Chapter 7 Environmental Baseline

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7 ENVIRONMENTAL BASELINE

7.1 Introduction

This section of the ESIA repeats the information on the baseline condition of the physical and biological environment that is presented in the Environmental and Social Baseline Report for the SCPX Project (RSK, 2011). This section presents a description of the environmental baseline conditions in the SCPX Project area and covers the following topics:

- Geology, geomorphology and geohazards
- Soils and ground conditions
- Landscape and visual receptors
- Surface water resources
- Groundwater resources
- Ecology
- Climate and air quality
- Noise
- Cultural heritage.

This chapter concludes with a summary of the key environmental sensitivities. Constraint maps within Appendix A highlight the location of key environment sensitivities.

7.2 Geology, Geomorphology and Geohazards

This section describes the geology underlying:

- The ROW for the SCPX pipeline and CSG1, which are located in the 'Mtkvari Basin'
- The site proposed for CSG2, which is located in the 'volcanic plateau' zone
- The PRMS, which is located in the 'Akhaltsikhe Basin'.

The section considers the geomorphology in these areas and the geological sensitivity and geohazards that the project must take into account.

7.2.1 Information from Desktop Literature Survey

The main source of information on geology and geomorphology in this report is the baseline literature survey carried out for the SCP ESIA (2002). The preliminary results of the site-specific ground investigations undertaken at CSG1, CSG2 and PRMS have also been reviewed for the purposes of this assessment.

With regard to the CSG2 location, the following information has been used to characterise the baseline conditions:

- geological survey information gathered for Energotrans's 'work design' for the re-route of a section of its 500kV electricity transmission line "Vardzia" to avoid the CSG2 facility
- information from Sh. Adamia, V. Alania, A. Chabukiani, G. Chichua, O. Enukidze and N. Sadradze (2010), *Evolution of the Late Cenozoic basins of Georgia (SW Caucasus): a review*, Geological Society, London, Special Publications 2010, v.340; pp. 239–259 doi: 10.1144/SP340.11.

In addition, information on mineral and subsoil deposits and locations has been based on correspondence from the Agency of Natural Resources (SCP/INC/0052, 2012).

7.2.2 Data Gaps and Field Survey Methods

The SCPX loop follows the ROW for the SCP pipeline, and the location of CSG2 and the PRMS are situated close to the existing SCP pipeline route, hence SCPX is characterised by the same geological formations and geomorphologic features as the SCP pipeline. However, ground investigations for the SCPX are nearing completion and preliminary information from the field surveys (where available) has been included in this section.

7.2.3 Baseline Geology

The territory of Georgia occupies the central part of the Black Sea–Caspian Sea basin. The latter represents a Late Alpine collision structure that was formed in the place of the ancient ocean Tethys as a result of the collision between the African-Arabian and Eurasian continents in the late Mesozoic to Tertiary.

The closure of the Tethys was accompanied by extensive volcanic activity and prolonged faulting, folding, deformation and displacement of sedimentary rocks that had previously formed the ocean floor. The final collision of the Afro-Asian and Eurasian continental plates formed the present day intracontinental Caucasus mountains separated by the Transcaucasian intermontaine basin.

From the Late Miocene to the early Pleistocene, volcanic eruptions in subaerial conditions occurred in the Lesser Caucasus simultaneous with the infilling of the Transcaucasian basin with sediments formed by the erosion of the newly formed mountain ranges.

The geological sequence within the Transcaucasian basin is likely to comprise Tertiary and Quaternary gravels, sands, clays and silts that are generally unconsolidated but may be cemented locally. Underlying these deposits will be Cretaceous and Tertiary sedimentary and volcanic rocks.

In the region around CSG2 and the PRMS Tertiary and Quaternary basalt, andesite, dolerite and dacite volcanic rocks occur over a large part of the Project area. These are overlain by Tertiary clays, silts, sands and gravels with a thin veneer of superficial deposits.

7.2.3.1 Geology at KP0–KP56 including CSG1

From KP0, the SCPX pipeline route crosses the unconsolidated Quaternary alluvial deposits of the Kvemo Kartli plain, composed of clays, silts and uncemented sands and gravels with cobbles.

Near Rustavi the route crosses a ridge of Tertiary sediments from the Neogene period, comprising marls, mudstones, sandstones and clays.

Beyond the Mtkvari River, terraced Quaternary floodplain deposits characterised by deposits of cobbles, gravels, sands, silts, silty clay, clays and weakly cemented conglomerates are encountered overlying the Tertiary sediments of the piedmont plain.

The pipeline route passes a depression by Kumisi that was formed as a result of extensive subsidence due to dissolution of salts in the soil matrix, climbing afterwards onto a ridge made of the Tertiary sedimentary strata described above overlain by Quaternary silts, sands and gravels before finally descending to the Algeti River.

The pipeline route crosses an area of clay deposits in Gardabani municipality at approximately KP11 (Agency of Natural Resources, 2012) shown in Figure 7-1.

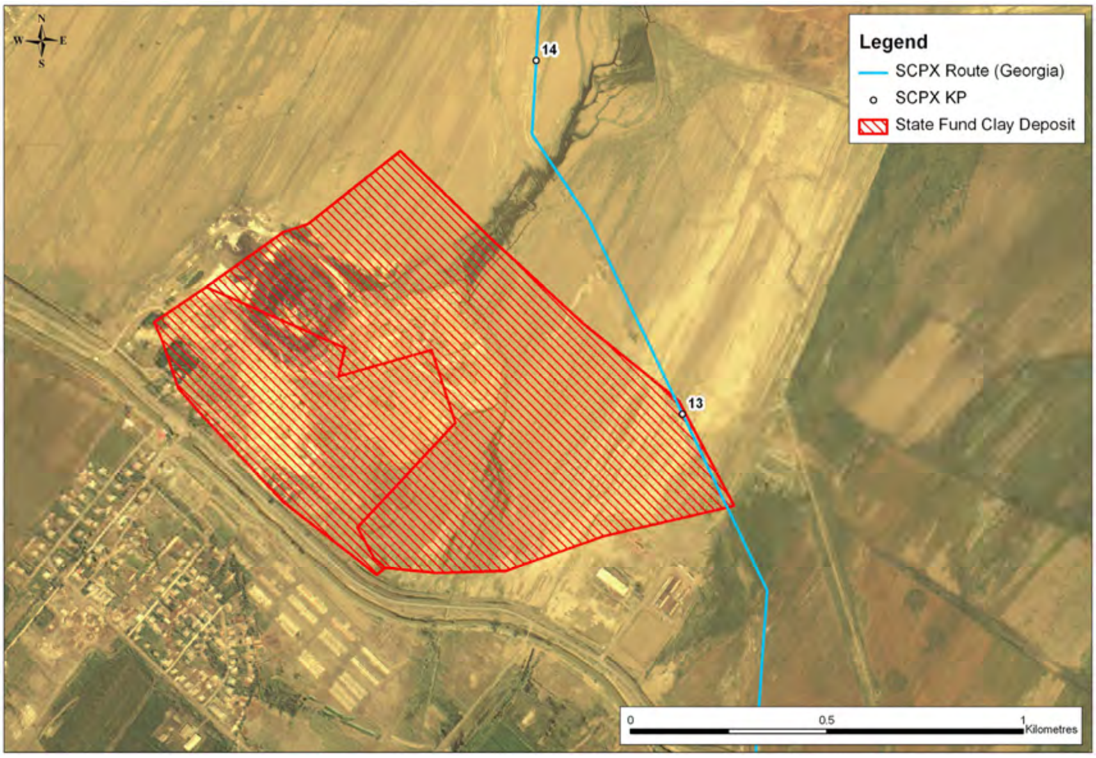

Figure 7-1: Area of clay deposits in Gardabani Region

7.2.3.2 Geology at CSG2

Post-Palaeogene volcanic formations in the central part of the Artvin–Bolnisi block and Achara–Trialeti belt are represented mainly by subaerial lava flows, volcanoclastites and also by alluvial, lacustrine and talus deposits. Highlands and plateaus of Javakheti, Akhalkalaki, Tsalka and Gomareti are made up of volcanic rocks that also filled ancient riverbeds (Kura, Khrami, Mashavera, Borjomi–Bakuriani lava flows).

There are two series reported:

- Upper Miocene– Lower Pliocene Goderdzi formation
- Upper Pliocene–Pleistocene Akhalkalaki, Tsalka, Kumurdo and Samsari formations. The Quaternary Borjomi–Bakuriani lava flows are also attributed to the latter.

Upper Miocene–Lower Pliocene, Goderdzi formation

Basaltic lavas and pyroclastic rocks represent the lower, basal level of the Goderdzi formation. In some places this level contains economical diatomite deposits (Kisatibi). Middle part of the section is represented mainly by volcanoclastic rocks. Pyroclastic rocks in the vicinity of the Goderdzi pass contain remains of petrified subtropical wood, which date the rocks as the Late Miocene–Pliocene. K–Ar dating[1] of tuffs point to their Late Miocene age (9.8 Ma). Maximal thickness of this part of the Goderdzi formation is about 500m. For the upper part of the Goderdzi formation laminated and/or banded andesite and dacite lavas with volcanoclastic interlayers are common. The andesite is a dominant rock unit. The total thickness of this part of the formation is about 250–300 m. The andesites and dacites varies from 9.4 Ma to 7.0 Ma.

[1] Potassium-argon dating

Upper Pliocene–Holocene, Akhalkalaki, Tsalka, Kumurdo and Samsari formations

The Akhalkalaki formation is widespread within the South Georgian highland (Javakheti), especially within the Tsalka and Akhalkalaki plateaus. Typical sections are located along the deep canyons of the Mtkvari, Khrami and Mashavera rivers. Basaltic (doleritic) lavas are dominant rock unites. In some places, they contain lenses of fluviatile to lacustrine and alluvial deposits, also pyroclastic rocks. Andesitic basalts are subordinate, more acidic rocks are rare. Owing to their low viscosity lavas could spread over large territories. They covered ancient relief and formed extensive flat plateau. The total thickness of the formation is approximately 100–300m. The age of the lower part of the Tsalka and Akhalkalaki formations is identified through mammalia fauna as Late Pliocene–Pleistocene. Radiometric age of the basalts supports the faunistic data (2.0+0.5 Ma). Both series are reported to be present at the site.

7.2.3.3 Geology at the PRMS

The ‘Akhaltsikhe Basin’ in which PRMS is located is a synclinal basin. The hills in the northern part of the basin are composed of Tertiary sedimentary rocks dissected by river valleys, with associated Palaeogene flysch deposits including clays, gypsiferous clays, sandstones, marls and limestones. Towards the Turkish border there are volcanic hills and pyroclastic deposits of tuff, breccia, tuff breccia, tuff sandstones and conglomerates interbedded with lava flows. A geological log from the PRMS water well, comprises interbedded volcano-sedimentary deposits recorded to a depth of 231m below ground level. No evidence of mineral deposits were recorded in the geological log.

The PRMS is situated within a state fund deposit of brown coal in Akhaltsikhe municipality (Agency of Natural Resources, 2012) shown in Figure 7-2.

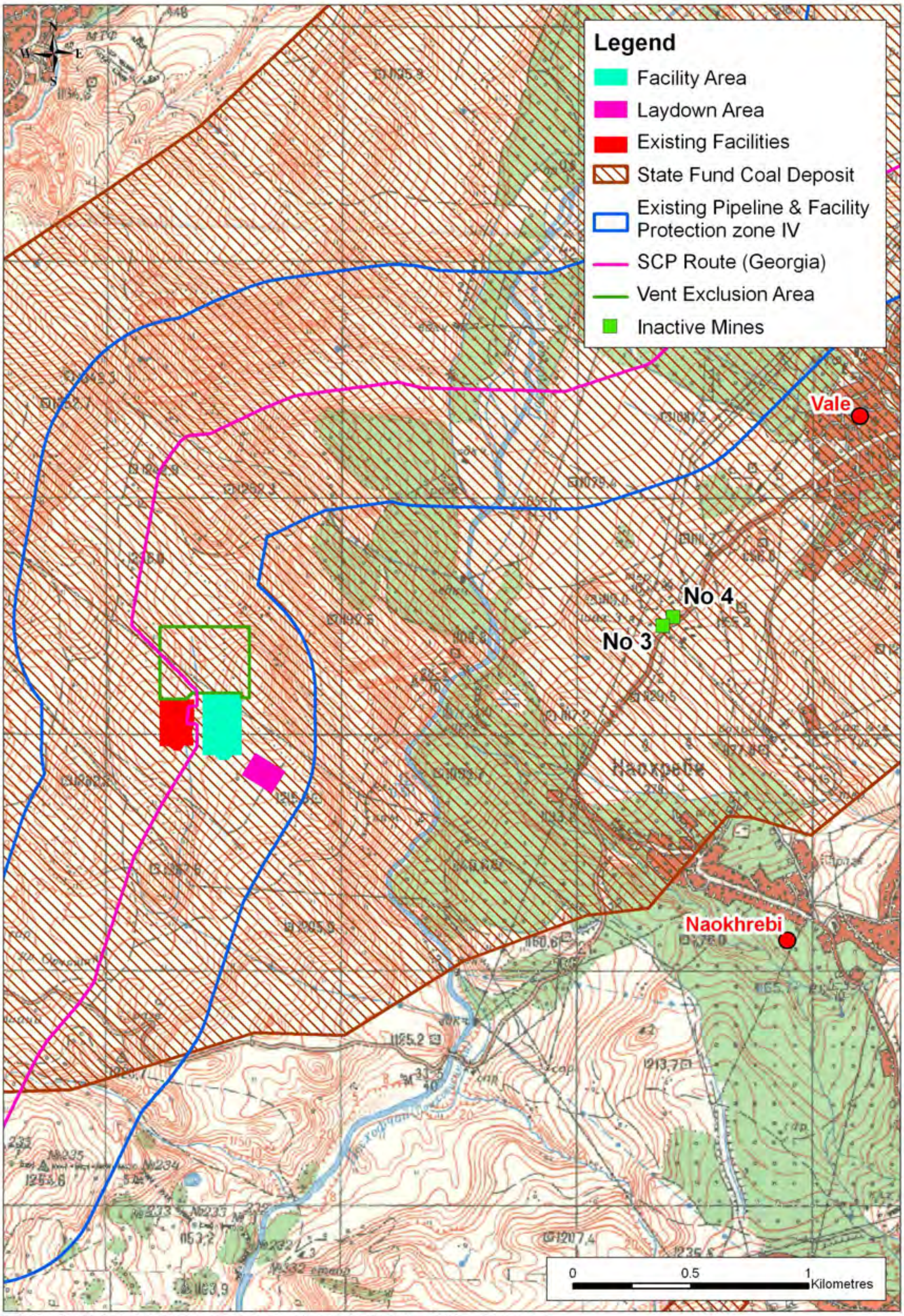

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Figure 7-2: Location of inactive mines and licenced mineral deposit of brown coal in the Akhaltsikhe municipality

7.2.4 Baseline Geomorphology

The geomorphology at the locations where the SCPX is to be constructed comprises two major classes of landscape, namely piedmont plain and mountain landscapes.

Piedmont plain landscapes are represented predominantly from the Georgian–Azerbaijan border to CSG1 and along the Georgian pipeline loop. They include landscapes of dry subtropical plain-steppe. There are also dry subtropical plain hilly steppes and fragments of arid forest-bush landscapes in this region.

Mountain landscapes, comprising predominantly sandstone and volcanic rock include landscapes of:

- Mountain steppe in the region surrounding Akhaltsikhe and the Javakheti Plateau, both located near the Turkish border
- Moderate humid eastern Caucasus type mountain forest landscapes (Trialeti Range)
- High-mountain/mountain-meadows (Tabatskuri region).

Elevations range from 300m at the Georgian–Azerbaijan border to 2500m within the Trialeti Range.

The proposed route has two major river crossings the Algeti River and Mtkvari River.

Geomorphology is also included within the description of the baseline landscape (Section 7.4).

7.2.4.1 Geomorphology at KP0–KP56 and CSG1

From KP0 to KP19, the SCPX pipeline route crosses the broad, low-lying Kvemo Kartli plain. It then rises over a low ridge of sedimentary rocks near Akhali Samgori before the topography falls away steeply towards the Mtkvari River.

Beyond the Mtkvari, the topography of the piedmont plain climbs gently to approximately 500m above mean sea level (AMSL) towards Marneuli and the Algeti River valley.

7.2.4.2 Geomorphology at CSG2

CSG2 is located in on a hillside in a ‘volcanic plateau’, which is characterised by undulating hills with streams and rivers draining to lakes and reservoirs in the basins (e.g. Tsalka Reservoir and Tabatskuri Lake).

7.2.4.3 Geomorphology at the PRMS

PRMS is located where the topography rises gently from the Potskhovi River valley over undulating volcanic hills and lava flows towards the Turkish border. The PRMS site lies within an open area of land that forms a shallow depression with the ground rising gently to the south, west and north. Beyond the site the land falls gently to the east.

7.2.5 Baseline Geohazards

The design and construction of the Project take account of geohazards including soil erosion, landslides and seismic events.

The landslide hazard was addressed between 2001 and 2004 during extensive geohazard assessment work carried out for the BTC and SCP pipeline project. For the SCPX alignment, a further landslide assessment has been carried out in 2011 as a confirmatory exercise of the BTC/SCP historical findings. As a result of this latest assessment, the SCPX route avoids shallow landslides identified on the hills west of the Mtkvari River and on the approach to the Algeti River.

The evaluation of the seismic hazards in the SCPX Project areas in Georgia that was carried out in 2001 (EQE International, 2001) is still valid. The region is actively being deformed by the collision of the African, Arabian and Indian tectonic plates with the southern margin of the Eurasian continent. It is characterised by west-east, north-east or north-west trending compressive faults that are characterised by reverse faulting and thrust faulting (distinguished by the dip angle of the fault plane). Both involve one fault block pushing up and over the second fault block. Thrust faults are characterised by dip angles of less than 45 degrees, and reverse faults exhibit dip angles of greater than 45 degrees. The Rustavi, Tsalka-Bedeni and Vale faults are listed as potentially active. These areas fall within seismic intensity zones 7–8.

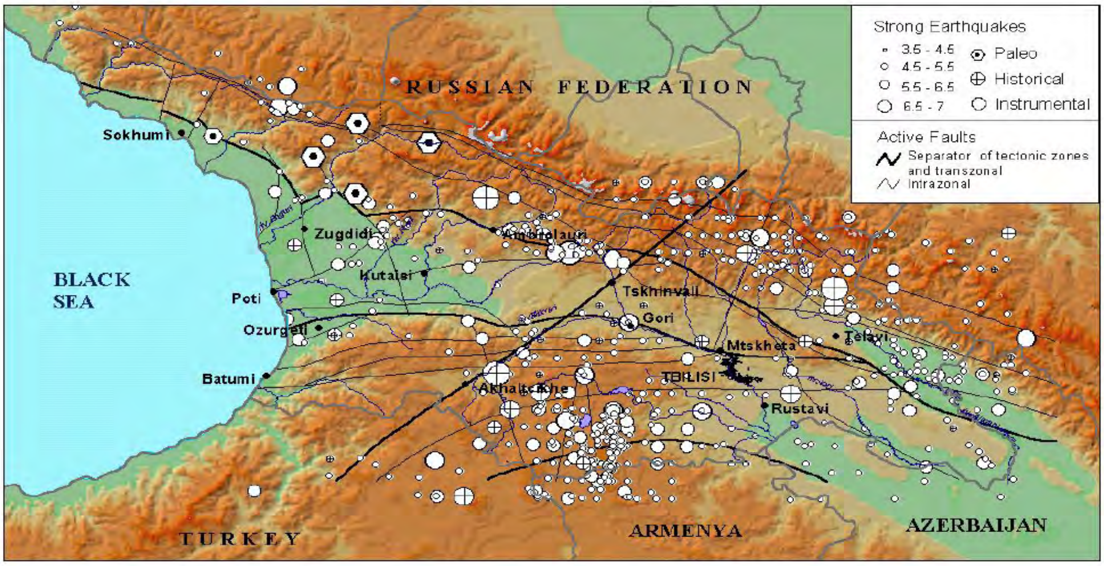


Figure 7-3: Seismic Faulting and Earthquake Epicentres in Georgia

(Academy of Science of Georgia, in tea@ig.acnet.ge)

7.2.5.1 Geohazards at KP0–KP56 and CSG1

Landslides and mudflows are common where fairly unstable deposits, such as clays and/or mudstones are on the slopes of ridges and hillsides. These conditions occur on the banks of rivers, where erosion processes are also active. However, the pipeline has been routed around known landslide hazards and the banks of the Mtkvari at the proposed crossing point have been assessed as stable. Baseline studies have confirmed there are no gullies considered likely to be prone to active and deep erosion or mudflows on the SCPX pipeline route.

The proposed route crosses the Rustavi Fault, at approximately KP26.6. The Rustavi Fault is a reverse fault with a NNW–ESE surface orientation that is deemed active based on the interpretation of existing literature, topographic maps and aerial photos. An active fault is defined as a fault that has moved during the recent geologic past (usually defined as the last 10,000 years) and which, because of its present tectonic setting, can undergo movement from time to time in the immediate geologic future. Movement along the fault may or may not generate earthquakes.

From KP55.7 the pipeline loop may encounter basaltic rock at shallow depth (for 300m).

The ground conditions at the CSG1 site are expected to comprise between 3 and 6m of firm to stiff high-plasticity clay soils overlying more than 20m of very dense sand and gravel with a groundwater level at some 10m below existing ground level. No major geohazards have been identified at the proposed location of CSG1. However, the site is susceptible to seasonal flooding (both natural and as a result of irrigation) and earthquake hazard (ground shaking).

The liquefaction susceptibility of the CSG1 area (liquefaction refers to the process by which saturated, unconsolidated sediments are transformed into a substance that acts like a liquid when agitated by seismic events) has been assessed as “low” under the anticipated seismic conditions.

7.2.5.2 Geohazards at CSG2

The ground conditions at the CSG2 location are expected to comprise a relatively thin cover (0 to 3m) of superficial deposits overlying moderately strong, becoming strong to very strong rock.

No major geohazards have been identified at the CSG2 location. Four minor geohazards have been identified as follows:

- Flooding – the impermeable bed rock at shallow depth and the significant seasonal snow melt
- Excavatability – the presence of strong competent rock at shallow depth Slope stability
- Settlement potential – the poor natural drainage has resulted in areas of ‘boggy’ terrain prone to flooding with soft and saturated ground conditions. Seismic accelerations – the liquefaction susceptibility of the CSG2 area has been assessed as “low” under the anticipated seismic conditions. The rock that is present at or near to the surface over much of the area would not be susceptible to liquefaction.
- Earthquake hazard (ground shaking).

7.2.5.3 Geohazards at the PRMS

The ground conditions at the PRMS site are expected to comprise topsoil over stiff to very stiff clay with a little coarse sand and gravel. The thickness of the clay increases to the south from around 2m to 15m. Underlying the clay is moderately strong, highly fractured weathered basalt/andesite bed rock.

No major geohazards have been identified on the site. Five minor geohazards have been identified that will need consideration as follows:

- Flooding – the clay soils will have a low permeability and drainage is poor with some sheet flooding in depressions
- Excavatability – the presence of strong competent rock at shallow depth across part of the site
- Settlement potential – the settlement potential and variable thickness of the clay soils
- Seismic accelerations – the liquefaction susceptibility of the PRMS area has been assessed as “low” under the anticipated seismic conditions. The colluvial materials underlying the site would not be susceptible to liquefaction.
- Earthquake hazard (ground shaking).

7.2.6 Geological Sensitivities

The following subsections summarise the components of the baseline conditions that, in the Project context, are considered the most important based on the anticipated impacts of the Project development.

7.2.6.1 Key sensitivities at KP0–KP56 and CSG1

The key sensitivities along the pipeline route are the presence of competent rock at shallow depth from approximate KP55.7.

The point where the proposed route crosses the Rustavi tectonic fault represents a particular geological sensitivity.

At CSG1, the key sensitivities are seasonal flooding (man-made) and earthquake hazard (ground shaking).

7.2.6.2 Key sensitivities at CSG2

Earthquake hazard (ground shaking) and excavatability of strong competent rock for the installation of subsurface infrastructure are the main geological sensitivities at CSG2.

The presence of impermeable rock at shallow depth influences drainage, especially during the spring snow melt.

7.2.6.3 Key sensitivities at the PRMS

Earthquake hazard (ground shaking) is the main geological sensitivity at PRMS. There is some sheet flooding in depressions.

7.3 Soils and Ground Conditions

This section describes the types of soil that may be crossed by the proposed SCPX pipeline route and Facilities, its structure and the baseline soil fertility.

It also identifies areas of soil contamination along the pipeline route and at the facility locations to establish the baseline level of contamination so that the ESIA for the SCPX Project can quantify the impact of construction on soil.

This section is based largely on the results of fieldwork undertaken in May and June 2011.

7.3.1 Information from Desktop Literature Survey

In preparation for the fieldwork, the field survey reports, soil mapping and literature review compiled for the SCP project ESIA was reviewed. The main sources of literature used in the SCP project ESIA review were:

- Anjaparidze I., *Meliorative Soil Science*, Ganatleba, Tbilisi (1977)
- Sabashvili M., *Soils in Georgia*, Metsniereba, Tbilisi (1965)
- Talakhadze G., *Main Soil Types in Georgia*, Sabchota Sakartvelo, Tbilisi (1964).

Additional detailed information on the soil types along the proposed SCPX route was reviewed in:

- *Soil Map of Georgia,* prepared by Georgian State Project and Scientific-Research Institute of Land Organization, approved by the Scientific Boards of Georgian Soil Science Society, Georgian State Agrarian University, M. Sabashvili Scientific-Research Institute of Soil Science, Agrochemistry and Melioration and Georgian State Project and Scientific-Research Institute of Land Organization (1999)
- Prof. Talakhadze G., *Soils in Georgia*, Ganatleba, Tbilisi (1983)
- Talakhadze G. and Mindeli K., *Specific Soil Science*, Ganatleba, Tbilisi (1976)
- Sabashvili M., *Soils in Georgian SSR*, Metsniereba, Tbilisi (1965).
- CB&I, *SCPX Expansion Project Soil Erosion Survey Report,* CB&I (2011)
- URS Scott Wilson, *Geotechnical Investigation – Ground Investigation Factual Report'* (November 2011).

According to those sources:

- The soil along the route of the pipeline (KP0–56) ranges from swampy soils in the east near Jandari lake (brown sierozem with saline soil complexes and alluvial carbonate and non-carbonate soils) to Solonetz and saline soils (with humus containing gypsum crystals) around KP50.
- At the site of CSG1 (KP3) there is a brown sierozem soil (based on maps in SCP ESIA).
- At the site of CSG2 (KP142) there is black soil. Parts of the SCP ROW in this area were assessed as having a severe erosion risk.
- At the site of PRMS, the soils have been classified as brown (forest) soils (based on maps in SCP ESIA).

7.3.2 Data Gaps and Field Survey Methods

Two sections along the SCPX route (at KP25 and KP28.5) diverge from the SCP route by more than 50m). These areas were not covered in the phase 1 soil surveys for the SCP ESIA. In other places, the area surveyed in the phase 1 soil survey for the SCP pipeline does not fully encompass the SCPX ROW.

The existing information on soil structure and fertility of the SCP ROW was considered insufficient to assess the impact of the SCPX Project owing to potential differences in soil properties.

A survey team was mobilised and carried out:

- A topsoil survey
- A phase 1 (non-intrusive) survey to identify soil contamination of the pipeline route and the Facilities.

The phase 1 survey did not identify any contaminated areas; therefore, no phase 2 (intrusive) sampling of contaminated soils was undertaken.

7.3.2.1 Topsoil survey

The team took soil samples at regular intervals of approximately 5km between KP1 close to the border with Azerbaijan and a point just beyond KP54 to determine the soil types present along the proposed pipeline route. Table 7-1 gives the coordinates of the sample locations.

Table 7-1: Soil Fertility Sample Locations

X Coordinate	Y Coordinate	SCPX Sample ID
08513968	04587466	SCPX-SF1 (c. KP1.0)
08511234	04591943	SCPX-SF2 (c. KP7.4)
08509150	04595943	SCPX-SF3 (c. KP12.0)
08508708	04598410	SCPX-SF4 (c. KP14.7)
08508986	04603380	SCPX-SF5 (c. KP19.7)
08504746	04605762	SCPX-SF6 (c. KP25.5)
08504746	04605762	SCPX-SF6(D) (c. KP25.5)
08501417	04605487	SCPX-SF7 (c. KP29.0)
08496354	04606388	SCPX-SF8 (c. KP34.6)
08490254	04606318	SCPX-SF9 (c. KP41.5)
08487909	04604134	SCPX-SF10 (c. KP44.7)
08484144	04601073	SCPX-SF11 (c. KP49.8)
08481481	04597732	SCPX-SF12 (c. KP54.1)
08481481	04597732	SCPX-SF12(D) (c. KP54.1)

The surveyors followed the ‘Code of Practice for Site Investigations’ outlined within BS 5930:1999.

Each sample consisted of an “envelope” pattern with five sub-samples taken from a 10m x 10m area (one from each corner of the square and one from the centre). Each sub-sample was excavated to a maximum depth of 300mm using a spade that was cleaned thoroughly before re-use. This allowed for the investigation of topsoil depth. Soils were collected directly into a sample container (that was supplied clean). The five sub-samples were combined and mixed thoroughly (homogenised) to create a composite sample for chemical analysis. The soil samples were placed in a one-litre sealable plastic bag (for the particle density analysis) and a 1kg plastic tub (for the NPK, salinity analysis and organic carbon). Samples were packed securely in cool boxes for dispatch to two laboratories in the UK (Structural Soils and Envirolab, both RSK companies).

At each site, the soil scientist made global positioning system (GPS) readings, took photographs and recorded observations on a form including the following parameters:

- Land use
- Surface characteristics
- Soil colour
- Topsoil depth
- Hole depth.

The Structural Soils laboratory undertook particle size distribution (PSD) analysis using a methodology accredited by UKAS accredited methodology in line with BS 1377-2:1990. Envirolab utilises UK-approved testing techniques and hold accreditation from the United Kingdom Accreditation Service (UKAS) and MCERTS (the Environment Agency Monitoring Certification Scheme that is based on international standards and provides for the product certification of instruments, the competency of personnel and the accreditation of laboratories). Envirolab is accredited to the international standard for testing and calibration laboratories ISO 17025 and to the quality management standard ISO 9001. Envirolab tested the soil samples for:

- Nitrogen, phosphorous and potassium (water soluble)
- Particle size distribution
- Salinity (water soluble), as NaCl
- Total organic carbon.

The topsoil proved to be too thin (maximum thickness 0.3m for sample SCPX-SF5) and too dry for bulk density analysis to be undertaken in the field, and too many granular soils/deposits and roots were present in the topsoil. Instead the bulk density was inferred from the results of the particle size distribution analysis with reference to guidance in the literature as described in Section 7.3.1.

The soil scientist classified the soil at each sample location from field observations and the fertility of the samples using the World Reference Base for Soils Resources (WRB).

7.3.2.2 Phase 1 contamination survey

The team carried out a phase 1 contamination survey of the SCPX pipeline route. The scope of work was to make a visual observation of the area, looking for evidence of any surface contamination (e.g. hydrocarbon-impacted soils), fly-tipped waste (including asbestos) and storage of hazardous chemicals.

The team travelled in a westerly direction from KP1 to the proposed new pigging station facility at KP56, surveying a 100m-wide corridor. Where possible, the survey was conducted from a vehicle travelling alongside the ROW or by accessing existing tracks to the BTC/SCP ROW. Driving on agricultural land was prohibited so a large proportion of the route was inspected on foot. The field survey team leader used a GPS unit pre-programmed with the SCPX ROW route to ensure the survey remained centred on the SCPX ROW.

The survey team visually inspected the large expanses of (predominantly agricultural) fields from a distance unless potentially contaminative practices were identified, as they were considered to be at a low risk of contamination. Such large expanses of open fields were considered low risk owing to the lack of potentially contaminative activities (as land use is generally restricted to cultivation and grazing) and where industrial land use was a significant distance from the ROW.

Where the proposed ROW sufficiently overlapped with the existing SCP/BTC ROW, the team did not consider it necessary to inspect the entire 100m width of the corridor, as this is inspected regularly by pipeline security patrols. These patrols report contamination to the operations team who arrange for remediation and/or removal of waste. Information from the BTC/SCP Operations in Georgia has confirmed that there have been no reported contamination incidents along the ROW and at the proposed SCPX facility locations over past two years.

The survey team recorded the location of any relevant observations noting the GPS coordinates on the survey pro forma and taking photographs where necessary. Field survey forms were completed in sections along the ROW where significant topographical or land-use boundaries were encountered.

The team also surveyed the proposed sites for CSG1, CSG2, CSG2 access road and the PRMS to identify any existing potential contamination issues. Separate field survey pro formas were used for these areas.

7.3.3 Baseline Soils

7.3.3.1 Soil types

The field survey found the main soil types in the SCPX ROW to be:

- Grey cinnamonic
    - Gypseous (gypsum-containing) grey cinnamonic soil
    - Grey cinnamonic solonetz
- Meadow grey cinnamonic soils.

Grey cinnamonic (Figure 7-4) and meadow grey cinnamonic (Figure 7-5) soils are included in the soil group of the subtropical dry steppe zone that occupies a total area of 714,200ha, in Georgia. Meadow grey cinnamonic soils are the most widespread soils in the subtropical dry steppe zone (occupying 228,800ha). Grey cinnamonic soils are the second most widespread (occupying 173,000ha).

Figure 7-4: Grey Cinammonic Soil Encountered at SCPX SF5 Sampling Location

Figure 7-5: Meadow Grey Cinammonic Soil Encountered at SCPX SF7 Sampling Location

Table 7-2 presents the soils found in the samples taken from different sections of the pipeline route.

Table 7-2: Soil Types Recorded along SCPX Pipeline

Start KP	End KP	Soil Type
1 (SCPX-SF1)	14.7 (SCPX-SF4)	Meadow grey cinnamonic
14.7 (SCPX-SF4)	19.8 (SCPX-SF5)	Grey cinnamonic
19.8 (SCPX-SF5)	29 (SCPX-SF7)	Gypseous grey cinnamonic
29 (SCPX-SF7)	34.6 (SCPX-SF8)	Meadow grey cinnamonic
34.6 (SCPX-SF8)	41.4 (SCPX-SF9)	Grey cinnamonic solonetz
41.4 (SCPX-SF9)	44.8 (SCPX-SF10)	Grey cinnamonic
44.8 (SCPX-SF10)	49.9 (SCPX-SF11)	Meadow grey cinnamonic
49.9 (SCPX-SF11)	54 (SCPX-SF12)	Calcareous grey cinnamonic

Grey cinnamonic soil

Grey cinnamonic soils and its subtypes (gypseous grey cinnamonic soils and grey cinnamonic solonetz) were observed along the sections of the SCPX route between KP14.7–29, KP34.6–44.8 and KP49.9–54.

They develop mostly on calcareous deluvial-proluvial and old alluvial clayey strata, and are found less frequently on loess-like clayey strata. They are formed by intensive weathering of the strata, facilitated by sufficient warmth and heavy precipitation in winter and early spring. Vigorous weathering determines the clay formation that is typical of grey cinnamonic soils. It is particularly well expressed in the middle part of the profile, where the summer moisture content is higher than in the upper layer that dries out.

Grey cinnamonic soils are of heavy mechanical (clayey) composition. They are characterised by thickness, high density with clay formation across the entire depth profile, the presence of carbonates and an alkaline reaction (though sometimes only slight). The humus content is typically 4–5%. The nitrogen content depends on the humus content and varies from 0.12 to 0.31%. The phosphorus content ranges between 0.16 and 0.20%, and the potassium content ranges between 1.4 and 1.7%.

Another characteristic of these soils is carbonate formation. It results in the presence of carbonates across the entire depth profile, although the carbonate content is highest in the lower (deeper) layers.

Grey cinnamonic soils are frequently characterised by varying degrees of salinisation or alkalinisation, which is expressed mostly in the deep layers of the profile. In the low-lying land around Gardabani, these soils require irrigation to improve soil fertility. This often facilitates irrigational erosion. These soils can be used successfully for agricultural crops, provided land improvement and agrotechnical measures are applied.

Gypseous (gypsum-containing) grey cinnamonic soils are found in Gardabani (Samgori plain) and Marneuli districts. They occupy a total area of 58,000 ha, which comprises 0.8% of the soil cover of the country. Gypseous grey cinnamonic soils are the result of evolution of grey cinnamonic soils that have been permanently subject to effects of mineralised groundwater and salt enrichment.

Gypseous grey cinnamonic soils are of illuvial genesis and display less clay formation, though it increases by depth. Layers with high gypsum content have lower clay content and visa versa. The humus layer is thin, and the humus is accumulated in the upper soil layer (4–5%); its content decreases in gypseous layers and by depth. The nitrogen content is higher in the humus-containing layers. It decreases in gypsum-containing layers (reduced to 0.01%). The total phosphorus content varies between 0.12 and 0.19% while the potassium content is fairly high (1.8–1.9%). The reaction is slightly alkaline (pH of 7.2–8.0).

Gypseous grey cinnamonic soils are characterised by good structure, high water permeability and lower density. They are more susceptible to erosion. Where these soils have a humus layer 20–25 cm thick, they can be successfully used for crop cultivation.

Topsoil depth ranged from 10-30cm.

Meadow grey cinnamonic soil

Meadow grey cinnamonic soil was observed between KP0–14.7, KP29–34.6 and KP44.8–49.9 (see Table 7-2 above). Meadow grey cinnamonic soils occupy approximately 228,800ha (3.3% of Georgia). This soil occurs in the lowlands of the Marneuli and Gardabani districts and is less common in the Kaspi district.

In general, meadow cinnamonic soil has low humus content though it may occur deep in the profile (Talakhadze et al., 1983; R. Kirvalidze, 1985). Meadow grey cinnamonic soil is characterised by heavy loamy-clayey mechanical composition. The clay content in the upper layer of the profile is 73.7%, and in the middle layer 80–82%. It decreases to 65–68% lower down. The humus content in meadow grey cinnamonic soils is generally low (1%). The nitrogen content ranges between 0.01 and 0.16% in the upper layers. The phosphorus and potassium content is medium (0.12–0.14% and 1.1–1.4% respectively).

Owing to its mechanical composition, meadow grey cinnamonic soil is characterised by high density, low water permeability, a coarse structure and, in general, poor physical and physico-mechanical properties in agronomic terms. This soil type is prone to layer gleisation at depth, salinisation to varying degrees and alkalinisation of some layers.

Meadow grey cinnamonic soil is calcareous from the surface. Its carbonate content varies with depth. A high carbonate content is sometimes observed in deep layers. Therefore, this soil type always has a pH exceeding 7, and sometimes even 8.

The filtration capacity of meadow grey cinnamonic soil is extremely low. Water permeability is particularly low in the middle part of the profile, with a filtration factor of $5 \times 10^{-6} – 3 \times 10^{-7}$.

Topsoil depth was in the region of 30cm.

7.3.3.2 Soils in SCPX ROW KP0–KP56

Soil classification

Soil classification was found to be relatively consistent. Vegetation was observed in all locations sampled (although the locations of SF1 and SF8 were more sparsely vegetated) Table 7-3 indicates the soil classification of each topsoil sample obtained. The soil classification was found to be relatively consistent. Vegetation was observed in all locations sampled (although the locations of SF1 and SF8 were more sparsely vegetated).

Table 7-3: Topsoil Classification and Density based on Particle Size Distribution and Field Logs

Location (Sample ID)	Topsoil Type	Soil Constituents (%)	Classification	Inferred Bulk Density (g/cm3)*	Topsoil depth (cm)
KP1 (SF1)	Meadow grey cinnamonic	Clay: 41 Silt: 59 Sand: 0 Gravel:0	Silty clay	1.5	12
KP7.4 (SF2)	Meadow grey cinnamonic	Clay: 55 Silt: 41 Sand: 4 Gravel: 0	Silty clay	1.5	20–22
KP12 (SF3)	Meadow grey cinnamonic	Clay: 12 Silt: 46 Sand:18 Gravel: 24	Sandy clayey silt	1.5–1.6	25
KP14.7 (SF4)	Meadow grey cinnamonic	Clay: 56 Silt: 37 Sand: 7 Gravel: 0	Slightly sandy silty clay	1.5	26
KP19.7 (SF5)	Grey cinnamonic	Clay: 40 Silt: 30 Sand: 22 Gravel: 8	Slightly gravelly sandy silty clay	1.5	30
KP25.5 (SF6)	Grey cinnamonic	Clay: 27 Silt: 24 Sand: 10 Gravel: 39	Gravelly slightly sandy silty clay	1.6	10
KP25.5 (SF6 (D))	Grey cinnamonic	Clay: 28 Silt: 22 Sand: 9 Gravel: 41	Gravelly slightly sandy silty clay	1.6	10
KP29 (SF7)	Meadow grey cinnamonic	Clay: 62 Silt: 36 Sand: 2 Gravel: 0	Silty clay	1.5	12
KP34.6 (SF8)	Grey cinnamonic	Clay: 15 Silt:13 Sand: 22 Gravel: 50	Very gravelly sandy silty clay	1.7	10–20
KP41.5 (SF9)	Grey cinnamonic	Clay: 41 Silt: 31 Sand: 22 Gravel: 6	Slightly gravelly sandy silty clay	1.5	11–13
KP44.7 (SF10)	Grey cinnamonic	Clay: 54 Silt: 39	Slightly sandy silty clay	1.5	10–11

Location (Sample ID)	Topsoil Type	Soil Constituents (%)	Classification	Inferred Bulk Density (g/cm3)*	Topsoil depth (cm)
		Sand: 7 Gravel: 0			
KP49.8 (SF11)	Meadow grey cinnamonic	Clay: 56 Silt: 32 Sand: 12 Gravel: 0	Slightly sandy silty clay	1.5	15
KP54.1 (SF12)	Grey cinnamonic	Clay: 37 Silt: 40 Sand: 19 Gravel: 4	Slightly gravelly sandy silty clay	1.5	20
KP54.1 (SF12(D))	Grey cinnamonic	Clay: 32 Silt: 52 Sand:14 Gravel: 2	Slightly gravelly sandy silty clay	1.5	20

* Inferred bulk density based on British Standard (BS 8002:1994)

The bulk density of these soil samples is unlikely to vary considerably. The vegetation cover observed is associated with shallow rooting and is unlikely to facilitate high levels of compaction, so the inferred bulk density values provided in Table 7-3 are typical for the soil types observed.

Soil fertility

Table 7-4 summarises the results of the analysis of baseline fertility parameters (water-soluble nitrogen, phosphorus and potassium) for soil samples taken along the SCPX route KP0–KP56. This soluble fraction represents the fraction of the nutrients that is most likely to be lost during pipeline construction (i.e. loss by leaching during storage). The concentration of nitrogen varied along the proposed SCPX pipeline route between 0.6mg/kg (SF3) and 21.4mg/kg (SF8). The concentration of phosphorous was consistently below the laboratory detection limit for all samples. Similarly, with the exception of four samples (one of which was a duplicate (SF12 and SF12(D)), the levels of potassium in the soil were below the laboratory detection limit (10mg/kg).

Table 7-4: Baseline Soil Fertility Chemical Analysis Results

Location (Sample ID)	Nitrogen (water soluble) (mg/kg) (LOD: 0.2mg/kg)	Phosphorus (water soluble) (mg/kg) (LOD: 10mg/kg)	Potassium (water soluble) (mg/kg) (LOD: 10mg/kg)	Salinity (water soluble) (mg/kg) (LOD: 16mg/kg)
KP1.0 (SF1)	4.6	<10	<10	<16
KP7.4 (SF2)	3.9	<10	<10	34
KP12.0 (SF3)	0.6	<10	<10	18
KP14.7 (SF4)	1.0	<10	<10	165
KP19.7 (SF5)	0.8	<10	<10	<16
KP25.5 (SF6)	1.1	<10	<10	<16
KP25.5 (SF6(D))	5.4	<10	<10	<16
KP29.0 (SF7)	3.0	<10	22.3	<16
KP34.6 (SF8)	21.4	<10	13.5	17

Location (Sample ID)	Nitrogen (water soluble) (mg/kg) (LOD: 0.2mg/kg)	Phosphorus (water soluble) (mg/kg) (LOD: 10mg/kg)	Potassium (water soluble) (mg/kg) (LOD: 10mg/kg)	Salinity (water soluble) (mg/kg) (LOD: 16mg/kg)
KP41.5 (SF9)	4.8	<10	<10	<16
KP44.7 (SF10)	1.2	<10	<10	33
KP49.8 (SF11)	3.8	<10	<10	<16
KP54.1 (SF12)	8.2	<10	31.1	<16
KP54.1 (SF12(D))	8.6	<10	32.0	<16

Note: LOD = limit of detection

The higher concentrations of nitrogen and potassium at KP34.6 may be evidence that the area was heavily cultivated in the past. The fluvial gravels encountered at shallow depth in the excavations at this location provide further evidence to support this, as they have been reworked into the topsoil relatively recently.

The higher concentration salinity at KP14.7 is likely a result of naturally occurring evaporation of ground or irrigation water and is not considered significant.

Phase 1 soil contamination

The survey team did not observe evidence of soil contamination by oil or chemicals at ground level and did not identify any specific potential sources of such contamination. However, they did observe some fly-tipping of waste. Table 7-5 summarises location where particular observations were recorded. (Maps of the Phase 1 survey observation locations are shown in the Map Appendix to the ESBR.)

Table 7-5: Phase 1 Survey Features Observed

Approximate Location	GPS coordinate	Feature	Comment
KP10.0	X: 08319665 Y: 04610012	General domestic waste	Collection of plastic bottles, food packets and newspapers adjacent to a culverted drain. No evidence of contamination on surface of the surrounding soils. Possibly a combination of wind-blown and dumped. This covered an area no larger than 3m x 3m.
KP14.1	X: 0858574 Y: 04597994	Large pipeline	Pipeline (*c*.500mm) crossing proposed ROW at ground level. No evidence of contamination at surface level. No deterioration in vegetation quality. Although these pipes in their current condition do not constitute a significant source of contamination, any damage to them, or significant deterioration in quality, could potentially cause significant contamination (depending on pipeline contents).
KP24.4	X: 08505584 Y: 04605961	Building rubble (some 30 to 40m from proposed pipeline)	Insulated building materials. Identified as being non-asbestos owing to the absence of visible fibres along broken surfaces. Located in a depression approximately 0.5m deep and 3m x 1.5m. A number of other depressions noted in ground surface

Approximate Location	GPS coordinate	Feature	Comment
			in the vicinity.
KP24.9.	X: 08505423 Y: 04605938	Unknown compound (possibly old bunker/military facility) some 70m north-west of proposed route	Over-grown within the compound. Pipe work noted, leading into buildings. No evidence of potential sources contamination at time of survey.
KP25.2	X: 08504994 Y: 04605741	Large pipeline	Pipeline (*c*.500mm) crossing proposed ROW at ground level. No evidence of contamination at surface level. No deterioration in vegetation quality. Although these pipes in their current condition do not constitute a significant source of contamination, any damage to them, or significant deterioration in quality, could potentially cause significant contamination (depending on pipeline contents).
KP25.2	X: 08504882 Y: 04605683	General domestic waste	Collection of rubbish. Mostly plastic and glass bottles and plastic bags some 50–60m south of proposed pipeline. No evidence of contamination at surface.
KP25.4	X: 08504684 Y: 04605734	Building rubble and plastic bottles	Located in a depression approximately 6m x 4m on the proposed ROW. Material identified as being non-asbestos owing to the absence of visible fibres along broken surfaces.
KP25.8	X: 08504466 Y: 04605734	Building materials and general domestic waste	Fibrous mineral insulation (not asbestos), bricks and concrete. A local person advised that he is removing all the material for himself. Other waste at the location generally included plastic and glass containers
KP29.7	X: 08501417 Y: 04605487	Lightly quarried area (historically)	Shallow workings noted across the area, covering approximately 1000m^2. According to local soil scientist, area previously mined for gypsum.
KP30.0	X: 08500720 Y: 04605327	Anthrax pit	Location and coordinates confirmed by SCPX prior to survey. Delineated by a fenced boundary. Land surrounding the disused warehouse adjacent to the anthrax pit (and railway) showed no sign of contamination at surface level.
KP30.5	X: 08500169 Y: 04605094	Disused derelict warehouse/industrial facility (some 90m south of pipeline route)	Adjacent to pipeline security/police depot. No detailed survey was undertaken of this facility as it was fenced off and marked as private land. A single above ground tank (<200 litres) was noted No evidence of contamination was identified from outside of the fencing.
KP40.1	X: 08491000 Y: 04607302	Derelict 'Firm Tree Manufacturing Plant'	Site located to the west of the road crossing at this point. The exact historic practices on site are not known. No existing potential sources were identified at the time of the survey. Inspection within the boundary of the site was not undertaken

A number of domestic gas and water pipes were also observed during the survey of the proposed ROW. The survey did not identify any areas requiring phase 2 investigation (i.e. targeted sampling and analysis).

Figure 7-6: Pipeline Crossing Proposed ROW at Approximately KP14.1

Figure 7-7: Fragments of Building Material (Non-Asbestos) at *c.* KP24.4

Figure 7-8: Collection of Rubbish South of Proposed Route at *c.* KP25.2

Figure 7-9: Aboveground Pipeline Crossing Proposed Route at *c.* KP25.2

Figure 7-10: Fibrous Insulation Material and General Waste *c.* KP25.8

Figure 7-11: Evidence of Shallow Historic Workings (probably Gypsum) *c.* KP29.7

Figure 7-12: Anthrax Pit by Fence (Right Side of Photograph), Derelict Warehouse and Mtkvari in Background *c.* KP30

Figure 7-13: 'Firm Tree Manufacturing Plant' in Background at KP40.1

7.3.3.3 Soils at CSG1

Soil classification

The meadow grey cinnamonic topsoil at the proposed site for CSG1 was exposed at surface level in linear tracks probably made by plant/machinery crossing the field.

Figure 7-14: Soil Exposed at the Proposed CSG1 Site

7.3.3.4 Phase 1 soil contamination

The phase 1 survey of the proposed CSG1 site did not identify any evidence of contamination.

7.3.3.5 Soils at CSG2

Soil classification
Black soil is exposed at an outcrop in the western part of the CSG2 site. This has been recorded to comprise dark brown sandy silty clayey topsoil with humic-rich soils and organic matter visible to at least 0.1m below ground level.

Figure 7-15: Outcrop of Soil in Western Part of CSG2 Site

Phase 1 soil contamination
The phase 1 survey observed a number of square concrete bases with cast iron screws (possibly pylon footings) in the centre of the site (GPS coordinate X: 08404423, Y: 04614778). No soil contamination or sources of contamination were identified.

Figure 7-16: Possible Pylon Footing in Centre of CSG2 Site

7.3.3.6 Soils at CSG2 access road Options D and D1

Phase 1 soil contamination

The phase 1 survey did not identify any contaminated soil or sources of contamination requiring targeted sampling along the proposed access route, but observed domestic waste (plastic and glass bottles, cardboard and fabric) that had been deposited at the existing road junction to the east of Burnasheti village (GPS coordinate X: 08403342, Y: 04610657).

Figure 7-17: Waste Deposited at Road/Track Junction East of Burnasheti Village

7.3.3.7 Soils at the PRMS

Soil classification

The trial pits excavated for the geotechnical investigation found a deep brown, slightly sandy clay topsoil containing sub-angular basalt gravel above a stiff clay subsoil.

Phase 1 soil contamination

The phase 1 survey did not identify any contaminated soil or sources of contamination requiring targeted sampling at the proposed site for PRMS, but observed remains of previous use.

An octagonal-shaped subsurface structure was found in the eastern portion of the site with a culverted concrete substructure exposed adjacent to it. The original purpose of these obsolete structures was not ascertained. No contamination was associated with them.

Figure 7-18: Concrete Culvert Structure Exposed in Eastern Part of PRMS

A disused object (cylindrical c. 1.5 to 2.0m diameter and c. 1.75m in height) whose original purpose could not be identified) was noted to the south-east of the existing facility (GPS coordinate X: 08319740, y: 04609748).

A square fenced area (c. 35m x 35m) was noted in the south-east portion of the site. The precise purpose of this was not confirmed; however, it is likely that it is to prevent grazing across this area (GPS coordinate X: 08319611, y: 04609926).

Isolated rocks were noted primarily in the western portion of the site.

7.3.4 *Soil Erosion Potential*

Erosion is a natural process that wears away the land surface. Rates of natural erosion are often relatively low because the rate of removal is often balanced by the rate at which new soil is formed. Where the land surface is disturbed, topsoil and/or subsoil is removed and particularly when vegetation is removed, erosion rates increase. During pipeline construction, soil is temporarily removed prior to installation of the pipeline and stored, which can cause degradation due to anaerobic conditions. After reinstatement, the soil has a lower degree of cohesion and is much more erodible.

The SCPX Project Soil Erosion Report (CB&I October 2011) defines seven erosion classes. The CB&I report has classed the soil along the SCPX route following the Erosion Control Manual for Onshore Pipelines. The definition of the erosion classes used has been summarised in Table 7-6.

Table 7-6: Definition of Erosion Classes

Erosion Class	Verbal Assessment	Erosion Rate (tonnes/ha)	Visual Assessment
1	Very slight	<2	No evidence of compaction or crusting of the soil. No wash marks or scour features. No splash pedestals or exposed roots or channels.

Erosion Class	Verbal Assessment	Erosion Rate (tonnes/ha)	Visual Assessment
2	Slight	2–5	Some crusting of soil surface. Localised wash but no or minor scouring. Rills (channels <1m^2 in cross-sectional area and < 30cm deep) every 50–100m. Small splash pedestals where stones or exposed roots protect underlying soil.
3	Moderate	5–10	Wash marks. Discontinuous rills spaced every 20–50m. Splash pedestals and exposed roots mark level of former surface. Slight risk of pollution problems downstream.
4	High	10–50	Connected and continuous network of rills every 5–10m or gullies (> 1m^2 in cross-sectional area and >30cm deep) spaced every 50–100m. Washing out of seeds and young plants. Reseeding may be required. Danger of pollution and sedimentation problems downstream.
5	Severe	50–100	Continuous network of rills every 2–5 m or gullies every 20m. Access to site becomes difficult. Revegetation work impaired and remedial measures required. Damage to roads by erosion and sedimentation. Siltation of water bodies.
6	Very severe	100–500	Continuous network of channels with gullies every 5–10m. Surrounding soil heavily crusted. Integrity of the pipeline threatened by exposure. Severe siltation, pollution and eutrophication problems.
7	Catastrophic	>500	Extensive network of rills and gullies; large gullies (>10m^2 in cross-sectional area) every 20m. Most of original surface washed away exposing pipeline. Severe damage from erosion and sedimentation on-site and downstream.

Classification of the sensitivity of the soil in SCPX locations to erosion takes account of the factors including rainfall, soil erodibility, slope steepness and vegetation.

Grey cinnamonic soils and meadow grey cinnamonic soils are susceptible to suffosion and irrigational erosion due to water moving in the soil and dissolving salts and gypsum, (sometimes in fairly large quantities), which leads to formation of cavities of varying sizes. If such cavities reach sufficient size, the upper layers of the soil collapse. This usually occurs in spring when precipitation falls in the form of showers and downpours. Surplus water results in surface overwetting and the water-logged soil collapses due to weight in the form of suffosion. Surface run-off flowing slowly over the flat surface in suffosional areas can cause fairly intensive erosion. Unsystematic and surplus irrigation also triggers irrigational erosion.

7.3.4.1 Soil erosion potential at KP0–KP56

Table 7-7 presents the erosion class and estimated erosion rate that for sections of the SCPX route. This is the result of a desktop review and field-survey verification exercise along the SCPX ROW, carried out by the Project engineering team in June 2011.

Table 7-7: Erosion Classification on SCPX ROW

Location	Estimated Erosion Rate (t/ha)	Erosion Class
KP0-12	2.699	2
KP12	0.000	Stream
KP12–19	3.084	2

Location	Estimated Erosion Rate (t/ha)	Erosion Class
KP19–26	1.604	1
KP26–27	19.749	4
KP27–27.2	53.676	5
KP27.2–27.9	2.344	2
KP27.9–28	6.416	3
KP28–28.5	2.590	2
KP28.5–29	1.905	1
KP29–29.2	7.709	3
KP29.2–29.7	164.761	6
KP29.7–30	0.000	Mtkvari crossing
KP30–38	2.313	2
KP38–42	2.699	2
KP42–43.2	14.314	4
KP43.2–43.6	7.157	3
KP43.6–46	3.084	2
KP45.9 and 46.01	0.000	Gabions currently installed
KP46–54	3.084	2
KP54–54.4	22.148	4
KP54.4–54.5	22.148	4
KP54.5–55	2.591	2
KP55–56	25.120	4

Results are consistent with erosion monitoring for the BTC and SCP pipelines where all areas from KP0-56 have been reinstated to achieve an erosion class of 3 or less. An erosion class of 4 or above has been recorded in a total of seven places along the proposed SCPX ROW, in areas where the ROW deviates slightly from the SCP ROW. The location with the highest erosion class is associated with the steeply sloping land down towards the Mtkvari River crossing (see Figure 7-19).

Figure 7-19: View West at *c.* KP29.7 at Area Classified as Erosion Class 6

7.3.4.2 *Soil erosion potential at CSG1*

The proposed site of CSG1 is in erosion class 2.

7.3.4.3 *Soil erosion potential at CSG2*

Parts of the previous SCP ROW close to the site proposed for CSG2 were assessed as having as severe erosion risk mainly because of the erodibility of the black soil and the topography, aspect and altitude of the terrain. However satellite monitoring of the existing BTC and SCP ROW has demonstrated that reinstatement to an Erosion Class of 3 or better has been achieved in the area.

7.3.4.4 Soil erosion potential at the PRMS

The SCP ESIA did not identify PRMS as being at severe risk of erosion.

7.3.5 Soil Sensitivities

The following summarises the components of the baseline conditions that, in the Project context, are considered the most important based on the anticipated impacts of the Project development:

- The SCPX route in the vicinity of KP29 is classed as having very severe erosion. KP26–27, KP42–43, KP54–54.5 and KP55–56 are all classed as having high - severe erosion
- Areas of fly-tipping and building rubble along the ROW in locations at KP10, KP24.4, KP25.2, KP25.4 and KP25.8 and on the proposed CSG2 access road
- An existing above ground pipeline crosses the pipeline at KP14 and KP25
- KP30 where a fenced anthrax pit is located adjacent to and outside the ROW
- A number of surface working or disused sites were identified at KP24.9 and KP29.7
- Wetlands between KP0 and KP01, at CSG2 and the CSG2 access road (see Section 7.7.3).

7.4 Landscape and Visual Receptors

This section describes the landscapes that occur along the proposed SCPX pipeline route and at the Facilities and the quality of views of the project components from vantage points.

It also identifies the zone of visual impact, i.e. the areas from which the SCPX Facilities and pipeline route corridor will be visible.

This section is based largely on the results of fieldwork undertaken in May 2011.

7.4.1 Information from Desktop Literature Survey

The main information sources for the desktop review were:

- Aerial photographs and maps of the ROW and environs
- Section 8.9 of the SCP Project ESIA Landscape and Land use, and Appendix E Landscape Assessment & Management Plan, April 2002
- Biorestoration As-built Data BTC-SCP Pipeline – Georgia, December 2007
- Project Biorestoration Review BTC and SCP Pipeline – Georgia, December 2007
- 2009 landscape monitoring pro formas.

In addition, aerial photographs, maps, ecological and archaeological survey data, geology and land use reports were reviewed.

Information regarding the baseline landform, land use, topography and relief, land cover, and settlement pattern and locations was obtained.

7.4.2 Data Gaps and Field Survey Methods

A review of the 2009 landscape monitoring pro formas provided an understanding of the habitat types within the landscape along the ROW and at the CSG1, CSG2 and PRMS sites. This was used to help develop the field survey sheets and identify the potential impacts on specific landscape elements such as grasslands, field boundaries, and trees. Field surveys were undertaken to identify and confirm landscape and visual receptors in close proximity to and along the existing and proposed pipeline route corridor, and to identify and record any potential changes, such as changes in land use, land cover or settlement pattern, during this time.

While the proposed pipeline is routed in close proximity and paralleling the ROW for the SCP pipeline, route deviations do occur. In addition, the proposed CSG1, CSG2, PRMS and pigging station at KP56 are all proposed to be located on greenfield sites. However, it is noted that both CSG1 and PRMS are located adjacent to similar existing facilities, CSG1 is located adjacent to PSG1 and SCP Area 72, and the PRMS is located adjacent to Area 80. In addition, the nature and scale of the proposed facilities at CSG1, CSG2, PRMS and pigging station at KP56 may potentially give rise to impacts at sensitive visual receptors, previously unaffected by the SCP Project, and such receptors were required to be identified and assessed.

To inform the field surveys and to assist the identification of sensitive visual receptors around CSG2, computer-generated zone of theoretical visibility (ZTV) maps were produced for a preliminary site design. The ZTV illustrates the theoretical extent of visibility of the proposed vent stack (likely to be the tallest site structure) for alternative heights of 50m, 75m, and 100m and a provisional compressor building height of 18.7m high. The ZTVs are based on a bare earth topographical model, and do not take into account any screening effects due to buildings or vegetation. The ZTVs for CSG2 are presented in Appendix B to the ESBR.

In addition to the ZTVS, to identify sensitive visual receptors around CSG1, CSG2 and PRMS, the local roads were travelled and local villages visited during field surveys to identify potential views towards the proposed sites. The identification of views of the CSG1 and PRMS sites in the field was aided by the presence of similar existing facilities adjacent to these sites, i.e. PSG1 and Area 72 adjacent to CSG1, and Area 80 adjacent to PRMS.

Subsequent to the field surveys, additional ZTVs have been prepared for CSG2, CSG1 and PRMS and these are presented on figures in Appendix B of the ESBR. The ZTV for CSG1 is based on alternative proposed vent stack heights of 120m and 80m. The ZTVs for CSG2 and PRMS are based on alternative proposed vent stack heights of 80m and 40m. Additionally a ZTV for CSG2 has been prepared for a compressor exhaust-stack height of 25.5m.

The field surveys were undertaken to gain a first hand understanding of the existing landscape and visual context and assess the extent of visibility of the pipeline route corridor, CSG1, CSG2, the PRMS and the pigging station at KP56. During the field surveys, sensitive receptors potentially affected by the proposed development, such as views from nearby settlements and roads, were identified, and representative photographs were taken from vantage points to illustrate the baseline character and visual context.

Viewpoints to illustrate the baseline landscape character and views towards the pipeline route corridor, CSG1, CSG2, the PRMS and the pigging station at KP56 were photographed and the positions recorded using the following equipment:

- Trimble GeoXT GPS unit
- Canon EOS450D Digital SLR camera with a Sigma 30mm F1.4 Lens
- Manfrotto camera tripod with panoramic head and levelling plates.

Photographs illustrating typical landscape character and views have been used to prepare photomontage illustrations of the proposed facilities at CSG1, CSG2, the PRMS and the pigging station at KP56 to assess the significance of likely landscape and visual impacts and are contained in Appendix A.

7.4.3 *Baseline Landscape Character*

When reading this section, reference should be made to the following figures, which can be found in Appendix B of the ESBR and Chapter 5 and Appendix A of the ESIA:

- The location of the pipeline route corridor and the proposed facilities at CSG1, CSG2 and PRMS
- The viewpoint locations recorded to illustrate the exiting baseline
- Baseline photographs for the representative viewpoint locations.

7.4.3.1 Landscape character at KP0–KP56

CSG1 and the pipeline loop is located within the Mtkvari basin geomorphologial region. This region is composed of a piedmont plain dissected by the Mtkvari River and overlain in places by quaternary deposits.

From KP0 to KP12 the proposed pipeline has been routed in a north-westerly direction across the broad, low-lying Kvemo Kartli plain, a landscape characterised by a flat relief that is open thus allowing long-distance views to be gained to distant hills, settlements and industry. The land use and pattern is characterised by large, rectilinear fields defined by water distribution and irrigation channels. Fields are occasionally enclosed by tree and shrub vegetation, which act as windbreaks. The natural landscape of dry steppe and semi-desert, with fragmented areas of semi-plains bluestem-wormwood grass vegetation on grey-brown and saline soils, with occasional scrub, wetland areas and wet and moist meadows, has been modified extensively by human activity with intensive land use and cover predominated by pasture and arable uses (refer to Viewpoint 1, 8510174E, 4594785N).

Detracting and prominent features within the wider landscape include the power station, electricity transmission towers, and tall chimneystacks near Rustavi to the north-west and a large group of tall telecommunications masts, which forms part of a military training area to the north-east (refer to Viewpoint 2, 8509084E, 4595902N). The settlements of Nazarlo, Kesalo, Gardabani, Tbiltskaro and Nagebi are located to the west of the pipeline route corridor (KP0–KP12), and to the east the settlements of Jandari, Lemshveniera north-west of Jandari Lake. Nazarlo, Kesalo, Gardabani and Jandari are situated on low-lying land with flat relief, whilst Lemshveniera occupies a more elevated position that affords distant views over the landscape. However, views from all of these settlements are interrupted and filtered by tree and shrub vegetation related to cultural land uses (windbreaks, gardens and orchards) within and adjacent the villages.

Between KP12 and KP20 the proposed pipeline has been routed in a northerly direction across a low ridge of sedimentary rocks and a landscape characterised by a gently undulating relief, with the topography gently rising to the north. The landscape is open with few distinctive natural features, with long-distance, panoramic views available across the steppe to distant hills, settlements and industry. From KP19, views to the south-west are dominated by industry and power generation. In closer proximity, numerous overhead electricity transmission lines and associated towers interrupt views. Pastoral land use dominates, and there is no discernible field pattern. Long, shallow irrigation channels occasionally descend to the south-west. The natural landscape of dry steppe and semi-desert has been modified strongly by human activity land use and cover predominated by pasture and occasional arable use (refer to Viewpoint 3, 8508857E, 4602899N).

Between KP20 and KP30 the proposed pipeline continues across the low ridge of sedimentary rocks near Akhali Samgori and has been routed in a northerly, north-westerly then broadly westerly direction to the north of the settlement of Akhali Samgori before the topography falls away steeply towards the Mtkvari. Again, the natural landscape of dry steppe and semi-desert has been modified strongly by land use, predominated by pasture and occasional arable use. Near Akhali Samgori, cultural land uses including orchard and arable are present in medium- to large-sized fields, defined by tree and shrub vegetation (refer to Viewpoint 4, 8505565E, 4605902N). The relief varies, with gently undulating landform rising to a level plateau to the north of Akhali Samgori between KP24 and KP26. From the level plateau the proposed pipeline route descends a steep slope onto a flat terrace and passes near to an existing SCP pipeline block valve station. Near the block valve station the landscape is interrupted by the presence of numerous overhead electricity transmission lines and associated towers (refer to Viewpoint 5, 8501381E, 4605854N).

After crossing the flat terrace, the proposed pipeline is routed across a road lined by mature pine trees, and then descends a steep slope down towards the Mtkvari River. The relief varies greatly, with the landform incised by dry gorges and bisected by a road. The landform is scarred by landslips and erosion (refer to Viewpoint 6, 8500822E, 4605366N).

Beyond the Mtkvari, the topography of the piedmont plain climbs gently to approximately 500m above mean sea level (AMSL) towards Marneuli and the Algeti River valley.

From KP30 to KP31 the proposed pipeline is routed across the Mtkvari River. From KP31 to KP42 the proposed pipeline is routed across a flat to gently undulating floodplain crossed by irrigation channels. The landscape is open with expansive distant views available across the flood plain and steppe landscape. Near the river, fragments of flood plain (tugay) forest landscape are present with areas of riparian forest and scrub on the riverbanks (refer to Viewpoint 7, 8455384E, 4606870N).

From KP42 to the end of the proposed loop at KP56 the landscape is homogenous in terms of land cover and use. The landscape of dry plains bluestem-wormwood steppe is strongly modified and degraded in part by cultural land uses and cover predominated by pasture, with some areas intensively grazed, and occasional arable uses (refer to Viewpoint 8, 8455384E, 4606870N).

Localised areas of wetland and wetter grassland (wet and moist meadows) are found along section of the pipeline route corridor, particularly between KP42 and 43, and near the railway line at KP50 to 55, where tributaries of Lake Kumisi and the Algeti River, and the Algeti River itself, incise the flat steppe landscape. The Komisi depression, formed as a result of extensive solifluction (dissolution of salts in the soil matrix, which causes localised subsidence), is noted in this area. The relief varies from flat to gently undulating terrain, to more steeply sloping terrain with low hillocks and dry valleys between KP43 and 48 where the proposed pipeline is routed across the north-west slopes at the foot of the Iaghluji Ridge (refer to Viewpoint 9, 8486605E, 4603564N).

The terrain between KP54 and KP56 at the Algeti River crossing varies greatly and beyond KP55 the land cover of intensively grazed pasture is interspersed with rocky outcrops (refer to Viewpoint 15, 8478374E, 4597030N).

7.4.3.2 Landscape character at CSG1

CSG1 is located within the Mtkvari basin geomorphologial region, within the broad, low-lying Kvemo Kartli plain.

The landscape at CSG1 is characterised by a large-sized rectilinear pastoral field with flat relief. Irrigation channels and tree shrub vegetation acting as a windbreak form the boundary to the field. The windbreak vegetation limits views across the wider landscape (refer to Viewpoint 10, 8512154E, 4589081N). Within the field, the character is influenced by the presence of the existing BTC facility (PSG1) and SCP facility (Area 72) (refer to Viewpoint 1, 8512154E, 4589081N). Within the wider landscape beyond the CSG1 site boundary, the landscape is characterised by a flat relief that is open thus allowing long-distance views to distant hills, settlements and industry. The land use and pattern is characterised by large, rectilinear fields defined by water distribution and irrigation channels. Fields are occasionally enclosed by tree and shrub windbreak vegetation (as per the CSG1 site). The natural landscape of dry steppe and semi-desert, with fragmented areas of semi-plains bluestem-wormwood grass vegetation on grey-brown and saline soils, with occasional scrub, wetland areas, and wet and moist meadows, has been modified extensively by human activity with intensive land use and cover predominated by pasture and arable uses (refer to Viewpoint 1, 8510174E, 4594785N).

Detracting and prominent features within the wider landscape include the power station, electricity transmission towers, and tall chimneystacks near Rustavi to the north-west (refer to Viewpoint 2, 8509084E, 4595902N). The settlements of Nazarlo and Kesalo are located to the west of the CSG1 site and to the east are the settlements of Jandari and Lemshveniera north-west of Jandari Lake. Nazarlo, Kesalo and Jandari are situated on low-lying land with flat relief, while Lemshveniera occupies a more elevated position that affords distant views over the landscape and towards CSG1. However, views from all of these settlements are interrupted and filtered or screened by tree and shrub vegetation related to cultural land uses (gardens and orchard) within and adjacent the villages. Additionally the trees and shrubs that bound the CSG1 site provide screening of the existing facilities, with only the upper portions of the taller elements of the existing facility visible above the tree lines (refer to Viewpoint 12, 8509676E, 4588370N and Viewpoint 13, 8515060E, 4593093N). Open, uninterrupted oblique views of the existing facilities at CSG1 and the proposed CSG1 site are available to road users travelling south towards Jandari (refer to Viewpoint 14, 8513505E, 4591569N).

7.4.3.3 Landscape character at pigging station KP56

The landscape at the proposed pigging station at KP56 is characterised by dry plains bluestem-wormwood steppe, strongly modified and degraded by cultural land uses of intensively grazed pasture, with occasional scrub vegetation. The undulating and varied relief features occasional rocky outcrops and hillocks (refer to Viewpoint 15, 8478374E, 4597030N). Visual receptors are limited to shepherds and users of the adjacent road.

7.4.3.4 Landscape character at CSG2

The CSG2 site, to the south of Rekha, is located on the south slope of the Trialeti Ridge. CSG2 is located within a ‘volcanic plateau’ geomorphological zone that comprises steep peaks, a volcanic plain and historic lava flows.

The plateau is composed of Upper Cretaceous and Tertiary igneous rocks including lavas and shallow intrusive rocks such as andesite, basalt and dolerite. The relief of hills and hillocks is fragmented quite intensively by erosion gorges with streams and rivers draining to lakes and reservoirs in the basins (e.g. Tsalka Reservoir and Tabatskuri Lake), with hills and hillocks. Along the Ktsia River a wide floodplain and the first upper terrace are developed.

The landscape at CSG2 comprises a subalpine meadow used for cattle grazing (refer to Viewpoint 16, 8403507E, 4614924N). The gently undulating relief features wet depressions and rocky outcrops. To the east, south and west the terrain becomes more varied, with hillocks and ridges containing and enclosing the site. Extensive belts of pine plantation on the ridgelines to the south and west provide further enclosure (refer to Viewpoint 17, 8403174E, 4614540N). The site is undeveloped and man-made influences are restricted to the extensive pine plantations and to grazing activities.

To the north, the terrain of hillocks and ridges reduces in elevation, with terraces descending northwards to the wide floodplain of the Ktsia River. Beyond the river to the north lies the village of Rekha, on the south slope of the Trialeti Ridge, and is surrounded by a fragmented relief of gorges, hills and hillocks.

On the river embankments, and in the area between the river and the village, areas of deciduous scrub and riparian woodland vegetation occur. Within and adjacent to the settlement the landscape is strongly modified foothill steppes and steppe meadows, which is predominately used as pasture, but also with large areas of cultural land use including arable and gardens.

Views toward the CSG2 site from Rekha encompass the Ktsia River and the floodplain fields, across to the undulating, ridgelines with pine plantations in the vicinity of the CSG2 site. There are distant views of the dramatic skyline of snow capped mountain peaks beyond. Views of the CSG2 site are restricted to elevated positions within the village, though the intervening ridgelines limit views. Intervening riverside trees and the undulating ridgelines to the south of the CSG2 site restrict views from lower lying areas (refer to Viewpoint 18, 8405264E, 4616631N).

7.4.3.5 Landscape character at the PRMS

The PRMS is located within the Akhaltsikhe synclinal basin, which is composed of undulating hills and valleys and forms the geomorphological zone between the Trialeti range and the Turkish border. The hills are composed of tertiary sedimentary rocks dissected by river valleys and their associated deposits. Beyond the Potskhovi River valley the topography rises gently over volcanic hills and lava flows towards the Turkish border.

The proposed PRMS site is located in a remote location on a plateau in the northern part of the Erusheti hill, adjacent to the existing SCP facility, Area 80. The northern part of the Erusheti hill is a flat-surface plain, which is bordered by the hilly relief of relatively small height.

The land cover comprises rough grassland (steppe and xeric grassland), with occasional areas of scrub vegetation and rocky outcrops (refer to Viewpoint 19, 8319272E, 4609693N). The site is contained to the north, west and south by varied terrain of hillocks, and more prominent hills beyond. From this elevated position distant views may be gained across the deep valley of the Postkhovi River to the settlements of Julda (south-east) and Vale (north-west) on the eastern valley slopes.

Within the wider landscape, the relief comprises mountains with dome-shaped massifs and steep-sided valleys and occasional flat plateaus. Within the villages and valley bottoms, land use is dominated by cultural uses of gardens, orchards and hay fields, with large areas of deciduous and coniferous forest. The middle valley slopes feature coniferous forests, and the upper slopes have land cover of subalpine and alpine meadow with scrub vegetation.

7.4.4 Landscape Sensitivities

The sensitivity of a landscape and its constituent features is not absolute; it will vary according to its key characteristics and the values placed on them.

The sensitivity of visual receptors varies. The most sensitive visual receptors are those with a particular interest in their surroundings or where prolonged viewing opportunities may be gained, e.g. residential locations, special visitor or recreational sites, nationally or locally recognised footpaths, or promoted scenic drives or tourist routes.

The following subsections summarise the components of the baseline conditions that, in the Project context, are considered the most important based on the anticipated impacts of the Project development.

7.4.4.1 Landscape sensitivities at KP0–KP56

The proposed pipeline route corridor has low landscape sensitivity. Its characteristic features include:

- Predominantly flat relief, though varied topography occurs such as the terraces above the Mtkvari River
- Open, large-sized fields in a rectilinear, functional, man-made pattern predominantly formed by the irrigation channels (KP0 to KP12)
- A natural landscape that has been strongly degraded and modified by cultural land uses, such as arable and pastoral agriculture

- A large-scale landscape with broad, distant views
- The frequent presence of detractors including industrial features (chimney stacks, power station and electricity transmission towers).

Along the proposed pipeline route corridor, sensitive features are limited to a small number of the vegetated field boundaries and areas of occasional scrub.

Visual receptors are limited to road users and shepherds.

7.4.4.2 Landscape sensitivities at CSG1

The area around CSG1 has low landscape sensitivity. It is characterised by flat relief, a large rectilinear pastoral field and the presence of the existing operational facility (BTC PSG1, SCP Area 72).

The ZTV for the vent stack indicates that both the 120m and 80m stack alternatives would be visible from the villages of Jandari, Nazarlo, Kesalo, Gardabani and Mzianeti.

Visual receptors include some parts of the outskirts of Nazarlo (refer to viewpoint 12, 8509676E, 4588370N) and the village of Lemshveniera situated at higher elevation to the east, which may have direct views of the CSG1 site (refer to viewpoint 13 8515060E, 4593093N). Such receptors are assessed as being high sensitivity. In other areas the views are interrupted and filtered by intervening vegetation. Road users (as assessed as being medium sensitivity) travelling south toward Jandari may have oblique uninterrupted views of the CSG1 site (refer to Viewpoint 14, 8513505E, 4591569N).

7.4.4.3 Landscape sensitivities at pigging station KP56

The landscape at KP56 is of strongly degraded, intensively grazed steppe that has low landscape sensitivity. Visual receptors include working shepherds and users of the adjacent road, both of which are assessed as being medium sensitivity (refer to Viewpoint 15, 8478374E, 4597030N).

7.4.4.4 Landscape sensitivities at CSG2

The distinctive natural landforms at CSG2 are only partially modified by the presence of the pine plantations, which do not significantly degrade the landscape character. The quality, condition and character of this area have medium sensitivity to the introduction of new unnatural features.

Computer-generated ZTV plans have been prepared to identify the extent to which the proposed development will be visible and to identify settlements where people would be sensitive to landscape changes. The ZTV plans are based on a bare earth terrain model and do not take account of any localised screening that may occur due to obstruction by buildings, or vegetation. A ZTV for proposed alternative vent-stack heights of 80m and 40m has been prepared, and an additional ZTV for the compressor building at 25.5m has been prepared.

The ZTV for the vent stack indicates theoretical visibility from the following visual receptors, i.e. the villages, Rekha (refer to viewpoint 18, 8405264E, 4616631N), Khando (refer to, viewpoint 20, 8401038E, 4618457N), Gumbati, Ashkala, Jinisi, Kushi Oliangi and Burnasheti. Such receptors are assessed as being of high sensitivity. In addition the ZTV indicates theoretical visibility from the road between Rekha and Khando (refer to viewpoint 19, E, N). Road users are assessed as being of medium sensitivity.

The ZTV for the compressor building indicates theoretical visibility from Rekha only.

7.4.4.5 Landscape sensitivities at the PRMS

The landscape around the PRMS has low landscape sensitivity. It is characterised by an open plateau of grassland and the presence of the existing facility at Area 80.

The ZTV for the vent stack indicates visibility from the villages of Vale, Naokhrebi, Tsinubani, Abatkhevi, Julda and Tskaltbila. Such receptors are assessed as being of high sensitivity.

The only close views of the site would be from the approach road to the Area 80 facility and from the landscape immediately surrounding the site (refer to viewpoint 21, 8319272E, 4609693N). Distant views towards the PRMS site may be gained from Julda (refer to viewpoint 22, 8322750E, 4608281N) and Vale (refer to viewpoint 23, 8323003E, 4610766N). From these locations distant views of the exiting facilities at Area 80 may be gained.

7.4.4.6 Summary of landscape and visual sensitivity

The following summarise the components of the baseline conditions:

- CSG1: Landscape sensitivity is low, with visual receptors from nearby villages of high sensitivity
- Pigging station: Landscape sensitivity is low, with visual receptors on the adjacent road of medium sensitivity
- CSG2: landscape sensitivity medium, with visual receptors at Khando and Rekha being high sensitivity (medium for road users)
- PRMS: Landscape sensitivity is low, with visual receptors in Julda and Vale of high sensitivity.

7.5 Surface Water

This section describes the baseline quality of the water in major surface water bodies that the SCPX Project will cross or be located near to, namely:

- Jandari Lake, which is close to the proposed site of CSG1
- Mtkvari River, which the SCPX pipeline loop will cross at KP30
- Algeti River, which the SCPX pipeline loop will cross at KP54.5
- Tsalka Lake, which is about 12km east of the proposed site of CSG2, but which is fed by the Ktsia River that runs at its closest some 800m to the north of the CSG2 site
- Wetland areas close to the CSG2 location.

This section contains the results of analysis of samples of the water from the Mtkvari and Algeti Rivers collected in 2011. Water from these rivers is used for irrigation and for domestic supplies. Descriptions of these rivers can be found below.

Water quality

Water quality results were compared with the following international standards (for benchmarking purposes only) to establish the relative quality status of the water bodies:

- EU Directive 2006/44/EC: Freshwater Fish Directive. These include ‘guide’ (i.e. good) and ‘mandatory’ levels for a range of parameters for two types of water body:
    - Salmonid waters (i.e. capable of sustaining species such as salmon and trout that generally require uncontaminated, well-oxygenated water)
    - Cyprinid waters (i.e. able to support species such as carp, which are generally more tolerant of lower oxygen levels and greater levels of contamination).

Both Cyprinid and Salmonid fish species have been identified in rivers close to or crossed by the SCPX Project and therefore both types of water body are considered appropriate for the purposes of this assessment.

7.5.1 *Information from Desktop Literature Survey*

In preparation for the fieldwork, 'Hydrology and Surface Water Quality', Section 8.8, of the SCP Project ESIA was reviewed. Additional detailed information on surface water quality was derived from water monitoring undertaken in connection with the SCP and BTC pipelines, including:

- The sampling of surface water from irrigation channels close to the BTC project's PSG1 and analysis for total petroleum hydrocarbon (TPH) and benzene, toluene, ethylbenzene and xylene (BTEX)
- Groundwater and surface water monitoring report (ref. 44406788, September 2005): organic analysis with baseline TPH analysis for surface water sampling locations at Tsalka Lake, and from a drainage ditch close to the BTC project's PSG1
- Groundwater and surface water monitoring report (ref. 44408200/LORP0004, November 2007): organic analysis with baseline TPH analysis for surface water sampling locations from the Ktsia River (at locations available closest to the site) and a small stream immediately adjacent to proposed CSG2 site
- Groundwater and surface water monitoring report (testing undertaken by Azecolab test report ref. C004P207, dated July 2011): organic analysis with baseline TPH analysis for surface water sampling locations at Tsalka Lake and the BTC project's PSG1.

According to those sources, the Mtkvari and Algeti rivers, Lake Tsalka and water from the PSG1 drainage channel is of good quality. It had levels of contaminants generally below detection limits, but varying levels of hardness, turbidity and conductivity. Sulphur Reducing Bacteria were present in all these surface waters. Coliforms were only detected in Lake Tsalka.

7.5.2 *Data Gaps and Field Survey Methods*

7.5.2.1 *Data gaps*

A review of information suggesting that the irrigation channels at CSG1 are not linked with Jandari Lake led to a decision not to test the water in the lake.

Owing to the time lapsed since the SCP ESIA in 2002, it was considered important to test the current baseline surface water quality of the Mtkvari and Algeti rivers for inclusion in the environmental baseline for the SCPX ESIA. It was not considered necessary to acquire additional monitoring data above that already collected by BP for the surface water quality surrounding CSG2.

Samples of water were collected on 26 May 2011 from the location where the SCPX pipeline will cross the Mtkvari and Algeti rivers. The GPS coordinates of the sampling locations during both the low flow and high flow sampling visits were E8500489 N4605182 (Mtkvari East) and E8481143 N4597484 (Algeti). These samples were to characterise the water quality when the flow rate is high in spring.

Samples of water were collected from the same locations on the Mtkvari and Algeti rivers on 1 and 6 September 2011 respectively. These samples were to characterise the water quality when the flow rate is low in the summer.

The testing of surface water quality that BP has undertaken in areas regarded as sensitive in previous ESIAs and as part of ongoing operational monitoring associated with the BTC project provides useful information on the quality of surface water at the proposed sites for CSG1 (the BTC project's PSG1) and CSG2 (Tsalka area, including Ktsia River and associated minor tributaries TSW 10). The results of the monitoring undertaken by BP between 2005 and 2010 indicate that the surface water in the vicinity of CSG2 is not impacted by petroleum hydrocarbons (including polycyclic aromatic hydrocarbons), as results are generally below the laboratory detection limit.

As the SCPX pipeline route ends far to the east of Lake Tsalka, and vehicle movements alone are unlikely to alter its water quality significantly, water from Lake Tsalka was not tested for the SCPX ESIA.

Surface water in streams crossed by the access road were not sampled and tested as the risks from operational impacts were considered low.

The wetland areas at CSG2 were not sampled as they were observed to be dry at the time of the survey. It is therefore considered to be of relatively low sensitivity owing to the apparent seasonal nature. As such, these features were not included in the survey.

Surface water data was not collected in proximity to the proposed PRMS location as no surface water courses/bodies were identified in close proximity to the site that could be impacted by the construction.

7.5.2.2 Survey methods

The following equipment was mobilised to the sampling points:

- GPS unit
- Sample containers
- Field survey form
- Laboratory trip blank
- Cool box
- Nitrile gloves
- Casting line
- Multiparameter probe(s) for field measurements
- Chain of custody paper work.

The laboratory trip blank was sent to the sample collection locations and returned to the laboratory with the samples to ensure that the quality of the samples was not impacted during transit.

The safest sample collection methodology was selected at each sampling point. The nature of the banks and channel at the Algeti crossing allowed samples to be collected directly into the sample containers. The Mtkvari sampling point has steep banks and deeper faster flowing water, so the sample container was attached to a line and cast repeatedly from the bank into deep water away from the bank until sufficient sample was obtained.

During the sampling in May, ‘in situ’ field measurements of temperature, pH, conductivity, dissolved oxygen and turbidity were recorded at a safe distance from the bank once the sample had been recovered. During the sampling in September, the field analysis equipment malfunctioned, so the whole analysis was carried out in the laboratory. This was not considered to have had a significant effect on the results obtained.

The samples were securely packed into cool boxes and delivered to Gamma Laboratory in Tbilisi for testing. Gamma Laboratory itself is accredited by the United National Accreditation Agency – Accreditation Centre of Georgia. Its test equipment is calibrated and certified by Sakstandarti (the State department of Georgia for Standardization, Metrology and Certification). Gamma laboratories carried out quality assurance testing of a liquid concentrate prepared by an ISO 17025 accredited laboratory in the UK (Envirolab). The marginal variation in results of the quality assurance exercise was considered satisfactory and has been ascribed to laboratory technique (ICPMS vs. AAS method) and sensitivity of laboratory equipment close to the limit of detection.

Gamma Laboratory was selected because it is accredited by the national body of accreditation, is located in Tbilisi and is close to the sampling locations. If there is an extended period between sampling and testing, deterioration of the sample can alter the results of the biological analysis and organic (TPH) analysis. Microbiology testing commenced as soon as the samples arrived at the laboratory, to prevent any deterioration in quality of the sample and any significant alteration in bacteria present.

Gamma Laboratory analysed the samples for the parameters listed in Table 7-8. The table also shows the laboratory methodologies and detection limits.

Table 7-8: Parameters and Methods for Surface Water Analysis

Analyte	Unit	Method Detection Limit (MDL/LOD)	Method Description	Method Reference
pH	pH unit	0.1	pH meter (Lab and Field)	ISO 10523
Conductivity	uS/cm or S/cm	0.001	Conductivity meter (Lab and Field)	EPA 120.1
Turbidity	FTU	0.1	Turbidity meter (Lab and Field)	ISO 7027
Dissolved oxygen	mg/l O_2	0.2	Oxymeter (Lab and Field)	
Suspended solids	mg/l	0.002	Gravimetrical (Lab and Field)	EPA-160.1
Sulphate (SO_4)	mg/l	0.5	Turbidimetric	ISO 9280
Chloride (Cl-)	mg/l	0.05	Titrimetric	ISO 9297
Arsenic (As)	mg/l	0.05	Spectrofotorimetric	ISO 6595
Barium (Ba)	mg/l	0.1	Turbidimetric	SST 50:2005
Chromium (Cr)	mg/l	0.007	Atomic Absorption Spectrometry	ISO 9174
Cadmium (Cd)	mg/l	0.001	Atomic Absorption Spectrometry	ISO 8288
Copper (Cu)	mg/l	0.003	Atomic Absorption Spectrometry	ISO 8288
Mercury (Hg)	mg/l	0.0002	Atomic Absorption Spectrometry	ISO 5666
Lead (Pb)	mg/l	0.01	Atomic Absorption Spectrometry	ISO 8288
Nickel (Ni)	mg/l	0.003	Atomic Absorption Spectrometry	ISO 8288
Iron (Fe)	mg/l	0.02	Atomic Absorption Spectrometry	ISO 6332
Manganese (Mn)	mg/l	0.02	Spectrofotorimetric	ISO 6333
Selenium (Se)	mg/l	0.02	Spectrofotorimetric	GOST 19413
Aluminium (Al)	Mg/l	0.02	Spectrofotorimetric	ISO 10566
Zinc (Zn)	mg/l	0.003	Atomic Absorption Spectrometry	ISO 8288
COD	mg/l O_2	0.10	Titrimetric	ISO 8467
BOD5	mg/l O_2	0.20	Titrimetric	ISO 8467
TPH (Total)	mg/l	0.04	GC-FID	EPA 418
Total coliform	MPN	N/A	Membrane Filtration Method	ISO 9308:1,2,3
E. coli	MPN	N/A	Membrane Filtration Method	ISO 9308:1,2,3

7.5.3 Baseline Surface Water

7.5.3.1 Mtkvari East River morphology

The Mtkvari East River is a single-thread, broad, slightly meandering river with large well-wooded islands. Weirs control water levels both upstream and downstream on the crossing so the reach is deep and slow flowing. There are regulated flows and water depths owing to weirs both upstream and downstream.

The right bank is stable and consists of densely wooded shore backed by mature forest. The left bank is also stable.

The right floodplain is around 100m wide and represents a point bar on a curve in the river course. It is flanked by a terrace some 10m higher than the floodplain. The left floodplain is largely open grassland with a derelict factory immediately upstream of the crossing. The floodplain is flanked by high rock cliffs 200m from the river.

The bed material is uncertain, but gravel bars are observed on the right bank. Bed-form type is uncertain; owing to low velocities it is probably plane mud bed and sandy ripples.

7.5.3.2 Mtkvari East River hydrology

Hydrological analysis has been carried out for the Mtkvari East River. The hydraulic modelling has predicted the maximum flow rates under a range of periodic predicted flood events ranging from a one-in-five-year event (Q5) to a one-in-10,000-year event (Q10,000) (Table 7-9).

Table 7-9: Maximum Flow rates at a Range of Flood Events – Mtkvari East River

Site	Q5 (m^3/s)	Q20 (m^3/s)	Q50 (m^3/s)	Q100 (m^3/s)	Q200 (m^3/s)	Q500 (m^3/s)	Q1000 (m^3/s)	Q10000 (m^3/s)
Mtkvari River	1031	1389	1768	2105	2378	2757	3052	3494

7.5.3.3 Mtkvari East River water quality

Table 7-10 presents the results of the field measurements and laboratory analyses of the spring and summer water samples. Field measurements, only available during the high flow sampling, are given in brackets.

Table 7-10: Results of Laboratory Analysis from Mtkvari East River

Analyte	Result of Sample Obtained on 26/05/11	Result of Sample Obtained on 01/09/11
Temperature (°C)	(17.0*)	-
pH	7.95 (7.70*)	7.85
Conductivity (S/m)	0.03172 (0.03230*)	0.04147
Dissolved oxygen (mg/l)	6.35 (6.77*)	7.12
Turbidity (FTU**)	3530 (3676*)	441
Suspended solids (mg/l)	2109	180
Total TPH	<0.04	<0.04
Sulphate (mg/l)	100	70
Barium (mg/l)	<0.05	<0.05
Calcium (mg/l)	54	67
Chloride (mg/l)	12.07	13.0
Arsenic (mg/l)	<0.01	<0.01
Cadmium (mg/l)	<0.001	<0.001

Analyte	Result of Sample Obtained on 26/05/11	Result of Sample Obtained on 01/09/11
Copper (mg/l)	<0.003	<0.003
Mercury (mg/l)	<0.0002	<0.0002
Lead (mg/l)	<0.01	<0.01
Nickel (mg/l)	<0.003	<0.003
Iron (mg/l)	<0.01	0.55
Selenium (mg/l)	<0.02	<0.02
Zinc (mg/l)	<0.003	<0.003
Aluminium (mg/l)	<0.02	<0.02
Manganese (mg/l)	<0.01	0.33
Chromium (mg/l))	<0.01	<0.01
BOD5 (mg/l O_2)	2.40	1.54
COD (mg/l O_2)	325.6	15.12
Total coliform (/100ml)	500,000	83,000
E. coli (/100ml)	500,000	60,000

* Field measurement; ** Formazin turbidity unit

The Mtkvari East has much higher turbidity in spring when it carries a heavier sediment load.

All heavy metals analysed were at concentrations below the laboratory limit of detection, except for iron and manganese in samples obtained during the low flow period (0.55mg/l and 0.33mg/l, respectively). TPH was also below the laboratory limit of detection. The COD data varies quite considerably between the spring and summer samples. Increased flow rates associated with spring river flow results in a greater concentration of sediment (including organic compounds) in solution. This, in turn, has a direct effect (i.e. an increase) on the results of coliform concentration, COD, turbidity and suspended solids.

Coliforms were present at more significant levels in the spring than in the summer.

In addition to the above, direct comparison of the results (where possible) against the EU Directive 2006/44/EC Freshwater Fish Directive indicates that the majority of the results are not in excess of the Directive water quality limits for waters to be able to support salmonid and cyprinid fish species. The exception to this is dissolved oxygen (DO) during the spring sample (probably owing to the heavier sediment load) and suspended solids in both the spring and summer samples. Dissolved oxygen can result from several scenarios and is associated with an oxygen demand within the water body. Cooler water generally has a higher potential level of DO. Increased sedimentation generally increases water temperature and therefore is usually associated with a reduction in DO. Furthermore, sediment with high organic content (i.e. decomposing plant/animal remains) would also be associated with lower concentrations of DO owing to the oxygen demand of aerobic bacteria.

7.5.3.4 Algeti River morphology

The Algeti River is a single-thread gravel-bed river, 20m wide, with local tendency to braid and to avulse. It is fast flowing and silt laden. This river is very sensitive to change in terms of lateral stability, incision and scour.

The east bank is 1m high and consists of alluvial unconsolidated gravel. Rapid bend tightening upstream of the crossing is causing rapid bank retreat and if left unprotected could lead to out-flanking of any future protection works and exposure of pipeline in the floodplain.

The west bank is 1m high and consists of recent alluvial unconsolidated gravel. It is *c*.200m wide and sits below a gentle slope up onto flanking hills. The right floodplain is of limited width, *c*.40m, below a gentle slope up onto flanking hills.

Plane pebble and cobble bed with low amplitude bars and braid bars. The river is subject to general scour, local scour, bendway scour and confluence scour, and recent incision is likely to be progressive. Avulsion is possible.

7.5.3.5 *Algeti River hydrology*

Hydrological analysis has been carried out for the Algeti River. The hydrological analysis has predicted the maximum flow rates under a range of periodic predicted flood events ranging from a one-in–five-year event (Q5) to a one-in-10,000-year event (Q10,000) (Table 7-11).

Table 7-11: Maximum Flow Rates at a Range of Flood Events – Algeti River

Site	Q5 (m^3/s)	Q20 (m^3/s)	Q50 (m^3/s)	Q100 (m^3/s)	Q200 (m^3/s)	Q500 (m^3/s)	Q1000 (m^3/s)	Q10000 (m^3/s)
Algeti River	283	381	485	577	652	756	837	958

Hydraulic modelling results for the Algeti crossing indicate a vertical scour of between 0.5m and 1.0m during the 1:200 year flood event. The unrestricted active zone covers the entire floodplain.

7.5.3.6 *Algeti River water quality*

Table 7-12 presents the results of the field measurements and laboratory analyses of the spring and summer water samples. Field measurements, only available during the high flow sampling, are given in brackets.

Table 7-12: Results of Laboratory Analysis from Algeti River

Analyte	Result of Sample Obtained on 26/05/11	Result of Sample Obtained on 06/09/11
Temperature (°C)	(17.4*)	-
pH	7.65 (7.35*)	8.3
Conductivity (S/m)	0.09326 (0.0954*)	0.08268
Dissolved oxygen (mg/l)	6.57 (6.63*)	7.39
Turbidity (FTU**)	4220 (4375*)	346.3
Suspended solids (mg/l)	2186.0	315.2
Total TPH	<0.04	<0.04
Sulphate (mg/l)	325	132
Barium (mg/l)	<0.05	<0.05
Calcium (mg/l)	124	106
Chloride (mg/l)	24.16	9.23
Arsenic (mg/l)	<0.01	<0.01
Cadmium (mg/l)	<0.001	<0.001
Copper (mg/l)	<0.003	<0.003
Mercury (mg/l)	<0.0002	<0.0002
Lead (mg/l)	<0.01	<0.01
Nickel (mg/l)	<0.003	<0.003
Iron (mg/l)	<0.01	1.37
Selenium	<0.02	<0.02
Zinc (mg/l)	<0.003	<0.003
Aluminium (mg/l)	<0.02	<0.02
Manganese (mg/l)	<0.01	0.29
Chromium (mg/l))	<0.01	<0.01
BOD5 (mg/l O_2)	3.45	1.01
COD (mg/l O_2)	281.2	22.96

Analyte	Result of Sample Obtained on 26/05/11	Result of Sample Obtained on 06/09/11
Total coliform (/100ml)	80000	2000
E. coli (/100ml)	80000	100

* Field measurement; ** Formazin turbidity unit

The Algeti River is also more turbid in spring than in summer, and generally more turbid than the Mtkvari River.

Like the Mtkvari, the Algeti had heavy metals at concentrations below the laboratory limit of detection, except for low levels of iron and manganese in the summer samples. TPH was also below the laboratory limit of detection. As above, the COD data varies quite considerably between the spring and summer samples, associated with increased flow rates and a greater concentration of sediment (including organic compounds) in solution. Increased flow rates associated with spring river flow results in a greater concentration of sediment in solution.

Coliforms were lower than in the Mtkvari, but were substantially higher in the spring than in the summer.

In addition to the above, direct comparison of the results (where possible) against the EU Directive 2006/44/EC Freshwater Fish Directive indicates that the majority of the results are not in excess of the Directive water quality limits for waters to be able to support salmonid and cyprinid fish species. As with above, the exception to this is dissolved oxygen during the spring sample (probably owing to the heavier sediment load) and suspended solids in both the spring and summer samples. Furthermore, BOD (spring only) and iron (summer only) both exceed the guidelines for salmonid waters.

7.5.4 Surface Water Sensitivities

The following subsections summarise the components of the baseline conditions that, in the Project context, are considered the most important based on the anticipated impacts of the Project development.

7.5.4.1 Surface water sensitivities at KP0–KP56 and CSG1

The parameters/determinands tested were directly compared to the water quality standards within the EU Directive 2006/44/EC Freshwater Fish Directive. Where a direct comparison could be made, the majority of determinands tested did not exceed these thresholds. The exception to this was the values for dissolved oxygen and suspended solids in the spring sampling from both the Mtkvari and Algeti rivers. Elevated concentrations of BOD were also encountered in the spring sample from the Algeti River.

Summer sampling from the two rivers encountered elevated concentrations of suspended solids, as well as a marginally elevated concentration of iron from the Algeti sample.

7.5.4.2 Surface water sensitivities at CSG2

Historic monitoring from surface water bodies in the vicinity of CSG2 is not impacted by petroleum hydrocarbons (including polycyclic aromatic hydrocarbons), as results are all below the laboratory detection limit.

7.5.4.3 Surface water sensitivities at the PRMS

Surface water data was not collected in proximity to the proposed PRMS location as no surface water courses/bodies were identified in close proximity to the site that could be impacted by the construction.

7.6 Groundwater

This section describes the baseline quality of the groundwater in the shallow aquifers located at CSG1 (KP4.7), CSG2 (KP142 to KP143) and PRMS (KP246). In addition, it also describes the hydrogeological conditions along the proposed SCPX loop itself (KP0 to KP56)

The section presents results of analyses of groundwater samples collected from the CSG1 and CSG2 site and additional background information from reports on groundwater quality and hydrogeological conditions. It also summarises groundwater quality information from monitoring at the PSG1 site adjacent to CSG1, groundwater quality information from monitoring locations in the vicinity of CSG2 and quality of the groundwater within a potable water supply borehole drilled at Area 80. Groundwater monitoring data is not available along the proposed SCPX pipeline loop, as it was agreed with the Ministry of Environmental Protection (MoE) that monitoring was not required in this area due to its relative sensitivity compared with other areas along the BTC pipeline route.

The information provided will allow the impact of the SCPX on potentially sensitive groundwater resources to be assessed.

Water quality
Groundwater quality results were compared with the following UK/EC Drinking Water standards (for benchmarking purposes only) to establish the relative status of the groundwater:

- Statutory Instrument 2010 No. 994. The Water Supply (Water Quality) Regulations
- Council Directive 76/464/EEC. Water pollution by discharges of certain dangerous substances
- Council Directive 98/83/EC. The quality of water intended for human consumption (The Drinking Water Directive)
- Council Directive 2000/60/EC. Establishing a framework for Community action in the field of water policy (The Water Framework Directive)
- Environment Agency (2011) Chemical Standards Database (web-based).

7.6.1 Information from Desktop Literature Survey

In preparation for the fieldwork, Sections 8.5 and 8.7 *'Geomorphology, Geology and Geohazards'* and '*Contamination*' of both the BTC and SCP Project ESIAs were reviewed. Additional detailed information on groundwater quality was derived from water monitoring undertaken in connection with the SCP/BTC pipelines, including:

- Groundwater and surface water monitoring report (ref. 44406788, September 2005; ref. 44407250, September 2006): organic analysis with baseline TPH analysis for groundwater samples from five wells used for water abstraction at the BTC project's PSG1 (GPS coordinates 8512173 E 4589543 N, 8512104 E 4589207 N, 8512426 E 4589172 N, 8512276 E 4589114 N and 8512146 E 4589463 N) and three groundwater monitoring wells in proximity to the proposed CSG2 site (GPS coordinates 8512426 E 4589172 N, 8512276 E 4589114 N and 8512173 E 4589543 N)

- Groundwater and surface water monitoring data undertaken by BP (BTC) as part of the ongoing groundwater and surface water monitoring programme (using the monitoring wells referred to above) between 2007 and 2010
- Surface water monitoring (testing undertaken by Azecolab, test report ref. C004P207, dated July 2011): organic analysis with baseline TPH analysis for samples from the wells identified above at the BTC project's PSG1
- Chemical analysis results of the borehole drilled at Area 80 for the potable water supply of the accommodation facility, dated 27 October 2009
- Chemical analysis results of the borehole drilled at Area 80 for the potable water supply of the accommodation facility, presented in report by the National Environment Agency reference no. 22, dated 9 January 2012
- Report on Hydrogeological Conditions of the Area Adjacent to the Gas Compressor Station (under construction) in Tsalka District, Georgia for Drinking and Technical Water Supply, Rev 2, GeoEngineering Limited, dated 4 April 2012
- Preparation of Hydrogeology Report, Drinking Water Well Design and Assistance in Obtaining Permits for Borehole Construction, report no. 41131_r1_Eng, Draft Version, prepared by DG Consulting Limited, dated 2012
- Report on 'Results of drilling and hydro-geologic exploration works carried out for the potable water supply of the accommodation facility at "Area 80" gas pumping station of the Baku-Tbilisi-Ceyhan Pipeline Company (Georgia)', prepared by Sainjgeo Limited, date unknown.

7.6.1.1 CSG1 and pipeline loop

The main morphological unit along thee loop is the Marneuli-Gardabani accumulative depression, which comprises a synclinal basin underlying thick Quaternary series. The geological structure of the Marneuli-Gardabani artesian basin and adjacent areas includes Cretaceous, Palaeogene, Neogene and Quaternary sedimentary formations, which are mainly represented by terrigenous and partially carbonatic facies. A geological cross section is included in Figure 7-20.

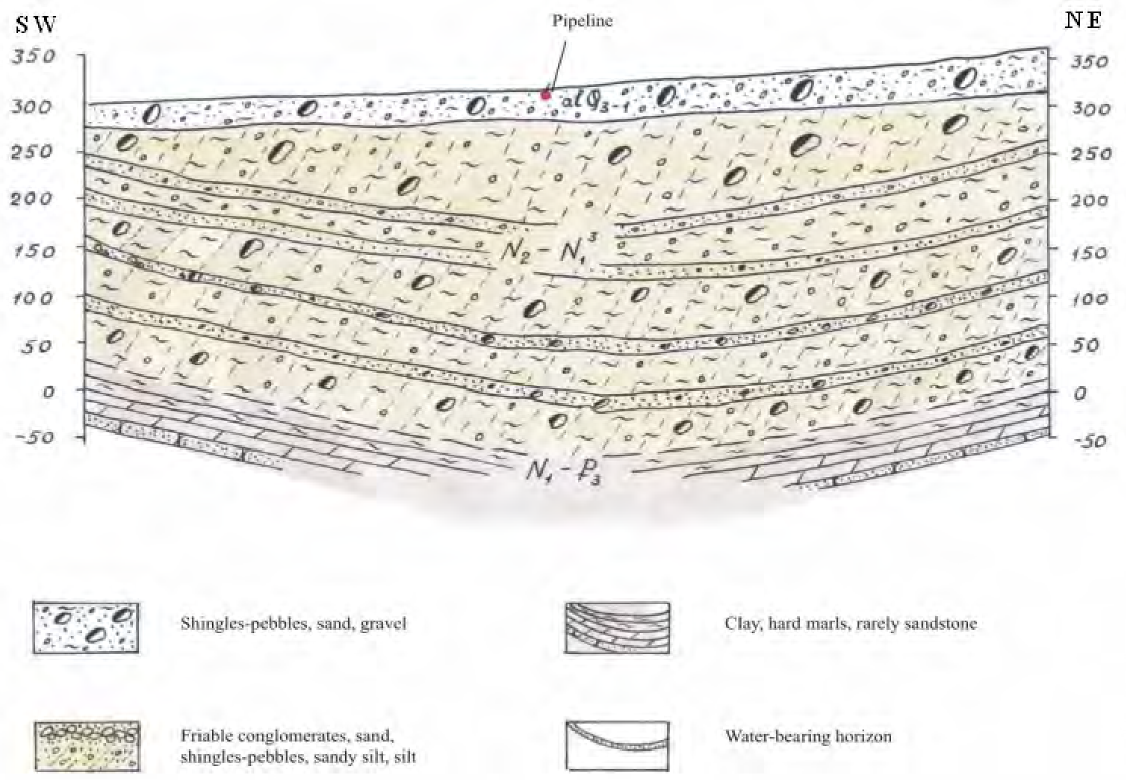


Figure 7-20: Hydrogeological cross section of Marneuli Gardabani Artesian basin

The following major water-bearing horizons and complexes as well as water-impermeable layers were identified in the BTC ESIA in terms of quantitative and qualitative characteristics of water content:

- Water-bearing horizon of riverbed and floodplain recent alluvial sediments (alQ4)
- Water-bearing horizon of early Quaternary alluvial sediments (alQ 3-1)
- Water-bearing horizon of the Upper Miocene-Pliocene volcanogenic-continental facies (N21- N13)
- Water-impermeable Miocene-Oligocene sediments (N1-P3)
- Water-bearing complex of Eocene-Palaeocene volcanogenic-sedimentary strata (P2-P1)
- Water-bearing horizon of Senton carbonate strata (K2Sn)

The literature review identified two important aquifers in the region of the proposed SCP expansion loop and the proposed construction area of CSG1 as riverbed and floodplain recent alluvial sediments and the early Quaternary alluvial sediments.

Riverbed and Floodplain Recent Alluvial Sediments (alQ4)
Owing to the bacteriological contamination and industrial pollution associated with the Mtkvari River and the high sulphate content and high mineralisation of the alluvial sediments of the Algeti River, abstraction of the groundwater from the riverbed and floodplain recent alluvial deposits close to these rivers is restricted. Based on this literature review, the composition of groundwater is primarily bicarbonate-calcium. The total mineralisation is 0.3 – 0.5g/l. Water temperature varies within 12 - 16 ^{o}C by seasons, water hardness is 4.5 – 9.5mg/eq. These alluvial deposits are mostly recharged by river water, partly by atmospheric precipitation and throughflow from other water-bearing horizons.

The recent alluvial sediments of the River Khrami do not directly underlie the proposed SCPX route itself. However, it is recognised that the Early Quaternary Alluvial Sediments (described below), recent alluvial sediments and the underlying Mio-Pliocene pressurised water may be in hydraulic continuity. The River Khrami alluvium aquifer is largely exploited for the supply of potable water and the riverbank water abstraction facility at the confluence of the River Khrami and Debeda provides potable and industrial water for Rustavi.

Early Quaternary alluvial sediments (alQ 3-1)
The early Quaternary Alluvial Sediments are located beneath the majority of the proposed SCPX pipeline loop and comprise three main aquifer units. The aquifer unit within the pipeline corridor is referred to as the Gardabani aquifer and, according to the BTC and SCP ESIAs, extensive borehole data demonstrates that the depth to the water table varies from 2m to 36m below ground level. Recharge to this aquifer unit is predominantly by water losses from irrigation channels and atmospheric precipitation. The chemical composition of groundwater was identified in the BTC and SCP Project ESIAs as predominantly bicarbonate-sulphate calcium. However, it is also often sulphate-bicarbonate magnesium type. In addition water-bearing strata have also been encountered in the early Quaternary sediments of the Marneuli lowland and piezometric levels vary from 0.5m to 20m below ground level. This chemical composition is predominantly bicarbonate-sulphate calcium-sodium type and the aquifer is recharged by river and irrigation water and precipitation. It is also noted that a hydraulic link has been identified between the Marneuli Lowlands aquifer, the recent alluvial horizon groundwater and the underlying Mio-Pliocene pressurised water. Groundwater from the early quaternary sediments is mostly used in the Marneuli lowlands for supply of water to agricultural facilities.

Upper Miocene-Pliocene volcanogenic-continental facies (N21- N13)

The Upper Miocene-Pliocene volcanogenic-continental facies are encountered below the sedimentary deposits across the entirety of the pipeline expansion route and the proposed location of CSG1. These igneous deposits comprise friable conglomerates, sands and pebbles with a silty matrix and boreholes reaching 500m depth have identified seven artesian water-bearing horizons, separated by impermeable cohesive strata. This aquifer also outcrops in the far western section of the proposed pipeline expansion route and the location of the proposed pigging station, between approximately KP55 and KP56. It is of various chemical compositions and the horizon is mainly recharged by infiltration of river water, which takes place in the lower parts of the alluvial fans. The overall groundwater flow direction within these deposits is from north-west to south-east and the natural discharge of the horizon occurs mostly through seepage into surface water courses.

The groundwater within the underlying Upper Miocene-Pliocene volcanogenic-continental facies presents a limited resource and is encountered at a significant depth. This combined with the presence of intermittent impermeable horizons providing protection to the water-bearing horizons present make this aquifer less vulnerable to potential surface contamination. This resource is utilised for localised water supply and the existing PSG1 facility currently utilises this resource for potable and operational purposes, and it is proposed that the CSG1 will utilise this water-bearing complex for potable water supply. Groundwater monitoring data in proximity to the CSG1 development site (from PSG1) indicates the absence of contaminants of concern within the underlying groundwater from the five monitoring wells located on site. Furthermore, concentrations of organic contaminants (TPH, PAH and semi-volatile organic compounds (SVOCs)) have all been below, or close to, the laboratory detection limit. The BTC and SCP Project ESIAs confirmed that the concentrations of analytes in the groundwater samples, which were collected in the vicinity of the proposed SCPX CSG1 location were not in excess of UK drinking water standards.

Deeper Aquifers

As with the SCP and BTC ESIA studies, the water-bearing complex of Eocene-Palaeocene volcanogenic-sedimentary strata and the Senton carbonate strata are also not considered to be significant in the context of this study owing to the hydraulic isolation from the upper formations and the pipeline.

Contamination

A suspected H_2S odour and discoloured groundwater at was encountered at 11.4m bgl during the drilling of borehole GE-BH014 as part of the SCPX geotechnical investigations. The borehole is located at KP29 on the eastern bank of the Mtkvari River. A preliminary contamination desk study and sampling and analysis of groundwater and ground gas was undertaken (URS Desk Study Report for Potential Contamination encountered at Kura River, Georgia: KP 029 2012). The sampling involved the collection of a single sample of ground gas and a single sample of groundwater. Ground gas testing recorded levels of H_2S of 4ppm. The groundwater was sent for subsequent chemical analysis. Levels of VOCs, SVOCs, BTEX and PCBs were below the laboratory limit of detection. All metals were below the limit of detection with the exception of boron with a recorded concentration of 3801 mg/kg. Based on the results of the desk study, combined with the groundwater and ground gas analytical results, it was considered that the H_2S odour encountered during drilling could most likely be attributed to the release of naturally occurring H_2S from a fracture within the sandstone. The elevated boron concentration was considered to be the result of naturally occurring boron within the underlying geology (sandstone).

7.6.1.2 CSG2

The hydrogeology of the Tsalka area in the vicinity of CSG2 is characterised by the presence of four water-bearing units, as detailed below[2]:

[2] GeoEngineering, 2012

- Upper Quaternary alluvial, deluvial proluvial and lacustrine formations (adplQIII-IV)
- Upper Quaternary (azQIII)
- Upper Pliocene–Middle-Quaternary lava formations (βN23-Q1- Tsalka Suite)
- Lower Pliocene Lava Layers (αN21)

A geological cross section is included in Figure 7-21.

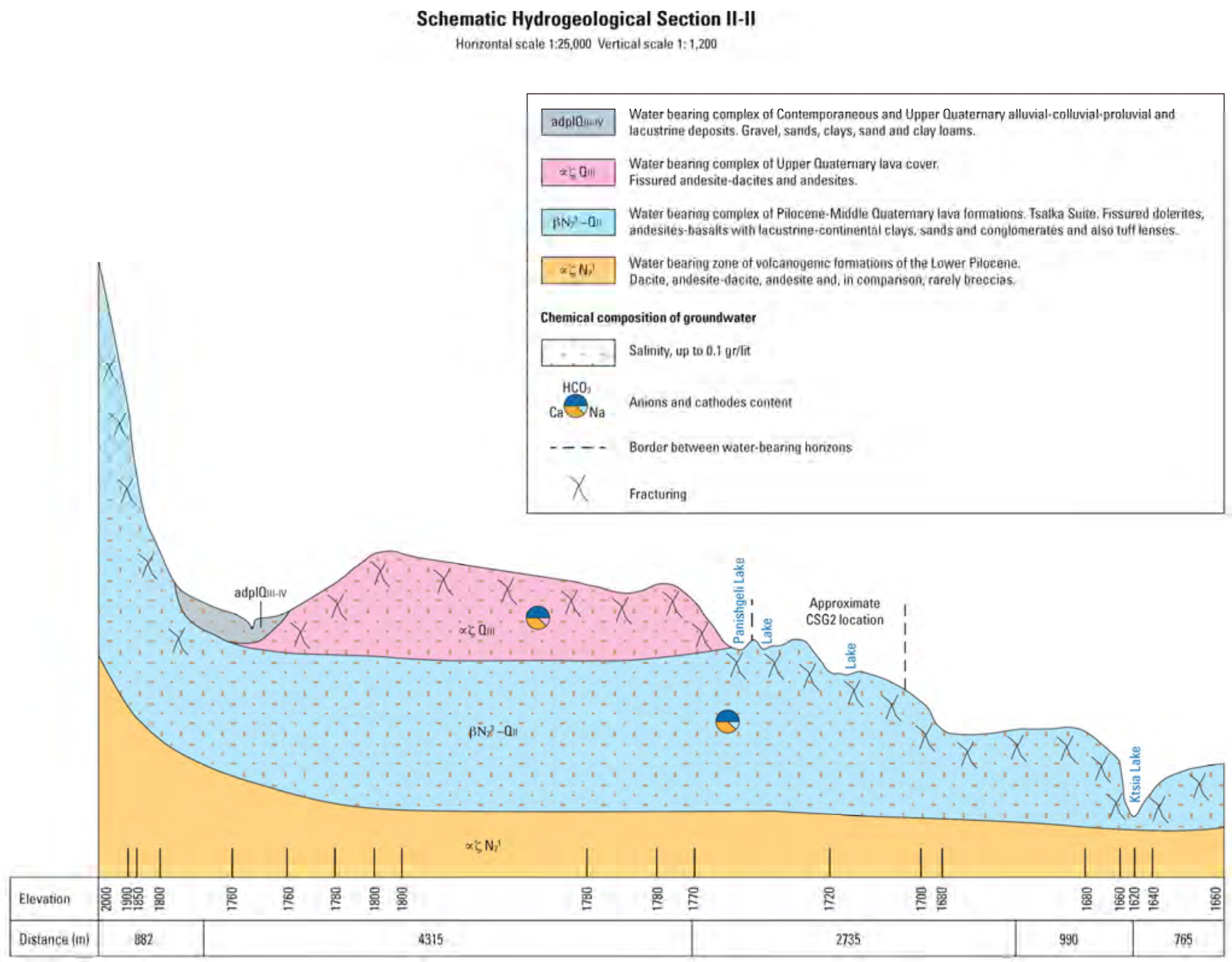


Figure 7-21: A Hydrogeological Cross Section in the vicinity of CSG2

Upper Quaternary alluvial, deluvial proluvial and lacustrine formations (adplQIII-IV)
These units occur in localised pockets within the Tsalka depression and in Narianis Veli. The lithology consists of friable alluvial formations (unconsolidated sands and silts) and lacustrine clay-silts. Groundwater is shallow (depth is either less than 2m or ranges within2 – 5m) and does not have aggressive properties. It is unlikely that these aquifers are exploited for the supply of potable water given the abundance of high yield springs in the general areas of occurrence of this formation.

Upper Quaternary (azQIII)
Overlying the Tsalka Formation are the Upper Quaternary fractured lavas. In this formation discharge occurs through high-yielding springs, for which the Tsalka District is renowned and which frequently form river sources. In addition, the high yield (in excess of 15l/sec) of

these quaternary lavas provides an important water resource with high-quality potable properties that are widely used for drinking and sanitary water supply.

Upper Pliocene–Middle-Quaternary lava formations (βN23-Q1- Tsalka Suite)
The water-bearing unit immediately underlying CSG2 is the Upper Pliocene–Middle Quaternary lava layers. The fissured dolerites and andesite-basalts are also interbedded with lacustrine-continental clays, producing impermeable horizons within this formation. The lava cover is intensively folded within the Tsalka depression. The thickness of the lava cover reaches several hundred meters.

The principal mechanisms for recharge of the Upper Pliocene-Middle Quaternary water-bearing unit is a combination of infiltration of atmospheric precipitation, surface water and hydraulic connection with the adjacent aquifer units.

Natural discharge of these horizons occurs through high yield springs, which frequently form river sources. These springs include the Dashbashi spring group (south-east of Tsalka) with total yield exceeding 3,500 l/sec, Bezhano spring (south-west of Tabatskuri lake) with yield of 250 l/sec, Burnasheti spring (at village Burnasheti) with yield of 2,000 l/sec.

It should be noted that groundwater horizons connected to lava cover are characterised by a fairly stable regime, which is probably owing to high permeability of the strata and the regulating influence of lakes. In addition, these unique water resources that have yields in excess of 20m3/sec are characterised by high quality potable properties and are widely used for water supply.

Lower Pliocene Lava Layers (αN21)
The water-bearing horizon of Lower Pliocene (upper part of Kisatibi series) lava layers consist of andesite, andesite-dacite, liparite and their associated pyroclastic deposits.

Owing to high porosity and intensive fissuring, this formation is highly permeable. According to the degree of relief dissection, depth of the groundwater changes from 20 to 150m. Owing to the absence of impermeable strata within the Kisatibi series, groundwater is never found under artesian conditions. Pressurized groundwater has been found through boreholes only on the western shore of Tabatskuri lake, where andesite is covered by Quaternary sandy silts and silty lacustrine sediments. Water of this horizon has low mineralization (M<0.5g/l) and is of hydrocarbonate calcium type.

The horizon is mainly recharged by atmospheric precipitation and partially at the expense of water outflow from the Upper Pliocene - Lower Quaternary lava horizon. The Kissatibi series is connected to high yield springs (>1 l/sec). Waters of this horizon are widely used for water supply of large settlements, such as Akhaltsikhe, Adigeni, Uraveli and others.

7.6.1.3 PRMS

The hydrogeology of the PRMS development area is characterised by two main aquifer units:

- Recent Alluvial sediments of riverbed and flooplain (alQ4)
- Water-bearing complex of Upper Miocene-Lower Pliocene (Kisatibi series) lava layers (αN21 & N12 - N21)

Recent Alluvial sediments of riverbed and flooplain (alQ4)
Water-bearing horizon of recent alluvial sediments of riverbed and floodplain have a wide distribution on the wide valley areas of the Mtkvari, Tsinubnistskali, Abastumani, Potskhovi and Kvabliani. Sediments of the lower floodplain terraces contain water, while the upper terraces are sporadically water-bearing. The yield of springs connected to alluvial sediments

varies within a wide range, namely from 0.01 to 12.0 l/sec. The yield of only one spring, located near village Tmogvi, reaches 30 l/sec.

Water of bicarbonate calcium-sodium chemical composition predominates. Bicarbonate-sulphate magnesium water is less frequent. Correspondingly, mineralization varies from 0.1 to 1.1g/l. Fluctuation in temperature is within 4-18^{o}C according to the seasons.

Upper Miocene-Lower Pliocene (Kisatibi series) (αN21 & N12 - N21)
Water-bearing horizon of Lower Pliocene (upper part of the Kisatibi series) lava layers is exposed in outcrops on a fairly large area in the vicinity of villages Mikeltsminda and Tsira within the study area. Refer to previous sections for detailed description of this horizon.

Water-bearing complex of Upper Miocene-Lower Pliocene (lower part of Kisatibi series) lava layers is exposed over a large area, namely south of the village Arali, between the villages Skhvlisi and Tskaltbila and south of the village Varkhani.

The lithology of the complex includes andesite, andesite-dacitic and dacitic tuff and tuffaceous breccia lava layers. The water content varies significantly and depends on the degree of fissuring of the strata. Thus, yield of springs connected to the lower part of the Kisatibi series does not exceed 0.2 l/sec in the central part of Akhaltsikhe depression, while high-yield springs (50-80 l/sec) occur in these series outside the 10km route corridor, namely near the village Atskvita. Circulation is mostly of through fissure systems, less frequently through natural porosity as well as fissures.

Groundwater chemical composition of the Kisatibi series is generally bicarbonate calcium-sodium or calcium-magnesium. Mineralization varies from 0.1 to 0.7g/l. Temperature reaches 13^{o}C.

Data from the borehole drilled to provide a water supply to the Area 80 accommodation facility indicate that the shallowest groundwater horizon is some 70–80m below ground level. Other water-bearing horizons were also encountered at depths of 89–123m and 164–220m. The potable water supply itself is drawn by a pump and well installed some 80m below ground level.

7.6.2 Data Gaps and Field Survey Methods

7.6.2.1 Data gaps

The testing of groundwater quality that BP has undertaken as part of ongoing monitoring at the BTC project's PSG1, describes the baseline for CSG1. The BTC groundwater monitoring programme contains wells in the vicinity of CSG2 and information from the potable water supply borehole at Area 80 provides an indication of groundwater quality and level at the PRMS. Taking advantage of the presence of suitable equipment, the Project installed additional groundwater monitoring wells during the geotechnical surveys.

During the SCPX geotechnical inspection of the Facility sites, four groundwater monitoring wells were installed at CSG1 and the PRMS, and six at CSG2. Well locations were identified based on a triangulation technique to cover the likely upstream and downstream shallow groundwater flow at the facility locations. Well locations were adjusted slightly to try to prevent damage during the construction period. Locations of the groundwater monitoring wells are provided in Appendix D to the ESBR.

Drillers' logs were provided to RSK for review and to determine groundwater depth and whether a sufficient quantity of water was likely to be available for sample collection and subsequent testing. The logs indicated the presence of standing water in three of the four boreholes drilled at CSG1 and three of the six boreholes drilled at CSG2. All groundwater monitoring wells drilled at the PRMS were dry. No standing water was encountered in any of the wells installed at the PRMS.

Samples were first collected from wells BHC1-01 and BHC1-04 at CSG1 on Monday 5 December 2011. A second round of groundwater sampling and monitoring was undertaken in May and June 2012, including monitoring from both the proposed CSG1 and CSG2 sites. The sampling and monitoring was undertaken in accordance with the methodology outlined in Section 6.2.2.

Determinations of groundwater depth at CSG1 indicated two of the four monitoring wells (BHC1-01 and BHC1-04) to contain standing water. Two monitoring wells (BHC 2-02 and BHC 2-03) at CSG2 contained standing water at the time of the monitoring/sampling visit in May 2012.

7.6.2.2 Survey methods

The following equipment was mobilised to the sampling points:

- GPS unit
- Sample containers
- Field survey forms
- Cool box
- Nitrile gloves
- Disposable bailers
- Multiparameter probe for field measurement
- Chain of custody paperwork.

Each monitoring well was located using a site plan and recorded GPS coordinates. The monitoring wells have a lockable cover over a 50mm stand pipe with a stopcock. The cover was removed.

A dip meter was inserted into the well, and the depth of the water and the base of the monitoring well in comparison to ground level were recorded at each location.

For each monitoring well a new, dedicated clean disposable bailer was used. A line was attached to the top of the bailer, before it was inserted into the monitoring well and allowed to sink and fill with water.

Three well volumes of water were extracted using the bailer, to purge the well. Where an insufficient volume of water was available, the monitoring well was purged until the well was dry.

Following the purging process, the bailer was inserted into the well to obtain the water sample.

Once the sample had been extracted, a multi-parameter probe was utilised to obtain field measurements of temperature, pH, conductivity, dissolved oxygen, turbidity, redox potential and total dissolved solids (TDS).

The following information for each sample was noted on the field survey form.

- Unique sample reference
- GPS reference
- Photograph number
- Description of sample
- Relevant field measurements.

Four sample containers were filled: two 1-litre glass containers, one 1-litre plastic container and one 40ml vial. The following information was written on each sample container:

- A unique sample reference and job number
- Date
- Location
- Surveyor initials.

The water samples were packed securely into a cool box together with the chain of custody paperwork and the field analysis data. The cool boxes was delivered directly to Gamma Laboratory (see Section 5.2.2) in Tbilisi for testing.

Gamma Laboratory was selected because it is located in Tbilisi close to the sampling points. It is best practice to commence testing on a sample as soon as possible after the date of collection. An extended period between sampling and testing allows deterioration of the sample that can alter the results of the organic (TPH) analysis. Testing commenced as soon as the samples arrived at the laboratory, to prevent any deterioration in quality of the sample.

Gamma Laboratory analysed the samples for the parameters listed in Table 7-13. The table also shows the laboratory methodologies and detection limits.

Table 7-13: Parameters and Methods for Groundwater Analysis by Gamma

Analyte	Unit	Method Detection Limit (MDL/LOD)	Method Description	Method Reference
pH	pH unit	0.1	Hanna Multiparameter Meter (Field)	
Conductivity	uS/cm	0.001	Hanna Multiparameter Meter (Lab and Field)	
Turbidity	Nephelometric Turbidity Unit (NTU)	0.1	Hatch 2200 Turbidity Meter (Field)	
Dissolved oxygen	Mg/l	0.2	Hanna Multiparameter Meter (Lab and Field)	
TDS	ppm	0.002	Hanna Multiparameter Meter (Lab and Field)	
Sulphate (SO_4)	mg/l	0.5	Turbidimetric	ISO 9280
Chloride (Cl-)	mg/l	0.05	Titrimetric	ISO 9297
Aluminium (Al)	mg/l	0.02	Spectrofotorimetric	ISO 10566
Arsenic (As)	mg/l	0.05	Spectrofotorimetric	ISO 6595
Barium (Ba)	mg/l	0.1	Turbidimetric	SST 50:2005
Chromium (Cr)	mg/l	0.007	AAS	ISO 9174
Cadmium (Cd)	mg/l	0.001	AAS	ISO 8288
Calcium (Ca)	mg/l	0.5	AAS	ISO 7980
		2.0	EDTA titrimetric	ISO 6058
Copper (Cu)	mg/l	0.003	AAS	ISO 8288
Selenium (Se)	mg/l	0.02	Fluorescence method	GOST 19413-89
Mercury (Hg)	mg/l	0.0002	AAS	ISO 5666
Lead (Pb)	mg/l	0.01	AAS	ISO 8288
Nickel (Ni)	mg/l	0.003	AAS	ISO 8288
Iron (Fe)	mg/l	0.02	AAS	ISO 6332
Manganese (Mn)	mg/l	0.02	Spectrofotorimetric	ISO 6333
Zinc (Zn)	mg/l	0.003	AAS	ISO 8288

Analyte	Unit	Method Detection Limit (MDL/LOD)	Method Description	Method Reference
TPH (Total)	mg/l	0.04	GC-FID	EPA 418

7.6.3 Baseline Groundwater

7.6.3.1 Groundwater quality at CSG1

Monitoring wells BHC1-02 (GPS coordinates 8511531 E 4589597 N) and BHC1-03 (GPS coordinates 8511844 E 4588495 N) were dry on both the 5 December 2011 and 4 June 2012.

Table 7-14 presents the results of the field measurements and laboratory analyses of the water samples collected from the two monitoring wells (BHC1-01 and BHC1-04) that contained groundwater on 5 December 2011 and 4 June 2012. Table 7-15 provides data from the ongoing monitoring undertaken by BP(BTC) between 2005 and 2010.

Table 7-14: Results of Laboratory Analysis from Monitoring Wells at CSG1 Development Site (2011 and 2012)

Analyte	Unit	BHC1-01 (GPS coordinates E8511316, N4589348)		BHC1-04 (GPS coordinates E8512136, N4588739)	
		05/12/11	04/06/12	05/12/11	04/06/12
Geology ***		Gravel		Gravel	
Ortho. height	m	286.605		284.038	
Depth to base (05/12/11)	m	13.45	13.18	13.38	
Depth to water during drilling	m	10.0 / 11.0		10.0 / 11.0	
Depth to water relative to ground level	m	10.27	11.25	9.98	10.80
Depth to water relative to datum	m	276.335	275.335	274.058	273.238
Temperature	°C	(14.73*)	(19.05*)	(14.92*)	(18.27*)
pH		(8.07*)	(7.01*)	(7.59*)	6.87
Conductivity	uS/m	4316 (4930*)	(3457*)	3731 (4338*)	(3513*)
Dissolved oxygen	mg/l	4.87 (4.41*)	(2.38*)	4.21 (4.21*)	(2.82*)
Turbidity	NTU**	(628*)	(1214*)	(641*)	(1188*)
Redox potential	pHmV	(-61.2*)	(22.4*)	(-68.1*)	(25.9*)
TDS	ppm	2151	1729	2170	1760
Total TPH	mg/l	<0.04	<0.04	<0.04	<0.04
Sulphate	mg/l	2200	1320	1980	1480
Barium	mg/l	<0.05	<0.05	<0.05	<0.05
Calcium	mg/l	500	500	352	364
Chloride	mg/l	292.5	262.7	279.3	289.9
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Cadmium	mg/l	<0.001	<0.001	<0.001	<0.001
Copper	mg/l	<0.003	<0.003	<0.003	<0.003
Mercury	mg/l	<0.0002	<0.0002	<0.0002	<0.0002

Analyte	Unit	BHC1-01 (GPS coordinates E8511316, N4589348)		BHC1-04 (GPS coordinates E8512136, N4588739)	
Lead	mg/l	<0.01	<0.01	<0.01	<0.01
Nickel	mg/l	<0.003	<0.003	<0.003	<0.003
Iron	mg/l	24.2****	0.07	34.1****	0.13
Selenium	mg/l	<0.02	<0.02	<0.02	<0.02
Zinc	mg/l	0.01	<0.003	0.01	<0.003
Aluminium	mg/l	0.125	-	0.165	-
Manganese	mg/l	<0.04	-	<0.04	-
Chromium	mg/l	0.125 ****	<0.01	0.165 ****	<0.01

* Field measurement; ** nephelometric turbidity unit; ***based on drillers logs; ****potential erroneous result subject to re-test

Table 7-15: Historical Data from PSG1

Analyte	PSG1MW1 (8512425 E 4589172 N)						PSG1MW2 (8512276 E 4589114 N)						PSG1MW3 (8512146 E 4589463 N)						PSG1MW4 (8512173 E 4589543 N)						PSG1MW5 (8512104 E 4589207 N)					
	2005	2006	2007	2008	2009	2010	2005	2006	2007	2008	2009	2010	2005	2006	2007	2008	2009	2010	2005	2006	2007	2008	2009	2010	2005	2006	2007	2008	2009	2010
Arsenic µg/l	<1	3	3	-	-	-	2	3	<1	-	-	-	2	7	2	-	-	-	<1	3	3	-	-	-	2	5	2	-	-	-
Barium µg/l	3	32	36	-	-	-	13	21	21	-	-	-	13	18	16	-	-	-	1	44	34	-	-	-	20	42	37	-	-	-
Cadmium µg/l	<0.4	<0.4	<0.4	-	-	-	<0.4	<0.4	<0.4	-	-	-	<0.4	<0.4	<0.4	-	-	-	<0.4	<0.4	<0.4	-	-	-	<0.4	<0.4	<0.4	-	-	-
Calcium µg/l	29,020	228,600	210,000	-	-	-	201,600	290,000	230,000	-	-	-	295,900	349,800		-	-	-	13,130	60,6800	52,0000	-	-	-	340,900	615,400	540,000	-	-	-
Chromium µg/l	<1	2	3	-	-	-	<1	<1	7	-	-	-	<1	4	4	-	-	-	<1	3	2	-	-	-	2	3	4	-	-	-
Copper µg/l	<1	6	4	-	-	-	3	4	5	-	-	-	4	4	6	-	-	-	2	2	3	-	-	-	2	1	3	-	-	-
Iron µg/l	NA	<835	9500	-	-	-	14	-	-	-	-	-	24	-	-	-	-	-	152	-	-	-	-	-	47	-	-	-	-	-
Lead µg/l	<1	<1	<1	-	-	-	<1	<1	<1	-	-	-	<1	<1	<1	-	-	-	<1	<2	<1	-	-	-	<1	2	6	-	-	-
Manganese µg/l	162	5	3	-	-	-	1010	144	24	-	-	-	468	18	3	-	-	-	4	2	3	-	-	-	<1	3	2	-	-	-
Nickel µg/l	2	4	7	-	-	-	6	4	22	-	-	-	10	5	21	-	-	-	<1	7	8	-	-	-	5	5	5	-	-	-
Selenium µg/l	5	18	17	-	-	-	18	29	22	-	-	-	26	40	27	-	-	-	3	39	38	-	-	-	22	47	41	-	-	-
Mercury µg/l	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	-	-	-
Sulphate mg/l	864	800	710	-	-	-	1793	1405	1200	-	-	-	2260	1743	1500	-	-	-	285	1899	1800	-	-	-	2031	2056	1900	-	-	-
Chloride mg/l	173	155	170	-	-	-	302	243	220	-	-	-	354	279	240	-	-	-	87	322	280	-	-	-	331	334	300	-	-	-
Total TPH µg/l	<10	54	<10	230	<10	<10	<10	<10	<10	160	<10	<10	<10	<10	<10	250	<10	<10	<10	12	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Total PAH µg/l	<0.01	<0.01	<0.027	<0.1	-	-	0.769	0.615	<0.027	<0.1	-	-	<0.01	<0.01	<0.027	<0.1	-	-	<0.01	<0.01	<0.027	<0.1	-	-	<0.01	<0.01	<0.027	<0.1	-	-

The results indicate that the organic and inorganic compounds tested are generally present at concentrations below or close to the laboratory detection limit. This is generally consistent with the BTC groundwater monitoring data from the adjacent PSG1 site in the 2005 and 2010 BTC monitoring reports, and the groundwater quality reported in the SCP ESIA in 2002. It is noted that the 2011 SCPX ESIA groundwater monitoring recorded concentrations of sulphate (BHC1-01 and BHC1-04), iron (BHC1 and BHG1-04), chromium (BHC1-01 and BHC1-04) and chloride (BHC1-01 and BHC1-04) in excess of the UK/EC Drinking Water Standards (used for benchmarking purposes only). However, the concentrations of iron and chromium in the groundwater samples collected in June 2012 were recorded below the UK drinking water standards. The contrast in the concentrations of iron recorded between the 2011 SCPX baseline monitoring, the ongoing BTC programme and the 2012 SCPX baseline monitoring in the vicinity of the proposed CSG1 location suggest that the chemical result for iron and chromium obtained in December 2011 may represent erroneous results. The concentrations of sulphate and chloride are broadly consistent with the monitoring results associated with the adjacent PSG1 site and have not varied significantly between the December 2011 and the June 2012 monitoring visits.

It was noted that three of the monitoring wells recorded elevated concentrations of TPH during the 2008 visit (PSG1MW1 to PSG1MW3). However, the subsequent 2009 and 2010 monitoring rounds demonstrate that the concentrations returned to below the detection limit. No pollution incident was reported during the 2008 period and, as such, it is possible that the 2008 data represents an erroneous result.

7.6.3.2 Groundwater quality at CSG2

Geotechnical investigations at CSG2 revealed groundwater presence generally 5–15m below the surface.

Monitoring wells BHC2-01 (GPS coordinates 8403160 E 4615103 N), BHC2-04 (GPS coordinates 8404148 E 4614548 N) and BHC2-05 (GPS coordinates 8403399 E 4615348 N) were observed to be dry on 24 May 2012. In addition, monitoring well BHC2-06 (GPS coordinates 8404317 E 4615050 N) was not serviceable owing to a dysfunctional installation cover. Table 7-16 presents the results of the field measurements and laboratory analysis of the water samples collected from the two monitoring wells (BHC2-02 and BHC2-03) that contained groundwater on 24 May 2012. Table 7-17 provides data from the ongoing monitoring programme undertaken by BP (BTC) between 2006 and 2010. This has also been used to inform the baseline groundwater quality in the vicinity of CSG2 and the upper reaches of the access road. The monitoring wells used to establish a baseline from the region include TMW12, TMW13 and TMW20.

Table 7-16: Results of Laboratory Analysis from Monitoring Wells at CSG2 Development Site (24 May 2012)

Analyte	Unit	BHC2-02 (GPS coordinates E8403671, N4614564)	BHC2-03 (GPS coordinates E8404272, N4614837)
Geology***		Clay/rock (basalt)	Rock (basalt)
Ortho. height	m	1717.959	1701.632
Depth to base	m	15.42	20.3
Depth to water relative to ground level	m	10.08	7.05
Depth to water relative to datum	m	1707.879	1694.582
Temperature	°C	11.2	9.48
pH		6.92	7.09
Conductivity	uS/m	109	108

Analyte	Unit	BHC2-02 (GPS coordinates E8403671, N4614564)	BHC2-03 (GPS coordinates E8404272, N4614837)
Dissolved oxygen	mg/l	0.77	1.35
Turbidity	NTU**	758	427
Redox potential	pHmV	-8.9	-65.9
TDS	ppm	55	91
Total TPH	mg/l	<0.04	<0.04
Sulphate	mg/l	5.6	6.0
Barium	mg/l	<0.05	<0.05
Calcium	mg/l	17.2	12.0
Chloride	mg/l	15.62	11.36
Arsenic	mg/l	<0.01	<0.01
Cadmium	mg/l	<0.001	<0.001
Copper	mg/l	<0.003	<0.003
Mercury	mg/l	<0.0002	<0.0002
Lead	mg/l	<0.01	<0.01
Nickel	mg/l	<0.003	<0.003
Iron	mg/l	5.6	2.5
Zinc	mg/l	0.009	<0.03
Chromium	mg/l	<0.01	<0.01

* Field measurement; ** nephelometric turbidity unit; *** based on drillers logs

Table 7-17: Historical Analyses of Groundwater in vicinity of CSG2 (2006–2010)

Analyte Date	Groundwater Monitoring Location TMW13				Groundwater Monitoring Location TMW20			
	2006	2007	2008	2010	2006	2007	2008	2010
pH	8.15	8.13	Dry	<0.2	No test	Dry	Dry	<0.2**
Total TPH (µg/l)	<10	<10	Dry	<10	No test	Dry	Dry	<10
Total PAH (µg/l)	0.437	<0.027	Dry	-	No test	Dry	Dry	-
Sulphate (soluble) (µg/l)	<3	10	Dry	-	No test	Dry	Dry	-
Calcium (dissolved) (µg/l)	59,000	92,000	Dry	-	No test	Dry	Dry	-
Chloride (mg/l)	<1	1	Dry	-	No test	Dry	Dry	-
Manganese (dissolved) (µg/l)	481	750	Dry	-	No test	Dry	Dry	-
Magnesium (dissolved) (µg/l)	10,640	16,000	Dry	-	No test	Dry	Dry	-
Iron (total) (µg/l)	23,880	13,000	Dry	-	No test	Dry	Dry	-
Potassium (dissolved) (mg/l)	1.7	3	Dry	-	No test	Dry	Dry	-
Sodium (dissolved) (mg/l)	12.3	22	Dry	-	No test	Dry	Dry	-
Nitrate as NO_3 (mg/l)	2.2	<0.3	Dry	-	No test	Dry	Dry	-
Total alkalinity as $CaCO_3$	245	440	Dry	-	No test	Dry	Dry	-

** Naphthalene only

A comparison of the results from both the ongoing BP (BTC) monitoring and the more recent SCPX baseline monitoring summarised in Table 7-16 and Table 7-17 against the

UK/EC drinking water standards (used for benchmarking purposes only) indicate that iron (recorded during the ongoing BTC monitoring programme and recent SCPX baseline monitoring) and manganese (recorded during the ongoing BTC monitoring only) to be in excess of these threshold criteria. These concentrations are likely to be consistent with the local hydrogeological characteristics and therefore influenced by the mineralogy of the surrounding geology.

7.6.3.3 Groundwater quality at the PRMS

The hydrogeological section on the SCP ESIA places the PRMS within the tectonically fissured Akhaltsikhe artesian basin, in which the migration of carbonate acid and enriches the groundwater with a chemical trace elements and gaseous composition (carbon dioxide or nitrogen).

A subsequent monitoring visit undertaken on 6 June 2012 recorded the absence of groundwater within the monitoring wells (see Table 7-18).

Table 7-18: Results of Groundwater Conditions Encountered at Monitoring Well Locations (6 June 2012)

	BHA81-01 (GPS coordinates E8319555.068, N4610114.075)	BHA81-012 (GPS coordinates E8319683.935, N4609948.155)	BHA81-03 (GPS coordinates E8319178.797, N4609975.510)	BHA81-04 (GPS coordinates E8319646.989, N4609702.986)
Geology Type*	Rock (basalt)	Rock (basalt)	Silty clay	Silt/weathered rock
Depth to water relative to ground level	Dry	Dry	Dry	Dry
Depth to base (m)	10.0	9.95	10.48	10.26

* Based on drillers logs

In addition to the information above, groundwater quality data in the form of chemical test results from the borehole drilled at Area 80 for the potable water supply of the accommodation facility was provided by BP for review (2009 and 2012 data). With the exception of marginally elevated sulphate concentrations and where a direct comparison could be made, determinands were not reported in excess of the UK/EC drinking water standards (for benchmarking purposes only). A summary of the results is provided below in Table 7-19.

Table 7-19: Results of Groundwater Conditions Encountered at Area 80 Potable Water Supply Wells (During Drilling)

Analyte	2009 Results	2012 Results
Ammonium / Ammonia Nitrogen mg/l	0.4	0.054
Hydrocarbonate µg/l	354	268.4
Calcium mg/l	52	53.2
Magnesium mg/l	34	16.9
Potassium mg/l	4.39	2.10
Copper mg/l	-	0.107

Analyte	2009 Results	2012 Results
Iron mg/l	-	0.055
Zinc mg/l	-	0.013
Copper mg/l	-	0.107
Manganese mg/l	-	0.0204
Nickel mg/l	-	0.10
Lead mg/l	-	0.065
Suspended solids mg/l	-	5.4
Chloride mg/l	53	110.3
Sulphate mg/l	120	358.2
Total coliforms, in 250ml sample	-	Not detected
E. coli, in 250ml sample	-	Not detected

7.6.4 Groundwater Sensitivities

The following subsections summarise the components of the baseline conditions that, in the project context, are considered the most important based on the anticipated impacts of the project development.

7.6.4.1 Groundwater sensitivities at KP0 to KP56 and CSG1

With the exception of the groundwater data collected from boreholes at CSG1 and PSG1, no specific monitoring has been undertaken on the proposed SCPX ROW. In terms of water-bearing strata, the Early Quaternary Alluvial Sediments underlie the majority of the route from KP0 to KP55, with localised recent alluvial sediments of the Mtkvari and Algeti rivers. Deposits of the Miocene-Pliocene volcanogenic-continental facies outcrop in the far western section of the proposed pipeline expansion route and in the vicinity of the proposed pigging station.

Given the depth of pipeline construction and the hydraulic link identified between aquifer units, the following water-bearing horizons are considered most sensitive in the context of this study:

- Riverbed and floodplain recent alluvial sediments (associated with the River Mtkvari, Algeti and Khrami)
- Early Quaternary alluvial sediments: shingles-pebbles, friable conglomerates, loams, sandy loams.

The results of samples in the vicinity of CSG1 indicate that the groundwater is not impacted by organic contamination. However, it is noted that concentrations of sulphate, chloride, chromium and iron were encountered in excess of the UK/EC Drinking Water Standards during the most recent sampling. These samples were collected from the aquifer within the early Quaternary alluvial sediments.

7.6.4.2 Groundwater sensitivities at CSG2

It is noted that groundwater horizons connected to the lava cover at the proposed construction site of CSG2 are characterised by a fairly stable groundwater regime. This is probably a result of the high permeability of the strata and the regulating influence of lakes. The abundance and importance of this resource for potable supplies, the high-quality potable properties and high permeability of the formation indicates the principal groundwater sensitivity to be the Upper Pliocene–Middle-Quaternary lava formation (Tsalka Suite).

The groundwater results obtained during a single round of groundwater monitoring from monitoring wells installed on the proposed site itself and three existing groundwater monitoring results in the vicinity of CSG2, indicate that the groundwater beneath the site is unlikely to be impacted by contamination. The results of the inorganic determinands that are consistently in excess of UK/EC drinking water standards (iron and manganese) are likely to be consistent with the local hydrogeological characteristics and therefore influenced by the mineralogy of the surrounding geology.

7.6.4.3 Groundwater sensitivities at the PRMS

The monitoring wells located at the PRMS site, installed as part of the geotechnical investigation for the SCPX Project, did not contain any groundwater as the depth to the shallowest groundwater horizon underlying the site is understood to be in the region of 80m below ground level in the Upper Miocene-Lower Pliocene (Kisatibi series) lava deposits. Given the depth to groundwater, this water-bearing horizon is not considered to be sensitive to the proposed construction at PRMS.

A review of the chemical test data from the borehole supplying potable water for the existing accommodation facility indicate that, where a direct comparison could be made, determinands are generally not present in excess of the UK/EC drinking water standards.

7.7 Ecology

This section describes the flora and fauna present in the proposed SCPX pipeline route and at the Facilities.

This section is based largely on the results of fieldwork undertaken over the period May to September 2011.

7.7.1 Information from Desktop Literature Survey

The following recognised publications were used to identify and classify plants and habitats crossed along the proposed pipeline route:

- Bakradze, M. A. (1977) ’Simpatrical Populations of Parthenogenetic and Bisexual Species of Rock Lizard of Genus Lacerta in Georgia’, PhD thesis, Tbilisi State University and S. N. Djanashia State Museum of Georgia, Tbilisi: 146 p.
- Bakradze, M. A., Vedmederya, V. I. (1979) ’Specificity of Distribution of Reptiles of Lesser Caucasus within Georgia (Meskhet-Javakheti)’, in *Some Groups of Animals of Arid Regions of Caucasus*, Metsniereba, Tbilisi:146-156.
- Bannikov, A. G., Darevskyi, I. S., Ishchenkov,. G., Rustamov, A. K., Shcherbak, N. N. (1977) ’Manual for Identification of Amphibians and Reptiles of USSR’, Publishing House "Prosveshenie", Moscow: 411c.
- Bukhnikashvili, A. (2004) ’Cadastre of Small Mammals (Insectivora, Chiroptera, Lagomorpha, Rodentia) of Georgia’, Publishing House ’Universal’, Tbilisi: 144 p.
- Bukhnikashvili, A., Kandaurov, A., Natradze, I. (2007) ‘Otter (*Lutra lutra*) in Georgia – 1996-2006 years’, in Collection ’Mammals of Mountain Territories’ (edited by Rojhkov, V. V. and Tembotova, F. A.), Materials of International Conference 13–18 August 2007, Association of Scientific Publishing Houses KMK, M.: 56–60.
- Bukhnikashvili, A., Kandaurov, A., Natradze I. (2008) ’Bats Conservation Action Plan for Georgia’, Publ. Universal, Tbilisi: 102 pp.
- Bukhnikashvili, A., Natradze, I. (2008) ’Geoffroy’s Bat (*Myotis emarginatus*) in Georgia. Present Status of the Species’, Proceedings of the Institute of Zoology, “Metsniereba”, Tbilisi, Vol. XXIII: 177–179.
- Bukhnikashvili, A. K., Kandaurov, A. S., Natradze, J.M. (2004) ‘Records of Bats in Georgia over the Last 140 Years’, *Plecotus* M, № 7: 41–57.

- Chkhikvishvili, I. D. (1938) ‘Materials about Ornitofauna of Javakheti’, Tbilisi: 305–328.
- Gagnidze, R. (2005) *Vascular Plants of Georgia. A Nomenclatural Checklist*. Tbilisi, Publishing House “Universali”, 247 p.
- Gurielidze, Z. (1996) ‘Large Mammals’, Publication - Biodiversity Country Study of Georgia, Tbilisi: 74–82.
- Janashvili, A. (1963) ’Animals of Georgia’, *Vertebrata*, Publication of National Academy of Georgia, Tbilisi, Vol. III: 458 p.
- Jordania, R. G. (1960) ‘Amphibians Collection Catalogue of Zoological Department of S. N. Djanashia Georgian State Museum’, *Bulletin of S. N. Djanashia State Museum of Georgia*, XX-A: 160–170.
- Jordania, R. G. (1962) ‘Ornitophauna of Lesser Caucasus (in range of republic of Georgia)’, Tbilisi: 288p.
- Kutubidze, M. (1985) *Manual for Identification of Birds in Georgia*, TSU Publishing House, 645p.
- Makashvili, A. (1991) *The Botanical Dictionary*. Tbilisi, Publishing House “Metsniereba”, 246 p.
- Muskhelishvili, T. A. (1970) *Reptiles of Eastern Georgia*, Tbilisi.
- Nakhutsrishvili, G. (1999) *The Vegetation of Georgia (Caucasus)*. Braun-Blanquetia, vol. 15.
- Red List of Georgia (2006), Tbilisi
- Sikmashvili, N. M. (1975) ’Studies of Batracho- and Herpetofauna of Lesser Caucasus (Meskhet-Djavakheti)’, *Bulletin of State Museum of Georgia*, 28-A: 36–402.
- Tarxnishvili, D. (2002) ’Herpetological Fauna of Javakheti Plateau in Southern Georgia’, *Proceedings of the Institute of Zoology*, Vol. XXI: 262–268.
- Tarxnishvili, D., Kandaurov A., Bukhnikashvili A. (2002) ‘Declines of Amphibians and Reptiles in Georgia during the 20th Century: Virtual vs. Actual Problems’, *Zeitschrift für Feldherpetologie*, № 9: 89–107.

The desktop search undertaken to identify records of species which could be present within 250m of the proposed route (a 500m survey corridor) collected 198 records of animals that could potentially use the habitats along the route. The most important/protected of these species are included in Table 7-20.

Table 7-20: Key Species Identified in Desktop Literature Survey

Species	Scientific Name	Group	National Status	Other
Four-lined snake	*Elaphe quatuorlineata*	Reptile	Not protected but rare	IUCN cat. NT*
Mediterranean tortoise	*Testudo graeca*	Reptile	Georgian Red List	IUCN cat. VU*
Snake-eyed lizard	*Ophisops elegans*	Reptile	Georgian Red List	IUCN cat. VU*
Syrian spadefoot toad	*Pelobates syriacus*	Amphibian	Georgian Red List	IUCN cat. EN*
Red-necked grebe	*Podiceps grisegena*	Bird	Georgian Red List	Ramsar and Bonn Convention
Black stork	*Ciconia nigra*	Bird	Georgian Red List	Ramsar and Bonn Convention
White stork	*Ciconia ciconia*	Bird	Georgian Red List	Ramsar and Bonn Convention
Ruddy shelduck	*Tadorna ferruginea*	Bird	Georgian Red List	Ramsar and Bonn Convention

Species	Scientific Name	Group	National Status	Other
Egyptian vulture	*Neophron percnopterus*	Bird	Georgian Red List	Ramsar and Bonn Convention
Eurasian griffon vulture	*Gyps fulvus*	Bird	Georgian Red List	-
Eurasian black vulture	*Aegypius monachus*	Bird	Georgian Red List	Ramsar and Bonn Convention
Long-legged buzzard	*Buteo rufinus*	Bird	Georgian Red List	Ramsar and Bonn Convention
Greater spotted eagle	*Aquila clanga*	Bird	Georgian Red List	Ramsar and Bonn Convention
Imperial eagle	*Aquila heliaca*	Bird	Georgian Red List	Ramsar and Bonn Convention
Lesser kestrel	*Falco naumanni*	Bird	Georgian Red List	Ramsar and Bonn Convention
Red-footed falcon	*Falco vespertinus*	Bird	Georgian Red List	Ramsar and Bonn Convention
Saker falcon	*Falco cherrug*	Bird	Georgian Red List	Ramsar and Bonn Convention
Grey crane	*Grus grus*	Bird	Georgian Red List	Ramsar and Bonn Convention
Brandt's hamster	*Mesocricetus brandtii*	Mammal	Georgian Red List	IUCN cat. NT*

*Endangered (EN): a taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU): a taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.
Near Threatened (NT): a taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

Monitoring data from post-construction surveys of the original SCP pipeline (Biodiversity Monitoring Programme, Faunal Component, 2005–2009) were also reviewed. The results of these are summarised in Table 7-2. Monitoring (and original SCP/BTC baseline) surveys identified the following species along the SCP pipeline route:

- Snake-eyed lizard (surveys finished in 2007 as population was considered stable)
- European marsh turtle (found throughout all surveys)
- Caspian terrapin (found throughout all surveys)
- Syrian spadefoot toad (recorded 2004–2008 but none found in 2009)
- Brandt's hamster (recorded throughout survey period along SCP route)
- Common otter (although not recorded in the sections of river crossed by the SCPX route).

Table 7-21: Results of Post-construction Surveys Undertaken along the SCP/BTC Pipeline (2005–2009)

Ecological Receptor	2005	Population Trend from Previous Year)	2006	Population Trend from Previous Year)	2007	Population Trend from Previous Year)	2008	Population Trend from Previous Year)	2009	Population Trend from Previous Year)
Faunal Surveys										
Spadefoot toad (*Pelobates syriacus*)	Present		Present	+	Present	-	Present	-	Not present but absence not related to pipeline activities	
Otter (*Luta lutra*)	Present		Present	+	Present	+	Present	Same as previous year	Present	Same as previous year
Snake-eyed lizard (*Ophysops elegans*)	Present		Present	+	Present	-	Removed from survey as abundance confirmed			
European marsh turtle (*Emys orbicularis*)	Present		Present	+	Present	-	Present	+	Present	-
Caspian terrapin (*Mauremis caspica*)	Present		Present	-	Present	-	Present	+	Present	-
Brandt's hamster (*Mesocricetus brandti*)	Present	-	Present	-	Present	-	Present	-	Present	-
Dragonflies and damselflies	Present		Present	+	Present	+	Present	-	Present	-
Nesting populations of waterfowl: little egret (*Egretta garzetta*)	Present	+	Present	+	Present	+	Present	-	Present	+
Nesting populations of waterfowl: cattle heron (*Bubulcus ibis*)	Present	-	Present	-	Present	+	Present	-	Present	+
Nesting populations of waterfowl: night heron (*Nycticorax nycticorax*)	Present	-	Present	-	Present	+	Present	-	Present	+

Ecological Receptor	2005	Population Trend from Previous Year)	2006	Population Trend from Previous Year)	2007	Population Trend from Previous Year)	2008	Population Trend from Previous Year)	2009	Population Trend from Previous Year)
Wintering migrating birds	Present	+	Present	numbers +, diversity -	Present	numbers +, diversity -	Present	numbers +, diversity -	Present	numbers +, diversity -
Flora Surveys (numbers/fertility and vitality index) N.B. First symbol represents changes in numbers, second symbol represents changes in species diversity										
Pasqueflower *(Pulsatilla georgica)* population 1		+/same as previous year		+/-		+/-		-/-		-/-
Pasqueflower *(Pulsatilla georgica)* population 2		-/-		-/-		-/+		+/-		-/-
Frog orchid *(Coeloglossum viride)* population 1		-/+		+/+		-/-		same as previous year /same as previous year/+		same as previous year/+
Frog orchid *(Coeloglossum viride)* population 2		-/+		-/-		-/-		-/+		-/-
Frog orchid *(Coeloglossum viride)* population 3		-/same as previous year		-/-		-/-		-/ same as previous year /same as previous year		-/-
Frog orchid *(Coeloglossum viride)* population 4		-/same as previous year		+/-		-/ same as previous year		-/ same as previous year /same as previous year		+/-
Traunsteinera *(Traunsteinera sphaerica)* population 1		-/+		-/+		-/-		-/-		-/-
Traunsteinera *(Traunsteinera sphaerica)* population 2		-/+		-/+		-/+		-/-		-/-
Sea buckthorn *(Hippophaë rhamnoides)*		same as previous year /same as previous year		same as previous year /same as previous		same as previous year /same as previous year		same as previous year /same as previous year		same as previous year /same as previous year

Ecological Receptor	2005	Population Trend from Previous Year)	2006	Population Trend from Previous Year)	2007	Population Trend from Previous Year)	2008	Population Trend from Previous Year)	2009	Population Trend from Previous Year)
				year						
Globe-daisy *(Globularia trichosantha)* population 1		-/+		-/+		+/-		+/-		+/+
Globe-daisy *(Globularia trichosantha)* population 2		-/+		-/+		-/-		+/-		+/+

As shown in the table above, the post-construction monitoring surveys identified no long-term adverse effects on any ecological receptors due to construction or operation of the original SCP pipeline. SCP/BTC post-construction monitoring surveys have shown that the reinstated areas of the route have become vegetated and floral species diversity is nearly back to pre-construction levels (relevant monitoring points to SCPX are GE001, 002, 003, 004 and 009). The post-construction monitoring surveys also imply that there were no significant impacts on faunal species relating to disturbance or habitat loss. However, as the species are known to be present in areas close to the SCPX route, the post-construction monitoring surveys were used to guide baseline surveys for the new route. The aim of these surveys was to identify any receptors that could have moved into the proposed working area (and be directly injured during construction) or any new areas of 'valuable' habitat that were not affected by SCP.

7.7.1.1 Protected areas and other sites of potential significance

As part of the SCP Project, surveys were undertaken to identify 'sensitive' sites near the pipeline ROW (but not directly crossed by the route). Relevant to the SCPX Project are surveys that were undertaken at the Jandari Lake (near KP0), Mtkvari River Island (KP30) and Kumisi Lake (KP44). The two lakes support wintering bird species and the island supports nesting birds. SCP post-construction surveys undertaken in 2005–2009 showed no significant changes in bird numbers or the compositions of the assemblages present. At the two lakes there were slight fluctuations throughout the whole survey period (long after pipeline construction) and so surveyors attributed this to natural changes in bird numbers as it could not be linked with pipeline operation. No surveys were proposed for migratory species, as it was considered that the SCPX Project would not be likely to have a significant effect as birds will be in transit.

No significant adverse impacts were observed at these sites following SCP pipeline construction. It was considered that the SCPX Project would cause comparable disturbance and require similar land take therefore surveys were not undertaken.

The SCPX scoping study identified the Ktsia-Tabatskuri managed reserve 10km away from the proposed CSG2 site. It was established to protect a unique high-mountain wetland ecosystem (with associated floral and faunal species). Owing to the distance of the reserve from the CSG2 site and the fact that the habitats on the CSG2 site could not support the features protected by the reserve, no surveys were undertaken there for the SCPX Project.

7.7.2 Data Gaps and Field Survey Methods

7.7.2.1 Data gaps

Two sections along the SCPX route (at KP25 and KP28.5) diverge from the SCP route by more than 50m). These areas were not covered in the habitat surveys for the SCP ESIA.

The information from the SCP ROW surveys of 2000 needed to be updated to produce a robust ecological baseline description for the SCPX Project.

7.7.2.2 Surveys undertaken

Ecological surveys along the SCPX route (listed in Table 7-22) comprised:

- A phase 1 habitat survey (also looking for signs of faunal activity) of KP0 to KP56
- A phase 1 habitat survey of the proposed CSG1 location (KP4)
- A phase 1 habitat survey and further detailed surveys of the proposed CSG2 location and its associated access road (KP142)
- A phase 1 habitat survey of the proposed CSG2 access road camp location
- A phase 1 habitat survey of the PRMS (KP246)
- Detailed amphibian and reptile surveys of the irrigation channels situated between KP0 and KP12 and of suitable habitats between KP30 and KP54

- Riparian habitat and macroinvertebrate surveys at the Mtkvari East River crossing (KP30) and the Algeti River crossing (KP55)
- A macroinvertebrate survey at the Aji River crossing (KP27)
- A detailed tree inventory at the Algeti River Crossing (KP54)
- Fish surveys of the Aji River Crossing (KP27) and the Algeti River crossing (KP55).

The phase 1 habitat surveys of the SCPX pipeline route were undertaken 27 May–2 June, which was considered the optimal time for the survey. It encompassed the mass vegetation period and coincided with a period of high animal activity, allowing signs indicative of animal presence or activity to be recorded. In 2011, the very cold and wet early spring period delayed vegetation, so surveys undertaken any earlier than this would not have produced reliable results.

Phase 1 surveys were undertaken at CSG2 1–7 June (flora – an optimal time for spring-flowering species), 2–4 July (fauna) and 7–9 July (faunal – optimal time for spring breeding of many species and coincides with a period of high activity for all animal species). Faunal surveys, timed to coincide with autumn bird-migration periods and another peak in animal activity, were then repeated 24–27 August and finished on 29 August 2011.

Phase 1 survey of the CSG2 access road construction camp was undertaken on the 14 June 2012.

At the PRMS, phase 1 fauna surveys were undertaken 13–15 July and flora surveys were undertaken 8–12 June. Again, given the location of the PRMS in Georgia, these survey times were considered optimal to detect the species (both plant and animal) that could be present.

The original SCP Project highlighted the potential for important amphibian and reptile species to be present in irrigation channels (and the Mariin channel) located between KP0 and KP12. In addition, between KP30 and KP54, the SCP Project post-construction monitoring surveys identified populations of the Red List species snake-eyed lizard in 2004 and Syrian spadefoot toad up to 2007, when the surveys finished. These areas were targeted for detailed amphibian surveys undertaken from 7 June to 15 June 2011, a peak period in amphibian activity (coinciding with breeding of the Syrian spadefoot toad).

The riparian surveys of the Mtkvari and Algeti were undertaken to coincide with mass flowering periods and spring peaks in animal activity. The botanical surveys were undertaken 4–5 June (Mtkvari) and 3–6 June (Algeti). The faunal surveys were undertaken 3–6 June (Mtkvari and Algeti). These times of year were considered optimal given the types of plants and animals expected to be present at this location. The detailed tree inventory at the Algeti was carried out on 19–21 August 2012.

Macroinvertebrate surveys were undertaken between 18 and 20 May (Mtkvari) and between 24 and 26 May (Algeti), then repeated 31 August–1 September (Mtkvari) and 6–7 September (Algeti). These times were considered optimal as the first survey coincided with a period when benthic communities flourish and the second was undertaken at a time when environmental stressors affect the aquatic environment (dictating the invertebrate assemblage present, i.e. which ones could tolerate the resultant water conditions, and therefore allowing assumptions to be made regarding water quality). A macroinvertebrate survey was also undertaken at the Aji in August 2012.

Fish surveys were undertaken at the Algeti at the same time as both the Algeti macroinvertebrate surveys. The first survey was undertaken before the spawning season to determine the baseline adult fish stock. The second survey took place after spawning to identify both juvenile and adult fish. A post-spawning fish survey was undertaken at the Aji in September 2012, which again allowed for the identification of both juvenile and adult fish.

Table 7-22: Survey Timings and Locations

Survey	Location	Survey Period
Reptile/amphibian surveys	Irrigation channels between KP0 and KP12	7–15th June
Amphibian survey	Mariin Channel and associated swamp area (KP12)	7–15th June
Pond survey (revisit known spadefoot ponds to see if they still exist)	Near KP40	7–15th June
Snake-eyed lizard survey	Various locations between KP30.4 and 54.2	7–15th June
Spring botanical survey	CSG2 and associated access road (KP142)	8–12 June
Early zoological summer survey	CSG2 and associated access road (KP142)	7–9 July
Late summer-early autumn zoological survey	CSG2 and associated access road (KP142)	24–27, 29 August
Phase 1 survey (flora and fauna)	PRMS	8–12 June and 13–15 July
Macroinvertebrate surveys	Mtkvari East River crossing and associated inlet (KP30)	Spring: 18 and 20 May Summer: 31 August–1 September
Macroinvertebrate survey	Aji River (KP27)	August 2012
Macroinvertebrate and fish surveys	Algeti River (KP54)	Spring: 24–26 May Summer: 6–7 September
Fish survey	Aji River (KP27)	September 2012
Phase 1 survey (flora and fauna)	CSG1 and entire SCPX route in Georgia (KP0–KP56)	27 May–2 June
Riparian habitat survey	Mtkvari East River crossing and associated inlet (KP30)	Botanical: 4–5 June Faunal: 3–6 June
Riparian surveys at the Algeti crossing	Algeti River (KP54)	Botanical and Faunal: 3–6 June
Tree inventory	Algeti River (KP54)	19–21 August (2012)
Phase 1 survey (flora and fauna)	CSG2 access road construction camp	14 June (2012)

7.7.2.3 Phase 1 habitat survey with a faunal walkover – Pipeline

Flora

The botanical surveyors walked the route of the proposed SCPX pipeline loop and recorded all habitats within a 100m corridor (50m either side of the pipeline centre line).

Habitats were recorded and classified by use of at least one quadrat in each new habitat crossed. The quadrats were chosen to record ‘representative’ habitats, so it did not matter where they were within the habitat as long as they were in the ROW. The size of the quadrats depended on the habitats encountered in the field and followed the recommendations made by Tuxen (1970) and the UK NVC system (see Table 7-23).

Table 7-23: Area (m^2) of Permanent Plots for Different Habitats

Habitat Type	Area/m^2
Meadows	4
Wetlands	4
Scrub	25
Forests	100

In addition to the quadrats located within the ROW, reference quadrats were also placed in corresponding habitats outside the ROW (which would not be affected by pipeline construction) to collect data for post-construction monitoring of reinstatement works.

The botanists used red and white hazard tape to demarcate the limits of the quadrat and then recorded the location of the four quadrat corners using a GPS handset. (Accuracy of the GPS handsets is dependent on the number of satellites in view at the time of the reading. The accuracy varied between 2m and 3m, and was 4m in rare cases. Accuracy was recorded at each reading).

Once survey locations had been chosen:

- Each quadrat location was marked on field maps and the GPS coordinates of the four corners were recorded (using a GPS handset)
- In each plot, the following structural features were recorded: community type, height of herb layer (cm), coverage of herb layer (%) and the number of higher plant species present
- The coverage of moss layer was recorded (if present)
- For all plants within the plots, phenological phases were recorded (vegetative, Veg; flowering, Fl; fructification, Fr; senile, S). Cover (%) of vegetation (higher plants) was estimated as the percentage of ground occupied by a perpendicular projection of the aerial parts of the species
- Cover was measured by the method of visual estimation using the 10-point Domin scale of cover-abundance (see Table 7-24) to avoid underestimation of the importance of species with scattered individuals.

Table 7-24: Phase 1 Domin Scale of Cover-Abundance

Points	Cover-Abundance
+	One individual, reduced vigour
1	Rare
2	Sparse
3	<4%, frequent
4	5–10%
5	11–25%
6	26–33%
7	34–50%
8	51–75%
9	76–90%
10	91–100%

During the survey, surveyors specifically looked for Georgian Red List Species identified during the literature review and *Iris iberica* and *Tulipa biebersteiniana,* two important species endemic to the region that could be found in the area crossed by the pipeline. *Iris iberica* is endemic of East Transcaucasia (Georgia and Azerbaijan), and *Tulipa biebersteiniana* is a rare species of Georgian flora known from only very few localities in East Georgia.

Fauna
The habitat surveyors walked the entire SCPX pipeline loop route, starting at KP0 and heading west. They assessed the potential of the habitats crossed within the 100m corridor for their ability to support amphibians, reptiles, birds, mammals and invertebrates (particularly with regard to protected/rare/endemic animal species).

Ornithologists reviewed aerial photographs to identify sites likely to be used by birds. The surveys were undertaken during the breeding season to facilitate the observation of nests, and avoided wet and windy weather when birds are less active. The ornithologists arrived at site before the other surveyors as the presence of other ecologists walking around the site can scare away birds before they are recorded. The ornithologists:

- Undertook a preliminary review of the site on arrival to identify potential bird resting, breeding and feeding areas
- Walked transects of fixed length (which was determined in the field and noted on the daily field recording sheet) and recorded all birds seen within a set distance from the transect (usually done by choosing a natural landmark when on site) to estimate population densities
- Looked for evidence of presence on the ground (e.g. nests)
- Recorded the start and end points of all transects on GPS handsets and on field maps.

Aerial photographs were reviewed to identify ponds and wetland habitats that can support amphibians. The surveyors discussed the botanists' findings in these areas. Where suitable habitats were encountered:

- The surveyors recorded GPS coordinates of all transects (start and end points of features traversed) and noted the size of the feature and variables such as water quality, permanence of feature, vegetation present and time taken to walk the perimeter
- The surveyors walked the entire perimeter of the feature (where access permitted), searching it for evidence of breeding (presence of spawn, larvae, tadpoles or adult individuals). If none could be seen (owing to dense vegetation in the water body) then a dip net was also used to try to capture amphibians. Any caught individuals were identified and immediately returned to the water body.

The surveyors identified habitats within the survey that are suitable to support reptile species. In areas deemed suitable for reptiles, surveys were undertaken during the early morning (after bird surveys have been completed) and afternoon on suitable days, avoiding the hottest times of the day. Surveyors did not handle any dangerous snakes. All identification was done purely through visual observation. The surveyors:

- Carried out an initial walkover
- Walked quietly along pre-determined transects with start and end points recorded on a GPS handset and hand-drawn on a map, and sought to verify reptile presence by observation of individuals, shed skin, shell, presence of eggs, etc.
- Searched a pre-set number of refuges (the number checked was determined based on the number of refuges noted during the initial walkover). While walking the transects, surveyors walked and surveyed an area 5m either side of the transect route.

From aerial photographs, the surveyors identified habitats within the survey that are suitable to support mammal species. Once the bird surveys had been completed, the surveyors:

- Undertook a preliminary review of the habitats present to ground-truth aerial photographs and judge which mammal species (identified during the desk-top review) the habitats could support
- Walked transects throughout the survey area (the length of each transect depended upon the type and extent of habitat being surveyed). All suitable areas were thoroughly searched and the time spent surveying (and distance walked) was recorded in the field data sheet
- Identified mammal species by direct observation or identification of tracks, droppings, excavations, feeding damage (gnawed nuts) and resting locations such as sets, holts or nests

- Detected the presence of small mammals by the presence of holes, high-pitched squeaks and turning over objects to expose runs.

A general zoologist visited all the habitats that had potential to support rare/valuable invertebrates. The zoologist:

- Searched discrete habitat areas (<10m²) fully
- Recorded any individuals observed or found under refuges on standard field survey forms.

7.7.2.4 Phase 1 habitat survey of CSG1 location

The proposed CSG1 location was visited during the phase 1 habitat survey and again during the amphibian/reptile walkover of the irrigation channels. Transects and quadrats were used as described in Section 7.7.2.3 to record the habitats present and identify those with the potential to support important species.

7.7.2.5 Phase 1 habitat survey and further detailed surveys of proposed CSG2 location and associated access track (KP142)

Phase 1 habitat surveys within the proposed CSG2 location were undertaken along transects (running across the site perpendicular to the SCPX route) spaced 100m apart. Quadrats were placed along these transects to gather representative data for each of the habitats present. Quadrats were placed where habitats change (in the opinion of the surveyor) but were spaced at no more than 200m intervals along the transects. A quadrat was then set up in representative habitats (reflecting the dominant habitats within the site) outside of the CSG2 location for use during post-construction monitoring. Data inside the quadrat (and the size of the quadrat) was then recorded in the same manner as described in Section 7.7.2.3.

Botanical surveys along the access road proceeded in a similar fashion to surveys along the pipeline (as both are linear structures). Surveys concentrated on the access track and a buffer 50m either side. Quadrats were placed on the track where it crosses different habitats (in the opinion of the surveyor). As the track will be a permanent structure, it was not considered necessary to place a reference ‘control’ quadrat perpendicular to the survey quadrat but outside of the future working area (as there will be no reinstatement to monitor). However, within the 100m survey corridor, the botanists took additional samples to show areas of poorer botanical value that the track could be routed through. Once survey locations have been chosen, surveys were undertaken following the methodology detailed in Section 7.7.2.3.

Faunal surveys were undertaken to assess the habitats for amphibians, mammals, birds, invertebrates and reptiles as detailed Section 7.7.2.3. Following the habitat assessment, transects were walked throughout the CSG2 site and along the access track to record the animal species present. The coordinates of all transects (and the corners of all quadrats) were recorded using a GPS handset with 2–3m accuracy.

7.7.2.6 Phase 1 habitat survey of CSG2 access road construction camp

A Phase 1 Habitat Survey was carried out using the methodology described in Section 7.7.2.3 except that quadrats were taken within representative habitats inside the boundary of the proposed camp only. In addition, an ornithological survey was also carried out by walking transects on the construction camp area.

7.7.2.7 Phase 1 habitat survey of PRMS (KP246)

Flora and fauna surveys were undertaken at the PRMS using the same methods as those employed for the proposed CSG2 location (see Sections 7.7.2.5).

7.7.2.8 Detailed amphibian and reptile surveys (KP0–KP12 and KP30–53)

All habitats within the survey area (either the entire pond being surveyed or the 100m stretch of ditch) were assessed on their potential to support amphibians (this was because they might have dried since previous surveys along the BTC/SCP route). The surveys focussed on 100m sections of the ditches/irrigation channels (50m either side of the proposed crossing point). If the features were present, and still considered suitable for amphibians, then the survey team applied the amphibian survey methods described in Section 7.7.2.3.

Between KP30 and KP54 habitat assessments and transects as described in Section 7.7.2.3 targeted the Syrian spadefoot toad and snake-eyed lizard particularly.

7.7.2.9 Riparian and macroinvertebrate surveys of Aji River Crossing (KP27), Mtkvari East River crossing (KP30) and Algeti River crossing (KP55)

Riparian survey[3]

The same botanical and faunal surveys described in Section 7.7.2.4 were carried out in the riparian survey area. The riparian surveys of the Mtkvari and Algeti rivers covered the perceived area of influence for pipeline construction at the river crossing locations: 100m along the pipeline route either side of the river crossing, 200m upstream and 200m downstream.

The tree inventory carried out in August 2012 at the Algeti River Crossing focussed on identifying precise locations of well-established (exceeding 3m in height) individual trees included in the Georgian Red List (GRL) within the SCPX Pipeline ROW. Well-developed trees comprising the first forest layer, which are important for forest closeness and habitat integrity, were also recorded. Height, diameter at breast height, condition and location of these species, in addition to GRL species were recorded. Approximate estimates of numbers, height, diameter and condition were also recorded for other tree species within the Construction ROW.

Macroinvertebrate survey

The length of the watercourse that constituted the macroinvertebrate survey area was determined by identifying the lower end of the study unit and estimating an upstream distance of 30 times the stream width. The lower end of the study unit was randomly located at the point of access to the stream and below a riffle section of the river (allowing the riffle section to constitute part of the survey area). This reach length ensured that characteristic riffle/pool sequences were represented and sampled.

Locations of specific macroinvertebrate sample sites within the reach at the Mtkvari crossing were determined through careful identification of two riffle areas and two depositional zones. The O-frame kicknet (500-micrometre net mesh) was used to collect three composite samples from each riffle and three composite samples from each slack-water zone (run or pool, where present). Ten per cent of the replicate riffle samples were stored in separate containers. A leaf litter sample (also known as coarse particulate organic matter or CPOM) was also collected from the stream reach. Leaf litter was gathered from a minimum of two depositional locations and include decayed and newly deposited material. All samples were collected from stream-bank no deeper than 0.8–0.9m. The samples were collected from the following sampling points:

- Aji
    - 12m upstream of crossing point (8502923/4605738) – Station 1
    - 65m upstream of crossing point (8502935/4605786) – Station 2
    - 15m downstream of crossing point (8502912/4605714) – Station 3

[3] Only macroinvertebrate surveys were undertaken at the Aji River Crossing

    - 50m downstream of crossing point (8502907/4605679)–- Station 4
- Algeti
    - 6m upstream of the crossing (848109/4597480) – Station 1
    - 388m upstream of the crossing (8481040/4597500) – Station 2
    - 75m downstream of the crossing (8481170/4597410) – Station 3
    - 170m downstream of the crossing (8509030/4597300) – Station 4
- Mtkvari
    - 24m upstream of the crossing (8500320/4605170) – Station 1
    - 67m upstream of the crossing (8500280/4605180) – Station 2
    - 20m downstream of the crossing (8500270/4605170) – Station 3
    - 56m downstream of the crossing (8500290/4605130) – Station 4.

7.7.2.10 Fish surveys of Aji River crossing (KP27) and Algeti River crossing (KP55)

Fish surveys at the Aji were undertaken in September 2012, and surveys at the Algeti were undertaken at the same time as the invertebrate surveys. At the Algeti, fish surveys involved deploying two mini hoop nets (50cm diameter, 1m long and 6mm mesh) in the afternoon (an hour before sunset). The nets were located within the immediate vicinity of the proposed pipeline crossing point. The closed end of the hoop nets were tied off to shore and the net was then stretched upstream so that the open end faced the downstream flow. Sticks were then wedged between the hoops on each net to keep the net from collapsing. The nets were collected the following morning at least an hour after sunrise. All fish were returned to the river following the survey.

The fish survey at the Aji followed similar methodology other than that the nets were deployed at 8am and the survey lasted 4 hours.

7.7.3 Baseline Ecological Conditions

7.7.3.1 Ecology observed at KP0–KP56: flora on SCPX route

The habitats recorded along the route are as follows:

- Wetlands
- Wet meadows
- Moist meadows
- Grassland
- Steppic grassland
- Steppes
- Hemixerophytic shrubbery (shibljak)
- Tragacanthic scrub
- Deciduous scrub.

Wetland habitat is shown on the constraints maps in Appendix A. Habitat maps are included in Appendix E of the ESBR.

Table 7-25: Habitats Recorded along Proposed Pipeline Route

Habitat	Characteristics	Notable Species	Conservation value
Wetland	Dominated by reed beds that form dense stands; reed beds are developed in areas where water level is at or above ground for most of the year.	Common reed (*Phragmites australis*)	The wetland habitat supports the lowest number of species in comparison with other studied vegetation units. Reed beds are among the most common vegetation units in Georgia and no high conservation value species are associated with this habitat along the SCPX route.
Wet meadow	Developed in waterlogged areas under specific environmental conditions (e.g. waterlogging, nutrient-poor media etc.).	Common reed (*Phragmites australis*) Bulrush (*Bolboschoenus maritimus*)	Supports relatively low number of species due to having specific environmental conditions necessary for creation. Common reed- and bulrush-dominated communities are very widespread in Georgia and they do not support any species of high conservation value.
Moist Meadow	Comprises the following communities: (1) bulrush-dominated communities (2) communities with predominance of couch grass (*Elytrigia repens*), (3) meadow grass (*Poa pratensis*) dominated communities and (4) grass-dominated groupings.	Bulrush (*Bolboschoenus maritimus*) Couch grass (*Elytrigia repens*), Meadow grass (*Poa pratensis*)	The heavily modified structure of the communities, and their impoverished floristic composition, indicates that moist meadow communities along the SCPX route are of secondary origin. They do not support any species of high conservation value.
Grassland	Diverse habitat with a high mosaicity of associated plant communities. Widely used as hay meadow and most of the communities are developed on areas that were cultivated to grow crops (alfalfa) in the past.	Generally co-dominated by various grass and other herb species (*Gramineto-mixtoherbeta*) Communities are composed of common plant species across a vast area of the country.	Low habitat conservation value as it does not support either communities or individual species of high conservation value.
Steppic grassland	Infested with weeds and exotic species; majority of associated species are widespread plants in Georgia.	Annual ryegrass (*Lolium rigidum*) Couch grass (*Elymus repens*) Meadow grass (*Poa pratensis*)	Species poor and does not support any species or communities of high conservation value and they represent heavily modified and secondary plant associations.
Steppes	Diverse habitat with associated high number of species. This habitat supports high number of weeds and ruderal species.	Beard grass (*Bothriochloa ischaemum*) Fescue (*Festuca valesiaca*) Various herbs Ephemeral plant species	Overall conservation value of this habitat is low as it does not support either communities or individual species of high conservation value.

Habitat	Characteristics	Notable Species	Conservation value
Hemixerophytic shrubbery (shibljak)	Common habitat in drier parts of East Georgia dominated by deciduous shrub species.	Habitat is dominated by deciduous Christ's thorn (*Paliurus spina christi*).	Species poor and does not support any species of high conservation value.
Tragacanthic scrub	This monodominant habitat occupies very limited area. Habitat is widespread in drier parts of Georgia.	Habitat is dominated by thorny cushion forming dwarf Caucasian vetch (*Astragalus caucasicus*).	Common habitat almost throughout drier parts of Georgia and does not support any species of conservation value.
Deciduous scrub	This monodominant habitat occupies very limited area.	Species poor habitat purely dominated by cork-barked elm (*Ulmus suberosa*)	Species poor and does not support any species of high conservation value.

It is noteworthy that the most common habitats are moist meadow (with associated mosaic plant communities) (~20% of total area), steppes (~23%) and steppic grasslands (~8%). Extensive areas are covered with spontaneous vegetation represented by mixture of very common and frequently pioneer species, weeds and exotics; spontaneous vegetation does not form stable plant communities and is characterised by inter-annual fluctuation in floristic composition. Spontaneous vegetation does not have any conservation value. The ROW also supports scattered trees and shrubs that do not form communities or habitats. The descriptions of studied habitats are provided below.

Wetland is represented by common reed (*Phragmites australis*) dominated communities frequently referred as reed beds (main examples of this habitat type can be found at KP0-1 near the Azeri border). Reed beds are almost purely dominated by common reed, which forms dense stands; reed beds are developed in areas where water level is at or above ground most likely for the most of the year. The wetland habitat supports the lowest number of species in comparison with other studied vegetation units; only four species were recorded within the $4m^2$ sample quadrat to record different habitat characteristics. Reed beds are among the most common vegetation units in Georgia; they are found from sea level up to high mountains and usually support the least number of species. No high conservation value species are associated with this habitat along the SCPX route.

Figure 7-22: Common Reed (foreground) Dominates Wetland Habitat

Wet meadow habitat supports plant grouping co-dominated by common reed and bulrush (*Bolboschoenus maritimus*). This habitat is developed in waterlogged areas and supports relatively low number of species. Wet meadow habitats are established under specific environmental conditions (waterlogging, nutrient-poor media, etc.) and are usually species-poor. Common reed- and bulrush-dominated communities are very widespread in Georgia and they do not support any species of high conservation value.

Grassland is the most diverse habitat with a high mosaicity of associated plant communities. In general, almost all plant communities under this habitat are co-dominated by various grass and other herb species (*Gramineto-mixtoherbeta*). It is obvious that grassland habitat is used widely as hay meadow and most of the communities are developed on areas that were cultivated to grow crops (alfalfa) in the past. All communities are composed of common plant species of Georgian flora with vast distributional area throughout the country. Many species are weeds and ruderals (pioneer species which colonise disturbed sites). Overall conservation value of this habitat is low, as it does not support either communities or individual species of high conservation value.

Steppes are composed of different variants of beard-grass (*Bothriochloa ischaemum*) dominated communities. In these variants, dominant beard-grass is associated by:

- Various herbs
- Fescue (*Festuca valesiaca*)
- Ephemeral plant species.

Steppe communities are species rich with average 20 species recorded in 4m^2 sample quadrats. Steppes are of fragmentary distribution along the SCPX route and are predominantly associated with dry slopes (such as KP33–37). Steppes also support high number of weeds and ruderal species. Overall conservation value of this habitat is low as it does not support either communities or individual species of high conservation value.

Steppic grasslands are dominated by annual ryegrass (*Lolium rigidum*). It is likely that annual ryegrass communities are developed on areas once covered with couch grass (*Elymus repens*) or meadow grass (*Poa pratensis*) dominated plant groupings; at present, the above communities could be still found locally combined with ryegrass-dominated units.

Steppic grasslands are infested with weeds and exotic species; majority of associated species are widespread plants in Georgia. Steppic grasslands are rather species poor with average 13 species recorded in $4m^2$ sample quadrats. This habitat does not support any communities or species of high conservation value and they represent heavily modified and secondary plant associations.

Hemixerophytic shrubbery, frequently referred to as 'shibljak' in scientific literature, is a very common habitat in drier parts of East Georgia. This habitat occupies a limited area along the SCPX route and is dominated by deciduous Christ's thorn (*Paliurus spina christi*). This habitat is rather poor in species; most of its associates are weeds and ruderal plants widespread in East Georgia. Overall conservation value of this habitat is low, as it does not support either communities or individual species of high conservation value.

Tragacanthic scrub is dominated by thorny cushion forming dwarf Caucasian vetch (*Astragalus caucasicus*). This habitat is of limited distribution within the study area and does not form extensive thickets. This habitat is typical for the dry parts of East and South Georgia. It does not support any species of high conservation value.

Deciduous scrub, a small fragment of deciduous scrub was recorded on the channel bank close to PSG1. It is composed of cork-barked elm (*Ulmus suberosa*). This habitat does not support any species of high conservation value.

Summary
None of the habitats visited as part of the general phase 1 habitat survey for the route (excluding the specialised riparian survey) are considered to be of high ecological value. In addition, neither of the target plant species (*Iris iberica* and *Tulipa biebersteiniana)* nor any GRL flora were recorded, nor were any habitats with the potential to support these species. All habitats crossed are relatively species-poor, subject to anthropogenic influence and are no more/less valuable than the other habitats outside of the pipeline ROW.

7.7.3.2 Ecology observed at KP0–KP56: fauna on SCPX route (not including river crossings)

The first 11km of the route directly crosses wetland habitats and irrigation channels (including a well-developed, permanent wetland stretching along the route for 250m from KP0). Surveys of this area recorded a number of common breeding birds (e.g. common quail (*Coturnix coturnix*) and crested lark (*Galerida cristata*)) and common amphibians (e.g. marsh frog (*Rana ridibunda*) and green toad (*Bufo viridis*)). A diverse assemblage of commonly occurring reptiles was also found at this location (especially in the channel at KP12). Species observed included Schmidt's or Caspian whip snake (*Dolichophis schmidti),* marsh turtle (*Emys orbicularis* IUCN Red List Near Threatened) (included in the SCP monitoring programme), Caspian terrapin (*Mauremys caspica*) (included in the SCP monitoring programme), Caucasus emerald lizard (*Lacerta strigata*) and grass snake (*Natrix natrix*). Surveys of this section also identified an active Brandt's hamster ((*Mesocricetus brandti)* IUCN Red List Near Threatened and Georgian Red List) burrow (just outside the ROW between KP0 and KP4), a Mediterranean tortoise (*Testudo graeca*) (Georgian Red List and IUCN Red List 'Vulnerable') and an individual four-lined snake (*Elaphe quatuorlineata*). The latter is rare in Georgia (found only in East Georgia) and listed as 'Near Threatened' by IUCN. However, it is not protected by national legislation.

Features of interest between KP0 and 12 included several reed beds at coordinates:

- 8510844/4592564
- 8510750/4592952
- 8510423/4593127
- 8511507/4591708
- 8513325/4588110

- 8510163/4593335
- 8509894/4594134.

It is unlikely that these support any additional species to those identified during the 2011 surveys. However, they only held small amounts of water during the surveys and so their importance to the local amphibian population could not be fully assessed.

The majority of the route from KP12 to KP33 crosses heavily modified habitats that are used as arable land or pasture. The only exceptions to this are the Mtkvari River (KP30 (discussed later) and a minor gully located at 8500927/4605293, which was only used by commonly occurring bird species at the time of the survey). Species observed between KP12 and KP33 were commonly occurring and not of conservation concern, e.g. European bee-eater (*Merops apiaster*), northern wheatear (*Oenanthe oenanthe)* and marsh frog (*Rana ridibunda*).

Figure 7-23: Minor Gully at 8500927/4605293

Figure 7-24: Marsh Turtle

Some bird species covered by the Ramsar and Bonn conventions were noted, e.g. cattle egret (*Bubulcus ibis*), little egret (*Egretta garzetta*) and common buzzard (*Buteo buteo*). However, they are not listed on the Georgian Red List because they are common and widespread in Georgia. The main species of note in this section was an individual four-lined snake (*Elaphe quatuorlineata*). Although not on the Red List, it is a relatively rare species in Georgia.

The land crossed between KP33 and KP56 comprises heavily modified meadows used for grazing, hay harvesting and cattle movements. This has resulted in high levels of degradation and disturbance. Therefore, surveys recorded similar bird, reptile and amphibian assemblages to the rest of the route. The only exceptions were the sightings of the Georgian Red List species the griffon vulture (*Gyps fulvus*) and Eastern imperial eagle (*Aquila heliaca*). However, these were seen in flight. Of note is the fact that, despite detailed surveys detecting an abundance of common reptile and amphibian species (indicating that survey conditions were suitable), no Syrian spadefoot toads (*Pelobates syriacus*) or snake-eyed lizards (*Ophisops elegans)* were recorded.

The absence of snake-eyed lizards may be explained by the increased presence of Schmidt's whip snake (which preys on lizards) in the survey area (it was recorded twice during the survey and local residents indicate that it is fairly abundant). This might also explain why surveyors recorded fewer Caucasus emerald lizards than expected. As mentioned earlier, the Syrian spadefoot toad was not recorded in the last year of monitoring associated with the original SCP pipeline (2009). Therefore, as suitable features exist near the SCPX route but no spadefoot toads (or tadpoles) were recorded, it can be assumed that the species is absent from the SCPX pipeline ROW.

7.7.3.3 Aji River crossing

Aquatic Ecology

Macroinvertebrate surveys
The findings of the Aji survey recorded a 'low-to-moderate' total taxa richness (43 taxa), which is lower than the findings from the Algeti. This difference can possibly be explained by seasonal variations. There was no clear dominance by a single taxon at the Aji and a relatively moderate number of predator species was recorded, indicating that the environment is not stressed. A low percentage of pollution tolerant species (23%) indicates that the Aji is relatively unpolluted.

Fish surveys
A fish survey was undertaken at the Aji River crossing in September 2012 to identify the fish species present in the river and to calculate a fish index of biotic integrity (IBI) (which allows the fish population present to be classified as either excellent, good, fair, poor or very poor based on a number of criteria – see Appendix F to the ESBR for details). A total of four species were recorded during the survey (See Table 7-26). The IBI for the Aji was recorded as 'Fair'.

Table 7-26 Number of Fish Caught during Aji Survey in September 2012

Fish Species	Catch	Conservation Status*	Endemic
Kura bleak (*Alburnus filippi*)	4	NE	Trans-Caucasian
Kura gudgeon (*Gobio persa*)	14	NE	Kura-Araks basin
Chub (*Leuciscus cephalus*)	3	LC	Not Endemic
Kura barbel (*Barbus lacerta cyri*)	12	NE	Not Endemic
*IUCN Status codes: NE = Not Evaluated, LC = Least Concern,			

During the survey Kura gudgeon and Kura barbel were the most abundant species, each comprising over a third of the total catch. The relative proportion of the total represented by each fish species is illustrated in Figure 7-25

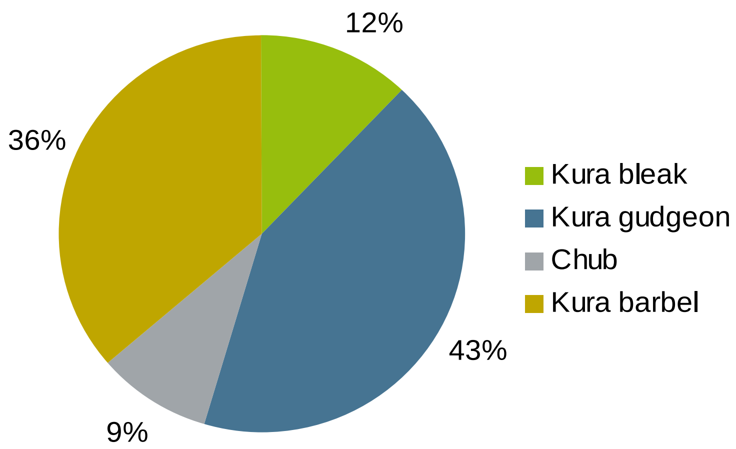


Figure 7-25 Proportion of Total Catch Represented by Each Species Caught in Aji River during September 2012 Survey

None of the species identified are included on the Georgian Red List or classified as being of conservation concern.

In addition to the fish survey, a literature search was undertaken and local fishermen were asked to complete a short questionnaire relating to fishing catches on the Aji

Table 7-27 lists species of fish that have been recorded in the Aji, based on historical landing data and interviews with fishermen.

Table 7-27: Fish Species Found in Aji River Based on Historical Landing Data and Interviews with Fishermen

Fish species	Landings*	Conservation staus**	Endemic Species
Common khramilu (*Capoeta capoeta*)	F	NE	Not Endemic
Kura barbel (*Barbus lacerta cyri*)	VF	NE	Not Endemic
Chub (*Leuciscus cephalus*)	VF	LC	Not Endemic
Riffle minnow (*Alburnoides bipunctatus*)	R	LC (Listed in Appendix III of Bern Convention)	Not Endemic
Kura gudgeon (Gobio persa)	A	NE	Kura-Araks basin
*VF: 85–100% per catch, F: 65–85% per catch, A: 20–60% per catch, R: 10–20% per catch, VR: 0–10% per catch			
**IUCN Status codes: NE = Not Evaluated, LC = Least Concern			

The Kura gudgeon, was identified by the local fishermen as being present in the section of the Aji crossed by the pipeline route. This species is caught in 'average' numbers, indicating that good, self-sustaining populations could be present in this section of the river. The riffle minnow is listed in Appendix III of the Bern Convention, as a protected fauna species. This species was rarely landed by the fishermen, indicating that it is not common in this section of river. The common khramilu, Kura barbel and chub were all identified by the fishermen as being landed either frequently or very frequently, indicating (albeit qualitatively) a relatively healthy fish population in this region of the Aji. This is reflected by the IBI rating recorded during the September 2012 survey, (taking into consideration the species caught, numbers caught, riparian habitat and stream-bank quality) which graded the Aji as ‘Fair’.

7.7.3.4 Mtkvari River crossing

Terrestrial Ecology

The western bank of the river supports the following habitats: riparian forest, riparian scrub and steppic grassland. The area of riparian forest has been modified heavily by long-term anthropogenic pressure (e.g. tree-felling, grazing and trampling). In addition, the ground vegetation is dominated entirely by weeds and other common species. Therefore, this area is not considered botanically important. The riparian scrub is represented by blackberry (*Rubus sp*.) thickets and tamarisk (*Tamarix ramosissima*) dominated communities. The former are species-poor communities that occur on roadsides and other man-made habitats. The latter are typical components of riparian vegetation in East Georgia. Steppic grassland is a secondary habitat that has developed on land previously used for agricultural purposes. It contains several weeds and common Georgian plants; no high conservation species were recorded.

Only commonly occurring animal species were recorded during the surveys, including Caspian terrapin, dice snake, European legless lizard and Caucasus emerald lizard. A single Lebetine viper (*Vipera lebetina*) was recorded during the walkover The Eastern bank of the river supports ruined buildings (with no potential to support bats), riparian scrub (as above) and steppes. The latter are represented by communities dominated by beard-grass (*Bothriochloa ischaemum*). This habitat is heavily infested by weeds and its primary structure is considerably transformed. This habitat is very common in semi-arid regions of East Georgia and its conservation value is low. Zoological surveys identified common reptile species (Caucasian agama, Schmidt’s whip snake, European blind snake, Caucasus emerald lizard, dice snake, Caspian terrapin and European legless lizard), fox (*Vulpes vulpes*) and two individuals of the Georgian Red List and IUCN Red List ‘Vulnerable’ species Mediterranean tortoise (*Testudo graeca*).

Both banks support small populations of the Georgian Red List species smooth-leaved elm (*Ulmus minor*) and also supported a diverse bird assemblage, e.g. great cormorant (*Phalacrocorax carbo*), grey heron (*Ardea cinerea*), cattle egret (*Bubulcus ibis*), little egret (*Egretta garzetta*), night heron (*Nycticorax nycticorax*), common buzzard (*Buteo buteo*), black kite (*Milvus migrans*), common kestrel (*Falco tinnunculus*) oystercatcher (*Haematopus ostralegus*). However, no birds were recorded breeding at the site (most were in flight 100m +/- of the crossing point), none were of conservation concern (according to IUCN, despite some being listed on the Ramsar Convention and Bonn Convention) and none are included on the Georgian Red List.

Aquatic Ecology

Macroinvertebrate surveys
Macroinvertebrate surveys in the spring revealed that that the Mtkvari had a ‘moderate’ taxa richness (49 taxa); with a ‘high’ dominance of the community by a single taxon (aquatic worms, 50%). This indicated a stressed environment. In addition, there was a high dominance of collector-gatherers (consumers of fine-particle benthic organic matter that tend to be more pollution tolerant), which also indicated a stressed watercourse. However, there was a significant rise in taxa richness when surveys were repeated in the summer (119 taxa). In addition, there was a change in the invertebrate community structure, with significantly lower collector-gathers and higher pollution-intolerant species. This change in structure (due to the seasonal variation) indicated higher dissolved oxygen levels and less

pollution. This was observed in the surface water results (Table 7-10) with summer samples having higher dissolved oxygen content and significantly lower suspended solids levels and turbidity. This could be explained by reduced levels of surface run-off and eutrophication during the summer months.

In terms of general abundance and richness indicators, the Mtkvari is dominated by pollution-tolerant species (blackfly larva). However, the reduced representation of the Hydropsychidae taxa in the summer months indicates a general upward trend in water quality at that time of year. It should be noted that the dominant invertebrates are univoltine taxa (one generation per year) that are relatively mobile; they can swim or drift to colonise optimum patches for shelter and feeding. Therefore, they are able to persist in disturbed environments where substrate stability is low.

Fish surveys

The Mtkvari River could not be surveyed safely owing to its depth and size. Therefore, a literature search was undertaken and local fishermen were asked to complete a short questionnaire relating to fishing catches on the Mtkvari. This was considered the best approach because, as the Mtkvari is one of the major rivers in Georgia, it is likely to constitute an important fishing resource for the Georgian population. Information regarding which species are caught in the river was requested and used to supplement the desk-based study.

The section of river crossed by the pipeline supports a diverse macrobenthic invertebrate assemblage that, in turn, is likely to support a diverse fish community similar to the Algeti (Table 7-29). Table 7-28 lists species of fish that have been recorded in the Mtkvari, based on historical landing data and interviews with fishermen.

Table 7-28: Fish species found in Mtkvari River Based on Historical Landing Data and Interviews with Fishermen

Fish species	Landings*	Conservation status **	Endemic Species
Common khramilu (*Capoeta capoeta*)	F	NE	Not Endemic
Kura barbel (*Barbus lacerta cyri*)	VF	NE	Not Endemic
Barbel mursa (*Barbus mursa*)	A	NE	Trans-Caucasian
Chanari barbel (*Luciobarbus capito*)	A	VU	Caspian and Aral basin
Chub (*Leuciscus cephalus*)	VF	LC	Not Endemic
Bream (*Abramis brama*)	A	LC	Not Endemic
Kura undermouth (*Chondrostoma cyri*)	R	NE	Trans-Caucasian
Vimba bream (*Vimba vimba*)	R	LC	Not Endemic
Roach (*Rutilus rutilus*)	R	LC	Not Endemic
Danube bleak (*Chalcalburnus chalcoides*)	A	NE	Not Endemic
Carp (*Cyprinus carpio*)	VF	VU	Not Endemic
Crucian carp (*Carassius carassius*)	F	LC	Not Endemic
Riffle minnow (*Alburnoides bipunctatus*)	R	LC (Listed in Appendix III of Bern Convention)	Not Endemic
Kura bleak (*Alburnus filippi*)	VR	NE	Trans-Caucasian
Kura gudgeon (*Gobio persa*)	A	NE	Kura-Araks basin
Blackbrow bleak (*Acanthalburnus microlepis*)	VR	NE	Kura-Araks basin

Fish species	Landings*	Conservation status **	Endemic Species
Amur Bitterling (*Rhodeus sericeus*)	R	LC (Listed in Appendix III of Bern Convention)	Not Endemic
Kura stoneloach (*Nemacheilus brandti*)	VR	DD	Trans-Caucasian
Golden spineloach (*Sabanejewia aurata*)	VR	DD	Not Endemic
*VF: 85-100% per catch, F: 65-85% per catch, A: 20-60% per catch, R: 10-20% per catch, VR: 0-10% per catch			
**IUCN Status codes: NE = Not Evaluated, DD = Data Deficient, LC = Least Concern, VU = Vulnerable			

In a similar manner to the Algeti, endemic fish species are present in the section of the Mtkvari crossed by the pipeline route. However, the fish are more likely to be of value to the local fishing community than to conservation organisations. This is reflected in the number of species possibly present that are considered game fish by the Georgian fishing community. Interviews with local fisherman have also provided a subjective assessment regarding the abundance of the fish species likely to be present in the Mtkvari.

Of the endemic species, only the Kura gudgeon, Blackbrow bleak and chanari barbell are considered endemic on the sub-regional scale, the golden spineloach, Kura stoneloach and Kura bleak are very rarely landed (implying that they are not common in this section of the river) but the others are landed in ‘average’ numbers (indicating that good, self-sustaining populations could be present in this section of the river). Similarly, Chanari barbell and Carp the species classified as ‘Vulnerable’ by the IUCN that could be present, are usually caught in ‘average’ and ‘very frequent’ numbers respectively. This all indicates (albeit qualitatively) a relatively healthy fish population in this region of the Mtkvari.

7.7.3.5 Algeti River crossing

Terrestrial Ecology

The western bank of the Algeti at the proposed pipeline crossing point supports riparian scrub and grassland. The riparian scrub supports two vegetation units: blackberry (*Rubus sp*.) thickets and smooth-leaved elm (Georgian Red List) dominated communities. All plant species associated with the blackberry thickets are common and widespread in Georgia. The smooth-leaved elm dominated scrub (located at the northern and southern extremes of the survey area) represents a secondary community. This replaced the primary riparian forest that would have grown along the bank originally. This community is heavily modified owing to long-term anthropogenic pressure, with a high number of associated weed species, and the elms are underdeveloped with asymmetric crowns.

The grassland habitat is comprised of herbaceous communities dominated by grasses and various perennials. Surveyors recorded that the grassland habitat is used widely as hay meadow and most of the communities are developed on areas that were cultivated to grow crops (alfalfa) in the past. All communities are composed of common plant species of Georgian flora with vast distributional areas throughout the country. Many species are weeds and ruderals (pioneer species to colonise disturbed sites). Overall conservation value of this habitat is low, as it does not support either communities or individual species of high conservation value.

The eastern bank of the Algeti supports riparian forest, riparian scrub, grassland and wetland. The riparian forests were represented by two major communities dominated respectively by grey poplar (*Populus canescens*) and Russian olive (*Elaeagnus angustifolia*). Both communities are heavily disturbed owing to logging, grazing and trampling. They are characterised by thinned canopy layer and a high number of associated weeds and roadside species indicating the impoverishment of original floristic composition. The riparian scrub was the same as that found on the western bank, and the grassland only contained common species and had been modified heavily by long-term grazing. As noted above, a detailed tree inventory of the SCPX ROW identified a number of immature, diseased and/or damaged smooth-leaved elm individuals on this bank.

The wetland is represented by freshwater marsh community purely dominated by cosmopolitan cattail (*Typha laxmannii*). Cattail-dominated communities are widespread in Georgia and they are extremely species-poor because they are developed in waterlogged areas where plant establishment is restricted. Wetland habitat on the study area does not support any species of high conservation value.

A detailed tree inventory carried out at the east and west banks of the Algeti noted again the effects of long-term anthropogenic pressure such as grazing and trampling on the riparian habitat. Many large trees were observed with dead tops and branches in addition to the presence of a small number of dead standing trees.

The inventory confirmed the presence of nine well-established and mature (>3m height) individuals of the smooth-leaved elm within the construction ROW on the east bank at approximately KP54.5. All individuals were recorded with perforated and discoloured leaves most likely caused by elm leaf beetles. In addition, on the east and west bank approximately 200 immature (diameter <0.015m), diseased and/or damaged saplings of smooth-leaved elm were identified within the ROW. Other species present included almond-leaved willow (*Salix triandra*), white poplar (*Populus canescens*), black mulberry (*Morus nigra*) and black poplar (*Populus nigra*), the latter comprising four mature individuals (height <20m) on the eastern bank.

The only animal species recorded on the western bank were fox, European badger (*Meles meles*) and medium lizard (*Lacerta media*, classed as ‘Least Concern’ on the IUCN Red List), none of which are rare or protected in Georgia. However, there were remnants of floodplain forest with mature trees at 8480962/4597599 and 8481290/4597325; some of these trees contained features (e.g. holes, cracks and splits) that could potentially support roosting bats (which are known to forage and commute along the river).

The habitats on the eastern bank support commonly occurring reptiles and amphibians (marsh frog (*Rana ridibunda*), Caucasus emerald lizard (*Lacerta strigata*) and the medium lizard (*Lacerta media)*) and foxes (*Vulpes vulpes*). The only species of note to be recorded (five individuals) was the Georgian Red Listed and IUCN Red List ‘Vulnerable’ Mediterranean tortoise (*Testudo graeca*). A number of birds were recorded at the river crossing, e.g. common kestrel (*Falco tinnunculus*), European turtle-dove (*Streptopelia turtur*), cuckoo (*Cuculus canorus*), scops owl (*Otus scops*), hoopoe (*Upupa epops*), common kingfisher (*Alcedo atthis*) and European roller (*Coracias garrulus*). However, none were recorded breeding at the site (most were in flight 100m +/- the crossing point), none are of conservation concern according to IUCN (although the European roller is ‘Near Threatened’) and none are included on the Georgian Red List.

Figure 7-26: Mediterranean Tortoise (*Testudo graeca*)

Aquatic Ecology

Macroinvertebrate surveys

The spring findings of the Algeti were similar to those of the Mtkvari. A 'moderate' taxa richness was recorded (50 taxa), with a high dominance by a single taxon (68%), indicating a stressed environment. The Algeti did support a higher proportion of pollution-intolerant mayflies, caddis flies and stoneflies (which could have indicated that the stream integrity was good), but other intolerant assemblages were rare (and the overall number of pollution-intolerant species was low). In the summer, the taxa richness did increase (the same as the Mtkvari) but the community structure did not change significantly (unlike the Mtkvari). However, the percentage of pollution-intolerant species decreased, which indicated increased pollution or a reduction in oxygen levels. In addition, there was a slight increase in predator macroinvertebrates during the summer; further indicating a stressed environment.

There was a greater dominance of a pollution-tolerant species (midges) in the macroinvertebrate surveys of the Algeti. This indicates that the water was polluted to some degree. Again, it should be noted that the dominant invertebrates are univoltine taxa (one generation per year) that are relatively mobile; they can swim or drift to colonise optimum patches for shelter and feeding. Therefore, they are able to persist in disturbed environments where substrate stability is low.

Fish surveys

Surveys were undertaken at the Algeti River crossing in May and September 2011 to identify what fish species were present in the river and to calculate a fish index of biotic integrity (IBI) (which allows the fish population present to be classified as either excellent, good, fair, poor or very poor based on a number of criteria – see Appendix F to the ESBR for details). A total of seven species were recorded during the September survey, and six species were recorded during the May survey (see Table 7-29).

Table 7-29: Number of Fish Caught during Algeti Survey in September and May 2011

Fish Species	September Catch	May Catch	Conservation Status*	Endemic Species
Kura bleak (*Alburnus filippi*)	5	15	NE	Trans-Caucasian
Kura gudgeon (*Gobio persa*)	8	19	NE	Kura-Araks basin

Fish Species	September Catch	May Catch	Conservation Status*	Endemic Species
Carp (*Cyprinus carpio*)	5	10	VU	Not Endemic
Kura barbel (*Barbus lacerta cyri*)	5	13	NE	Not Endemic
Amur bitterling (*Rhodeus sericeus*)	2	0	LC (Appendix III of Bern Convention)	Not Endemic
Kura stoneloach (*Nemacheilus brandti*)	4	19	DD	Trans-Caucasian
Crucian carp (*Carassius carassius*)	8	15	LC	Not Endemic
*IUCN Status codes: NE = Not Evaluated, LC = Least Concern, VU = Vulnerable				

During the September catch Kura gudgeon and crucian carp were the most abundant species, each comprising approximately 22% of the total catch. The relative proportion of the total represented by each fish species is illustrated in Figure 7-27.

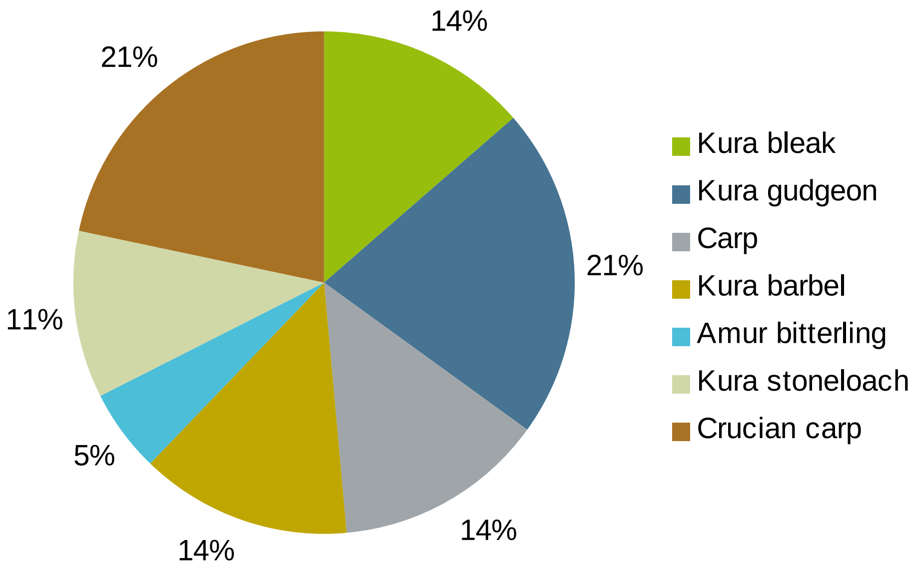


Figure 7-27: Proportion of Total Catch Represented by Each Species Caught in Algeti River during September 2011 Survey

Kura gudgeon was also one of the most abundant species to be caught during the May survey, comprising approximately 21% of the total catch; the Kura stoneloach also comprised approximately 21% of the total May catch. The relative proportion of the total represented by each fish species is illustrated in Figure 7-28.

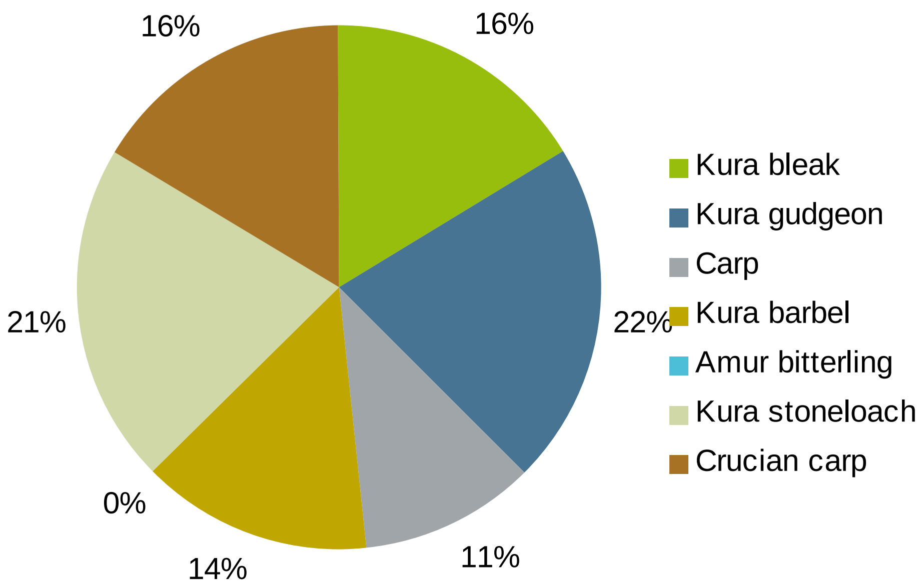


Figure 7-28: Proportion of Total Catch Represented by Each Species Caught in River Algeti during May 2011 Survey

None of the species identified are included on the Georgian Red List or classified as being of conservation concern (some are not listed by IUCN, others are only 'Least Concern') but it should be noted that the Kura gudgeon is an endemic species at the sub-regional scale. Records (from 2002) identified that the proposed pipeline crossing point is located in the spawning/nursing habitat of two other endemic species: barbel mursa (*barbus mursa*) and golden spined loach (*Sabanejewia aurata*). However, these species were not identified during the surveys.

Surveys recorded species that are typically observed in this stretch of the Algeti and relatively common throughout Georgia. They are often caught for food by local fishermen and are not included on the Georgian Red List. Only the carp is considered vulnerable (within the Caspian region) by the IUCN. This limited species diversity is reflected in the fish IBI for the Algeti (taking into consideration the species caught, numbers caught, riparian habitat and stream-bank quality), which ranged from poor to very poor in the spring to poor-to-fair in the summer.

7.7.3.6 Ecology observed at CSG1

Flora

The proposed CSG1 location predominantly comprises wet and moist meadow habitats. These are composed of plant communities of couch grass, meadow grass and bulrush. They are similar to other examples of the same habitats found along the SCPX route in that they are modified heavily with an impoverished floristic composition. Therefore, the area does not support any species of high conservation value.

There is an irrigation channel in the south-western corner of the site that is lined by a windbreak. The average height of the trees is 8m and the coverage of the canopy layer is about 50%. The windbreak is man-made and of low conservation value, although some of these trees contained features (e.g. holes, cracks and splits) that could potentially support roosting bats (which are known to forage and commute along the windbreak).

Fauna

A diverse assemblage of reptiles and amphibians was recorded in the irrigation channel in the south-western corner of the site (as part of the targeted reptile and amphibian surveys between KP0 and KP12 – see Appendix F of the ESBR for full details) but none are included on the Georgian Red List or of conservation concern (according to IUCN). Brandt's hamster (*Mesocricetus brandti*) was recorded close to KP2, but outside the 100m-width survey area.

7.7.3.7 Ecology observed at CSG2

Flora

The proposed CSG2 site is comprised predominantly of subalpine meadows, with a pine plantation abutting the south-western boundary and a small ravine on the north-eastern edge (comprising scattered willow trees of no conservation value). Owing to its close location to settlements, the meadow has been affected heavily by long-term grazing. This has resulted in all the palatable species being removed and only those with mechanical/chemical defences remaining. However, the meadow can still be split into two communities: grass-forb-dominated subalpine meadows and wet subalpine meadows. The only plant species of note to be recorded at the site is the CITES-listed marsh orchid (*Dactylorhiza urvilleana*) (Figure 7-29).

Figure 7-29: Marsh Orchid

Figure 7-30: Meadow Dominated by Lady's Mantle

Grass-forb-dominated subalpine meadows are composed of diverse communities with dominance of various species of grasses and predominantly perennial herbaceous plants. Field studies revealed that larger areas within the CSG2 area are occupied by lady's mantle (*Alchemilla erythropoda*) dominated communities (Figure 7-30); these communities are clearly of secondary origin as the leading species is avoided by livestock. They are widespread in the Caucasian mountains and support a set of common species including weeds and ruderals (pioneer species to colonise disturbed sites).

Wet meadows are dominated by acute sedge (*Carex acuta*) associated by soft rush (*Juncus effusus*). This habitat is developed in areas where water table is high and local areas are even waterlogged (Figure 7-32). It occupies rather limited area within CSG2 site. The leading species are typical components of wet meadows; soft rush occurs in almost all altitudinal zones from sea level to high-mountains and frequently colonises moist and wet sites. Wet meadows are species-poor communities and do not support any species of high conservation value.

According to anecdotal data, the pine plantation was established in the 1950s to stabilise slopes and prevent erosion and landslides. It is noteworthy that this artificial habitat has been managed poorly since establishment resulting in considerable mortality of planted pines and low biodiversity associated with this habitat (it has no understorey). Pine plantations support low numbers of species in ground vegetation; the majority of associated plants are common species of Georgian flora and no species of high conservation value are recorded to occur in the herbaceous layer.

Fauna

In the first site surveys (undertaken in July) the majority of animal species recorded were either amphibians or birds. This is to be expected considering the habitats present on site. The majority of species commonly occur throughout Georgia, e.g. marsh frog, smooth newt (*Lissotriton vulgaris*) (Figure 7-31), long-legged wood frog (*Rana macrocnemis*), common quail and corn bunting (*Miliaria calandra*). A Georgian Red Listed and IUCN Red List 'Vulnerable' Eastern imperial eagle (*Aquila heliaca*) was seen flying over the site. The assemblage of birds recorded in the pine plantation, although slightly different in composition (owing to the change in habitat), comprised mainly commonly occurring species (although common buzzard (Bonn Convention and Ramsar Convention) was noted). The site was also seen to support a diverse butterfly assemblage comprising the commonly occurring species of *Pieris* spp., *Euplagia* spp. and *Gonepteryx* spp.

Figure 7-31: Smooth Newts

Figure 7-32: Minor Lake (Waterlogged Area Along Transect 3)

The second survey (undertaken in August) did not record any significant change in the composition of amphibians/birds using the site. The only change in baseline conditions was that a fox had dug an earth (den) on site and that a Eurasian sparrowhawk (Bonn Convention species) was observed in the pine plantation. It should be noted that early ecological surveys were undertaken of the CSG2 location and CSG2 access road in July 2010 and that these recorded a lesser kestrel (*Falco naumanni*), a Georgian Red List Species, along the proposed access track. However, despite numerous birds being recorded on and around the site in 2011 (including common kestrel), lesser kestrels were never observed. Therefore, the species either no longer uses the site or the site is not a vital foraging/breeding ground for the species.

7.7.3.8 Ecology observed at CSG2 access road

The proposed CSG2 access road crosses disturbed subalpine meadows with impoverished floristic composition (due to grazing), pine plantations, cultivated land (potato and corn fields), several minor wetland fragments (which, although botanically species-poor, provide breeding opportunities for amphibians and foraging opportunities for birds) and small streams. Subalpine meadows are composed of grass-forb-dominated communities with dominance of matgrass, brome and meadow grass, and sedge-dominated wet meadows. All these communities are characterised by low biodiversity and they do not support any species of conservation value. Pine plantation is also a (botanically) species-poor habitat and no protected plant species were recorded in its ground vegetation.

Faunal surveys identified a number of common amphibians and reptiles along the route including Dahl's lizard (*Lacerta dahlia*), sand lizard (*Lacerta agilis*), green toad (*Bufo viridis*), long-legged wood frog (*Rana macrocnemis*), smooth newt (*Triturus vulgaris*) and marsh frog (*Rana ridibunda*). Areas of importance for these species include the piles of stones/boulders along the length of the track, the pine plantation (as the region lacks tree cover and other natural refuges) at 8403218/4614716 and the wetlands at 8403821/4611507, 8403175/4614299 and 8404008/4612568.

A large, common breeding bird assemblage was recorded along the access road, comprising species such as common quail (*Coturnix coturnix*), white wagtail (*Motacilla alba*), common whitethroat (*Sylvia communis*) and red-backed shrike (*Lanius collurio*). This was to be expected as the entire Tsalka depression (which includes areas adjacent to the proposed CSG2 facility) is known to be an important area for birds during both breeding and migration periods (although during the migration period they are likely to pass over the proposed CSG2 site and not actually occupy it). One species of note was the corncrake (*Crex crex*), which is not evenly distributed throughout Georgia and is considered by local specialists to be in decline. This species was recorded at several wetland fragments along the route (including one at 8405359/4609637 and one at 8405363/4609792). Eastern imperial eagles were seen flying over the access track (but no nests were recorded nearby) and white stork (*Ciconia ciconia*) were recorded nesting at Nardevani (a village between 8405362/4603793 and 8407896/4606521). The pine plantation at 8403218/4614716 also supports a diverse assemblage of breeding birds (including common buzzard), reflecting the scarcity of this type of habitat around the survey area. Numerous Georgian Red List bird species were recorded flying over the access track (e.g. long-legged buzzard (*Buteo rufinus*), saker falcon (*Falco cherrug*), eastern imperial eagle (*Aquila heliaca*) and white stork (*Ciconia ciconia*)) (Figure 7-33) but none were observed breeding close to the proposed route.

Figure 7-33: White Stork Nesting at Nardevani

7.7.3.9 *Ecology observed at CSG2 access road camp*

The CSG2 access road camp is a heavily grazed meadow with artificial, 30–40m-wide parallel terraces. The vegetation cover of area is heavily transformed by grazing and (especially) trampling; many typical palatable species were eliminated and replaced with weeds and non-palatable species avoided by cattle. The overall vegetation coverage is approximately 70%; the site supports a single vegetation community: subalpine meadow with forbs and grasses dominated by lady's mantle (*Alchemilla erythropoda*) and fescue

(*Festuca sulcata*). Ornithological surveys only identified five to six pairs of wheatear (*Oenanthe oenanthe*) on this site.

7.7.3.10 Ecology observed at the PRMS

The proposed PRMS site consists of four main habitats: steppes, xeric grassland, scrub and agricultural. As with the areas surveyed along the SCPX pipeline route, the majority of the site is intensively grazed and trampled. The steppe habitat was represented by two vegetation units: communities dominated by grasses and forbs and communities dominated by crouch grass (associated with a mix of herbaceous species). Neither of these communities supported any plant species of high conservation value. Xeric grassland is present in the eastern and northern parts of the study area on stony substrata with very thin soil cover. This habitat has been grazed heavily and is characterised by an abundance of weeds and ruderals. As such, it has no conservation value. Scrub habitat occupies limited area and is represented by three vegetation units:

- Polidominant shrubbery with grasses and forbs
- Blackthorn (*Prunus spinosa*) dominated scrub
- Buckthorn (*Rhamnus pallasii*) dominated communities.

Polidominant shrubbery supports high species diversity. In total, 49 plant species were recorded in a 25m^2 sample quadrat; this is a rather high figure considering woody habitats generally support a limited number of plant species compared to habitats dominated by herbaceous species.

Blackthorn-dominated scrub is found locally in the southern part of the study area. This habitat is very common in Georgia and found throughout the country in roadsides, forest margins and other low conservation value sites.

Buckthorn-dominated communities were recorded in the eastern part of the study area. These communities are widespread in drier parts of Georgia; they support rather rich flora but most of the associated species are weeds and common taxa in country.

No legally protected plant species were recorded on the PRMS site and its immediate surroundings. However, the site supports populations of six endemic species: *Teucrium nuchense, Jurinea blanda, Lotus caucasicus, Melampyrum caucasicum, Vicia iberica* and *Astragalus kozlovskyi* (this species is well-represented also in the immediate surroundings of the study area). The first five species are Caucasian endemics, and the sixth is endemic to Georgia. All the above species are widespread in Georgia and are not known to be threatened or decreasing.

The habitats on site are common and have been modified by construction activity; at the time of the survey, drilling work was being undertaken creating some disturbance. The site does not provide animals with valuable foraging/breeding/resting sites. As such, the site only supports a small assemblage of common breeding birds, foxes, two species of common amphibian (marsh frog and green toad) and the rock agama. A Red List bird species the Eastern Imperial eagle (*Aquila heliaca*) was observed flying over the site but none were recorded nesting on or near the site. Therefore, the site is not considered to be of any specific value to the local faunal population.

7.7.3.11 Ecology observed at the PRMS construction camp options

There are currently two potential options for the PRMS construction camp location. Option 1b is located to the south-west of the proposed PRMS, adjacent to a small wetland area. The site is currently used for grazing and a small part is cropped (a cornfield). Option 5 is located to the south-east of the proposed PRMS location. The majority of the proposed area is currently cropped or left as fallow, with a small part of scrub. These sites will be subject to detailed pre-construction ecological surveys prior to selection of a preferred camp location (as described in Chapter 10, Section 10.7.4).

7.7.4 *Ecological Sensitivities*

The following subsections summarise the components of the baseline conditions that, in the project context, are considered the most important based on the anticipated impacts of the project development.

7.7.4.1 *Key sensitivities at KP0–KP56*

None of the habitats visited as part of the general phase 1 habitat survey for the route (excluding the specialised riparian survey) are considered to be of high ecological value. In addition, neither of the target plant species (*Iris iberica* and *Tulipa biebersteiniana)* were recorded, nor were any habitats with the potential to support these species. All habitats crossed are relatively species-poor, subject to anthropogenic influence and are no more/less valuable than the other habitats outside of the pipeline ROW.

The key ecological sensitivities along the proposed route are:

- Irrigation channels between KP0 and KP12, which are used by a diverse assemblage of amphibians (possibly for breeding) that are commonly occurring and reptiles (such as the rare four-lined snake, the Mediterranean tortoise (a Georgian Red List species) and the European marsh turtle, which is the subject of SCP monitoring surveys)
- A Brandt's Hamster (IUCN Red List Near Threatened and Georgian Red List) was recorded near KP2 during the faunal surveys
- The channel at KP12, which is known to support a diverse assemblage of reptiles and amphibians (including the European marsh turtle, which was the subject of SCP monitoring surveys)
- Mediterranean tortoise (a Georgian Red List species and one considered 'Vulnerable by IUCN), which is known to inhabit the eastern banks of the Algeti and Mtkvari
- Smooth-leaved elm (Georgian Red List species) on the banks of both the Mtkvari and Algeti rivers
- Chanari barbel, the only species to be classified as 'Vulnerable' by the IUCN that could be present, is usually caught in 'average' numbers. This all indicates (albeit qualitatively) a relatively healthy (although not ecologically valuable) fish population in this region of the Mtkvari.
- Carp (an IUCN vulnerable fish species) which inhabits the Algeti River and is caught by local fishermen relatively frequently.

7.7.4.2 *Key sensitivities at CSG1*

- The boundary features of the proposed CSG1 site (such as the irrigation channel in the south-west corner of the site and the windbreak) are more sensitive than the actual site itself. The irrigation channel supports commonly occurring amphibians and the windbreak has features (e.g. split bark) that could support roosting bats.
- A Brandt's Hamster (IUCN Red List Near Threatened and Georgian Red List) burrow was found near KP2 but outside of the actual survey area.

7.7.4.3 *Key sensitivities at CSG2*

The key ecological sensitivities at CSG2 are:

- Populations of the CITES-listed marsh orchid throughout the site
- The pine plantation abutting the south-west corner of the site, which is used by a number of breeding birds
- Several breeding bird species, including corncrake (which is considered by local surveyors to be in decline and which is likely to inhabit and breed in wetland areas).

7.7.4.4 Key sensitivities at CSG2 access road

The key ecological sensitivities at the CSG2 access road are:

- The pine plantation at 8403218/4614716, which is used by several breeding birds (owing to the scarcity of similar habitats in the surrounding area)
- The wetlands at 8403821/4611507, 8405359/4609637, 8405363/4609793, 8403175/4614299 and 8404008/4612568, which support commonly occurring amphibians
- The presence of corncrake (*Crex crex*), which is considered by local specialists to be in decline and inhabits wetland fragments along the CSG2 access route
- White stork (a Georgian Red List species) nesting on abandoned wooden power poles in Nardevani between 8405362/4603793 and 8407896/4606521.

7.7.4.5 Key sensitivities at the PRMS

The only ecological sensitivities at the PRMS are six endemic plant species that grow on the site (mainly around the boundary of the survey area). However, despite being endemic, these species are common in Georgia.

7.8 Climate and Air Quality

This section describes the climatic characteristics for the Georgian section of the proposed SCPX pipeline route and for the locations at CSG1, CSG2 and the PRMS in terms of sunshine, ambient air temperature, ground temperature, relative humidity, wind speed and wind direction, and atmospheric pressure.

7.8.1 Climate Information from Desktop Literature Survey

7.8.1.1 General

The Greater Caucasus Range serves as a barrier to the cold air from the north, so Georgia generally has a relatively warm climate with few extreme meteorological events. The country east of the Surami range has a dry subtropical climate (Kordzakhia, 1961).

Air masses move predominantly west-to-east over the region, rising over the mountain ranges. This gives the western parts of Georgia a damp climate with rain falling throughout the year, while the eastern side of the mountain ranges, where the SCPX pipeline will be installed, experiences lower relative humidity and a subtropical climate with moderate precipitation, pronounced seasonal variations in climatic parameters (warm summers and mild winters) and a high level of solar radiation.

At the higher altitude where CSG2 will be built, air temperatures are lower and wind speeds stronger. The CSG2 site experiences cold, snowy winters and long, mild summers with more rainfall.

PRMS is located in the humid subtropical mountainous climate zone with cool winters and mild summers.

The meteorological data presented in the SCP ESIA (2002) was based on the EIA for the Western Route Export Pipeline (1996) enhanced with meteorological data from Tbilisi Airport and data from a climatic study to support the preliminary engineering design of the SCP gas export system (Kvaerner 2001). This has now been enhanced further by reference to four weather stations associated with the SCP and SCPX Projects:

- A weather station at PSG1 has recorded temperature, wind speed, wind direction and humidity data most days since May 2008

- A weather station placed at the oil spill response base (OSRB) Tsalka (41°35'24.56"N 44° 3'9.21"E elevation 1572m) has recorded daily temperature, rainfall and wind speed (average and maximum) since January 2011
- A weather station placed at the proposed site for CSG2 (41°39'58.37"N 43°50'34.86"E, elevation 1714m) has recorded daily temperature, rainfall and wind speed (average and maximum) since December 2010
- A weather station at the PRMS has recorded daily temperature, wind speed, wind direction and humidity data discontinuously since May 2008.

7.8.1.2 Sunshine

The pipeline ROW is in an area that has recorded around 2350 hours of sunshine per year. Gardabani, near the Azerbaijan-Georgia border, has the highest sunshine duration in the area (6.9 hours daily mean). The intensity and duration of sunshine is typically reduced significantly by cloud cover. Clear and cloudy days recorded at CSG1 and PRMS are identified in Table 7-30.

The observation record is incomplete, however even with substantial data gaps, the records from the weather station at PRMS has more cloudy days than CSG1 from April to December.

Table 7-30: Clear and Cloudy Days at CSG1 and PRMS

Month	CSG1		PRMS	
	Clear days	Cloudy or partly cloudy days	Clear days	Cloudy or partly cloudy days
2010				
Jan	15	16	2	16
Feb	11	17	0	19
Mar	14	17	6	17
Apr	12	18	3	19
May	16	8	7	9
Jun	18	4	7	12
Jul	18	4	6	10
Aug	17	6	7	11
Sep	14	5	4	8
Oct	11	17	2	20
Nov	15	9	10	2
Dec	25	5	5	11

The rate of solar radiation input, considering both direct and diffused (scattered and reflected) sunlight has been calculated at approximately 115–140kcal/cm^2 between sea level and an altitude of 500m. This figure would be slightly elevated for regions of greater altitude (SCP ESIA 2002).

7.8.1.3 Air temperature

SCPX pipeline ROW and CSG1

The SCPX pipeline ROW is at relatively low altitude. CSG1, near the Georgia–Azerbaijan border, is at an elevation of 286m. Influenced by the dry plains of Azerbaijan, it experiences relatively warm temperatures throughout the year, compared to other parts of the country.

The first frosts of the year tend to arrive in November; winter usually lasts until the beginning of April, when the temperatures start to climb.

The monthly average of temperatures recorded at the weather station at CSG1 did not dip below 0°C in 2010, and were just under 0°C in the first two months of 2011. However, the

SCP document 'Technical Note - Design Ambient Temperature Review' (CB&I, 2012) presents an analysis of meteorological data from a number of sources and maximum and minimum temperatures and monthly average temperatures for CSG1, CSG2 and the PRMS are reproduced from this document as Table 7-31 and Figure 7-34.

CSG2

The site of CSG2 is at an altitude of 1714m in the transition zone between the dry subtropical climate in the east and the colder mountainous climate to the west and it experiences winter temperatures considerably lower than at CSG1. The weather station that was set up at CSG2 in January 2011 recorded its lowest temperature of -15.9°C in January 2011; the average of measurements in February was only -6.99°C.

Spring arrives in May, when average temperatures climb above 7°C. The highest summer temperature recorded in 2011 at CSG2 was 30.9°C in July.

The weather station at the Oil Spill Response Base (OSRB) near Tsalka is at an elevation 130m lower than CSG2, but it shows that spring arrives in May, and after four months of summer, during which temperatures peaked at 31°C in July, the temperatures start to fall back in October, when the average of temperature measurements was 6.95°C.

PRMS

At the Georgia–Turkey border, west of the mountain ranges, the temperatures are generally higher than at CSG2, though not as high as at the lower altitudes by the border with Azerbaijan.

In January 2010, the monthly average of temperatures recorded at the PRMS was -3.77°C, and the minimum temperature recorded was -12.8°C. By April, the average monthly temperature climbed above 0°C. During the period between May and September, the monthly average of temperatures remained above 10°C, with the maximum temperature of 27.6°C recorded in July.

In October, the monthly average of temperatures fell back below 10°C and the first frosts appeared.

Summary temperature data for CSG1, CSG2 and the PRMS are presented in Table 7-31 and Figure 7-34.

Table 7-31: Site Absolute Maximum and Minimum Temperatures and Monthly Average Temperatures for CSG1, CSG2 and PRMS (reproduced from Technical Note - Design Ambient Temperature Review)

	Absolute Minimum Temperature °C	Absolute Maximum Temperature °C	Monthly Average Temperature, °C											
			Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
CSG1	-25	42	3	5	11	15	19	25	28	27	23	17	10	4
CSG2	-36	31	-6	-5	-2	4	8	12	15	15	11	6	0	-4
PRMS	-34	37	-5	-3	2	7	12	16	19	19	15	9	3	-3

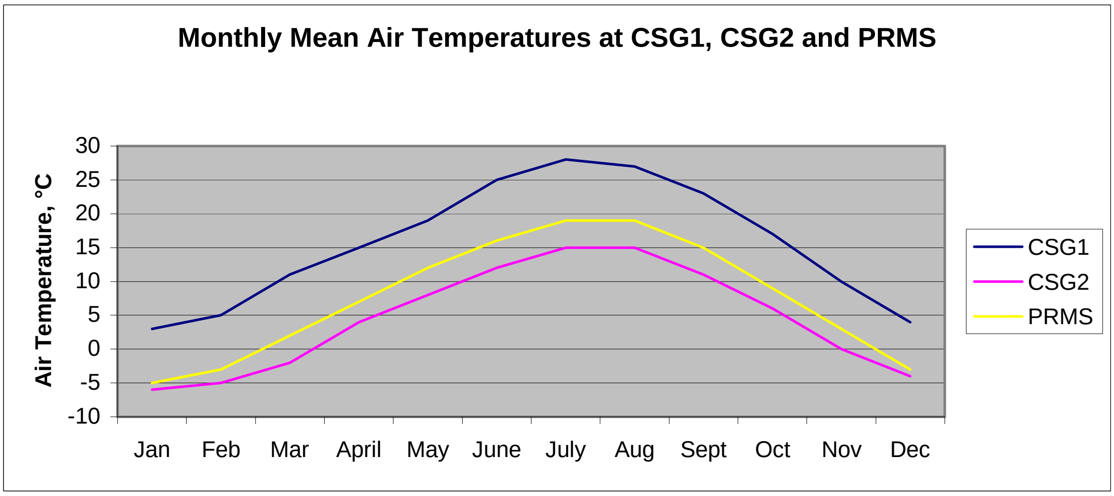


Figure 7-34: Graph of Monthly Mean Air Temperatures at CSG1, CSG2 and PRMS

7.8.1.4 Soil temperature

In the SCPX ROW at KP0, Kvaerner (2001) reported the temperature of the ground surface as being in the range 10 to 19°C, falling to 7 to 17°C by KP56. Kvaerner considered that the ground temperature at 1.54m below the surface would be in the range 14 to 16°C at KP0, falling to 12 to 14°C at KP56.

At CSG2, Kvaerner reported the temperature of the ground surface to be in the range -2.5°C to 12.5°C, and the temperature at 1.54m below the surface to be in the range 3 to 6°C. (SCP ESIA 2002).

At PRMS, Kvaerner reported the temperature of the ground surface to be in the range 3°C to 15°C, and the temperature at 1.54m below the surface to be in the range 7 to 10°C.

7.8.1.5 Air humidity

The atmospheric moisture content increases from the dry subtropical climate by the border with Azerbaijan to a humid subtropical climate west of the mountains. Local humidity is closely dependent on factors such as altitude. At the Azerbaijan–Georgia border the average annual humidity has been estimated at 69%, with the maximum monthly average (78%) in December, and the lowest (59%) in July.

Measurements of air temperature and dew point at CSG2 suggest an annual mean humidity of approximately 69%, with a wide range from a minimum of 51% in December to a maximum of 84% in September. At the PRMS the annual average humidity was approximately 67% in 2010, ranging from 56% in August to 81% in January.

7.8.1.6 Precipitation

Annual precipitation also increases from the dry subtropical climate in the east of the country towards the west.

At the Azerbaijan-Georgia border, the average annual rainfall rarely exceeds 451mm, but in exceptionally wet years it can be significantly higher (e.g. in 1936 Gardabani recorded 655mm). The average monthly rainfall is 35mm. April to June is the period with the highest rainfall (average 57mm/month). The rest of the year is drier (average 16–17mm/month in December to February).

The weather stations that were set up in 2011 at the OSRB and at CSG2 recorded high monthly rainfall in June (118mm at CSG2, 144mm at the OSRB). Relatively low rainfall was recorded at the OSRB in February and March (13mm and 16mm respectively), when much of the precipitation may have fallen as snow. More substantial rainfall (26.9-55.88mm/month) was recorded in April and in the period July–October. Table 7-32 identifies the rainfall recorded at CSG2 and OSRB.

Table 7-32: Rainfall at CSG2 and Tsalka OSRB in 2011

Month	CSG2: Total Rainfall (mm)	OSRB: Total Rainfall (mm)
Jan	N/A	0.00
Feb	N/A	13.21
Mar	N/A	16.00
Apr	N/A	55.88
May	N/A	80.01
Jun	117.86	144.27
Jul	51.31	40.89
Aug	55.88	55.88
Sep	32.00	26.92
Oct	22.86	27.69
Nov	1.78	2.03
Dec	0.00	0.00

Note: CSG2 rain gauge operational from 31 May

At the Georgian-Turkish border, the range of average annual precipitation is 508mm to 654mm. April and October is the period with the highest rainfall, with May and June being considered the wettest months (82mm/month and 88mm/month respectively). December (32mm/month) and January (30mm/month) are the driest months.

There is a strong correlation between altitude, air temperature and snow cover. Falling snow can lie as snow cover when ground temperatures are below 2°C. The CSG2 location usually has snow cover for around 90 days per year.

7.8.1.7 Wind

SCPX Pipeline ROW and CSG1
In the area of the SCPX pipeline ROW the annual average wind speed has been reported as 4.8m/s (SCP ESIA 2002), and the range of monthly average wind speeds is 3.8m/s (December) to 5.7m/s (June). The winds mostly come from the quadrant west through north, and the predominant wind direction is north-westerly.

The recent wind data from the weather station at PSG1 agrees with the wind direction reported in the SCP ESIA 2002, but recorded lower average winds and much lower maximum wind speeds, suggesting that the weather station is not in a particularly exposed position. Wind speed data recorded at various locations are identified in Table 7-33 and Table 7-34. Wind roses for CSG2, the OSRB at Tsalka, CSG1 and PRMS are presented in Figure 7-35, below.

CSG2
At CSG2, wind speeds have been reported to be lower than at the Azerbaijan–Georgia border (SCP ESIA 2002) with predominantly northerly and north-westerly wind directions, but with a significant easterly component too.

However, data from the weather stations installed at the CSG2 site and at the OSRB location suggests that local landforms may play a significant role, with the wind at the OSRB having a more east–west axis, while the wind at CSG2 has a north-west–south-east axis. Data from these weather stations also suggests that the average wind speed in this locality is significantly higher than at PSG1, with monthly average wind speeds of up to 8.6m/s (February) and the period February through April experiencing maximum wind speeds of 24 to 26m/s. Wind speeds of over 10m/s have been recorded at most times of year.

PRMS

At the PRMS it was reported in the SCP ESIA (2002) that easterly and westerly winds predominate, and recent records from PRMS do show that winds from the north-east and south-west predominate. However, the recent records from the weather station at PRMS have average wind speeds consistently lower (2.5 m/s in March) than the average wind speed (6.7m/s) reported at the Georgia-Turkey border in the SCP ESIA (2002). Again this suggests that the current weather station may not be fully exposed to the wind.

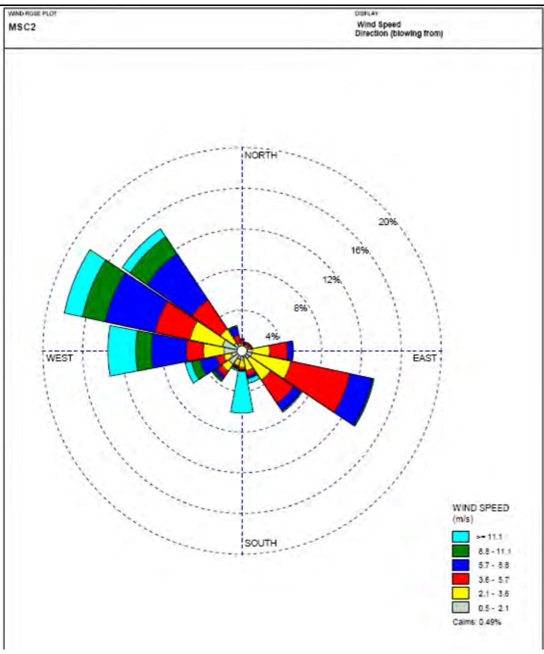
Table 7-33: Wind Speed at PSG1 and at the PRMS

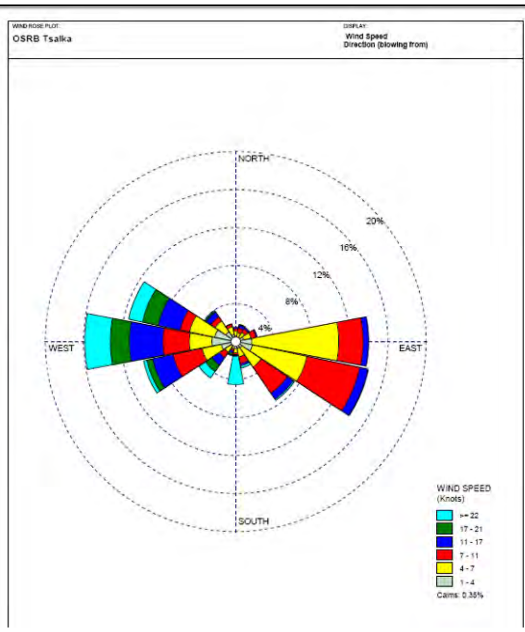
Month	PSG1		PRMS	
	Average Wind Speed (m/s)	Max. Wind Speed (m/s)	Average Wind Speed (m/s)	Max. Wind Speed (m/s)
2010				
Jan	4.3	20	1*	1*
Feb	1.8	4	1.6	3
Mar	2.8	7	2.4	4
Apr	2.5	8	1.8	3
May	2.2	4	2	3
Jun	1.75	4	1.6	3
Jul	2.4	4	1.8	3
Aug	2.2	4	1.8	3
Sep	2.6	4	2	3
Oct	3.1	5	1*	1*
Nov	1*	1*	1*	1*
Dec	1*	1*	1*	1*
2011				
Jan	1.4	2	3	3
Feb	3.0	7	2.6	7
Mar	2.7	5	2.3	4
Apr	No data	No data	No data	No data
May	No data	No data	No data	No data
Jun	No data	No data	No data	No data
Jul	1.5	7.0	1.1	6.0
Aug	1.9	6.0	1.3	5.0
Sep	1.0	12.0	0.7	4.0
Oct	0.9	0.0	0.6	6.0
Nov	0.1	1.0	0.6	4.0
Dec	0.5	7.0	0.7	3.0

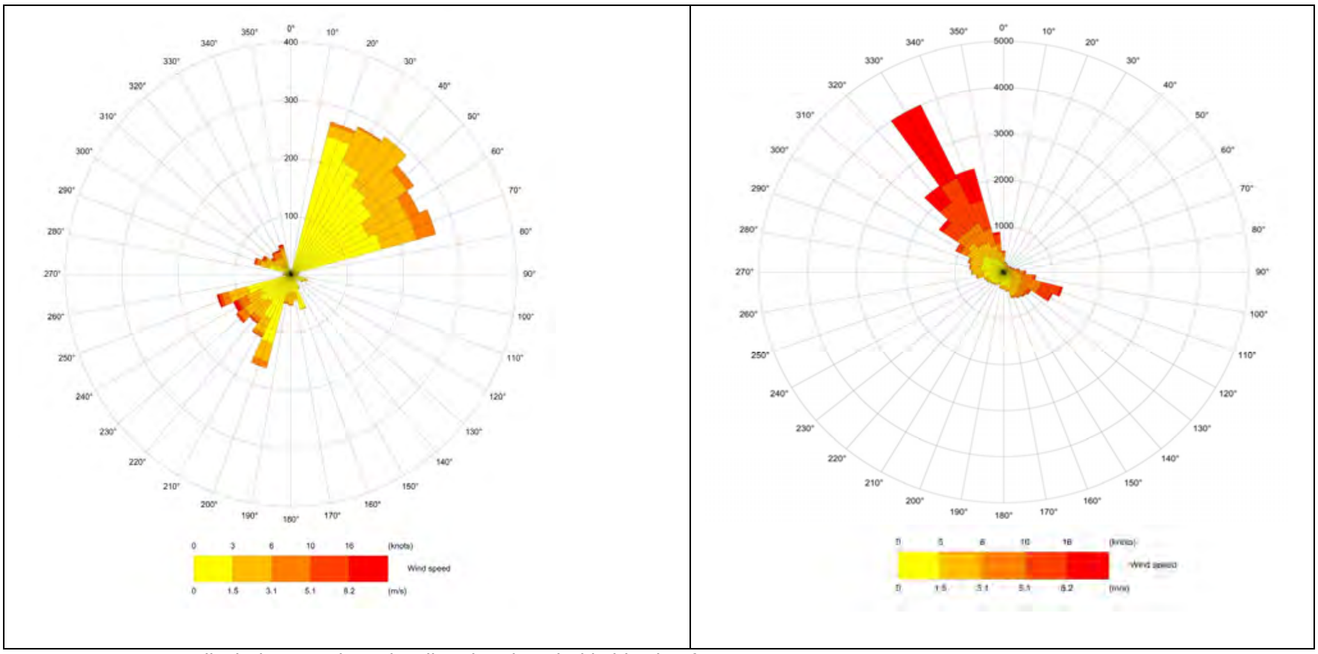
* Unreliable data, possible equipment malfunction

Table 7-34: Wind Speed at CSG2 and at Tsalka OSRB

Month	CSG2		OSRB	
	Average Wind Speed (m/s)	Max. Wind Speed (m/s)	Average Wind Speed (m/s)	Max. Wind Speed (m/s)
2011				
Jan	4.63	19.08	4.37	16.67
Feb	8.76	26.43	7.64	26.72
Mar	6.04	24.03	5.50	19.74
Apr	6.03	26.01	4.34	15.62
May	3.57	12.06	3.31	13.14
Jun	3.25	14.99	3.07	14.27
Jul	3.07	10.22	2.58	9.87
Aug	2.72	8.96	2.71	8.96
Sep	3.13	12.26	2.65	12.18
Oct	3.66	18.02	2.32	2.34
Nov	4.41	20.66	2.51	18.45
Dec	3.00	3.00	4.49	19.28







Note: All wind roses show the direction the wind is blowing from.

Figure 7-35: Wind Roses for (Clockwise) CSG2 and Tsalka OSRB CSG1 and PRMS

7.8.1.8 *Atmospheric pressure*

The mean annual pressure recorded for a reference station in Tbilisi was given in the SCP ESIA (2002) as 969.2mb. The lowest atmospheric pressures are associated with late spring to early autumn (963.7mb in July), and the highest are associated with the cold winter months (973.5mb in November).

Because CSG2 and PRMS are located at significantly higher altitude than Tbilisi, the atmospheric pressure will be considerably lower at these locations.

7.8.1.9 *Snowfall at CSG2*

The CSG2 site typically experiences significant snowfall between November and April. Measurements of the depth of accumulated snow were measured to inform the conceptual design of the CSG2 access road, and are reproduced in Table 7-35. The snowfall experienced at CSG2 may constrain access at same times of year.

Table 7-35: Snow Depth at CSG2

Date	Snow Height (cm)	Drifted Snow Height (cm)
18.02.2011	22	50–60
23.02.2011	20–22	50–60
02.03.2011	15–18	45–50
10.03.2011	18–20	50
16.03.2011	62–65	120–130
24.03.2011	55–58	110–120
28.03.2011	40–45	100–110
04.04.2011	32–35	70–75
12.04.2011	10–15	70

Date	Snow Height (cm)	Drifted Snow Height (cm)
19.04.2011	22–25	70
26.04.2011	2–5	50

7.8.2 *Air Quality Information from Desktop Literature Survey*

This section of the report describes air quality in the vicinity of the facility locations i.e. CSG1, CSG2 and PRMS.

7.8.2.1 *Relevant air quality standards*

In the European Union, the Air Quality Framework Directive (1996) established a framework under which the EU could set limit or target values for specified air pollutants. A number of 'daughter directives' followed, setting standards for additional pollutants. These were in the main consolidated by the Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe.

The World Health Organization (WHO) has published its own air quality guidelines for worldwide use, based on scientific evidence concerning air pollution and human health. The EU standards are based in part on the WHO guidelines, and the majority of the standards are similar.

Relevant European and WHO air quality standards are summarised in Table 7-36.

Table 7-36: WHO and European Air Quality Standards

Substance	EU Directive (µg/m³)		WHO Guidelines (µg/m³)	
Nitrogen dioxide (NO_2)	40	Annual mean	40	Annual mean
	200	Hourly mean, not to be exceeded more than 18 times per calendar year	200	Hourly mean
Sulphur dioxide (SO_2)	-	-	500	10-minute mean
	350	Hourly mean, not to be exceeded more than 24 times per calendar year	-	-
	125	24-hour mean not to be exceeded more than 3 times a calendar year	20	24-hour mean
	20	Annual or winter mean-critical level for ecosystem protection	-	
Particles (PM_{10})	40	Annual mean	20	Annual mean
	50	24-hour mean, not to be exceeded more than 35 times per calendar year	50	24-hour mean
Particles ($PM_{2.5}$)	-	24-hour mean	25	24-hour mean
	25	Annual mean, to be achieved by 2015	10	Annual mean
	20	Annual mean, to be achieved by 2020		
Carbon monoxide (CO)	10,000	8-hour mean	10000	8-hour mean
Benzene	5	Annual mean	-	-

7.8.2.2 *Existing air quality information*

A programme of air quality monitoring is carried out by BP Operations at the existing BTC/SCP facilities (PSG1/Area 72 and Area 80) where CSG1 and PRMS will be collocated: Nitrogen dioxide, sulphur dioxide and benzene were measured approximately quarterly until 2010 when the frequency was reduced to annually, using diffusion tubes at locations around the existing Facilities.

Table 7-37, Table 7-38 and Table 7-39 summarise the mean concentrations of nitrogen dioxide, sulphur dioxide and benzene, respectively, from 2007 to 2011.

The measured NO_2 concentrations are all substantially below the EU and WHO annual mean standard, and are consistent with semi-rural background concentrations. Data for the years 2008 and 2009 are significantly lower than those for the preceding and following years.

It is considered that quarterly measurements will provide a reasonable approximation to annual mean concentrations.

Table 7-37: Mean Nitrogen Dioxide Concentrations Measured at PSG1 and PRMS

Location	BP Point ID	Grid reference		Mean NO_2 (µg/m^3)					Mean: 2007–2011
		x	y	2007	2008	2009	2010	2011	
PSG1	AAQ1	8512281	4589692	7.7	1.2	0.4	*	4.2	3.4
PSG1	AAQ2	8512416	4589430	10	1.6	0.4	6.1	5.1	4.6
PSG1	AAQ3	8512319	4588991	13.3	2.1	0.4	4.6	3.8	4.8
PSG1	AAQ4	8512535	4589125	7	1.6	0.4	6.7	6	4.3
PSG1	AAQ5	8512627	4589361	8	1.7	0.5	5.1	5.3	4.1
PRMS	AA11	8319390	4609919	*	0.8	0.3	4.2	3.1	2.1
PRMS	AAQ12	8319491	4610191	*	0.6	0.2	4.4	2.6	2.0
PRMS	AAQ13	8319285	4610311	*	0.5	0.1	2.1	1.3	1.0
PRMS	AAQ14	8319173	4609753	*	0.2	0.2	3.7	1.8	1.5
PRMS	AAQ15	8319516	4610086	*	0.6	0.2	3.4	3.2	1.9

* No data

The measured SO_2 concentrations represent periods of several (typically 30) days and are not therefore appropriate for comparison against daily or hourly mean standards, however diffusion tubes are the only appropriate methodology for monitoring SO_2 in this circumstance and the values obtained are substantially below the daily and hourly standards giving a strong indication that frequent exceedance is unlikely. The majority of the SO_2 concentrations measured are substantially below the European standard for the protection of ecosystems, which, although not strictly applicable to the CSG1 or the PRMS (and therefore used for benchmarking purposes only), provides a further benchmark against which the data may be compared.

Table 7-38: Mean Sulphur Dioxide Concentrations Measured at PSG1 and Area 80

Location	BP Point ID	Grid Reference		Mean SO_2 (µg/m^3)				
		x	y	2007	2008	2009	2010	2011
PSG1	AAQ1	8512281	4589692	4.1	1.5	0.6	6.7	7
PSG1	AAQ2	8512416	4589430	17.7	1.6	0.5	13.1	12.7

Location	BP Point ID	Grid Reference		Mean SO_2 (µg/m^3)				
		x	y	2007	2008	2009	2010	2011
PSG1	AAQ3	8512319	4588991	24.5	1.2	0.5	60.5	8
PSG1	AAQ4	8512535	4589125	3.5	3.0	0.6	8.7	7
PSG1	AAQ5	8512627	4589361	2.5	2.9	2.8	5.9	6.1
Area 80	AAQ11	8319390	4609919	*	1.1	0.4	11.8	4.6
Area 80	AAQ12	8319491	4610191	*	0.5	0.4	12	5
Area 80	AAQ13	8319285	4610311	*	0.7	0.3	7.1	6.1
Area 80	AAQ14	8319173	4609753	*	0.7	0.3	20.3	7.2
Area 80	AAQ15	8319516	4610086	*	0.8	0.4	5.8	5.8

* No data

The benzene concentrations measured do not exceed the European annual mean standard of 5µg/m^3 and would be consistent with rural background concentrations.

Table 7-39: Mean Benzene Concentrations Measured at PSG1 and Area 80

Location	BP Point ID	Grid Reference		Mean Benzene (µg/m^3)				
		x	y	2007	2008	2009	2010	2011
PSG1	AAQ1	8512281	4589692	0.4	1.8	0.8	0.5	0.55
PSG1	AAQ2	8512416	4589430	1.5	0.6	0.7	0.6	0.4
PSG1	AAQ3	8512319	4588991	0.4	0.6	0.6	0.5	0.65
PSG1	AAQ4	8512535	4589125	0.9	0.5	0.6	0.5	0.55
PSG1	AAQ5	8512627	4589361	2.1	0.6	0.8	0.5	0.5
A80	AAQ11	8319390	4609919	*	0.4	0.4	0.3	0.15
A80	AAQ12	8319491	4610191	*	0.4	0.2	0.1	0.25
A80	AAQ13	8319285	4610311	*	0.4	0.3	0.2	0.25
A80	AAQ14	8319173	4609753	*	0.3	0.3	0.2	0.25
A80	AAQ15	8319516	4610086	*	0.3	0.3	0.2	0.25

* No data

7.8.3 Data Gaps and Field Survey Methods

7.8.3.1 Data gaps

The existing BP Operations air quality monitoring at PSG1 and PRMS provide information on likely NO_2, SO_2 and benzene concentrations experienced at the boundary of these sites, although no information is available concerning existing air quality at CSG2 owing to the greenfield nature of the site.

The existing BP Operations air quality monitoring programme does not routinely include monitoring of particulate matter (PM_{10} or $PM_{2.5}$) as levels were demonstrated to be low during the early operations phase.

As defined in the scoping study two rounds of baseline air quality monitoring should be conducted to acquire data using diffusion tubes for NO_2, benzene (as part of VOC) and SO_2, and using a sampler for PM_{10} and $PM_{2.5}$. One round was to be carried out during summer at CSG1, CSG2 and the PRMS to capture agricultural emissions (e.g. stubble burning). The other round was to be carried out in winter at CSG1 and the PRMS only (CSG2 being inaccessible due to snow) to capture the potential for higher emissions from community fuel combustion and seasonal meteorological differences, to affect local air quality.

The baseline air-quality field survey was conducted to attempt to address these data gaps.

7.8.3.2 Field survey methods

Baseline air quality monitoring was conducted at a number of locations at and around the proposed facility locations:

- CSG1 (collocated with the existing PSG1)
- CSG2
- PRMS (collocated with the existing Area 80).

Nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and volatile organic compounds (VOC, including benzene) were measured using passive diffusion tubes.

Airborne particulates (PM_{10} and $PM_{2.5}$) were sampled using paired sequential low volume samplers (Sven Leckel SEQ 47/50) to obtain 24-hour samples of airborne PM_{10} and $PM_{2.5}$, for approximately 14 days at each at CSG1 and PRMS.

Portable, battery-powered nephelometers were deployed in May and June 2012 at CSG2, where no mains electricity supply is present.

Nitrogen dioxide, sulphur dioxide and volatile organic compounds
NO_2, SO_2 and VOC concentrations were measured using passive diffusion tubes, as follows:

- NO_2 diffusion tubes
- SO_2 diffusion tubes
- Carbopack tubes for benzene and VOC.

Diffusion tubes were transported, deployed and analysed in accordance with BS EN 13528-2:2002. Travel blanks were employed to account for possible exposure in transit.[4]

NO_2 and SO_2 diffusion tubes were exposed for periods of approximately one month and VOC tubes for approximately two weeks.

Potential diffusion tube sites were initially proposed based on a desk study at locations intended to represent receptors (typically dwellings) and conditions up and down the prevailing wind direction of the proposed CSG1, CSG2 and PRMS facilities.

The proposed monitoring locations were then inspected in the field at the micro-scale to identify appropriate locations that, as far as practicable, were:

- Capable of mounting diffusion tubes 1.5 to 2m above ground level
- More than 1m from obstructions such as buildings or trees to avoid local air flow perturbations
- At secure locations agreed with the landowner
- Away from obvious local sources of emissions, e.g. residential flues or chimneys.

Tubes were mounted on existing structures such as telegraph poles or street furniture.

[4] Due to difficulties in the field, the travel blanks from the summer 2011 survey were lost and hence re-surveys were undertaken in 2012.

Following exposure, the tubes were collected and returned to the approved laboratory for analysis. In the laboratory, the tubes were analysed in accordance with BS EN 13528-2:2002.

Particulate matter
At CSG1 and A80, where an electricity supply was available, sampling of ambient airborne particulate matter was carried out according to the following European Reference Methods:

- BS EN 12341:1999 for measurement of PM_{10}
- BS EN 14907:2005 for measurement of $PM_{2.5}$.

Paired sequential low volume samplers (Sven Leckel SEQ 47/50) were used to obtain 24-hour samples of airborne PM_{10} and $PM_{2.5}$ daily, for 14 days at each of CSG1 and A80. The instruments are gravimetric European Reference samplers according to the methodology set out in BS EN 12341:1999 and BS EN 14907:2005. A measured volume of air is drawn through a conditioned and pre-weighed filter, which is subsequently re-weighed in the laboratory to determine the quantity of particulate matter retained on the filter. The sequential sampler is fitted with a carousel that stores up to 17 filters, which are automatically exchanged daily to capture daily sample periods without daily attendance. The sequential samplers operate on a mains electricity supply (230V, 50/60Hz).

Portable, battery-powered nephelometers were deployed in May and June 2012 at CSG2, where no mains electricity supply is present. Nephelometers are not equivalent to the reference methods for the determination of airborne particulates, although they provide near continuous data and are considered to represent a proportionate, practicable technique for CSG2. The units were powered using 110Ah ‘leisure batteries’ allowing approximately one week of operation between battery changes. The nephelometers were fitted with in-line filter mounts, in which were placed pre-weighed filters which were re-weighed on their return from the field to the laboratory, such that the nephelometer readings could be ‘scaled’ or corrected according to the mass of particulate matter retained on the filters and the sampled air volume.

Guidance on the macro and micro-scale siting of air quality monitoring points is provided by a number of relevant documents, including: BS 12341:1999, Directive 2008/50/EC and UK DEFRA Technical Guidance on Local Air Quality Management TG(09). Based on this guidance, the following criteria were applied as far as practicable in the selection of PM monitoring locations:

- Sites should be secure to prevent loss, damage or tamper by unauthorised persons
- An appropriate electricity supply shall be available, provided by a competent person
- The site and instrument shall be safely accessible to authorised persons
- Sites should be in as open a setting as possible in relation to surrounding buildings
- The flow around the sampler’s inlet shall be unrestricted without any obstructions (such as balconies, trees, vertical surfaces or walls, etc.) affecting the air flow in the vicinity of the samplers
- Immediately above the inlet should be open to the sky, with no overhanging trees, structures or buildings
- Inlets shall be set at the same height (between 1.5m and 8m) above the ground
- Inlets shall be positioned away from existing major local sources (e.g. stacks, car parks) in order to avoid drifting plumes
- There should be no medium-sized emission sources (e.g. example, petrol stations, ventilation outlets to catering establishments etc) within 20m
- Cars/vans/lorries should not normally or regularly stop with their engines idling within 5m of the sample inlet

- The sampler's exhaust outlet shall be positioned so that recirculation of exhaust air to the sampler inlet is avoided.

7.8.3.3 Sampling locations

The reference method particulate matter samplers were deployed at locations within the existing boundaries of PSG1 and the PRMS (Area 80) owing to the requirement for security and a power supply.

Diffusion tubes were deployed at locations intended to represent community receptors. The locations are presented in Table 7-40, Table 7-41 and Table 7-42.

Table 7-40: Monitoring Locations at CSG1

Monitoring Location	Grid Reference	Description	Equipment and Durations
CSG1-1	8510941, 04591393	Farm	NO_2 tubes, for 1 month SO_2 tube for 1 month VOC tube for 2 weeks
CSG1-2	08512741, 04589722	Farmhouse at former military base near CSG1	NO_2 tubes, for 1 month SO_2 tube for 1 month
CSG1-3	08513006, 04587965	Farm, Zargeri Ltd	NO_2 tubes, for 1 month SO_2 tube for 1 month VOC tube for 2 weeks
CSG1-4	08509211, 04588945	Kesalo Village, house	NO_2 tubes, for 1 month SO_2 tube for 1 month
CSG1-PM	08512004, 04589387	Within CSG1 boundary, at available electricity supply	SEQ-47 for PM_{10}, for 2 weeks SEQ-47 for $PM_{2.5}$, for 2 weeks Minivol for PM_{10}, for 2 weeks Minivol for $PM_{2.5}$, for 2 weeks

Table 7-41: Monitoring Locations at CSG2

Monitoring Location	Grid Reference	Description	Equipment & Durations
CSG2-1	08401095, 04618229	Khando village, house behind farms at beginning of village	NO_2 tubes, for 1 month SO_2 tube for 1 month VOC tube for 2 weeks
CSG2-2	08405203, 04616562	Rekha village, first house right side of village entrance	NO_2 tubes, for 1 month SO_2 tube for 1 month
CSG2-3	08407505, 04614502	Avranlo village	NO_2 tubes, for 1 month SO_2 tube for 1 month
CSG2-4	08405966, 04613082	Kizilkilisa village	NO_2 tubes, for 1 month SO_2 tube for 1 month VOC tube for 2 weeks
CSG2-6	08402812, 04611028	Burnasheti village, house	NO_2 tubes, for 1 month SO_2 tube for 1 month

Table 7-42: Monitoring Locations at the PRMS

Monitoring Location	Grid Reference	Description	Equipment and Durations
PRMS -1	08319073, 04610971	Approx. 1km north of the PRMS boundary	NO_2 tubes, for 1 month SO2 tube for 1 month
PRMS -2	08321383, 04610349	Naokhrebi village	NO_2 tubes, for 1 month SO_2 tube for 1 month VOC tube for 2 weeks
PRMS -3	08318550,	Abandoned building	NO_2 tubes, for 1 month

Monitoring Location	Grid Reference	Description	Equipment and Durations
	04609010		SO_2 tube for 1 month
PRMS -4	08318773, 04610030	Remains of building	NO_2 tubes, for 1 month SO_2 tube for 1 month VOC tube for 2 weeks
PRMS –PM	08319152, 04609897	Within existing A80 boundary, as required a power supply	SEQ-47 for PM_{10}, for 2 weeks SEQ-47 for $PM_{2.5}$, for 2 weeks Minivol for PM_{10}, for 2 weeks Minivol for $PM_{2.5}$, for 2 weeks

7.8.4 *Baseline Air Quality*

Results for summer and winter measurements taken at CSG1, CSG2 and the PRMS in 2011 and 2012 (summer results only) are summarised in the following sections. The results were used to estimate annual mean concentrations by separately averaging summer and winter results and then taking the mean of these 'seasonal averages'.

The VOC tubes were analysed for 'top 10' compounds in addition to those stated. The 'top 10' most abundant compounds adsorbed by the tube were identified. A number of compounds were detected at low concentrations.

The results from the PM instruments sited at CSG1 for the winter survey are considered invalid. However, re-sampling was not considered necessary as winter levels are likely to be influenced in the main by domestic fuel burning, e.g. coal or wood, and the majority of villages in this location use electricity and piped gas for cooking and electricity for heating. The original 2011 survey did not yield PM_{10} or $PM_{2.5}$ results for summer or winter at CSG2. Access to CSG2 was not considered practicable in winter, although re-sampling of summer PM_{10} and $PM_{2.5}$ concentrations at CSG2 was carried out in May and June 2012.

A large proportion of the diffusion tubes, including both VOC tubes, went missing from the CSG2 locality during the summer 2011 exposure; therefore, a re-sampling campaign was conducted in May and June 2012.

Sampling of benzene and VOC was originally undertaken at CSG1 and PRMS in summer 2011; however, the results were considered spurious so a re-sampling campaign of benzene and other VOC was carried out in May and June 2012.

The travel blanks from the 2012 SO_2 monitoring gave elevated results comparable with the exposed tubes. The laboratory confirmed that normal quality procedures were in place and therefore although it is likely that the tubes were contaminated at some point, the source of the apparent contamination is not clear, as normally elevated SO_2 results would also be associated with elevated NO_2 and or VOC results, which did not occur. It is not usual to 'blank correct' diffusion tube results by subtracting results of blank tubes. Therefore, the results are presented unadjusted, but it should be noted that these may overestimate actual summer 2012 concentrations and the estimated annual mean concentrations of SO_2.

The travel blank results for NO_2 and VOC were satisfactorily low.

7.8.4.1 *Air quality at CSG1*

The results of diffusion tube monitoring around CSG1 are presented in Table 7-43.

Table 7-43: Summer and Winter Campaign Diffusion Tube Results, CSG1

Monitoring Location	Period	Measured Pollutant Concentrations (µg/m^3)										
		NO_2	SO_2	Benzene	Toluene	Ethylbenzene	Xylene	Iso-butane	N-butane	Iso-pentane	N-pentane	N-hexane
CSG1 - 1	Summer 2011	18.1	27.2	-	-	-	-	-	-	-	-	-
	Summer 2012	7.0	16.6	0.8	1.1	1.3	2.6	1.4	1.9	1.8	3.9	1.1
	Winter 2011	5	10.4	0.8	0.1	0	0.1	5.9	1.9	0.9	1.5	0.0
	'Annual' Mean	8.8	16.2	0.8	0.6	0.7	1.4	3.7	1.9	1.3	2.7	0.5
CSG1 - 2	Summer 2011	13.9	31.6	-	-	-	-	-	-	-	-	-
	Summer 2012	6.7	12.6									
	Winter 2011	3.7	5.2	1.6	1.4	0.2	0.9	10.7	3.7	2.4	5.5	0.6
	'Annual' Mean	7.0	13.6	-	-	-	-	-	-	-	-	-
CSG1 - 3	Summer	11.1	16.8	-	-	-	-	-	-	-	-	-
	Summer 2012 A	14.0	10.6	0.7	1.1	1.3	2.6	1.9	1.9	1.8	3.0	1.1
	Summer 2012 B	9.3	20.9	0.6	1.1	1.3	2.6	1.9	1.9	1.5	3.0	1.1
	Winter 2011	5	3.2	1.4	1.4	0.2	0.7	5.6	3.4	2.4	4.3	0.2
	'Annual' Mean	8.2	9.7	-	-	-	-	-	-	-	-	-
CSG1 - 4	Summer 2011 A	14.1	21.7	-	-	-	-	-	-	-	-	-
	Summer 2011 B	17.0	24.0	-	-	-	-	-	-	--	-	-
	Summer 2012	8.1	10.5									
	Winter 2011 A	5.6	3.7	-	-	-	-	-	-	-	-	-
	Winter 2011 B	3.1	3.3	-	-	-	-	-	-	-	-	-
	'Annual' Mean	8.7	11.1	-	-	-	-	-	-	-	-	-

The NO_2 concentrations measured by the BP Operations programme are all substantially below the EU and WHO annual mean standard, and are consistent with semi-rural background concentrations.

Nitrogen dioxide concentrations measured for SCPX had a range of 3.1 to 18.1 µg/m^3. The estimated annual means are slightly higher than the results obtained by the BP Operations monitoring programme in 2007–2011 (see Table 7-37), but they do not exceed the EU or WHO standards/guidelines.

The precision of diffusion tube sampling of NO_2 is generally cited, in terms of coefficient of variation, as approximately 25%. Within this uncertainty, the duplicate NO_2 tubes were in reasonable agreement.

The summer results are generally greater than the winter concentrations, most likely due to the photocatalytic mediation of NO_2 formation. The weather during the summer campaign was fair and this may have contributed to elevated concentrations. None of the results exceeds the applicable EU and WHO standard.

Winter NO_2 results are generally lower than those measured in summer, probably reflecting seasonal variation. Although not a full year's data, the estimated annual means based on the means of the summer and winter results are considered likely to reflect annual mean conditions, which are well below the EU and WHO annual standard.

The BP Operations programme SO_2 results are in the main substantially below the daily and hourly standards giving a strong indication that frequent exceedance is unlikely. A single elevated SO_2 result of 60 µg/m^3 is reported at location AAQ3 in 2010, although this is based upon a single measurement and is likely to reflect atypical conditions or may be erroneous. The majority of the SO_2 concentrations measured are substantially below the European standard for the protection of ecosystems, which, although not strictly applicable to the CSG1 or the PRMS, provides a further benchmark against which the data may be compared.

Sulphur dioxide results from the SCPX programme at CSG1 were in general greater than those obtained by the BP Operations programme.

The winter SO_2 results are lower than those obtained during summer, and the winter mean results are more consistent with the existing BP Operations monitoring results.

Although some individual SO_2 measurements do exceed the EU criteria for the protection of human health or the protection of ecosystems, none of the estimated annual mean concentrations exceed the EU Protection of ecosystems criterion, which, although not strictly applicable to the CSG1, may be used as a benchmark against which the data may be compared.

Summer, winter and estimated annual mean benzene results were low, and do not exceed the relevant EU standard. The VOC tubes were analysed for 'top 10' compounds in addition to those stated. The 'top 10' most abundant compounds adsorbed by the tube are identified. A number of compounds were detected at low concentrations.

Table 7-44 presents the summer 24-hour mean PM_{10} and $PM_{2.5}$ results from CSG1. PM_{10} ranges between 13.3 and 46.0 µg/m^3 (see Figure 7-36) and $PM_{2.5}$ between 4.8 and 22.2 µg/m^3 (see Figure 7-37).

Table 7-44: Summer Campaign PM_{10} and $PM_{2.5}$ Results, CSG1

Date	24-hour mean PM_{10} ($\mu g/m^3$)	24-hour mean $PM_{2.5}$, ($\mu g/m^3$)
07/07/2011	24.8	15.8
08/07/2011	46.0	21.3
09/07/2011	35.2	18.5
10/07/2011	29.8	16.1
11/07/2011	24.2	13.4
12/07/2011	13.3	4.8
13/07/2011	24.6	15.3
14/07/2011	21.3	13.7
15/07/2011	19.4	11.5
16/07/2011	30.8	19.0
17/07/2011	34.8	18.5
18/07/2011	31.4	17.4
19/07/2011	28.0	18.0
20/07/2011	42.2	22.2
Period mean	29.0	16.1

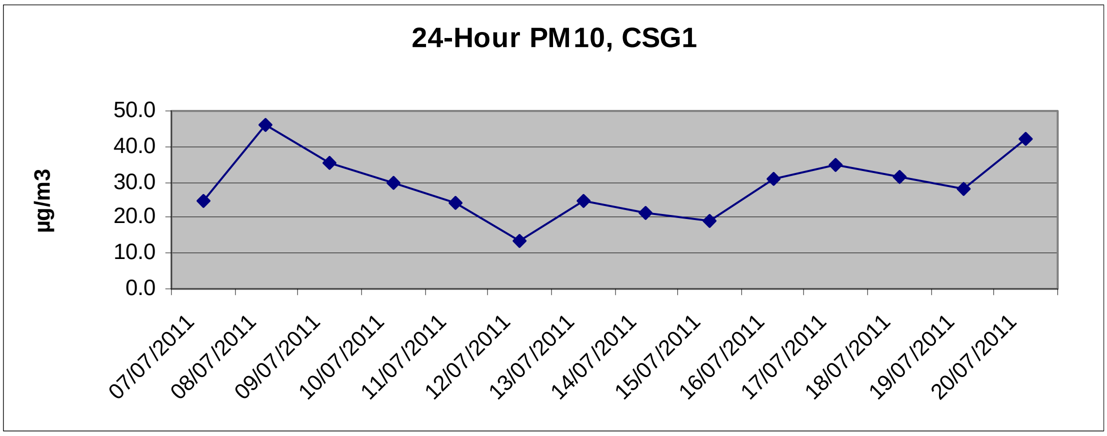


Figure 7-36: Graph of Summer 24-hour Mean PM_{10} Results at CSG1

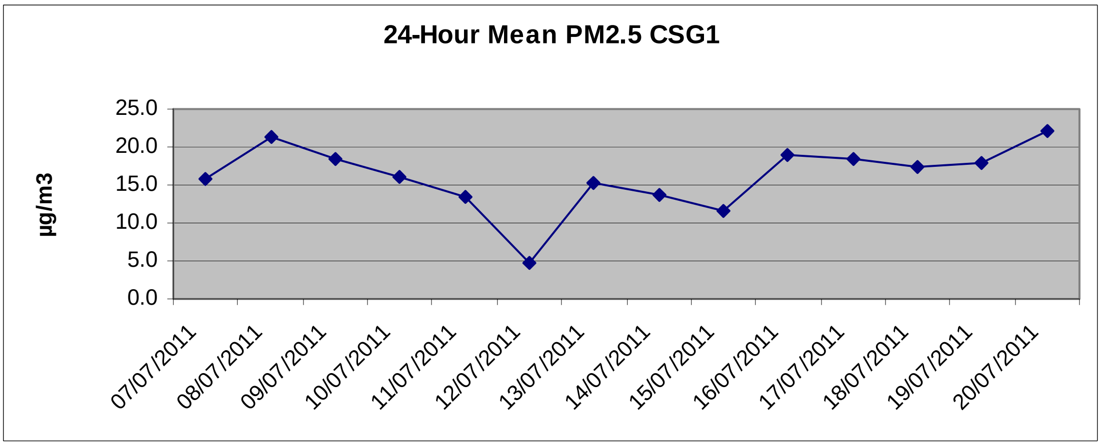


Figure 7-37: Graph of Summer 24-hour Mean $PM_{2.5}$ Results at CSG1

The PM results are somewhat higher than the anticipated annual mean. However, the sampling was carried out during the summer, so dry summer weather may cause an overestimation of the annual mean. Soils and deposited dust on surfaces are likely to be drier during the summer, and more readily available for suspension or resuspension in air.

The PM_{10} results do not exceed the EU and WHO 24-hour mean standards/guidelines, and the period mean for the 14-day sampling period does not exceed the EU annual mean standard. The period mean does exceed the WHO annual mean standard for PM_{10}, although, as noted previously, summer PM_{10} concentrations are likely to be an overestimate of the annual mean. Unfortunately, owing to technical difficulties, no PM_{10} data were obtained for the winter campaign at CSG1, however as noted previously results are expected to be lower than in summer due to more favourable meteorological conditions.

The $PM_{2.5}$ results do not exceed the WHO 24-hour mean guideline. The period mean does not exceed the EU annual mean limit value standard for $PM_{2.5}$, but would exceed the WHO annual mean standard. Again, these summer concentrations are likely to overestimate the annual mean.

7.8.4.2 Air quality at CSG2

Table 7-45 presents the results of diffusion tube analysis from the summer and winter SCPX survey campaigns, 2011 and summer survey (2012).

Table 7-45: Summer and Winter Campaign Diffusion Tube Results, CSG2

Monitoring Location	Period	Measured Pollutant Concentrations, µg/m³										
		NO_2	SO_2	Benzene	Toluene	Ethylbenzene	Xylene	Iso-butane	N-butane	Iso-pentane	N-pentane	N-hexane
CSG2-1	Summer 2011	Missing	Missing	-	-	-	-	-	-	-	-	-
	Summer 2012	2.7	(49.9[5])									
	Winter 2011	0.9	1.5	0.6	0.3	0	0.1	0	2.6	0	0.5	0
	'Annual' Mean	1.8	1.5									
CSG2-2	Summer 2011	4.5	8.4	-	-	-	-	-	-	-	-	-
	Summer 2012	3.1	5.1									
	Winter 2011 A	1.5	2.6	-	-	-	-	-	-	-	-	-
	Winter 2011 B	0.5	6.5	-	-	-	-	-	-	-	-	-
	'Annual' Mean	2.4	5.7	-	-	-	-	-	-	-	-	-
CSG2-3	Summer 2011	4.7	6.2	-	-	-	-	-	-	-	-	-
	Summer 2012	2.2	12.2									
	Winter 2011	<0.5	5.2	-	-	-	-	-	-	-	-	-
	'Annual' Mean	2.0	7.2	-	-	-	-	-	-	-	-	-
CSG2-4	Summer 2011	Missing	5.7	Missing	Missing	Missing	Missing	Missing	Missing	Missing	Missing	Missing
	Summer 2012	2.1	7.3	0.6	0.1	0.1	0.4	0.2	0.1	0.1	0.1	0.1
	Winter 2011	1.8	1.5	1	0.8	0.2	0.7	1.6	0.9	0.8	1.5	0.1
	'Annual' Mean	1.8	3.6	-	-	-	-	-	-	-	-	-
CSG2-5	Summer 2011	Missing	Missing	-	-	-	-	-	-	-	-	-
	Summer 2012 A	1.1	8.4	<0.3	0.1	0.1	0.4	0.2	0.1	0.1	0.1	0.1
	Summer 2012 B	1.4	7.2	0.4	0.1	0.1	0.4	0.3	0.1	0.1	0.1	0.1
	Winter 2011	1.6	2.3	-	-	-	-	-	-	-	-	-
	'Annual' Mean	1.4	5.1	-	-	-	-	-	-	-	-	-
CSG2-6	Summer 2011	Missing	Missing	-	-	-	-	-	-	-	-	-
	Summer 2012	2.2	9.4									

[5] This result was considered spurious on the basis of incompatibility with results from surrounding locations and the poor performance of the blank tubes. As it was also not obtained at a receptor location, it was excluded from the calculation of the annual mean.

Monitoring Location	Period	Measured Pollutant Concentrations, µg/m^3										
		NO_2	SO_2	Benzene	Toluene	Ethylbenzene	Xylene	Iso-butane	N-butane	Iso-pentane	N-pentane	N-hexane
	Winter 2011	1.6	4.9	2.2	2.9	0.2	2.9	8.1	1.1	0.4	22.8	12.5
	'Annual' Mean	1.9	7.2	-	-	-	-	-	-	-	-	-

Summer, winter and estimated annual mean NO_2 and SO_2 concentrations measured in the vicinity of CSG2 were substantially below the EU and WHO annual mean standard for NO_2, the annual mean EU standard for SO_2 for the protection of ecosystems (although this is not strictly applicable, but is provided as a benchmark) and the daily mean WHO standard for SO_2 (although the sampling period was greater than one day), and are considered to be consistent with a rural setting. Winter NO_2 and SO_2 results are in general lower than summer results. The reasons for this are probably related to photochemistry, in the case of NO_2. A single elevated SO_2 result was obtained at the CSG2 weather station (CSG2-1), although this datum was considered likely to be spurious or erroneous based on incompatibility with results from surrounding locations and the poor performance of the blank tubes, so it was excluded.

The VOC tubes were analysed for the ‘top 10’ most abundant compounds adsorbed by the tube in addition to those stated. A number of compounds were detected at low concentrations. The winter tube at CSG2-6 showed greater, although still very low, concentrations. It is hypothesised that waste burning may have been carried out in the vicinity of this tube.

Gravimetrically corrected daily mean PM_{10} measurements for the CSG2 weather station location in summer 2012 do not exceed the EU or WHO 24-hour mean standards/guidelines, and the period mean for the 13-day sampling period would not exceed the EU or WHO annual mean standards. As noted previously, summer PM_{10} concentrations are likely to be an overestimate of the annual mean, and the measurements are considered consistent with a rural background setting.

The gravimetrically corrected daily mean $PM_{2.5}$ results for the CSG2 Weather Station location in summer 2012 do not exceed the WHO 24-hour mean guideline and the 13-day period mean would not exceed the EU or WHO annual mean standards. These are presented in Table 7-46 and Figure 7-38.

Table 7-46: Summer Campaign PM_{10} and $PM_{2.5}$ Results, CSG2

Date	24-hour mean PM_{10}, µg/m^3	24-hour mean $PM_{2.5}$, µg/m^3
30/05/2012	23.2	11.3
31/05/2012	27.9	14.5
01/6/2012	10.9	5.6
02/6/2012	2.3	1.1
03/6/2012	10.0	6.9
04/6/2012	14.3	9.8
05/6/2012	0.0	0.0
06/6/2012	15.3	9.6
07/6/2012	18.8	11.1
08/6/2012	7.4	4.5
9/6/2012	3.3	0.8
10/6/2012	6.5	2.9
11/6/2012	1.5	0.2
Period mean:	10.9	6.4

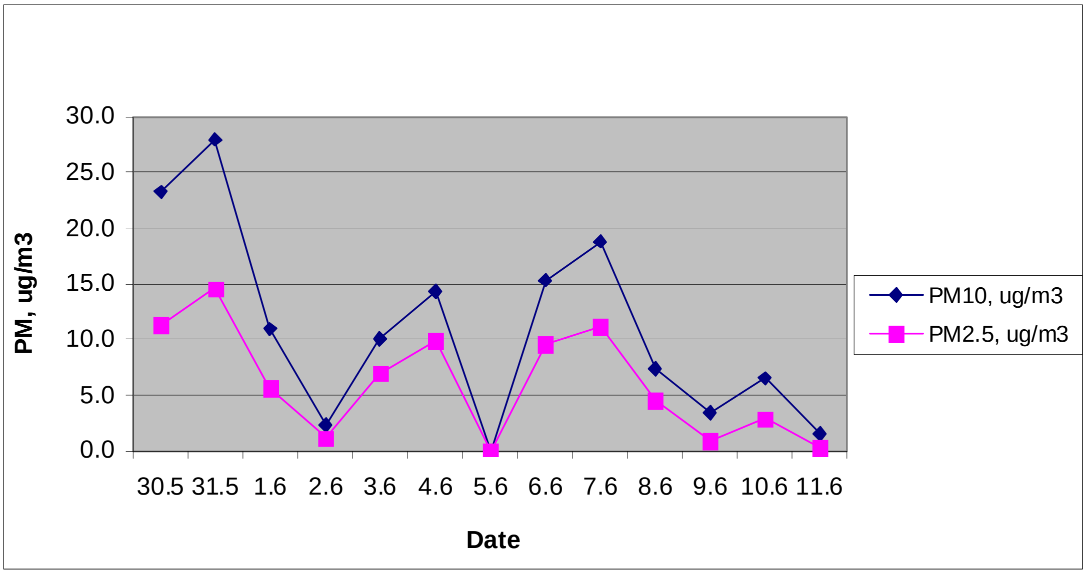


Figure 7-38: 24-Hour PM10 and PM2.5, CSG2 Weather Station, Summer 2012

7.8.4.3 Air quality at the PRMS

Results from the BP Operations programme (up to 2011) for NO_2, SO_2 and benzene measured in the vicinity of PRMS are presented in Table 7-37, Table 7-38 and Table 7-39 above.

The BP Operations measured NO_2 concentrations are all substantially below the EU and WHO annual mean standard and are consistent with semi-rural background concentrations.

Although representing periods of several weeks, the BP Operations SO_2 results are substantially below the daily and hourly standards giving a strong indication that frequent exceedance is unlikely. The majority of the SO_2 concentrations measured are substantially below the European standard for the protection of ecosystems (which, although not strictly applicable to the PRMS, provides a further benchmark against which the data may be compared). However, a single elevated SO_2 result of 20.3µg/m^3 is reported which would marginally exceed this standard, at location AAQ14 in 2010.

The BP Operations programme benzene concentrations measured do not exceed the European annual mean standard of 5µg/m^3, and are consistent with rural background concentrations.

Table 7-47 presents the results of the analysis of diffusion tubes from the summer and winter campaigns.

Table 7-47: Summer and Winter Campaign Diffusion Tube Results, PRMS

Monitoring Location	Period	Measured Pollutant Concentrations, µg/m³										
		NO_2	SO_2	Benzene	Toluene	Ethylbenzene	Xylene	Iso-butane	N-butane	Iso-pentane	N-pentane	N-hexane
PRMS 1	Summer 2011	1.5	4.6	-	-	-	-	-	-	-	-	-
	Summer 2012	2.6	9.4									
	Winter 2011	<0.5	8.4	-	-	-	-	-	-	-	-	-
	'Annual' Mean	1.3	7.7	-	-	-	-	-	-	-	-	-
PRMS 2	Summer 2011	2.3	7.9	-	-	-	-	-	-	-	-	-
	Summer 2012	2.4	7.3	0.4	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.1
	Winter 2011	2	1.4	0.8	0.6	0.1	0.5	1.6	0.8	0.6	1.8	0.1
	'Annual' Mean	2.2	4.5	0.6	0.3	0.1	0.4	0.8	0.4	0.3	0.9	0.1
PRMS 3	Summer 2011	2	36.4	-	-	-	-	-	-	-	-	-
	Summer 2012	15.5	10.1									
	Winter 2011	0.5	9.9	-	-	-	-	-	-	-	-	-
	'Annual' Mean	4.6	16.7	-	-	-	-	-	-	-	-	-
PRMS 4	Summer 2011 A	2.7	5	-	-	-	-	-	-	-	-	-
	Summer 2011 B	2.9	14.3	-	-	-	-	-	-	-	-	-
	Summer 2012 A	2.1	10.2	<0.3	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.1
	Summer 2012 B	2.9	18.5	0.3	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.1
	Winter 2011 A	2.7	1.7	0.2	0.2	0	0.1	0.1	1.5	0	0.3	0
	Winter 2012 B	2.6	1.9	-	-	-	-	-	-	-	-	-
	'Annual' Mean	2.7	6.9	0.3	0.1	0.0	0.2	0.1	0.8	0.0	0.2	0.0

The SCPX programme individual summer and winter NO_2 concentrations in the vicinity of the PRMS were in the range <0.5 to 15.5 µg/m^3. The estimated annual mean NO_2 concentrations were between 1.3 and 4.6µg/m^3 and were substantially below the EU and WHO annual mean standards. They showed relatively little variation and were considered consistent with the rural setting and the concentrations measured by the BP Operations programme in 2010 and 2011.

An unexpectedly high SO_2 result was obtained at location PRMS-3 in summer 2011, whilst the 2011 duplicate results at location 4 were poor, with one result being low as expected for a rural location, and the other result being higher than expected. The difference between these results was greater than 25%, indicating poor duplication and suggesting that one or more of the results may be erroneous. An elevated individual SO_2 result was obtained at PRMS-4 in summer 2012; however, its duplicate result was lower, suggesting that one or more of the results may be erroneous. It is noted that occasional elevated SO_2 results are present in the BP data also.

Winter SO_2 results were generally lower and were more consistent with results reported by the BP Operations programme, suggesting that the summer results may have overestimated the annual mean concentrations.

The estimated annual mean SO_2 results do not exceed the EU hourly or daily standards (although the sampling period was greater than one day) or the annual mean ecosystem standard (not strictly applicable but comparison made for benchmarking purposes) or the daily mean WHO standard (although the sampling period was greater than one day). The results are comparable with those obtained at CSG2.

Summer and winter measurements and estimated annual mean concentrations of benzene were low, considered consistent with a rural setting and do not exceed the EU standard. The VOC tubes from the winter survey were analysed for ‘top 10’ compounds in addition to those stated. The ‘top 10’ most abundant compounds adsorbed by the tube are identified. A number of compounds were detected at low concentrations.

Table 7-48 presents the summer 24-hour mean PM_{10} and $PM_{2.5}$ results from around the PRMS. PM_{10} ranges between 5.0 and 40.6 µg/m^3 and $PM_{2.5}$ between 4.1 and 22.5 µg/m^3.

The summer 24-hour mean PM_{10} results from around the PRMS do not exceed the EU or WHO 24-hour mean standard, and the period mean does not exceed the EU annual mean standard, however the period mean does exceed the WHO annual mean standard for PM_{10}.

The summer 24-hour mean $PM_{2.5}$ results from around the PRMS does not exceed the WHO 24-hour mean standard. The period mean does not exceed the EU annual mean limit value standard for $PM_{2.5}$, but would exceed the WHO annual mean standard.

Soils and deposited dust on surfaces are likely to be drier during the summer, and more readily available for suspension or resuspension in air, leading to higher concentrations of suspended particulate matter. The PM_{10} and $PM_{2.5}$ data obtained during winter survey are lower than those obtained during summer.

The mean of the summer and winter PM_{10} and $PM_{2.5}$ concentrations are 14.2µg/m^3 and 8.6µg/m^3, respectively and do not exceed the respective WHO annual mean standards. These are consistent with a rural location.

Table 7-48: Summer Campaign PM_{10} and $PM_{2.5}$ Results, PRMS

Date	24-Hour Mean PM_{10} (µg/m^3)	24-Hour Mean $PM_{2.5}$ (µg/m^3)
01/08/2011	28.6	16.7
02/08/2011	31.3	18.3
03/08/2011	30.7	18.0

Date	24-Hour Mean PM_{10} (µg/m³)	24-Hour Mean $PM_{2.5}$ (µg/m³)
04/08/2011	40.6	22.5
05/08/2011	35.8	16.6
06/08/2011	31.3	19.1
07/08/2011	28.4	17.3
08/08/2011	5.0	4.1
09/08/2011	Invalid sample	4.5
10/08/2011	8.8	5.8
11/08/2011	7.3	6.6
12/08/2011	13.3	4.7
13/08/2011	16.1	8.9
14/08//2011	7.6	8.9
Mean	21.4	12.3

Table 7-49: Winter Campaign PM_{10} and $PM_{2.5}$ Results, PRMS

Date	24-Hour Mean PM_{10} (µg/m³)	24-Hour Mean $PM_{2.5}$ (µg/m³)
01/11/2011	3	4
02/11/2011	8	4
03/11/2011	13	3
04/11/2011	4	0
05/11/2011	9	3
06/11/2011	6	7
07/11/2011	5	7
08/11/2011	2	5
09/11/2011	19	1
10/11/2011	0	11
11/11/2011	21	18
12/11/2011	8	11
13/11/2011	0	0
14/11/2011	6	7
Mean	7	5

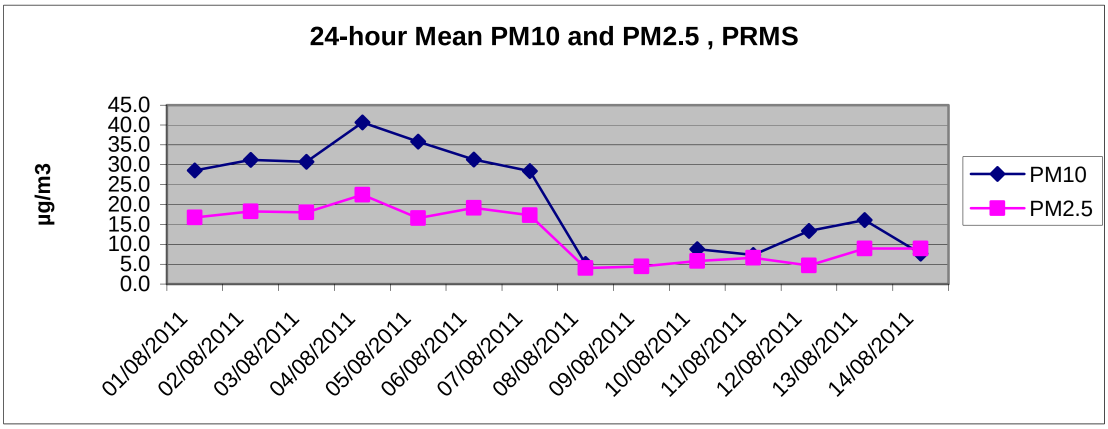


Figure 7-39: Graph of Summer 24-hour Mean PM_{10} and PM2.5 Results at PRMS

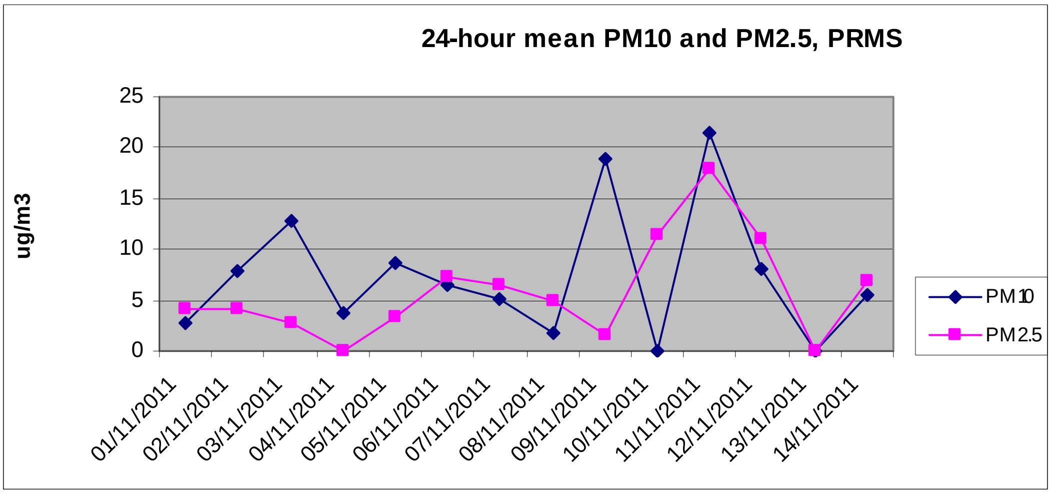


Figure 7-40: Graph of Winter 24-hour Mean PM_{10} and $PM_{2.5}$ Results at PRMS

7.8.5 Air Quality Sensitivity

The areas relevant to the Project are predominantly rural or semi-rural in nature, and air quality in these areas of Georgia is generally likely to be good.

Small communities are sited within approximately 1km of the proposed facilities. Existing ambient air quality may be affected by domestic emissions of volatile organic compounds (VOC) from kerosene fuelled domestic heating and lighting, and oxides of nitrogen, carbon monoxide, sulphur dioxide and particulate matter from domestic and agricultural activities such as burning of materials as waste or for fuel and operation of plant.

The following subsections summarise the components of the baseline conditions that, in the project context, are considered the most important based on the anticipated impacts of the project development.

7.8.5.1 Key sensitivities at CSG1

Estimated annual mean NO_2 concentrations do not exceed the EU or WHO standards/guidelines. The weather during the summer campaign was fair and this may have contributed to elevated concentrations, while winter NO_2 results are generally lower than those measured in summer. Although not a full year's data, the estimated annual means of the summer and winter results are more likely to reflect annual mean conditions and are consistent with the results obtained by the BP Operations monitoring programme.

The SO_2 concentrations measured in the SCPX summer campaign do not exceed the EU criteria for the protection of human health. Some individual results would exceed the EU threshold for the protection of ecosystems, although the estimated annual mean concentrations do not. This limit is not strictly applicable to the CSG1 location and is used for benchmarking purposes only. The winter SO_2 results were lower than those obtained during summer, and the winter and mean results are consistent with the BP Operations monitoring results.

Summer, winter and estimated annual mean benzene concentrations do not exceed the EU standard.

The PM results are generally higher than the anticipated annual mean, however the sampling was carried out during the summer. The PM_{10} results do not exceed the EU and WHO 24-hour mean standards/guidelines, and the period mean for the 14 day sampling period would not exceed the EU annual mean standard. The period mean would exceed the WHO annual mean standard for PM_{10}, due to possible overestimation by using summer results. The $PM_{2.5}$ results would not exceed the WHO 24-hour mean guideline. The period mean would not exceed the EU annual mean limit value standard for $PM_{2.5}$, but would exceed the WHO annual mean standard, again due to the use of summer data only.

7.8.5.2 *Key sensitivities at CSG2*

Summer, winter and estimated annual mean NO_2 concentrations measured in the vicinity of CSG2 were substantially below the EU and WHO annual mean standard and are considered to be consistent with a rural setting. With the exception of one suspected spurious result, summer, winter and estimated annual mean SO_2 concentrations in the vicinity of CSG2 were below the EU hourly, daily and annual mean (benchmark only) standards, and the WHO daily standard (although sample durations were greater than one day). Winter NO_2 and SO_2 results are in general lower than summer results.

Gravimetrically corrected daily mean PM_{10} measurements for the CSG2 weather station location in summer 2012 do not exceed the EU or WHO 24-hour mean standards/guidelines, and the period mean for the 13-day sampling period does not exceed the EU or WHO annual mean standards. As noted previously, summer PM_{10} concentrations are likely to be an overestimate of the annual mean, and the measurements are considered consistent with a rural background setting.

The gravimetrically corrected daily mean $PM_{2.5}$ results for the CSG2 weather station location in summer 2012 do not exceed the WHO 24-hour mean guideline and the 13-day period mean does not exceed the EU or WHO annual mean standards.

7.8.5.3 *Key sensitivities at the PRMS*

Summer, winter and mean NO_2 concentrations were substantially below the EU and WHO annual mean standards. They showed relatively little variation and were considered consistent with the rural setting and the concentrations measured by the BP Operations programme in 2010 and 2011.

Some elevated individual SO_2 measurements were obtained in both summer 2011 and summer 2012 which would exceed the level of the EU annual mean standard for the protection of ecosystems (used for benchmarking purposes only) and the WHO 24-hour mean guideline. Winter results were generally lower and were more consistent with results reported by the BP Operations programme, suggesting that the summer results may have overestimated the annual mean concentrations.

The estimated annual mean SO_2 results do not exceed the EU hourly or daily standards (although the sampling period was greater than one day), the annual mean standard for the protection of ecosystems (used for benchmarking purposes only) or the WHO 24-hour mean guideline or WHO standards and are comparable with those obtained at CSG2.

Summer, winter and estimated annual mean concentrations of benzene were low, considered consistent with a rural setting, and do not exceed the EU standard.

The summer 24-hour mean PM_{10} results from around the PRMS do not exceed the EU or WHO 24-hour mean standard, and the period mean does not exceed the EU annual mean standard, however the period mean does exceed the WHO annual mean standard for PM_{10}. The summer 24-hour mean $PM_{2.5}$ results from around the PRMS do not exceed the WHO 24-hour mean standard. The period mean does not exceed the EU annual mean limit value standard for $PM_{2.5}$, but does exceed the WHO annual mean standard, again potentially due to over-estimation using summer only results. Low PM_{10} and $PM_{2.5}$ concentrations were measured in winter. The mean of summer and winter concentrations of PM_{10} and $PM_{2.5}$ were well below the annual average air quality standard as expected at a rural location.

7.9 Noise

This section describes the noise environment at residential receptors near to CSG1, CSG2 and the PRMS.

7.9.1 *Information from Desktop Literature Survey*

Existing baseline noise data was reviewed from noise monitoring undertaken at PSG1 and PSG1 camp, the PRMS and Akhaltsikhe camp (2007 monthly, 2008 quarterly, 2009 now annual). Additional night-time noise measurements were recorded at the BTC block valves in 2008. Night-time noise monitoring was also carried out at villages and the closest dwelling houses around the proposed CSG1 and CSG2 locations in October 2010. As part of these surveys, measurements for plant noise were taken at site boundaries and at the nearest receptor locations. The methodology used does not constitute guidance for taking noise measurements for a background noise survey for the purposes of establishing new developments. These noise surveys found that noise from the existing plant is not audible at most of the nearest residential receptors, the exception possibly being the residents on the military camp near to CSG1.

RSK reviewed BTC/SCP operations complaints logs, but did not identify any complaints regarding noise from the existing plant sites.

7.9.2 *Data Gaps and Field Survey Methods*

7.9.2.1 *Data gaps*

The historical noise data from 2007 to 2009 was found to be insufficient to act as the baseline noise assessment for assessing the proposed development, or to supplement new noise measurements, for a variety of reasons.

To fill these data gaps, RSK carried out an unattended 24-hour noise survey at locations representing the nearest residential receptors. CSG1, CSG2 and PRMS are in rural locations and it was not considered likely that noise levels would alter significantly between weekend and weekday periods. A 24-hour survey was considered sufficient to capture representative diurnal variation in noise levels at the receptor locations. Community liaison officers were deployed into the field to identify noise monitoring locations based upon the following criteria:

- Receptor type – residents were identified as the most sensitive receptors in the development areas
- Proximity to the proposed developments
- Likely baseline noise environment – lower being the more sensitive.

7.9.2.2 *Survey methods*

Surveyors were mobilised to perform the noise measurements. The equipment used at each location is listed in Table 7-50. (Location maps are provided in Appendix G to the ESBR). The ‘representing receptors’ column within the results tables refer to nearby receptors that are considered represented by measurements at other locations owing to proximity and similar noise environment. The representativeness of data is explored in the sections for individual sites.

Table 7-50: Monitoring Equipment per Location

Location	Location Coordinates	SLM #	Microphone #
CSG1-N1	8512553 E 4589120 N	NOR140 Kit # 26	NOR1225 (s/n. 107008)
CSG1-N4	8513705 E 4590469 N	NOR140 Kit # 11	Gras-41AL/S #10 (s/n. 568)
CSG1-N6	8513010 E 4587967 N	NOR140 Kit # 22	Gras-41AL/S #8 (s/n. 562)
CSG1-N10	8510976 E 4591400 N	NOR140 Kit # 12	NOR1225 (s/n. 96190)
CSG1-N11	8510159 E 4587905 N	NOR140 Kit # 26	NOR1225 (s/n. 107008)
CSG2-N1	8402837 E 4611016 N	NOR140 Kit # 26	NOR1225 (s/n. 107008)
CSG2-N2	8405951 E 4614071 N	NOR140 Kit # 12	NOR1225 (s/n. 96190)
CSG2-N3	8405227 E 4616566 N	NOR140 Kit # 22	NOR1225 (s/n. 107010)
CSG2-N4	8401097 E 4618233 N	NOR140 Kit # 24	Gras-41AL/S #8 (s/n. 562)
PRMS-N1	8401097 E 4618233 N	NOR140 Kit # 12	Gras-41AL/S #8 (s/n. 562)
PRMS-N10	8401097 E 4618233 N	NOR140 Kit # 22	NOR1225 (s/n. 107010)
Monitoring Kits			
Kit # 11:	Norsonic NOR140 type 1 sound level meter ('SLM') (serial no. 3329-R) with NOR1209 pre-amplifier (serial no. 12817) and NOR1225 microphone (serial no. 48133) protected by foam NOR141 windshield		
Kit # 12	Norsonic NOR140 type 1 SLM (serial no. 3330-R) with NOR1209 pre-amplifier (serial no. 12816) and NOR1225 microphone (serial no. 96190) protected by foam NOR141 windshield		
Kit # 22	Norsonic NOR140 type 1 SLM (serial no. 4078-R) with NOR1209 pre-amplifier (serial no. 13491) and NOR1225 microphone (serial no. 107010) protected by foam NOR141 windshield		
Kit # 24	Norsonic NOR140 type 1 SLM (serial no. 4080-R) with NOR1209 pre-amplifier (serial no. 13493) and NOR1225 microphone (serial no. 107012) protected by foam NOR141 windshield		
Kit # 26	Norsonic NOR140 type 1 SLM (serial no. 4090-R) with NOR1209 pre-amplifier (serial no. 13480) and NOR1225 microphone (serial no. 107008) protected by foam NOR141 windshield		

Additional equipment used was:

- Three CA-1317 weather protection kits
- Short-term measurements: Norsonic 118 type 1 SLM (serial no. 31677) with pre-amplifier and microphone protected by foam windshield
- Calibration: Norsonic 1251 acoustic calibrator (serial no. 32194)
- Anenometer: Holdpeak HP-816A.

The survey measured background noise levels following British standard BS 7445-2:2003 '*Description and measurement of environmental noise'* Part 1: Guide to Quantities and Procedures. It recommends (in paragraph 5.4.3.3) that to facilitate the comparison of measurements of noise from different sources, 'it may be necessary to carry out measurements under selected meteorological conditions which are reproducible and correspond to quite stable propagation conditions.' These conditions include:

- Wind speed between 1 and 5m/s (measured at a height of 3 to 11m above the ground)
- No strong temperature inversions near the ground
- No heavy precipitation.

7.9.2.3 Weather conditions

Weather conditions were variable during the noise survey and notes were taken during installation and decommissioning of sound level meters (SLMs) with observations over the duration of the survey period while being in the local area of the SLMs. This latter means of assessing weather was not possible with location CS1-N11 as the acoustic consultant was not in the local area overnight during measurement at this location. However, in addition, it was possible to identify significant levels of rain and wind from the audio recording of the meters.

Based on anemometer data taken from site and an analysis of the audio, certain times were considered unsuitable for noise measurement as a result of inclement weather (see Table 7-51).

Table 7-51: Measurement Data Excluded due to Poor Weather Conditions

Location	Times Excluded	Reason
CSG1-N11	07/06/11 02:45 – 07/06/11 08:15	Rain
CSG2-N1	07/06/11 15:50 – 07/06/11 16:15	Rain
CSG2-N3	08/06/11 16:00 – 08/06/11 16:30	Rain
CSG2-N4	08/06/11 15:30 – 08/06/11 16:15	Rain

The SLMs and calibrator used conformed to the requirements of BS 7445. The equipment used had a calibration history that is traceable to a certified calibration institution.

The monitors were set so that a noise level appropriate to the location in question would trigger an audio recording of unrepresentative sound sources and poor weather conditions (i.e. rain and wind), allowing them to be identified. To identify threshold values for the purposes of the construction assessment, $L_{Aeq,\ T}$ for day, evening and night-time periods were recorded in addition to the L_{A90}.

Measurements were taken in ‘free-field’ conditions where possible, i.e. at least 3.5m from the façade of any building. The measurement location at CSG1-N6 was 2m from the residential building, as this was a position shielded from the tree rustle in the light breeze that would have otherwise dominated the background noise. The building had a structured wood façade and would not be considered reflective to a degree that would affect the measurement at this location.

Measurements were set to log octave band data for 15-minute periods (a time-period considered suitable to obtain a representative noise level), but a resolution of 1 second for the broadband sound pressure level. This allows for analysis by different time-periods. Calibration checks for the SLM were made before and after each measurement using the acoustic calibrator.

7.9.3 Baseline Noise Measurement

Noise data was analysed using Norsonic’s NorReview software package, which enables multiple time-frames to be extracted for the purposes of presenting $L_{Aeq,\ T}$ and for statistical analysis. This software was also utilised to exclude data that was affected by sources unrepresentative of the receptor location or because of poor weather (wind, rain). A full set of measurement results is presented in Appendix G to the ESBR with comments on times where data was partially excluded.

Measurements were recorded at CSG1-N4, but were excluded from the results for a variety of reasons, but mainly because it was evident from the night-time noise levels that a hydrological feature (sluice gate) was dominating the background noise and therefore would not represent the wider area around Jandari village.

Table 7-52 summarises the monitoring data, which is presented graphically per site on Figure 7-41, Figure 7-42 and Figure 7-43. Measurements consisted of several daytime periods. For instance, the measurement at location CSG1-N10 was started one day ('1st daytime), measured overnight and stopped the next day ('2nd daytime')[6].

Table 7-52: Background Noise Monitoring (dB) Summary for Daytime (07:00–23:00) and Night-time (23:00–07:00)

Area	CSG1				CSG2				PRMS	
Location	N1	N6	N10	N11	N1	N2	N3	N4	N1	N10
First Day of monitoring LA90, T	40	33	30	34	37	29	44	32	39	36
Second day of monitoring LA90, T	43	33	28	37	35	28	43	32	35	28
Third day of monitoring LA90, T	-	-	30	-	-	-	-	-	-	-
Night-time LA90, T	48	33	29	36	35	25	44	24	37	33
Lowest LA90, 15 min	38	30	23	31	34	22	40	22	31	24
Start time of lowest LA90, 15 min	14:30	12:00	09:15	13:30	02:45	04:15	15:30	02:45	13:30	09:45
00:00	48	34	31	39	36	28	46	31	38	32
01:00	48	35	28	37	35	28	45	24	37	33
02:00	48	34	30	35	35	25	45	22	35	32
03:00	48	32	27	PW	35	24	45	23	37	33
04:00	48	32	30	PW	36	23	43	23	36	34
05:00	49	37	36	PW	39	26	44	32	42	36
06:00	47	39	31	PW	38	26	45	32	37	34
07:00	46	36	30	PW	37	29	44	31	36	29
08:00	45	35	29	36	38	26	44	32	35	26
09:00	45	35	26	37	37	27	44	30	36	28
10:00	44	33	29	37	37	28	43	35	36	26
11:00	43	32	28	33	37	29	43	34	35	27
12:00	42	32	30	33	37	28	43	33	34	28
13:00	39	31	31	32	38	29	44	33	32	27
14:00	38	36	29	33	38	30	44	32	37	34
15:00	39	35	32	36	PW	32	41	33	36	31
16:00	39	34	33	36	35	PW	PW	32	37	32
17:00	39	33	31	36	35	28	44	SS	37	31
18:00	41	31	28	36	37	32	45	32	38	34
19:00	42	31	29	38	37	30	43	36	39	38

[6] Owing to security concerns at location CSG1-N10, the measurement was stopped and equipment uninstalled before background noise levels could be measured during the early afternoon. A third day of measurements was taken to acquire the missing time period.

Area	CSG1				CSG2				PRMS	
Location	N1	N6	N10	N11	N1	N2	N3	N4	N1	N10
20:00	43	34	30	39	36	30	42	33	39	36
21:00	47	34	29	40	35	29	45	34	41	IE
22:00	47	35	30	40	35	27	45	30	39	IE
23:00	47	34	31	39	36	27	45	28	38	36

Notes: IE = Instrument error/data corruption, SS = survey stopped to meet JMP, PW = poor weather

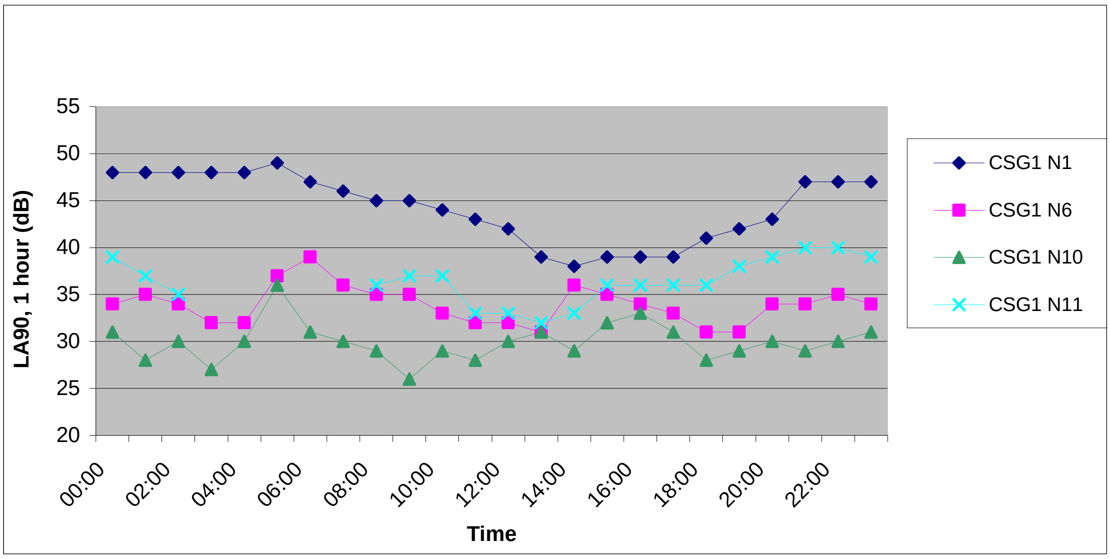


Figure 7-41: CSG1 Hourly LA90 Levels

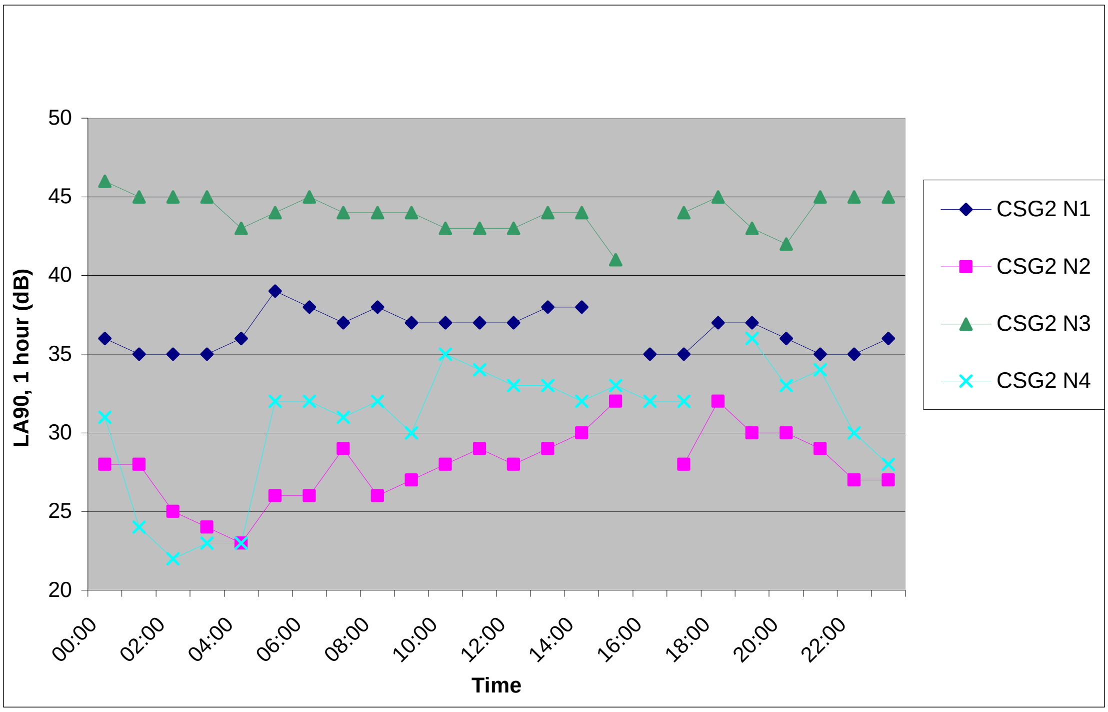


Figure 7-42: CSG2 Hourly LA90 Levels

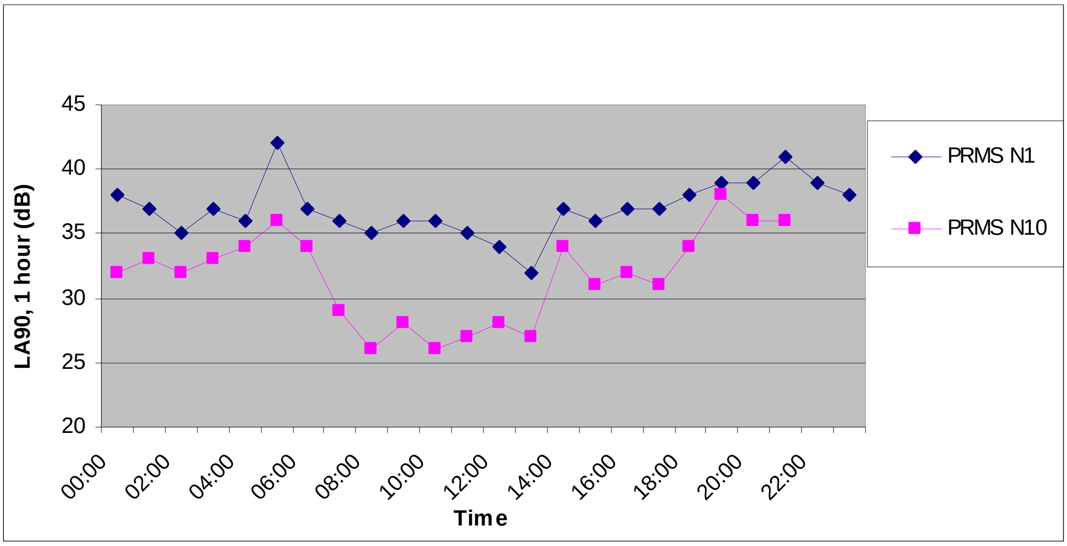


Figure 7-43: PRMS Hourly L_{A90} Levels

Often the night-time noise level was higher than the daytime. This would be considered unusual. Normally human activity, which tends to dominate the noise environment, reduces during the night. The audio recording suggests that the reasons for higher night-time noise during this survey are the levels of noise from fauna, especially bird song (when considering night-time averages) and insect noise which was sufficiently continuous at some of the locations to form a noise source that during elevated background noise levels at times when they would normally be expected to be at their lowest (01:00–04:00).

Where an isolated specific noise source is not affecting the baseline noise environment at the residential receptors, the baseline noise environment was dominated by noise from fauna. Often this was farm noise associated with the residential receptor.

7.9.3.1 Noise at CSG1

Noise surveys at CSG1 locations were conducted at the following times:

- CSG1-N1: 31 May 2011 14:11 – 1 June 2011 13:15
- CSG1-N4: 31 May 2011 11:23 – 1 June 2011 17:40 (measurement removed as dominant noise source considered to be unrepresentative of wider village receptor)
- CSG1-N6: 31 May 2011 12:19 – 1 June 2011 13:31
- CSG1-N10: 31 May 2011 16:16 – 1 June 2011 11:52, 6 June 2011 12:13 – 15:54
- CSG1-N11: 6 June 2011 10:23 – 7 June 2011 10:16.

Table 7-53 summarises standard noise indices for the noise monitoring locations around CSG1 for daytime (07:00–23:00) and night-time (23:00-07:00) periods. Where a location has more than one measurement during the same hour on more than one day (for instance, if the measurement began at 18:00 and ended at 19:00 the next day there would be two hours of measurement representing 18:00–19:00), the lowest measured level has been used.

Table 7-53: Noise Parameter Summary at CSG1 Locations for Daytime and Night-time

Location	L_{Amax}(dB)		L_{A10}, T (dB)		L_{Aeq}, T (dB)		L_{A90}, T(dB)	
	Day	Night	Day	Night	Day	Night	Day	Night
CSG1- N1	92.2	74.3	49.0	53.3	49.9	50.9	39.5	47.6
CSG1-N6	91.8	73.2	47.7	47.0	50.0	46.8	33.4	33.4
CSG1-N10	87.5	99.7	44.3	47.1	45.9	55.9	28.0	29.1
CSG1-N11	77.4	70.5	45.3	45.5	43.0	43.6	34.4	36.0

The measurement locations are described in Table 7-54.

Table 7-54: Noise Monitoring Locations around CSG1

Ref	Distances (m)		Representing Receptors	Description
	CSG1 to Monitor	CSG1 to Nearest Dwelling		
CSG1-N1	250	250	Disused military camp (CSG1-N3)/ single farmstead near SPPD building(CSG1-N1)	Corner of chain-linked fence compound, approximately 10m from the security building ('SPPD') opposite the entrance to PSG1. Located due to security risk at CSG1-N3 that had nowhere to chain up equipment.
CSG1-N4	1600	1600	See CSG1-N6	Garden of nearest residential receptor in direction of PSG1. Approximately 70m from water sluice, which was elevating background noise at night within a localised area (not discernible during the day).
CSG1-N6	1500	1500	Farmsteads/two receptors (CSG1-N5, CSG1-N6), Jandari village, CSG1-N9 and CSG1-N10 use[7]	Two metres from side of residential log cabin in the direction of PSG1. Located here to make use of post and to be at a distance from leafy trees and stream.
CSG1-N10	2500	2000	See CSG1-N6	Thirty metres from an unoccupied (during the summer) barn in the direction of PSG1. Not located at nearest residence CSG1-N9 due to high level of farmyard noise.
CSG1-N11	2800	2800	Nazarlo village/ multiple receptors	Thirty metres from façade of the nearest resident in the direction of PSG1. Located away from trees and minor watercourse.

[7] It is considered that the measurement at location CSG1-N6 is likely to be representative of the noise environment within Jandari (at distances from the hydrological feature) and locations to the north of CSG1 (CSG1-N9 and CSG1-N10). The measurement location at CSG1-N10 was taken while the building was unoccupied. Background noise levels at this location are likely to be higher when the building is occupied as a result of farmyard noise.

The noise sources at monitoring locations around CSG1 are described in Table 7-55.

Table 7-55: Noise Sources at CSG1 Locations

Location	Noise Sources
CSG1- N3	Dominated by PSG1 plant noise, which noticeably increased in noise during the night. Other sources: sporadic road traffic, fauna (birds, insects and dogs), local security staff.
CSG1-N4	L_{Aeq} dominated by bird noise (even at night), hydrological feature (8513701.75102 4590545.28449) 75m (behind two buildings) significant in terms of background noise level. Other sources: occasional road traffic, other fauna (dogs, insects), residents and planes.
CSG1-N6	Noise sources include farmyard noise (residents, fowl, dogs) and other fauna (birds, insects) and planes. Train noise evident at night.
CSG1-N10	Bird song only obvious frequent noise. Other noise sources include other fauna noise (occasional dog or cattle noise) and planes. Train noise evident at night. Also indistinct background increase at night, considered likely to be increase from PSG1 as measured at CSG1-N3.
CSG1-N11	Agricultural noise (manual labour and vehicles) during the day. Insect noise evident at night. Other farmyard noise (dogs, geese), bird song during both day and night.

It was apparent from the measurement at locations CSG1-N1 that noise from the existing pump station increased during the night. This was faintly audible in the night-time noise recording at CSG1-N10. A review of operational logs did not identify an obvious reason for this change in noise output (for example, the noise level changes coinciding with changes to pump operation, one of the major noise site noise contributors).

7.9.3.2 Noise at CSG2

Noise surveys at CSG1 locations were conducted at the following times:

- CSG2-N1: 7 June 2011 15:48 – 8 June 2011 15:06
- CSG2-N2: 7 June 2011 16:51 – 8 June 2011 15:46
- CSG2-N3: 7 June 2011 17:36 – 8 June 2011 16:15
- CSG2-N4: 7 June 2011 18:20 – 8 June 2011 16:46.

Table 7-56 summarises standard noise indices for the noise monitoring locations around CSG2 for daytime (07:00–23:00) and night-time (23:00–07:00) periods. The SPPD security building at CSG1-N2 is not considered a receptor for the purposes of assessing a baseline noise environment.

Table 7-56: Noise Parameter Summary at CSG2 Locations for Daytime and Night-time

Location	L_{Amax}(dB)		L_{A10}, T(dB)		L_{Aeq}, T(dB)		L_{A90}, T(dB)	
	Day	Night	Day	Night	Day	Night	Day	Night
CSG2-N1	87.8	81.2	53.1	44.6	55.5	48.0	35.4	35.1

Location	L_{Amax}(dB)		L_{A10}, T(dB)		L_{Aeq}, T(dB)		L_{A90}, T(dB)	
	Day	Night	Day	Night	Day	Night	Day	Night
CSG2-N2	91.3	57.9	37.4	35.8	49.7	33.5	28.2	25.1
CSG2-N3	76.8	76.1	46.9	46.8	47.7	46.2	42.8	44.3
CSG2-N4	91.9	70.4	47.8	43.3	50.8	41.7	32.2	23.6

The measurement locations are described in Table 7-57.

Table 7-57: Noise Monitoring Locations around CSG2

Ref	Distances (m)		Representing Receptors	Description
	CSG2 to Monitor	CSG2 to Nearest Dwelling		
CSG2-N1	4000	4000	Burnasheti village/ multiple receptors, Rekha and Kizilkilisa village	On low (0.5m) boundary wall in garden of approximately the nearest residence to the proposed CSG2 site. Location considered a similar noise environment to other villages surrounding the CSG2 with the exception of Khando.
CSG2-N2	1800	2300	Originally chosen to represent Kizilkilisa village, although this is considered more closely represented by CSG2-N1	Corner of chain-linked fence compound, approximately 10m from the security building ('SPPD') on pipeline route. Located due to security risk at nearest village.
CSG2-N3	1800	1800	Rekha village affected by river noise (see CSG2-N1)	Field location, approximately 20m to the side of the first residence in Rekha village travelling north-west.
CSG2-N4	4100	4100	Khando village/ multiple receptors	Garden location 5m to façade of nearest residence in the direction of the proposed CSG2 site.

The noise sources at monitoring locations around CSG2 are described in Table 7-58.

Table 7-58: Noise Sources at CSG2 Locations

Location	Noise Sources
CSG2-N1	Farmyard noise (dogs, chickens) and other fauna. Residents. Occasional road traffic and planes
CSG2-N2	Bird song, security guard noise, planes
CSG2-N3	Farmyard noise (dogs, chickens, pigs, equipment, occasional vehicular manoeuvring) and other fauna (birdsong, insects). Residents
CSG2-N4	Farmyard noise (dogs, chickens, pigs, equipment, occasional vehicular manoeuvring) and other fauna (birdsong, insects). Residents

Monitoring locations CSG2-N1 and CSG2-N4 were in residential gardens, where most of the noise sources were associated with farmyard noise. Monitoring location CSG2-N2 recorded noise from a fenced compound, and recorded noises associated with work there. Monitoring locations CSG2-N2 and CSG2-N4 are within a wide-open space distant from trees, so noise from fauna was less evident than at the other two monitoring locations. The measurement at location CSG2-N3 is considered representative of the noise environment experienced by much of Rekha village. However, at distances farthest from the river directly west of the village it is considered that the noise environment is represented closer by the measurement at location CSG2-N4.

7.9.3.3 Noise at the PRMS

The noise survey as was conducted at PRMS locations described in Table 7-59 at the following times:

- PRMS-N1: 9 June 2011 17:32 – 10 June 2011 18:06
- PRMS-N10: 9 June 2011 18:04 – 10 June 2011 14:14.

Table 7-59: Noise Parameter Summary at PRMS Locations

Location	L_{Amax}(dB)		L_{A10}, 16 hour(dB)		L_{Aeq}, T(dB)		L_{A90}, 16 hour(dB)	
	Day	Night	Day	Night	Day	Night	Day	Night
PRMS-N1	87.6	76.5	46.2	47.5	47.5	47.3	35.3	36.6
PRMS-N10	82.3	95.9	49.8	40.5	51.6	45.1	28.0	32.8

The measurement locations are described in Table 7-60.

Table 7-60: Noise Monitoring Locations around the PRMS

Ref	Distances (m)		Representing Receptors	Description
	PRMS to Monitor	PRMS to Nearest Dwelling		
A81-N1	1400	1400	Naokhrebi village/ multiple receptors	Garden location 10m to façade of nearest residence in the direction of Naokhrebi village from PRMS.
A81-N10	1800	1800	Vale resident/ single receptor	Garden location 10m to façade of nearest residence in the direction of Vale from PRMS.

The monitoring locations were in residential gardens and most of the noise sources are associated with farmyard noise. The noise sources at monitoring locations around the PRMS are described in Table 7-61.

Table 7-61: Noise Sources at PRMS Locations

Location	Noise Sources
PRMS-N1	Farmyard noise (dogs, chickens, cattle, equipment, occasional vehicular manoeuvring) and other fauna (birdsong, insects). Traffic on main road. Residents. Distant river noise.

Location	Noise Sources
PRMS-N10	Farmyard noise (dogs, chickens, cattle, equipment, occasional vehicular manoeuvring) and other fauna (birdsong, insects). Traffic on main road. Residents. Distant river noise.

7.9.4 Noise Sensitivity

The following subsections summarise the components of the baseline conditions that, in the project context, are considered the most important based on the anticipated impacts of the project development.

7.9.4.1 Key noise sensitivities at CSG1

The closest receptors to CSG1 are residential (a single settlement 250m) and at Jandari (1.5km) which would be deemed to be sensitive to relative noise changes as well as absolute noise levels. The PSG1 plant dominates the noise environment immediately surrounding CSG1. Farther from CSG1, as the plant noise decreases, local farming sources of noise are more apparent. At these locations distant (500-1000 m) from CSG1, during the day noise levels depend on the level of activity of the residence, as very few external noise sources exist (except occasional vehicular traffic).

During the night, noise levels are dominated by insect noise and, in the early morning, bird song. Diurnal variation is not consistent amongst all receptors and therefore it would be difficult to propose less sensitive times at which noisier operations could be conducted to minimise disruption.

There are low levels of background noise at a distance from CSG1. At receptors close to CSG1, the noise environment is affected by the existing facilities. No complaints about noise have been received by residents close to the proposed CSG1 location.

Seasonal differences are less likely to be apparent in these low lands with less snowfall during the winter than CSG2. In addition, it is likely that at some receptor locations, winter noise levels will increase as farms become reoccupied during the winter months.

7.9.4.2 Key noise sensitivities at CSG2

The closest receptors to CSG2 are residential (1.8km) villages Kizilkilisa and Rekha, which would be deemed to be sensitive to relative noise changes as well as absolute noise levels.

The noise environment surrounding CSG2 varies according to the density of habitation with higher noise levels in the more densely populated villages of Burnasheti and Kizilkilisa (less noise sensitive) to the south and east of the development site and very low levels to the north in Khando (more noise sensitive). Village noise is dominated by animals and vehicular traffic, except for Rekha where a river flowing the length of the village (north to south) elevates noise levels. As the river noise decreases farther north and east within the village, sensitivity to noise would increase. Therefore, in Rekha, the closest residents to CSG2 would be considered less noise sensitive than residents farther away.

Diurnal variation is not consistent amongst all receptors. Seasonal variation in noise at Rekha is likely as a result of the river freezing. However, the population will be less sensitive in winter as windows and shutters will be closed. Seasonal variation will be less apparent in Khando as levels are already very low at this location. In the larger villages to the south, seasonal variation may not be as apparent as noise sources within the properties themselves dominate their noise environment.

7.9.4.3 Key noise sensitivities at the PRMS

The closest receptors to PRMS are residential at the village of Naokhrebi (1.4km), which would be deemed to be sensitive to relative noise changes as well as absolute noise levels.

The closest residents are isolated houses that exist in low noise environments with few sources.

The existing noise levels at the closest receptors are maintained above a certain level as a result of a distant river; this is likely to be affected by seasonal variation.

7.10 Cultural Heritage

Establishing an accurate cultural heritage baseline is a key input into the Project design. This chapter provides an overview of the context of cultural heritage resources in Georgia. It describes the results of the baseline surveys undertaken and provides a list of heritage sites within the vicinity of the pipeline corridor, facilities, access roads and camp/storage areas. Sites requiring further study are discussed and areas requiring preliminary trial trenching presented.

The known archaeological sites in the vicinity of the SCPX Project have been identified for an area approximately 500m wide around the project activities and potential areas of concern highlighted. A group of independent Georgian experts surveyed a 100m corridor along the pipeline route, access roads and the Facilities (compressor stations, PRMS and pigging station) locations.

7.10.1 Information from Desktop Literature Survey

The archaeological documentary sources available in Georgia are very large and detailed, relating to many years of work. However, they are rather patchy in that some sites and areas are concentrated on, leaving other areas disregarded or with only summary reports. The lack of an effective coordinate system meant that many finds are poorly geographically referenced, possibly only using the village or municipality name.

The most up-to-date and accurate source of information for the Project area is the results of cultural heritage studies undertaken during the BTC and SCP project. This consisted of an ESIA, which included a surface survey and consideration of the potential of pre-construction evidence, detailed evaluation and excavation work prior to construction and the results of the archaeological monitoring of construction. All this data was collected to international standards using, for the first time, GPS units, satellite and aerial images, which were then transferred to a geographical information system (GIS).

7.10.2 Overview and Context of Georgian Heritage Resources

The Georgian nation has a long written history and a wealth of historic sites, monuments and artefacts. It also has archaeological sites dating to periods long before written records began. Its earliest archaeological sites date to the late Pliocene geological epoch nearly two million years ago, and have yielded early hominid fossils (*Homo erectus*). Later remains include churches, monasteries, castles and fortifications that date to the well-known medieval period. Larger settlements in Georgia contain a diverse stock of historic secular and non-military buildings from a number of international styles that date up until the time of Soviet period, which began in 1922. Among the best-known and most frequently encountered archaeological remains in Georgia are those of the Early, Middle and Late Bronze Age periods (approximately 3000–800 BC). This period marks the earliest substantial evidence of social stratification, which is exemplified by objects made of intricately worked gold and semi-precious stones that are among Georgia's national treasures. The best known of these objects have been recovered from the kurgans, burial chambers of the Trialeti culture (3000–1500 BC) where presumed warrior leaders were buried.

This historic context section briefly describes Georgian prehistory and history by period and presents the cultural historical information needed to understand the significance of a particular archaeological site or monument.

7.10.2.1 Lower Palaeolithic (2,000,000–200,000 years ago)

This is a time before the emergence of anatomically modern humans. Early members of the genus *Homo* (*Homo erectus*) lived in small bands, apparently foraging radially from a home base located near some key environmental feature. Fossil remains and crude flake or cobble stone tools are the only artefactual remains from these earliest periods of human history. Remains of this period are extremely scarce worldwide and their importance lies in the clues to anatomical development and behavioural patterns of these earliest members of the genus *Homo*. Sites from this period can be dated by archaeomagnetic study and by potassium/argon dating if volcanic deposits are present.

The site of Dmanisi south-east of Tbilisi yielded a series of Pliocene faunal remains and was first investigated in the 1980s. Later, in 1991 and again in the summer of 2001, international archaeological teams recovered fossilised *Homo erectus* bones from the site. In addition, simple chipped-stone tools of the so-called Oldowan and Acheulean tradition have been found at the site. The site of Dmanisi, dating to between 1.8 and 1.4 million years ago is one of the earliest *Homo erectus* find sites outside of the African continent.

7.10.2.2 Middle Palaeolithic (200,000–30,000 years ago)

This very long period corresponds to the emergence of archaic *Homo sapiens* such as *neanderthalensis*. Throughout Europe and south-west Asia, the latter part of this period of human history is marked by what is called the Mousterian stone tool assemblage, which in comparison to the Acheulean stone-tool kit involved more elaborate and skilfully made tools and a wider variety of tool shapes. As was the case in northern Europe during much of this period, Georgia was a glacial or peri-glacial environment.

Mousterian stone tools have been found at over 75 sites throughout Georgia.

7.10.2.3 Upper Palaeolithic (30,000 years ago – 12,000 BC)

The Upper Palaeolithic corresponds to the Late Pleistocene period and saw the appearance in Europe, south-west Asia and Georgia of anatomically modern humans. Technologically, the period showed a dramatic rise in the variety and complexity of stone tool types. Tool assemblages with distinctive stylistic patterns can be tracked geographically, suggesting to some archaeologists the emergence of culturally and perhaps linguistically distinctive groups, i.e. ethnic groups. It is also suggested by some that this period saw the full development of human linguistic capability. Upper Palaeolithic peoples of Georgia probably relied on group hunting techniques of a few types of large animals such as deer, bison, wild horses, mountain goat, bear and mountain lion, the remains of which are found in abundance at Upper Palaeolithic sites. Natural rock shelters and caves and places strategically located to exploit movements of their prey were the most common habitation sites of this period.

At least 33 significant Upper Palaeolithic sites are known throughout Georgia.

7.10.2.4 Mesolithic (12,000–8000 BC)

The end of the Pleistocene epoch and the start of the Holocene mark the start of Mesolithic period. Retreat of the Würm glaciation created a more moderate climate allowing exploitation of a wider range of environments. Hunting continues to be a major focus of economic activity, but now focuses on a wider range of prey. Individual animals of a variety of sizes, both herd animals and solitary species, were hunted, suggesting smaller scale individualistic hunting techniques. Wild prey included a variety of deer, boar, horses and sheep. Systematic foraging for seasonal plant resources also became an important part of the economic repertoire. Open-air sites became more common than cave sites at this time in Georgia and elsewhere in Europe and south-west Asia. The most notable shift in artefact assemblages for this period was the proliferation of tool-making materials and tool types. Microliths (small flint and obsidian blades) and polished grinding stones, all of which were used for plant processing, became common. Net-sinker stones and harpoons suggest greater reliance on fish. The shift from Upper Palaeolithic to Mesolithic society is interpreted, quite simply, as adaptation to a different and broader range of resources that became available in the temperate Holocene environment.

Only 12 significant Mesolithic sites are known throughout Georgia.

7.10.2.5 Neolithic period (8000–3500 BC)

The beginning of the Neolithic period is sometimes referred to as a revolution because of the dramatic shift in the human economy that it brought. With the coming of the Neolithic, humans shifted from a hunting-and-gathering way of life to one based on the domestication of animals and plants, i.e. on agricultural and animal husbandry. Along with these basic changes came the invention of pottery for cooking and storage of plant foods and the wide-scale introduction of ground and polished stone tools such as adzes, hoes and axes for clearing the land and tilling the soil. Building technology both for shelter and food storage also saw major advances. It appears that the Neolithic way of life was introduced in a fully developed form from elsewhere, as there is no evidence for the slow transition to an agricultural existence.

In contrast to the Palaeolithic and Mesolithic periods, pottery shards (the remains of cooking and storage jars) become the dominant artefacts in Georgian archaeological assemblages, reflecting the importance of food processing and storage. Georgian Neolithic pottery forms are typically flat-bottomed, round-sided jars and bowls without handles. Appliqué and incised decorations are common from the very start of Georgia’s pottery-making tradition. Surface treatment often includes burnishing. Round-sided bowls and relatively small jars are the most common forms. A wide variety of locally available tempering materials are seen in these early ceramics, including gravel, sand, ground ceramic, straw and crushed obsidian.

The first stand-alone Georgian Neolithic houses consisted of a series of abutting and interconnected rooms made of mud and mud bricks supported by wood beams and probably roofed with saplings and mud. Rooms were round or elliptical in plan with different sized rooms apparently having different standard uses. Large rooms (*c*.2.5 x 5m) had built-in hearths and were probably used for socialising and sleeping. Medium-sized rooms (*c*.1.25 x 2m) were probably used as a craft area, and small rooms (*c*.0.5 x 0.75m) must have served for storage. This settlement organisation is exemplified at the site of Imiris-Gora in south-central Georgia.

Approximately 60 Neolithic sites are known throughout Georgia; most are in western Georgia, although south-central Georgia has a concentration of sites from this period.

7.10.2.6 Bronze Age (3500–800 BC/IV–I millennia)

Bronze Age cultures throughout Europe, the Mediterranean and south-west Asia depended on the plant and animal domesticates and associated technical advances, such as pottery and the working of native metals, to build a new type of society. This new society was ruled by a military and priestly elite who apparently practised a religion that included elaborate burial rituals and specific belief in an afterlife in which worldly material goods were of value. The rulers of these first stratified societies justified their status and set themselves apart from the common social classes through elaborate burial rituals and the consumption of luxury goods such as finely crafted ornaments of bronze and precious metals, and precious stones. Other, perishable commodities were surely involved but no physical record was left for us to interpret. Increased technical sophistication of craftspeople and geographically extensive systems of land and sea trade provided the logistic underpinning of these societies in differential access to luxury goods. All of these physical and social characteristics of Bronze Age society emerged slowly over hundreds of years in Georgia, first becoming apparent in the Kura-Araxes culture of the Eneolithic (Late Neolithic) and Early Bronze Age periods (3500–3000 BC) and later during the Middle Bronze Age “florescent period” of the Trialeti culture (2500–1900 BC). Both cultures appear, from the geographical distribution of their remains, to have been centred in Georgia, especially south-central Georgia, but to have extended beyond into Armenia, Azerbaijan, eastern Turkey and further south.

The Kura-Araxes culture (also known as Mtkvari-Araksi), the first Bronze Age culture of Georgia, corresponds to the Eneolithic and Early Bronze Age periods in the area (3500–3000 BC). It is so named because of the geographical concentration of its occupation sites between the Mtkvari and Araxes rivers of Georgia. Sites include necropolises (burial clusters) and settlements. Typical houses were single storey and constructed of mud brick, stone and dried mud with wood reinforcement. Floor plans were very similar, being rectangular with a small rectangular room at the door end and an adjoining, larger, square room at the rear. Variation in size, but not proportions, was common. A typical overall house plan was 4m x 7m. Houses were clustered together in rows, oriented to optimise solar exposure and shelter from the wind and tended to be located on small rises just above the floodplains. Typical settlement area was approximately one-half of a hectare.

The Kura-Araxes culture, as defined by characteristic ceramic decorative traits and other diagnostic elements, is first identified in the Late Neolithic. Kura-Araxes peoples either developed or adopted bronze smelting technology in the mid-fourth millennium BC.

The Trialeti culture (3000–1500 BC) corresponds to approximately the Middle Bronze Age in Georgia. Its area of influence extended beyond the boundaries of present-day Georgia, especially to the south and east. The culture is named for the Trialeti plateau, an area of south-central Georgia where the culture was first investigated archaeologically in the 1930s. This area also has the densest concentration of Trialeti remains. The Trialeti culture is best known for the large and elaborate tombs or *kurgans* that characterise its florescent period (2500-1900 BC). These were large circular stone and wood tomb constructions, some as large as 12m high and 100m across. Trialeti's florescent period is marked by the first *kurgans*, which were designed as the resting places of single elite individuals. Previously, the tombs held the remains of multiple individuals who were interred sequentially over time. Burial goods include an array of plain and decorative chipped stone, ground stone and metal tools and weapons, as well as ornamental objects of gold, silver and precious stones. Some of the best-known and most impressive objects displayed in the Treasury of Georgia's National Art Museum were excavated from large Trialeti *kurgans*.

The Middle and Late Bronze Age in Georgia saw the start of the historical distinction between eastern and western Georgia. At this time west Georgia, including the area of the Black Sea littoral, saw the complementary development of the Colchis (Kolkheti) culture. This culture was, from its early stages, distinct from the Trialeti tradition in nearly all aspects of its material culture. The Colchis (Kolkheti) culture, whose designation became synonymous with western Georgia, lasted well into the Iron Age and was in commercial contact with Greeks from Miletus and elsewhere. The best-known Colchis (Kolcheti) site is Vani, a major commercial, political, and religious centre that has been subject to years of archaeological excavation and study.

7.10.2.7 Iron Age (800–400 BC)

The transition from the Late Bronze Age to the Iron Age is in fact very difficult to identify. A conservative archaeological opinion is that ironworking did not become the predominant metallurgical technology until the first quarter of the first millennium BC. Nonetheless, it is clear that long before this, in the late Bronze Age (after the demise of the Trialeti culture), a series of significant technological and economic changes were occurring. Not all of these changes were caused by or even associated with a shift from the alloy-casting bronze techniques to iron smelting. The changes included use of an increasingly effective range of agricultural techniques, including deeper ploughing facilitated by draft animals and more sophisticated ploughs, use of crop rotation and the development of drought-resistant wheat. These agricultural improvements in turn assisted in a transition from nomadic to sedentary herding techniques. All of the technological changes led to a larger more sedentary population that also appears to have made populations more prone to regional economic independence. In Georgia and elsewhere in Europe and south-west Asia, it has been speculated that the wider distribution of raw materials for ironworking and the more robust and diversified local agricultural economies were the primary factors that allowed greater regional independence. According to this view, the earlier Bronze Age economies required greater access to trade goods to assure access to needed food and craft products.

There are hundreds of significant Iron Age sites throughout Georgia. Sites are concentrated in alluvial settings in both West Georgia (traditional Colchis or Kolkheti) and East Georgia (traditional Iberia).

Prehistory to history
Traditionally, the Iron Age ended not because of new technological developments but rather because of the advent of history. Written accounts allow us to identify societies not by their typical artefacts or material but by reference to specific named kings, dynasties, wars and invasions. This increased detail brings additional complexity that challenges historical understanding. In the case of Georgia, this is especially true. The sweep of events and cross-cutting influences in Georgian history is almost overwhelming, involving influences from numerous civilisations, many ethno-linguistic and religious groups, and a seemingly countless series of invasions and re-invasions. Context for resource management of Georgia's historic period can best be presented as a series of three periods, each of which interacted with one another and with indigenous Georgian cultural patterns in a different way.

7.10.2.8 Ancient (Classical) Historical Period (500 BC to Late AD 400s)

The major civilisational influences on Georgia in ancient times were as follows.

Nomads from central Asian steppes
There was constant contact between Caucasian peoples and horse-riding nomads since about 300 BC onward.

Persians and Persian Empires
The Achaemenid Empire dominated eastern Anatolia and the Caucasus directly between *c*.550–*c*.330 BC. At that time, a number of proto-Georgian groups were pushed northward along the Black Sea coast. Persia's access to Georgia came overland from the south and east, thereby affecting eastern Georgia more directly. Many believe that the Greek influence on Georgian culture is more evident in the later shared Christian traditions and that the Persians had a more profound effect on pre-Christian socio-political systems than did the Greeks. The old Georgian socio-economic system, 'naxarar' was also more Iranian and less classical. In this system, a semi-divine monarchy and a clan structure are the central elements of the political process, as opposed to elected magistrates with a centralised bureaucracy as was the case with Rome and Byzantium. Graphic and other decorative arts of the later Medieval Christian period still showed the strong influence of the Persian artistic tradition.

Greeks
Greek traders and, later, the conquest of Alexander the Great are just two examples among many of Greek influence on Georgia during the ancient period. Greek presence in, and knowledge of, the area is attested to by the writings of Greek historians such as Herodotus and by Greek legends (which were based on experiences that extend back into the Bronze Age). Construction of the Greek trading port of Phasis (Phasii) the Georgian coast of the Black Sea, and the inland distribution of identifiable Greek artefacts are elements of the Greek influence attested to by the archaeological record. The Kingdom of Colchis (Kolkheti) in western Georgia, with its inland capital at Vani was the principal counterpart for Greek trade in the Classical period. The most marked and continuous contact between Greece during the Archaic and Classical periods was via sea trade across the Black Sea. Later a major overland influence came to Georgia as the Greek armies of Alexander defeated the Achmaemenid Persians in the 330s BC, also occupying Georgia.

Romans and the Roman Empire

The Romans replaced the Greeks as the dominant ‘classical civilisation’ competing for control of the Eastern Mediterranean and other adjacent regions. The Roman Legions, led by Pompey, occupied Georgia in the first century BC as part of a successful military campaign against the Parthians of Persia. The writings of the Greek geographer Strabo provide some of the most reliable information on ancient Georgia at the time of the Roman occupation.

There are numerous archaeological sites and excavated monuments from this period. Recent archaeological excavations at the fifth–fourth century BC site of Vani, in Colchis (Kolkheti), have yielded artefacts with Iranian motifs. An archaeological site in the suburbs of Tbilisi that dates to the second to third century AD is the Hellenistic necropolis at Armazis-Khevi near the medieval Iberian capital of Mtskheta. A bowl was recovered there with an inscription in Pahlavi, and other artefacts were recovered that display both Iranian and classical influence. Parthian gold coin hoards were recovered in Iberia (west Georgia). Other archaeological evidence includes carved stone stele showing seventh century AD Iberian and Armenian nobles wearing Iranian dress.

The most important sites of this period are located on prime agricultural land in alluvial valleys in western and eastern Georgia.

7.10.2.9 Medieval period (Late AD 400s–1450s)

Indigenous Christianity

The Georgian Christian tradition began shortly before the start of the medieval period when St Nino came from Cappadocia (north-eastern Turkey) to evangelise in Georgia in the early fourth century AD. King Mirian of Georgia converted to Christianity in AD 347. The earliest surviving example of the Georgian writing system in Georgia is an inscription in the Bolnisis Sioni Church dating to AD 483, shortly after that time. A slightly earlier inscription has been identified in Jerusalem. (Nearly 800 years earlier, in fourth century BC, the Georgian King Pharnavaz had developed a system of writing for the Georgian language.) Since the fourth-century conversion of Mirian, despite numerous pagan and Muslim incursions, Georgia has retained its identity as a Christian nation.

Nomadic invaders

There was constant contact between Caucasian peoples and Central Asian nomads since the fourth century BC. In the eleventh century, the Seljuks appeared. Georgia, however, continued as a united political entity in the face of such invasion, until the later Mongol period in the thirteenth and fourteenth centuries. In the fifteenth century, the Ottomans conquered Anatolia, and, as a result, they made frequent incursions into the Caucasus. Georgia, Azerbaijan and eastern Armenia. They then fell under the rule of the Persians once more, and there was continued fighting between the Turks and the Persians.

Arab invasions

Beginning in the seventh century, the Arabs invaded and held portions of western Georgia, conquering Tbilisi for the first time in AD 645. During the Arab period, major Georgian centres fell to the Arabs and were again liberated by Christian uprisings. For a period in the ninth century, western Georgia was ruled directly by the Islamic ‘Tbilisi Emirate’.

There are numerous archaeological sites and monuments from this period throughout Georgia, including the Mtskheta monuments (see Section 8.2.11 and 8.3). Some structures are complete, well preserved and still in use. Others are dilapidated. Some remains are in still poorer condition, being limited to foundation stones of main buildings, or sometimes partially standing walls or parts of buildings.

7.10.2.10 *Modern period (AD 1450s–present)*

Historical themes of the modern period include internal political fragmentation in Georgia, as well as influence and aggression from a new mix of foreign powers vying for control of the area.

Ottoman Turks

The Ottoman Turks captured Byzantium in 1452 and extended their control westward into the Balkans and southward through the eastern Mediterranean into Egypt. The Ottoman Empire became a force for relative stability and later of secular modernisation in the region. The Ottomans invaded and ruled parts of Georgia until the start of the nineteenth century, fighting with the Persians for control of the Caucasus.

Shiite Safavids

Persia under the Shiite Safavids expanded its influence in the 1500s directly into the area, taking control of the eastern Caucasus and incorporating Azerbaijan into its Empire. Shiite orientation of Azeri Islam dates from this period. The sixteenth century also saw Safavid invasions in eastern Georgia. Under the combined threat from Safavid, Persia and Ottoman Turks, and as a result of declining regional overland trade with the Orient, this was a period of decline and fragmentation for Georgia.

Russian Empire

The Russian Empire expanded south-eastward into the Caucasus under Tsar Nicholas I (1801–1825). Weakening of the Persian Safavids allowed the Russians to enter the eastern Caucasus. The steadily mounting power of Russia throughout this period brought the Russians into a three-way struggle for control of the Caucasus. The three powers were the Ottomans, the Safavids and the Romanov royal family.

Soviet Union (1922–1991)

Georgia and the other Caucasus states were incorporated forcibly into the Soviet Union in the 1920s. Unlike previous Russian Imperial involvement in Georgia, the Soviet period had the effect of cutting off cultural contact with international traditions. This had a dramatic effect on architecture of all types. Civic buildings including government and cultural structures, residential structures, industrial structures and civil works all took on standard characteristics of the centrally planned Soviet economy.

The modern period was a time of regional decline for the eastern Mediterranean and the Middle East, and of national decline for Georgia itself. The European discovery of alternate sea routes to the Orient and the discovery of the Americas at the end of the fifteenth century marginalised the formerly central economic role of the Middle East.

Subsurface remains from the pre-Russian part of this period have a legitimate archaeological value in Georgia, although they have not been a major focus of investigation to date. Later subsurface remains (from the Russian and Soviet periods) have not yet taken on archaeological significance. There are numerous significant monuments from the modern pre-Russian and Russian period throughout Georgia. Such monuments, including churches, theatres, government and residential structures, are most often located in towns or urban centres. Structures from the Soviet period are generally not considered a positive aspect of Georgia’s architectural heritage and are rarely inventoried as historic monuments.

7.10.3 Data Gaps and Field Survey Methods

Although there is good coverage of the archaeological evidence from the BTC and SCP pipelines as a result of monitoring of construction, new sources of archaeological evidence are continuously being added. Since the BTC/SCP construction period, new studies have taken place adding to the knowledge of the area and to some specific points adjacent to the Project. The pipeline loop in Georgia is generally constructed in parallel with the existing BTC and SCP pipelines, therefore evidence gained during these projects is a useful source of baseline information. There are some areas where the pipeline diverges slightly from the existing route and these areas, along with the greenfield Facility and supporting infrastructure locations, needed further study.

High-resolution satellite imagery is a valuable resource that was not available during the BTC and SCP project, and additional features have been added to the database using this source.

The cultural heritage literature reviews and field surveys were undertaken between March 2010 and July 2011 to supplement existing information and covered the following project components:

- Pipeline loop sections
- Facilities such as compressor sites, PRMS, construction camps and pigging stations
- CSG2 access roads.

The objective of the survey was to identify any sensitive heritage issues within the proposed work areas, i.e. to establish the cultural heritage baseline. Several surveys were undertaken at different periods to allow for seasonal changes in visibility of features and as different access road options were considered.

Additional information was gathered in mid-2012 during preparation for Phase 2 work on the CSG2 access road and the first visual surveys were undertaken at the CSG2 access road construction camp.

7.10.3.1 Literature review

Sources for the literature review include the original BTC and SCP Pipeline ESIA, results from cultural heritage excavations associated with the BTC and SCP construction, and scientific material that has been published since 2003. These literature sources indicated the presence of a number of heritage sites located in the vicinity of the proposed SCPX pipeline loop sections and the access roads to the compressor site. Satellite imagery was also examined for evidence of archaeological features, some of which were subsequently visited on the ground.

The first 50 kilometres (km) of the pipeline from the Azerbaijan border has revealed very little in archaeological evidence, both from earlier sources and from observations of the BTC and SCP pipelines. This area is a low-lying plain with little surface undulation. It has been thought of as having little potential for the survival or discovery of significant archaeological remains. However, a deeply buried Chalcolithic settlement was located at Beyouk Kasik in Azerbaijan just 5km from the border in a very similar environment during BTC trenching operations. This shows that significant archaeological features could be located deep underground, leaving little surface indication.

The results from construction of the BTC and SCP pipelines showed that Tsalka municipality contained a very high density of archaeological features. This confirms information from archaeological literature that the area was very highly occupied in early times.

7.10.3.2 Field survey

Following the literature review, a surface inspection of a 100m pipeline loop corridor and the CSG1, CSG2 and PRMS locations was undertaken in 2010 by a group of Georgian independent experts. Additional surveys were undertaken as parts of the project were progressively re-defined; these included examination of the route of the access roads to CSG2 and the CSG2 site during July 2011, survey of the pigging station location at KP55 and 56 in October 2011 and supplementary site visits in December 2011. Surveys of the CSG2 access road construction camp were undertaken in mid-2012. At this stage, the field survey comprised only visual assessment for the presence of visible archaeological features and aboveground monuments with no intrusive work. The intention was to collect data on all evidence of cultural heritage features within the area of influence.

A number of undistinguishable earthwork features are thought to be the result of military activities in the recent or relatively recent past. These were noted, but have not been included in the assessment (e.g. in the valley to the north of KP53).

Information was collected on a pro-forma record sheet, together with coordinates generated by Garmin GPS units in the project Pulkovo grid system. The team took digital photographs of each location. The site information was prepared as a survey report and data added to the project GIS database.

7.10.4 Baseline Archaeological Conditions

The baseline survey identified a number of known and potential archaeological sites in the vicinity of the proposed pipeline route and access roads. These are detailed in Table 7-62 and their positions are marked on the constraints map in Appendix A. More detailed survey results are also included in Appendix H to the ESBR.

7.10.4.1 Archaeology KP0–KP56

There are no identified sites from KP0 to KP52. There is a group of features in the area around the Algeti River from KP52 to KP54, while there is an area with no identified features from here to the pigging station at KP56. These locations are marked on constraints maps in Appendix A and described below.

The majority of sites were identified as a result of archaeological monitoring on the BTC and SCP Project that developed into chance find excavations to record the threatened features. Between KP52 and KP54 potential and confirmed archaeological sites were found on the BTC and SCP pipeline ROW during construction. This includes SCPX CH06 (BTC/SCP Site ID IV-325), six anomalies noted in the SCP trench profile. The anomalies were spread across a 220m section of the trench. Some were slightly basin shaped and others were narrow and straight walled to square-like in shape. No artefacts were noted in association with these anomalies. The basin-shaped feature may represent patches of buried A horizon soils. The square ones were interpreted as possible recent modern postholes. No construction-phase excavations were undertaken. There were four surface finds in this location during the 2010 and 2011 field walkover survey.

CH07 (BTC/SCP Site ID IV-263 and IV-253) is a multicomponent site identified during BTC construction, first as a ceramic scatter on the surface (IV-263) identified after stripping an later during BTC trenching as Medieval period structural remains. The remains of several structures were found and the majority of artefacts recovered appear to date to the 11th to 13th centuries, although some earlier (Bronze Age and later pre-Medieval period) materials were also found. CH08 refers to a series of predominantly Medieval period finds made during BTC construction. These are recorded over a wide area around KP54 on both BTC and SCP pipelines and include part of a pithos (BTC/SCP Site ID IV-235); an indeterminate pit feature (BTC/SCP Site ID IV-254); a collection of stone mounds and depressions spread over an area measuring roughly 300m in length and extending exterior to the BTC and SCP ROW (BTC/SCP ID IV-002); an indeterminate feature found in a bank after grading (IV-307); and a large rock-and-earth mound located to the north of the BTC and SCP ROW thought to potentially represent a burial mound (BTC/SCP Site ID IV-003).

Figure 7-44: CH07 (KP53) Medieval Settlement on BTC and SCP Pipelines, Looking West

Figure 7-45: CH08 (KP54) Medieval Settlement Excavated on BTC and SCP Pipelines, Looking North

During a survey to examine alternative routes, a series of earthwork hollows were seen on the hillside to the north of the route (CH61). This was subsequently examined on satellite imagery and seen to be a series of similar features running to the north. They are probably of late medieval or recent origin. Further east of these sites is a spread of large stones over 1m in length (CH63). This could be the remains of a prehistoric structure, although there appears to be no order to it, or else it is the result of clearance of the field for mechanical cultivation.

Figure 7-46: CH61 (KP53) Earthwork Features, Looking West

7.10.4.2 Archaeology at CSG1

The survey did not reveal any evidence of cultural heritage remains at the selected location or at any of the three alternative locations (sites were surveyed as part of the CSG1 site selection process). This also includes the location for the proposed CSG1 construction camp.

7.10.4.3 Archaeology at CSG2, access road and access road construction camp

CSG2

The compressor station location (i.e. the station and adjacent areas that will be utilised for construction) contains a number of stony mounds, which are potentially burial mounds (CH54–CH66, see Appendix A). All other identified features are outside the margins of the compressor station location as shown on the project GIS.

There is a stone-built chapel (CH69) over 500m west of CSG2. This rectangular structure is of relatively recent construction and is used for worship by individual members of local communities. The chapel is not protected under any legal designation, but represents a site of cultural heritage significance.

CSG2 access road

The CSG2 access road originates at the Millennium Road near the village of Nardevani. From Nardevani to Kushi the road runs though the flood plain of the Ktsia River, it then gains elevation to the CSG2 site crossing lower river terraces and several plateaus separated by steep slopes and minor drainages. It passes by the villages of Berta, Beshtasheni, Ozni and Kizilkilisa.

South of the compressor site and through the area that the access road will pass there are a number of small stony mounds, which are possibly burial mounds (CH54–CH66, see Appendix A). The landscape south of this is one of a valley draining to the south-east and fringed with large mountains.

A broad range of cultural heritage properties is associated with the access road. Within the valley are several large villages with their attendant arable fields and connected by a series of roads and trackways. Some of these roads have been established for a long period of time. One is a routeway that crosses the river over the bridge at Kushi (CH68) and then cross the low land before heading off into the open ground and hills to the south-west (CH71), where there is an approximately 60m-long, well-preserved section of road (CH60). This is strategic routeway rather than one linking villages and it probably had its origins before the medieval period and continued to be used through the Russian Imperial period.

Figure 7-47: CH60 Historic Road, Looking West

Surveys for the various route options considered for the access road also looked further to the west where the Sapitiakhsho Church (CH53) was located alongside a portion of road. Another active religious cultural heritage site is Berta Monastery (CH72).

To the south-east of the study area, a large settlement was discovered in Nardevani (CH09). This contained remains of buildings and enclosures along with gullies and hollows designed to hold snow from the winter to be used as irrigation water to assist in establishing crops. The site is probably of late medieval date, although there are several mounds nearby that may be originate as prehistoric burial mounds (CH10–13). Other adjacent areas also show signs of fairly recent land use, particularly the deserted settlements near Burnasheti (CH14) and Ozni (CH41). Other confirmed archaeological sites in the vicinity of the access road consist of burial mounds including some excavated by Kuftin in the 1940s (Topkar kurgans), CH10, CH164 to CH167, CH208, CH210, and 215; and megalithic stones (CH67). In addition, there are many linear and mounded stone features of indeterminate origin (potential archaeology) visible along the route including the extant field systems.

Figure 7-48: CH53 Sapitiakhsho Church, Looking West

Determining the nature of these stone features is complicated by current and past land use. When the fields came to be laid out, existing mounds and rock outcrops would have been incorporated in the field boundaries. Cleared stone in the fields would have ended up in the nearest convenient location, which would be any nearby cairn, so progressively any pre-existing mound would have stone added to it, changing its shape and becoming merged with the field boundary. Repeated ploughing, especially once tractors were introduced, along the perimeter of a mound would gradually erode the edge and make a circular mound more elongated in the direction of the field boundary. This can be seen in several examples, especially at CH10 where the earth mound has been eroded by the road on one side and the ploughed field on the other.

The effect of this process is that it is very difficult to be definitive about the origins of any mound composed of stone. In an area where there is known to be small prehistoric burial mounds, identifying those and distinguishing them from pure clearance cairns is very difficult.

CSG2 access road temporary construction camp

The access road construction camp location lies between the villages of Nardevani (to the west) and Aiazmi (to the east) on the south side of the Millennium Road and to the south of an existing Millennium Road camp.

Several site identification walkover surveys were carried out for the camp. These resulted in the identification of approximately 20 stone and/or earth mounds potentially representing archaeology within the proposed camp foot print. Site evaluation (Phase 2) excavations were undertaken in June and July 2012.

In the main, the Phase 2 study results were negative. None of the mounds proved to be significant archaeology. Artefact recovery was light, the majority of materials ranged in date from the Mesolithic to modern periods. A few Mousterian tradition stone artefacts were also found but not in archaeological context. The terraces were mapped and sectioned. Based on the construction techniques and an analysis of ceramic artefacts found in association, the terraces are thought to have been constructed during the Medieval period, prior to 1400

(Narimanishvili, 2012). One archaeological feature was found (CH276) at the southern camp boundary: a dry laid stone wall remnant. Phase 2 excavation suggests that it predates the Medieval terracing. Artefacts found in association with this wall consist primarily of obsidian debitage. A small number of Mesolithic period stone tools were also found. The wall was not excavated fully and as it may represent the northern extent of a larger site or feature (Narimanishvili, 2012)

7.10.4.4 Archaeology at the PRMS

The field survey for potential sites in the area for the expansion of the PRMS, in Adigeni municipality, did not reveal any evidence of cultural heritage remains at either of the two option locations.

7.10.5 Archaeological Sensitivities

The following subsections summarise the components of the baseline conditions that, in the project context, are considered the most important based on the anticipated impacts of the project development.

7.10.5.1 Archaeological sensitivities at KP0-KP55

Within the SCPX pipeline loop, three locations (CH06-CH08) have potential archaeological deposits that are considered sensitive.

7.10.5.2 Archaeological sensitivities at CSG1

No features have been identified in this area. This region has a relatively high sensitivity due to the discovery of the Chalcolithic settlement at Beyouk Kasik in a similar environment to this location.

7.10.5.3 Archaeological sensitivities at CSG2, CSG2 access road and construction camp

The compressor site and its associated working areas, construction camps and the access road are all found in Tsalka municipality, which has a very high concentration of archaeological sites. The finds on the BTC/SCP pipeline were at the densest per kilometre through this area, so it can be expected that work on the proposed areas will encounter numerous archaeological features.

The stone-built chapel (CH69) over 500m west of CSG2 is not protected under any legal designation, but represents a site of cultural heritage significance.

The compressor site and adjacent area contains a number of stony mounds, which are potentially burial mounds (CH54–66). All the other identified features appear to be outside the margins of the compressor site.

The access road passes through an area where many features have previously been identified. There are a large number of possible to probable archaeological sites and features in close proximity to the CSG2 access road.

The road will follow the existing track leading from Nardevani to Kushi, beside the earthwork settlement (CH09), and then turn across open land towards Berta. The route crosses the line of the large route way (CH68). The route follows the line of the road leading from Berta to Burnasheti, where there is one well-preserved portion of road for a length of 60m (CH60). This section of road also contains the possible megalithic stone structure (CH67).

Before Burnasheti, the road runs due north across open land towards CSG2. This is an area where numbers of small stony mounds have been identified (CH16–38). This area contains several probable and confirmed burial mounds (Bronze Age kurgans) and many stone features of indeterminate origin.

A potentially significant archaeological feature (CH276) has been identified by the Project at the south end of the CGS2 access road construction camp. This site is a wall remnant found in association with Mesolithic period artefacts

7.10.5.4 Archaeological sensitivities at the PRMS

No archaeological features were identified in this area during the survey.

Table 7-62: Heritage Sites in the SCP Expansion Project Area

Site ID (from ESBR Appendix H)	Description	Name/Location
SCPX Pipeline Loop		
CH01	Potential site	KP52
CH05	Obsidian and flint surface scatter and isolated Bronze Age or Classical Period burial found during preconstruction study of the Marneuli Camp Helipad (BTC/SCP Site ID CH207)	Marneuli Helipad
CH06	Features recorded in BTC trench KP52, no further information	Jandari
CH07	Multicomponent site, main occupation is Medieval period (11th to 13th centuries) includes structural remains, other features, and associated artefacts; found in association with BTC construction (BTC/SCP Site IDs IV-253, IV-263)	Narlin-Dara
CH08	Excavation BTC54, medieval settlement evidence	Salmanlo
CH61	Earthwork features visible on Google Earth	Narlin-Dara
CH63	spread of large stones over 1m in length	Narlin-Dara
CSG2 Compressor Site		
CH02	Excavation BTC KP142.04. Artefact scatter found during BTC and SCP right-of-way preparation KP142 (BTC/SCP Site ID IV-169)	CSG2
CH03	Artefact scatter found during BTC and SCP right-of-way preparation KP142 (BTC/SCP Site ID IV-261)	CSG2
CH04	Stone mound identified during BTC right-of-way preparation KP143, determined to be non-cultural (BTC Site ID IV-162)	CSG2
CH54	Elevation with high concentration of surface stones, 4877 sq m. Potential burial mound	CSG2
CH55	Stones on the surface, 493 sq m. Potential burial mound	CSG2
CH56	Stones on the surface, 65 sq m. Potential burial mound	CSG2
CH58	Elevation with high concentration of surface stones, 257 sq m. Potential burial mound	CSG2
CH59	Elevation with high concentration of surface stones, 240 sq m. Potential burial mound	CSG2
CH62	Stones on the surface, 41 sq m. Potential burial mound	CSG2
CH64	Stones on the surface, 50 sq m. Potential burial mound	CSG2
CH65	Stones on the surface, 90 sq m. Potential burial mound	CSG2
CH66	Elevation with high concentration of surface stones 1160 sq m. Potential burial mound	CSG2
CH69	Chapel. Rectangular roofed structure, currently in use	CSG2
CH70	Stone monolith. Rectangular roughly dressed stone pillar, approximately 1m tall	CSG2
Access Road		
CH09	Settlement remains. Consisting of earthwork sunken structures, surface walls and scatters of ceramics	Nardevani
CH10	Potential Kurgan	Nardevani
CH11	Potential Kurgan	Nardevani
CH12	Potential Kurgan	Nardevani
CH13	Potential Kurgan	Kushi

Site ID (from ESBR Appendix H)	Description	Name/Location
CH14	Earthwork settlement	Burnasheti
CH15	Obsidian flake scatter	Kushi
CH16	Potential Kurgan	Burnasheti Ozni
CH17	Potential Kurgan	Burnasheti Ozni
CH18	Potential Kurgan	Burnasheti Ozni
CH19	Potential Kurgan	Burnasheti Ozni
CH20	Potential Kurgan	Burnasheti Ozni
CH21	Potential Kurgan	Burnasheti Ozni
CH22	Potential Kurgan	Burnasheti Ozni
CH23	Potential Kurgan	Burnasheti Ozni
CH24	Potential Kurgan	Burnasheti Ozni
CH25	Potential Kurgan	Burnasheti Ozni
CH26	Potential Kurgan	Burnasheti Ozni
CH27	Potential Kurgan	Burnasheti Ozni
CH28	Potential Kurgan	Burnasheti Ozni
CH29	Potential Kurgan	Burnasheti Ozni
CH30	Potential Kurgan	Burnasheti Ozni
CH31	Potential Kurgan	Burnasheti Ozni
CH32	Potential Kurgan	Burnasheti Ozni
CH33	Potential Kurgan	Burnasheti Ozni
CH34	Potential Kurgan	Burnasheti Ozni
CH35	Potential Kurgan	Burnasheti Ozni
CH36	Potential Kurgan	Burnasheti Ozni
CH37	Potential Kurgan	Burnasheti Ozni
CH38	Potential Kurgan	Burnasheti Ozni
CH39	Modern cemetery	Beshtasheni bypass
CH40	Settlement	Darakovi
CH41	Bronze Age settlement	Ozni Bypass
CH42	Kurgan	Ozni
CH43	Kurgan	Ozni
CH44	Kurgan	Ozni
CH45	Kurgan	Ozni
CH46	Kurgan	Burnasheti
CH47	Kurgan	Burnasheti
CH48	Kurgan	Berta
CH49	Kurgan	Beshtasheni
CH50	Kurgan	Beshtasheni
CH51	Kurgan	Beshtasheni
CH52	Kurgan	Beshtasheni
CH53	Church	Sapitiakhsho
CH57	Earthwork enclosure	Ozni
CH60	Well-preserved historical road	Berta
CH67	Megalithic stone structure	Berta
CH68	Well-preserved historical road	Kushi
CH71	Route of historical road (including CH60 well preserved portion)	Berta
CH072	Church	Berta Church
CH073	Stone mound, possible archaeology	Nardevani

Site ID (from ESBR Appendix H)	Description	Name/Location
CH074	Stone mound, possible archaeology	Nardevani
CH075	Stone mound, possible archaeology	Nardevani
CH093	Stone mound, possible archaeology	Nardevani
CH094	Stone mound, possible archaeology	Nardevani
CH095	Stone mound, possible archaeology	Nardevani
CH096	Stone mound, possible archaeology	Burnasheti/Ozni
CH097	Stone mound, possible archaeology	Nardevani
CH099	Within CH009 Polygon	Nardevani
CH100	Within CH009 Polygon	Nardevani
CH101	Within CH009 Polygon	Nardevani
CH114	Stone mound, possible archaeology	Burnasheti/Ozni
CH115	Stone mound, possible archaeology	Burnasheti/Ozni
CH117	Potential kurgan	Burnasheti/Ozni
CH120	Stone mound, possible archaeology	Nardevani
CH123	Stone mound, possible archaeology	Nardevani
CH124	Stone mound, possible archaeology	Nardevani
CH125	Stone mound, possible archaeology	Nardevani
CH127	Stone mound, possible archaeology	Kushi
CH128	Historic road (segment)	Kushi
CH129	Stone mound, possible archaeology	Kushi/Berta
CH132	Stone mound, possible archaeology	Kushi
CH145	Stone mound, possible archaeology	Kushi
CH157	Stone mound, possible archaeology	Berta
CH158	Stone mound, possible archaeology	Ozni
CH161	Probable burial mound	Berta/Burnasheti
CH162	Probable burial mound	Berta/Burnasheti
CH163	Probable burial mound	Berta/Burnasheti
CH164	Probable burial mound	Berta/Burnasheti
CH165	Probable burial mound	Berta/Burnasheti
CH166	Probable burial mound	Berta/Burnasheti
CH167	Probable burial mound	Berta/Burnasheti
CH169	Stone mound, possible archaeology	Burnasheti/Ozni
CH170	Stone mound, possible archaeology	Burnasheti/Ozni
CH171	Stone mound, possible archaeology	Burnasheti/Ozni
CH172	Mound, unlikely to be archaeology	Burnasheti/Ozni
CH173	Mound, unlikely to be archaeology	Burnasheti/Ozni
CH175	Mound, unlikely to be archaeology	Burnasheti/Ozni
CH176	Stone mound, possible archaeology	Burnasheti/Ozni
CH177	Mound, unlikely to be archaeology	Burnasheti/Ozni
CH178	Mound, unlikely to be archaeology	Burnasheti/Ozni

Site ID (from ESBR Appendix H)	Description	Name/Location
CH179	Stone mound, possible archaeology	Burnasheti/Ozni
CH180	Stone mound, possible archaeology	Burnasheti/Ozni
CH181	Stone mound, possible archaeology	Burnasheti/Ozni
CH182	Mound, unlikely to be archaeology	Burnasheti/Ozni
CH183	Mound, unlikely to be archaeology	Burnasheti/Ozni
CH186	Stone mound, possible archaeology	Burnasheti/Ozni
CH187	Stone mound, possible archaeology	Burnasheti/Ozni
CH188	Stone mound, possible archaeology	Burnasheti/Ozni
CH189	Stone mound, possible archaeology	Burnasheti/Ozni
CH190	Stone mound, possible archaeology	Burnasheti/Ozni
CH198	Stone mound, possible archaeology	Burnasheti/Ozni
CH204	Stone mound, possible archaeology	Ozni
CH205	Stone mound, possible archaeology	Ozni
CH206	Stone mound, possible archaeology	Ozni
CH208	Probable burial mound	Ozni
CH210	Probable burial mound	Ozni
CH213	Stone mound, possible archaeology	Ozni
CH214	Stone mound, possible archaeology	Ozni
CH215	Probable burial mound	Ozni
CH216	Stone mound, possible archaeology	Ozni
CH219	Stone mound, possible archaeology	Ozni
CH220	Stone mound, possible archaeology	Kizilkilisa
CH222	Stone mound, possible archaeology	Kizilkilisa
CH223	Stone mound, possible archaeology	Kizilkilisa
CH224	Stone mound, possible archaeology	Kizilkilisa
CH225	Stone mound, possible archaeology	Kizilkilisa
CH226	Stone mound, possible archaeology	Kizilkilisa
CH227	Stone mound, possible archaeology	Kizilkilisa
CH228	Stone mound, possible archaeology	Kizilkilisa
CH229	Stone mound, possible archaeology	Kizilkilisa
CH244	Stone mound, possible archaeology	Kizilkilisa
CH245	Stone mound, possible archaeology	Kizilkilisa
CH246	Stone mound, possible archaeology	Kizilkilisa
CH247	Stone mound, possible archaeology	Kizilkilisa
CH248	Stone mound, possible archaeology	Kizilkilisa
CH252	Stone mound, possible archaeology	Kizilkilisa
CH253	Stone mound, possible archaeology	Kizilkilisa
CH254	Stone mound, possible archaeology	Kizilkilisa
CH255	Stone mound, possible archaeology	Kizilkilisa
CH256	Stone mound, possible archaeology	Ozni

Site ID (from ESBR Appendix H)	Description	Name/Location
CH257	Stone mound, possible archaeology	Ozni
CH258	Stone mound, possible archaeology	Ozni
CH258	Stone mound, possible archaeology	Ozni
CH259	Stone mound, possible archaeology	Ozni
CH259	Stone mound, possible archaeology	Ozni
CH260	Stone mound, possible archaeology	Ozni
CH260	Stone mound, possible archaeology	Ozni
CH261	Stone mound, possible archaeology	Ozni
CH262	Stone mound, possible archaeology	Ozni
CH263	Stone mound, possible archaeology	Ozni
CH263	Stone mound, possible archaeology	Ozni
CH264	Stone mound, possible archaeology	Ozni
CH265	Stone mound, possible archaeology	Ozni
CH266	Stone mound, possible archaeology	Ozni
CH267	Stone mound, possible archaeology	Ozni
CH267	Stone mound, possible archaeology	Ozni
CH268	Stone mound, possible archaeology	Nardevani/Kushi
CH269	Probable burial mound, large	Ozni
CH270	Probable burial mound, large	Ozni
CH273	Probable burial mound, large	Burnasheti/Ozni
CH274	Probable burial mound, large	Berta/Burnasheti
CH275	Historic road (segment)	Ozni
CH277	Cemetery, modern	Kizilkilisa Cemetery
CH278	Stone mound, possible archaeology	Ozni
CH279	Stone mound, possible archaeology	Ozni
CH280	Stone mound, possible archaeology	Ozni
CH281	Bridge	Kushi Bridge
CH282	War memorial	Kushi
CH283	Church	Kushi Church
CH284	Cemetery, modern	Kushi Cemetery
CH285	Previously excavated Burial (Kurgan) with satellite mounds	Topkar Kurgan
CH286	Previously excavated Burial (Kurgan) with satellite mounds	Topkar Kurgan
CH287	Kurgan with Greek church	Saqdrioni
CH288	Church and cemetery	Nardevani
CH289	Field system and terraces	Aiazmi
CH290	Cyclopean fortress	Nardevani Fortress
CH291	Cemetery, modern	Aiazmi Cemetery
CH292	Settlement remains, field system, and cairns	Nardevani

Site ID (from ESBR Appendix H)	Description	Name/Location
CH293	Cemetery, modern	Nardevani Cemetery
Access Road Temporary Construction Camp		
CH276	Wall remnant	Nardevani

7.11 Key Environmental Sensitivities

Certain environmental components identified are particularly sensitive to the development. In some cases they display the same sensitivities throughout the SCPX Project area:

- Soil is sensitive to compaction, soil degradation through long-term storage and soil erosion
- River water quality is sensitive to discharges of effluent containing chemicals, wastewater containing organic material, heavy metals and bacteria (e.g. domestic wastewater) into rivers, spills of oil and grease, additions of soil (e.g. due to erosion processes) and artificial changes to river flow rates
- Groundwater quality is sensitive to contamination from spills of oil and chemicals and discharges of wastewater, and groundwater levels are sensitive to abstraction of water for the SCPX Project. Some of the PACs have inadequate water supplies, wastewater treatment and waste disposal.

In other cases, differences can be distinguished between the sensitivities in different parts of the SCPX Project area.

7.11.1 Key Sensitivities at KP0–KP55 and CSG1

- The SCPX route in the vicinity of KP29 is classed as having very severe erosion. KP26–27, KP42–43, KP54–54.5 and KP55–56 are all classed as having high - severe erosion
- The point where the proposed route crosses the Rustavi tectonic fault represents a particular geological sensitivity
- Ground shaking and man-made flooding are sensitivities at CSG1
- Cohesive soils present along the ROW are susceptible to compaction
- Fly-tipping and old workings were found in nine locations along the pipeline. An anthrax pit is known to be located in the vicinity of KP30
- Wetlands between KP0 and KP01
- The sensitivity of the landscape is considered low in the area of CSG1 and the pipeline; it has been degraded and modified by agriculture and industrial development. However there are some sensitive features, such as vegetated field boundaries and areas of occasional scrub, along the pipeline route
- Visual receptors at CSG1 are likely to be in Nazarlo and Lemshveniera and road users travelling towards Jandari, along the pipeline receptors are restricted to road users and shepherds
- Water quality on the Mtkvari is generally good, with the majority of the results not in excess of the EU Freshwater Fish Directive water quality limits for waters to be able to support salmonid and cyprinid fish species. The exception to this is dissolved oxygen during the spring sample and suspended solids in both the spring and summer samples

- The Algeti water quality results indicate that dissolved oxygen during the spring sample and suspended solids in both the spring and summer samples exceed the limits of the EU Freshwater Fish Directive. Furthermore, BOD (spring only) and iron (summer only) both exceed the guidelines for salmonid waters
- Groundwater around CSG1 was recorded to contain excess concentrations of chloride, chromium and iron, according to the UK/EC Drinking Water Standards during the first sampling round, levels were however below the relevant standards and consistent with the results of historical monitoring in the area
- Given the depth of pipeline construction and the hydraulic link identified between aquifer units, the riverbed and floodplain recent alluvial sediments and the early Quaternary alluvial sediments water-bearing horizons are considered most sensitive along the pipeline route and at CSG1
- All irrigation channels between KP0 and KP12, which are used by a diverse assemblage of commonly occurring amphibians (possibly for breeding) and reptiles (such as the rare four-lined snake, Mediterranean tortoise (a Georgian Red List species) and the European marsh turtle, which is the subject of SCP monitoring surveys)
- A Brandt's hamster (IUCN Red List Near Threatened and Georgian Red List) was recorded near KP2 during the faunal surveys
- The channel at KP12 is known to support a diverse assemblage of reptiles and amphibians (including the European marsh turtle, which was the subject of SCP monitoring surveys)
- The Mediterranean tortoise (a Georgian Red List species and one considered 'Vulnerable by IUCN) is known to inhabit the eastern banks of the Algeti and Mtkvari.
- Smooth-leaved elms (Georgian Red List species) on the banks of both the Mtkvari and Algeti rivers and trees at the crossing could support bats
- The potential presence of the Chanari Barbel in the Mtkvari River and the recording of the Carp in the Algeti River (both classed as IUCN vulnerable)
- The boundary features of the proposed CSG1 site (such as the irrigation channel in the south-west corner of the site and the windbreak) are more sensitive than the actual site itself. The irrigation channel supports commonly occurring amphibians and the windbreak has features (e.g. split bark) that could support roosting bats
- Summer, winter and estimated annual mean NO_2 results do not exceed EU or WHO standards/guidelines. Winter NO_2 are generally lower than those measured in summer, reflecting seasonal variation. Although not a full year's data, the means of the summer and winter results are more likely to reflect annual mean conditions, and do not exceed the EU or WHO standards/guidelines
- Estimated annual mean SO_2 results do not exceed the EU criteria for the protection of human health or the protection of ecosystems (for benchmarking purposes), although some elevated individual measurements were obtained
- Summer, winter and estimated annual mean benzene concentrations do not exceed the EU standard
- The PM results are generally higher than the anticipated annual mean because the sampling was carried out during the summer. All results are witihin the relevant air quality standards/guidelines except $PM_{2.5}$, which exceesd the WHO annual mean standard. However, these are summer measurements only which are expected to over-estimate the annual mean
- Residential areas around the compressor station may be sensitive to increased noise levels; although no complaints have been received regarding existing plant noise
- Three locations (CH06-CH08) have potential archaeological deposits that are considered sensitive. The region as a whole has a higher sensitivity owing to the discovery of the Chalcolithic settlement at Beyouk Kasik, in Azerbaijan, close to the border with Georgia, in a similar environment to this location, although no features have been identified.

7.11.2 Key Sensitivities at CSG2 , the Access Road and Access Road Construction Camp

- Excavatability of strong competent rock for the installation of subsurface infrastructure is a geological sensitivity at CSG2. It is also in a zone where earthquakes are known to occur
- Wetlands at CSG2 and along the access road
- The distinctive natural landscape character at CSG2 is sensitive to the introduction of new unnatural features
- Sensitive receptors at the villages of Khando, Rekha, Gumbati, Ashkala, Jinisi, Kushi Oliangi and Burnasheti all have the potential to views of the vent stack (at 50m), those at Rekha may also see compressor buildings
- The water quality of the Ktsia River (2km from site), and of Lake Tsalka into which it discharges, contains no evidence of petroleum hydrocarbons
- The high-quality potable properties and high permeability of the Upper Pliocene–Middle-Quaternary lava formation (Tsalka Suite) makes this formation the most sensitive to potential contamination. Its characteristics are consistent with local hydrological characteristics
- The CITES-listed marsh orchid populations that occur on the site are common in Georgia and sensitive to disturbance
- Species such as the corncrake (CSG2 and CSG2 access road) and the white stork (GPS coordinates 8405362/4603793 and 8407896/4606521, CSG2 access road) are sensitive to disturbance during the bird-breeding season
- The pine plantation abutting the south-west corner of the site that is used by a number of breeding birds is sensitive to disturbance
- The wetlands at 8403821/4611507, 8405359/4609637, 8405363/4609793, 8403175/4614299 and 8404008/4612568, which support commonly occurring amphibians
- Summer, winter and estimated annual mean NO_2 and SO_2 concentrations measured in the vicinity of CSG2 were substantially below the EU and WHO annual mean standard and are considered to be consistent with a rural setting. Winter NO_2 and SO_2 results are in general lower than summer results
- Summer, winter and estimated annual mean benzene concentrations do not exceed the EU standard. PM_{10} measurements made in summer at the CSG2 Weather Station do not exceed the EU or WHO 24-hour mean standards/guidelines, and the period mean period does not exceed the EU or WHO annual mean standards. As noted previously, summer PM_{10} concentrations are likely to be an overestimate of the annual mean, and the measurements are considered consistent with a rural background setting
- $PM_{2.5}$ results at the CSG2 weather station in summer do not exceed the WHO 24-hour mean guideline and the 13-day period mean does not exceed the EU or WHO annual mean standards
- Noise levels in Rekha, the closest village to CSG2, are elevated by the nearby river; more distant villages experience quieter background noise
- The compressor site and adjacent area contains a number of stony mounds, which are potentially burial mounds (CH54–66)
- A number of potential to probable cultural heritage features are in the vicinity of the CSG2 access road and the known feature (CH276) is present at the CSG2 access road construction camp
- The stone-built chapel (CH69) over 500m west of CSG2 is not protected under any legal designation, but represents a site of cultural heritage significance.

7.11.3 Key Sensitivities at PRMS

- Earthquake hazard (ground shaking) is the main geological sensitivity at PRMS. There is some sheet flooding in depressions
- Low landscape sensitivity characterised by an open plateau of grassland and the presence of the existing facility at Area 80. Visual receptors are limited to distant view from settlements located on the valley sides to the north-east and south-east, including views from the village of Julda and Vale (high sensitivity)
- Six endemic plant species were found growing on the site (mainly around the boundary of the survey area)
- Summer, winter and mean NO_2 concentrations were substantially below the EU and WHO annual mean standards. They showed relatively little variation
- One individual measurement of SO_2 at PRMS 3 that exceeded the EU ecosystem standard and the WHO daily mean standard (although not measured over the appropriate time period) was obtained. However, in general, summer, winter and estimated annual mean concentrations do not exceed the EU ecosystem standard or the WHO daily mean standard. Suspected contamination of the samples suggests the summer 2012 and estimated annual mean SO_2 concentrations are likely to be overestimates of actual SO_2 concentrations
- Summer, winter and estimated annual mean concentrations of benzene were low, considered consistent with a rural setting, and do not exceed the EU standard
- The mean of summer and winter concentrations of PM_{10} and $PM_{2.5}$ were well below the annual average air quality standards as expected at a rural location
- The closest residents to the PRMS are isolated houses that have slightly elevated noise owing to a nearby river. The nearest village is 1.4km distance.