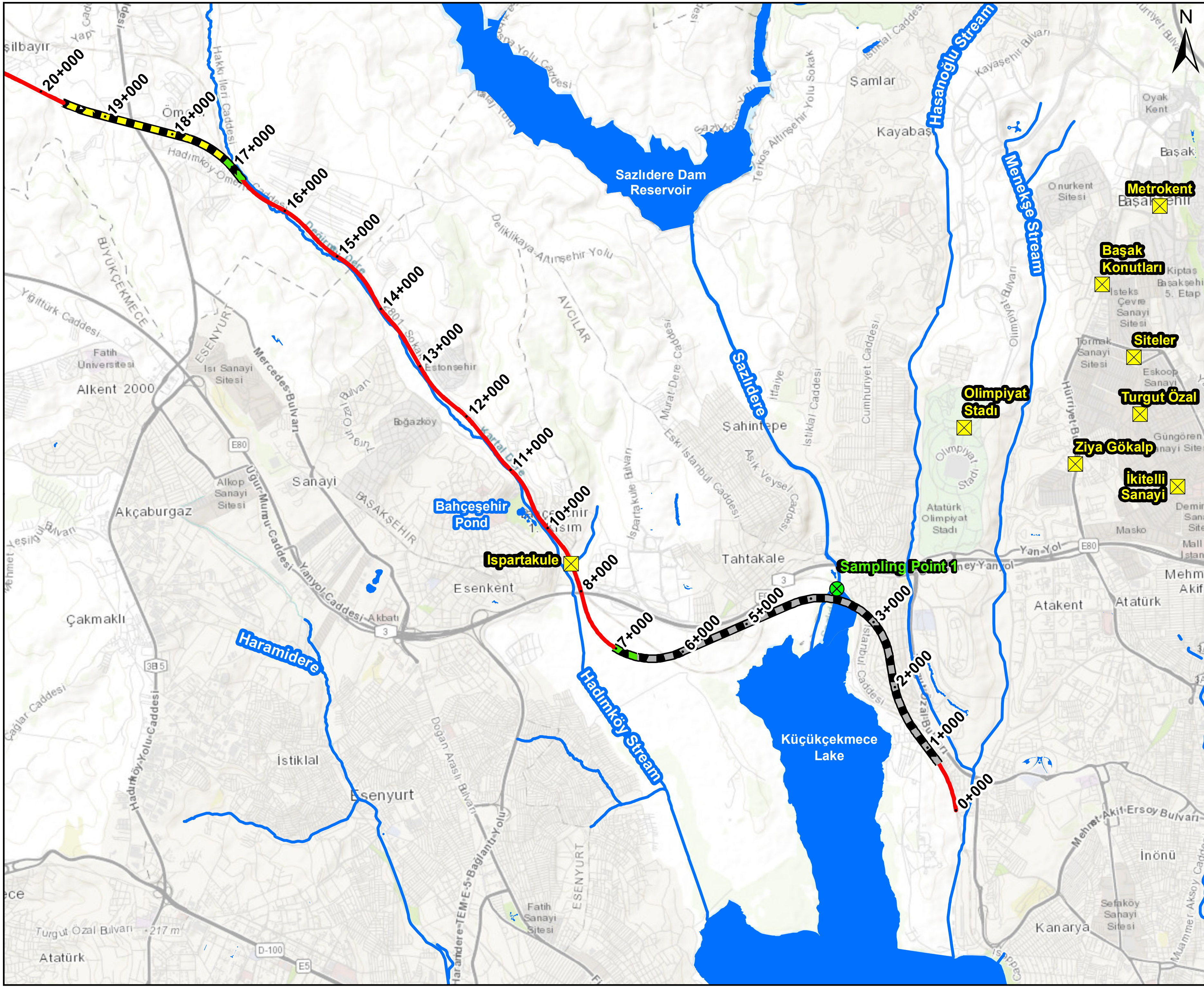
[174] Sweco Mühendislik Müşavirlik ve Tasarım Ltd. Şti.(2017). Halkali – Kapikule Railway Project EIA Report.
[175] TS EN ISO 5667 Part 1 (2007) and Part 3 (2018).

11.3.10. The study area for the assessment of flood risk is defined by the extent by which flood risk may be influenced. An extent of approximately 1km upstream and downstream of the Project is considered appropriate, although this will be influenced by the likely extent of the floodplain and the likely impact of the works within the floodplain.

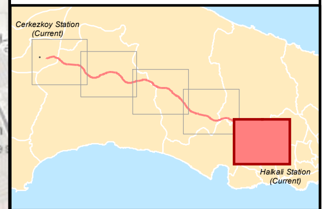
11.3.11. Surface water receptors located in close proximity to the Project are shown in **Figure 11-1** and the key watershed catchments are shown in **Figure 11-2**.



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Sampling Point Location
- Railway Stations (Current)
- Proposed Railway Route
- Tunnel (TBM - Double Tube)
- Tunnel (NATM)
- Tunnel (Cut - Cover)
- Waterway
- Inland Water



Note:
Data provided based on OpenStreetMap data.

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 11-1 - Surface Water Features

Scale at A4: 1:70,000

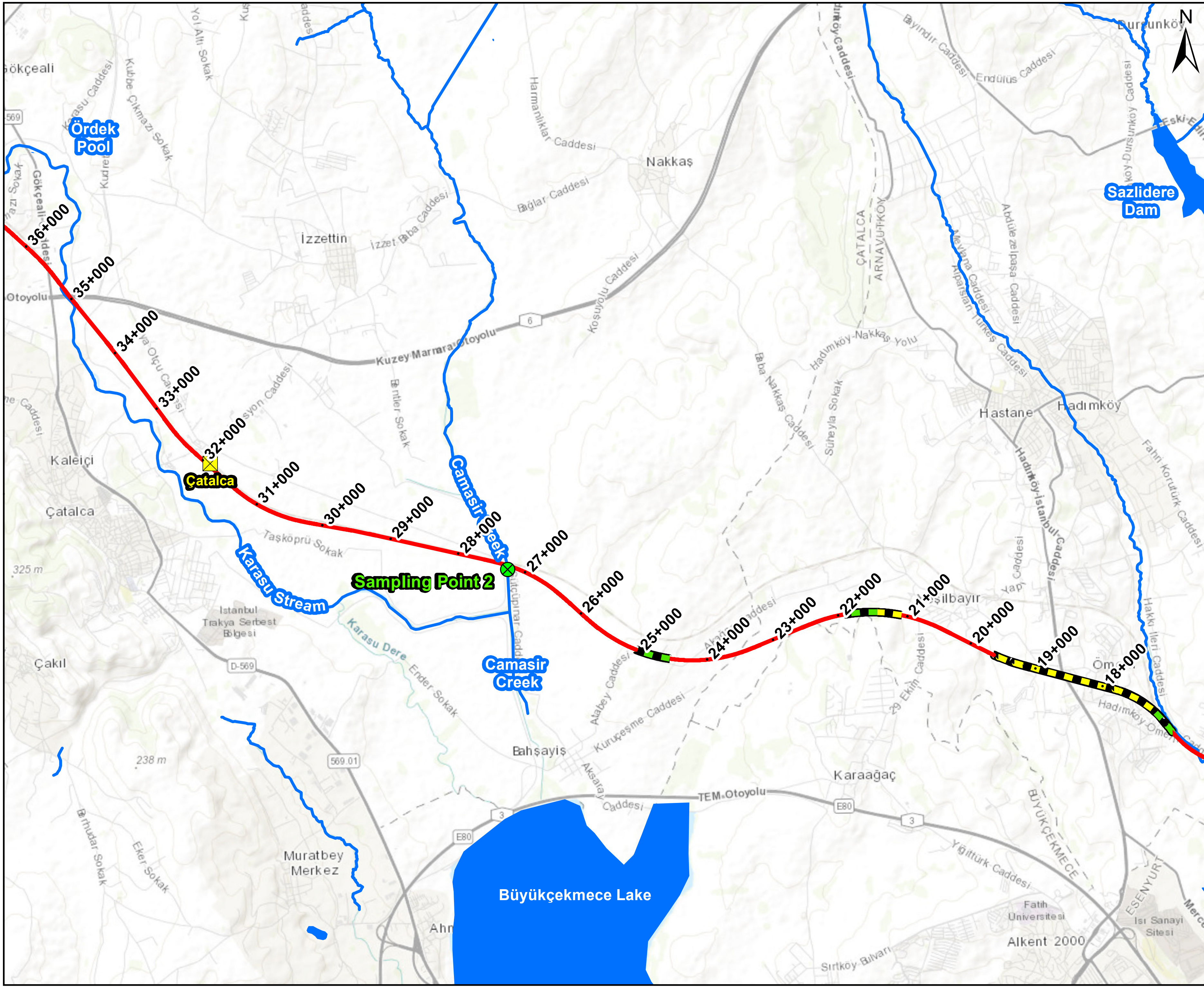
Drawn: DG

Stage 1 check	Stage 2 check	Originated	Date
JG	JW	DG	22/02/2021

0 0.25 0.5 1 1.5 2 Km

Drawing Number: Figure 11-1 (1 / 5)

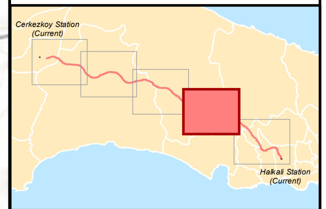
Path: \\uk.wspgroup.com\central data\Projects\700698xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\GIS\Mxd\Figure 11-1 - Surface Water Receptors.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Sampling Point Location
- Railway Stations (Current)
- Proposed Railway Route
- Tunnel (NATM)
- Tunnel (Cut - Cover)
- Waterway
- Inland Water



Note:
Data provided based on OpenStreetMap data.

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 11-1 - Surface Water Features

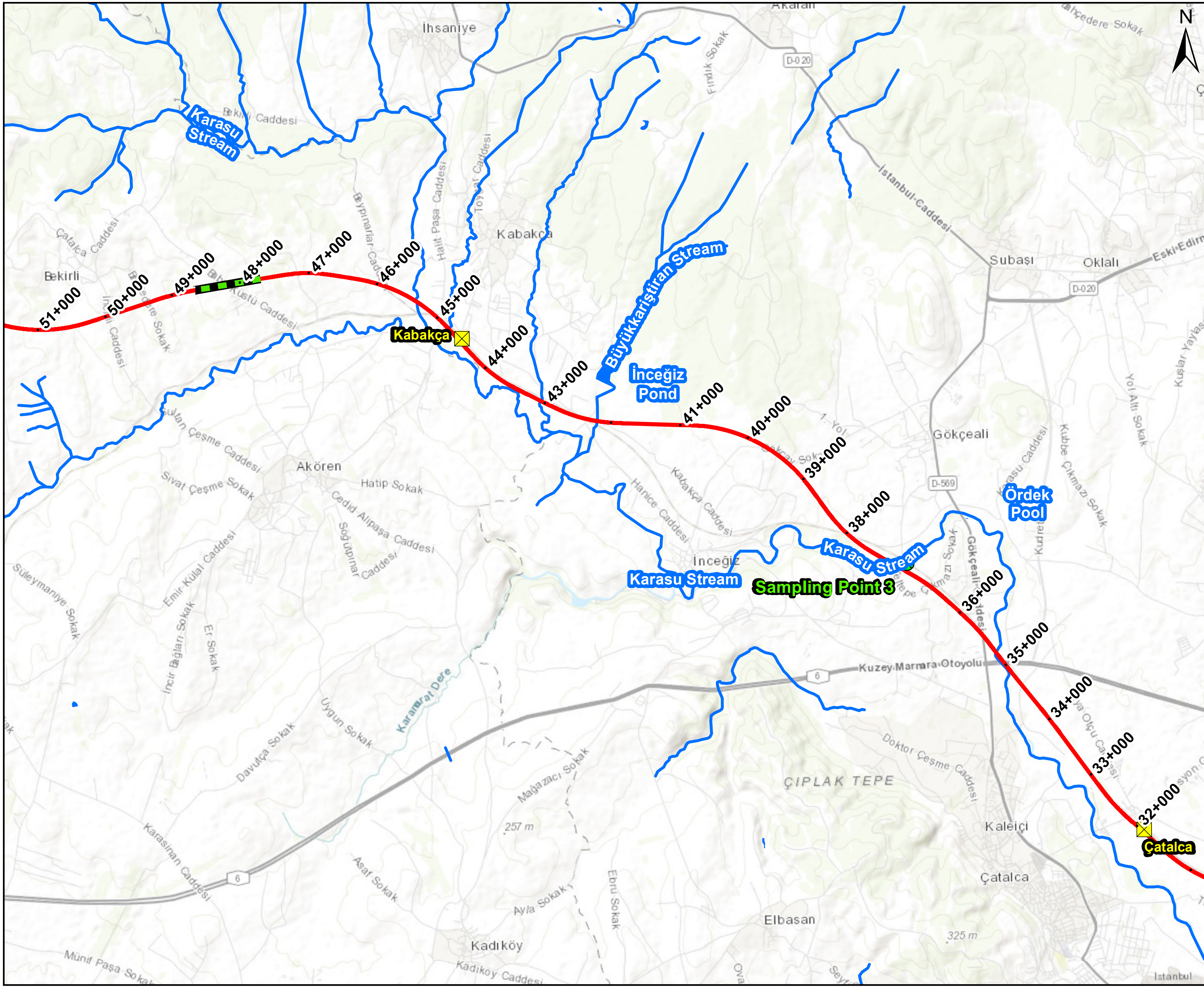
Scale at A4: 1:70,000

Drawn			
DG			
Stage 1 check	Stage 2 check	Originated	Date
JG	JW	DG	22/02/2021

0 0.25 0.5 1 1.5 2
Km

Drawing Number: Figure 11-1 (2 / 5)

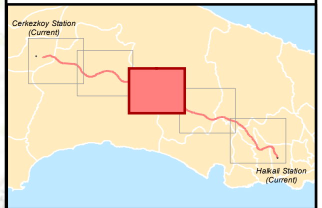
Path: \\uk.wspgroup.com\central data\Projects\700698xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\GIS\Mxd\Figure 11-1 - Surface Water Receptors.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Sampling Point Location
- Railway Stations (Current)
- Proposed Railway Route
- Tunnel (Cut - Cover)
- Waterway
- Inland Water



Note:
Data provided based on OpenStreetMap data.

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 11-1 - Surface Water Features

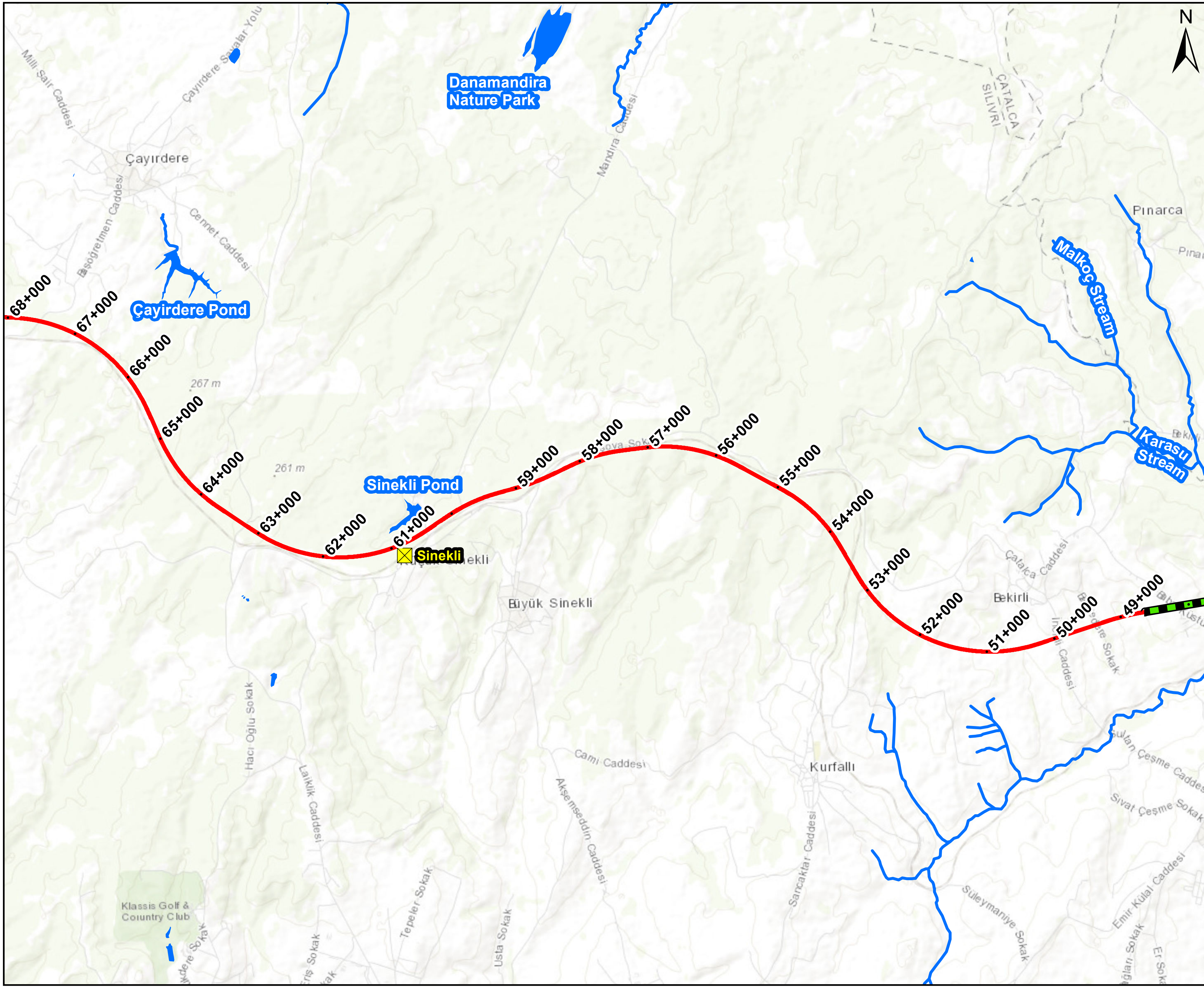
Scale at A4: 1:70,000

Drawn			
DG			
Stage 1 check	Stage 2 check	Originated	Date
JG	JW	DG	22/02/2021

0 0.25 0.5 1 1.5 2
Km

Drawing Number: Figure 11-1 (3 / 5)

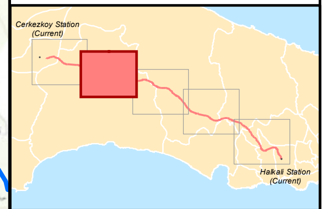
Path: \\uk.wspgroup.com\central data\Projects\700698xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\GIS\Mxd\Figure 11-1 - Surface Water Receptors.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Railway Stations (Current)
- Proposed Railway Route
- Tunnel (Cut - Cover)
- Waterway
- Inland Water



Note:
Data provided based on OpenStreetMap data.

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 11-1 - Surface Water Features

Scale at A4: 1:70,000

Drawn: DG

Stage 1 check	Stage 2 check	Originated	Date
JG	JW	DG	22/02/2021

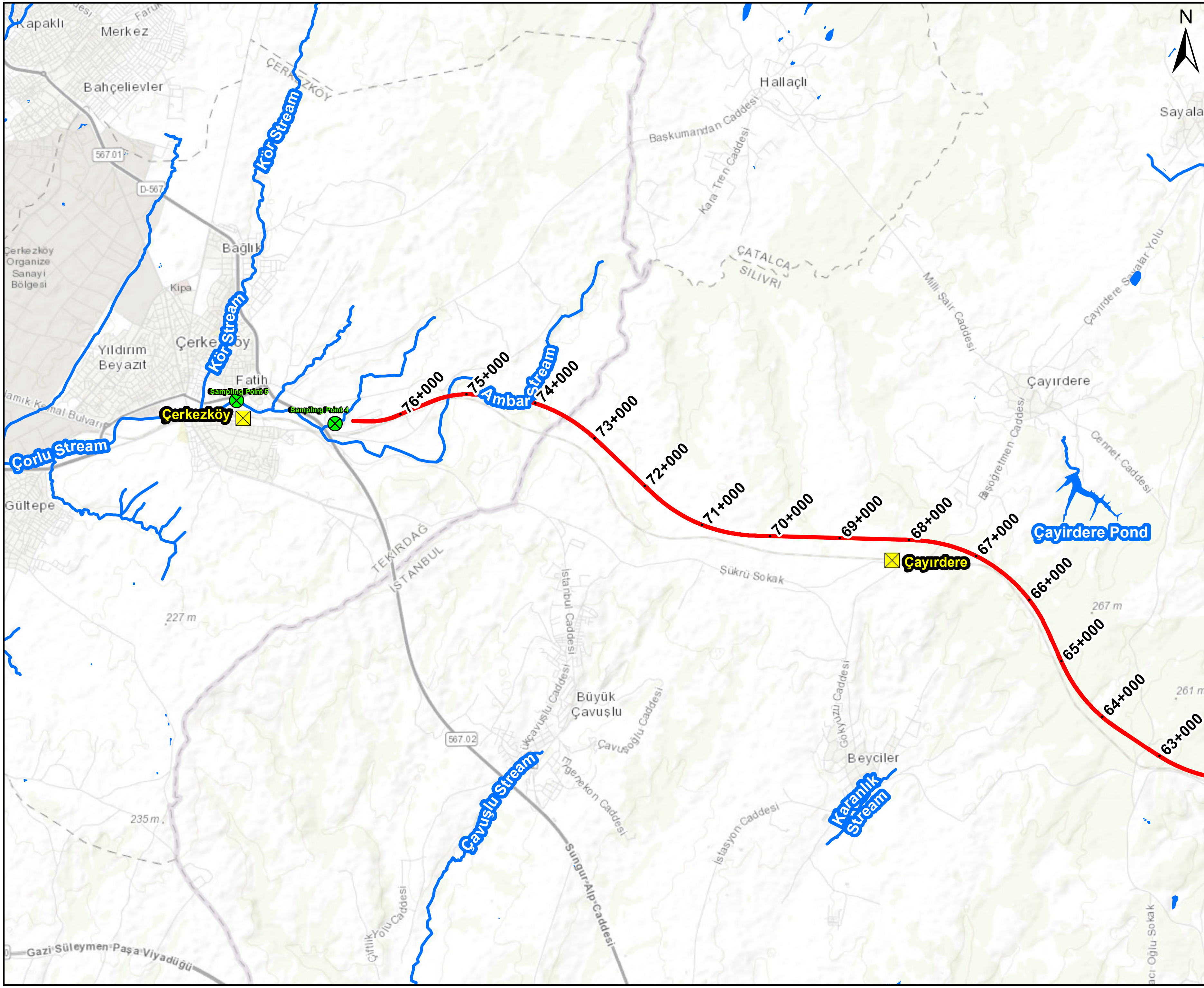
0 0.25 0.5 1 1.5 2
Km

wsp

Drawing Number: Figure 11-1 (4 / 5)

Path: \\uk.wspgroup.com\central data\Projects\700698xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\GIS\Mxd\Figure 11-1 - Surface Water Receptors.mxd

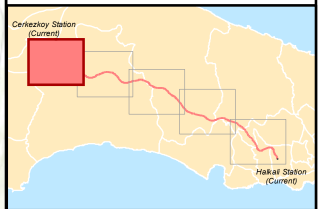
Path: \\uk.wspgroup.com\central data\Projects\700698xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\GIS\Mxd\Figure 11-1 - Surface Water Receptors.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Sampling Point Location
- Railway Stations (Current)
- Proposed Railway Route
- Waterway
- Inland Water



Note:
Data provided based on OpenStreetMap data.

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 11-1 - Surface Water Features

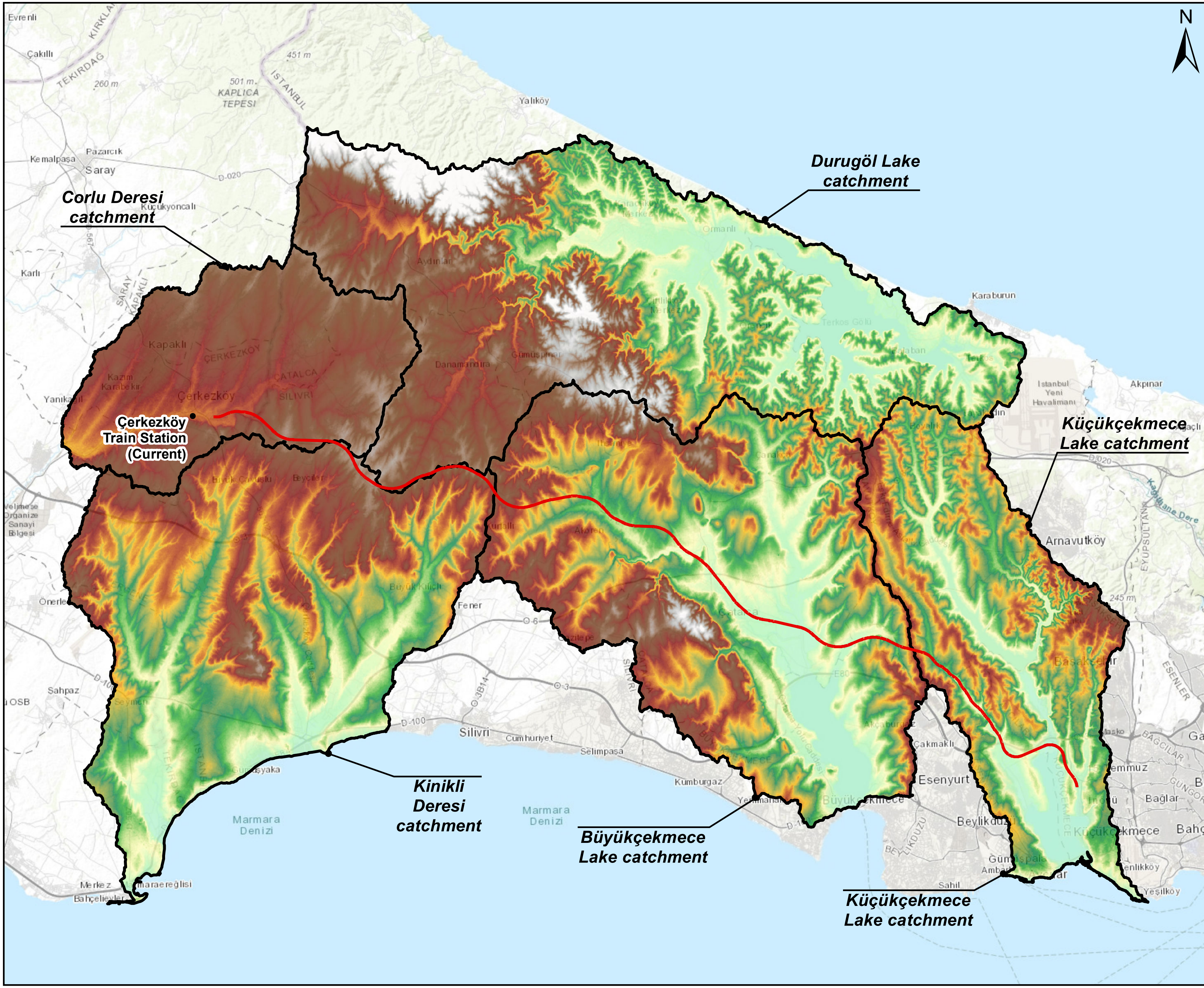
Scale at A4: 1:70,000

0 0.25 0.5 1 1.5 2 Km

Drawn	Stage 1 check	Stage 2 check	Originated	Date
DG	JG	JW	DG	22/02/2021

wsp

Drawing Number: Figure 11-1 (5 / 5)



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Proposed Railway Route
- Catchments

Elevation (m)

High : 401

Low : -12

Note:
Catchments derived from Shuttle Radar Topography Mission (SRTM).

Drawing Status	FINAL
Job Title:	HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE
Drawing Title	Figure 11-2 Watershed Catchments
Scale at A4	1:350,000
Drawn	DG
Stage 1 check	JG
Stage 2 check	JW
Originated	DG
Date	22/02/2021
Drawing Number	Figure 11-2

0 1.25 2.5 5 7.5 10 Km

Path: \\uk.wspgroup.com\central data\Projects\700698xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\GIS\Mxd\Figure 11-2 - Key Watershed Catchments.mxd

11.4 BASELINE CONDITIONS

PROJECT SETTING

11.4.1. The majority of the Project is located within the Marmara River Basin, with the very west of the Project passing into the Meriç Ergene River Basin on the approach to Çerkezköy.

11.4.2. The Project passes through five main watershed catchments as shown in **Figure 11-2**:

- Küçükçekmece Lake – catchment that includes the Sazli Stream and Hadımköy Stream / Eşkinoz Creek.
- Büyükçekmece Lake – catchment that includes Karasu Stream.
- Durugöl Lake – catchment that includes Kumluca / Karacaköy / Binkiliç Creek that extends to the north of the Project.
- Kinikli Creek – catchment that extends to the south of the Project.
- Corlu Creek – catchment that encompasses Çerkezköy to the west of the Project.

11.4.3. The baseline conditions considered within the assessment include:

- Identified watercourses that may be affected by the Project.
- Identified lakes and ponds that may be affected by the Project.
- The results of baseline surface water quality sampling.
- Areas that may be at risk of flooding and that may be affected by the Project.

11.4.4. Ecological receptors, including aquatic ecology and habitats, are discussed in **Chapter 8: Ecology**.

11.4.5. Groundwater resources, including impacts to below ground aquifers and groundwater dependent ecosystems, are discussed in **Chapter 12: Geology and Hydrogeology**.

WATERCOURSES

11.4.6. The Project crosses or is located in close proximity to several watercourses. The Project also crosses approximately 70 smaller tributaries and overland flow routes that drain to these watercourses. A summary of watercourses is provided in **Table 11-1** and shown in **Figure 11-1**.

11.4.7. Information regarding peak flood flows for the 1 in 100 annual probability (Q100) and 1 in 500 annual probability (Q500) has been obtained from two sources: the hydraulic design of the proposed structures[176] and the National EIA for the Project (2017)[174]. Differences in these flow rates are likely to be attributable to the exact location that the flow was determined and the method of determination (noting that it is not unusual to have differences in estimated flow rate).

[176] Grontmij (2020). List of Structures Ispartakule-Çerkezköy.

Table 11-1 - Watercourses

Watercourse	Chainage	Description
Sazlı Stream	4+000	The Project will cross beneath the Sazlı Stream and the proposed Kanal Istanbul project immediately upstream of Küçükçekmece Lake. The Project is will be in a new tunnel (TBM-twin bore) at this crossing point. The Sazlı Stream conveys flow from the upstream Sazlıdere Dam that provides the western side of Istanbul with drinking water.
Hadımköy Stream / Eşkinoz Creek	7+500 – 17+200	The Hadımköy Stream, sometimes referred to as the Eşkinoz Creek, flows parallel to the Project and within approximately 200m of the Project for approximately 9.7km. The Project is located adjacent to the existing railway along this section. The Project will cross this watercourse at chainage 16+272 in three box culverts (3m by 3m). It is understood that new structures will be required adjacent to the existing structures. The Q100 peak flow at the location of this crossing is estimated to be 30 m^3/s. The Q500 peak flow at the location of this crossing is estimated to be 136 m^3/s. The watercourse discharges to Küçükçekmece Lake approximately 4.5km downstream of the Project.
Camasir Creek at inlet of Büyükçekmece Lake	27+260	The Project will cross Camasir Creek, which forms the inlet channel of Büyükçekmece Lake, approximately 4km upstream of the Lake. The Project is immediately adjacent to the existing railway at this location. The Project will cross the watercourse via a 161.2m span bridge (chainage 27+179 to 27+340). It is understood that a new structure will be required adjacent to the existing structure, which consists of 4 piers, 3 of which will be located within the Camasir Creek. The Q100 peak flow at this crossing is estimated to be 267 m^3/s. The Q500 peak flow at this crossing is estimated to be 380-395 m^3/s.
Karasu Stream	27+260 – 38+980 42+150 – 46+390	The Karasu Stream is located within 1km of the Project, for approximately 11.7km, between the crossing at chainage 27+260 to chainage 38+980, and again for approximately 4.2km from chainage 42+150 to chainage 46+390. The Project will cross the Karasu Stream via a bridge (161.2m span, chainage 35+143 to 35+304), immediately adjacent to the existing railway. It is understood that a new structure will be required adjacent to the existing structure. The new structure will consist of 4 piers, 1 of which will be located within the Karasu Stream. The Project will cross the Karasu Stream again via a new bridge (95.6m span, chainage 37+150 to 37+245). The bridge structure at this location of consist of 2 piers, both of which will be

Watercourse	Chainage	Description
		located within the Karasu Stream. At this location the Project is approximately 30m to the south of the existing railway. At the crossing between chainage 35+143 to 35+304, the Q100 peak flow is estimated to be 428 m^3/s and the Q500 peak flow is estimated to be 613-663 m^3/s. At the crossing between chainage 37+150 to 37+245, the Q100 peak flow is estimated to be 381 m^3/s and the Q500 peak flow is estimated to be 542-606 m^3/s. The Project will cross four large tributaries of the Karasu Stream around chainage 42+199, chainage 43+030, chainage 44+791 and chainage 45+350 as shown on Figure 11-1. The largest of these is at chainage 45+350 via a bridge (161.2m span, between chainage 45+271 and 45+432) consisting of 4 piers, 2 of which will be located within the Karasu Stream, approximately 600m upstream of the tributary's confluence with the Karasu Stream. The Q100 peak flow at the approximate location of this crossing is estimated to be 134 m^3/s. The Q500 peak flow at the approximate location of this crossing is estimated to be 193-240 m^3/s.
Ambar Creek	74+053 – 75+268	The Project will cross the Ambar Creek three times. The bridge crossing between chainage 74+005 and 74+100 (95.6m span) will consist of 2 piers, one of which will be located within the Ambar Creek. The second bridge crossing at chainage crossing between chainage 74+700 and 74+763 (62.8m span) will consist of 1 pier which will be located within the Amber Creek. The third bridge crossing between chainage 75+220 and 75+316 (span 95.6m) will consist of 2 piers, 1 of which will enter the Amber Creek. The proposed crossings between chainage 74+005 and 74+100 and between chainage 74+700 and 74+763 will be new crossings on this watercourse where the Project is located between 180m and 330m north of the existing railway. The watercourse is already crossed at chainage 75+268 by the existing railway, and the Project is located immediately north of this existing crossing. A new structure will be required adjacent to the existing structure. The Q100 peak flow at the location of the most downstream crossing is estimated to be 227 m^3/s. The Q500 peak flow at the location of this crossing is estimated to be 328-317 m^3/s. The Ambar Creek is the main tributary of the Corlu Creek that flows through Çerkezköy approximately 4km downstream of the most westerly crossing. Corlu Creek is reported to be of poor quality and not suitable for water supply. The Azinlar Creek is located approximately 200m west of chainage 76+700 of the Project. The Azinlar Creek is also a tributary of the Corlu Creek.

11.4.8. **Figure 11-3** is a copy of Figure II-20 from the National EIA for the Project (2017)[174] and shows the estimated Q500 flow rate for the key watercourses and tributaries which will be crossed by the Project.

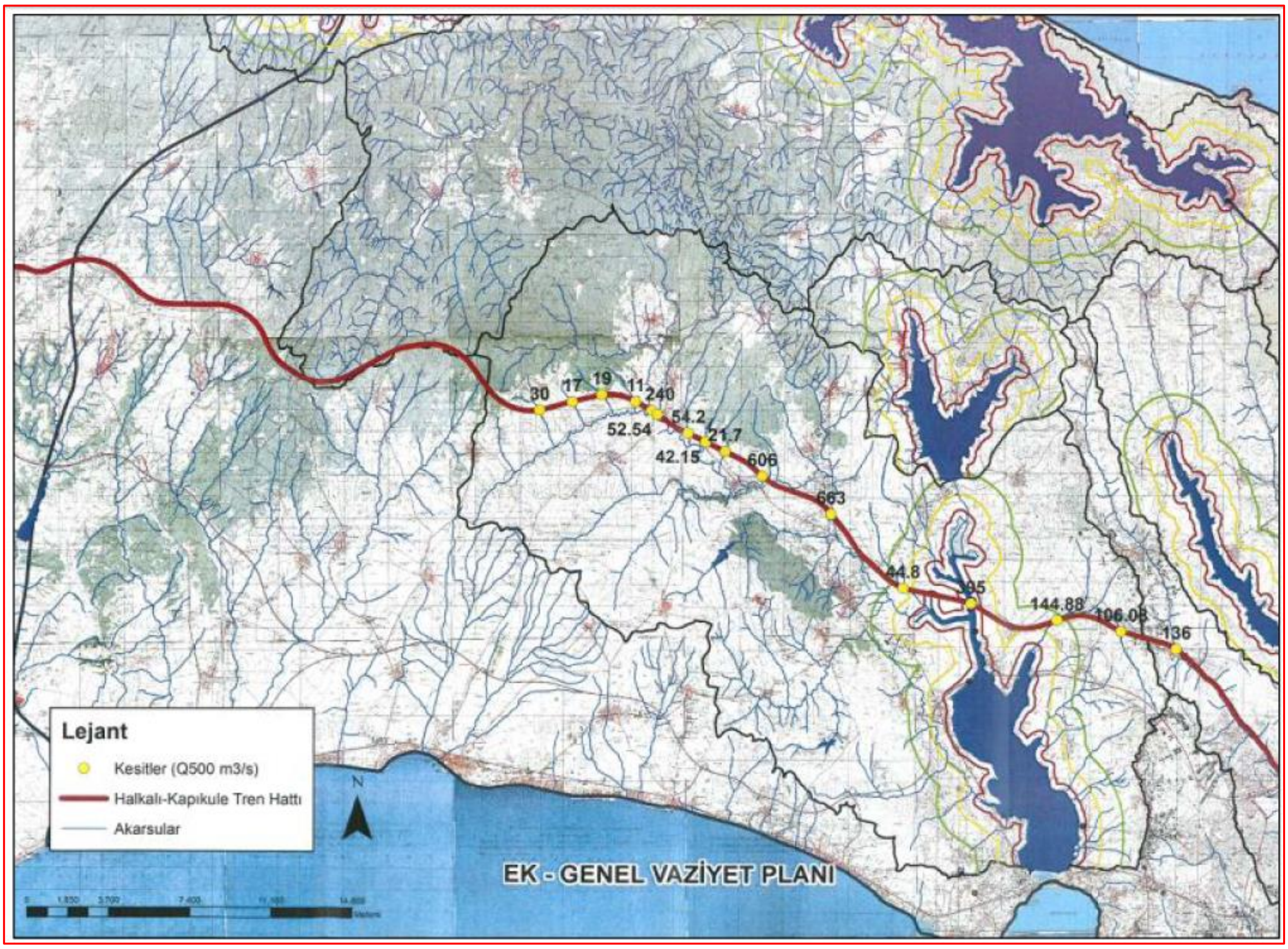


Figure 11-3 - Flow rates of rivers which intersect between CH0+000-73+000 and have Q500 flow rates over 100 m^3/s

LAKES AND PONDS

11.4.9. The majority of the Project will pass through the drainage catchment of two lakes, namely Küçükçekmece Lake and Büyükçekmece Lake. The Project is also located within the drainage catchment of the Durugöl Lake and is within 1km of the smaller Bahçeşehir Pond, İnceğiz Pond, Sinekli Pond and Çayirdere Pond. The Project is located approximately 4km west of Sazlıdere Dam. There are no other known significant waterbodies within 5km of the Project.

11.4.10. A summary of these features is provided below.

Küçükçekmece Lake

11.4.11. The Project passes approximately 400m west and immediately north of Küçükçekmece Lake. The Project will be located in a tunnel to the north of Küçükçekmece Lake, which will also pass beneath the proposed Kanal Istanbul project that connects to Küçükçekmece Lake.

11.4.12. The Küçükçekmece Lake has a surface area of approximately $16km^2$ and is a lagoon separated from the sea by a single shallow and narrow channel that passes through a tongue of sand and pebbles carried along the coast from the sea, above which the E5 highway is constructed that provides a strategic road link along the southern coast.

11.4.13. The watercourses of the Sazli Stream, Hadımköy Stream/Eşkinoz Creek (crossed by the Project as discussed above) and Nakkas Creek discharge to the Küçükçekmece Lake and provide the predominant inflow into the lake. The stream at the foot of the Küçükçekmece Lake discharges water from the Lake to the Marmara Sea. The lake is predominantly freshwater although some marine water inflow from the Marmara Sea into Küçükçekmece Lake has been observed. However, this is indicated to be minimal and predominantly affects the lower extents of the lake where the water is monitored to be brackish[177]. In some tide and weather conditions, particularly associated with high wind action, sea water also overtops the tongue of sand and pebbles into the Küçükçekmece Lake.

11.4.14. Küçükçekmece Lake is reported to be of poor quality due to pollution from surrounding urban areas within the drainage catchment of the Lake. The Lake is reported to receive high nutrient loading from irrigation water and poor sanitary treatment of wastewater, and also receive industrial waste that is discharged directly to the Lake. The Küçükçekmece Environmental Protection project led by the Istanbul Water and Sewerage Administration (ISKI) is striving to reduce wastewater discharge to the Lake[178]. The Lake is not deemed suitable to provide drinking water supply but does support water sports.

11.4.15. The Küçükçekmece Lake wetland area supports significant numbers of wintering waterbirds. The Lake is considered a critical habitat and important bird area due to the size of the regularly occurring waterbird assemblage (which meets threshold for designation as a Ramsar site under Criterion 5[179]). The ecological value of Küçükçekmece Lake is discussed further in **Chapter 8: Ecology**.

Büyükçekmece Lake

11.4.16. The Project will pass approximately 1km to north of Büyükçekmece Lake, at its closest point. As discussed above, the Project also crosses the Camasir Creek that forms the inlet to Büyükçekmece Lake approximately 4km upstream of Büyükçekmece Lake. The Project is immediately adjacent to the existing railway at this crossing.

11.4.17. Büyükçekmece Lake is fed by the Karasu Stream and provides one of the main drinking water sources for Istanbul. The Lake was deepened by the General Directorate of State Hydraulic Works (DSi) in 1988 and a dam was built on the sea foot of the Lake to reinforce the natural tongue that was formed by deposition of sand and gravel. The lake has a surface area of approximately $28km^2$.

[177] Küçükçekmece Lagoon Hydrodynamics and Sediment Transport: Choosing an Appropriate Model. Taner, Mehmet. Cem Şenduran, August 2007.
[178] The Scientific World Journal 9:1215-29 (2009). Water Quality Determination of Kucukcekmece Lake, Turkey by Using Multispectral Satellite Data.
[179] The Ramsar Sites Criteria (2014). Available at: https://www.ramsar.org/sites/default/files/documents/library/ramsarsites_criteria_eng.pdf (Accessed 20/07/20).

11.4.18. The water quality of the Lake is under pressure from growing urbanisation and is reported to be adversely affected by domestic and industrial wastewater discharges as well as agricultural runoff. Nutrient levels are generally moderate however the input of the above pollutants is reported to pose risk of eutrophic conditions with risk of excessive plant growth and, subsequently, depleted oxygen levels[180,181].

11.4.19. The Büyükçekmece Lake wetland area is important for wintering and passage waterbird species and also supports a range of breeding waterbirds. The ecological value of Büyükçekmece Lake is discussed further in **Chapter 8: Ecology**.

Durugöl Lake

11.4.20. The Project passes through the most upstream extent of the drainage catchment of Durugöl Lake. The Lake has a surface area of approximately 39 km^2 and is fed by the Kumluca Creek (known in upstream sections as the Karacaköy / Binkiliç Creek). The upper tributaries of the Lake are located within approximately 1km of the Project, although the lake is approximately 35km downstream of the Project. The Lake is used as a drinking water source for Istanbul and other surrounding areas. The Lake is freshwater with no known connection to the sea.

Sazlıdere Dam

11.4.21. The Sazlıdere Dam was constructed along the alignment of the Sazli Stream in 1996 by the DSi to provide drinking water supply to the western side of Istanbul. The Project is located approximately 4km west of Sazlıdere Dam but will not be located within the drainage catchment of the Dam.

Bahçeşehir Pond

11.4.22. The Bahçeşehir Pond is an ornamental pond located in Bahçeşehir Park. It is reported to be the largest artificial pond in Istanbul and covers an area of 26,000 m^2[(182)]. The Pond is located at chainage 10+300 approximately 60m west of the Project. The Hadımköy Stream / Eşkinoz Creek passes between the Project and the Pond.

İnceğiz Pond

11.4.23. İnceğiz Pond is located approximately 500m north of the Project at chainage 42+150. The Project will cross the Büyükkariştiran Creek via a bridge (95.6m span) that conveys discharge from İnceğiz Pond to Karasu Stream approximately 600m downstream of the crossing. The Pond is a popular recreational and fishing spot.

Sinekli Pond

11.4.24. Sinekli Pond is located approximately 200m north of the Project at chainage 60+600. The Pond discharges to Göl Creek that flows north for approximately 20km to discharge to Binkiliç Creek, that

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[180] H.Gonca Coskun and Guler Yalcin, Fresenius Environmental Bulletin 23(3):746-750 (2014). Water Quality Determination of Buyukcekmece Lake, Turkey by Using Remote Sensing and GIS Techniques. .
[181] Nese Yilmaz, Desalination and Water Treatment 159:3-12 (2019). Water quality assessment based on the phytoplankton composition of Buyukcekmece Dam Lake and its influent streams (Istanbul), Turkey. .
[182] Basaksehir Belediyesi (2020). Bahçeşehir Pond. Available at: https://www.basaksehir.bel.tr/bahcesehir-golet (Accessed 20/07/20).

in turns discharges to Durugöl Lake approximately 15km downstream. The Pond is a popular recreational and fishing spot.

Çayirdere Pond

11.4.25. Çayirdere Pond is located approximately 1.2km north of the Project at chainage 66+000. The Pond discharges to Köy Creek that flows north for approximately 5.5km to discharge to Ambar Creek. Ambar Creek will be crossed by the Project towards its downstream extent as discussed in **Table 11-1**.

SURFACE WATER QUALITY SAMPLING

11.4.26. A summary of the sampling results undertaken in January 2016 and July 2020 is provided in **Table 11-2** below. The location of the samples is shown in **Figure 11-1**.

11.4.27. The samples have been compared against the water quality classes set out in the Regulation on Control of Water Pollution (2004) that classifies water quality into 4 classifications from I to IV (Class I: High quality; Class II: Lightly polluted; Class III: Polluted; Class IV: Highly polluted).

11.4.28. The samples have also been compared against the quality status thresholds for the Water Framework Directive (WFD) relevant to Bulgaria for the characterisation of surface waters (2014). The WFD is not yet directly applicable in Turkey and no local WFD standards have been developed, however in order to consider how water quality may compare to typical WFD objectives, the objectives for Bulgaria have been applied given the proximity of the Project to Bulgaria. This analysis is indicative and is intended for general observation only.

11.4.29. Physio-chemical quality is typically indicated by parameters such as pH, Dissolved Oxygen, Biological Oxygen Demand, Nitrates, Nitrites and Phosphorous that support biological indicators. Poor physio-chemical quality is often caused by agricultural runoff and wastewater discharges. Chemical quality is indicated by the presence of metals, minerals and other chemical elements that can be attributable to a wide range of sources such as highway runoff, industrial discharges or contaminated land.

11.4.30. A summary of the findings of the surface water quality sampling is provided below:

- Sample 1: Sazli Stream is indicated to have good chemical quality but variable quality of physio-chemical parameters with elevated Biological Oxygen Demand, Nitrates, Nitrites and Faecal Coliforms.
- Sample 2: Camasir Creek at the inlet channel of Büyükçekmece Lake is indicated to have generally good chemical quality although elevated Aluminium and Iron levels are noted. Physio-chemical quality is generally good although elevated Nitrate, Nitrite and Faecal Coliforms levels are noted.
- Sample 3: Karasu Stream is indicated to have relatively poor physio-chemical quality with high pH and elevated Biological Oxygen Demand, Nitrates, Nitrites and Phosphorous. Chemical quality is also poor with elevated levels of Copper, Iron, Chlorine and Sulphur.
- Sample 4: Azinlar Creek is indicated to have poor physio-chemical quality across the majority of relevant indicators. Chemical quality is generally good although with elevated levels of Aluminium and Sulphur.
- Sample 5: Corlu Creek is indicated to have generally moderate physio-chemical quality with low Dissolved Oxygen and elevated Biological Oxygen Demand, Nitrogen and Phosphorous. Chemical quality is generally good although with elevated levels of Aluminium and Sulphur.

11.4.31. Low Dissolved Oxygen and elevated levels of Biological Oxygen Demand, Nitrates, Nitrites, Phosphorous and Faecal Coliforms are often associated with nutrient-rich agricultural runoff and wastewater discharges with high organic loading.

11.4.32. Poor chemical quality is often associated with industrial discharges or highway runoff than can be high in metals, minerals and other specific pollutants.

Table 11-2 - Summary of Surface Water Quality Sampling

	Sample Point 1 Sazli Stream Chainage 4+170 41°03'32.81"N 28°44'43.79"E			Sample Point 2 Camasir Creek Chainage 27+230 41°08'10.36"N 28°31'53.23"E			Sample Point 3 Karasu Stream Chainage 37+150 41°11'07.81"N 28°26'25.18"E			Sample Point 4 Azinlar Creek 0.2km west of Chainage 76+700 41°16'42.86"N 28°01'33.58"E			Sample Point 5 Corlu Creek 1.6km west of Chainage 76+700 41°16'48.04"N 28°00'13.41"E		
Parameter – Unit	**Result**	**Local Regs**	**WFD Regs**	**Result**	**Local Regs**	**WFD Regs**	**Result**	**Local Regs**	**WFD Regs**	**Result**	**Local Regs**	**WFD Regs**	**Result**	**Local Regs**	**WFD Regs**
Temperature (°C)	6.2	I	n/a	1.9	I	n/a	29.4	III	n/a	25.2	III	n/a	26.8	III	n/a
pH	7.72	I, II or III	Good	7.91	I, II or III	Good	6.08	III	Poor	7.08	I, II or III	Good	7.41	I, II or III	Good
Dissolved oxygen (mg/l)	6.84	II	Good	8.15	I	High	10.07	I	Good	1.24	IV	Poor	5.04	III	Mod.
Chemical oxygen demand (mg/l)	20	I	n/a	16	I	n/a	14.2	I	n/a	257	IV	n/a	28.1	I	n/a
Biological oxygen demand (mg/l)	9	III	Poor	<4	I	Good	5.64	II	Poor	105	IV	Poor	12	III	Poor
Ammonium NH_4 (mg/l)	0.162	I	Good	0.018	I	High	<0.021	I	High	25.85	IV	Poor	0.074	I	Good
Nitrate NO_3 (mg/l)	5	II	Poor	8.15	II	Poor	15.1	III	Poor	<0.45	I	Good	1.97	I	Mod.
Nitrite NO_2 (mg/l)	0.148	III	Poor	0.023	III	Good	0.627	IV	Poor	<0.32	LOD	LOD	<0.32	LOD	LOD
Total Nitrogen (mg/l)	3.89	III	Poor	0.54	II	Good	4.36	III	Poor	28.6	IV	Poor	4.56	III	Poor
Total Phosphorus (mg/l)	0.47	III	Mod.	0.08	II	Mod.	5.58	IV	Poor	66	IV	Poor	0.397	III	Mod.
Phosphate PO_4 (mg/l)	n/a	n/a	n/a	n/a	n/a	n/a	<0.31	n/a	LOD	<0.31	n/a	LOD	<0.31	n/a	LOD
Conductivity (µS/cm)	n/a	n/a	n/a	n/a	n/a	n/a	874	n/a	Mod.	925	n/a	Mod.	862	n/a	Mod.
Aluminium (mg/l)	0.049	I	Fail	0.401	III	Fail	0.234	I	Fail	0.301	III	Fail	0.212	III	Fail
Arsenic (µg/l)	<5	I	Good	<5	I	Good	3	I	Good	2	I	Good	4	I	Good
Copper (µg/l)	<2	I	Good	<2	I	Good	54	III	Fail	1	I	Good	2	I	Good
Barium (µg/l)	48	I	n/a	62	I	n/a	172	I	n/a	86	I	n/a	80	I	n/a

Parameter – Unit	Sample Point 1 Sazli Stream Chainage 4+170 41°03'32.81"N 28°44'43.79"E			Sample Point 2 Camasir Creek Chainage 27+230 41°08'10.36"N 28°31'53.23"E			Sample Point 3 Karasu Stream Chainage 37+150 41°11'07.81"N 28°26'25.18"E			Sample Point 4 Azinlar Creek 0.2km west of Chainage 76+700 41°16'42.86"N 28°01'33.58"E			Sample Point 5 Corlu Creek 1.6km west of Chainage 76+700 41°16'48.04"N 28°00'13.41"E		
	Result	Local Regs	WFD Regs	Result	Local Regs	WFD Regs	Result	Local Regs	WFD Regs	Result	Local Regs	WFD Regs	Result	Local Regs	WFD Regs
Boron (µg/l)	100	I	n/a	<10	I	n/a	321	I	n/a	73	I	n/a	131	I	n/a
Mercury (µg/l)	<0.5	I	n/a	<0.5	I	n/a	<0.1	I	n/a	<0.1	I	n/a	<0.1	I	n/a
Zinc (µg/l)	<1	I	Good	<1	I	Good	43	I	Good	66	I	Good	<5	I	Good
Iron (µg/l)	43	I	Good	197	I	Fail	1330	III	Fail	272	I	Fail	240	I	Fail
Fluoride (µg/l)	<100	I	n/a	250	I	n/a	<100	I	n/a	<100	I	n/a	<100	I	n/a
Cadmium (µg/l)	<1	I	n/a	<1	I	n/a	<0.5	I	n/a	<0.5	I	n/a	<0.5	I	n/a
Cobalt (µg/l)	<1	I	n/a	<1	I	n/a	2	I	n/a	0.7	I	n/a	0.85	I	n/a
Chromium 6 (µg/l)	<20	I	LOD	<20	I	LOD	<20	I	LOD	<20	I	LOD	<20	I	LOD
Chromium Total (µg/l)	<2	I	n/a	<2	I	n/a	1	I	n/a	<1	I	n/a	<1	I	n/a
Lead (µg/l)	<5	I	n/a	<5	I	n/a	2	I	n/a	<0.5	I	n/a	<0.5	I	n/a
Nickel (µg/l)	<5	I	n/a	<5	I	n/a	5	I	n/a	8	I	n/a	<5	I	n/a
Selenium (µg/l)	<5	I	n/a	<5	I	n/a	0.5	I	n/a	0.7	I	n/a	0.7	I	n/a
Free Chlorine (µg/l)	<10	I	n/a	<10	I	n/a	198	IV	n/a	<10	I	n/a	<10	I	n/a
Cyanide (µg/l)	<5	I	Good	<5	I	Good	<5	I	Good	<5	I	Good	<5	I	Good
Sulphur (µg/l)	<2	I	n/a	<2	I	n/a	<100	IV	n/a	111	IV	n/a	<100	IV	n/a
Faecal Coliform (counts per 100ml)	4000	IV	n/a	400	III	n/a	27	II	n/a	170	II	n/a	140	II	n/a
Total Coliform (counts per 100ml)	5500	II	n/a	5000	II	n/a	70	I	n/a	280	II	n/a	220	II	n/a

Parameter – Unit	Sample Point 1 Sazli Stream Chainage 4+170 41°03'32.81"N 28°44'43.79"E			Sample Point 2 Camasir Creek Chainage 27+230 41°08'10.36"N 28°31'53.23"E			Sample Point 3 Karasu Stream Chainage 37+150 41°11'07.81"N 28°26'25.18"E			Sample Point 4 Azinlar Creek 0.2km west of Chainage 76+700 41°16'42.86"N 28°01'33.58"E			Sample Point 5 Corlu Creek 1.6km west of Chainage 76+700 41°16'48.04"N 28°00'13.41"E		
	Result	Local Regs	WFD Regs	Result	Local Regs	WFD Regs	Result	Local Regs	WFD Regs	Result	Local Regs	WFD Regs	Result	Local Regs	WFD Regs
Oil and Grease (mg /l)	<10	I, II or III	n/a	<10	I, II or III	n/a	<10	I, II or III	n/a	11.6	I, II or III	n/a	<10	I, II or III	n/a

Key:
Mod.: Moderate; LOD: Limit of detection too high to draw conclusion; N/A: Parameter not monitored.

FLOOD RISK

Coastal Flood Risk

11.4.33. The Flood Surge Map provided in **Figure 11-15** of the National EIA for the Project (2017)[174] indicates that the Project is not located in an area that is at risk of flooding from 'flood surge'. It is interpreted that 'flood surge' refers to flooding that may arise during extreme river and sea / wave events although the flood mechanisms considered by this map are not detailed. A copy of the flood surge map is presented in **Figure 11-4**. No other flood risk mapping or coastal flood risk analysis is available in Turkey.

11.4.34. The normal tidal range in the Marmara Sea is reported to be very small with a typical diurnal tidal range of 10-20cm[183]. A review of available data sources indicates a predicted sea level rise within the Istanbul area of between 45-75cm over the next 100 years depending on the modelled climate change scenario[184]. There is however no known analysis of how this predicted rise would increase coastal flood risk or storm surge that would predominantly affect lower lying coastal areas.

11.4.35. A review of topography along the Project indicates it will be at an elevation of approximately 9m above datum at Chainage 0+000, to enable it to tie into existing infrastructure at that elevation at Halkali. The Project is at its closest point to the sea at Chainage 0+000, although this is still approximately 4km from the coast. It is considered unlikely that the Project would be at risk of coastal flooding given its 9m elevation above sea level.

11.4.36. The Project rises steadily from Chainage 0+000 to approximately 83m at Chainage 2+400 before dropping towards the north of Küçükçekmece Lake to pass beneath the Kanal Istanbul project. The north of Küçükçekmece Lake is located approximately 8km from the coast. An increase in normal tide levels in the Marmara Sea could affect the normal water level of the lake (given hydraulic connectivity), and may therefore pose flood risk to the entrance to the tunnel, although the magnitude of the influence of tidal levels to water levels in Küçükçekmece Lake is uncertain and there is currently no available data to inform this assessment. Given the distance of the Project from the coast at this location it is considered unlikely that the Project would be at risk of tidal storm surge caused by high winds and wave action.

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[183] Küçükçekmece Lagoon Hydrodynamics and Sediment Transport: Choosing an Appropriate Model. Taner, Mehmet. Cem Şenduran, August 2007.
[184] Istanbul Climate Change Action Plan, Summary Report 2018, Istanbul Metropolitan Municipality

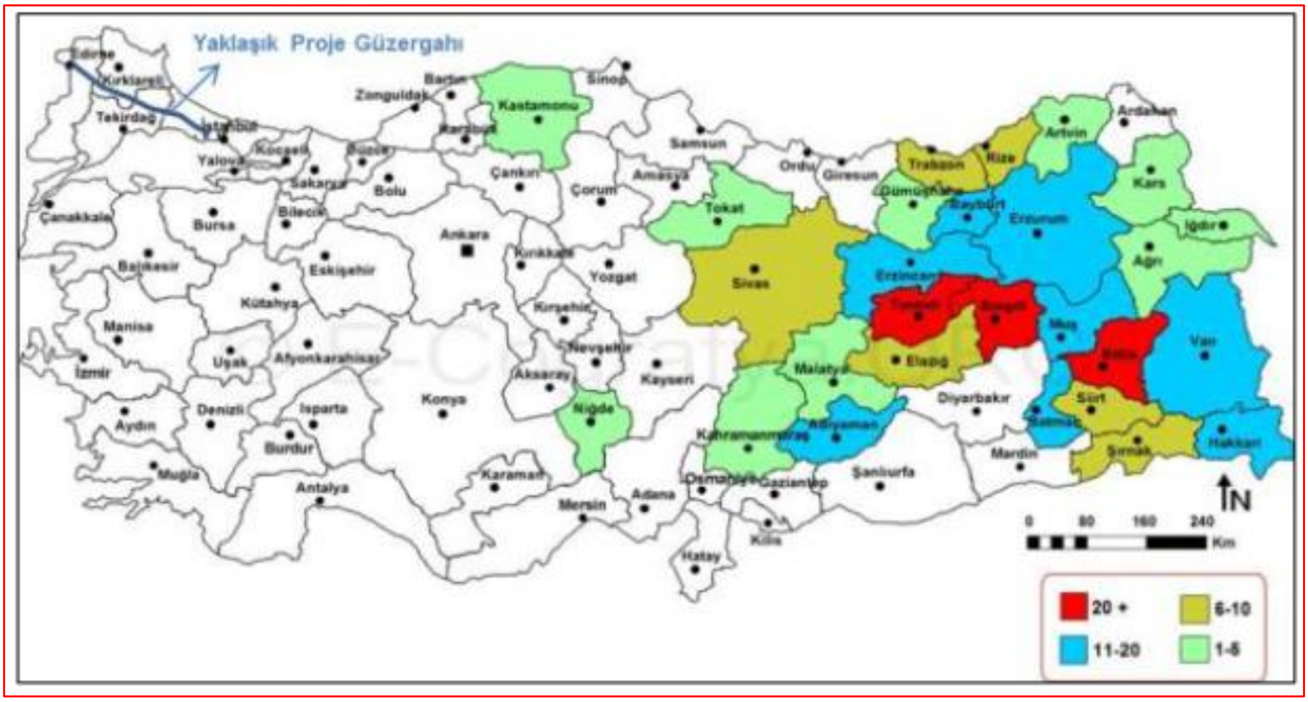

Figure 11-4 - Turkey Flood Surge Map

Fluvial Flood Risk

11.4.37. Correspondence received from the DSi to inform the National EIA for the Project (2017) makes reference to a significant flooding event that occurred in Istanbul in September 2009, suggesting that this involved flooding along the Hadımköy Stream.

11.4.38. Correspondence received from the DSi to inform the National EIA for the Project (2017) also makes reference to the Q500 flows close to the Büyükçekmece Lake as well as the 'max. altitude' of the Lake that has been determined as 6.68 – this is understood to mean a maximum water level of 6.68m above datum. The correspondence stresses the importance of considering the water level of Büyükçekmece Lake in the design of the Project.

11.4.39. There are no other known historic records of flooding in proximity to the Project.

11.4.40. Superficial alluvial deposits are mapped on geological mapping (see **Chapter 12: Geology and Hydrogeology** for more information). These deposits may indicate the fluvial flood extent as evidenced by historic deposition of alluvial materials that are typically deposited by rivers and floodwaters. The indicative flood extents informed by the mapped alluvial deposits indicates that the Project may be located in areas of fluvial flood risk at the following locations:

- As the Project crosses beneath the Sazlı Stream and the proposed Kanal Istanbul project immediately upstream of Küçükçekmece Lake. However, the Project will be in a tunnel at this location, so it is not considered to be at risk of flooding from fluvial sources.
- As the Project traverses parallel to the Hadımköy Stream / Eşkinoz Creek for approximately 9.7km between approximate chainage 7+500 to chainage 17+200. The Project is located immediately adjacent to the alignment of the existing railway along this section.

- As the Project crosses an unnamed tributary of Büyükçekmece Lake between approximate chainage 22+000 and chainage 23+500. The Project is located approximately 800m south of the existing railway at this location.
- As the Project crosses the Camasir Creek that forms the inlet channel of Büyükçekmece Lake and follows the alignment of Karasu Stream, with alluvial deposits shown between approximate chainage 25+500 and chainage 38+000. The Project is located adjacent to the existing railway along this section.
- As the Project crosses the upper extents and tributaries of the Karasu Stream, with alluvial deposits indicated between approximate chainage 42+500 and chainage 45+750. The Project is located adjacent to the existing railway along this section.

11.4.41. Information regarding estimated peak flood flows during the Q100 and Q500 events has been obtained from the National EIA for the Project[174] and design information[176]. These have been presented in **Table 11-1** for the key watercourses crossed by the Project.

11.4.42. The failure of the Sazlidere Dam could pose risk to downstream receptors between the Dam and Küçükçekmece Lake, following the alignment of the Sazli Stream. This is unlikely to affect the Project as it is in tunnel at this location.

FUTURE BASELINE

11.4.43. The potential effects of climate change may affect surface water features and flood risk throughout Turkey in the future. The nature of these effects is hard to predict, however scientific consensus suggests the potential for longer and more intense rainfall events that may lead to increased river flows and increased flood risk. Sea level rise and increase wave height may also increase coastal flood risk and coastal erosion. Climate change may also result in longer periods of low rainfall or drought causing reduced river flow, reduced dilution of pollutants and lower water levels in lakes. The wider effects of climate change are considered further in **Chapter 14: Climate Change** and align with the assessment presented in this chapter.

11.5 POTENTIAL IMPACTS AND EFFECTS

CONSTRUCTION PHASE

11.5.1. Review of the Project indicates that the following potentially significant impacts could occur during the construction of the Project:

- Increased pollution risks to surface water bodies from increased sedimentation and disposal or spillage of fuels or other harmful substances that may be discharged, spilled directly or migrate to local surface water receptors.
- Increased risks to surface waters from discharge of foul effluent from construction compounds / construction workers accommodation and increased water demand associated with construction compounds / construction workers accommodation.
- Increased flood risk associated with temporary works within areas of fluvial flood risk and within watercourses and increased flood risk associated with surface water discharges during construction.

11.5.2. A summary of each of these impacts is provided below. The impact assessment has not taken into consideration standard good practice measures that would be expected as part of the construction methodology, for example the management of sediment laden runoff or maintaining hydraulic connectivity in watercourses crossed by the Project. In some instances, the predicted impact magnitude is therefore high, as this provides a reasonable worst-case scenario. Mitigation measures and residual effects are discussed in **Section 11.6** and **Section 11.7**.

Pollution Risks to Surface Water Bodies from Increased Sedimentation and Spillages

11.5.3. This impact would be associated with construction activities taking place along the Project which may lead to sedimentation and / or have the potential to cause pollution from the discharge, spillage or migration of fuels or other harmful substances.

11.5.4. Temporary increased sedimentation within watercourses caused by surface water runoff containing elevated levels of suspended particles may result from construction activities such as land clearance, excavation, dewatering of excavations, tunnelling, wheel washings, areas of bare earth, construction of earth embankments, and construction materials such as aggregate and stockpiles of topsoil. Temporary increased sedimentation within watercourses is also likely to occur as a result of the construction of bridge piers within the watercourse channel.

11.5.5. Runoff with high sediment loads may have direct adverse impacts on adjacent water bodies through increasing turbidity (affecting potable water quality and ecological quality through reducing light penetration and reducing plant growth) and by smothering vegetation and bed substrates (thus impacting on invertebrate and fish communities through the destruction of feeding areas, refuges and breeding and or spawning areas). Organic sediments can also have indirect effects on physio-chemical properties such as dissolved oxygen demand and pH and may also contain heavy metals and other soluble pollutants that can affect chemical water quality and potable supplies. As discussed in **Chapter 12: Geology and Hydrogeology**, contaminated soils may also be present along the Project, most likely associated with historic sewage disposal, waste and fuel storage, or past spills from agricultural machinery.

11.5.6. Increased pollution risks from the discharge or spillage of fuels or other harmful substances associated with temporary works may also migrate to local surface water receptors. Hydrocarbons form a film on the surface of the water body, deplete oxygen levels and may be toxic to fish. If materials and activities are not stored and carried out in designated areas, runoff and washdown may enter a water body, adversely affect the aquatic environment or contaminate drinking water supplies. The most common source of pollution is from leaks and spillages of hydrocarbons from mechanical plant or storage vessels. Concrete and cement products can also pose a significant risk to the water environment and chemical water quality. These products are highly alkaline and corrosive. For the most part, it is only when large quantities of hazardous substances are spilled, or the spillage is directly into the water body, that a significant risk of acute toxicity or drinking water contamination would arise in the receiving water. The risks are likely to be greater with the construction of bridges and culverts that will cross the watercourse and may require works within the watercourse channel. The risk could also be associated with the discharge or runoff from concrete wash water from batching plants.

11.5.7. Without the inclusion of appropriate mitigation, the potential impact to surface water features located within close proximity to the works that could be affected by direct discharge or migration of pollutants will be moderate to large adverse with **Moderate (significant)** to **Minor (not significant)** effects. The risk to surface water features that are located further from the works will be less as pollutants will disperse and settle on the ground or be diluted or settle in upstream water features. Potential impacts are therefore likely to be slight adverse with **Minor to Neutral (not significant)** effects.

11.5.8. It is currently uncertain if dewatering of the excavated material from the proposed TBM-twin bore tunnel (under the Kanal Istanbul), beneath the Sazli Stream and to the north of Küçükçekmece Lake will be required, however if required it is possible that this water may be discharged to Küçükçekmece Lake or, alternatively, to the lower reaches of Sazli Stream or Hadımköy Stream / Eşkinoz Creek. This water may be high in sediment and have low dissolved oxygen, as well as contain other chemical pollutants. The Lake will provide considerable dilution of pollutants and is not used for drinking water supply given its current poor water quality, however without robust treatment of water prior to discharge the impacts to Küçükçekmece Lake are considered to be moderate adverse with **Minor (not significant)** effects. If discharge to an adjacent watercourse is proposed, without mitigation the potential impacts to the lower reaches of Sazli Stream and Hadımköy Stream / Eşkinoz Creek are considered to be large adverse with **Moderate (significant)** effects.

11.5.9. A summary of likely impacts to surface water features associated with increased pollution risk during construction is summarised in **Table 11-3**.

Table 11-3 - Impacts and Effects to Water Quality During Construction

Receptor	Sensitivity	Summary of Impacts	Impact Magnitude	Significance
Sazli Stream	High	Project is located in a deep tunnel beneath watercourse. Direct migration of sediment and pollutants unlikely given distance from on-ground works to watercourse. Discharge of dewatering from tunnel construction could occur.	Large Adverse	Moderate Adverse (Significant)
Küçükçekmece Lake	Very High	Project is located in a deep tunnel to north of lake. Direct migration of sediment and pollutants unlikely given distance from on-ground works to lake. Dewatering of excavated tunnel material may be discharged to lake.	Moderate Adverse	Moderate Adverse (Significant)
Hadımköy Stream / Eşkinoz Creek	High	Project is located in close proximity of watercourses and crosses watercourses. Increased sediment and pollution risk will be likely particularly for construction of in-channel culverts. Discharge of dewatering from tunnel construction could occur.	Large Adverse	Moderate Adverse (Significant)

Receptor	Sensitivity	Summary of Impacts	Impact Magnitude	Significance
Camasir Creek Karasu Stream Ambar Creek	High	Project is located in close proximity of watercourses and crosses watercourses, with bridge piers within the watercourse. Increased sediment and pollution risk will be likely.	Large Adverse	Moderate Adverse (Significant)
Bahçeşehir Pond	Medium	Pond separated from Project by Hadımköy Stream / Eşkinoz Creek. Direct migration of significant volume of sediment and pollutants unlikely.	Slight Adverse	Minor Adverse (Not Significant)
Büyükçekmece Lake	Very High	Project crosses Camasir Creek that forms the inlet to Lake approximately 4km upstream via bridge. Sediment and pollutants likely to settle, disperse and dilute in upstream watercourse and direct migration of significant volume of pollutants to the Lake unlikely. However, management of pollutants in this area will be of upmost importance given the lake's use as a drinking water supply.	Slight Adverse	Minor Adverse (Not Significant)
Sinekli Pond	Medium	Pond located approximately 330m north of Project. Direct migration of significant volume of sediment and pollutants unlikely.	Slight Adverse	Minor Adverse (Not Significant)
Corlu Creek	High	Watercourse approximately 4km downstream of the most westerly crossing of Ambar Creek (upstream of Corlu Creek). Sediment and pollutants likely to settle, disperse and dilute. Direct migration of sediment and pollutants unlikely.	Slight Adverse	Minor Adverse (Not Significant)
Minor watercourses and tributaries crossed	Low - Medium	Project crosses many smaller watercourses and tributaries. Increased sediment and pollution risk will be likely particularly for	Moderate Adverse	Minor Adverse (Not Significant)

Receptor	Sensitivity	Summary of Impacts	Impact Magnitude	Significance
by the Project alignment		construction of in-channel culverts.		
Çayirdere Pond	Medium	Pond located 1.5km north of the Project. Sediments and pollutants contained in tributaries will settle, disperse and dilute. Direct migration of sediment and pollutants unlikely.	Slight Adverse	Minor Adverse (Not Significant)
Durugöl Lake	Very High	Lake located 35km downstream of the Project. Sediments and pollutants contained in tributaries will settle, disperse and dilute. No impact predicted.	No Change	Neutral (Not Significant)
Kumluca / Karacaköy / Binkiliç Creek Kinikli Creek	High	Watercourses located significant distance from the Project. Migration of sediment and pollutants unlikely. Sediments and pollutants contained in tributaries will settle, disperse and dilute. No impact predicted.	No Change	Neutral (Not Significant)
Sazlıdere Dam	High	Dam located upstream of the Project.	No Change	Neutral (Not Significant)
İnceğiz Pond	Medium	Pond located upstream of the Project.	No Change	Neutral (Not Significant)

Pollution Risks to Surface Water Bodies from Construction Compounds / Construction Workers Accommodation

11.5.10. Impacts could typically be associated with pollution risk from the discharge of foul effluent from construction compounds / construction workers accommodation, and increased water demand associated with construction compounds / construction workers accommodation. Construction compounds can also pose risks associated with the discharge, spillage or migration of fuels or other harmful substances as discussed above.

11.5.11. It is expected there will be three main construction compounds / construction workers accommodation during the construction phase. The locations of these construction compounds / construction workers accommodation will be determined by the Contractor in later stages of the

Project, however for the purpose of this ESIA three indicative locations have been considered, as follows:

Table 11-4 - Indicative Location of Construction Compounds / Construction Workers Accommodation

Construction Compound / Construction Workers Accommodation	Approximate Chainage Location	Surface Water Features
1: Smaller, near Halkali	Chainage 7+000	Within approximately 100m of Hadımköy Stream / Eşkinoz Creek.
2: Largest, near Kabakça	Chainage 46+500	Within approximately 100m of minor tributary of Karasu Stream that is approximately 650m downstream of construction compounds / construction workers accommodation.
3: Smaller, near Çerkezköy	Chainage 75+250	Within approximately 100m of Ambar Creek.

11.5.12. The construction compounds, which include construction workers accommodation, are likely to be between 5,000m^2 and 9,000m^2 in physical extent, with an average occupancy of 185 construction workers in the accommodation at each construction compound. The total number of construction workers is expected to be approximately 1,100. Each compound will have construction workers accommodation, including dormitories and bathrooms, offices, healthcare facilities, sports facilities and catering / canteen facilities that will require water supply and drainage.

11.5.13. It is understood that non-potable water will be pumped from groundwater resources and sourced from the local water network (water pipes) and drinking water will be provided in bottled containers. The provision of water supply to the construction compounds / construction workers accommodation is predicted to have negligible impact to local surface water features.

11.5.14. Wastewater discharge from welfare facilities at each construction compound / construction workers accommodation is estimated to be approximately 240,000 litres/day[185]. Following a similar approach to that adopted for the adjacent under-construction Cerkezkoy to Kapikule railway, it is expected that wastewater will be collected in sealed tanks and removed from compounds in tankers, for disposal at a wastewater treatment plant. The discharge of wastewater from the construction compounds / construction workers accommodation is therefore predicted to have negligible impact to local surface water features.

[185] Information provided by to the under-construction Cerkezkoy to Kapikule railway contractor (by AYGM and TCDD).

11.5.15. The risks associated with the discharge, spillage or migration of fuels or other harmful substances from construction compounds will be similar to those discussed above. These risks are most likely to be associated with the storage of constriction plant and construction materials within the compounds, including harmful materials such as fuels and cement products as well as constriction waste.

11.5.16. A summary of likely impacts to surface water features associated with discharge of foul effluent from construction compounds / construction workers accommodation, increased water demand associated with construction compounds / construction workers accommodation, and discharge, spillage or migration of fuels or other harmful substances is summarised in **Table 11-5**. In summary, is considered that there will be **Neutral (not significant)** effects associated with the discharge of foul effluent and water demand, but potentially **Moderate (significant)** effects associated with pollution from fuels or other harmful substances.

Table 11-5 - Impacts and Effects to Surface Water Features from Construction Compounds / Construction Workers Accommodation

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
Surface water features within study area	Very High to Low	Pollution risks from discharge of untreated wastewater from construction compounds / construction workers accommodation. Wastewater will be collected and removed from compounds in tankers for disposal at a wastewater treatment plant.	No Change	Neutral (Not Significant)
Surface water features within study area	Very High to Low	Non-potable water will be pumped from groundwater resources and sourced from the local water network (water pipes). Drinking water will be provided in bottled containers.	No Change	Neutral (Not Significant)
Surface water features within study area	Very High to Low	Pollution risks from discharge, spillage or migration of fuels or other harmful substances from construction compounds.	Moderate to Large Adverse	Moderate Adverse (Significant)

Increased Fluvial and Surface Water Flood Risk

11.5.17. Impacts could typically be associated with areas where construction activities and temporary works are taking place along the Project within watercourses and in areas of fluvial flood risk, or where there may be increased surface water discharge during construction.

11.5.18. The Project will cross several watercourses and many small tributaries. Temporary works within watercourses (most notably the construction of new culverts and bridge piers) and within fluvial floodplains (such as embankment construction and new bridge pier structures) could reduce the hydraulic capacity of the watercourse, displace floodwater storage or sever floodplain conveyance if the hydraulic connectivity and capacity of these features are not maintained throughout construction. This in turn could increase flood risk to people, property and infrastructure elsewhere during the construction phase. Prior to the inclusion of appropriate mitigation, the potential risk to people, property and infrastructure is considered to be moderate adverse, with **Moderate (significant)** to **Minor (not significant)** effects. Please note that impacts associated with permanent works are assessed as operational phase impacts below.

11.5.19. The majority of the Project is located within rural areas. The risk of increased flooding to adjacent properties during construction is therefore likely to be low although there may still be an increase in flood risk to lower-vulnerability agricultural land or road infrastructure. The risks to property are likely to be greatest on the approach to Çerkezköy where the Project crosses the Ambar Creek in close proximity to urban areas. There may also be risks to the existing railway that is in close proximity to the Project along much of its length although the railway is generally raised above adjacent ground levels.

11.5.20. Construction works will increase the area of impermeable surfacing or compacted soils, particularly associated with construction compounds / construction workers accommodation, that may increase the rate and volume of runoff discharged to adjacent watercourses. This in turn could lead to increased flood risk during large rainfall events if an appropriate drainage strategy is not implemented. The impacts are not likely to be significant as the increase area of runoff will still be relatively small compared to the wider catchment of the watercourses. Prior to the inclusion of appropriate mitigation, the potential risk to people, property and infrastructure is considered to be slight adverse, with **Minor (not significant)** effects.

11.5.21. It is currently uncertain if dewatering of the excavated material from the proposed TBM-twin bore tunnel beneath the Sazli Stream and to the north of Küçükçekmece Lake will be required during the construction phase, however if required it is possible that this water may be discharged to Küçükçekmece Lake or, alternatively, to the lower reaches of Sazli Stream or Hadımköy Stream / Eşkinoz Creek. The volume of water discharged to the Lake or adjacent watercourses will be very small compared to the volume of the Lake and catchment of the watercourses therefore impacts are considered to be negligible with **Neutral (not significant)** effects.

11.5.22. A summary of likely impacts to flood risk associated with works in areas of fluvial flood risk, works within watercourses and potential discharge of dewatering during the construction phase is summarised in **Table 11-6**.

Table 11-6 - Impacts and Effects to Flood Risk During Construction

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
People, property and infrastructure	Very High to Medium	Temporary reduction of watercourse capacity, floodplain storage and flood flow conveyance could increase fluvial	Moderate Adverse	Moderate to Minor Adverse (Significant)

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
close to the Project. Existing railway.		flood risk elsewhere. Probability of extreme flood event occurring during construction is low. Existing railway typically raised above adjacent ground level.		
People, property and infrastructure elsewhere. Existing railway.	Very High to Medium	Increased rate and volume of surface water runoff associated with impermeable surfaces and compacted soils.	Slight Adverse	Minor Adverse (Not Significant)
People, property and infrastructure elsewhere. Existing railway.	Very High to Medium	If discharge of tunnel dewatering required, volume will be negligible in comparison to volume of Küçükçekmece Lake and catchment of receiving watercourses.	No Change	Neutral (Not Significant)

Impacts to Watercourse Flow and Connectivity

11.5.23. As discussed above the Project will cross several watercourses and many small tributaries. Temporary works within watercourses (most notably the construction of new culverts) could reduce the hydraulic capacity of the watercourse either by temporary diversion, restriction or blockage of the watercourse to facilitate the construction of new structures. This in turn may reduce the volume of river flows downstream of the Project available for abstraction or supporting water environments. This is most likely to be a greater risk to smaller watercourses and tributaries that have a low flow, and therefore the risk to larger watercourses that have a larger catchment is likely to be low.

11.5.24. Prior to the inclusion of appropriate mitigation, the potential risk to watercourse flows and connectivity is considered to be large adverse to smaller watercourses and tributaries with potential for slight adverse to larger watercourses, with overall **Minor (not significant)** effects. Please note that impacts associated with permanent works are assessed as operational phase impacts below.

Table 11-7- Impacts and Effects to Watercourse Flow and Connectivity During Construction

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
Watercourses within study area	High to Low	Impact to watercourse flows downstream of Project associated with temporary diversion, restriction or blockage of watercourse.	Slight to Large Adverse	Minor Adverse (Not Significant)

OPERATIONAL PHASE

11.5.25. A review of the Project indicates that the following potentially significant effects could occur during the operation of the Project:

- Polluted surface water runoff that may be discharged to surface water bodies.
- Increased wastewater discharge and increased water demand associated with railway stations.
- Increased flood risk associated with proposed drainage systems.
- Increased flood risk caused by displacement of flood water storage or crossing of watercourses that may impact flood flow conveyance.
- Impacts to hydrology, hydromorphology and flow dynamics associated with the proposed crossing or realignment of watercourses.

11.5.26. A summary of each of these impacts is provided below. The impact assessment has taken into consideration measures that are proposed as part of the Project design (for example the sizing of watercourse crossings) but has not taken into consideration other standard good practice measures that are not yet confirmed (for example flood mitigation or treatment systems). Mitigation measures and residual effects are discussed in **Section 11.6** and **Section 11.7**, and the mitigation has been included in the **ESMP** that the Contractor and TCDD Transport will implement during construction and operation respectively.

Polluted Surface Water Runoff That May Be Discharged to Surface Water Bodies

11.5.27. The Project will be served by a new drainage system that will drain the track within the Project corridor. The Project will be electrified and, as such, the risk of typical pollutants such as oils and fuels are unlikely to be present. Track maintenance trains/vehicles may not be electrified and may therefore pose a risk of diesel/oil leaks; however, this risk is low and it is assumed that the same vehicles will be used to maintain the Project as currently maintain the existing railway, therefore there would be no measurable change compared to baseline conditions. The increased risk to the quality of the surface water environment is therefore negligible with **Neutral (not significant)** effects.

11.5.28. During the operational phase of the Project, the maintenance of trains will be carried out at the existing maintenance station at Halkali. It has been confirmed that appropriate drainage and treatment systems are installed at this existing facility to manage risks to water quality and that waste products, such as waste oil, are disposed of correctly (i.e. with appropriate pre-treatment or to a designated facility) and with the necessary agreements from the DSi Regional Directorates. The increased risk to the quality of the surface water environment associated with stationary trains and train maintenance is therefore negligible with **Neutral (not significant)** effects.

11.5.29. A summary of likely impacts to surface water quality during the operational phase is summarised in **Table 11-8**.

Table 11-8 - Impacts and Effects to Surface Water Quality During Operation

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
Surface water features within study area	Very High to Low	Trains will be electrified, and pollution risks low. Existing stations and sidings/depots are expected to be appropriately drained.	No Change	Neutral (Not Significant)

Wastewater Discharge and Water Demand Associated with Stations

11.5.30. No new stations are proposed as part of the Project. The 3 existing stations located along the Project (Halkali, Ispartakule and Catalca) are already supplied with water supply and drainage infrastructure. It is estimated that each station will be used by 500 people per day including 20 employees in the operational phase[174]. Assuming a daily water demand of 150 l/person/day, this indicates that approximately 75 m^3 (500 persons × 0.15 m^3/person-day = 75 m^3) of water will be required, and that approximately 75m^3 of wastewater will be generated assuming all water supply is converted to wastewater (as a worst-case scenario).

11.5.31. Wastewater from the existing facilities at Halkali and Ispartakule stations is discharged to the public sewerage network. Wastewater from the existing facilities at Catalca station is discharged to five septic tanks that in turn discharge to Karasu Stream as there is no public sewerage infrastructure located nearby. TCDD has confirmed that all existing wastewater systems have sufficient capacity to cater for the Project[186]. If any amendments are required to these systems, they will be made in accordance with the provisions of the Regulation on Control of Water Pollution and with agreement from the relevant DSi Regional Directorate.

11.5.32. Existing water supply infrastructure will be used to manage any increase in demand caused by the Project, with any increase in water demand agreed with the relevant DSi Regional Directorate.

11.5.33. A summary of likely impacts of increased wastewater discharge and increased water demand during the operational phase is summarised in **Table 11-9**.

[186] TCDD, September 2020.

Table 11-9 - Impacts and Effects of Increased Wastewater Discharge and Increased Water Demand During Operation

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
Surface water features within study area	Very High to Low	Existing water supply and wastewater systems serve stations. Any amendments to existing systems agreed with the relevant DSi Regional Directorate.	No Change	Neutral (Not Significant)

Coastal Flood Risk to the Project from Sea Level Rise and Storm Surge

11.5.34. As discussed in **Section 11.4**, the Project is considered to be at low risk of coastal flooding from sea level rise or storm surge. Around Halkali Station where the Project is at is closest point to the sea, the Project will be located approximately 4km from the coast and elevated at 9m above datum. The Project will tie into existing infrastructure at this location and will not be at any increased risk when compared to the existing railway infrastructure.

11.5.35. The Project may be at a potentially low risk of tidal flooding at the location of TBM tunnel under the Kanal Istanbul project, because the Project drops below existing ground level, which has an elevation of approximately 0m to -1m at this location, and is therefore close to what is likely to be the normal water level in Küçükçekmece Lake. An increase in sea level rise due to climate change (estimated to be 45-75cm over the next 100 years) may have an effect on normal water levels in the lake, although the magnitude of the tidal influence of the Marmara Sea on water levels in the lake is uncertain and there is no known available analysis to inform this assessment. The risk of tidal storm surge caused by high winds and wave action from the Marmara Sea is considered highly unlikely given the distance of the Project from the coast at this location, although the size of Küçükçekmece Lake could give rise to localised surge towards the Project from high winds that cross the lake itself.

11.5.36. The risk of flooding to the TBM tunnel beneath the Kanal Istanbul project could be mitigated through the inclusion of defence structures located adjacent to the entrance to the tunnel that would prevent the flow of water into the tunnel as well as implementation of flood warning systems as part of the detailed design for the Project, if required following further consideration by the designers.

11.5.37. A summary of likely impacts of increased flood risk associated with sea level rise and storm surge is summarised in **Table 11-9**, noting that this does not include the inclusion of mitigation.

Table 11-10 - Impacts and Effects of Increased Flood Risk Associated with Sea Level Rise During Operation

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
Proposed Project	Very High	Entrance to tunnel beneath Kanal Istanbul project could potentially be at flood risk from sea level rise without the	Very Large Adverse	Very Large Adverse

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
		inclusion of mitigation to prevent or manage the flow of water into the tunnel.		(Significant)

Flood Risk Associated with Proposed Drainage Systems

11.5.38. The Project will be served by a new drainage system that will drain the track within the Project corridor. Drainage lines will be installed in parallel to the railway line in order to ensure the continuance of surface flows and sustain natural hydrology. Furthermore, grill openings will be checked at certain intervals and the grill openings shall be cleaned if necessary, to avoid clogging of the drainage system during operation, as set out in the **ESMP**. The Q10 and Q100 rainfall events have been used to inform the design of the drainage systems, with sufficient capacity to cater for the Q100 rainfall event[186]. The wider effects of climate change are considered further in **Chapter 14: Climate Change** and align with the assessment presented in this Surface Water Environment Chapter.

11.5.39. The percolation of rainfall through the ballast will slow the rate of discharge and encourage infiltration through the base and therefore the increase in rate and volume will be small when compared to the baseline scenario. However, if natural infiltration is reduced and adjacent watercourses receive uncontrolled discharge from impermeable sections of the Project, this could lead to increased flood risk downstream of the Project. Without mitigation and prior to detailed assessment, the potential impact to people, property and infrastructure elsewhere is considered to be slight adverse with **Minor to Neutral (not significant)** effects.

11.5.40. A summary of likely impacts of increased flood risk associated with proposed drainage systems is summarised in **Table 11-11**.

Table 11-11 - Impacts and Effects of Increased Flood Risk Associated with Proposed Drainage Systems During Operation

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
People, property and infrastructure elsewhere Existing railway	Very High to Medium	New drainage systems will be constructed to drain railway corridor. Drainage systems will be designed for Q10 and Q100 rainfall events. Drainage systems will be regularly inspected and maintained. Reduced infiltration and uncontrolled discharge from impermeable surface could cause local increase in rate and	Slight Adverse	Minor Adverse to Neutral (Not Significant)

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
		volume of discharge and increase downstream flood risk. It is also uncertain if the design of drainage systems has taken climate change effects into account.		

Flood Risk Caused by Displacement of Flood Water Storage or Crossing of Watercourses That May Impact Flood Flow Conveyance

11.5.41. The hydraulic connectivity of all watercourses will be maintained along the Project through the construction of culverts and bridges, and watercourse crossings will be designed to avoid affecting the stability and long-term performance of riverbanks and flood defences. Some crossings require the siting of the piers within watercourse channels, this will be unavoidable and may impact flood flow conveyance.

11.5.42. Hydraulic calculations have been undertaken to inform the design of watercourse crossings[176]. These calculations have either been undertaken using the 'Rational Method' for smaller catchments of up to $10km^2$ or 'Synthetic Unit Hydrographical Method' for larger catchments greater than $10km^2$. Both methods consider the drainage catchment of the watercourse, the characteristics of the catchment and local meteorological data. Review of the hydraulic calculations indicates that all watercourse crossings have been sized using estimated flow rates for the Q10 and Q100 events, with sufficient capacity provided for the Q100 event. This approach is considered robust; however, it is uncertain if the design has considered the potential impacts of climate change on flood flows. It is therefore possible that design flood flows for the Q10 and Q100 events may be greater in the future. It is understood that the bridges and civil structures of the Project will have a design life of 100 years[187]. It is recommended that the design of all hydraulic structures is agreed with the DSi and the need to consider larger events is discussed and, if required, incorporated into the detailed design of the Project. The detailed design should be informed by consideration of increased fluvial flows caused by the effects of climate change. This consideration may confirm that the structures are adequately sized to accommodate an increased flow without increasing flood risk elsewhere, however larger structures or other supplementary mitigation (such as compensatory flood storage land) may be required. This is likely to be most important for the following locations and watercourse crossings where the Project is indicated to cross larger watercourses in close proximity to properties:

- Crossing of Hadımköy Stream / Eşkinoz Creek at chainage 16+272.

[187] Technical Due Diligence – Halkali Cerkezkoy Railway Line. Final Report Rev 3.0. June 2020. Atkins.

- Crossing of Karasu Stream at chainage 37+198.

11.5.43. The hydraulic calculations undertaken by AYGM considered the potential change in flood storage volume as a result of the piers located within the watercourses. Based on the results of the hydraulic calculations and the sizing of the piers in accordance with the 'Technical Specification (for general infrastructure requirements)', AYGM have confirmed that there is no requirement for additional flood storage land.

11.5.44. If climate change has not been considered, the potential increase in flood risk to people, property and infrastructure in close proximity to the watercourse crossings is considered to be slight adverse with **Minor (not significant)** effects. The wider effects of climate change are considered further in **Chapter 14: Climate Change** and align with the assessment presented in this Surface Water Environment Chapter.

11.5.45. It is uncertain if the design of the proposed hydraulic structures and railway corridor has given consideration to the displacement of floodplain storage or movement of flood flows across fluvial floodplains. As discussed in **Section 11.3**, there is no available fluvial flood mapping of Turkey however the geological dataset provides some indication of historic fluvial floodplains based on superficial alluvial deposits. Review of this information alongside the proposed design information indicates the following risk areas:

- Parallel to the Hadımköy Stream / Eşkinoz Creek. The Project will be located in what may be the fluvial floodplain of this watercourse between approximately chainage 7+500 to chainage 16+727 (at which point the railway crosses the watercourse). The Project is located immediately adjacent to the existing railway and therefore the risk of increased flood risk due to loss of floodplain storage or conveyance is likely to be low. However, the Project is indicated to be located at-grade or on shallow embankment and may therefore be at risk of flooding. Upstream of chainage 16+727 the Project is effectively 'buffered' by the existing railway and so is not expected to be at risk or pose any increased risk elsewhere due to loss of floodplain storage or conveyance.
- Where the Project will cross an unnamed tributary of Büyükçekmece Lake between approximate chainage 22+000 and chainage 23+500. Three box culverts (3x3mx3m) are proposed at this crossing and the Project is located on embankment. Geological mapping indicates the potential for a significant floodplain at this location which may not have been considered in the design of the crossing and Project, however the crossings have been designed to cater for the Q100 event and review of aerial mapping indicates no properties within the area that may be affected by increased flood risk. The impact is therefore considered to be low although the risk to agricultural land may increase.
- Along the downstream extents of the Karasu Stream from Camasir Creek at the inlet channel of Büyükçekmece Lake at chainage 25+500 to chainage 35+000. The Project is located immediately adjacent to the alignment of the existing railway along this section and review of aerial mapping indicates the area is largely rural with few properties. The impact to other receptors is therefore considered to be low, however the Project is only indicated to be located on shallow embankment through this section and it is uncertain if flood risk to the Project has been considered.
- Where the Project will cross the Karasu Stream, at chainage 35+224, a bridge with a 161.2m span is proposed at this location, which will have one pier in the channel. The fluvial floodplain is indicated to be large and there are several isolated properties in the vicinity, however the Project is located immediately south (downstream) of the existing railway and therefore the impact to

other receptors is likely to be low as the existing railway would already restrict flood flows. It is noted however that the Project is only indicated to be located on shallow embankment through this section and it is uncertain if flood risk to the Project has been considered.

- Where the Project will cross the Karasu Stream at chainage 37+198. A bridge with 95.6m span is proposed at this location, which will have 2 piers in the channel. The fluvial floodplain in indicated to be large. The surrounding land is predominantly rural however one property is located immediately south (upstream) of the crossing. The Project is approximately 320m upstream of the existing railway crossing. The Project may therefore increase flood risk to this property and surrounding agricultural land, if due consideration has not been given to the potential impact to floodplain storage and conveyance.
- Along the Karasu Stream from approximate chainage 42+500 to chainage 45+000. The Project may be located in the fluvial floodplain although is indicated to be located on embankment. The surrounding area is largely rural, and the Project is immediately adjacent to the existing railway through this area. However, review of aerial mapping indicates isolated properties close to chainage 44+500 that may be at increased flood risk if due consideration has not been given to the potential impact to floodplain storage and conveyance. The Project may also increase flood risk to agricultural land.
- Where the Project will cross a tributary of the Karasu Stream at chainage 45+350. A bridge with 161.2m span is proposed at this location, which will have 2 piers in the channel. Review of aerial mapping indicates the surrounding area is largely rural with a few isolated properties on the outskirts of Kabakça that are unlikely to be adversely affected.
- Where the Project will cross the Ambar Creek at three locations. Large bridge spans of 95.6m, 62.8m and 95.6m are proposed to cross the Ambar Creek, with a number of piers proposed in the channel for each of the 3 bridge crossings. There are no mapped superficial alluvial deposits that may indicate significant fluvial floodplain. Review of aerial mapping also indicates the area is rural. The Project may increase flood risk to surrounding agricultural land if due consideration has not been given to the potential impact to floodplain storage and conveyance.

11.5.46. Based on the data available, the design of the Project is understood to have given due consideration to the need to maintain flood flow conveyance through proposed hydraulic structures with all structures sized to have sufficient capacity for the Q100 event. The increase in flood risk to adjacent land, property and infrastructure is therefore likely to be low up to the Q100 event, although as discussed above, further consideration may need to be given to impacts to fluvial floodplain storage and conveyance and to the potential effects of climate change. The potential flood risk to the Project and the potential increase in flood risk to people, property and infrastructure in close proximity to the Project in areas that may be at fluvial flood risk is considered to be slight to moderate adverse with **Moderate (significant) to Minor (not significant)** effects.

11.5.47. A summary of likely impacts of increased flood risk caused by works in fluvial floodplains, displacement of flood water storage or crossing of watercourses is summarised in **Table 11-12**.

Table 11-12 - Impacts and Effects of Increased Flood Risk Caused by Displacement of Flood Water Storage or Crossing of Watercourses During Operation

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
People, property and infrastructure close to Project and the Project itself at locations where fluvial floodplains may be present.	Very High to Medium	Currently uncertain if the design of hydraulic structures and the Project itself has considered impacts to fluvial floodplain storage and conveyance at certain high-risk locations. Currently uncertain if the Project has taken into consideration flood risks to the Project at certain high-risk locations. It is also uncertain if the design of hydraulic structures has taken climate change effects into account.	Moderate to Slight Adverse	Minor to Moderate Adverse (Significant)
People, property and infrastructure close to the Project in all other locations where fluvial flooding unlikely to be significant.	Very High to Medium	Hydraulic structures, including piers in watercourses will be designed to have sufficient capacity for the Q100 event. However, it is uncertain if the design of hydraulic structures has taken climate change effects into account.	Slight Adverse	Minor Adverse (Not Significant)

Impacts to Hydrology, Hydromorphology and Flow Dynamics Associated with Proposed Watercourse Crossings

11.5.48. The hydraulic connectivity of all watercourses will be maintained by the design of proposed watercourse crossings (including the design of piers in the channel) and other drainage culverts. The proposed drainage system will also convey ballast drainage to adjacent watercourses thereby maintaining hydrological flows. No impact to ecological receptors that may depend on surface water flow is expected and it is considered that there will be **Neutral (not significant)** effects to surface water receptors. A more detailed assessment of potential impacts to wetlands, including Küçükçekmece and Büyükçekmece wetlands, is provided in **Chapter 8: Ecology**.

11.5.49. The detailed design of watercourse crossings has not yet been developed to a sufficient level of detail to understand how the construction of culverts and bridge pier structures could affect the profile and characterises of the watercourses. The structures could potentially increase erosion for the bed and banks of the watercourse and change sediment transport and deposit throughout the watercourse. The proposed culvert crossings will also cause some permanent impact to hydromorphology of the watercourse associated with the replacement of natural bed and banks with concrete structures, although this will be limited to the location of the crossings. Prior to the inclusion of appropriate mitigation, the potential impact to the hydromorphology and flow dynamics of the watercourses crossed by the Project is considered to be slight adverse with **Major (significant)** to **Minor (significant)** effects.

11.5.50. A review of the Project has also indicated several areas where existing watercourses are located in close proximity to the Project that may need further consideration. This may either pose erosion risk to the Project if the watercourses migrate or pose risk to the stability of the watercourse banks caused by the loading of the railway. The areas identified to be at greatest risk include:

- Karasu Stream between approximate chainage 43+000 to chainage 45+000.
- Karasu Stream at approximate chainage 35+000.
- Hadımköy Stream / Eşkinoz Creek at several locations between chainage 9+000 to chainage 16+727.

11.5.51. Prior to the inclusion of appropriate mitigation, the potential impact to the hydromorphology and flow dynamics of the watercourses located in close proximity to the Project that may require erosion and stability control is considered to be slight adverse with **Minor (not significant)** effects.

11.5.52. A summary of likely impacts to hydrology, hydromorphology and flow dynamics associated with the proposed crossing of watercourses is summarised in **Table 11-13**.

Table 11-13 - Impacts and Effects to Hydrology, Hydromorphology and Flow Dynamics associated with the Proposed Watercourse Crossings During Operation

Receptor	Sensitivity	Summary	Impact Magnitude	Significance
Watercourses and surface water habitats that rely on surface water inflows.	Very High to Low	Watercourse and drainage connectivity will be maintained. Hydrological catchments will be maintained.	No Change	Neutral (Not Significant)
Watercourses crossed by the Project.	Very High to Low	Watercourse crossings could affect profile and characteristics and change erosion and deposition processes.	Slight Adverse	Major to Minor Adverse (Significant)
Watercourses located in close proximity to the Project.	Very High to Low	Watercourses close to the Project may require erosion control or stability measures.	Slight Adverse	Minor Adverse (Not Significant)

11.6 MITIGATION AND ENHANCEMENT MEASURES

11.6.1. These mitigation and enhancement measures are also reflected within the **ESMP**. The Contractor will be required to develop the **ESMP** into the **CESMP** prior to the start of the construction phase.

TCDD Transport will be required to develop the **ESMP** into the **OESMP** prior to the start of the operational phase.

CONSTRUCTION PHASE

11.6.2. The mitigation and enhancement measures for the construction phase of the Project are outlined in **Table 11-14**.

Table 11-14 - Surface Water Mitigation Measures (Construction)

Effect	Mitigation Measure
Increased pollution risks to surface water bodies from increased sedimentation in overland flow and surface water discharge.	▪ Avoid the positioning of stockpiles near to watercourses (minimum 50m recommended) and ensure they are located outside areas at fluvial flood risk. ▪ Contain stockpiles with bunds or sediment fences and cover stockpiles when not in use. ▪ Control runoff during construction. Provide sediment barriers between earthworks and the watercourse to prevent sediment from washing into the river. Use of silt fences, silt traps, filter bunds, settlement basins and/or proprietary units such as a 'siltbuster' to treat sediment laden water generated on site before discharge should also be implemented. ▪ Pass any water generated by dewatering processes through silt busters or sediment tanks, prior to discharging this water to the any watercourse. Additional treatment may be required if other pollutants are present. ▪ Additional measures and pre-treatment required prior to discharging potentially polluted water from tunnel dewatering to include use of non-ecotoxic additives and oil separator. Sampling may be required prior to discharge. ▪ Access roads should be located 60m from watercourses as far as practicable. Site roads and approaches to watercourse crossings should be kept free from mud and cleaning water should not be discharged to the watercourse.
Increased pollution risks to surface water bodies from discharge or spillage of fuels or other harmful substances contained in overland flow.	▪ Fuels and potentially hazardous construction materials should be stored in bunded areas with external cut-off drainage and fuel should be stored in double skinned tanks with 110% capacity. No materials should be stored within 50m of a watercourse. ▪ Waste fuels and other fluid contaminants should be collected in leak-proof containers prior to removal from site to an approved processing facility. ▪ Fuelling and maintenance of construction vehicles and plant (including washdown) should be done on hard standing or on haul roads, with appropriate cut-off drainage and located away from watercourses. Drip trays should be placed beneath static plant such as generators and plant not in use. No plant should be stored within 50m of a watercourse and no maintenance should be undertaken within 50m of a watercourse. ▪ Spill kits in the form of oil absorbent booms and other spill containment equipment to be kept on site to be deployed in the event of a spillage, and site staff trained in their use. ▪ Concrete mixing and washing areas should be located more than 500m from any watercourse. Wastewater from these areas should not be discharged to a watercourse and should be disposed off-site.

Effect	Mitigation Measure
	▪ No surface water runoff from construction working areas or sites that may contain fuels or other harmful substances should be discharged to surface water receptors unless first subject to robust pre-treatment.
Increased pollution risks to surface water bodies from works within watercourse channels.	▪ Limit the clearance of vegetation on the channel banks. Where works are required on the watercourse banks, or in-channel, vegetation clearance should be restricted to the working area and should be undertaken only immediately prior to the commencement of those works. Vegetation should be re-established as soon as practicable. Use seeded biodegradable fibre matting to encourage re-vegetation after works on, or near, the banks. ▪ Until the beginning of the in-water works, preserve at least 20m depth of bankside vegetation from the channel bank to protect bank stability. ▪ Avoid works to watercourses during high flow events and during heavy rainfall to reduce the risk of fine sediment release, watercourse erosion and increased flood risk. ▪ Create a dry-working area for works within a watercourse channel or within the floodplain wherever possible using structures such as cofferdams. ▪ Use in-channel coffer dams where appropriate and or silt management systems such as silt curtains within watercourses that require diversion or in-channel construction works. ▪ Direct access of vehicles to watercourses should be minimised. If it is necessary for any vehicle to enter a watercourse, it should be inspected in advance and, if required, remedial action taken to prevent contamination from oil/fuel leakages. All drivers should be instructed in the use and safe disposal of clean up equipment and carry absorbent materials in their vehicles.
Increased risks to surface waters from discharge of foul effluent from construction compounds / construction workers accommodation.	▪ Wastewater will be collected in sealed tanks and removed from compounds in tankers, for disposal at a wastewater treatment plant. ▪ No surface water runoff from construction compounds should be discharged to surface water receptors unless first subject to robust pre-treatment. ▪ Construction plant, materials, waste facilities and welfare facilities within construction compounds should not be located within 500m of watercourses.
Increased risks to surface waters from increased water demand from construction compounds / construction workers accommodation.	▪ Non-potable water pumped from groundwater resources or brought to site in tankers. ▪ Drinking water provided in bottled containers. ▪ Provision of water to the construction compounds / construction workers accommodation in accordance with the Regulation on the Quality and Treatment of Water Intended for Potable Water Supply and as agreed with the relevant DSi Regional Directorates.

Effect	Mitigation Measure
Impact to watercourse flows and connectivity associated with diversion, restriction or blockage of watercourses.	▪ Hydraulic connectivity must be maintained, and no more than two-thirds of the watercourse capacity should be blocked. ▪ If watercourse diversion is required, maintain a temporary channel to maintain flow and connectivity whilst the permanent channel is prepared.
Increased flood risk associated with temporary works and water discharges.	▪ Avoid undertaking works within or adjacent to the watercourses as far as practicable. ▪ Minimise the required construction zone adjacent to and within watercourses to reduce the impacts of flow constriction and loss of fluvial floodplain storage and conveyance. ▪ Create a dry-working area for works within a watercourse channel or within the floodplain wherever possible. Hydraulic connectivity must be maintained, and no more than two-thirds of the watercourse capacity should be blocked. ▪ If watercourse diversion is required, maintain a temporary channel to maintain flow and connectivity whilst the permanent channel is prepared. ▪ Implement a construction-stage drainage strategy for construction compounds, construction workers accommodation and other large areas of impermeable surface to capture and attenuate runoff prior to discharge.

11.6.3. Before starting any works, the presence of any watercourses, drainage lines or other surface water features that are located within the works area should be identified. A full topographic survey should be undertaken prior to construction to identify other smaller watercourses or overland flow routes that may need to be incorporated into the design of the Project.

11.6.4. Specific Method Statements should be developed and implemented by the contractor for construction works in or near watercourses, including the construction of bridges, culverts, outfalls and watercourse realignments. These would include details of methods proposed to ensure dry working conditions and minimisation risk of pollution of the watercourses. Specific method statements should also be prepared for the management of water that may be generated from dewatering of the proposed TBM-twin bore tunnel (under the Kanal Istanbul).

11.6.5. Particular care must be taken when working in the protected area of Büyükçekmece Lake. The requirements of the Regulation on Control of Water Pollution, Regulation on Protection and Management of Water Basins and Regulation on Protection of the Wetlands must be followed.

11.6.6. Regular inspection of control and treatment measures should be undertaken throughout the construction period to ensure they are working effectively. This includes regular checking of construction plant for oil and fuel leaks, particularly when construction works are undertaken in or near watercourses.

11.6.7. A programme of water quality monitoring on watercourses downstream of the working corridor should be implemented throughout the construction period. The location and requirements of water quality monitoring should be agreed with the relevant DSi Regional Directorates. Baseline water quality monitoring has been undertaken at 5 locations close to the Project. This should be supplemented by additional baseline water quality monitoring undertaken at watercourses that are crossed by the Project and any watercourses that are downstream of the construction compounds / construction workers accommodation, once they have been selected by the contractor. The results of water quality monitoring should be compared with the baseline results throughout the construction period. Monitoring of increased turbidity in downstream watercourses during construction is recommended as increased turbidity can be a quick indicator of other longer-term pollution risks, for example reduced dissolved oxygen from organic sediment or long term accumulative of heavy metals.

11.6.8. Existing water supply systems, irrigation systems, flood defences and drainage ditches must be maintained during construction or appropriate diversions/alternative supplies arranged whilst existing systems are disturbed with appropriate advanced notification provided. Any damage caused to surface water infrastructure such as water supply systems, irrigation systems, flood defences and drainage ditches must be reinstated by the Contractor.

OPERATIONAL PHASE

11.6.9. The mitigation and enhancement measures proposed for the operational phase of the Project are outlined in **Table 11-15**.

Table 11-15 - Surface Water Mitigation Measures (Operation)

Effect	Mitigation Measure
Pollution to surface water bodies from surface water discharge.	▪ Provision of a new drainage system that will drain the track corridor (embedded in Project design). ▪ Maintain existing drainage and treatment at high-risk areas such as maintenance stations (embedded in Project operation and design). ▪ Collect waste products such as oil from maintenance stations and dispose of site in agreement with the DSi Regional Directorates (embedded in Project operation).
Pollution to surface water bodies from wastewater discharge.	▪ Maintain existing station drainage facilities (embedded in Project design). ▪ Obtain agreement from the relevant DSi Regional Directorates for any changes to existing drainage systems or increase in wastewater discharge.
Impacts to surface water bodies from increased water demand.	▪ Maintain existing station water supply facilities (embedded in Project design). ▪ Obtain agreement from the relevant DSi Regional Directorates for any changes to existing water supply systems or increase in water demand.

Effect	Mitigation Measure
Coastal flood risk to the Project from sea level rise and storm surge.	▪ Further consideration of the inclusion of flood defence structures at the entrance of the tunnel beneath the Kanal Istanbul project and inclusion of a flood warning system.
Increased flood risk from proposed drainage systems.	▪ Provision of a new drainage system to drain surface water from the railway corridor with sufficient capacity for the Q10 and Q100 events (embedded in Project design). ▪ Regular inspection and maintenance of drainage systems to remove blockages (embedded in Project operation). ▪ Consider climate change effects on capacity of drainage system. ▪ Detailed assessment and, if required, provision of attenuation to reduce rate and volume of increased runoff from impermeable surfaces.
Increased flood risk from displacement of flood water storage or crossing of watercourses.	▪ Full topographic survey undertaken prior to construction to identify all watercourses or overland flow routes that may need to be incorporated into the design of the Project. ▪ Design of watercourse crossings to have sufficient capacity for the Q100 event (embedded in Project design). ▪ Consider climate change effects. The assessment has identified high risk areas at the crossing of Hadımköy Stream / Eşkinoz Creek (chainage 16+272) and Karasu Stream (chainage 37+198) but other locations should be reviewed and considered. ▪ Further consideration to potential impacts to fluvial floodplain storage and conveyance in high risk areas, and provision of appropriate mitigation such as flood relief culverts beneath embankments or reprofiling of low-vulnerability land to provide compensation, i.e. to create additional flood storage capacity (for example agricultural land) in agreement with the relevant land owners. The assessment has identified high risk areas at Hadımköy Stream / Eşkinoz Creek (chainage 7+500 to chainage 16+727) and Karasu Stream (chainage 37+198 and chainage 44+500) but other locations should be reviewed and considered. ▪ Set back bridge piers from within watercourse where possible to remove any impacts on flow conveyance. Piers within watercourses designed to reduce displacement of water. ▪ Further consideration to flood risk to the Project from adjacent fluvial floodplains. If the operational risks are not considered acceptable to the potential impact on train service interruption the Project may need to be raised above adjacent ground level or other flood defence / management measures installed to improve the resilience of the Project. The assessment has identified high risk areas along Karasu Stream (chainage 25+500 to chainage 35+000, and chainage 35+224) but other locations should be reviewed and considered.

Effect	Mitigation Measure
	▪ Further consideration of the potential effects of climate change to flood flows and the extent/depth of the floodplain. ▪ Location of the Project above the maximum level of water within Büyükçekmece Lake that is stated to be 6.68mOD.
Impacts to hydrology, hydromorphology and flow dynamics from proposed crossing or realignment of watercourses.	▪ Provision of a new drainage system that will maintain natural hydrology (embedded in Project design). ▪ Maintain the stability, profile, hydraulic connectivity and hydraulic capacity of all watercourses crossed by the Project and in particular those with bridge piers within the watercourse. Provision of erosion control upstream and downstream of all watercourse crossings to prevent scour and impact to watercourse hydromorphology and geomorphology (e.g. rock armour, concrete bagwork and concrete scour mattress). ▪ Set back bridge piers from within watercourse to remove any impacts on flow conveyance. Piers within watercourses designed to reduce displacement of water. ▪ Bridge piers have been designed to reduce scour with the design foundation level for the piers being at least 1m below the lowest identified point in the bed of the watercourse. Provision of scour protection measures to the piers, which could include rock armour, concrete bagwork and concrete scour mattress. ▪ Provision of low flow channels through proposed culverts to maintain constant baseflow. ▪ Further consideration of stability risks where the Project is located in close proximity to watercourses. The assessment has identified high risk areas along Karasu Stream (chainage 35+000 and chainage 43+000 to chainage 45+000) and Hadımköy Stream / Eşkinoz Creek (chainage 9+000 to chainage 16+727) but other potential high-risk locations should be reviewed and considered.

11.7 RESIDUAL EFFECTS

11.7.1. The construction phase mitigation measures summarised above will significantly reduce the risk to the surface water environment during the construction of the Project. However, it will be difficult to fully prevent the risk of increased sedimentation and pollution to watercourses that are crossed by the Project and that will need works to be undertaken in the watercourse. These risks will however be temporary and unlikely to have significant or long-term effects to water quality. With the mitigation measures in place, it is anticipated that effects to surface water as a result of the Project will be **Minor Adverse (not significant)** during construction.

11.7.2. The operational phase mitigation measures proposed for the design of the Project are considered sufficient to manage all likely impacts to the surface water environment to negligible levels. The proposed crossings of watercourses will have a permanent effect to hydromorphology as will the provision of erosion control / bank reinforcement. However, these impacts will be localised to the watercourse crossing/location of the works and the measures will prevent wider hydromorphological and geomorphological impact elsewhere. With the mitigation measures in place, it is anticipated that effects to surface water as a result of the Project will be **Minor Adverse (not significant)** during operation.

11.8 SUMMARY

Table 11-16 - Summary of Potential Impacts, Effects and Mitigation (Surface Water Environment)

Topic	Baseline Summary	Phase	Potential Impact(s)	Effect (without mitigation)	Mitigation Measures	Residual Effects (after mitigation)
Surface Water Environment	Project crosses several large watercourses including Sazli Stream, Hadımköy Stream / Eşkinoz Creek, Camasir Creek, Karasu Stream, Ambar Creek and many smaller tributaries. Project is in the drainage catchment of Küçükçekmece Lake, Büyükçekmece Lake and Durugöl Lake, as well as smaller ponds including Bahçeşehir Pond, İnceğiz Pond, Sinekli Pond and Çayirdere Pond. Project generally at low risk of flooding although fluvial floodplains may be present along alignment of key watercourses.	Construction	Increased pollution risks to surface water bodies from increased sedimentation in overland flow and surface water discharge.	Large Adverse (Significant)	Implementation of sediment and erosion control measures. Minimise works in watercourse channels and minimise vegetation clearance. Create dry working area for working in watercourse channels.	Minor Adverse (Not Significant)
		Construction	Increased pollution risks to surface water bodies from spillage of fuels or other harmful substances contained in overland flow.	Moderate Adverse (Significant)	Appropriate storage and disposal of waste. Maintenance of vehicles and mechanical plant. Provision of spill containment equipment. Create dry working area for working in watercourse channels.	Neutral (Not Significant)
		Construction	Increased risks to surface waters from discharge of foul effluent from construction compounds / construction workers accommodation.	Neutral (Not Significant)	Wastewater removed via tanker and disposed of at wastewater treatment plant.	Neutral (Not Significant)
		Construction	Increased risks to surface waters from increased water demand from construction compounds / construction workers accommodation.	Neutral (Not Significant)	Non-potable water pumped from groundwater. Drinking water provided in bottled containers.	Neutral (Not Significant)
		Construction	Increased pollution risks to surface waters from discharge, migration or spillage of fuels and other harmful substances from construction compounds.	Moderate Adverse (Significant)	Appropriate storage of materials and plant. Provision of spill containment equipment. Robust pre-treatment of runoff.	Neutral (Not Significant)
		Construction	Impact to watercourse flows and connectivity associated with diversion, restriction or blockage of watercourses.	Minor Adverse (Not Significant)	Maintain hydraulic connectivity and provide temporary channels if required.	Neutral (Not Significant)
		Construction	Increased flood risk associated with temporary works and surface water discharges.	Moderate Adverse (Significant)	Minimise works in or adjacent to watercourse channels. Create a dry-working area for works within watercourse channels but maintain hydraulic connectivity. Provide temporary channels to maintain hydraulic connectivity if required. Implement construction-phase drainage strategy.	Neutral (Not Significant)

Topic	Baseline Summary	Phase	Potential Impact(s)	Effect (without mitigation)	Mitigation Measures	Residual Effects (after mitigation)
		Operation	Pollution to surface water bodies from surface water discharge.	Neutral (Not Significant)	Provision of appropriate drainage system. Maintain existing drainage and waste management systems serving high-risk areas.	Neutral (Not Significant)
		Operation	Pollution to surface water bodies from wastewater discharge.	Neutral (Not Significant)	Maintain existing station drainage facilities.	Neutral (Not Significant)
		Operation	Impacts to surface water bodies from increased water demand.	Neutral (Not Significant)	Maintain existing station water supply facilities.	Neutral (Not Significant)
		Operation	Coastal flood risk to the Project from sea level rise and storm surge.	Very Large Adverse (Significant)	Further consideration of the inclusion of flood defence structures at the entrance of the tunnel beneath the Kanal Istanbul project and inclusion of a flood warning system.	Neutral (Not Significant)
		Operation	Increased flood risk from proposed drainage systems.	Minor Adverse (Not Significant)	New drainage system with sufficient capacity for Q100 event. Attenuation may be required for new impermeable surfaces. Regular inspection and maintenance. Further assessment of climate change effects.	Neutral (Not Significant)
		Operation	Increased flood risk from crossing of watercourses, with bridge piers located within channel.	Moderate Adverse (Significant)	Watercourse crossings with sufficient capacity for the Q100 event. Piers within watercourses designed to reduce displacement of water. Further assessment of climate change effects.	Neutral (Not Significant)
		Operation	Risk to Project and increased flood risk from location of Project in fluvial floodplain and displacement of flood water storage.	Moderate Adverse (Significant)	Further assessment of impacts to fluvial floodplain storage and conveyance, and provision of mitigation. Further assessment of risks to Project and inclusion of mitigation in design. Piers within watercourses designed to reduce displacement of water. Further assessment of climate change effects.	Minor Adverse (Not Significant)
		Operation	Impacts to hydrology, hydromorphology and flow dynamics from proposed crossing of watercourses.	Minor Adverse (Not Significant)	Maintain stability, profile, hydraulic connectivity and hydraulic capacity of watercourses.	Minor Adverse (Not Significant)

Topic	Baseline Summary	Phase	Potential Impact(s)	Effect (without mitigation)	Mitigation Measures	Residual Effects (after mitigation)
					Provision of erosion control measure up and down stream of the watercourse crossing and around the bridge piers. Provision of low flow channels through proposed culverts.	