ANNEXES - CHAPTER 2

Annexe 2-2 Air Quality Impact Assessment - SENES

CBG EXTENSION PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT

AIR QUALITY IMPACT ASSESSMENT

Prepared for:

Compagnie des bauxites de Guinée (CBG)

Prepared by:

SENES Consultants
AN ARCADIS COMPANY

121 Granton Drive, Suite 12
Richmond Hill, Ontario
L4B 3N4

December 2014

Printed on Recycled Paper Containing Post-Consumer Fibre

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1.0 INTRODUCTION

CBG (Compagnie des bauxites de Guinée) is a mining company jointly owned by the Government of Guinea and Halco Mining (Alcoa, Rio Tinto Alcan and Dadco). CBG currently mines, rails, processes and ships about 13.5 MTPA of bauxite material at 3% moisture from its operations, which are located in Kamsar and Sangarédi in northwest Guinea, as shown in Figure 1. These facilities have been operating since 1973.

CBG is currently considering the expansion of its bauxite production of shipped material starting with 18.5 MPTA, to a plant capacity of 22.5 MTPA at 3% moisture by January 2017 and a further increase of 5 MTPA to a plant capacity of 27.5 MTPA by 2022.

In support of the planned Project, SENES Consultants (SENES) was retained by EEM to complete an air dispersion modelling study to assess the potential effects of CBG's expansion activities on ambient air quality. Various activities have the potential to generate emissions of Constituents of Potential Concern (COPCs), which include airborne dust (and its metallic components) and gaseous products of combustion (e.g., NO_x). The purpose of this report is to characterize the sources of COPCs at both Kamsar and Sangarédi, outline the approach used for air dispersion modelling, and evaluate the model predicted COPC concentrations using applicable ambient air quality criteria, standards, objectives or guidelines. The specific objectives of the air dispersion modelling assessment are:

1. To discuss background or baseline air quality conditions within the study areas;
2. To identify the principal sources of Constituents of Potential Concern (COPCs) and complete an emissions inventory for the Project including the expansion of the Kamsar Processing Facility and Sangarédi mining operations;
3. To evaluate the various COPC emissions sources using air dispersion modelling; and,
4. To assess the potential effects of the Project on ambient air quality for selected COPCs.

Selected outputs from the air dispersion model runs were also used as inputs to the water quality, biological, and socio economic effects assessments.

1.1 OVERVIEW OF THE REPORT

In addition to this introductory section, this report includes the following seven sections. Section 2.0 describes the assessment methodology including the spatial, temporal and technical boundaries, as well as the air quality criteria used to evaluate the model predictions. Section 3.0 discusses the existing air quality and climate, and Section 4.0 describes the assessment scenarios. Section 5.0 provides details of the emissions inventories and Section 6.0 describes the air dispersion modelling methods. Finally, Section 7.0 details the dispersion modelling results and Section 8.0 provides a summary and recommendations for additional mitigation and monitoring.

2.0 ASSESSMENT METHODOLOGY

Bauxite mining, raw material transportation, processing and product shipping activities associated with the Project have the potential to affect ambient air concentrations. This section describes the air quality impact assessment methodology including the Project-environment interactions, the spatial, temporal and technical boundaries as well as the air quality criteria, standards or guidelines applicable to the Project.

2.1 SPATIAL BOUNDARIES

2.1.1 Study Areas

Two (2) study areas have been defined for the purpose of this air quality effects assessment. These areas are the maximum areas within which Project-related air quality effects can be predicted or measured with a reasonable degree of accuracy and confidence. The study areas include the Project Footprint and any adjacent areas where Project-related air quality effects may be reasonably expected to occur. The study areas are as follows:

- The Kamsar study area encompasses a region approximately 10 km by 16 km centred on the Kamsar Processing Facility; and
- The Sangarédi study area encompasses a region approximately 22 km by 26 km which is roughly centred on CBG's existing rail loading facility, south of the Town of Sangarédi. This study area includes active, formerly active and planned bauxite mining areas.

Both study areas considered in this assessment are illustrated in Figure 1.

2.1.2 Project Footprint

The Project Footprint is the most immediate area of the Project that includes the area of direct physical disturbance associated with the construction or operation of the Project. The Project Footprint consists of three main components: the Kamsar Processing Facility, the Sangarédi mine (including mine haul roads) and the interconnecting rail network between the mine and Kamsar. The Project Footprint of the Kamsar Processing Facility is shown in Figure 2 and the Project Footprint of the Sangarédi mine is shown in Figure 3. Note that the Sangarédi Project Footprint includes approximately 21 km of the existing rail network, the mine haul roads as well as CBG offices.

2.2 TEMPORAL BOUNDARIES

The temporal boundaries for the assessment are defined based on the timing and duration of potential effects from activities associated with the Project. The assessment covers all major Project operating phases, each delineated by the anticipated maximum production rate, which is proposed to increase at various intervals through the life of the Project. The total life of the Project where air quality effects could occur from Project-related activities is expected to be approximately thirteen (13) years, and completed in three (3) production phases. Since the level of activity from each of the production phases differs, the extent of any related potential effects will also differ. For this reason, potential air quality effects from the Project were assessed for three separate production scenarios:

- Maximum phase I (18.5 MTPA) operation scenario (2.5 years);
- Maximum phase II (22.5 MTPA) operation scenario (4.5 years); and
- Maximum phase III (27.5 MTPA) operation scenario (6 years).

Additional details on the development of the above scenarios are provided in Section 4.0.

2.3 TECHNICAL BOUNDARIES

The air quality impact assessment is subject to some technical limitations due to a lack of information with which to predict air concentrations. These technical limitations have been considered in the assessment and pertain to the following:

- Many of the air contaminant emissions estimates from mining operations are based on US EPA AP-42 emission factors (US EPA 1995a) (e.g., drilling, blasting, material handling, processing/crushing and unpaved road dust). Most of these emission factors require further site-specific or activity-specific data that were not available at this time. For example, parameters such as material silt and moisture content and daily vehicle counts, among other parameters, were often unavailable. In such cases, professional judgement based on information from similar mining assessments, or default values from AP-42 were used in place of the site-specific data.
- At the time this assessment was prepared, the planned network of haul roads was not available. As a result, the road sources were based on existing roads visible in satellite imagery provided by CBG and the road shapefiles provided in the draft Insuco social impact assessment.

These technical limitations were overcome by using highly conservative estimation techniques and professional judgement. Attachment B provides a detailed account of assumptions that have been used in the assessment.

2.4 CONSTITUENTS OF POTENTIAL CONCERN

Ambient air quality is described by measurable air concentrations of Constituents of Potential Concern (COPCs). As previously mentioned, Project activities have the potential to generate emissions of COPCs including suspended particulate matter and gaseous products of combustion such as NO_x. As a result, the following COPCs are considered to be indicators of air quality:

- Particulate matter less than 10 microns (PM_{10})
- Particulate matter less than 2.5 microns ($PM_{2.5}$)
- Nitrogen dioxide (NO_2)
- Sulphur dioxide (SO_2)

In addition to COPCs, annual air concentrations of total suspended particulate (TSP) and its metallic constituents were determined in order to inform assessments carried out by other related disciplines such as the biological and water quality impact assessments. The trace metallic constituents of dust were selected based on the results of geochemical analysis of surficial soil samples collected the during baseline studies. Specifically, the following additional compounds were considered:

- Total suspended particulate (TSP) and its metallic constituents; including:
  - Aluminum (Al)
  - Antimony (Sb)
  - Arsenic (As)
  - Cadmium (Cd)
  - Chromium (Cr)
  - Copper (Cu)
  - Nickel (Ni)

2.5 REGULATORY FRAMEWORK

Air quality effects are assessed quantitatively by comparing model predicted COPC concentrations to air quality regulatory guidelines, which are typically based human health effects. There are currently no local air quality guidelines in Guinea. As funding for the Project is being sought from the International Finance Corporation (IFC), air quality guidelines from this organization have been applied in this assessment and are described below.

2.5.1 IFC General EHS Guidelines: Environmental (Air Emissions and Ambient Air Quality)

The methodology applied for the development of the air quality impact assessment conforms to the requirements of the Bureau Guinéen des Evaluations Environnementales (BGÉE) and its relevant legal framework. Concordance with the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability will also be assured. The IFC Environmental, Health and Safety Guidelines for Air Emissions and Ambient Air Quality, specify that: *"Projects should prevent or minimize impacts by ensuring that emissions do not result in pollution concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines* (Table 2.1) *or other internationally recognized sources"* (IFC 2007).

The WHO guidelines recognize the need for a staged approach to achieving the recommended guidelines and consequently provide interim targets for SO_2, PM_{10} and $PM_{2.5}$. The existing air quality environment in Kamsar and Sangarédi is already burdened by CBG's current bauxite processing, mining and transportation activities, in addition to activities undertaken by the local population. Local emission sources include activities such as local traffic, cooking fires, refuse fires and burning to clear brush. Other sources, particularly in the dry season, that will contribute to the air quality environment are hot dry winds (the Harmattan) that blow out of the east and northeast, carrying warm air and dust from the Sahara Desert to the Gulf of Guinea. Further, wind-blown dust from open exposed areas and brush fires also contribute greatly to the elevated local air concentrations. As such, for this Project, WHO Interim Target 1 is generally applied and referenced in this assessment.

Table 2.1: World Health Organization Ambient Air Quality Guidelines[1,2]

Contaminant	Averaging Period	Guideline Value (µg/m^3)			
		Interim Target 1	Interim Target 2	Interim Target 3	Guideline
SO_2	24 hour	125	50		20
	10 minute				500
NO_2	1 year				40
	1 hour				200
PM_{10}	1 year	70	50	30	20
	24 hour	150	100	75	50
$PM_{2.5}$	1 year	35	25	15	10
	24 hour	75	50	37.5	25

Notes:
[1] World Health Organization (WHO). Air Quality Guidelines Global Update, 2005. PM 24-hour value is the 99th percentile
[2] Interim targets are provided in recognition of the need for a staged approach to achieving the recommended guidelines

It is important note that the discussion herein focuses on air quality impacts on humans, as the WHO guidelines used in this assessment are based on health and nuisance effects relating to human exposure.

2.5.2 IFC EHS Guidelines for Mining

In addition to the air quality guidelines summarized in Section 2.5.1 from the IFC General EHS Guidelines, the IFC also provides a guideline specifically for mining operations which include additional air quality considerations. The *EHS Guidelines for Mining* (IFC 2007) outlines that the air emissions should be managed by meeting the WHO guidelines outlined in the General EHS Guidelines, and outlines mining-specific dust control techniques. These include:

- dust suppression techniques (e.g. wetting down, surfaces, use of agglomeration additives) for roads and work areas, optimization of traffic patterns, and reduction of travel speeds;
- prompt re-vegetation of exposed soils and other erodible materials, especially when areas are inactive;
- limits on clearing and opening up of new areas (i.e., only to be done when absolutely necessary);
- enclosure and/or efficient dust suppression of storage areas for dusty materials;
- loading, transfer, and discharge of materials should take place with a minimum height of fall, and be shielded against the wind, and consider use of dust suppression spray systems; and,
- conveyor systems for dusty materials should be covered and equipped with measures for cleaning return belts.

3.0 EXISTING ENVIRONMENT

3.1 METHODOLOGY

3.1.1 Ambient Air Quality Baseline Measurements

In an effort to characterize the existing ambient air quality within the Project area (both Kamsar and Sangarédi), an ambient air quality monitoring program was completed at the Project sites between February and May 2014. Air quality monitoring was completed in accordance with the IFC *Environmental, Health, and Safety (EHS) Guidelines – General EHS Guidelines: Environmental* (IFC 2007) requirements. The baseline monitoring was completed by CBG staff in accordance with detailed US EPA-based methods and procedures. Sample analysis was completed by Maxxam Analytics, an accredited Canadian laboratory. The basic procedure consisted of:

- selecting representative monitoring locations;
- collecting measurements of ambient air concentrations of both particulate matter (and its metallic constituents) and gaseous Contaminants of Potential Concern (COPCs) at the identified locations over a period of 24 hours (for particulates) or 30 days (for gaseous contaminants); and,
- validating and correcting the sample analysis data, and field notes to remove anomalous values.

The results of the ambient air quality monitoring program were also compared to ambient air quality data collected for the previous air quality impact assessment (AECOM 2011).

3.1.2 Air Quality Baseline Modelling

In addition to the measurement activities described in Section 3.1.1, air dispersion modelling of the baseline conditions for CBG's operations in Kamsar and Sangarédi was conducted. This allows for a direct comparison between the baseline model predictions and the predictions of potential future effects (Section 7.0). The ambient baseline monitoring data was also used to validate the baseline model.

Air dispersion modelling was undertaken using the CALMET/CALPUFF modelling system (Scire et. al. 1999, 2000a,b) to predict the incremental concentrations of TSP (and its metallic constituents), PM_{10}, $PM_{2.5}$, SO_2 and NO_2 within a modelling region or domain. As discussed in Section 6.0, the CALPUFF model has the ability to handle both complex meteorology and an array of multiple emissions sources from facilities and activities located over a large area. The CALPUFF modelling system is superior to AERMOD in areas with significant local terrain relief (i.e., hilly or mountainous areas with valley channelled air flows) or shoreline effects due

to the proximity of a large water body (i.e., the Atlantic Ocean) that alters the meteorological flow regime.

In general, the recommended methodologies outlined in the IFC *Environmental, Health, and Safety (EHS) Guidelines – General EHS Guidelines: Environmental* (IFC 2007) document were followed when completing the atmospheric dispersion modelling. The details of the modelling methodology are provided in Section 6.0.

Modelling baseline air quality is important where there is an existing facility that will be expanded as it will provide a meaningful benchmark against which the model predictions for the future expansion scenarios can be compared. In this manner, the incremental change resulting from implementation of the project can be reliably determined. Section 5.0 provides a summary of the emission estimates used in the baseline modelling assessment.

3.2 CLIMATE AND METEOROLOGY

3.2.1 Climate

Maritime Guinea is characterized by a tropical and humid climate that has two seasons:

- The dry season (mid-November through to May) is typified by hot dry winds (the Harmattan) that blow out of the east and northeast, carrying warm air and dust from the Sahara Desert to the Gulf of Guinea; and,
- The rainy season (lasting the balance of the year) brings heavy monsoon rains, high humidity and winds from the southwest. Rainfall is heaviest in the south of Guinea, diminishing towards northern coastal areas and the eastern interior.

Due to its proximity to the equator, the day-night cycle in Guinea varies little throughout the year. Average daily temperatures also vary only slightly throughout the year. There are no long term climate stations in the vicinity of Kamsar or Sangarédi. Boké, located approximately, 45 km inland, north-east of Kamsar, and 70 km southwest of Sangarédi has a long term climate data. Summary statistics based on data collected by the World Meteorological Organization are provided in Table 3.1.

Table 3.1: Boké Climate Normals (1961-1990)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Temp. 30 yr. Mean (^oC)	26.3	27.9	29.1	29.7	28.3	27.1	27.4	25.4	24	26.8	28.2	27.2	27.28
High Temp. 30 yr. Mean (^oC)	39.7	38.4	40.5	40.1	38.5	35	32.8	32.4	33.1	33.9	35.5	35.7	36.3
Low Temp. 30 yr. Mean (^oC)	14.4	15.7	17.7	19.9	20.9	20.4	20.7	20.5	19.7	20.1	18.1	14.4	18.54
Precip. Mean (mm)	0	0.1	0.2	9	105	258	485	424	545	317	67	2	184.36
Relative Humidity Mean (%)	53	58	53	55	67	76	75	82	92	78	69	58	68

Source: World Climate (2014)

Detailed historical weather and climate data are generally unavailable for Kamsar and Sangarédi, with the exception of a limited precipitation record in Sangarédi, which has been collected by CBG (Table 3.2). The monthly rainfall statistics for Boké located approximately 50 km northeast of Kamsar are also provided.

Table 3.2: Monthly Precipitation in Sangarédi and Boké

Month	Monthly Precipitation (mm)			
	Sangarédi (1974 to 1978 & 1980 to 2000)		Boké (1974 to 1978 & 1980 to 200)	
	Average	Maximum	Average	Maximum
Jan	2.3	31.0	0.5	7.1
Feb	0.8	19.8	1.0	22.1
Mar	1.8	35.8	0.3	4.7
Apr	18.6	95.0	5.0	42.6
May	111.3	222.2	89.3	217.0
Jun	270.9	514.2	240.7	440.1
Jul	427.4	711.2	463.7	691.2
Aug	447.1	648.5	522.1	789.1
Sep	437.8	745.5	456.5	807.6
Oct	316.2	498.6	313.0	468.0
Nov	71.9	195.9	59.5	232.3
Dec	0.5	10.8	1.2	14.3
Annual	2105.2	2995.8	2152.8	2990.8

Source: SNC Lavalin (2005)

3.2.2 Meteorological Modelling

In order to overcome the limited observing record in Kamsar and Sangarédi, five years of site-specific meteorology was developed for both sites for the 2009 to 2013 period. Hourly

meteorology was developed as described in Section 6.1. This meteorological data set was used as input to the air dispersion model.

3.3 AMBIENT AIR QUALITY

3.3.1 Ambient Air Quality Monitoring in Kamsar

Table 3.3 and Select TSP filters were also analyzed for metals including: aluminum; antimony; arsenic; cadmium; chromium; copper; and nickel. Aluminum was the only metal that was found to be above the detection limit of the laboratory instrumentation and is summarized in Table 3.3. All other results can be found in Attachment E. In general, aluminum concentrations were found to be low (less than 10 µg/m³).

Table 3.4 present a summary of the monitoring results for the two ambient air quality monitoring stations (AQ-1 and AQ-2) located in Kamsar for the spring 2014 monitoring campaign. Complete laboratory results are provided in Attachment E. Table 3.3 also presents the results of the ambient air quality PM_{10} and $PM_{2.5}$ monitoring undertaken in January 2011 around the CBG Bauxite Processing Facility in Kamsar (AECOM 2011). The locations of the ambient air quality monitoring stations are shown in Figure 2. The ambient monitoring locations for the 2011 particulate monitoring were further away from the CBG property than the 2014 measurement locations. Sample location AA1 was selected by AECOM to be representative of a background air concentration located on farmland north of Kamsar and sample location AA7 was selected to be representative of the Kamsar urban environment.

Table 3.3: Results of Baseline Particulate Monitoring in Kamsar (µg/m³)

Sample Location	No. Sample Days	Average Daily Concentration (µg/m³)				Max Daily Concentration (µg/m³)			
		TSP	PM_{10}	$PM_{2.5}$	Al	TSP	PM_{10}	$PM_{2.5}$	Al
AQ-1 Alcoa (2014)	12	160.3	112.6	70.5	3.0	300.2	244.4	117.7	7.1
AQ-2 Ecole (2014)	12	170.0	122.5	70.3	3.2	317.8	245.3	123.5	8.3
AA1 (North Kamsar) (2011)[a]	2	-	218.0	48.6	-	-	223.5	57.5	-
AA7 (CBG Garage) (2011)[a]	1	-	134.2	34.0	-	-	134.2	34.0	-
WHO Interim Target 1		-	150	75	-	-	150	75	-
WHO Interim Target 2		-	100	50	-	-	100	50	-
WHO Interim Target 3		-	75	37.5	-	-	75	37.5	-
WHO Guideline		-	50	25	-	-	50	25	-

Notes:
TSP: total suspended particulate; PM_{10}: fine particulate < 10 µm; $PM_{2.5}$: fine particulate < 2.5 µm.
[a] AECOM (2011)

The results of the ambient air quality monitoring campaign indicate that the Kamsar airshed is already burdened with fine particulates. While the observed average daily concentrations of PM_{10} and $PM_{2.5}$ measurements conducted in 2014 are below the WHO Interim Target 1, maximum daily concentrations of PM_{10} and $PM_{2.5}$ at AQ-1 and AQ-2 are approximately 60% higher than the WHO Interim Target 1. The results at AQ-1 and AQ-2 are generally consistent with the limited sampling conducted for the previous assessment of ambient air quality in Kamsar (AECOM 2011).

Select TSP filters were also analyzed for metals including: aluminum; antimony; arsenic; cadmium; chromium; copper; and nickel. Aluminum was the only metal that was found to be above the detection limit of the laboratory instrumentation and is summarized in Table 3.3. All other results can be found in Attachment E. In general, aluminum concentrations were found to be low (less than 10 µg/m³).

Table 3.4: Results of Baseline Gaseous Contaminant Monitoring in Kamsar (µg/m³) (30 Day Average)

Sample Location	No. of Samples	Average Monthly Concentration (µg/m³)			Maximum Monthly Concentration (µg/m³)		
		NO_2	NO_x	SO_2	NO_2	NO_x	SO_2
AQ-1 Alcoa	4	5.0	13.6	5.0	5.5	15.2	7.1

Notes:
NO_2: nitrogen dioxide; NO_x: oxides of nitrogen; SO_2: sulphur dioxide.

Ambient NO_2 and SO_2 measurements at AQ-1 are approximately 10% of applicable WHO guidelines, even after converting the 30-day measurements to common (i.e., 10-mintue, 24-hour and annual) averaging times.

3.3.2 Modelling of Existing Air Quality in Kamsar

As described previously, air dispersion modelling was conducted in order to evaluate the success of the ambient air quality monitoring campaign and to characterize existing air quality conditions in Kamsar. Contour plots for contaminants having WHO guidelines are presented in Attachment A and tabular results for all contaminants are provided in Attachment D.

The contour plots show maximum model predicted concentrations resulting from emissions from the Kamsar Processing Facility. It is important to note that the maximum predicted concentrations (for 10 min, 1-hour or 24-hour timeframes) shown in the figures represent the single highest concentration predicted to occur at each location, at any time during the 5-year modelling period. Therefore, the contours shown do not represent a “snapshot” in time as these maxima may occur on different days, under different meteorological conditions. Further, as

discussed in Section 6.0, all COPCs were modelled as a gas which does not consider plume depletion for particulate. Consequently the TSP, PM_{10} and $PM_{2.5}$ air concentrations are overestimated.

Maximum daily modelling results at AQ-1 and AQ-2 are presented in Table 3.5 and annual results in Table 3.6. Table 3.7 presents model results for 10 minute SO_2, and 1-hour NO_2.

Table 3.5: Predicted Maximum Daily Concentrations in Kamsar (µg/m^3)

Receptor Location	Predicted Maximum Daily Concentration (µg/m^3)			
	PM_{10}	$PM_{2.5}$	NO_2	SO_2
AQ-1 Alcoa - Maximum	243	122	48	66
AQ-1 Alcoa – 99th percentile[a]	186	93		
AQ-2 Ecole – Maximum	246	120	53	71
AQ-2 Ecole – 99th percentile[a]	160	80		
WHO Interim Target 1	150	75	-	125
WHO Interim Target 2	100	50	-	50
WHO Interim Target 3	75	37.5	-	-
WHO Guideline	50	25	-	20

a – 99th percentile of modelled data to compare to WHO guidelines

Model-predicted air concentrations of fine particulate (PM_{10} and $PM_{2.5}$) are above the WHO Interim Target 1. However, the model results show good agreement with ambient particulate and gaseous measurements shown in Section 3.3.1. The close agreement between the modelling predictions and the maximum observed baseline concentrations supports the inference that the CBG Bauxite Processing Facility at Kamsar is a primary source of fine particulate at AQ-1 and AQ-2. However, as previously mentioned, it is likely that other local sources of fine particulate are contributing to the baseline totals and only a portion of the measurements can be attributed to emissions from the Kamsar Processing Facility.

Table 3.6: Predicted Average Annual Concentrations in Kamsar (µg/m^3)

Receptor Location	Predicted Average Annual Concentration (µg/m^3)			
	PM_{10}	$PM_{2.5}$	NO_2	SO_2
AQ-1 Alcoa	44	23	11	14
AQ-2 Ecole	34	18	8	11
WHO Interim Target 1	70	35	-	-
WHO Interim Target 2	50	25	-	-
WHO Interim Target 3	30	15	-	-
WHO Guideline	20	10	40	-

Table 3.7: Predicted Concentrations for Other Averaging Periods in Kamsar (µg/m^3)

Receptor Location	Predicted Average Annual Concentration (µg/m^3)	
	NO_2	SO_2
	1-hour	10-minute[a]
AQ-1 Alcoa	141	347
AQ-2 Ecole	176	410
WHO Guideline	200	500

a – Converted from 1 hour average using the time averaging calculation noted in Section 4.2.1.

While the predicted annual concentrations of NO_2 are higher than the observed 30-day average values, this is explained by the limited monitoring period, the difference in averaging times (i.e., annual versus 30-day) and the conservative assumption of a 70% conversion of NO_x to NO_2 (see Section 6.4). After taking these considerations into account, predicted and monitored concentrations of gaseous COPCs agreed well (i.e., within a factor of 2, which is considered acceptable for air dispersion modelling).

3.3.3 Ambient Air Quality Monitoring in Sangarédi

Table 3.8 present a summary of the particulate monitoring results for the four ambient air quality monitoring stations (AQ-10, AQ-11, AQ-12 and AQ-13) located in Sangarédi for the spring 2014 monitoring campaign. The locations or the ambient air quality monitoring stations are shown in Figure 3. The results at AQ-10, AQ-11, AQ-12 and AQ-13 are broadly consistent with the limited sampling conducted for the previous assessment of ambient air quality in Sangarédi (AECOM 2011). In the previous assessment, daily concentrations of PM_{10} and $PM_{2.5}$ were measured only once at three locations (AA-1, AA-2, AA-3) Table 3.8.

Table 3.8: Results of Baseline Particulate Monitoring in Sangarédi (µg/m³)

Sample Location	No. of Sample Days	Average Daily Concentration (µg/m³)				Max Daily Concentration (µg/m³)			
		TSP	PM_{10}	$PM_{2.5}$	Al	TSP	PM_{10}	$PM_{2.5}$	Al
AQ-10 Kourawel (2014)	5	150.5	124.5	76.0	1.2	211.0	195.0	152.6	1.5
AQ-11 Hamdallay (2014)	6	129.7	95.7	62.6	1.8	150.1	115.2	85.0	1.8
AQ-12 Petoun BW (2014)	6	127.6	111.0	72.7	0.9	162.0	133.0	85.2	1.3
AQ-13 Paravi (2014)	5	124.6	80.7	35.9	1.2	162.9	89.7	54.4	1.6
AA-1 Sangarédi – (2011)[a]	1	1	116.3	34.5	-	1	116.3	34.5	-
AA-2 Hamdalaye – (2011)[a]	1	1	66.5	14.0	-	1	66.5	14.0	-
AA-3 BW – (2011)[a]	1	1	75.4	15.8	-	1	75.4	15.8	-
WHO Interim Target 1		-	150	75	-	-	150	75	-
WHO Interim Target 2		-	100	50	-	-	100	50	-
WHO Interim Target 3		-	75	37.5	-	-	75	37.5	-
Guideline		-	50	25	-	-	50	25	-

Notes:
TSP: total suspended particulate; PM_{10}: fine particulate < 10 µm; $PM_{2.5}$: fine particulate < 2.5 µm.
[a] –AECOM (2011)

Similar to Kamsar, the results of the ambient air quality monitoring campaign indicate that the Sangarédi airshed is already burdened with fine particulates. The maximum measurements from the 2014 sampling conducted at AQ-10, AQ-11 and AQ-12 exceeded the WHO Interim Target 1 for both PM_{10} and $PM_{2.5}$. During the 2014 sampling campaign, CBG staff noted that all four ambient air quality monitoring stations were influenced to some degree by local sources of dust that are unrelated to CBG activities (e.g., brush fires and from charcoal cooking fires). At AQ-10, which is not currently affected by mining activities, the average and maximum daily concentrations of PM_{10} and $PM_{2.5}$ were approximately 30 to 100% above the WHO Interim Target 1. By contrast, PM_{10} and $PM_{2.5}$ concentrations at AQ-13 are 30 to 40% below WHO guidelines, showing the least influence from local sources of dust and CBG activities.

Select TSP filters in Sangarédi were also analyzed for metals. With the exception of aluminum, all metals were below the method detection limit of the laboratory instrumentation. As can be seen in Table 3.8, the measured concentrations of aluminum are quite low and similar across all monitoring locations, even those locations which are far from current CBG operations. This suggests that CBG operations do not significantly contribute to existing concentrations of aluminum in air.

Similar to Kamsar, ambient NO_2 and SO_2 measurements at AQ-12 and AQ-13 (Table 3.10) were less than 10% of applicable WHO guidelines, even after converting the 30-day measurements to common (i.e., 10-mintue, 24-hour and annual) averaging times.

Table 3.9: Results of Baseline Gaseous Contaminant Monitoring in Sangarédi (µg/m³)

Sample Location	No. of Samples	Average Monthly Concentration (µg/m³)			Max Monthly Concentration (µg/m³)		
		NO_2	NO_x	SO_2	NO_2	NO_x	SO_2
AQ-12 Petoun BW	2	2.4	4.4	0.3	2.6	5.3	0.3
AQ-13 Paravi	2	0.9	1.6	0.5	0.9	2.1	0.5

Notes:
NO_2: nitrogen dioxide; NO_x: oxides of nitrogen; SO_2: sulphur dioxide.

3.3.4 Modelling of Existing Air Quality in Sangarédi

As described previously, air dispersion modelling was conducted to characterize existing air quality conditions in Sangarédi. Annual contour plots for contaminants having WHO guidelines are presented in Attachment A and tabular results for all contaminants are provided in Attachment D. Average annual modelling results at AQ-10, AQ-11, AQ-12 and AQ-13 are presented in Table 3.10.

Table 3.10: Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	1.0	0.1	0.1
AQ11	AQ-11 Hamdallay	622.252	1225.617	8.1	1.0	0.8
AQ12	AQ-12 Petoun BW	628.870	1224.203	2.9	0.5	0.4
AQ13	AQ-13 Paravi	616.710	1221.796	0.8	0.1	0.1
SR9	Kourawel	620.668	1234.753	1.0	0.1	0.1
SR10	Sintiourou Kourawel	620.513	1234.360	1.0	0.1	0.1
SR46	Hamdalaye	622.082	1225.627	7.3	0.9	0.7
SR58	Pora PK130	630.420	1222.985	0.9	0.1	0.1
SR59	Carrefour Parawol	631.430	1221.004	0.8	0.1	0.1
SR60	Kahel Mbody	621.990	1235.671	1.1	0.1	0.1
SR97	Madina Dian	632.551	1221.418	0.6	0.1	0.1
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40

3.3.5 Selected COPC Baseline Concentrations

Given the variability of background concentrations as well as local source contributions (i.e., domestic cooking, local roads and open burning), the model predicted COPC concentrations presented in this baseline assessment are generally considered to be reflective of the increment from the Project plus these local sources. As a result, baseline or background COPC concentrations were not added to model predicted concentrations.

3.4 GREENHOUSE GASES

Emissions of greenhouse gases (GHG) from existing CBG operations, including mining, rail, mobile equipment and vehicles, and bauxite processing, were estimated by CBG and are provided in the Environmental Management Plan.

4.0 ASSESSMENT SCENARIOS

For each production level described in Section 2.2, air quality effects were evaluated for the following scenarios:

- CBG Bauxite Processing Facility at Kamsar;
- the mining activities at Sangarédi;
- a proposed rail siding; and,
- construction activities.

In addition, emissions of COPCs (in both Kamsar and Sangarédi) were considered for two time scales:

- Long-term (or annual) potential effects, where sources were assumed to be operating at average production rates across a broad spatial extent; and,
- Short-term potential effects, where operation levels were close to the maximum daily production rate and sources were spatially concentrated, in order to capture worst-case, localized effects.

A description of each assessment scenario is provided in the following sections while details of the emissions inventories for each scenario are provided in Section 5.0.

4.1 KAMSAR PROCESSING FACILITY

Emissions of COPCs are expected from the crushing and processing activities at the Kamsar bauxite processing facility. The main sources of COPC emissions include the following:

- Dust emissions (and its metallic constituents) generated by bauxite processing, including:
  - Rail unloading (i.e., ore handling);
  - Primary and secondary crushing;
  - Material conveyor transfers;
  - Drying; and,
  - Wind erosion of stockpiles and open areas.
- Emissions of fuel combustion products (i.e., NO_x, SO_2 and fine particulate matter) from the following equipment:
  - Dryers;
  - Generators;
  - Boilers;
  - Line-haul and switching locomotives; and,
  - Idling shipping vessels.

Both short-term (maximum 1- and 24-hour) and long term (average annual) emissions were generated for the existing (13.5 MTPY – Section 3.3.2) and the three future production levels (i.e., 18.5 MTPY, 22.5 MTPY and 27.5 MTPY) at the Kamsar Processing Facility. These emission rates were then carried through and evaluated using air dispersion modelling.

4.2 SANGARÉDI MINING OPERATIONS

Emissions of COPCs are expected from mining and supporting activities at the Sangarédi mine. The main sources of COPC emissions include the following:

- Dust emissions (and its metallic constituents) generated by bauxite mining and shipping activities, including:
  - Drilling;
  - Blasting;
  - Ore handling;
  - Land clearing (i.e., dozing);
  - Road maintenance (i.e., grading);
  - Wind erosion of stockpiles and open areas; and,
  - Haul road traffic.
- Emissions of fuel combustion products (i.e., NO_x, SO_2 and fine particulate matter) from power generation and from the operation of diesel-powered mining equipment and vehicles.
- Emissions of wind-blown dust and gaseous COPCs from rail transportation.

In air dispersion modelling, it is generally not practical to model every year of scheduled production due to the excessive amount of computational time involved in carrying out the model runs and in processing the outputs, particularly for an area as large as the proposed Sangarédi mine expansion. Hence, it is common practice to select certain years for modelling that are considered to be representative of activities at the Project site over consecutive periods spanning the operating life of the Project. As a result, in order to assess the long-term (i.e., annual) potential effects to air quality for each future production level, specific years were selected to represent each level of production.

To select representative years for modelling, SENS used shapefiles provided by CBG which outlined the mining plan. The mine plan spanned 14 years of operations (2014 through 2027) across four production levels (13.5 MTPY, 18.5 MTPY, 22.5 MTPY and 27.5 MTPY). Further, the Project Description (dated June 2014) provided a breakdown of these 14 years as follows:

- Existing operations: 2014
- 18.5 MTPY: 2015 to 2017

- 22.5 MTPY: 2017 to 2021
- 27.5 MTPY: 2022 to 2027

Based on these ranges, SENES selected the following years to represent each production level:

- Existing operations (13.5 MTPY) represented by 2014
- 18.5 MTPY: represented by 2017
- 22.5 MTPY: represented by 2019
- 27.5 MTPY: represented by 2027

The years selected to assess annual air quality effects were generally chosen based on the proximity of the mining areas to nearby sensitive receptors (Figure 3). This approach assumes a consecutive progression through the mining plan (i.e., extraction areas will be decommissioned and rehabilitated in each subsequent year). Note that the modelled areas shown in Figure 3 are an approximation of the corresponding footprints shown in the CBG mine plan. The corresponding haul road network is also shown in Figure 3. This road network was assumed based on the locations of existing roads visible in satellite imagery and the road shapefiles provided in the draft Insuco social impact assessment. As a conservative measure, the longest route between a mining area and rail loading area was selected. Additional details are provided in Section 6.0.

Given the spatial extent of the proposed mining areas and haul road network, it was not possible to complete a separate model run for each individual mining area in order to assess nearby short-term effects, as the areas are interspersed over a large domain that is more than 400 km^2. Instead, a generic modelling approach was used to represent typical daily mining activities occurring within an extraction area of 200 m by 200 m. In addition, the effects of an unpaved haul road were also evaluated using a generic road stretching 2 km on either side of the mining area, which was modelled concurrently with extraction activities. A separate model run was also completed to assess the NO_2 impacts of blasting (1-hour average concentrations). Details of these approaches are provided in Section 6.0.

4.3 PROPOSED RAIL SIDING OPERATIONS

The proposed expansion of the Kamsar Processing Facility and Sangarédi mining operations will require additional rail sidings along the existing rail network. To optimize shipping for the expansion, two new rail sidings are proposed at 14 km and 118 km as described in the Project Description.

The assessment of potential effects from increased rail traffic with no siding was included in the assessment scenarios for Sangarédi mining operations (Section 4.2). The effects of the proposed

rail sidings were assessed using a separate, generic model run which included an idling train with three locomotives on a siding. The expected emissions are combustion products (i.e., gases and fine particulate) from the locomotives. The results from this modelled scenario were compared to applicable WHO guidelines to determine the effect of a rail siding on local ambient air quality.

4.4 CONSTRUCTION

On-land construction activities have the potential to result in Project-related environmental effects that could result in increased concentrations of ambient COPCs. Construction activities are anticipated at both the Kamsar Processing Facility and the Sangarédi mining operations, and are described in brief below.

Expansion of the Kamsar Processing Facility will require the following construction activities:

- modification to the existing rail yard;
- installation of the new rotary rail car dumper, primary and secondary crushers and dryer(s);
- modifications/upgrades to the conveyor system; and,
- construction of a new storage building additions and modifications.

Expansion of the Sangarédi mining operations will require the following construction activities:

- construction of a new rail siding and a new rail loading area near Parawi (applicable to 22.5 MTPY or 27.5 MTPY production levels only); and,
- development of new haul roads.

The construction emissions will be generated within the same footprint as site operations at the Kamasar Processing Facility and Sangarédi mine operations. At Kamsar, the construction activities are largely limited to building construction, and there are no major earthworks planned. Consequently, the emissions the COPCs during construction at Kamsar will be much less than during the operations phase. Although minor earthworks are planned at Sangarédi, the spatial and temporal extents of the construction activities are much smaller than the operational activities, which are major earthworks themselves. In all, the maximum emission scenarios are considered to adequately capture the effects of construction for both Kamsar and Sangarédi. Consequently, detailed dispersion modelling was not undertaken for construction.

5.0 EMISSIONS INVENTORY

5.1 COPC EMISSIONS

COPC emissions resulting from Project activities (in both Kamsar and Sangarédi) were primarily calculated using the US EPA's *Compilation of Air Pollutant Emissions Factors* (commonly known as AP-42 emission factors). These emission factors were used to estimate the maximum emission rates of the specified COPCs for each source and/or activity in each of the production expansion scenarios.

The methods used to calculate COPC emissions from the Project activities described previously in Section 4.0 are summarized below. The specific emission sources that have been included in the emissions inventories are:

- Bauxite dryers/kilns;
- Diesel generators;
- Material handling of bauxite;
- Drilling;
- Blasting;
- Explosives detonation;
- Grading;
- Wind erosion of stockpiles and open railcars;
- Unpaved road dust; and
- Fuel combustion by container ships at berth, locomotives, on-road vehicles and non-road mobile equipment.

Where appropriate, mitigation measures considered to be inherently part of the Project plans have been incorporated into the emissions scenarios. At the Kamsar Processing Facility, the following mitigation measures were considered:

- Enclosure and/or efficient dust suppression of storage areas for dusty materials;
- Loading, transfer, and discharge of materials is shielded against the wind;
- Loading, transfer, and discharge of materials employs additional dust suppression systems, including dry fogging or dust collectors (future scenarios only, does not exist as part of the existing controls);
- Conveyor systems for dusty materials are covered; and,
- Dryer stacks are equipped with wet scrubbers operating at 99% efficiency.

In the Sangarédi mining area, the following mitigation measures have been incorporated into the emissions inventories:

- Dust suppression techniques (e.g., watering, chemical dust suppressants) are applied to unpaved haul roads to achieve 80% control;
- Vehicle speed in the vicinity of rail loading areas and active mining areas will be restricted to 40 km/hour; and
- Prompt re-vegetation of exposed soils and other erodible materials, especially when areas are inactive.

As outlined in Section 4.0, emissions of COPCs (in both Kamsar and Sangarédi) were considered for two time scales: long-term (or annual) potential effects; and short-term potential effects. At the Kamsar Processing Facility, emission estimates for the long-term and short-term emissions scenarios differed little. The dominant sources of particulate and gaseous COPCs (e.g., dryer stacks, transfer towers and conveyors, diesel generators) in Kamsar were assumed to operate at close to maximum rates throughout the year. For example, while outdoor stockpiles were assumed to be the same size in both the long-term and short-term effects assessments, annual wind erosion emissions account for a natural control efficiency of 29% due to precipitation (i.e., 101 days per year with > 0.25 mm of precipitation; derived from CALMET).

By contrast, mining operations in Sangarédi vary considerably in both spatial and temporal extent. In order to address this variability, emissions were estimated separately for typical annual scenarios across the study area, as well as for a generic working area to evaluate short-term effects (see Section 4.2). As a result of these contrasting emissions scenarios, it is difficult to make direct comparisons between short-term and long-term emission rates in Sangarédi.

5.1.1 Bauxite Dryers

Emissions of TSP, NO_x and SO_2 from the existing Kamsar bauxite dryers (FOR001, FOR002, FOR003) were based on stack testing conducted at the Kamsar Processing Facility in 2006 (Table 5.1). The emission rates were then scaled up to account for the difference between the measured stack flow rate at the time of testing and the maximum flow rate of the three existing dryers at full production (510,000 m^3 per dryer per hour; Drytech International [2011]). PM_{10} emissions were conservatively assumed to be 50% of TSP emissions; $PM_{2.5}$ emissions were conservatively assumed to be equal to PM_{10}. Metallic constituents of particulate emissions were estimated based on geochemical analyses of the bauxite ore, as outlined in Attachment B.

Table 5.1: Bauxite Dryer Stack Testing Results

Dryer	Emission Rate (kg/hour)			Volumetric Flow Rate (m^3/hour)	Exhaust Temperature (K)
	TSP	NO_x	SO_2		
FOR001	103	25.3	29.3	444,563	329.7
FOR002	50	4.1	4.1	369,959	325.4
FOR003	63	29.9	34.7	502,113	322.5

Source: AECOM (2011), Annex F.

Emissions of COPCs from the future Kamsar bauxite dryers (FOR004, FOR005) were estimated by assuming equivalent COPC concentrations as in the existing dryers, with flow rates scaled up to account for the larger throughput of the new dryers. All emission rate estimates (for existing and future dryers) assume that the dryer exhaust stacks are controlled by wet scrubbers having at least 99% control efficiency of all COPCs.

5.1.2 Diesel Generators

Diesel electric generators are used to supply electricity at the Kamsar Processing Facility (Centrale Kamsar) and at the main CBG facility in Sangarédi (Centrale Sangarédi). Emissions from the generators were estimated based on the fuel consumption totals outlined in Attachment B and emission factors from AP-42, Chapter 3.4, Large Stationary Diesel and All Stationary Dual-fuel Engines and AP-42, Chapter 1.3, Fuel Oil Combustion (see Table 5.2). The generators at Centrale Kamsar consume both diesel and No. 6 (Bunker C) fuel oil, whereas the generators at Centrale Sangarédi consume only diesel. Daily average emission rates were calculated assuming generators operate 365 days per year in Kamsar and 350 days per year in Sangarédi.

Table 5.2: Generator Emission Factors

COPC	Diesel Emission Factor (lb/MMBtu)	No. 6 Fuel Oil Emission Factor [1] (lb/1000 gal.)
TSP	0.062	30.8 [2]
PM_{10}	0.0496	21.9 [3]
$PM_{2.5}$	0.0479	16.0 [3]
Antimony	–	0.00525
Arsenic	–	0.00132
Cadmium	–	0.000398
Chrome	–	0.000845
Copper	–	0.00176
Nickel	–	0.0845
NOx	3.2	55
SO_2	0.333 [4]	471 [5]

Notes:
[1] Conservatively assumed maximum of emission rates for all units at Centrale Kamsar burning No. 6 fuel oil
[2] TSP = 9.19S + 3.2; where S = 3% sulphur, based on Kamsar Dryer Inspection Report (Drytech International [2011])
[3] PM_{10} assumed to be 71% of TSP; $PM_{2.5}$ assumed to be 52% of TSP, based on AP-42 Table 1.3-4.
[4] SO_2 = 1.01S; where S = 0.33% sulphur, based on typical values from U.S EPA. Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling Compression-Ignition, page 14.
[5] SO_2 = 157S; where S = 3% sulphur, based on Kamsar Dryer Inspection Report (Drytech International [2011])

5.1.3 Material Handling

Material handling includes activities such as unloading ore to stockpiles at the train loading area in Sangarédi and conveyor transfer of wet and dry ore at the Kamsar Processing Facility. The specific material drops or transfers that were included in this assessment for each production scenario (both in Kamsar and Sangarédi) are outlined in Attachment B.

The emission factor equation for material drops from the US EPA AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles (US EPA 2006a) was used to the estimate emissions from outdoor material handling activities (e.g., loading/unloading of ore to/from haul trucks):

$$TSP = 0.74 \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \; kg / tonne$$

$$PM_{10} = 0.35 \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \; kg / tonne$$

$$PM_{2.5} = 0.053 \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \; kg / tonne$$

Where,

U = mean wind speed (m/s)

M = moisture content (%)

Outdoor material handling emissions depend on the average wind speed, as well as the moisture content of the material being handled. The moisture contents of the various materials considered in this assessment are outlined in Attachment B. Where site-specific moisture contents were not known, default AP-42 values were used and are also noted in Attachment B. The annual average wind speeds in Kamsar and Sangarédi were, respectively, 3.3 m/s and 2.8 m/s, based on the CALMET meteorology developed for this assessment (Section 6.1.3). The wind speed applied to indoor material handling was assumed to be 1 m/s. Annual emissions from outdoor material handling also account for a natural control efficiency of 29% due to precipitation.

At the Kamsar Processing Facility, material processing and handling activities predominately take place inside structures, as bauxite is moved along a network of material conveyors and transfer towers. Emission factors for material processing and handling at the Kamsar Processing Facility are shown in Table 5.3 and were drawn from AP-42, Chapter 11.24, Metallic Minerals Processing (US EPA 1995b). The existing transfer towers are partially enclosed and/or have dust control systems (with an assumed 80% control efficiency), while conveyors themselves are covered and are assumed not to be a significant source of dust emissions.

Table 5.3: Material Handling Emission Factors

Source	Material Handling Emission Factors (kg per Mg of material throughput)		
	TSP	**PM_{10}**	**$PM_{2.5}$**
Primary Crushing	0.01	0.004	0.002
Secondary Crushing	0.03	0.012	0.006
Material Handling and Transfer (Bauxite/Alumina)	0.06	0.03	0.015

Notes:

1 Primary and secondary crushing emission factors assume high moisture content in the ore (i.e., 12.5%)

2 Emissions of $PM_{2.5}$ conservatively assumed to be equal to 50% of PM_{10}, based on the AP-42 background document for Chapter 11.24.

As Project expansion activities progress at the Kamsar Processing Facility, the system of transfer towers and conveyors will be incrementally upgraded to increase material handling rates and improve dust controls. Upgraded material handling equipment will be partially enclosed with an

assumed 80% control efficiency, and employ dry fogging or upgraded dust collection systems with an assumed additional 80% dust control efficiency, for a total control efficiency of 96%.

The maximum amount of ore handled per hour during processing activities in Kamsar and mining activities in Sangarédi is outlined in Attachment B, along with the assumed dust control efficiencies for material handling at the Kamsar Processing Facility. Note that no controls were applied to material handling emissions in Sangarédi.

5.1.4 Drilling

Emissions of TSP and PM_{10} from development/exploration drilling were estimated using the emission factor provided in US EPA AP-42, Chapter 11.9 -Western Surface Coal Mining (US EPA 1998). $PM_{2.5}$ emissions were conservatively assumed to be equal to PM_{10}. All factors assume wet drilling operations:

$TSP = 0.59\ kg/hole$

$PM_{10} = 0.31\ kg/hole$

$PM_{2.5} = 0.31\ kg/hole$

This method requires an estimate of the number of holes drilled. The maximum number of holes drilled per day during the different production scenarios is outlined in Attachment B. Note that drilling was not considered concurrently with blasting and explosives detonation (i.e., drilling emissions were not part of the worst case short-term effects scenario).

5.1.5 Blasting

Emissions from blasting were estimated using the emission factors in US EPA AP-42, Chapter 11.9 – Western Surface Coal Mining (US EPA 1998):

$TSP = 0.00022(A)^{1.5}\ kg/blast$

$PM_{10} = 0.52 \times 0.00022(A)^{1.5}\ kg/blast$

$PM_{2.5} = 0.03 \times 0.00022(A)^{1.5}\ kg/blast$

Where,

A = area of the blast face (m^2)

This method requires an estimate of the horizontal area displaced by blasting as well as the frequency of blasting which is outlined in Attachment B for the various production scenarios. As a conservative measure, the frequency of blasting was assumed to be the same for each of the production levels. Consequently, the size of the blast increased relative to the increase in production.

5.1.6 Explosives Detonation

Blasting was assumed to use 100% ammonium nitrate/fuel oil (ANFO) explosive. Emission factors were drawn from US EPA AP-42, Chapter 13.3 – Explosives Detonation (US EPA 1995c):

CO = 34 kg/tonne emulsion

NOx = 8 kg/tonne emulsion

This method requires an estimate of the amount of ANFO required for blasting, which was calculated based on a generic powder factor for "soft" material of 0.25 kg ANFO per m³ of ore (Dyno Nobel 2010) and the volume of material removed per blast which is provided in Attachment B.

5.1.7 Grading

Emissions of dust (TSP, PM_{10}, $PM_{2.5}$) from grading unpaved haul roads in Sangarédi were estimated using the emission factor equation provided in US EPA AP-42, Chapter 11.9 - Western Surface Coal Mining (US EPA 1998):

$$TSP = 0.0034 \times S^{2.5}\ kg/VKT$$

$$PM_{10} = 0.60 \times 0.0056 \times S^{2.0}\ kg/VKT$$

$$PM_{2.5} = 0.031 \times 0.0034 \times S^{2.5}\ kg/VKT$$

Where,

S = mean vehicle speed (km/h)
VKT = vehicle kilometres travelled

This method requires an estimate of the speed of the grader (assumed to be 10 km per hour) as well as the number of kilometres travelled, which was calculated based on the length of each of the unpaved roads. For the short-term emissions scenarios, a grader was conservatively assumed

to complete a single trip per day along the generic road. For the long-term emissions scenarios, a grader was assumed to travel only on active haul roads and a natural control efficiency of 29% (due to precipitation) was assumed. Additional details are provided in Attachment B.

5.1.8 Wind Erosion from Stockpiles and Railcars

Wind erosion emissions from outdoor stockpiles, open areas, open railcars and active working areas in Sangarédi were estimated following the methodology outlined in the Western Regional Air Partnership (WRAP) Fugitive Dust Handbook (WRAP 2006):

$$TSP = 1.0 \times 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{F}{15}\right) kg / ha / day$$

$$PM_{10} = 0.5 \times 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{F}{15}\right) kg / ha / day$$

$$PM_{2.5} = 0.075 \times 1.7 \times \left(\frac{s}{1.5}\right) \times \left(\frac{F}{15}\right) kg / ha / day$$

Where,

s = average silt content of storage pile (%)

F = percentage of time in the year with unobstructed wind speed >5.4 m/s in percent (%) at the mean pile height

According to the WRAP Handbook, this methodology is applicable to short-term (i.e., 24-hour) averaging periods. It results in a conservative estimate of particulate matter emissions when applied on an annual basis.

Average monthly frequencies of wind speeds greater than 5.4 m/s were calculated for each stockpile using the CALMET dispersion meteorology and the mean pile heights as described in Attachment B. The silt contents of the various stockpiles considered in the assessment along with the surface areas used are also outlined in Attachment B. In the absence of site-specific information, the silt contents were based on default AP-42 values.

To calculate wind erosion emissions, one hundred percent of the surface area of each stockpile or working area was considered to be exposed to the wind, except for the long-term effect scenario at Sangarédi, where only 50% of the active extraction areas were considered to be exposed to the wind.

5.1.9 Unpaved Road Dust

For the Sangarédi mining activities, emissions of road dust from unpaved haul roads were estimated using the emission factor equations from US EPA AP-42, Chapter 13.2.2 (US EPA 2006b):

$$TSP = 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W}{3}\right)^{0.45} lb/VMT$$

$$PM_{10} = 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W}{3}\right)^{0.45} lb/VMT$$

$$PM_{2.5} = 0.15 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W}{3}\right)^{0.45} lb/VMT$$

Where,

s = silt content (%)
W = vehicle weight (tons)
VMT = vehicle miles travelled

To estimate emissions from industrial unpaved roads, silt content, average fleet weight, and the number of vehicle miles travelled is required. In the absence of site-specific information, an average silt content of 10% was assumed based on typical values in AP-42, Chapter 13.2.2. Vehicle weights were based on the list of existing mining equipment provided by CBG. The number and length vehicle trips was based on the capacity of haul trucks (90 tonnes; CAT 777F) and an analysis of the modelled road network connecting the planned extraction sites (see Figure 3). Additional details are provided in Attachment B.

The generation of dust from unpaved roads can be controlled through operational practices such as watering, applying chemical dust suppressants or driving at lower speeds. For this assessment it has been assumed that vehicle speeds within the active extraction areas and at the rail loading sites will be kept at or below 25 mph (44 km/h). This controls dust emissions by about 44% as suggested by the *WRAP Fugitive Dust Handbook* (WRAP 2006). It was also assumed that additional controls such as watering will be applied on an as needed basis to all roads such that dust emissions are controlled by an additional 80% at all times of the year. It is anticipated that frequency of application of dust controls for the haul roads will vary throughout the year, accounting for considerable natural dust control during the rainy season.

5.1.10 Fuel Combustion by Ships, Locomotives, Vehicles and Non-Road Mobile Equipment

The existing and future equipment fleet for both Kamsar and Sangarédi is provided in Attachment B, along with estimated fuel consumption for the different production scenarios. Fuel estimates were based on the fuel inventory completed for the CBG greenhouse gas inventories and split among the existing equipment fleet using assumed typical fuel efficiencies. Emissions were estimated using emission factors from the following US EPA documents:

- Ships at berth in Kamsar: *Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories* (US EPA 2009a);
- Locomotives: *Emission Factors for Locomotives* (US EPA 2009b); and,
- Vehicles and non-road mobile equipment: *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition* (US EPA 2010).

For this assessment, it was conservatively assumed that all locomotives, vehicle and mining equipment meet Tier 0 standards which are based on engine model years prior to 2001. A diesel sulphur content of 0.33% was assumed based on typical values for Tier 0 vehicles and equipment (US EPA 2010). Emission factors for these sources are summarized in Table 5.4.

Table 5.4: Locomotive, Vehicle and Non-Road Mobile Equipment Emission Factors

Source	Emission Factors						Conversion [3]
	TSP [1]	PM_{10}	$PM_{2.5}$ [1]	NO_x	SO_2 [2]	Units	
Tier 0 Vehicles & Non-road Equipment (>75 to 100 hp)	0.722	0.722	0.700	6.9	1.19	g/hp-hr	*BSFC:* 0.408 lb/hp-hr
Tier 0 Vehicles & Non-road Equipment (>100 to 750 hp)	0.402	0.402	0.390	8.38	1.19		*BSFC:* 0.367 lb/hp-hr
Tier 0 Locomotives (Line-haul)	0.32	0.32	0.31	8.6	1.0	g/bhp-hr	*Fuel density:* 20.8 bhp-hr/gal
Tier 0 Locomotives (Switching)	0.44	0.44	0.43	12.6	1.0		*Fuel density:* 15.2 bhp-hr/gal

Notes:
[1] PM_{10} assumed equal to TSP; $PM_{2.5}$ assumed equal to 97% of PM_{10}.
[2] SO_2 emission factors assume diesel fuel density of 7.1 lb per gal and sulphur content of 0.33% (US EPA 2010).
[3] BSFC: brake-specific fuel consumption in units of pounds per horsepower-hour (lb/hp-hr).

Emission factors for ships at berth in Kamsar are provided in Table 5.5. Emissions were based on typical values for a Kamsarmax type ships operating at berth at the Kamsar Processing Facility, while drawing power from its auxiliary engine at 10% load (US EPA 2009a).

Table 5.5: Ships at Berth Emission Factors

Source	Emission Factors						Conversion [2]
	TSP [1]	PM_{10}	$PM_{2.5}$ [1]	NO_x	SO_2	Units	
Kamsarmax Auxiliary Engine	0.49	0.49	0.45	13.9	4.2	g/kWh	*BSFC:* 217

Notes:
[1] PM_{10} assumed equal to TSP; $PM_{2.5}$ assumed equal to 92% of PM_{10}.
[2] BSFC: brake-specific fuel consumption.

5.1.11 Air Emission Rate Summary

A summary of emission rates for all sources in Kamsar and Sangarédi is provided in Table 5.6, Table 5.7 and Table 5.8 for emissions from the CBG Processing Facility in Kamsar, the mining activities in Sangarédi and the blasting activities in Sangarédi, respectively.

At the Kamsar Processing Facility, particulate emissions from the dryer stacks and material handling dominate the emissions inventory. Under existing conditions, dryer and material handling emissions are split evenly; however, as production increases and dust controls are upgraded for the network of transfer towers and conveyors, particulate emissions become dominated by the dryer stacks. The main source of gaseous emissions is fuel combustion, particularly in the dryers. As production increases, fuel requirements also increase which increase the emissions of NO_x and SO_2.

In the Sangarédi mining area, the mining haul roads are the dominant source of particulate emissions. As production increases and shifts north to the Kourawel area, the number and the average length of daily haul truck trips increase significantly, leading to a tenfold growth in annual dust emissions from haul road traffic compared to existing operations.

Table 5.6: Emission Estimates Used in Dispersion Modelling – Kamsar

Scenario	COPC	24 hour Average (g/s)				Annual Average (tonnes/year)			
		Dryers	Boilers & Electric Generators	Material Handling & Processing	Misc.	Dryers	Boilers & Electric Generators	Material Handling & Processing[1]	Misc.
Existing	TSP	70.9	3.9	70.5	0.2	2236	123	2217	6
	PM_{10}	35.5	2.8	34.8	0.2	1120	88	1094	6
	$PM_{2.5}$	35.2	2	17.3	0.1	1110	63	542	3
	NO_x	19.1	55.5	--	4	602	1750	--	126
	SO_2	22	59.7	--	0.6	694	1883	--	19
18.5 MTPY	TSP	107.8	5.4	54.5	0.2	3400	170	1709	6
	PM_{10}	53.9	3.8	27.1	0.2	1700	120	851	6
	$PM_{2.5}$	53.4	2.8	13.4	0.2	1684	88	423	6
	NO_x	29.1	76.5	--	5.5	918	2413	--	173
	SO_2	33.4	82.7	--	0.7	1053	2608	--	22
22.5 MTPY	TSP	107.8	5.8	27.4	0.3	3400	183	855	9
	PM_{10}	53.9	4.1	13.6	0.3	1700	129	423	9
	$PM_{2.5}$	53.4	3	6.6	0.2	1684	95	208	6
	NO_x	29.1	81.4	--	6.5	918	2567	--	205
	SO_2	33.4	88.1	--	0.8	1053	2778	--	25
27.5 MTPY	TSP	145	7.7	42	0.3	4573	243	1315	9
	PM_{10}	72.5	5.4	20.8	0.3	2286	170	653	9
	$PM_{2.5}$	71.8	4	10.3	0.3	2264	126	322	9
	NO_x	39	107.8	--	8.1	1230	3400	--	255
	SO_2	44.8	117	--	1.1	1413	3690	--	35

Notes:

[1] Annual emissions of dust (TSP, PM_{10}, $PM_{2.5}$) for outside material handling and processing sources (e.g., outdoor storage piles) have been assumed to have 28% natural dust control (i.e., from precipitation).

Table 5.7: Emission Estimates Used in Dispersion Modelling – Sangarédi

Scenario	COPC	24 hour Average (g/s)				Annual Average (tonnes/year)			
		Ore Extraction Areas	Haul Roads	Rail Loading Area & Stockpiles	Misc.	Ore Extraction Areas[1]	Haul Roads	Rail Loading Area & Stockpiles[1]	Misc.
Existing	TSP	7	60.3	1.1	2	246	1680	24	47
	PM_{10}	2.3	17.8	0.5	1.1	97	498	12	26
	$PM_{2.5}$	0.2	1.8	0.1	0.3	29	53	2	9
	NOx	0.9	0.3	0.01	11.8	53	37	0.4	373
	SO_2	0.01	0.05	0.002	1.2	5	6	0.1	39
18.5 MTPY	TSP	9.7	82.3	1.3	2.3	355	4605	28	53
	PM_{10}	3.2	24.3	0.6	1.2	141	1362	14	29
	$PM_{2.5}$	0.3	2.4	0.1	0.4	40	140	2	10
	NOx	1.2	0.2	0.02	13.2	71	49	0.6	418
	SO_2	0.01	0.03	0.003	1.4	7	8	0.1	44
22.5 MTPY	TSP	11.9	99.6	1.5	2.7	427	5573	34	64
	PM_{10}	3.9	29.4	0.8	1.5	169	1649	17	35
	$PM_{2.5}$	0.4	3	0.1	0.4	48	169	3	11
	NOx	1.4	0.2	0.03	14.7	84	56	0.9	464
	SO_2	0.01	0.04	0.01	1.5	8	10	0.2	49
27.5 MTPY	TSP	14.8	121.2	1.8	3.3	511	19294	40	77
	PM_{10}	4.9	35.8	0.9	1.7	201	5699	20	41
	$PM_{2.5}$	0.5	3.6	0.1	0.5	58	575	3	13
	NOx	1.7	0.3	0.03	15.4	98	67	1	487
	SO_2	0.01	0.04	0.01	1.6	9	11	0.2	51

Notes:

[1] Annual emissions of dust (TSP, PM_{10}, $PM_{2.5}$) for outside material handling and processing sources (e.g., outdoor storage piles) have been assumed to have 29% natural dust control (i.e., from precipitation).

Table 5.8: Maximum 1 Hour NO_x Emission Estimates (g/s) for Blasting – Sangarédi

Emissions Source	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Blasting	115.7	159.8	194.4	237.6

5.2 GREENHOUSE GASES

Greenhouse gas (GHG) emissions associated with the Project's expansion to 18.5 MTPY, 22.5 MTPY and 27.5 MTPY were estimated by CBG and are provided in the Environmental Management Plan.

6.0 AIR DISPERSION MODELLING

Air dispersion modelling was undertaken using the CALMET/CALPUFF modelling package (Scire et. al. 1999, 2000a,b) - a current state-of-the-art dispersion model.

CALMET is an advanced non-steady-state diagnostic meteorological model that produces hourly three-dimensional gridded wind fields from available meteorological, terrain and land use data (Scire et al. 2000a,b). The CALPUFF model has ability to handle both complex meteorology and an array of multiple emissions sources from facilities and activities located over a large area and is the US EPA regulatory model for long range transport studies. It is a multi-layer, multi-species, non-steady-state puff dispersion model that can simulate the effects of varying meteorological conditions in time and space on pollutant transport (Scire et al. 2000a,b). CALPUFF runs in conjunction with CALMET to estimate pollutant concentration for each source-receptor combination for each hour of input meteorology. The maximum predicted 1-hour, 24-hour and average annual concentrations are then determined from the hourly CALPUFF model outputs at each receptor point.

The main reasons for choosing a sophisticated modelling system like CALMET/CALPUFF are:

- it is applicable to spatial scales ranging from a few kilometres to more than 100 km;
- wind speed and wind direction vary in three spatial dimensions and in time, providing a more realistic simulation of plume movements;
- its ability to handle shoreline dispersion (and potential shoreline fumigation);
- its ability to handle calm wind conditions (wind speeds less than 0.5 m/s);
- it is based on sound, openly documented physical principles that have undergone independent review; and,
- the full three dimensional meteorology produced by CALMET allows for better simulation of local wind patterns, which are very important when assessing location specific predictions, such as sensitive receptor locations.

Air dispersion modelling can be used to predict the incremental concentrations of pollutants within a modelling region or domain; however, there are often uncertainties with respect to a model's ability to predict concentrations accurately. Many assumptions and simplifications are required to describe real phenomena using mathematical equations, and the processes of atmospheric motions and turbulence are simplified in dispersion models which introduce uncertainties. It is important to note the sources of this uncertainty:

- simplification and accuracy limitations related to source data (i.e., emissions and modelled source characteristics);
- limitations in the meteorological data input; and/or

- simplification of model physics to replicate the random nature of atmospheric dispersion processes.

The items noted above limit a model's ability to accurately predict time-averaged atmospheric concentrations for a given set of meteorological conditions. This means that dispersion modelling may over- or under-estimate measured ground-level concentrations at any specific time or place. However, models are reasonably reliable in estimating the magnitude of the overall maximum concentration occurring irrespective of time and space. For example, an error of ±10 to 40% for the highest estimated concentration is typical (Rhoads, 1981, and Hanna, 1993). However, a model is considered to perform well if the model predicted concentrations are within a factor of two of monitored values.

6.1 AIR DISPERSION METEOROLOGY

6.1.1 Review of Available Meteorological Data Sets

Available meteorological data near the Project study areas was reviewed and assessed for its representativeness of the meteorological conditions within the study areas.

Historical meteorological data from the nearest airport stations were examined including: Kawass airport (about 8 km east of Kamsar); Boké Baralande airport (about 50 km northeast of Kamsar); and Sangarédi airport. Upon examining the data at each station, it was found that the stations had incomplete meteorological data records and were not suitable for air dispersion modelling. As a result, meteorological modelling was used to develop representative site-specific surface and upper air meteorological data set for a five year period (2009 to 2013). Details of the meteorological modelling are provided in the following sections.

6.1.2 WRF-NMM Meteorological Modelling

The meteorological data set used for air dispersion modelling was derived using the Weather Research Forecast Non-hydrostatic Mesoscale Model (WRF-NMM)[1] for a five year period (2009 to 2013). WRF-NMM is a fully compressible, non-hydrostatic mesoscale meteorological model with a hydrostatic option. Version 3.4.1 of the WRF-NMM model was used in this study. A more detailed description of the WRF-NMM model can be found online[2].

In this study, WRF-NMM was run over a period of five years in so-called "hindcast" mode. It was initialised using Global mesoscale analyses available from the National Centre for

[1] The Weather Research and Forecasting Non-hydrostatic Mesoscale Model (WRF-NMM) is a state-of-the-art numerical prediction model developed at the US National Center for Environmental Prediction (NCEP).
[2] http://www.dtcenter.org/wrf-nmm/users/docs/user_guide/V3/users_guide_nmm_chap1-7.pdf

Environmental Prediction (NCEP). Global analyses have 0.5 degree horizontal grid resolution and 6-hour temporal resolution (i.e., data are available every 6 hours). The Global mesoscale analyses assimilate various available observations collected over the world, including land surface measurements, marine surface measurements, radiosonde, aircraft reports, profiler radar derived winds and satellite wind data[3]. The WRF-NMM model used Global analyses as both the initial conditions (updated every 24 hours) and the boundary conditions (updated every 6 hours). Updating the initial and boundary fields with the analysis that is based on actual observations provides a more realistic simulation of past meteorology.

The WRF-NMM model was applied over a large domain that extends more than 300 km east to west and 300 km north to south, in order to capture the large-scale (i.e., synoptic scale) meteorological characteristics in this region (see Figure 4). A grid spacing of 3 degrees was applied in order to better resolve realistic mesoscale meteorological features. The outputs from the WRF-NMM model were then used to drive the CALMET model, discussed in the following section.

6.1.3 CALMET Model

The CALMET meteorological model was used to simulate the meteorological conditions in the study areas shown in Figure 1 from January 1, 2009 to December 31, 2013 using a horizontal grid spacing of 200 m. The CALMET simulation was run in "No-Obs" mode and initialized using the three dimensional data outputs from the WRF-NMM model. This means that the 3D.DAT file which is used as the input to CALMET contains three dimensional profiles of wind speed, wind direction, temperature, humidity, pressure, ceiling height and cloud cover derived from WRF-NMM. The 3D.DAT data is then further refined using CALMET to adjust the winds for fine-scale terrain effects within the CALMET grid.

The "No-Obs" approach offers an advantage over using point (i.e., observation) measurements in terms of its ability to represent both the horizontal and vertical spatial variability of the meteorological fields. Specifically, the use of a mesoscale model facilitates the generation of three dimensional profiles and properly simulates wind fields at upper levels in the atmosphere. It also better defines the boundary layer heights (i.e., mixing heights) which results in a better simulation of plume dispersion.

The resulting CALMET meteorological fields have been evaluated to ensure that they capture the key meteorological features that govern atmospheric dispersion. Details of this evaluation are provided in Attachment C.

[3] http://www.nco.ncep.noaa.gov/pmb/products/gfs/

6.1.4 CALMET Geophysical Parameters

To properly simulate pollutant transport and atmospheric dispersion in CALPUFF, it is important to be able to accurately simulate the typical log-linear vertical profile of wind speed, temperature, turbulence intensity and wind direction within the atmospheric boundary layer (i.e., within about 2 km above the Earth's surface). In order to capture this vertical structure, a total of ten vertical layers were used in CALMET. The layer heights and depths are shown in Table 6.1. The center of the lowest 20 m layer (i.e., 10 m) should provide a reasonable comparison with winds at surface weather stations since anemometers are typically placed a height of 10 m.

Table 6.1: CALMET Wind Field Layer Heights

Depth of CALMET Layer (m)	Height of CALMET Layer (m)	Representative Layer
20	20	10-meter meteorology
20	40	30-meter meteorology
40	80	60-meter meteorology
80	160	120-meter meteorology
140	300	230-meter meteorology
300	600	450-meter meteorology
400	1000	800-meter meteorology
500	1500	1250-meter meteorology
700	2200	1850-meter meteorology
800	3000	2600-meter meteorology

The CALMET model requires a physical description of the surface in order to characterize the meteorological parameters near the surface. The geophysical parameters are:

- Terrain elevation data;
- Land use data;
- Surface roughness length;
- Albedo;
- Bowen ratio;
- Soil heat flux;
- Vegetation leaf area index; and,
- Anthropogenic heat flux.

The terrain elevation and land use data used in CALMET are outlined below. All other geophysical parameters listed above are based on default values outlined in the CALMET modelling guidelines (Scire *et al.* 2000a).

6.1.4.1 Terrain Elevation Data

Gridded terrain elevations for the modelling domain were derived from Digital Elevation Models (DEM) produced by the NASA's Shuttle Radar Topography Mission (SRTM)4. The spacing of the elevations is 3-arc seconds or approximately 90 m. The raw terrain data was processed in each gridded cell (i.e., 200 m by 200 m) within the CALMET modelling domain and the resulting terrain elevations are presented in Figure 5 (Kamsar study area) and Figure 6 (Sangarédi study area). This terrain field effectively resolves all major land features within the modelling domains.

6.1.4.2 Land Use Data

Land use and land cover data from the GlobCover Land Cover v2 dataset5 was processed for each CALMET grid cell to produce a 200 m resolution field of fractional land use categories and weighted land use values of surface and vegetation properties. CALMET defines 14 default land use categories (Table 6.2). Surface properties, such as albedo, Bowen ratio, roughness length, and soil heat flux and leaf area index are computed proportionately to the fractional land use category within each grid cell. The default values for these land use related parameters are listed in Table 6.2. The generated land use categories for each CALMET grid cell are also shown in Figure 7 (Kamsar study area) and Figure 8 (Sangarédi study area).

[4] http://dds.cr.usgs.gov/srtm/
[5] http://due.esrin.esa.int/globcover/

Table 6.2: CALMET Land Use Categories

Land Use	Description	Surface Roughness (m)	Albedo	Bowen Ratio	Soil Heat Flux Parameter	Anthropogenic Heat Flux (m)	Leaf Area Index
10	Urban or Built-up Land	1	0.18	1.5	0.25	0	0.2
20	Agricultural Land – Unirrigated	0.25	0.15	1	0.15	0	3
-20*	Agricultural Land – Irrigated	0.25	0.15	0.5	0.15	0	3
30	Rangeland	0.05	0.25	1	0.15	0	0.5
40	Forest Land	1	0.1	1	0.15	0	7
50	Water	0.001	0.1	0	1	0	0
54	Small Water Body	0.001	0.1	0	1	0	0
55	Large Water Body	0.001	0.1	0	1	0	0
60	Wetland	1	0.1	0.5	0.25	0	2
61	Forested Wetland	1	0.1	0.5	0.25	0	2
62	Nonforested Wetland	0.2	0.1	0.1	0.25	0	1
70	Barren Land	0.05	0.3	1	0.15	0	0.05
80	Tundra	0.2	0.3	0.5	0.15	0	0
90	Perennial Snow or Ice	0.05	0.7	0.5	0.15	0	0

6.2 CALPUFF MODELLING APPROACH

CALPUFF (version 6.42) dispersion modelling was performed using a "unit emission rate" approach. This means that the CALPUFF model was run separately for each individual source or groups of like sources (e.g., roads) using an emission rate of 1 g/s. Where multiple sources like roads were modelled together, a unit emission rate was applied to the aggregate of all sources in each CALPUFF model run. For example, in the case of 10 sources, a 1 g/s emission rate was divided evenly across those 10 sources. The results from each model run were then merged using CALSUM (version 1.5) which scaled the outputs from each model run using the emission rates outlined in Section 5.1.11. The model results were then processed by CALPOST (version 6.292) to estimate maximum 1-hour, 24-hour or annual concentrations at each receptor for each contaminant described in Section 2.4. To estimate 99th percentile 24-hour concentrations of PM_{10} and $PM_{2.5}$, the CALAVE/CALRANK (version 1.1/1.2) software package was used.

The CALPUFF model options used are outlined in Table 6.3. The CALPUFF model runs were performed for a single gaseous contaminant assuming no dry or wet deposition. This approach is conservative for particulate matter since is does not consider the depletion of particulates within a plume. In reality, heavier particles will fall out of a plume close to a source reducing the concentrations of particulate further beyond a source. Consequently the air concentrations of TSP, PM_{10} and $PM_{2.5}$ have been overestimated in this assessment. Two sensitivity tests were performed (one in each study area) to demonstrate the conservativeness of this approach. The results are outlined in Attachment C.

The CALPUFF model setup for each of the assessment scenarios outlined in Section 4.0 is described below. Recall that construction emissions were not carried through to dispersion modelling since the maximum emission scenarios assessed for both Kamsar and Sangarédi are considered to adequately capture the effects of construction.

Table 6.3: CALPUFF Model Options

Flag	Default	Used Value	Comments
MGAUSS	1	1	Vertical distribution used in the near field
MCTADJ	3	3	Terrain adjustment method (3 used for partial plume path adjustment)
MCTSG	0	0	Subgrid-Scale complex terrain flag
MSLUG	0	0	Near-field puffs modelled as elongated areas
MTRANS	1	1	Transitional Plume Rise modelled
MTIP	1	1	Stack-tip downwash
MRISE	1	1	Plume rise for point sources not subject to building downwash 1 = Birggs plume rise, 2 = Numerical plume rise
MBDW	1	2	Method used to simulate building downwash 1 = ISC method; 2 = PRIME method
MSHEAR	0	0	Vertical wind shear modelled above stack top
MSPLIT	0	0	Puff splitting allowed 0 = No; 1 = Yes
MCHEM	1	0	Chemical Transformation Scheme 0 = chemical transformation not modelled 1 = transformation rates computed internally (MESOPUFF II scheme)
MAQCHEM	0	0	Aqueous phase transformation flag (only used if MCHEM =1 or 3)
MWET	1	0	Wet removal modelled 0 = No; 1 = Yes
MDRY	1	0	Dry deposition modelled 0 = No; 1 = Yes
MTILT	0	0	Gravitational settling (plume tilt) modelled
MDISP	3	2	Methods used to compute dispersion coefficients 2 = (dispersion coefficients from internally calculated sigma v, sigma w using micrometeorological variables (u*, w*, L, etc.) 3 = PG dispersion coefficient for RURAL areas (computed using the ISCST multi-segment approximation) and MP coefficients in urban areas)
MTURBVW	3	3	Sigma measurements used (Used only if MDISP = 1or 5)
MDISP2	3	3	Back-up method used to compute dispersion when measured turbulence data are missing (Used only if MDISP=1 or 5)
MTAULY	0	0	[DIAGNOSTIC FEATURE] Method used for Lagrangian timescale for Sigma-y (used only if MDISP=1,2 or MSIDP2=1,2)
MTAUADV	0	0	[DIAGNOSTIC FEATURE] Method used for Advective-Decay timescale for Turbulence (used only if MDISP=2 or MDISP2=2)
MCTURB	1	1	Method used to compute turbulence sigma-v & sigma-w using micrometeorological variables (Used only if MDISP = 2 or MDISP2 = 2)
MROUGH	0	0	PG sigma y,z adjusted for roughness
MPARTL	1	1	Partial plume penetration of elevated inversion modeled for point sources; 0 = No, 1 = Yes
MPARTLBA	1	1	Partial plume penetration of elevated inversion modeled for buoyant area sources; 0 = No, 1 = Yes
MTINV	0	0	Strength of temp inversion provided in PROFILE.DAT extended records
MPDF	0	1	Probability Distribution Function used for dispersion under convective conditions 0 = No; 1 = Yes
MSGTIBL	0	0	Sub-grid TIBL module used for shore line
MBCON	0	0	Boundary conditions (concentration) modeled
MFOG	0	0	Configure for FOG Model output
MREG	1	0	Test options specified to see if they conform to regulatory values

6.2.1 Kamsar Processing Facility

In general, COPC emission sources at the Kamsar processing facility were characterized using information in the *Expansion Project FEL2 Study Preliminary Engineering Report* (Fluor 2014), which provided detailed descriptions of each stage of processing as well as equipment lists and process flow diagrams for each proposed phase of expansion. If required information was not found within Fluor (2014), model parameters from the AECOM (2011) air dispersion modelling assessment were used, if available. In their absence, professional judgement was used. In general, the operations at the Kamsar facility include:

- Rail unloading and crushing;
- Stockyard – material conveyance;
- Material drying and associated conveyance;
- Dry storage and ship loading; and
- Support services (e.g., power generation)

The model setup for these operations is discussed in the following sections according to the modelled source type used to parameterize each source (i.e., point, volume or area).

6.2.1.1 Point Sources

Point sources were used to represent emissions from the dryers, generators, boilers, locomotives and shipping vessels. The physical characteristics these sources are shown in Table 6.4. While most point source parameters were developed based on information from the Fluor (2014) and AECOM (2011) reports, the stack parameters for the locomotives were obtained from ENVIRON (2008) based on EMD GP-4X type engines (Model No. 16-645E3B). The parameters used to model emissions from ships at berth were based on professional judgement.

Buildings or other solid structures may affect the flow of air in the vicinity of a source and cause eddies to form on the downwind side of a building requiring the use of building downwash algorithms for point sources. In this assessment, the Plume Rise Model Enhancements algorithm (PRIME) was used as a building downwash option in CALPUFF. PRIME is designed to incorporate the fundamental features associated with building downwash: enhanced plume dispersion coefficients due to turbulent wake, reduced plume rise caused by a combination of the descending streamlines in the lee of the building, and the increased entrainment in the wake. Figure 9 shows the locations of the modelled point sources as well the building layout used in CALPUFF.

6.2.1.2 Area Sources

Area sources are typically used to represent ground-based emission sources such as open area wind erosion. As a result, area sources were used to represent emissions of windblown dust in and around the raw storage piles as well as the open area in front of the existing dry product storage building. In addition, an area source was used to represent emissions resulting from the transfer of dry product to the shipping vessels. The source parameters including elevation, effective release height and vertical initial dispersion factor (sigma-Y) are shown in Table 6.5 for all area sources modelled at Kamsar. Note that multiple area sources were necessary to model emissions from the raw storage pile area. Due to a limitation in CALPUFF, polygonal area sources must not cross a meteorological grid square, which is only 200 m by 200 m in this assessment (see Section 6.1.3).

6.2.1.3 Volume Sources

Volume sources are typically used to represent emissions released from sources having a vertical depth (e.g., a material transfer or drop) and are characterized as equal-sided areas with the release height typically set equal to half of the vertical depth. All material transfer points including transfer towers or pile stackers, as well as crushing and screening were modelled as volume sources. The source parameters including elevation, effective release height, and horizontal and vertical initial dispersion factors (sigma-Y and sigma-Z) are shown in Table 6.6 for all volume sources modelled at Kamsar.

Table 6.4: Physical Characteristics of Modelled Point Sources at Kamsar

Source Description	Source ID	UTM Coordinates		Base Elevation (m)	Release Height (m)	Exit Velocity (m/s)	Exit Temperature (°K)	Applicable Production Scenario			
		Easting (m)	Northing (m)					Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Existing dryer stack	OLDDRY	542513	1176686	9.4	64.0	15	326	✓	✓	✓	✓
New dryer stack	NEWDRY	542442	1176728	8.5	30.5	40	326		✓	✓	✓
Old generators	GENOLD	542415	1176901	7.2	14.6	0.1	698	✓			
Generator 9	GEN9	542381	1176890	6.0	22.0	25	743	✓	✓	✓	✓
Generator 10	GEN10	542364	1176877	5.5	22.0	25	743	✓	✓	✓	✓
Generators 11 and 12	GEN11_12	542328	1176868	4.4	22.0	50	743		✓	✓	✓
Generators 13 and 14	GEN13_14	542324	1176866	4.4	22.0	50	743		✓	✓	✓
Generator 15	GEN15	542319	1176865	4.4	22.0	25	743		✓	✓	✓
Boilers stacks 1-3	BOIL	542338	1176897	4.4	5.7	0.1	673	✓	✓	✓	✓
Yard locomotive	LOCOYD	542560	1176730	5.1	5.2	13.8	374	✓			
Locomotive	LOCO	542790	1177071	4.6	5.2	3.7	351	✓			
Locomotive 1	LOCO1	543105	1177220	4.4	5.2	3.7	351		✓	✓	✓
Locomotive 2	LOCO2	542488	1177227	3.7	5.2	3.7	351		✓	✓	✓
Locomotive 3	LOCO3	542950	1177673	3.3	5.2	3.7	351		✓	✓	✓
Ship 1 stack	SHIPSTK1	540569	1176397	0.1	28.0	16	621	✓	✓	✓	✓
Ship 2 stack	SHIPSTK2	540476	1176117	0	28.0	16	621				✓

Table 6.5: Physical Characteristics of Modelled Area Sources at Kamsar

Source Description	Source ID	UTM Coordinates		Base Elevation (m)	Release Height (m)	Initial Vertical Dimension (m)	Applicable Production Scenario			
		Easting (m)	Northing (m)				Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Area outside dry storage building (wind erosion)	DSA1	542414	1176853	7.4	0	0	✓	✓	✓	✓
Raw storage pile activities (area 1)	RPL1	542601	1176601	7.0	1	1	✓	✓	✓	✓
Raw storage pile activities (area 2)	RPL2	542801	1176603	5.7	1	1	✓	✓	✓	✓
Raw storage pile activities (area 3)	RPL3	542800	1176902	7.5	1	1	✓	✓	✓	✓
Raw storage pile activities (area 4)	RPL4	542601	1176830	12.7	1	1	✓	✓	✓	✓
Ship 1 loading particulate emissions	SHIP1	540502	1176226	0.0	8	0	✓	✓	✓	✓
Ship 2 loading particulate emissions	SHIP2	540410	1175946	0.0	8	0				✓

Table 6.6: Physical Characteristics of Modelled Volume Sources at Kamsar

Source Description	Source ID	UTM Coordinates		Base Elevation (m)	Release Height (m)	Initial Horizontal Dimension (m)	Initial Vertical Dimension (m)	Applicable Production Scenario			
		Easting (m)	Northing (m)					Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Primary crusher (existing)	PCRUSH	542756	1177058	4.8	1.0	2.3	4.7	✓			
Secondary crusher (existing)	SCRUSH	542601	1176830	4.4	15.0	3.5	9.3	✓			
Primary crusher 1 (future)	PCRUSH1	542904	1177165	4.6	5.9	2.3	5.4		✓	✓	✓
Primary crusher 2 (future)	PCRUSH2	542890	1177161	4.5	5.9	2.3	5.4		✓	✓	✓
Secondary crusher 1 (future)	SCRUSH1	542858	1177297	5.8	8.7	2.3	4.8		✓	✓	✓
Secondary crusher 2 (future)	SCRUSH2	542837	1177289	5.3	8.7	2.3	4.8		✓	✓	✓
Transfer tower 001	TAN001	542870	1176841	7.0	15.4	2.3	4.8	✓	✓	✓	✓
Transfer tower 002	TAN002	542902	1176746	6.2	10.1	1.6	3.1	✓	✓	✓	✓
Transfer tower 003	TAN003	542590	1176631	7.5	10.1	1.4	3.1	✓	✓	✓	✓
Transfer tower 004	TAN004	542560	1176730	9.5	15.8	2.3	4.9	✓	✓	✓	✓
Transfer tower 006	TAN006	542502	1176814	9.5	10.1	1.6	3.1	✓	✓	✓	✓
Transfer tower 007	TAN007	542424	1176791	7.9	10.1	2.3	3.1	✓	✓	✓	✓
Transfer tower 008	TAN008	542415	1176813	8.0	10.1	1.6	3.1	✓	✓	✓	✓
Transfer tower 010	TAN010	542282	1176733	5.9	12.5	2.3	11.6	✓	✓	✓	✓
Transfer tower 301	TAN301	542749	1177254	3.3	5.6	2.3	2.6	✓	✓	✓	✓
Transfer tower 305	TAN305	542449	1176727	8.7	3.3	1.6	1.5	✓	✓	✓	✓
Transfer tower 306	TAN306	542446	1176734	8.6	3.3	1.6	1.5				✓
Transfer tower 308	TAN308	540652	1176409	0.4	9.2	2.3	4.3				✓

Source Description	Source ID	UTM Coordinates		Base Elevation (m)	Release Height (m)	Initial Horizontal Dimension (m)	Initial Vertical Dimension (m)	Applicable Production Scenario			
		Easting (m)	Northing (m)					Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Transfer tower 309	TAN309	540571	1176149	0.0	23.6	1.7	7.3				✓
Corner island transfer tower (existing)	TANCI	540642	1176409	0.4	15.0	2.3	7.0				✓
Transfer tower TRE303	TRE303	542298	1176728	6.0	12.5	2.3	11.6				✓
Micogranulation	MICRO	542445	1176760	8.5	6.5	4.7	12.1	✓	✓	✓	✓
Dry product storage pile stacker (RPL003)	RPL003	542498	1176844	9.4	2.5	7.0	2.3	✓	✓	✓	✓
New dry product storage pile stacker (RPL003)	RPL301	542849	1176969	6.5	2.5	7.0	2.3				✓

6.2.2 Sangarédi Mining Operations

As discussed previously in Section 4.2, long-term and short-term effects to air quality from Sangarédi mining operations were assessed using two different modelling approaches. Long-term or annual effects were assessed by modelling emissions from extraction areas and supporting activities (e.g., haul roads, rail loading, etc.) corresponding to specific years of CBG's mine plan: 2017 representing 18.5 MTPY, 2019 representing 22.5 MTPY and 2027 representing 27.5 MTPY. For these model runs, emission sources at the Sangarédi mine were characterized using information provided by CBG, where available. Where information was not available, professional judgement based on similar mining assessments was used. In general, the operations at the Sangarédi mine include:

- Extracting bauxite using drill and blast methods;
- Transporting bauxite via truck to rail loading areas;
- Loading bauxite into rail cars;
- Transporting bauxite to Kamsar via rail; and
- Support services (e.g., power generation)

The sources modelled at the Sangarédi mine are illustrated in Figure 10 and are discussed in more detail in Sections 6.2.2.1 through 6.2.2.3 according to the modelled source type (i.e., point, volume or area). The approach used for modelling short-term effects is discussed in Section 6.2.2.4.

6.2.2.1 Point Sources

Similar to the Kamsar Processing Facility, point sources were used to represent the generator located at CBG's offices in Sangarédi (also known as Centrale Sangarédi), as well as a switching locomotive located in the vicinity of the existing rail loading area (see Figure 10). Table 6.7 shows the physical characteristics of these point sources. Table 6.7 also shows the parameters used to assess a proposed rail siding as described in Section 4.3, and illustrated in Figure 10.

6.2.2.2 Area Sources

Area sources were used to characterize the activities within the extraction areas since majority of the emissions within an extraction area will be emitted at grade. The areas encompass all emissions within an extraction area including clearing (i.e., bulldozing), drilling, blasting, loading bauxite into trucks, and vehicle/equipment movement within the extraction area itself.

As shown in Figure 10, multiple area sources were used to represent the extraction areas due to a limitation in CALPUFF which does not allow area sources to be bigger than a meteorological grid square (200 m by 200 m). In addition, as discussed in Section 4.2, these areas are considered to be an approximation of the corresponding footprints in the CBG mining plan as illustrated in Figure 3.

In general, area sources are 200 m by 200 m (a meteorological grid square), having a release height of 0 m and an initial vertical dispersion factor of 1 m. Some area sources in the 27.5 MTPY scenario in the vicinity of Kourawel had a slightly smaller area (120 m by 200 m) in order to better match the planned footprint of the extraction areas within this region.

6.2.2.3 Volume Sources

Volume sources were used to represent emissions from rail loading activities, the rail line and the unpaved haul roads. The locations of each of these sources are shown in Figure 10.

Since the current and future rail loading areas are quite large (approximately 1000 m long by 200 m wide) (see Figure 10), it was necessary to use multiple volume sources in order to represent emissions across the entire loading area. Emissions from unloading bauxite to stockpiles, wind erosion of stockpiles, loading bauxite to trains as well as vehicle/equipment travel within the rail loading areas were distributed evenly across the volume sources. Table 6.9 shows the modelled source characteristics for these volume sources.

In addition, a series of volume sources was also used to represent emissions from a moving train. The parameters used for modelling were based on the methods used in ENVIRON (2008). Emissions of combustion products from the locomotive(s) as well as windblown dust from the open cars of the train were distributed evenly across the volume sources.

Unpaved haul roads were also modelled as a series of volume sources following guidance published by the US EPA Haul Road Working Group (US EPA 2012). The separated volume source configuration was used and is based on the following parameterization:

- Top of Plume Height – 1.7 x Vehicle Height;
- Volume Source Release Height – 0.5 x Top of Plume height;
- Width of Plume – Vehicle Width + 6m;
- Initial Sigma Z – Top of Plume / 2.15 for use when modelling multiple volumes; and
- Initial Sigma Y – 2 x Vehicle Width / 2.15.

In order to have more reasonable model run times, a volume spacing of approximately 200 m was used to represent the unpaved haul roads. Table 6.9 shows the modelled source characteristics for the road volume sources.

Table 6.7: Physical Characteristics of Modelled Point Sources at Sangarédi

Source Description	Source ID	UTM Coordinates		Base Elevation (m)	Release Height (m)	Exit Velocity (m/s)	Exit Temperature (ºK)
		Easting (m)	Northing (m)				
Centrale Sangarédi	GEN	631682	1226294	201.6	14.6	0.1	698
Switching locomotive	LOCO_LD1	624.823	1224.246	201.2	5.2	13.8	374
Rail siding locomotive 1	GENOLD	542415	1176901	7.2	14.6	0.1	698
Rail siding locomotive 2	GEN9	542381	1176890	6.0	22.0	25	743
Rail siding locomotive 3	GEN10	542364	1176877	5.5	22.0	25	743

Table 6.8: Physical Characteristics of Modelled Area Sources at Sangarédi

Source Description	Total Number of Sources	Total Modelled Area (ha)	Release Height (m)	Initial Vertical Dimension (m)
Existing mining areas	33	132	0	1
18.5 MTPY mining areas	47	188	0	1
22.5 MTPY mining areas	56	224	0	1
27.5 MTPY mining areas	56	214	0	1

Table 6.9: Physical Characteristics of Modelled Volume Sources at Sangarédi

Source Description	Number of Sources	Release Height (m)	Initial Horizontal Dimension (m)	Initial Vertical Dimension (m)
Existing haul roads	65	4.0	10.42	3.72
18.5 MTPY haul roads	94	4.0	10.42	3.72
22.5 MTPY haul roads	108	4.0	10.42	3.72
27.5 MTPY haul roads	130	4.0	10.42	3.72
CBG access road between CBG offices and existing loading area (applies to all scenarios)	60	2.98	24.19	2.77
Moving rail source	105	2.38	9.30	1.11
Existing rail loading area[1]	13	2.5	69.77	1.16
Future rail loading area[2]	10	2.5	69.77	1.16

Notes:
[1] Applicable to the existing and 18.5 MTPY scenarios.
[2] Applicable to the 22.5 and 27.5 MTPY scenarios.

6.2.2.4 Short-Term Modelling Approach

As discussed in Section 4.2, a generic modelling approach was used to represent typical daily mining activities. Typical extraction activities (excluding blasting) were represented using a 200 m by 200 m area source with the same source parameters as described in Section 6.2.2.2. In addition, the effects of an unpaved haul road were also evaluated using a generic road stretching 2 km on either side of the mining area. The same source parameters used for unpaved haul roads described in Section 6.2.2.3 were applied to the generic road. Figure 11 illustrates the generic model setup.

In addition, the impact of blasting on 1-hour NO_2 concentrations was assessed using a separate model run which used a volume source to parameterize the initial dimensions of a blast. The horizontal dimension of a blast was assumed to be approximately 70 m wide and 20 m tall, with a release height of 10 m. Since the emissions from a blast are relatively instantaneous, CALPUFF was run used a 10-minute calculation time step, rather than a 1-hour time step in order to simulate such an event.

Both the generic and blasting model setups were evaluated for three separate locations within the Sangarédi modelling domain in order to assess the impact (if any) of local terrain or meteorological features on resulting concentrations (see Figure 10). The location having the highest maximum concentration based on a unit emission rate was selected to develop unit concentration curves in the direction of maximum predicted incremental concentrations (i.e., the change in concentration with distance). It was found that Location 2 resulted in the highest maximum concentrations and was used to develop unit concentration curves for the generic extraction area/road model setup and the blasting model setup.

The unit concentration curves were scaled using the emission rates outlined in Section 5.1.11 for each production level. This resulted in a series of concentrations curves for each COPC and applicable averaging periods. Note that this approach conservatively applied emissions representative of the maximum daily production rate and the maximum daily traffic count (see Attachment B) in order to assess the worst-case short-term effects to nearby villages. The resulting concentration curves are provided in Attachment D which shows that concentrations decrease exponentially with distance from a source(s) according to the following relationship:

$$C(x) = C_0 * e^{-a*x}$$

Equation 1

Where:
$C(x)$ = Concentration at distance x
x = distance in metres
C_0 = constant
$-a$ = constant

Attachment D also provides the mathematical relationships for each concentration curve presented. Using the equations provided Attachment D, concentrations of short-term COPCs were calculated for each sensitive receptor based on the separation distance between the villages and the nearest existing or planned extraction area. Distances were measured using CBG's 2014 mining plan.

In general, the equations presented in Attachment D can be applied directly to villages in order to estimate short-term concentrations of COPCs. However near some villages, there are other persistent Project activities (e.g., rail loading, trains, etc.) which may also contribute to ambient air concentrations of COPCs. For example, Hamdalaye (SR46) is within 1.5 km of the future train loading area and may be exposed to dust from activities at the planned rail loading area as well as emissions from nearby extraction area and unpaved roads. As a result, a "base" model run was also completed using maximum daily emission rates for the following sources: rail loading area activities, including ore handling, wind erosion and mobile equipment; a switching locomotive; moving trains; and Centrale Sangarédi. For each village, the resulting 1- or 24-hour "base" concentrations were added to concentrations estimated using the concentration curves in Attachment D such that Equation 1 becomes:

$$C(x) = C_0 * e^{-a*x} + C_{Base}$$ ***Equation 2***

Where:
$C(x)$ = Total concentration at distance x
C_{base} = concentration from "base" model run
x = distance in metres
C_0 = constant
$-a$ = constant

The total concentration ($C_{(x)}$) determined using Equation 2 can then compared to applicable WHO guidelines (Section 7.2.2).

To provide additional context to the short-term modelling assessment, the concentration curves can also be used to determine the setback distance required between a village and mining activities in order to meet applicable WHO guidelines. As a result, Section 7.2.2 discusses short-term impacts related to mining from the perspective of both setback distances as well as maximum predicted concentrations.

6.3 CALPUFF RECEPTOR GRID

Ground-level concentrations were modelled at defined receptor locations within each study area. A multi-nested grid approach was applied to the Kamsar study area, centred on the existing dryer stack. The finest receptor grid used was 100 m which extends 1 km beyond the dryer stack in order to better resolve concentrations near the site. The next tier has a grid spacing of 200 m and was applied to a distance of 2.2 km, while a coarser 500 m grid was applied to the remainder of the study area. Receptors were also placed along the property line using a spacing of 50 m.

For the annual model runs in the Sangarédi mining area, a receptor spacing of 500 m was used across the entire modelling domain. In addition, receptors were placed every 500 m along the haul roads at distances of 100 m and 200 m from the edge of the roadway. This helps to ensure that the predicted effects of dust emissions from the unpaved roads are better represented. Also, as recommended by the Haul Road Working Group (US EPA 2012), receptors should not be placed too close to a roadway (about 50 m).

For the generic model runs, a multi-nested grid approach was applied. The finest receptor grid used was 100 m and extends 500 m beyond the edge of the modelled sources. The next tier had a 250 m grid spacing and was applied to a distance of 1 km, while a coarser 500 m grid was applied to a distance of 2 km out from the sources. Receptor points with 1 km spacing were applied to the remainder of the modelling domain out to 4 km. In addition, receptors were placed every 250 m along the generic road at distances of 100, 200 and 500 m from the edge of the roadway.

Air quality concentrations were also predicted at sensitive receptor locations illustrated in Figure 3 and described in tabular format in Attachment C.

6.4 NO_X TO NO_2 CONVERSION

NO_x consists of both NO (nitric acid) and NO_2 (nitrogen dioxide). When generated in combustion sources, most of the NO_x is in the form of NO rather than NO_2. Since the WHO guidelines apply to NO_2 rather than NO_x, a conversion must be applied to NO_x in order to determine a concentration of NO_2.

To estimate concentrations of NO_2, the ambient ratio method (ARM) was used. This method involves the use of an empirical NO_2/NO_x ratio that is used to represent the conversion of NO_x to NO_2 in ambient air. For this assessment a NO_2/NO_x ratio of 0.7 was applied, which was developed based on the data collected for the baseline assessment (Section 3.0).

6.5 NON-STANDARD AVERAGING TIMES

Most of the COPCs assessed have WHO guidelines with standard averaging times (i.e., 1-hour, 24-hour or annual). However, SO_2 has a 10-minute WHO guideline which is considered to be a non-standard averaging period. As a result, a conversion factor of 1.65 was applied to 1-hour SO_2 model outputs in order to determine 10-minute concentrations. This factor is recommended in the *Air Dispersion Modelling Guideline for Ontario* (MOE 2009).

7.0 EFFECTS ASSESSMENT

The following sections outline the potential effects of the Project for each project phase and each production scenario. Where applicable, the results from the CALPUFF dispersion modelling have been presented in both graphical format showing the results in the study areas, and in tabular format at specific receptor locations. Complete graphical results are provided in Attachment A while complete tabular results are provided in Attachment D. Where exceedances of short-term WHO guidelines have been predicted, a frequency of exceedance analysis has been completed and the results are also presented graphically in Attachment A.

It is important to note that the maximum predicted short-term concentrations (for 10-min, 1-hour or 24-hour timeframes) shown on the contour plots represent the single highest concentration predicted to occur at each location, at any time during the 5-year modelling period. Therefore, the contours shown do not represent a "snapshot" in time as these maxima may occur on different days, and under different meteorological conditions.

While not considered to be a measure of the impact to air quality, contour plots showing annual TSP concentrations are also provided in Attachment A for completeness. In addition, the average deposition rates of annual TSP and its metallic constituents were calculated in order to inform the biological and water quality impacts assessments. Deposition values are provided in Attachment D.

7.1 KAMSAR PROCESSING FACILITY OPERATIONS

Graphical results for maximum predicted concentrations of COPCs for the 18.5, 22.5 and 27.5 MTPY production scenarios are presented in Attachment A. As discussed below, the concentrations of all COPCs exceed their respective WHO guidelines beyond the Project Footprint into a limited area of the study area for all levels of production. The exceedances of the PM_{10} and $PM_{2.5}$ criteria can largely be attributed to emissions of particulate matter from the transfer towers, followed by the dryer stacks. In contrast, predicted exceedances of the NO_2 and SO_2 WHO guidelines are due to fuel combustion. In particular, elevated concentrations of SO_2 can be linked to the sulphur content in the fuel (3%).

7.1.1 18.5 MTPY Production Scenario

The maximum predicted concentrations of COPCs for the 18.5 MTPY scenario are presented graphically in Attachment A along with plots showing the frequencies of exceedances of short-term WHO guidelines. The figures demonstrate that there are few exceedances of the WHO guidelines for $PM_{10,}$ $PM_{2.5}$, NO_2 and SO_2 beyond the Project Footprint. In particular, there are no more than 10 days of exceedances per year within 800 m of the Project Footprint for any

of the COPCs. The exceedance plots also show that exceedances of the WHO guidelines only occur up to about 1 km beyond the Project Footprint for any of the COPCs assessed.

7.1.2 22.5 MTPY Production Scenario

The maximum predicted concentrations of COPCs for the 22.5 MTPY scenario are presented graphically in Attachment A along with plots showing the frequencies of exceedances of short-term WHO guidelines. The figures demonstrate that there are very few exceedances of the WHO guidelines for PM_{10} and $PM_{2.5}$ beyond the Project Footprint. In particular, there are no more than 10 days of exceedances per year within 300 m of the Project Footprint for 24-hour concentrations of both PM_{10} and $PM_{2.5}$. The plots also show that exceedances of the 24-hour PM_{10} and $PM_{2.5}$ WHO guidelines only occur within about 500 m of the Project Footprint.

In addition, the figures in Attachment A show that there are no more than 10 exceedances per year of the 1-hour NO_2 or 10-minute SO_2 WHO guideline within 400 m of the Project Footprint. In addition, exceedances of the NO_2 or SO_2 WHO guidelines are only predicted to occur within about 1.1 km of the Project Footprint.

7.1.3 27.5 MTPY Production Scenario

The maximum predicted concentrations of COPCs for the 27.5 MTPY scenario are presented as graphically in Attachment A along with plots showing the frequencies of exceedances of short-term WHO guidelines. The figures demonstrate that there are very few exceedances of the WHO guidelines for PM_{10} and $PM_{2.5}$ beyond the Project Footprint. In particular, there are no more than 10 days of exceedances per year within 600 m of the project Footprint for either 24-hour concentrations PM_{10} and $PM_{2.5}$. The exceedance plots also show that exceedances of the 24-hour PM_{10} and $PM_{2.5}$ WHO guidelines occur up to about 1 km beyond the Project Footprint.

In addition, the figures in Attachment A show that there are no more than 10 exceedances per year of the 1-hour NO_2 or 10-minute SO_2 WHO guidelines within 1.2 km of the Project Footprint. The exceedance plots also show that exceedances of the NO_2 or SO_2 WHO guideline are only predicted to occur within about 2.5 km of the Project Footprint.

7.1.4 Comparison to Existing Operations

Table 7.1 shows the maximum predicted concentrations COPCs for each future production level at the Air Quality Monitoring locations, with the percent change in concentration from existing operations shown in Table 7.2. As can be seen in Table 7.2, there is a significant increase in NO_2 and SO_2 concentrations for each future production level relative to existing operations. For example, concentrations of NO_2 and SO_2 more than double in the 27.5 MTPY scenario relative

to existing operations. This increase can be attributed to increased consumption of No. 6 fuel oil and diesel required to support the planned production increases.

Despite the increase in production level, Table 7.2 shows that there is a decrease in predicted particulate matter concentrations between existing and all future production levels. The decreases can be attributed to the increased level of dust control assumed to be installed on new processing equipment. The most significant change is between existing and 22.5 MPTY, when all of the existing equipment is finally upgraded to include additional dust suppression such as dry fogging.

Table 7.1: 18.5, 22.5 and 27.5 MTPY Model Predicted COPC Concentrations in Kamsar (µg/m^3)

	18.5 MTPY				22.5 MTPY				27.5 MTPY			
	PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$	
	24-hour	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**
AQ-1	154	38	79	22	89	24	48	14	119	33	65	20
AQ-2	141	30	70	17	79	18	43	11	104	26	58	15

	18.5 MTPY				22.5 MTPY				27.5 MTPY			
	NO_2		SO_2		NO_2		SO_2		NO_2		SO_2	
	1-hour	**Annual**	**10-min**	**24-hour**	**1-hour**	**Annual**	**10-min**	**24-hour**	**1-hour**	**Annual**	**10-min**	**24-hour**
AQ-1	187	15	465	88	197	16	488	93	263	21	655	124
AQ-2	265	11	634	88	284	11	672	93	380	15	914	126

Table 7.2: Change in Future Model Predicted COPC Concentrations in Kamsar Compared to Existing Conditions

	18.5 MTPY				22.5 MTPY				27.5 MTPY			
	PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$	
	24-hour	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**
AQ-1	-17%	-14%	-15%	-4%	-52%	-45%	-48%	-39%	-36%	-25%	-30%	-13%
AQ-2	-12%	-12%	-13%	-6%	-51%	-47%	-46%	-39%	-35%	-24%	-28%	-17%

	18.5 MTPY				22.5 MTPY				27.5 MTPY			
	NO_2		SO_2		NO_2		SO_2		NO_2		SO_2	
	1-hour	**Annual**	**10-min**	**24-hour**	**1-hour**	**Annual**	**10-min**	**24-hour**	**1-hour**	**Annual**	**10-min**	**24-hour**
AQ-1	33%	36%	34%	33%	40%	45%	41%	41%	87%	91%	89%	88%
AQ-2	51%	38%	55%	24%	61%	38%	64%	31%	116%	88%	123%	77%

7.2 SANGARÉDI MINING OPERATIONS

7.2.1 Annual Air Quality Effects

Graphical results for predicted annual concentrations of COPCs for the 18.5, 22.5 and 27.5 MTPY production scenarios are presented Attachment A and summarized in sections 7.2.1.1, 7.2.1.2 and 7.2.1.3, respectively. As discussed below, the predicted annual concentrations of NO_2 and SO_2 are well within applicable WHO guidelines. Annual concentrations of $PM_{2.5}$ are only predicted to exceed the WHO guidelines into a limited area of the study area for the 22.5 MTPY and 27.5 MTPY production levels. The largest effects are predicted for annual PM_{10} concentrations which are shown to exceed the WHO Interim Target 1 guideline for all levels of production. The exceedances of the PM_{10} and $PM_{2.5}$ guidelines can largely be attributed to emissions of particulate matter from unpaved road dust.

7.2.1.1 18.5 MTPY Production Scenario

The annual predicted concentrations of COPCs for the 18.5 MTPY scenario are presented graphically in the figures provided in Attachment A. As the figures demonstrate, there is a limited area within the vicinity of the modelled road network where the annual WHO guidelines for PM_{10} are exceeded. Specifically, the WHO Interim Target 1 criteria for annual PM_{10} is predicted to be exceeded within about 1 km of the road network. All other COPCs are predicted to be below their applicable annual WHO guidelines.

In addition to the contour plots provided in Attachment A, Table 7.3 presents the model predicted annual COPC concentrations for those villages where annual WHO guidelines are predicted to be exceeded. The air quality monitoring locations are also provided in the Table for completeness. As can be seen in the Table, there are three sensitive receptors where any of the annual WHO guidelines for PM_{10} are exceeded: Hamdalaye, Pora PK130 and Carrefour Parawol. However, there are no village locations where the WHO Interim Target 1 guideline for PM_{10} is exceeded. There are also no village locations that have predicted annual $PM_{2.5}$ concentrations above the WHO guidelines.

Table 7.3: 18.5 MTPY Production Scenario - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	1.5	0.2	0.2
AQ11	AQ-11 Hamdallay	622.252	1225.617	**83.7**	**15.2**	13.6
AQ12	AQ-12 Petoun BW	628.870	1224.203	5.7	0.8	0.5
AQ13	AQ-13 Paravi	616.710	1221.796	1.0	0.2	0.2
SR46	Hamdalaye	622.082	1225.627	**46.6**	6.4	3.8
SR58	Pora PK130	630.420	1222.985	**59.3**	6.4	1.9
SR59	Carrefour Parawol	631.430	1221.004	**27.8**	2.9	0.8
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40

Notes:
Concentrations in **bold** exceed an applicable WHO Target or Guideline

7.2.1.2 22.5 MTPY Production Scenario

The annual predicted concentrations of COPCs for the 22.5 MTPY scenario are presented graphically in the figures provided in Attachment A. As the figures demonstrate, there is a limited area within the vicinity of the modelled road network and proposed rail loading location near Hamdalaye where the annual WHO guidelines for PM_{10} and $PM_{2.5}$ are predicted to be exceeded. In particular the WHO Interim Target 1 guideline for annual PM_{10} is predicted to be exceeded within about 600 m of the road network/proposed rail loading area near Hamdalaye. Additionally, the WHO Interim Target 3 guideline for annual $PM_{2.5}$ is predicted to be exceeded within about 200 m of the road network/proposed rail loading area near Hamdalaye. In contrast, annual NO_2 concentrations are predicted to be well below the applicable WHO guideline.

In addition to the contour plots, Table 7.4 presents the model predicted annual COPC concentrations for those villages where the annual WHO guidelines are predicted to be exceeded. In addition, concentrations predicted at the air quality monitoring locations are shown. As can be seen in the Table, there are three villages where an annual WHO guideline for PM_{10} is predicted to be exceeded: Hamdalaye, Carrefour Parawol, and Madina Dian. The highest predicted concentrations occur at Hamdalaye where the annual WHO Interim Target 1 level for PM_{10} and the annual Interim Target 3 level for $PM_{2.5}$ are predicted to be exceeded. This is a result of Hamdalaye's proximity to both a modelled road network (the main emissions source) and the proposed rail loading area.

Table 7.4: 22.5 MTPY Production Scenario - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	3.5	0.5	0.3
AQ11	AQ-11 Hamdallay	622.252	1225.617	**121.1**	**12.8**	4.0
AQ12	AQ-12 Petoun BW	628.870	1224.203	5.0	0.5	0.2
AQ13	AQ-13 Paravi	616.710	1221.796	1.7	0.2	0.3
SR46	Hamdalaye	622.082	1225.627	**203.8**	**21.0**	7.4
SR59	Carrefour Parawol	631.430	1221.004	**83.1**	8.7	2.0
SR97	Madina Dian	632.551	1221.418	**22.0**	2.4	0.8
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40

Notes:
Concentrations in **bold** exceed an applicable WHO Target or Guideline

7.2.1.3 27.5 MTPY Production Scenario

The annual predicted concentrations of COPCs for the 27.5 MTPY scenario are presented graphically in figures provided in Attachment A. As the figures demonstrate, there is a limited area within the vicinity of the modelled road network where the annual WHO guidelines for PM_{10} and $PM_{2.5}$ are predicted to be exceeded. The WHO Interim Target 1 guideline for annual PM_{10} is limited to within about 800 m of the road network and has the highest concentrations predicted in the vicinity of Kourawel. Additionally, the WHO Interim Target 1 guideline for annual $PM_{2.5}$ is predicted to be exceeded within about 250 m of the road network near Kourawel. Annual NO_2 concentrations are predicted to be below the applicable annual WHO guideline.

In addition to the contour plots, Table 7.5 presents the model predicted annual COPC concentrations for those villages where an annual WHO guidelines is predicted to be exceeded, in addition to concentrations predicted at the air quality monitoring locations. As can be seen in the Table, there are four villages where the annual WHO guideline for PM_{10} is exceeded in the 27.5 MTPY scenario: Kourawel, Sintiourou Kourawel, Hamdalaye, and Kahel Mbody. The highest predicted concentrations occur at Hamdalaye where the annual Interim Target 1 guideline for PM_{10} and the annual WHO Interim Target 3 guideline for $PM_{2.5}$ are predicted to be exceeded. Similar to the 22.5 MTPY scenario, this is a result of Hamdalaye's proximity to both a modelled road network and the proposed rail loading area in the 27.5 MTPY scenario.

Table 7.5: 27.5 MTPY Production Scenario - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
	Project Effects Criteria			70	35	40
AQ10	AQ-10 Kourawel	620.746	1234.554	**47.5**	**11.0**	11.8
AQ11	AQ-11 Hamdallay	622.252	1225.617	**53.0**	5.4	1.0
AQ12	AQ-12 Petoun BW	628.870	1224.203	0.6	0.1	0.04
AQ13	AQ-13 Paravi	616.710	1221.796	1.5	0.2	0.2
SR9	Kourawel	620.668	1234.753	**26.4**	5.2	4.9
SR10	Sintiourou Kourawel	620.513	1234.360	**52.2**	**12.9**	14.4
SR46	Hamdalaye	622.082	1225.627	**175.0**	**17.6**	2.7
SR60	Kahel Mbody	621.990	1235.671	**29.7**	4.2	2.4
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40

Notes:
Concentrations in **bold** exceed an applicable WHO Target or Guideline

7.2.1.4 Comparison to Existing Operations

Table 7.6 to Table 7.8 show the percent change in concentration from existing operations for each future production level at each of the air quality monitoring locations, along with the villages identified in Table 7.3 to Table 7.5. As can be seen in the tables, the predicted change in concentration relative to existing operations is highly variable. The change in concentration not only reflects the change in quantity of bauxite being mined, but the change in proximity of each receptor to mining activities, particularly the roads. This is evident in the contour plots provided in Attachment A which show how the shapes of the contours closely follow the road network, especially for particulate matter concentrations.

Table 7.6: Percent Change in Annual Predicted COPC Concentrations from Existing to 18.5MTPY Sangarédi Mining Operations

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Percent Change from Existing		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	43%	42%	-17%
AQ11	AQ-11 Hamdallay	622.252	1225.617	937%	1356%	674%
AQ12	AQ-12 Petoun BW	628.87	1224.203	99%	76%	-40%
AQ13	AQ-13 Paravi	616.710	1221.796	23%	66%	-36%
SR46	Hamdalaye	622.082	1225.627	539%	576%	137%
SR58	Pora PK130	630.420	1222.985	6559%	4886%	740%
SR59	Carrefour Parawol	631.430	1221.004	3575%	2636%	336%

Table 7.7: Percent Change in Annual Predicted COPC Concentrations from Existing to 22.5MTPY: Sangarédi Mining Operations

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Percent Change from Existing		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	234%	255%	25%
AQ11	AQ-11 Hamdallay	622.252	1225.617	1400%	1126%	128%
AQ12	AQ-12 Petoun BW	628.870	1224.203	74%	10%	-76%
AQ13	AQ-13 Paravi	616.710	1221.796	110%	66%	-4%
SR46	Hamdalaye	622.082	1225.627	2693%	2119%	362%
SR59	Carrefour Parawol	631.430	1221.004	10884%	8109%	990%
SR97	Madina Dian	632.551	1221.418	3570%	2784%	458%

Table 7.8: Percent Change in Annual Predicted COPC Concentrations from Existing to 27.5MTPY: Sangarédi Mining Operations

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Percent Change from Existing		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	4427%	7703%	4799%
AQ11	AQ-11 Hamdallay	622.252	1225.617	556%	417%	-43%
AQ12	AQ-12 Petoun BW	628.870	1224.203	-79%	-78%	-95%
AQ13	AQ-13 Paravi	616.710	1221.796	85%	66%	-36%
SR9	Kourawel	620.668	1234.753	2556%	3793%	2046%
SR10	Sintiourou Kourawel	620.513	1234.360	4989%	9256%	5997%
SR46	Hamdalaye	622.082	1225.627	2298%	1759%	69%
SR60	Kahel Mbody	621.990	1235.671	2619%	2760%	865%

7.2.2 Short-Term Air Quality Effects

As described previously, short-term air quality effects to ambient concentrations of particulate matter and SO_2 were assessed by modelling a generic working (or extraction) area together with a generic road, in order to represent a worst-case daily emissions scenario. Short-term effects of NO_2 are dominated by emissions from blasting and explosives detonation. For NO_2, an additional generic blasting scenario was considered separately from the generic extraction area, as described in Section 6.2.2.4.

For each village, the combined influence of all sources was considered as described in Section 6.2.2.4. Table 7.9 provides the predicted particulate concentrations for all villages where exceedances of 24-hour WHO guidelines for PM_{10} and $PM_{2.5}$ are predicted. The bold values are

those which exceed the WHO Interim Target 1 at least 1 time in the 5 year modelling period. Note that there are no predicted exceedances of the WHO Interim Target 1 guideline for $PM_{2.5}$. There were no exceedances of the 10-minute or 24-hour SO_2 WHO guidelines. As a result, these results are not presented here but can be found in Attachment D.

Similarly, Table 7.10 presents the maximum predicted 1-hour NO_2 concentrations resulting from blasting for those villages where an exceedance is predicted. The bold values are those which exceed the WHO guideline at least 1 time in the 5 year modelling period.

While it is possible to achieve additional control of emissions of particulate and gaseous COPCs in order to meet short-term WHO guidelines, it may be necessary to maintain minimum setback distances between mining activities (including blasting) and villages. As a result, setback distances for PM_{10}, $PM_{2.5}$, SO_2 and NO_2 for each of the production levels have also been determined (Table 7.11). In the vicinity of a typical unpaved road, the model results indicate that the largest setback distance required to meet the 24-hour WHO Interim Target 1 guideline for PM_{10} is 220 m. The largest setback distance required to meet the 24-hour WHO Interim Target 2 level for $PM_{2.5}$ in the vicinity of a road is 60 m. The largest setback distance required from a blast is 600 m in order to meet the 1-hour WHO guideline for NO_2.

In general, the setback distances shown in Table 7.11, can be applied directly to village locations within the modelling domain in order to assess whether the Project results in an exceedance of a WHO guideline. However as mentioned in Section 6.2.2.4, near some villages there are other persistent Project activities which contribute to ambient air concentrations of COPCs and increase these setback distance. For example, in the 27.5 MTPY scenario, the train loading area and rail network contributes an additional 8 $\mu g/m^3$ of PM_{10} to Hamdalaye on a 24-hour basis. When considered in conjunction with the generic extraction area and road that was modelled, this results in a setback distance of 375 m for the WHO guideline of 50 $\mu g/m^3$ (instead of 355 m as shown in Table 7.11). As can be seen, this incremental adjustment is minimal.

Table 7.9: Predicted 99th Percentile 24-hour PM_{10} and $PM_{2.5}$ Concentrations at Villages Exceeding WHO Guidelines

ID	Description	UTM Easting (km)	UTM Northing (km)	99th 24h PM_{10} Concentration (µg/m³)				99th 24h $PM_{2.5}$ Concentration (µg/m³)			
				Existing	18.5MTPY	22.5MTPY	27.5MTPY	Existing	18.5MTPY	22.5MTPY	27.5MTPY
SR7	Daara	617.521	1234.795	38.7	53.4	65.1	79.5	3.7	5.1	6.2	7.6
SR9	Kourawel	620.668	1234.753	65.6	90.6	110.4	134.9	6.3	8.7	10.6	12.9
SR10	Sintiourou Kourawel	620.513	1234.36	**188.4**	**439.4**	**534.6**	**653.5**	18.0	42.0	51.1	62.5
SR12	Mbourore	619.769	1227.786	**188.6**	**260.4**	**317.9**	**388.6**	18.0	24.9	30.5	37.3
SR14	Gueguere	616.594	1226.045	58.8	81.1	98.7	120.7	5.6	7.8	9.5	11.6
SR16	Parawi	615.513	1222.477	37.6	51.8	63.0	77.0	3.6	5.0	6.1	7.4
SR17	Fassely Fouta Be	619.263	1225.23	82.6	113.9	138.7	**169.6**	7.9	10.9	13.3	16.3
SR21	Kankalare	616.622	1221.213	93.0	127.9	**155.4**	**190.1**	9.0	12.4	15.1	18.4
SR22	Kankalare Hacoude	616.889	1221.438	27.3	37.1	45.1	55.2	2.8	3.7	4.5	5.5
SR35	Kagneka	622.325	1217.638	105.9	146.2	**177.7**	**217.2**	10.1	14.0	17.0	20.8
SR45	Sakidje	627.54	1220.872	**188.4**	**260.2**	**316.3**	**386.7**	18.0	24.9	30.2	37.0
SR46	Hamdalaye	622.082	1225.627	133.2	**183.5**	**227.2**	**277.5**	12.8	17.7	22.1	27.0
SR50	Boundou Wande	629.21	1224.05	29.0	39.9	48.3	59.0	2.8	3.8	4.6	5.7
SR57	Daroul	630.497	1223.646	**188.4**	**260.2**	**316.3**	**386.7**	18.0	24.9	30.2	37.0
SR58	Pora PK130	630.42	1222.985	**188.4**	**260.2**	**316.3**	**386.7**	18.0	24.9	30.2	37.0
SR59	Carrefour Parawol	631.43	1221.004	**188.4**	**260.2**	**316.3**	**386.6**	18.0	24.9	30.2	37.0
SR76	Parawol Aliou	624.789	1231.158	**188.7**	**260.5**	**316.8**	**387.3**	18.1	24.9	30.3	37.1
SR90	Sitako	634.252	1218.719	126.2	174.3	211.9	259.1	12.1	16.7	20.3	24.8
SR97	Madina Dian	632.551	1221.418	**188.4**	**260.1**	**316.2**	**386.6**	18.0	24.9	30.2	36.9
			WHO Interim Target 1	150				75			
			WHO Interim Target 2	100				50			
			WHO Interim Target 3	75				37.5			
			WHO Guideline	50				25			

Notes:

Bold values are predicted to exceed WHO Interim Target 1 (at least one time in 5 years)

Table 7.10: Predicted 1-hour NO_2 Concentrations at Villages Exceeding WHO Guidelines

ID	Description	UTM Easting (km)	UTM Northing (km)	1h NO_2 (µg/m³)			
				Existing	18.5MTPY	22.5MTPY	27.5MTPY
SR7	Daara	617.52	1234.80	**2484**	**3431**	**4172**	**5101**
SR9	Kourawel	620.67	1234.75	**5146**	**7108**	**8643**	**10566**
SR10	Sintiourou Kourawel	620.51	1234.36	**21993**	**62493**	**75991**	**92901**
SR11	Bandodji Touguidje	617.07	1228.40	157	**217**	**264**	**323**
SR12	Mbourore	619.77	1227.79	106	146	177	**217**
SR13	Sintiourou Lenguere	615.53	1226.64	**238**	**329**	**400**	**489**
SR14	Gueguere	616.59	1226.05	**4398**	**6075**	**7387**	**9031**
SR15	Fassely Belendere	615.05	1224.49	**317**	**438**	**532**	**651**
SR16	Parawi	615.51	1222.48	**2364**	**3265**	**3971**	**4854**
SR17	Fassely Fouta Be	619.26	1225.23	**7014**	**9688**	**11780**	**14402**
SR21	Kankalare	616.62	1221.21	**8072**	**11149**	**13557**	**16573**
SR22	Kankalare Hacoude	616.89	1221.44	**1363**	**1882**	**2289**	**2798**
SR35	Kagneka	622.33	1217.64	**9930**	**13715**	**16678**	**20389**
SR46	Hamdalaye	622.08	1225.63	**8628**	**11917**	**14491**	**17715**
SR50	Boundou Wande	629.21	1224.05	**1641**	**2266**	**2756**	**3369**
SR57	Daroul	630.50	1223.65	**2846**	**3931**	**4780**	**5844**
SR58	Pora PK130	630.42	1222.99	**2389**	**3299**	**4012**	**4905**
SR59	Carrefour Parawol	631.43	1221.00	**314**	**433**	**527**	**644**
SR76	Parawol Aliou	624.79	1231.16	**8781**	**12128**	**14747**	**18029**
SR77	Paragogo	623.44	1229.21	**1080**	**1492**	**1814**	**2218**
SR84	Cogon Lengue	636.35	1231.95	165	**227**	**276**	**338**
SR90	Sitako	634.25	1218.72	99	137	167	**204**
			WHO Guideline	200			

Notes:

Bold values are predicted to exceed the WHO guideline (at least one time in 5 years)

Table 7.11: Setback Distances Required to Meet Short-Term WHO Guidelines

COPC	Averaging Period	Criteria (µg/m³)		Corresponding Setback Distance (m)			
				Existing	18.5MTPY	22.5MTPY	27.5MTPY
PM_{10} (99th Percentile)	24-hour	Interim Target-1	150	130	170	195	220
		Interim Target-2	100	180	220	245	270
		Interim Target-3	75	215	255	280	305
		Guideline	50	265	305	330	355
$PM_{2.5}$ (99th Percentile)	24-hour	Interim Target-1	75	--	--	--	--
		Interim Target-2	50	--	--	35	60
		Interim Target-3	37.5	--	50	75	100
		Guideline	25	60	100	125	150
NO_2	1-hour	Guideline	200	525	555	575	595

7.3 PROPOSED RAIL SIDING

A generic model setup was used to assess an idling train with three locomotives idling on a rail siding. For the rail siding which is isolated from mining or processing activities (i.e., PK 14), the model results indicate that under the worst-case meteorological conditions, the 1-hour NO_2 WHO guideline is exceeded within approximately 625 m of the siding. None of the other WHO guidelines are exceeded.

Unlike PK 14, the proposed PK 118 siding is located in the Sangarédi mining area and within about 1 km of future extraction areas. As a result, there are some villages which may be influenced by NO_2 emissions from both the rail siding and emissions from regular mining activities and blasting in particular. Therefore, nearby villages located downwind from both a mining area and the proposed PK 118 rail siding (e.g., SR34 or SR47) may experience 1-hour NO_2 concentrations above WHO guidelines if both emission sources are present concurrently. However, it is unlikely that both activities will occur concurrently under worst-case meteorological conditions. Therefore, the number of exceedances is also likely to be limited.

8.0 CONCLUSION

As discussed in the preceding sections, exceedances of WHO guidelines were predicted for all COPCs at the Kamsar Processing Facility for all planned production increases. However, the predicted effects to air quality are limited around the Processing Facility, and generally only occur at locations within 1 km of the Project Footprint. Consequently, exceedances are expected to occur very infrequently within the town of Kamsar. In addition, planned upgrades to the processing equipment and new dust control systems are predicted to actually decrease particulate matter concentrations over time. The lowest particulate concentrations were predicted for the 22.5 MTPY scenario.

Similarly, the predicted effects to air quality from activities at the Sangarédi mine site are limited, and are related to occasional exceedances of WHO guidelines at locations in close proximity to the road network. Specifically, exceedances of the annual PM_{10} WHO Interim Target 1 guideline are predicted to be limited to about 1 km from a modelled road whereas exceedances of the $PM_{2.5}$ Interim Target 1 guideline are limited to 250 m from a road. While there are also exceedances predicted for 24-hour PM_{10} and $PM_{2.5}$ as well as 1-hour NO_2 from blasting, these effects will be also be limited to areas in close proximity (less than 1 km) to mining activities or roads. Furthermore, for most villages, exceedances of WHO guidelines will be limited to the amount of time it takes to finish extracting bauxite in a nearby mining. The exception will be for those villages which are also located near unpaved haul roads. In such cases, increased concentrations of particulate matter can be expected so long as the nearby haul road is in use.

8.1 MITIGATION AND MONITORING

8.1.1 Kamsar Processing Facility

In order to reduce off site concentrations of particulate matter and gaseous COPCs in the future, the following measures should be considered:

- Implement planned dust management systems during material processing;
- Reduce or eliminate the use of Bunker C fuel in favour of diesel; and
- Ensure dryer scrubbers are in good working order.

One real-time gas monitoring station should be placed to the north of the CBG plant where access to power is possible. The preferred location would be at the baseline air monitoring location AQ-2 école. Use of a standby generator for power is not recommended as emissions from the generator can affect the measurements. A real-time station would be housed in an air conditioned trailer and would contain the following instrumentation (or equivalent):

- chemiluminescence NO-NO_2-NO_X analyzer

- pulsed fluorescence SO_2 gas analyzer
- Beta Attenuation Mass (BAM) monitor(s) for PM_{10} and $PM_{2.5}$

However, if power is not available at this location and it is necessary to move the station closer to the CBG plant, it should be placed along the northern boundary where power is available in an area with good exposure. If the location is close to roads and other sources which generate large volumes of dust, it is recommended that mini-vol samplers be placed at the AQ-2 to periodically collect dust (TSP, PM_{10} and $PM_{2.5}$) samples at this location.

Sampling should be initiated in advance of expansion activities to confirm the existing conditions and continue through the operational period.

8.1.2 Sangarédi Mining Operations

In order to reduce off site concentrations of PM_{10}, $PM_{2.5}$ and NO_2 from haul roads and blasting activities in the future, the following measures should be considered:

- Commit to achieve at least 80% control of road dust via watering, or through the application of a chemical dust suppressant (e.g., calcium chloride);
- Reduce vehicle speeds on roads to 40 km/hr or less where possible;
- If feasible, consider paving the roads, particularly in the vicinity of villages;
- Optimise the haul roads to avoid villages, trying to keep 2 km away;
- Evaluate the option of using larger trucks to limit the total number of truck trips per day;
- Eliminate the new rail siding in the vicinity of Hamdalaye (this would have the most impact in the 22.MTPY scenario);
- Do a feasibility study to evaluate using conveyors to transport bauxite; and,
- Investigate feasibility of expanding the rail network to transport bauxite in lieu of using an extended road network.

Mini-vol samplers should be used to periodically collect TSP, PM_{10} and $PM_{2.5}$ samples in locations proximate to haul roads and mining areas to validate the results of the air quality assessment. Passive NO_X and samplers should also be used in locations proximate to the mining areas to confirm the results of the air quality assessment. As mining activities move, similarly the monitoring locations should be moved.

Sampling should be initiated in advance of expansion activities to confirm the existing conditions and continue through the operational period.

9.0 REFERENCES

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Scire, J., F. Robe, M. Fernau, E. Insley and R. Yamartino 2000a. *A Users Guide for the CALMET Meteorological Model (Version 5).* Earth Tech Inc., Concord, MA.

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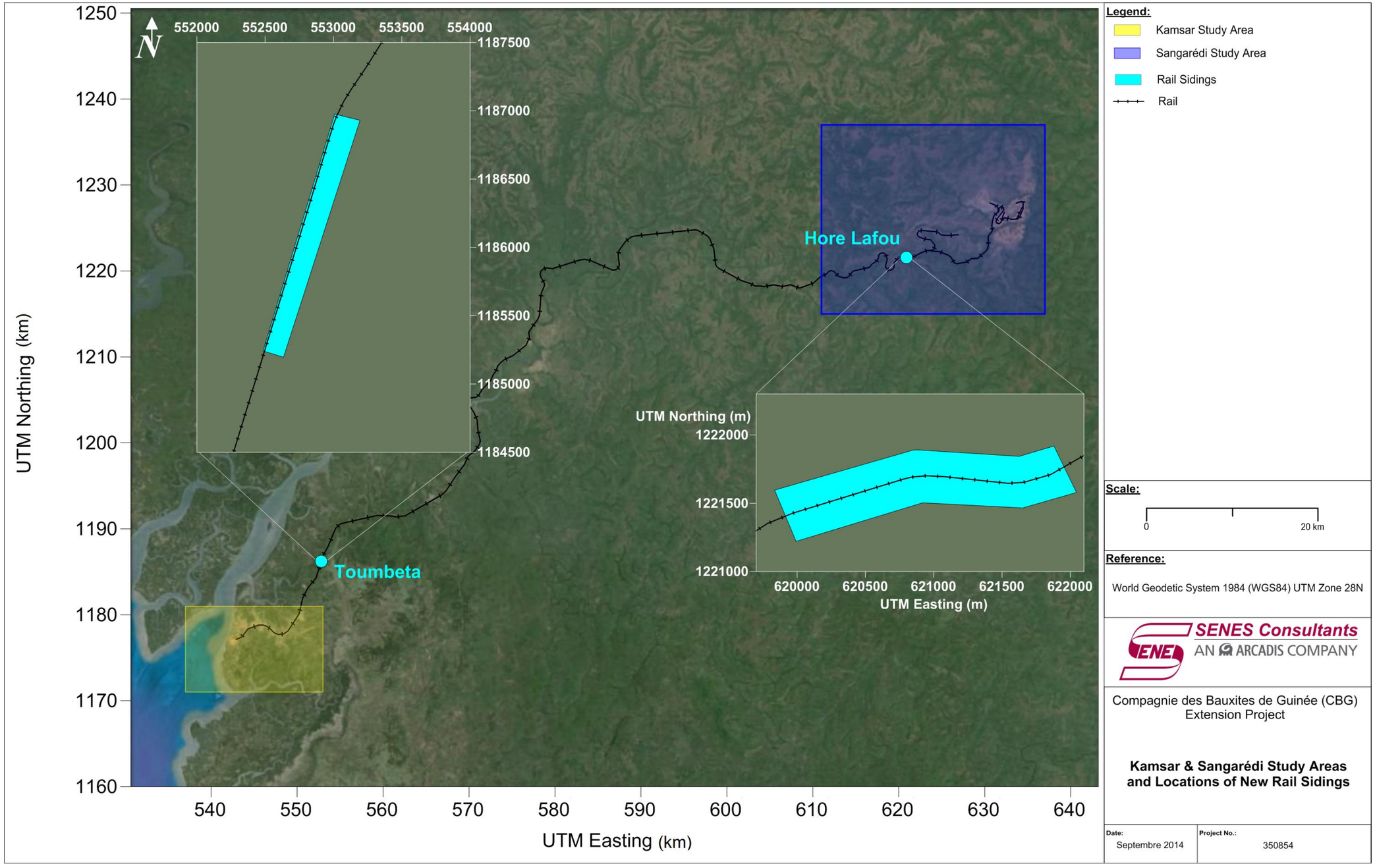
ATTACHMENT A:
FIGURES

Figure 1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552000
552500
553000
553500
554000
1187500
1187000
1186500
1186000
1185500
1185000
1184500
Hore Lafou
Toumbeta
UTM Northing (m)
1222000
1221500
1221000
620000
620500
621000
621500
622000
UTM Easting (m)
1250
1240
1230
1220
1210
1200
1190
1180
1170
1160
UTM Northing (km)
540
550
560
570
580
590
600
610
620
630
640
UTM Easting (km)
Legend:
Kamsar Study Area
Sangarédi Study Area
Rail Sidings
Rail
Scale:
0
20 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar & Sangarédi Study Areas
and Locations of New Rail Sidings
Date:
Septembre 2014
Project No.:
350854

Figure 2

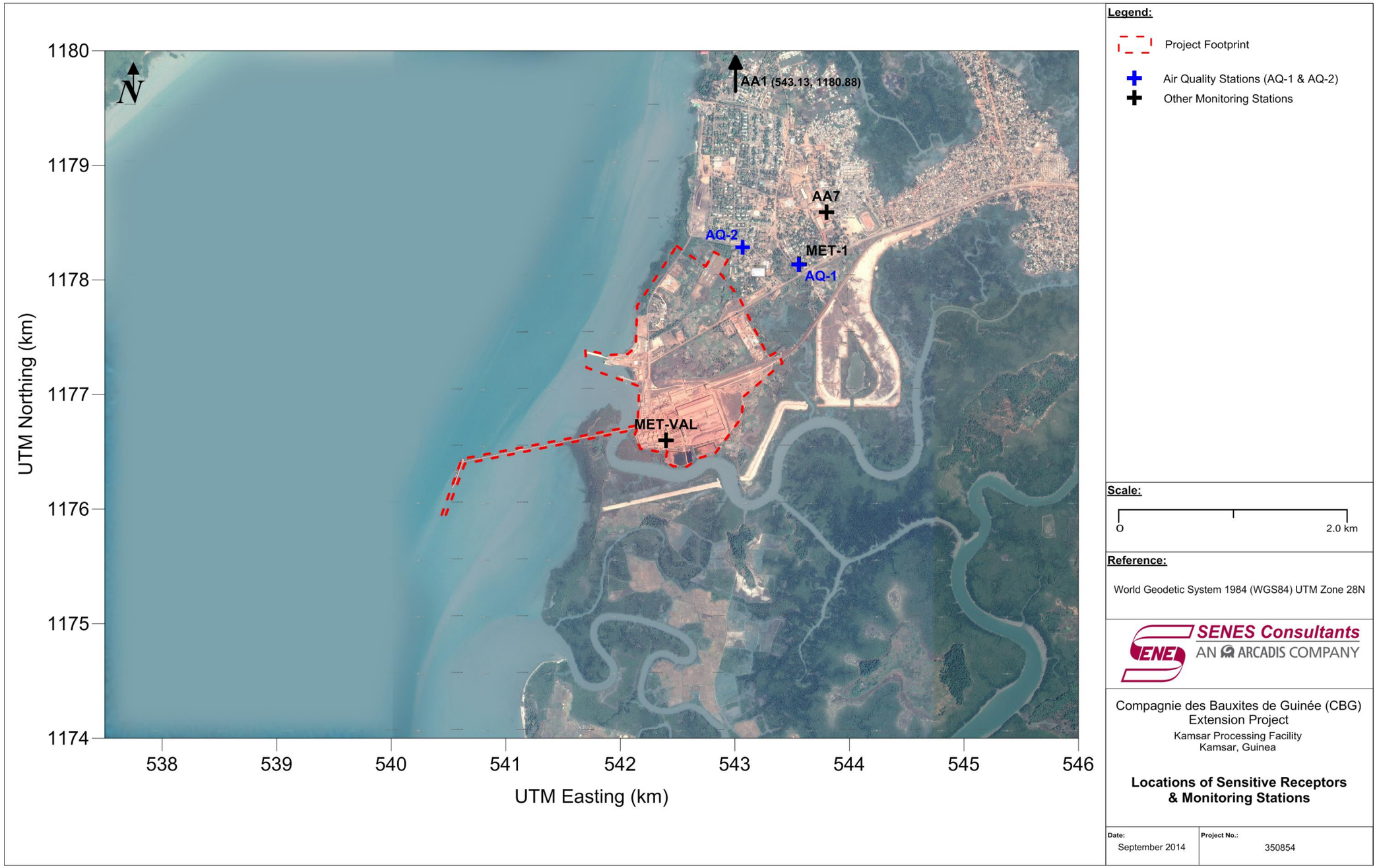

N
AA1 (543.13, 1180.88)
AA7
AQ-2
MET-1
AQ-1
MET-VAL
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Other Monitoring Stations
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
Locations of Sensitive Receptors
& Monitoring Stations
Date:
September 2014
Project No.:
350854

Figure 3

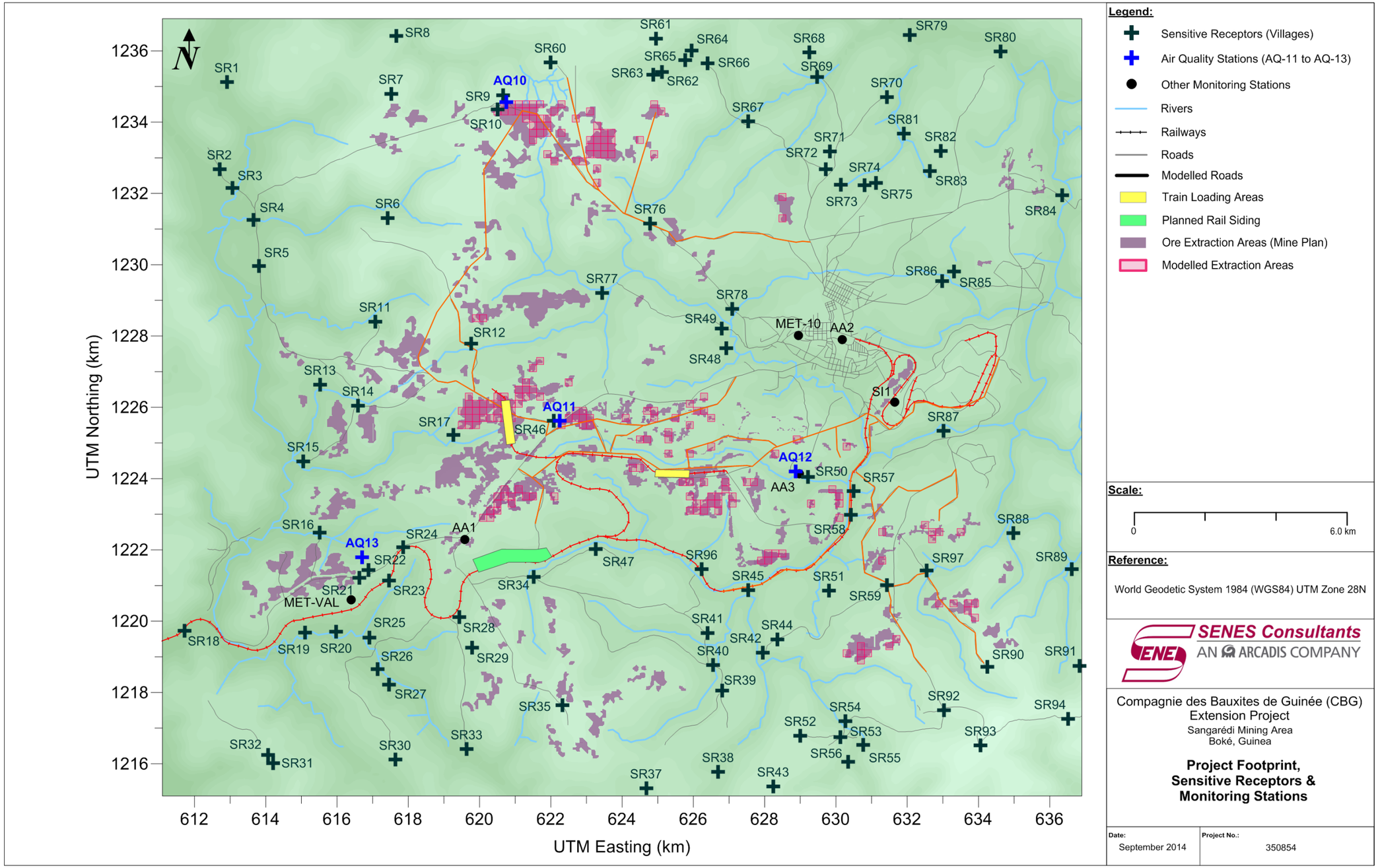

N
UTM Northing (km)
UTM Easting (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
612
614
616
618
620
622
624
626
628
630
632
634
636
AQ10
AQ11
AQ12
AQ13
AA1
AA2
AA3
MET-10
MET-VAL
SI1
Legend:
Sensitive Receptors (Villages)
Air Quality Stations (AQ-11 to AQ-13)
Other Monitoring Stations
Rivers
Railways
Roads
Modelled Roads
Train Loading Areas
Planned Rail Siding
Ore Extraction Areas (Mine Plan)
Modelled Extraction Areas
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
Project Footprint,
Sensitive Receptors &
Monitoring Stations
Date:
September 2014
Project No.:
350854

Figure 4

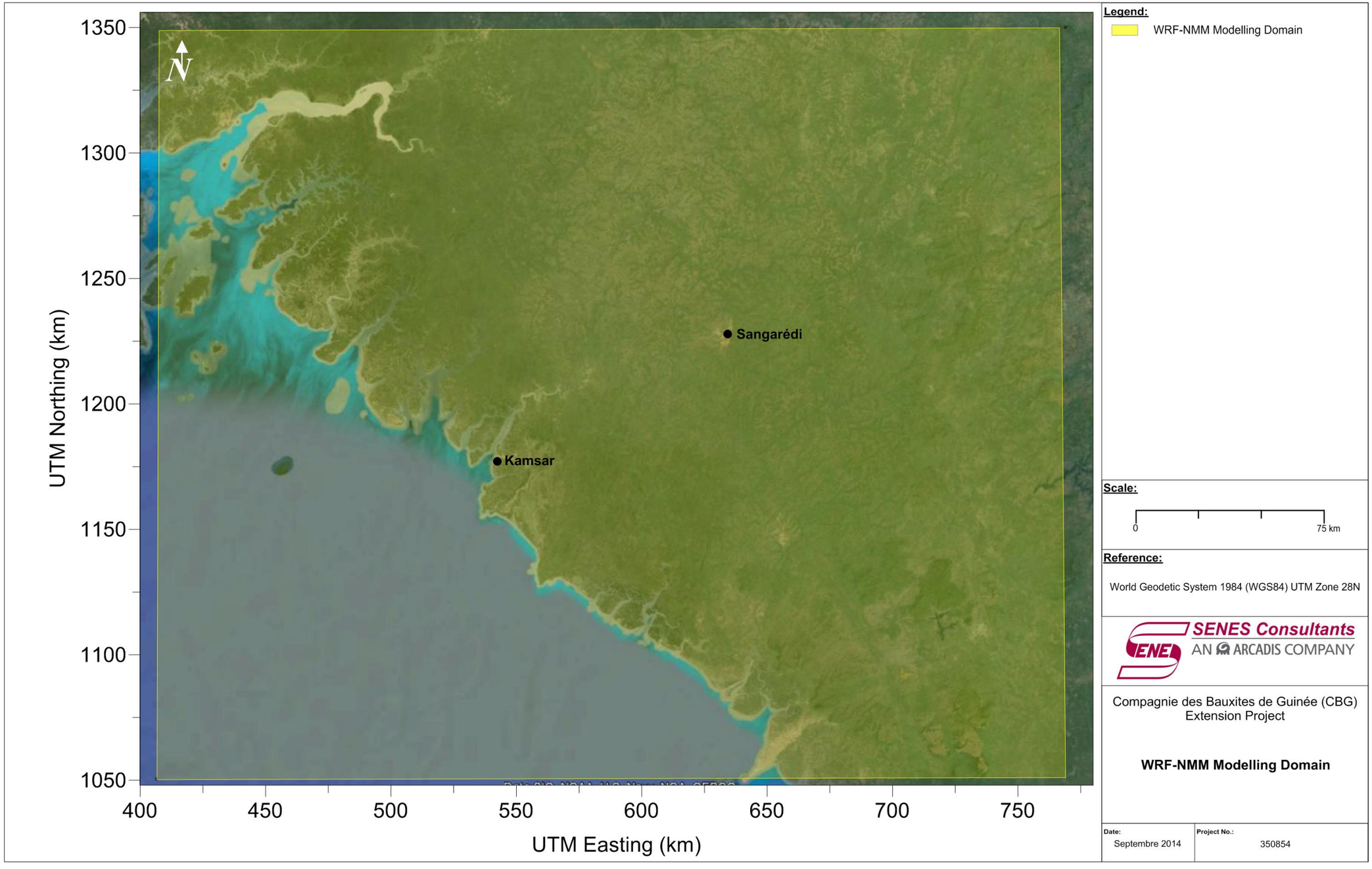

1350
1300
1250
1200
1150
1100
1050
UTM Northing (km)
400
450
500
550
600
650
700
750
UTM Easting (km)
N
Sangarédi
Kamsar
Legend:
WRF-NMM Modelling Domain
Scale:
0
75 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
WRF-NMM Modelling Domain
Date:
Septembre 2014
Project No.:
350854

Figure 5

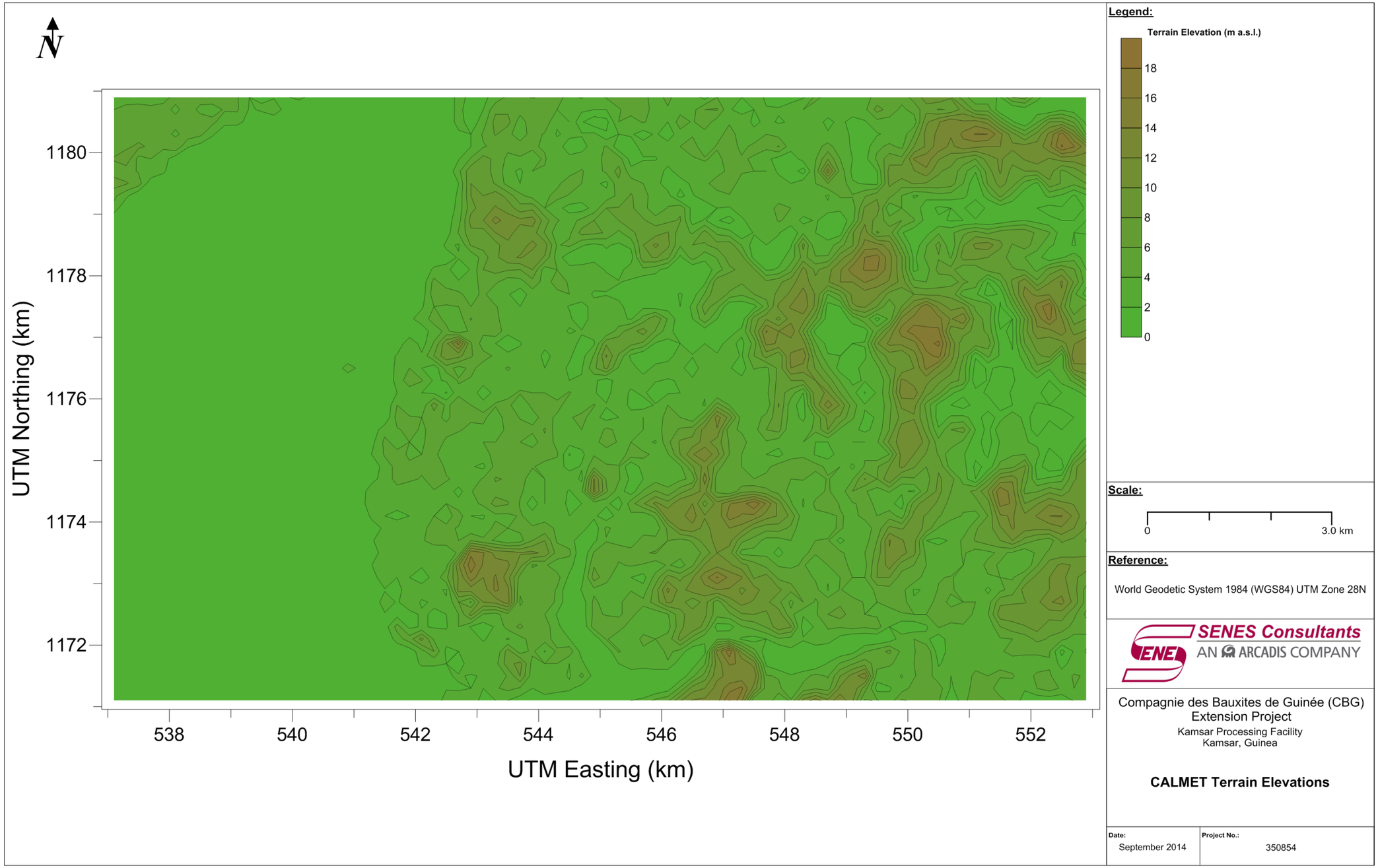

N
1180
1178
1176
1174
1172
UTM Northing (km)
538
540
542
544
546
548
550
552
UTM Easting (km)
Legend:
Terrain Elevation (m a.s.l.)
18
16
14
12
10
8
6
4
2
0
Scale:
0
3.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
CALMET Terrain Elevations
Date:
September 2014
Project No.:
350854

Figure 6

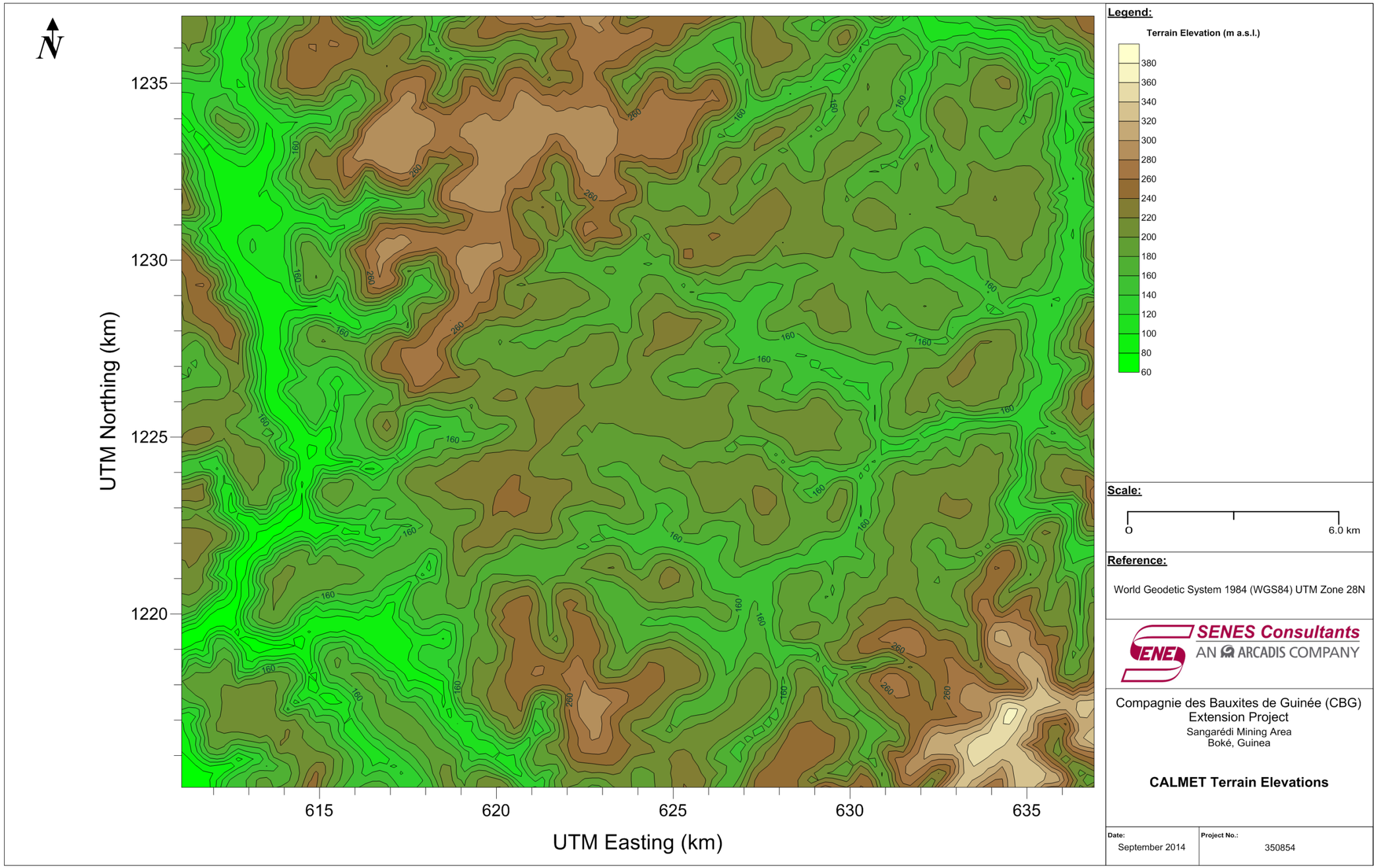

N
1235
1230
1225
1220
UTM Northing (km)
615
620
625
630
635
UTM Easting (km)
Legend:
Terrain Elevation (m a.s.l.)
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
CALMET Terrain Elevations
Date:
September 2014
Project No.:
350854

Figure 7

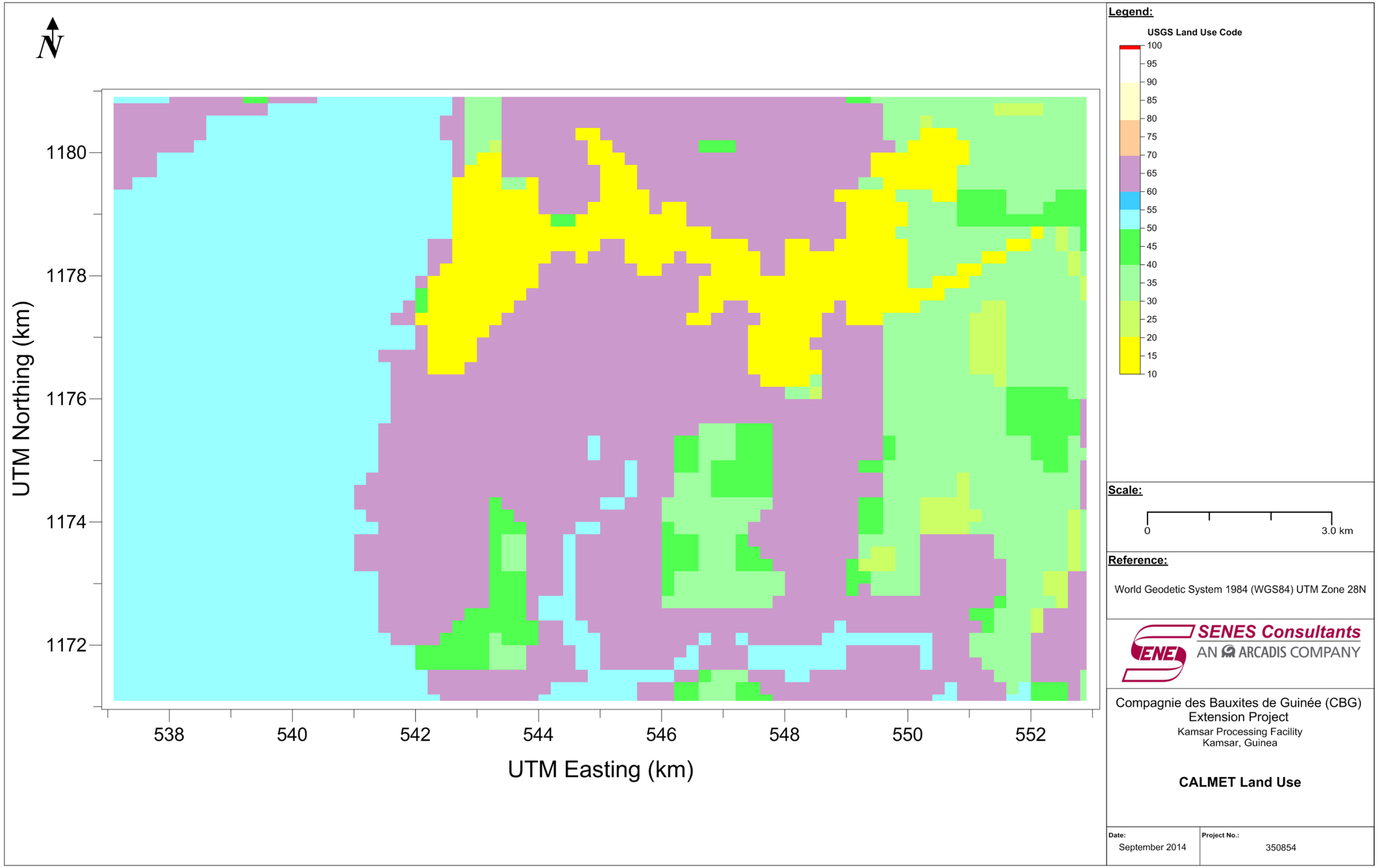

N
1180
1178
1176
1174
1172
UTM Northing (km)
538
540
542
544
546
548
550
552
UTM Easting (km)
Legend:
USGS Land Use Code
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
Scale:
0
3.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
CALMET Land Use
Date:
September 2014
Project No.:
350854

Figure 8

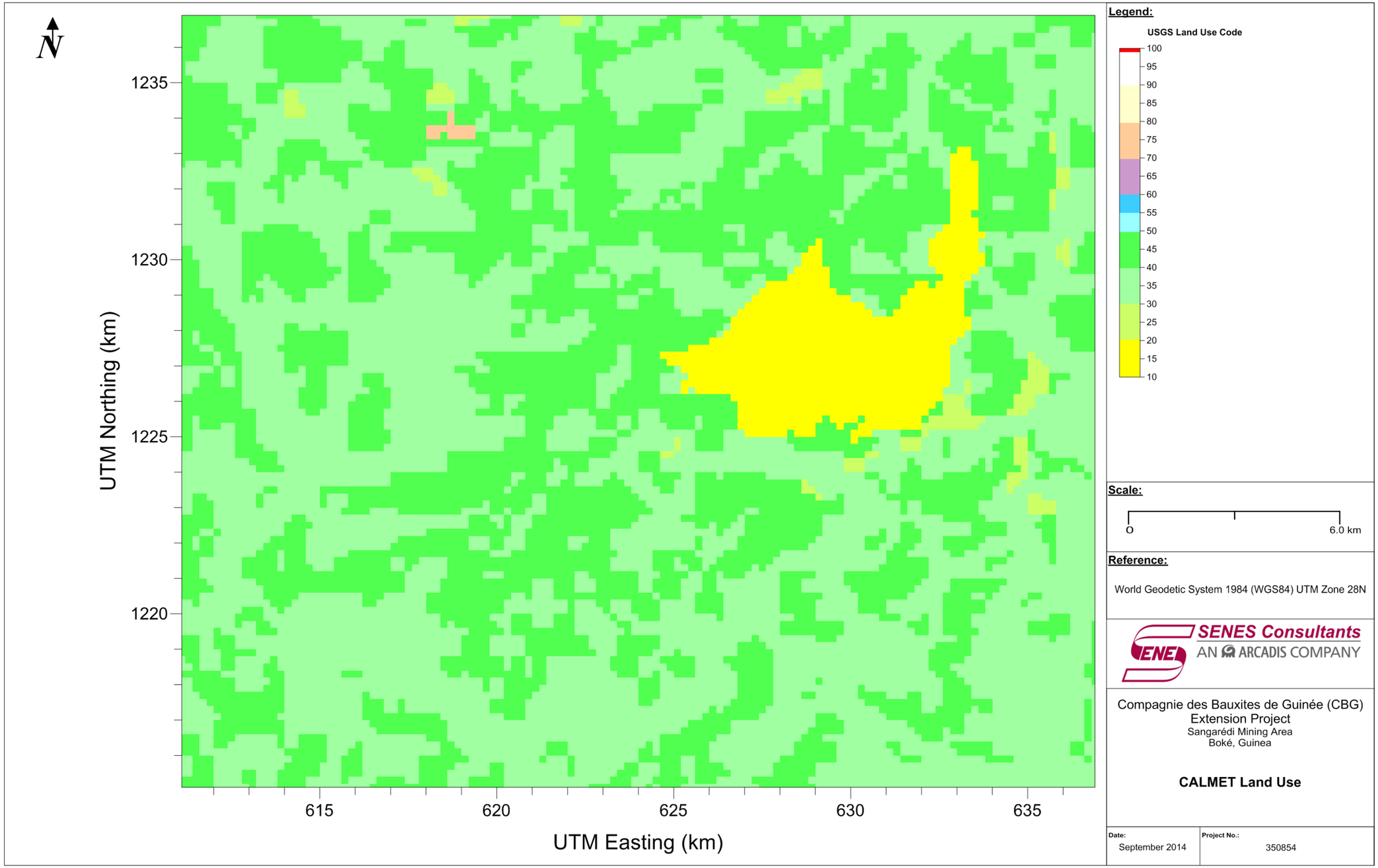
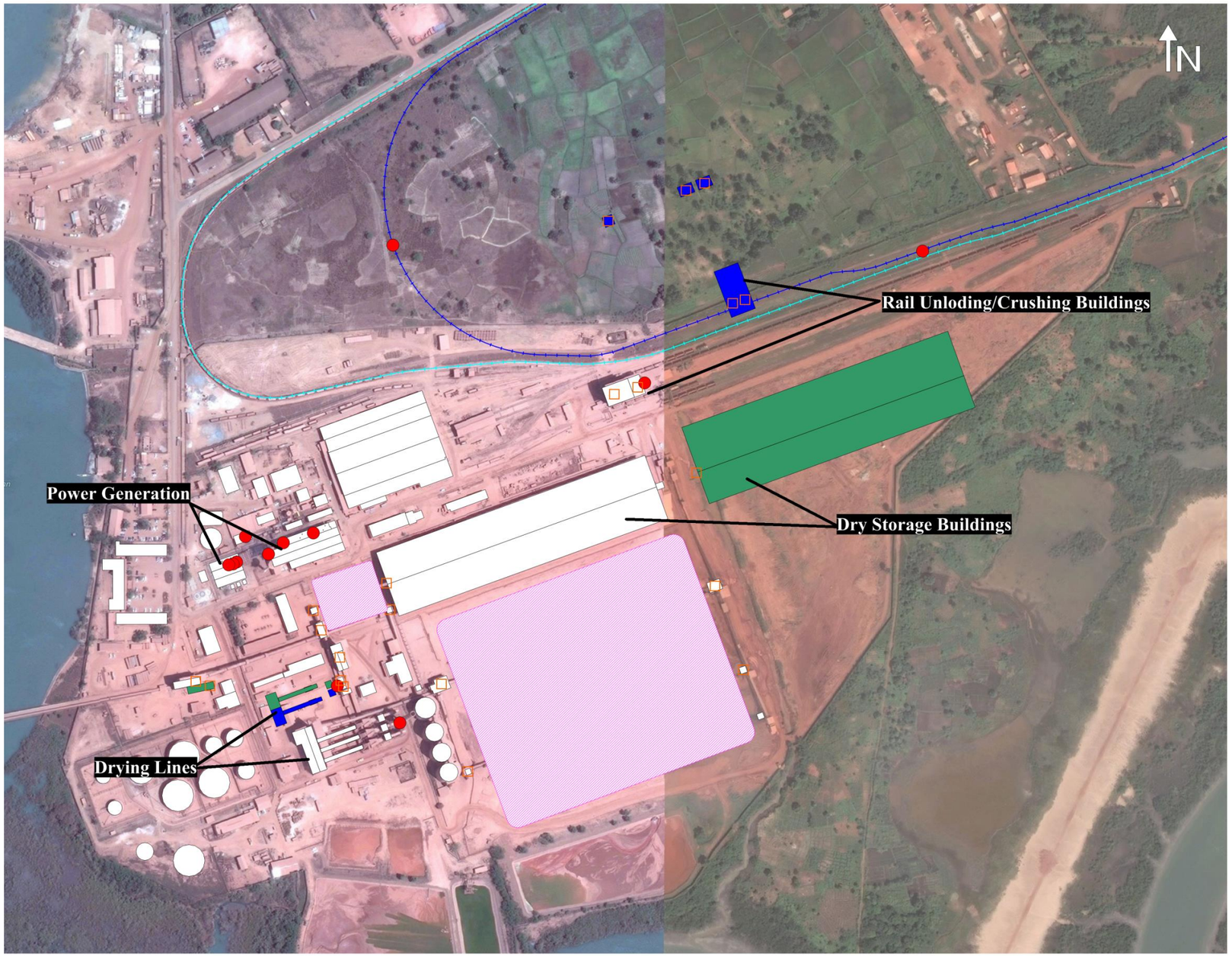

N
1235
1230
1225
1220
UTM Northing (km)
615
620
625
630
635
UTM Easting (km)
Legend:
USGS Land Use Code
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
CALMET Land Use
Date:
September 2014
Project No.:
350854

Figure 9



LEGEND:

- Point source
- Volume source
- Area source
- Existing building
- New building (18.5 MTPA)
- New building (27.5 MTPA)
- Existing rail line
- Future rail line

NOTES:

SCALE:

0 m 100 m 200 m

REFERENCE:

Basemap: Bing Maps 2014

SENES Consultants
AN ARCADIS COMPANY

Compagnie des bauxites de Guinée (CBG)
Extension Project
Kamsar, Guinea

Kamsar Model Setup

Drawn By:	Approved By:	Figure No.:
KT	JLK	
Date: Sept. 2014	Project Number: 350854	

Figure 10

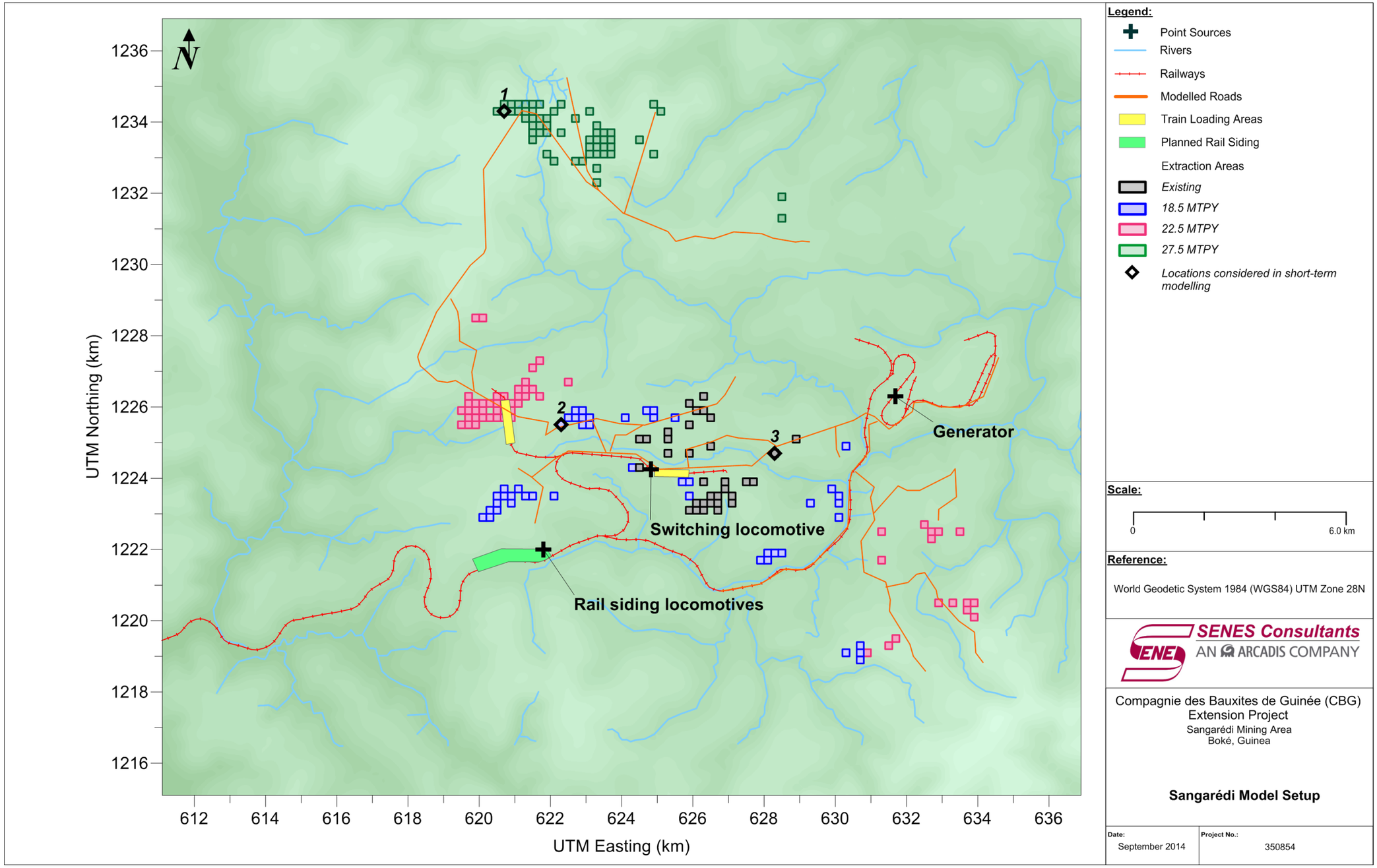
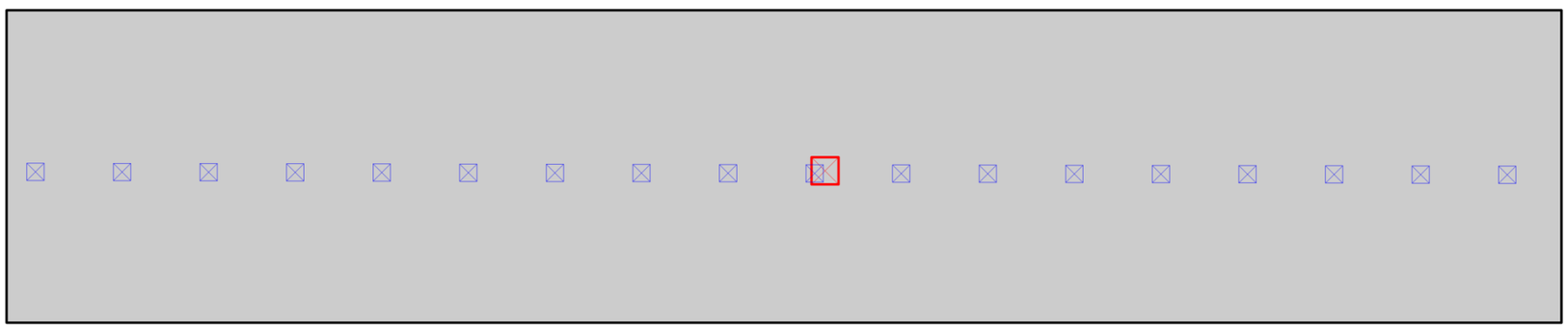

N
1
2
3
Generator
Switching locomotive
Rail siding locomotives
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
Legend:
Point Sources
Rivers
Railways
Modelled Roads
Train Loading Areas
Planned Rail Siding
Extraction Areas
Existing
18.5 MTPY
22.5 MTPY
27.5 MTPY
Locations considered in short-term modelling
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
Sangarédi Model Setup
Date:
September 2014
Project No.:
350854

Figure 11



Legend:

Generic Area Source (extraction area)

Generic Volume Source (haul road)

Scale:

0 600 m

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

SENES Consultants
AN ARCADIS COMPANY

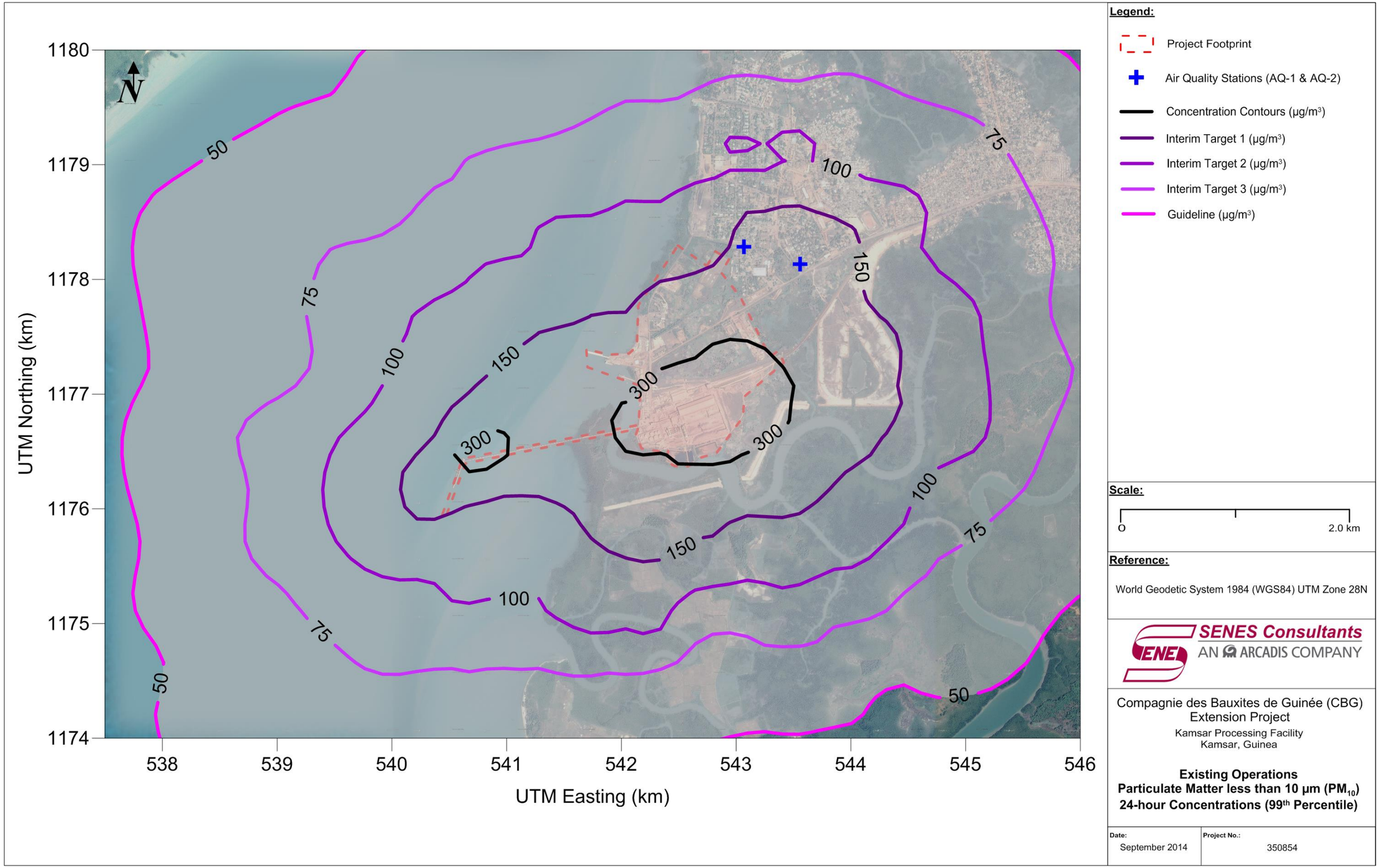
Compagnie des Bauxites de Guinée (CBG)
Extension Project

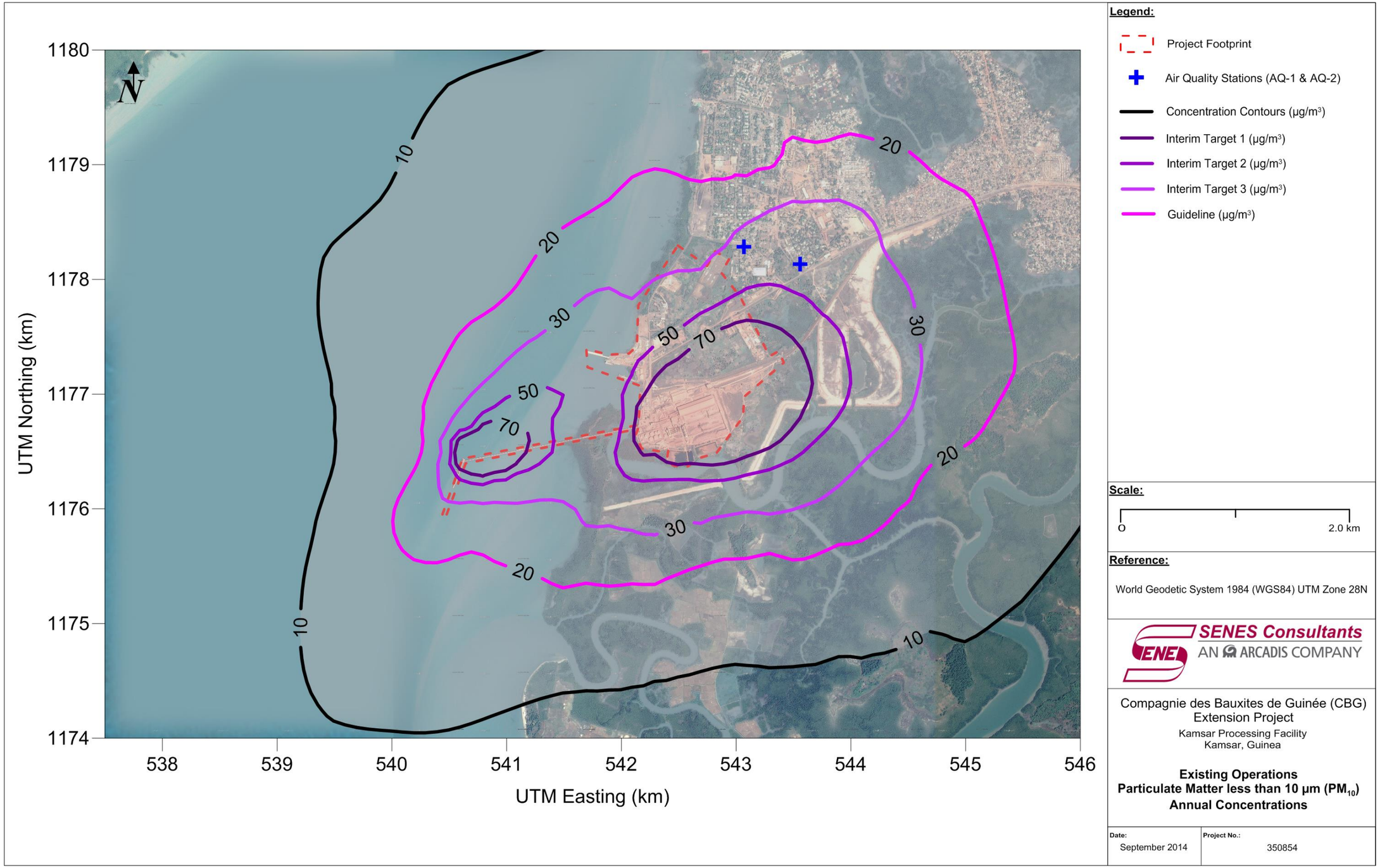
Sangarédi Generic 24-hour Model Setup

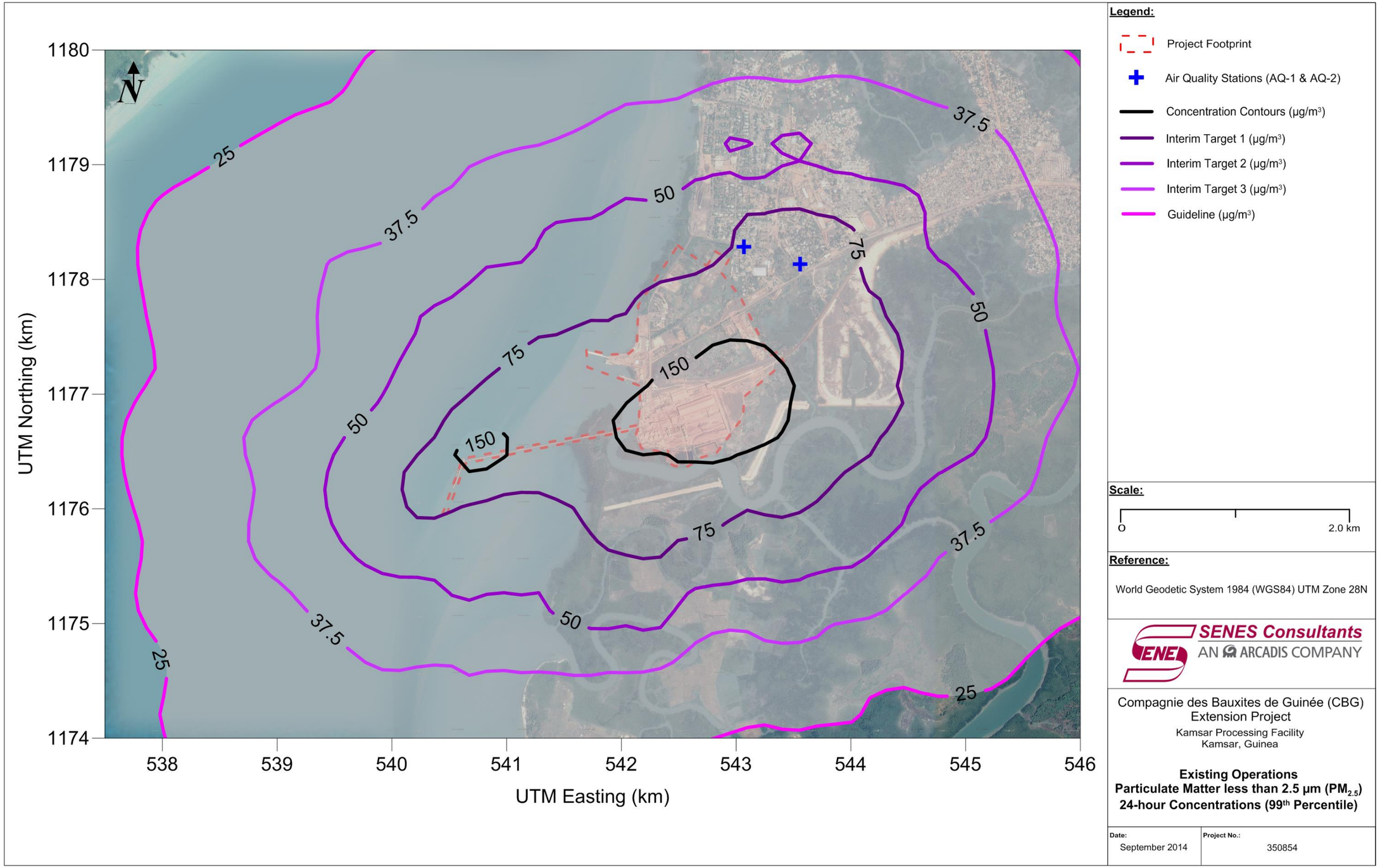
Date:	Project No.:
Septembre 2014	350854

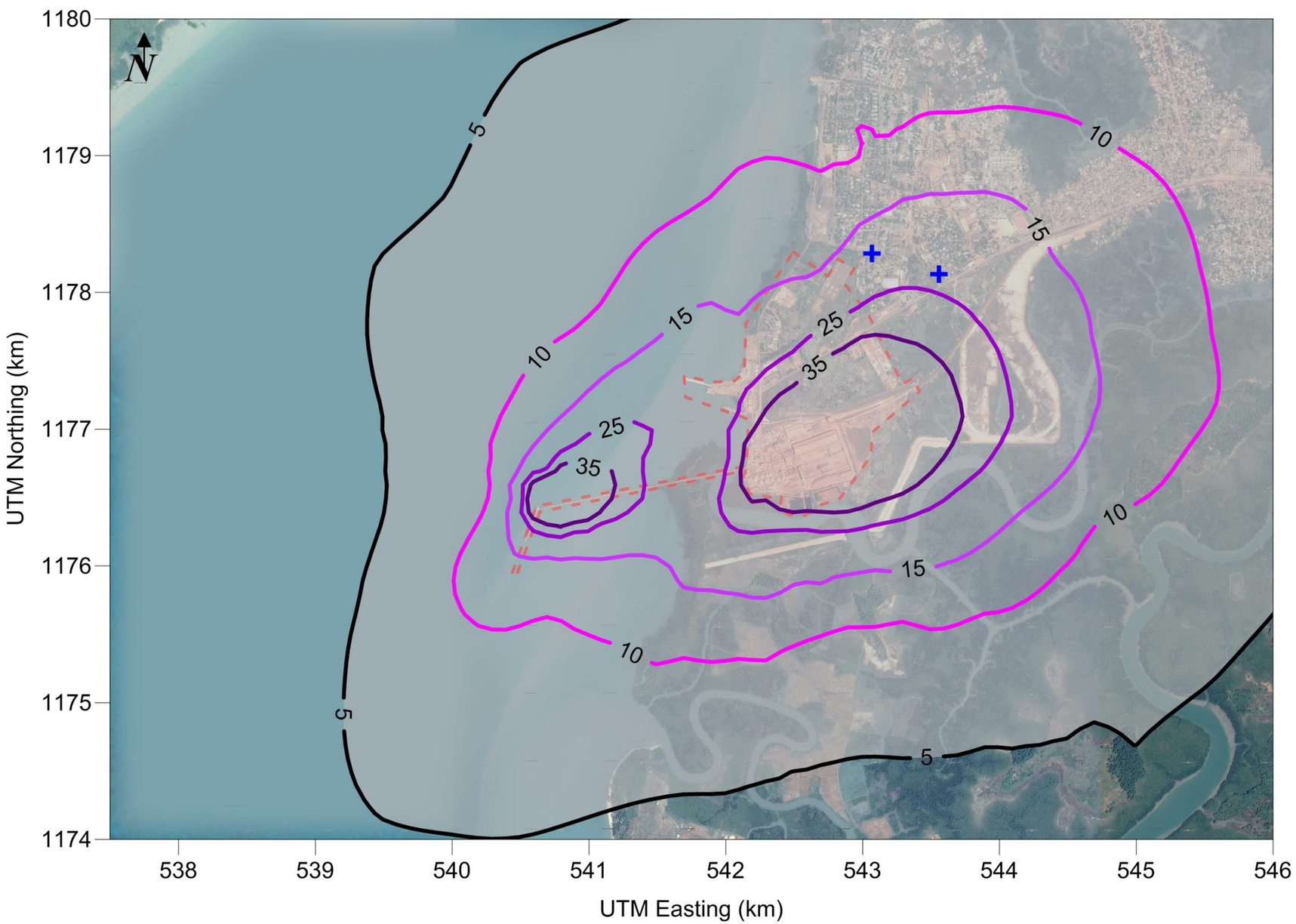
Kamsar

Existing Operations


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
50
75
100
150
300
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
Existing Operations
Particulate Matter less than 10 µm (PM10)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
10
20
30
50
70
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
Existing Operations
Particulate Matter less than 10 µm (PM10)
Annual Concentrations
Date:
September 2014
Project No.:
350854


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
25
37.5
50
75
150
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
Existing Operations
Particulate Matter less than 2.5 µm (PM2.5)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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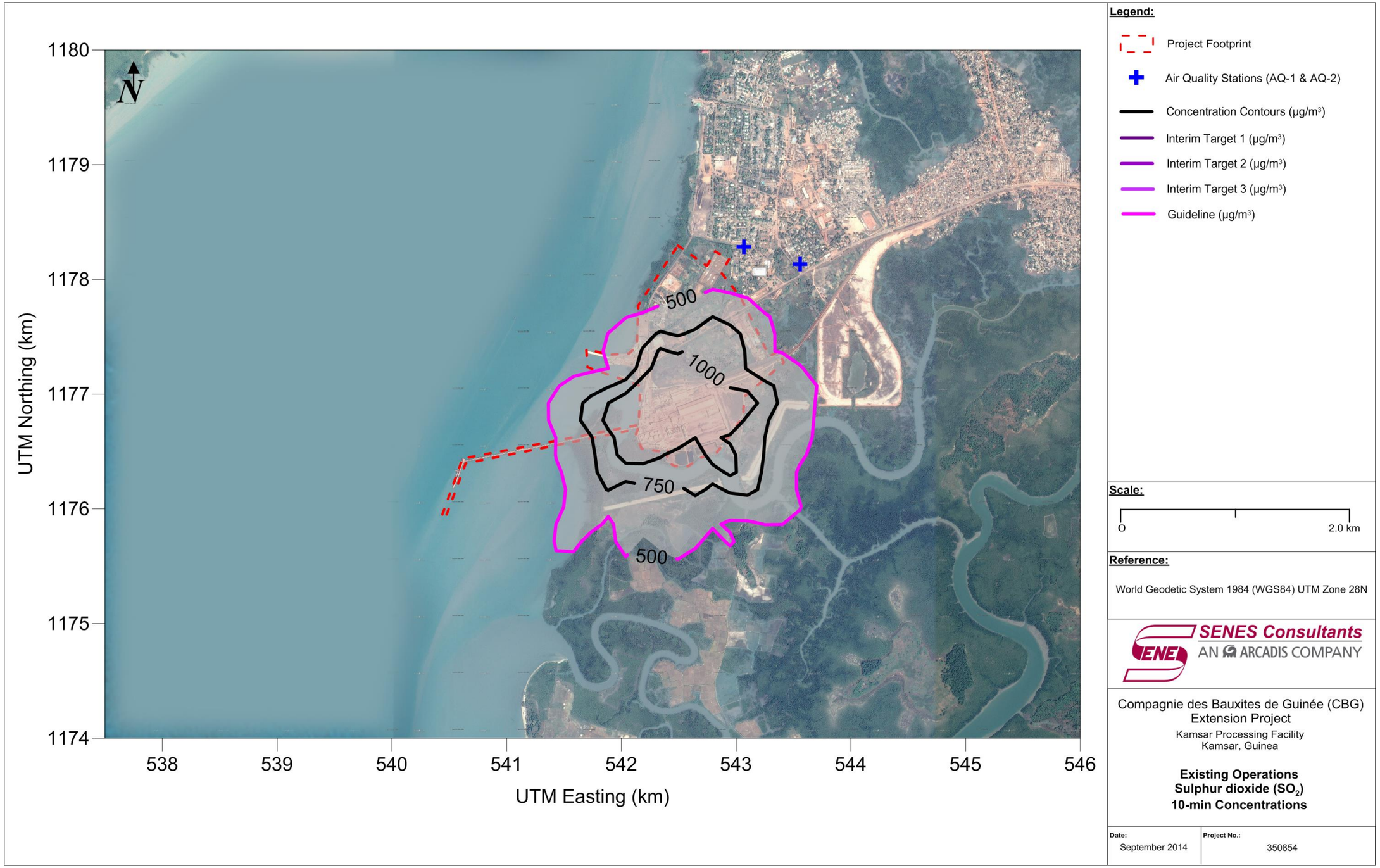
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Annual Concentrations

Date:	Project No.:
September 2014	350854


1180
1179
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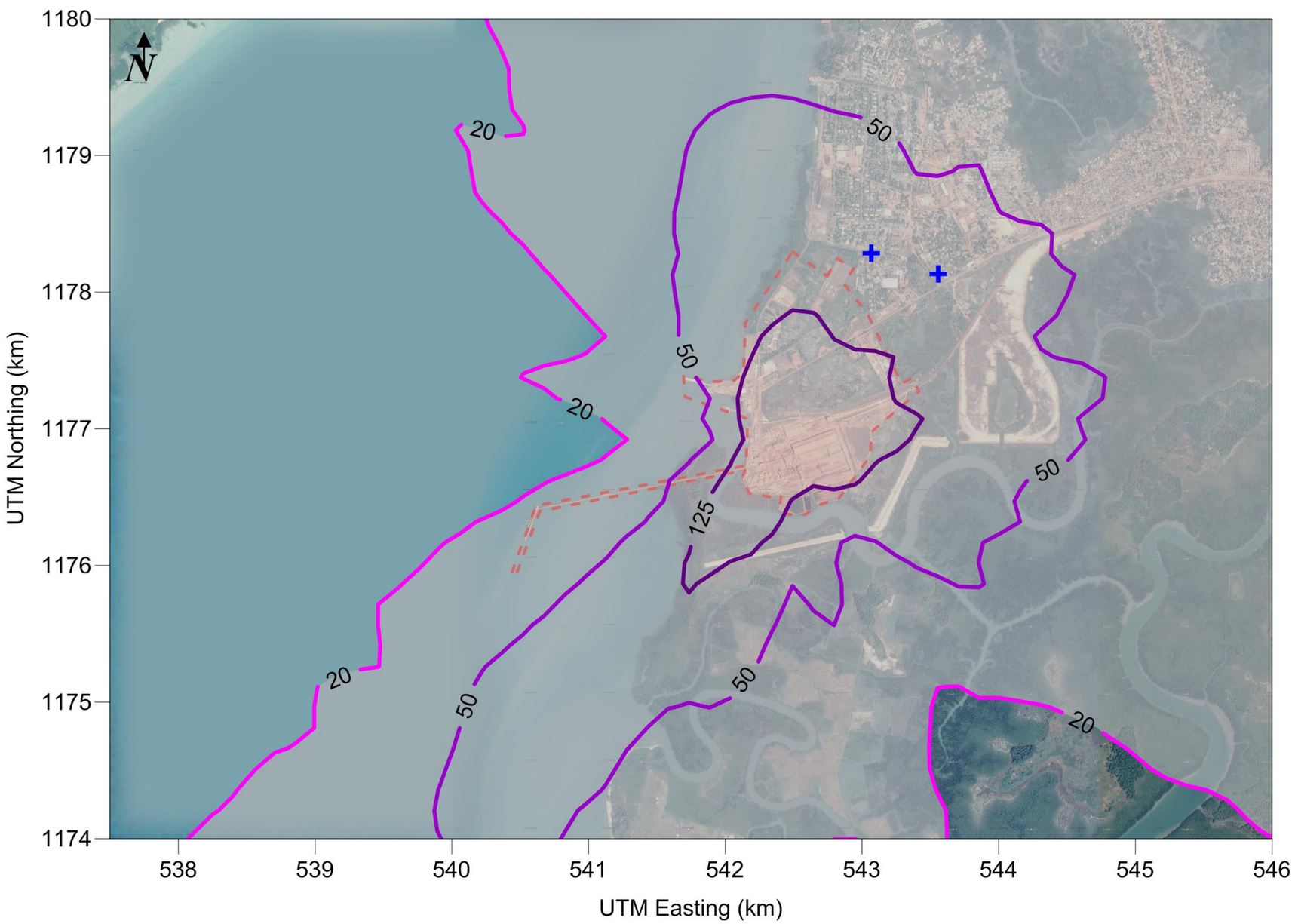
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
N
500
1000
750
500
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
Existing Operations
Sulphur dioxide (SO2)
10-min Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

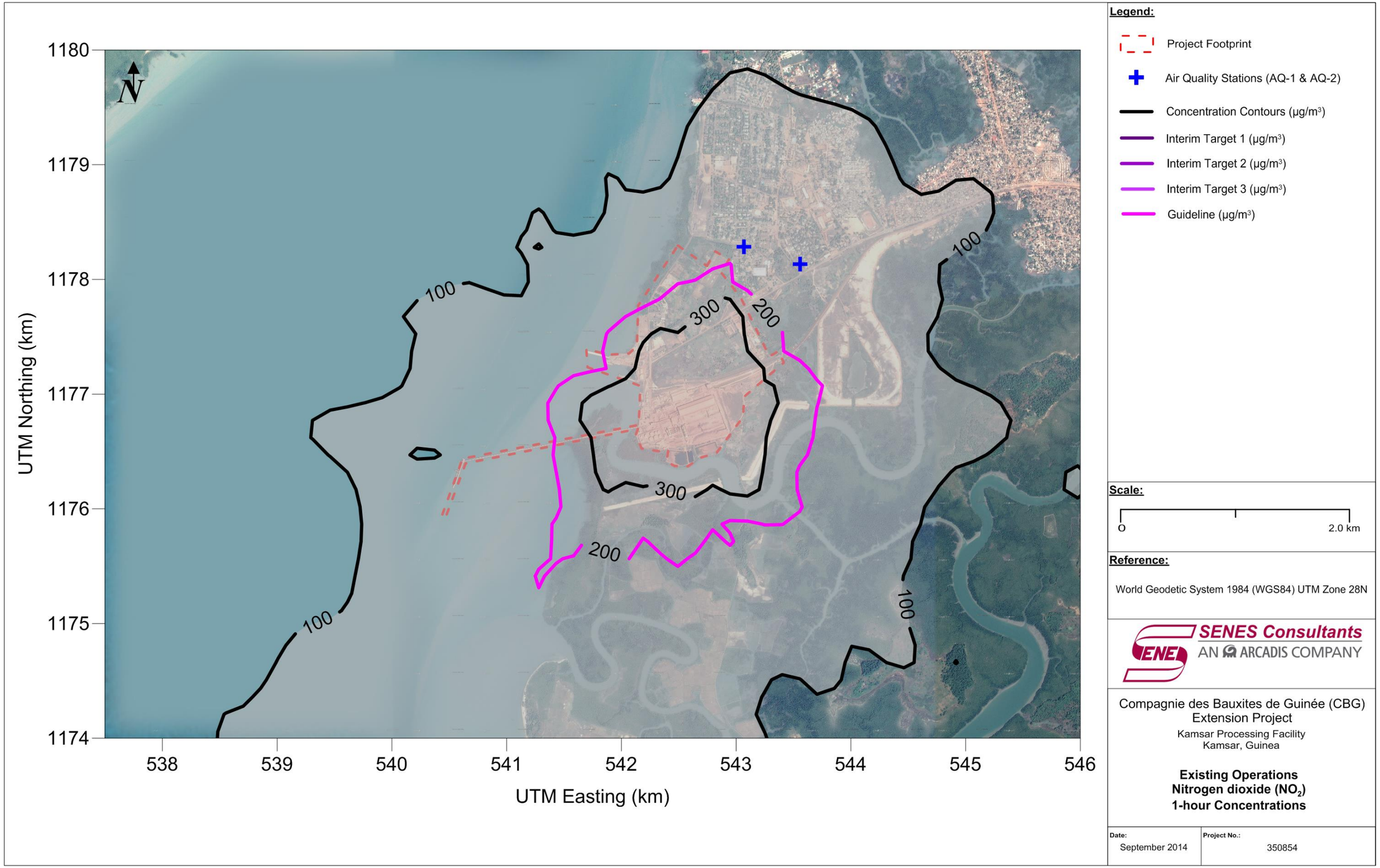
World Geodetic System 1984 (WGS84) UTM Zone 28N

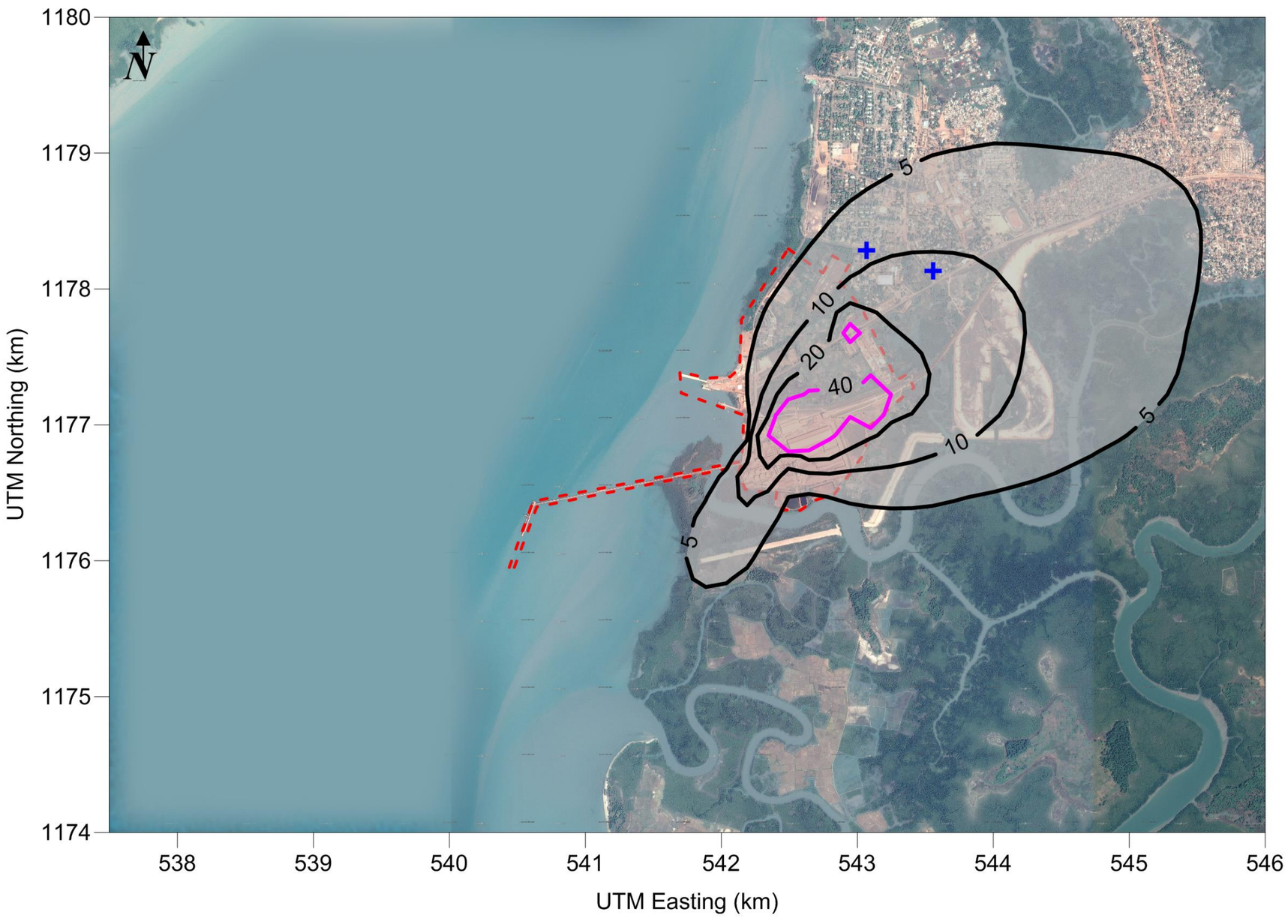
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Sulphur dioxide (SO_2)
24-hour Concentrations

Date:	Project No.:
September 2014	350854


1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
N
100
300
200
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
Existing Operations
Nitrogen dioxide (NO2)
1-hour Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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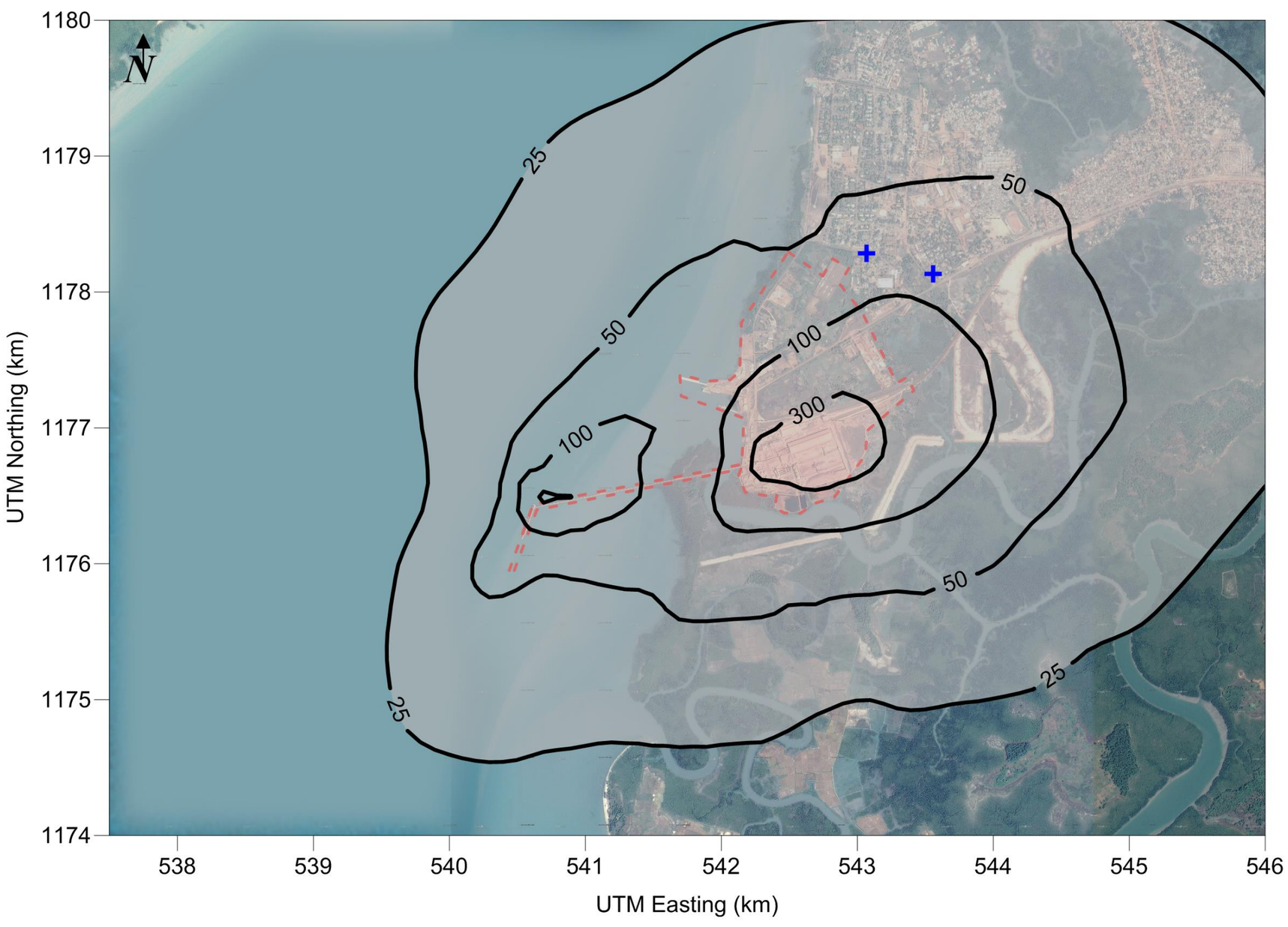
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Nitrogen dioxide (NO_2)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Concentration Contours (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

SENES Consultants
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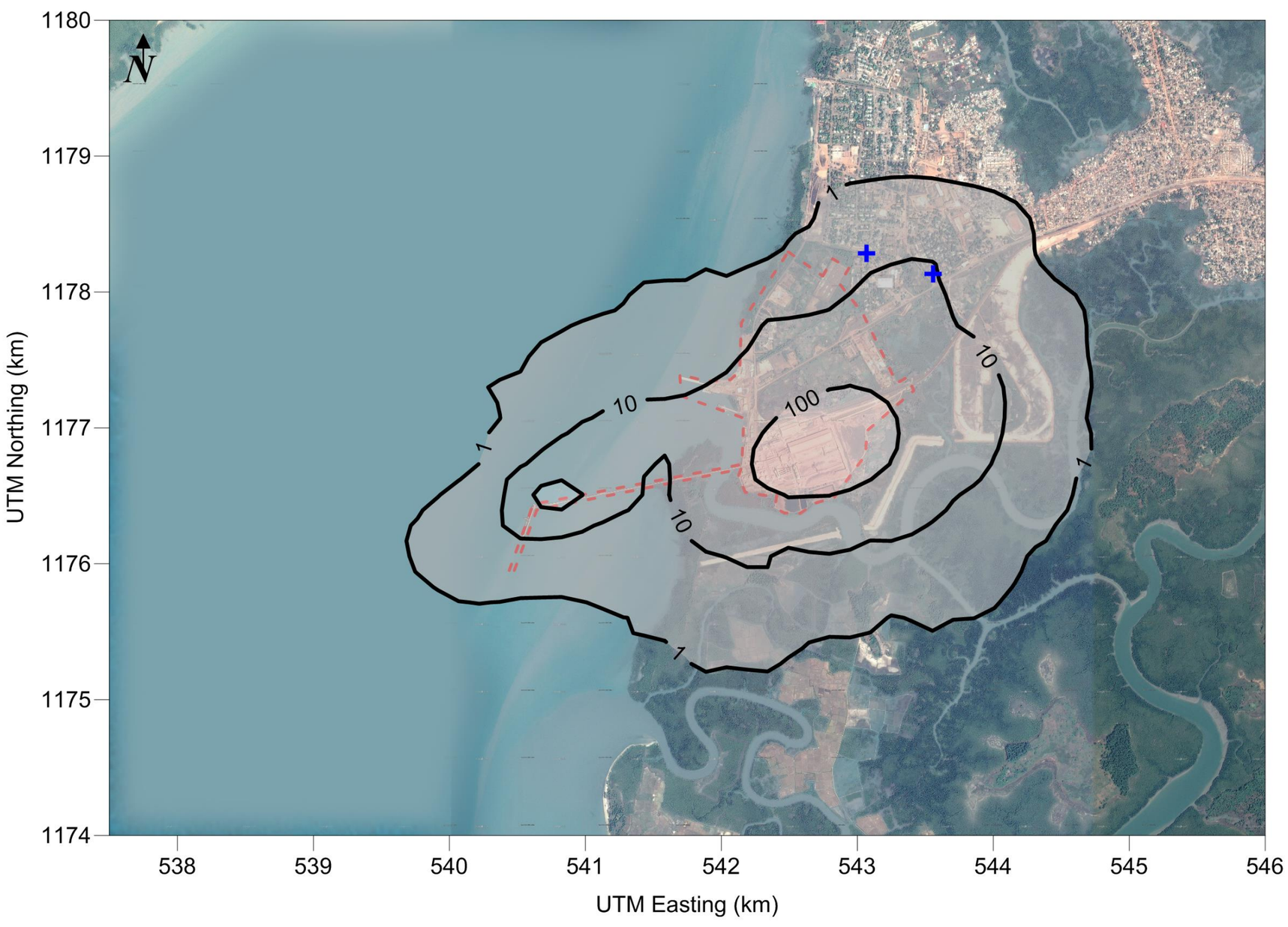
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Total Suspended Particulate (TSP)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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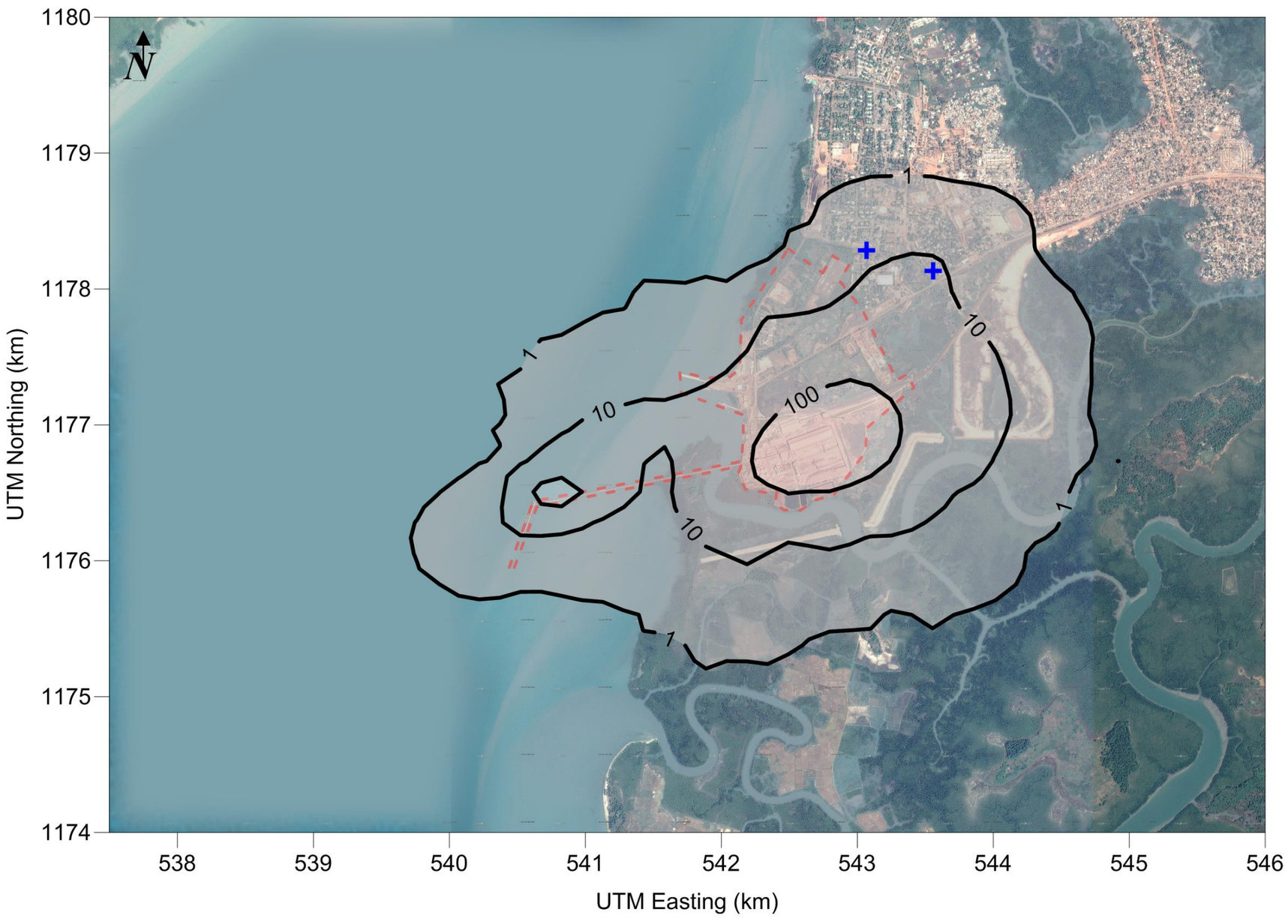
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 10 µm (PM_{10})

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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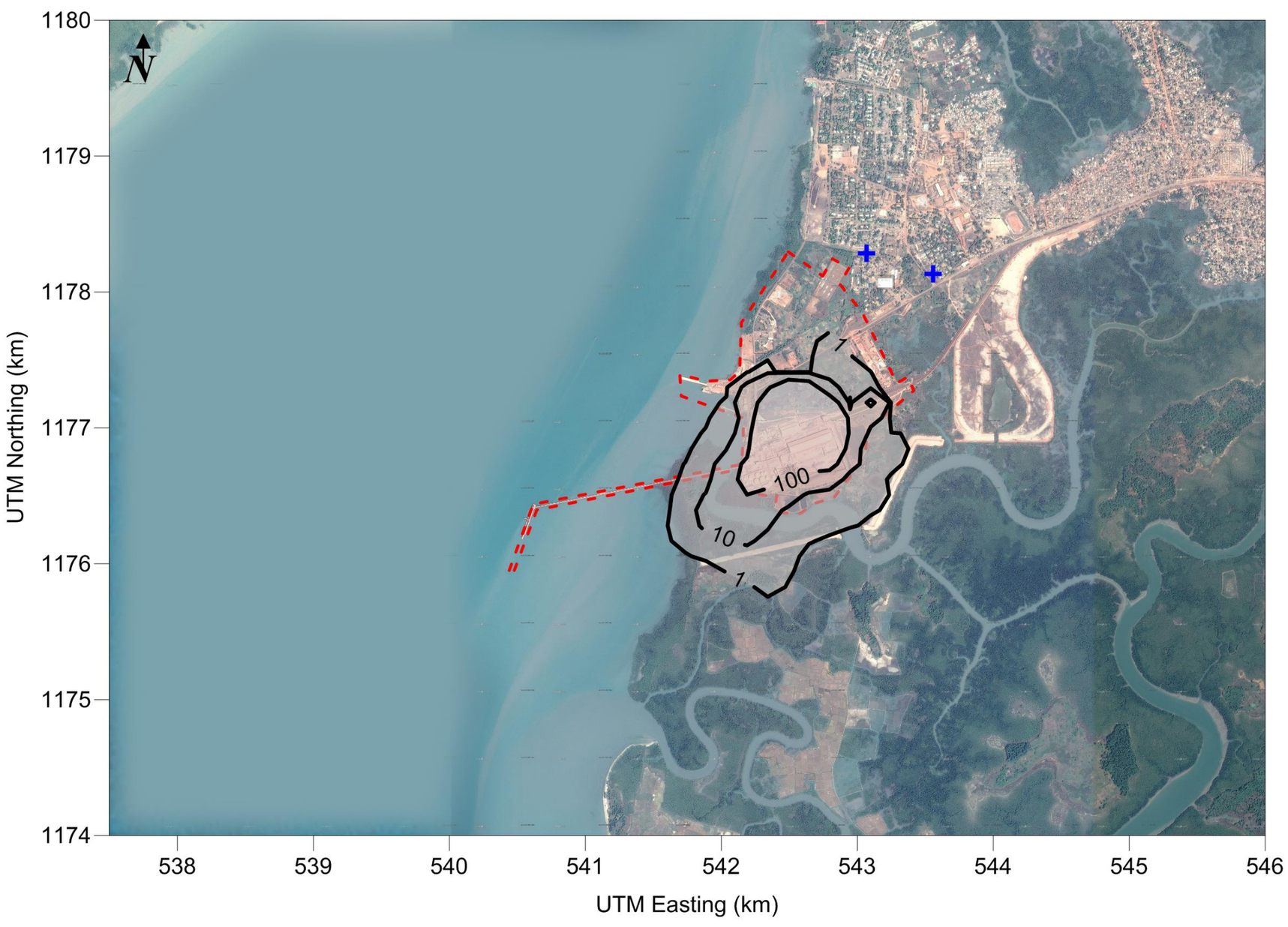
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Frequency of Exceedances (days per year)
of WHO 24-hour Interim Target-1 for
Particulate Matter less than 2.5 µm ($PM_{2.5}$)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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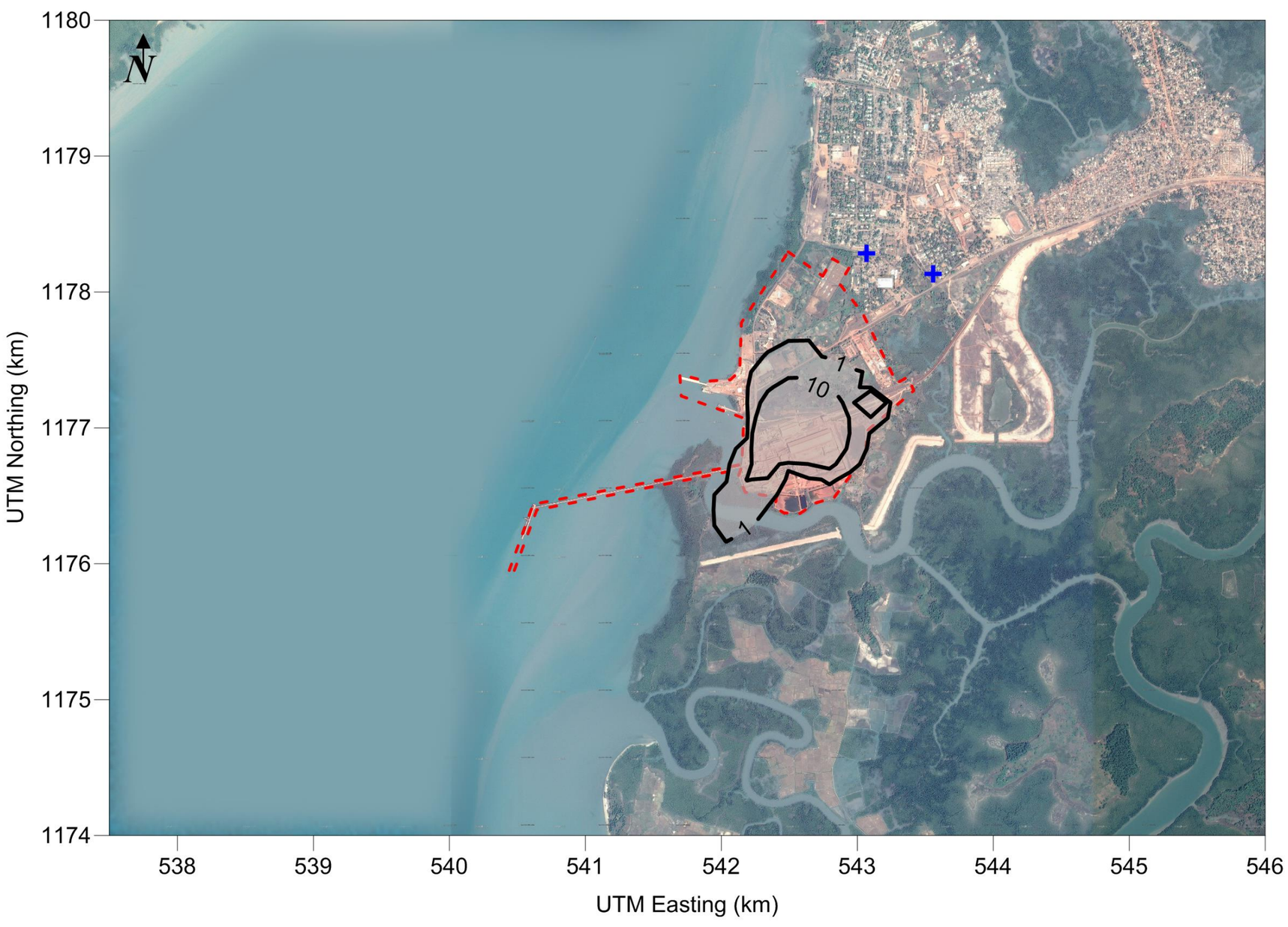
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Frequency of Exceedances (hours per year) of WHO 10-minute Guideline for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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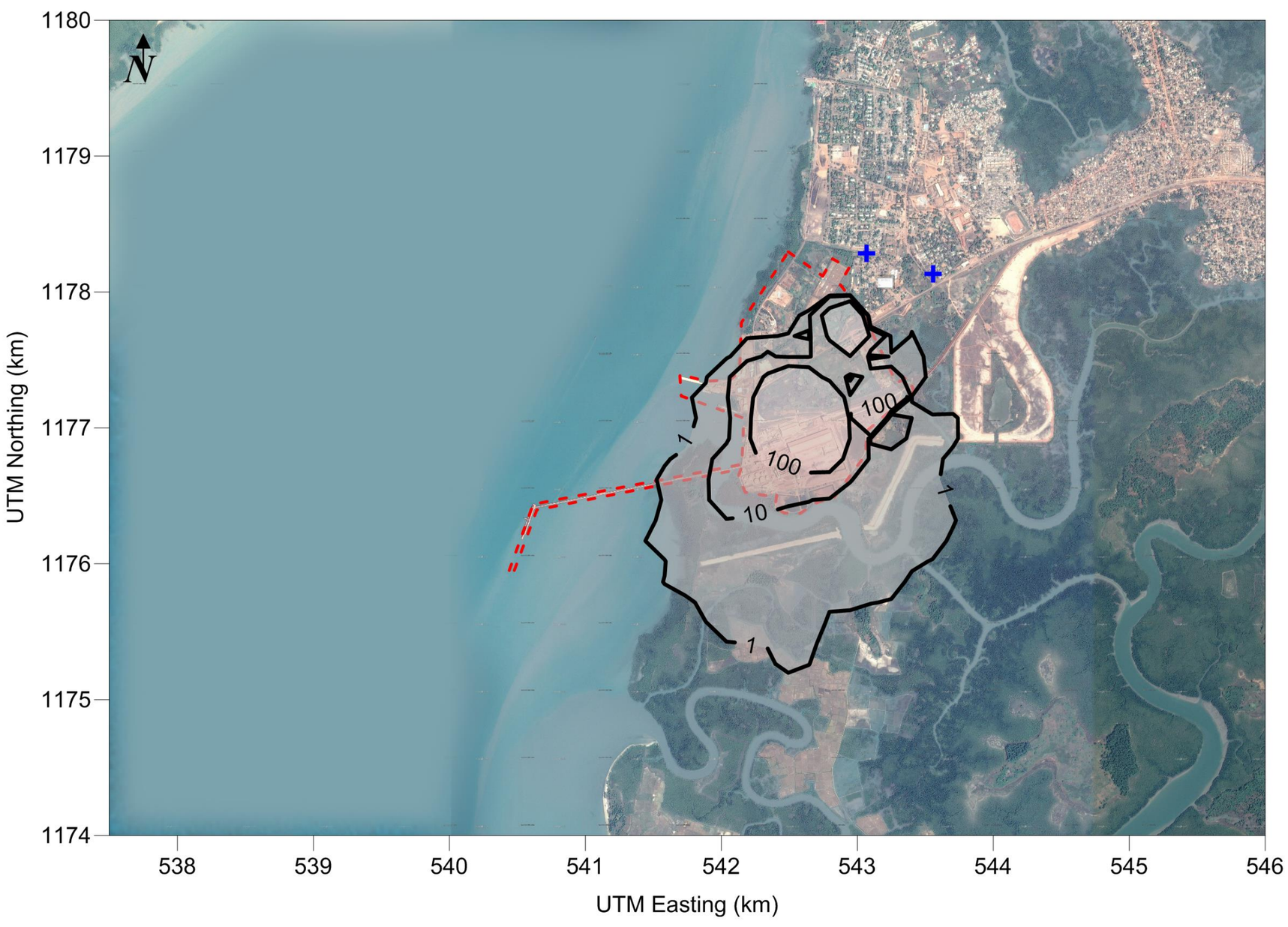
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

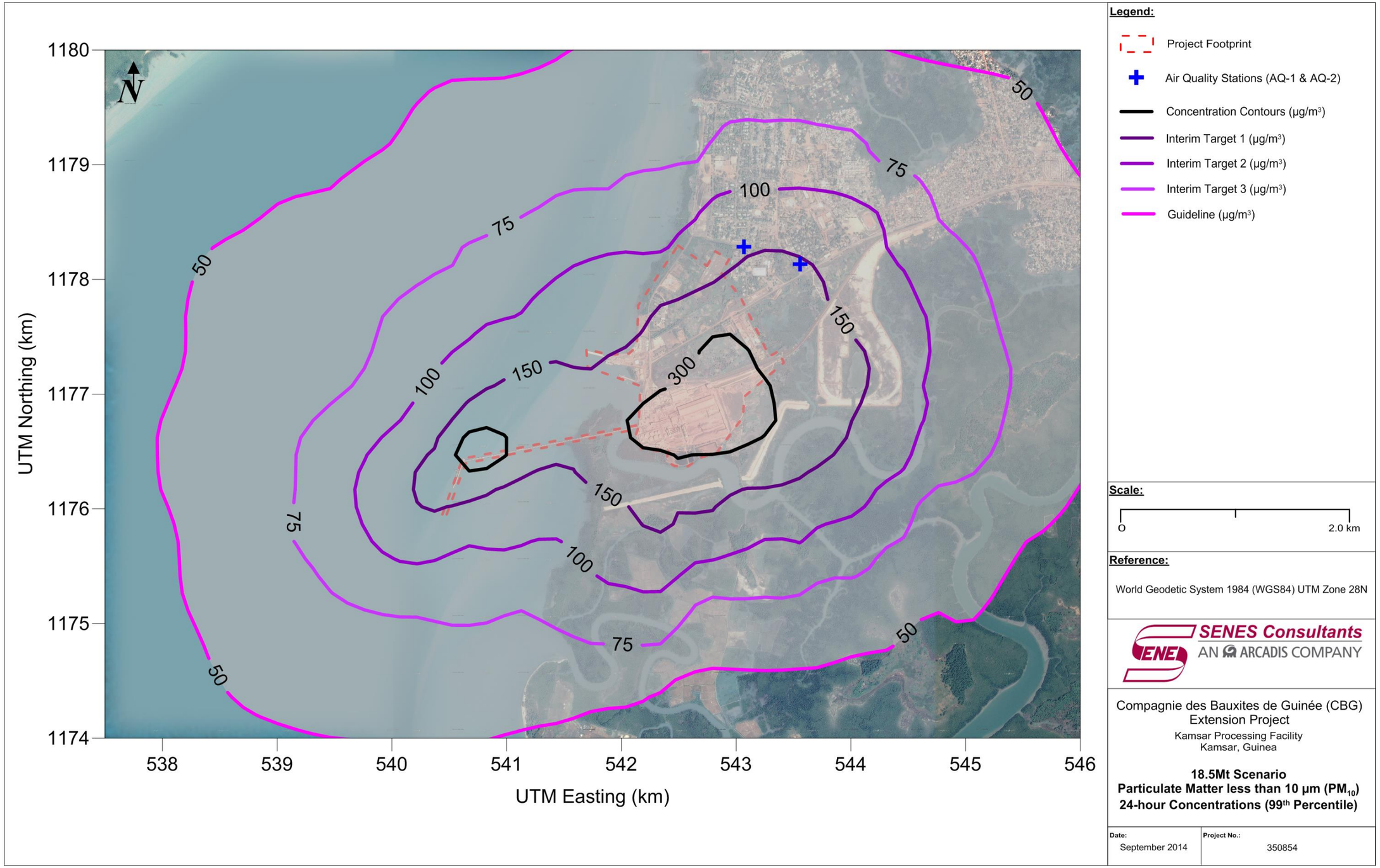
Kamsar Processing Facility
Kamsar, Guinea

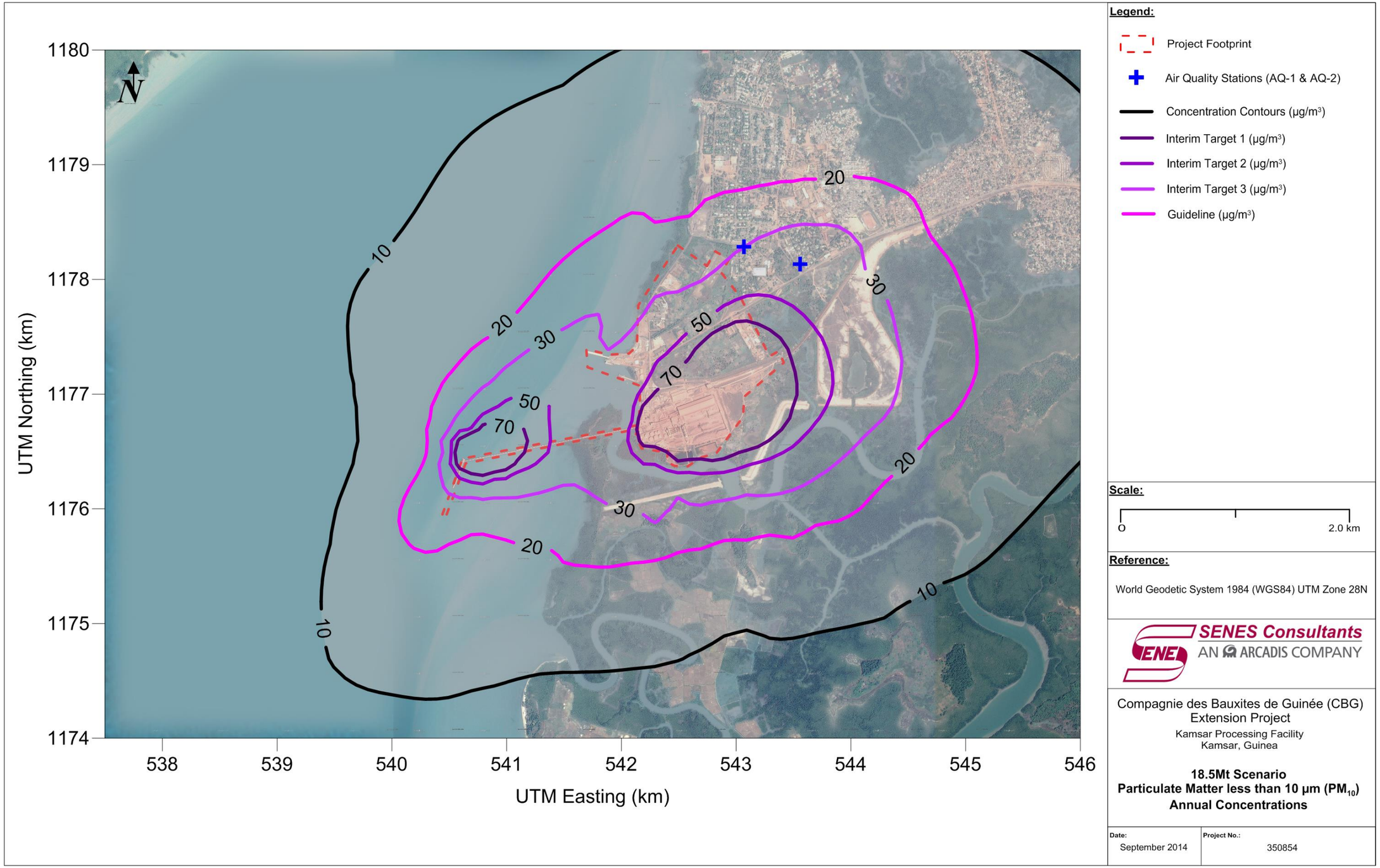
18.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 1-hour Guideline for Nitrogen Dioxide (NO_2)

Date:	Project No.:
September 2014	350854

Kamsar

18.5 MTPY


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
50
75
100
150
300
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Particulate Matter less than 10 µm (PM10)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854


N
1180
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1177
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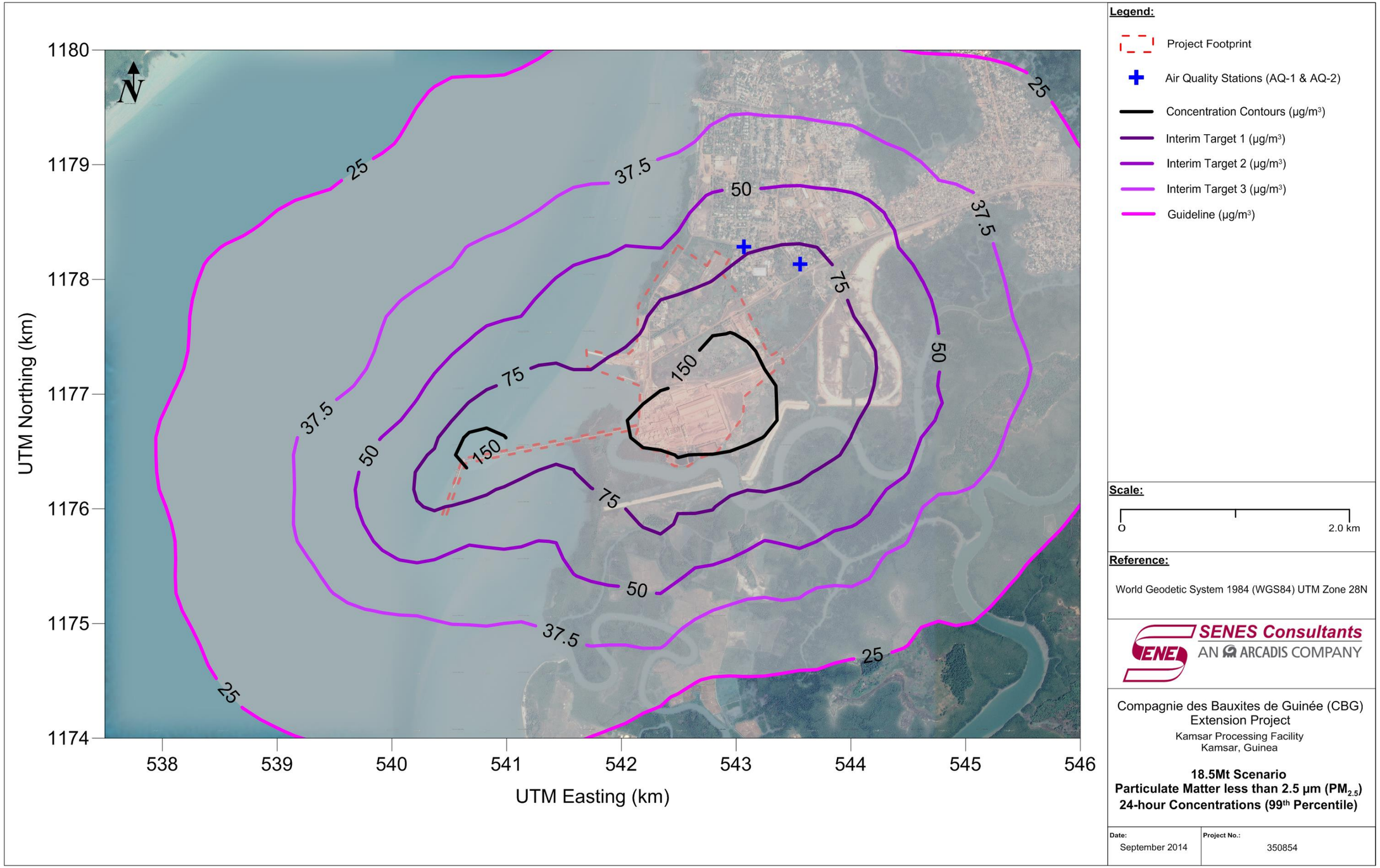
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
10
20
30
50
70
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Particulate Matter less than 10 µm (PM10)
Annual Concentrations
Date:
September 2014
Project No.:
350854


N
UTM Northing (km)
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1177
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1175
1174
UTM Easting (km)
538
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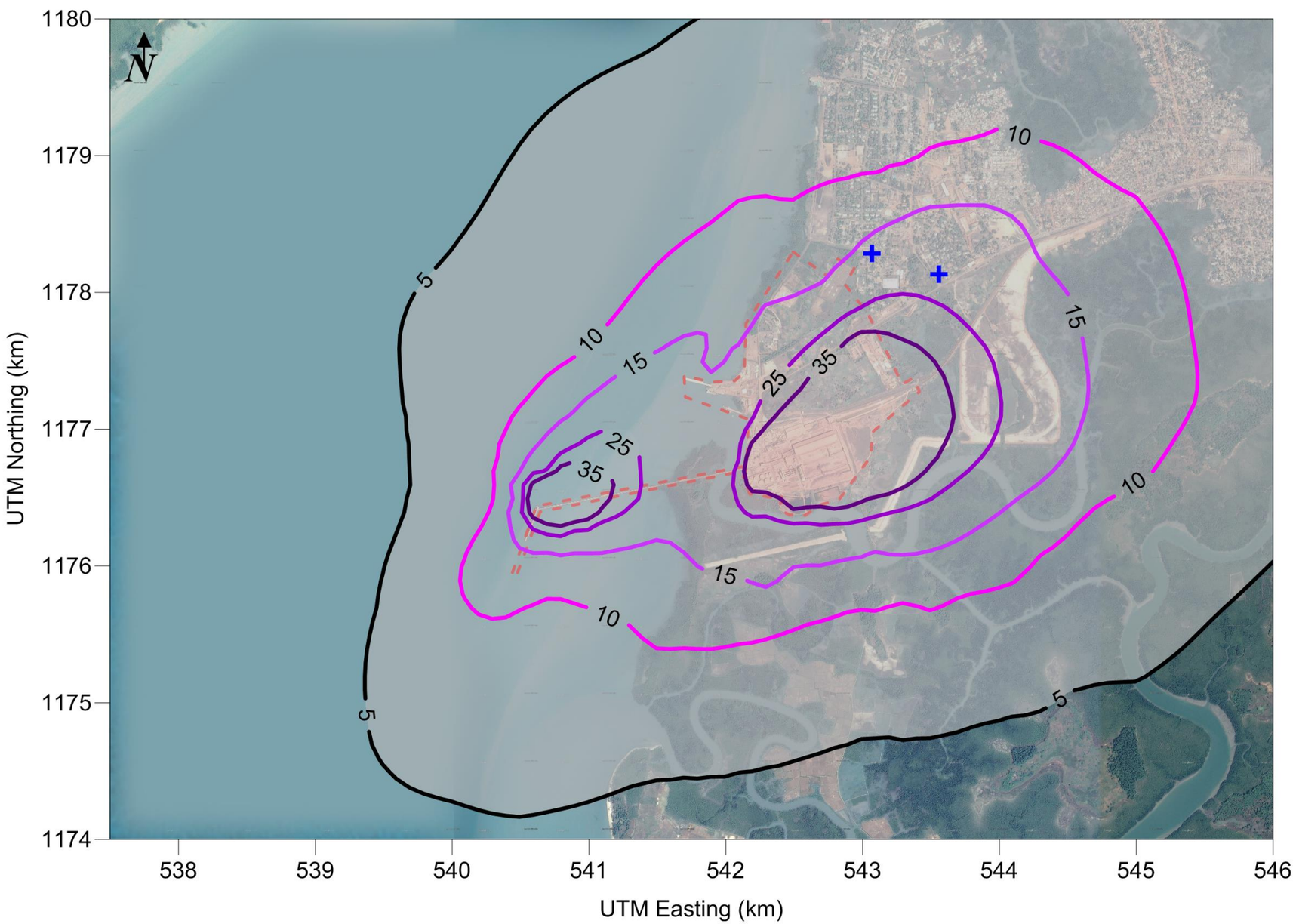
541
542
543
544
545
546
25
37.5
50
75
150
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Particulate Matter less than 2.5 µm (PM2.5)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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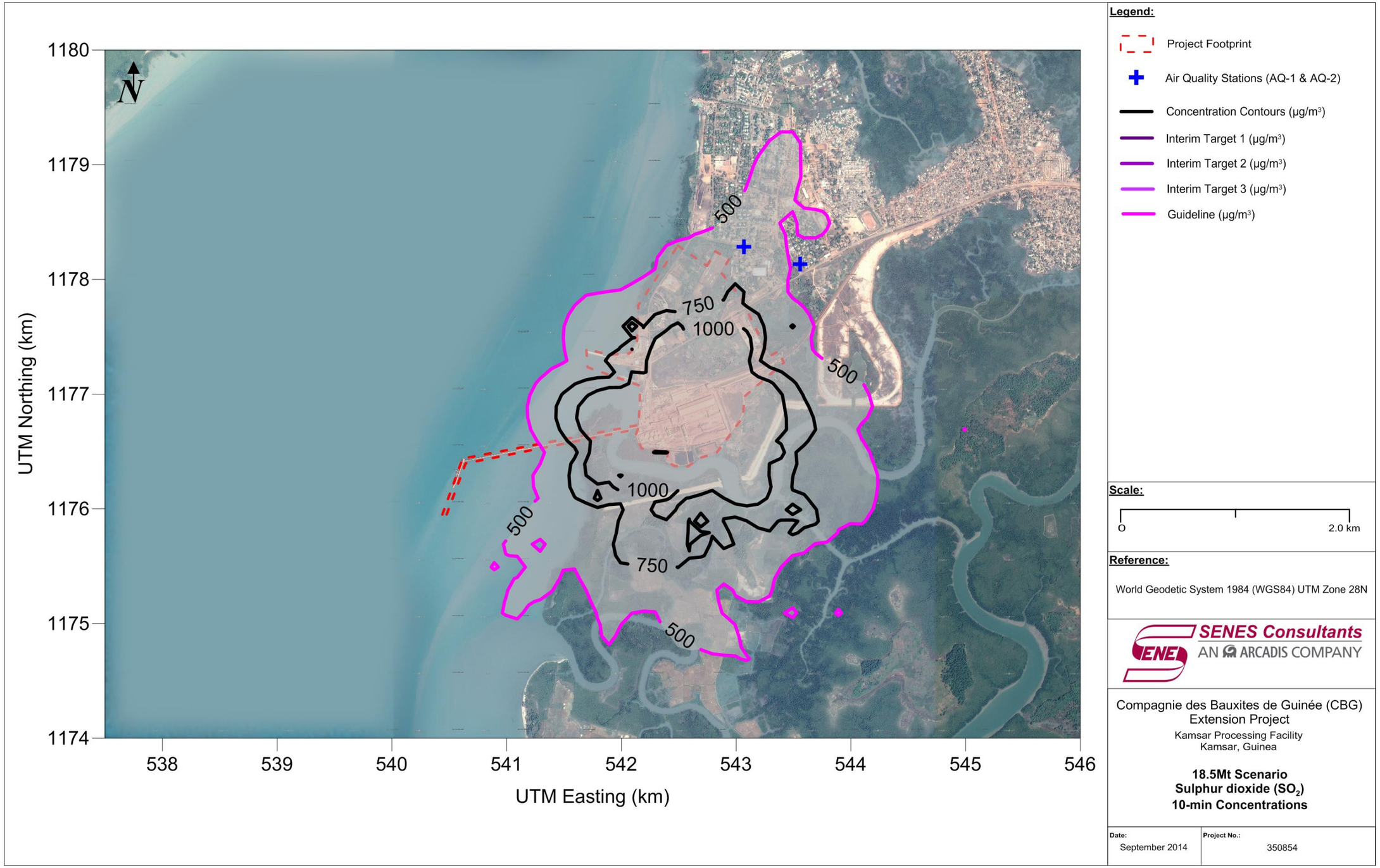
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

18.5Mt Scenario
Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Annual Concentrations

Date:	Project No.:
September 2014	350854


1180
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UTM Northing (km)
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541
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543
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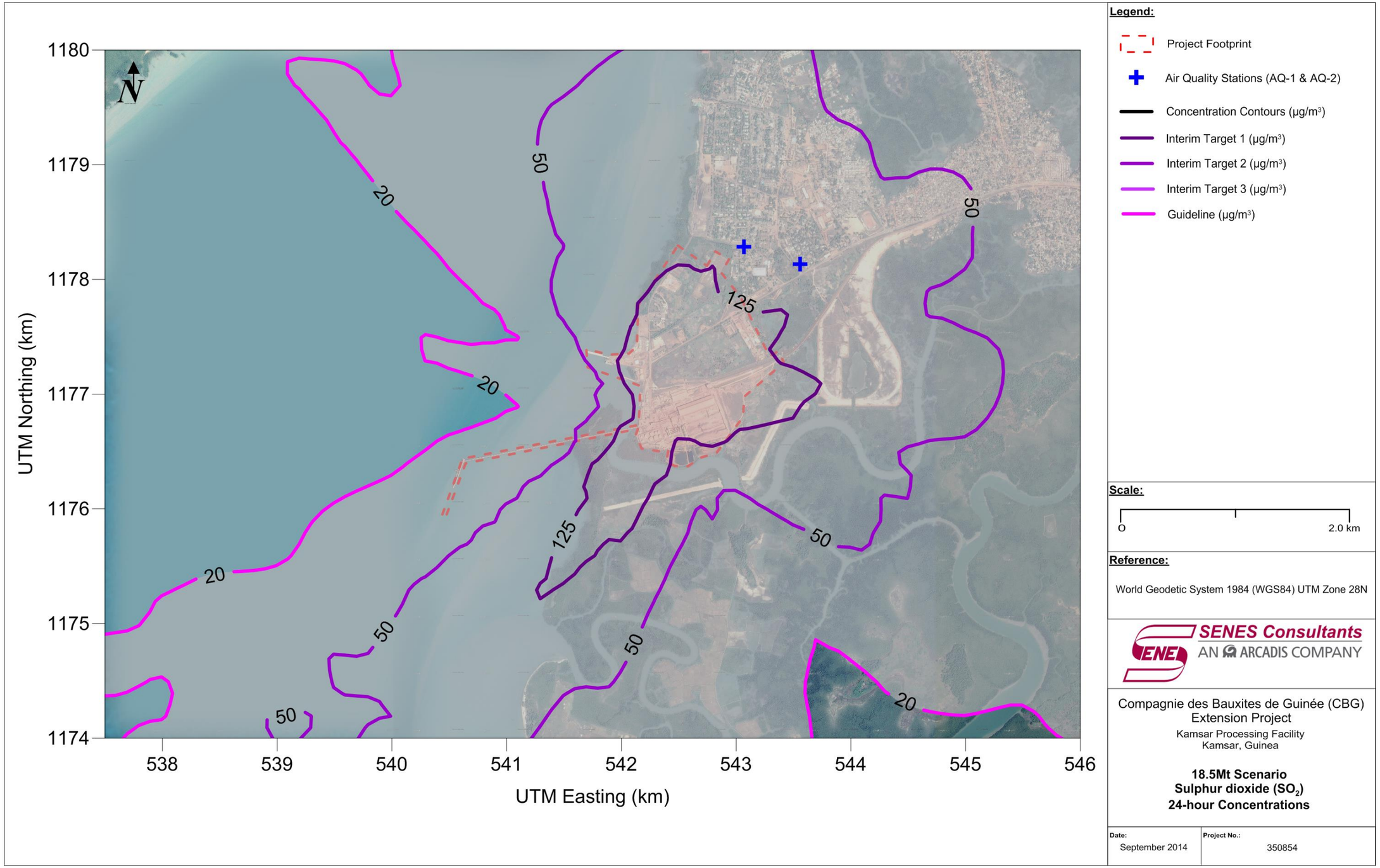
545
546
UTM Easting (km)
N
500
750
1000
500
1000
500
750
500
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Sulphur dioxide (SO_2)
10-min Concentrations
Date:
September 2014
Project No.:
350854


1180
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1174
UTM Northing (km)
538
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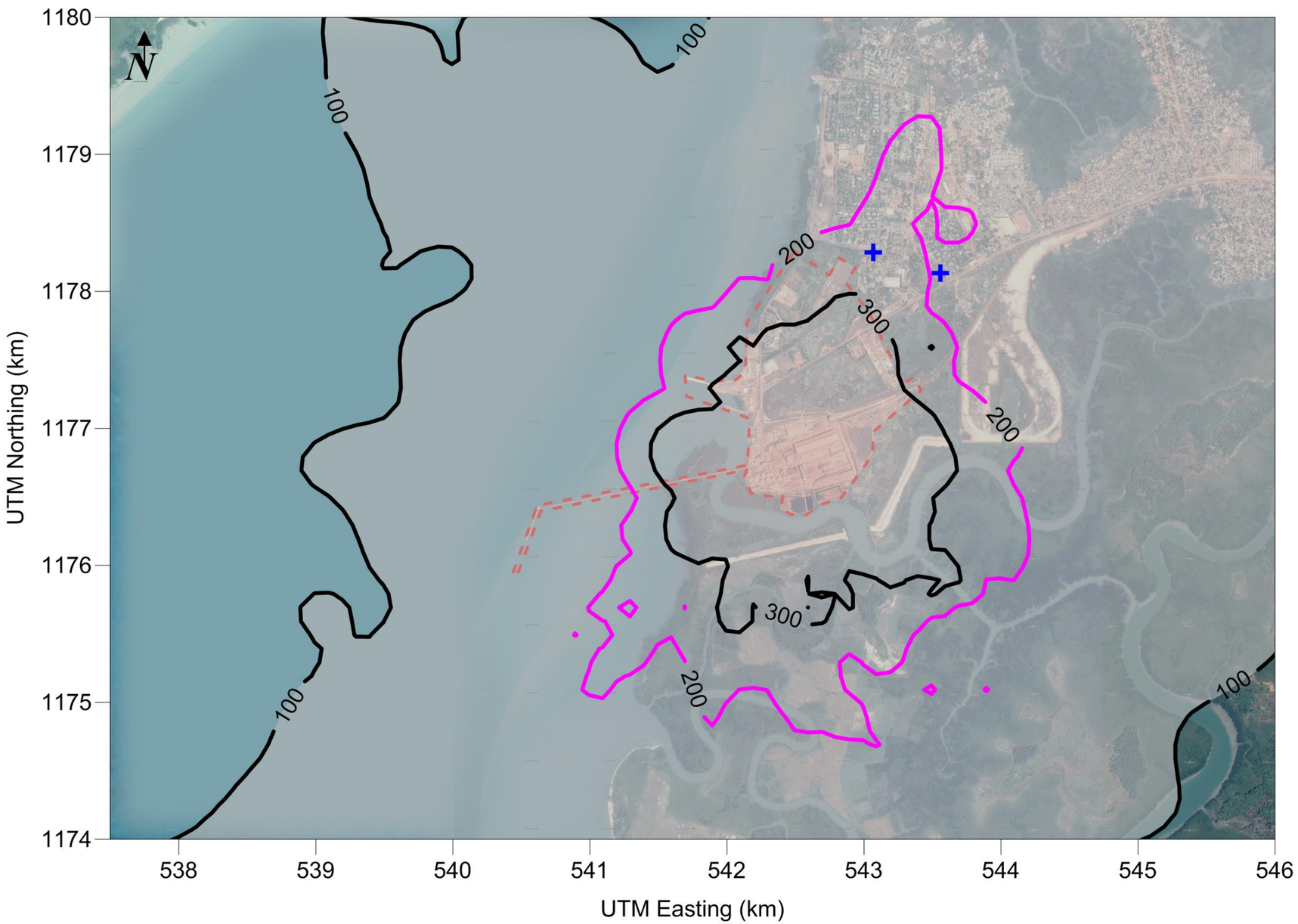
541
542
543
544
545
546
UTM Easting (km)
N
20
50
125
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Sulphur dioxide (SO_2)
24-hour Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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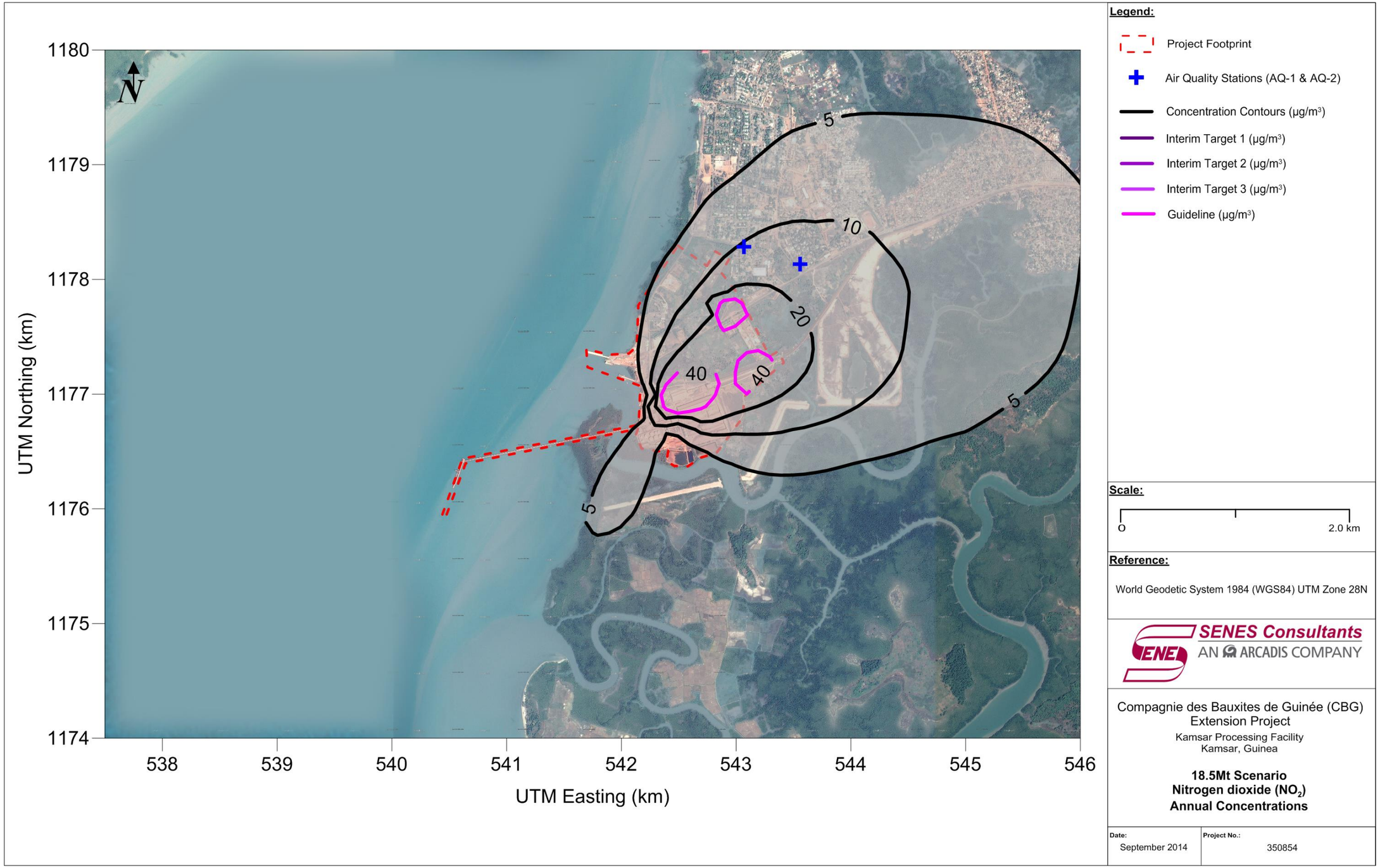
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

18.5Mt Scenario
Nitrogen dioxide (NO_2)
1-hour Concentrations

Date:	Project No.:
September 2014	350854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UTM Northing (km)
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546
UTM Easting (km)
N
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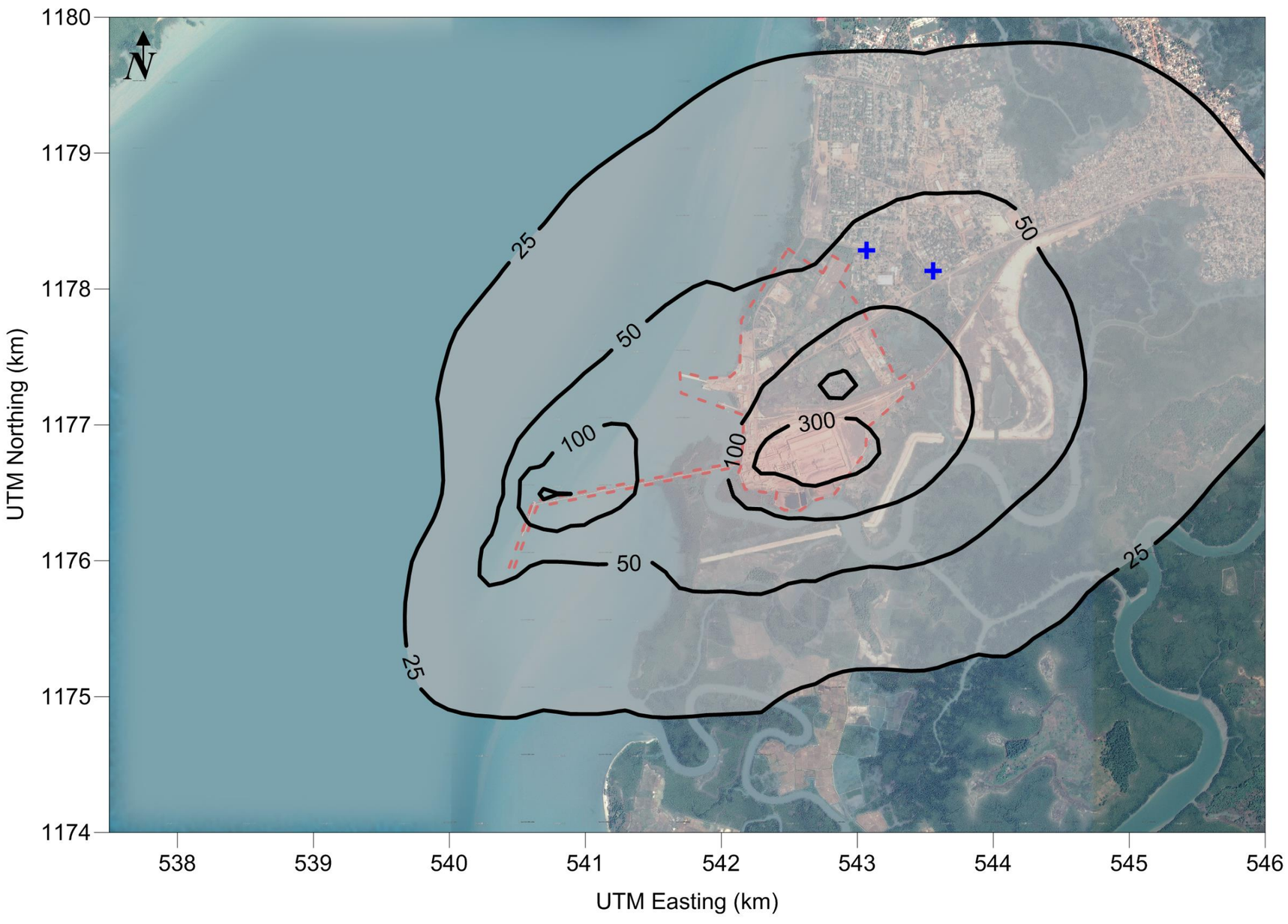
40
40
5
5
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Nitrogen dioxide (NO2)
Annual Concentrations
Date:
September 2014
Project No.:
350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Concentration Contours (µg/m³)

Scale:

0 — 2.0 km

Reference:

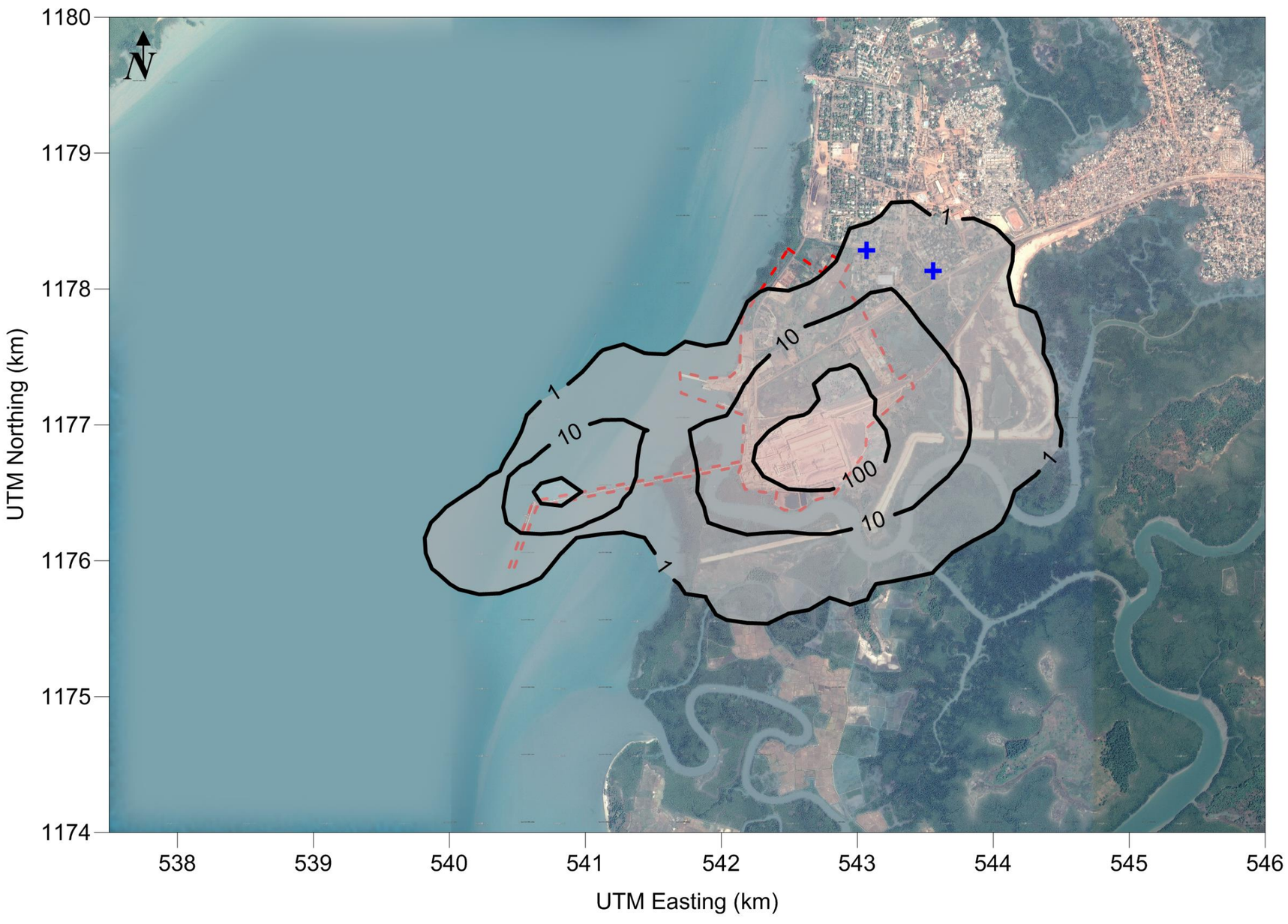
World Geodetic System 1984 (WGS84) UTM Zone 28N

SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

18.5Mt Scenario
Total Suspended Particulate (TSP)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

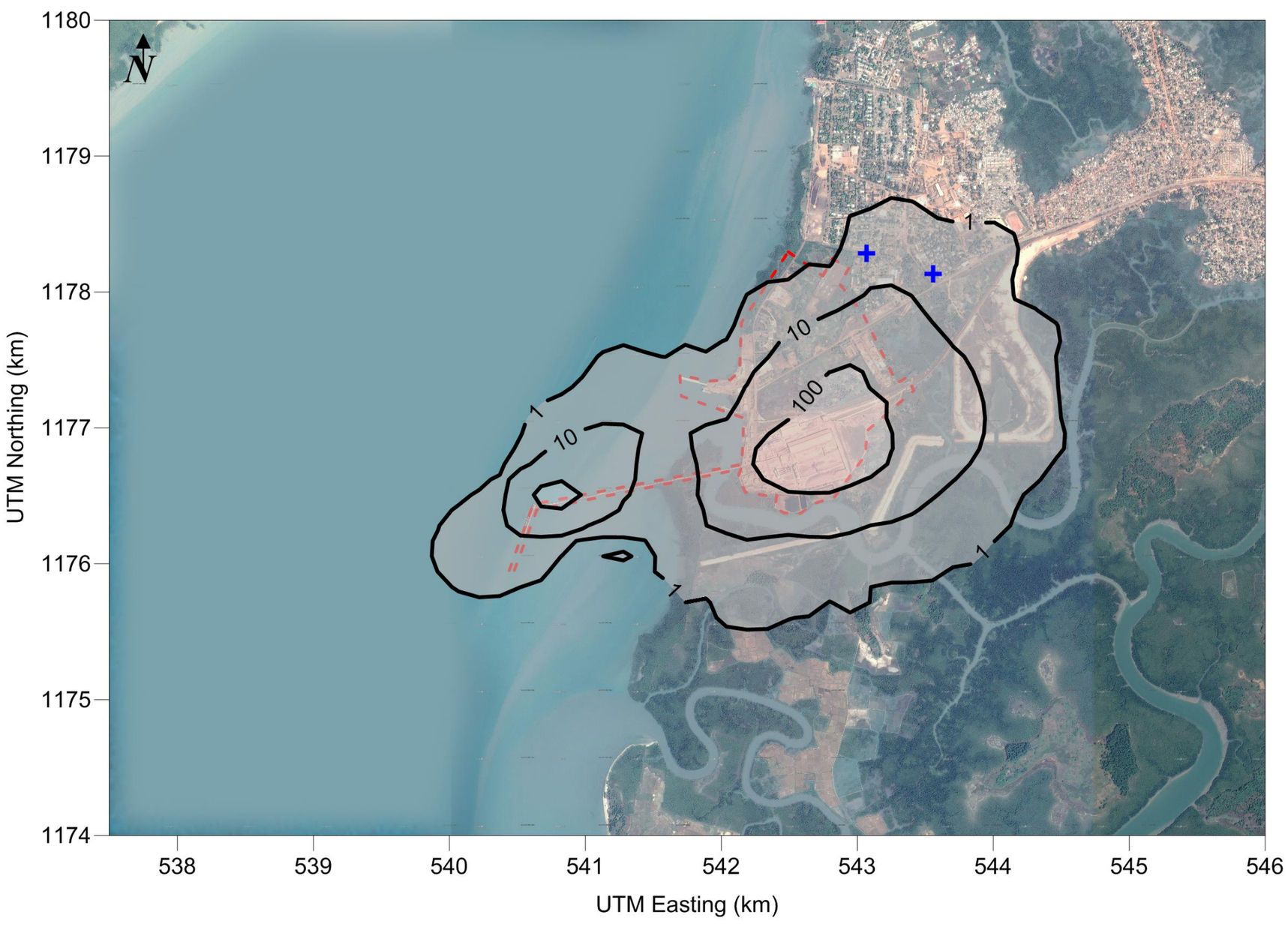
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

18.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 10 µm (PM_{10})

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

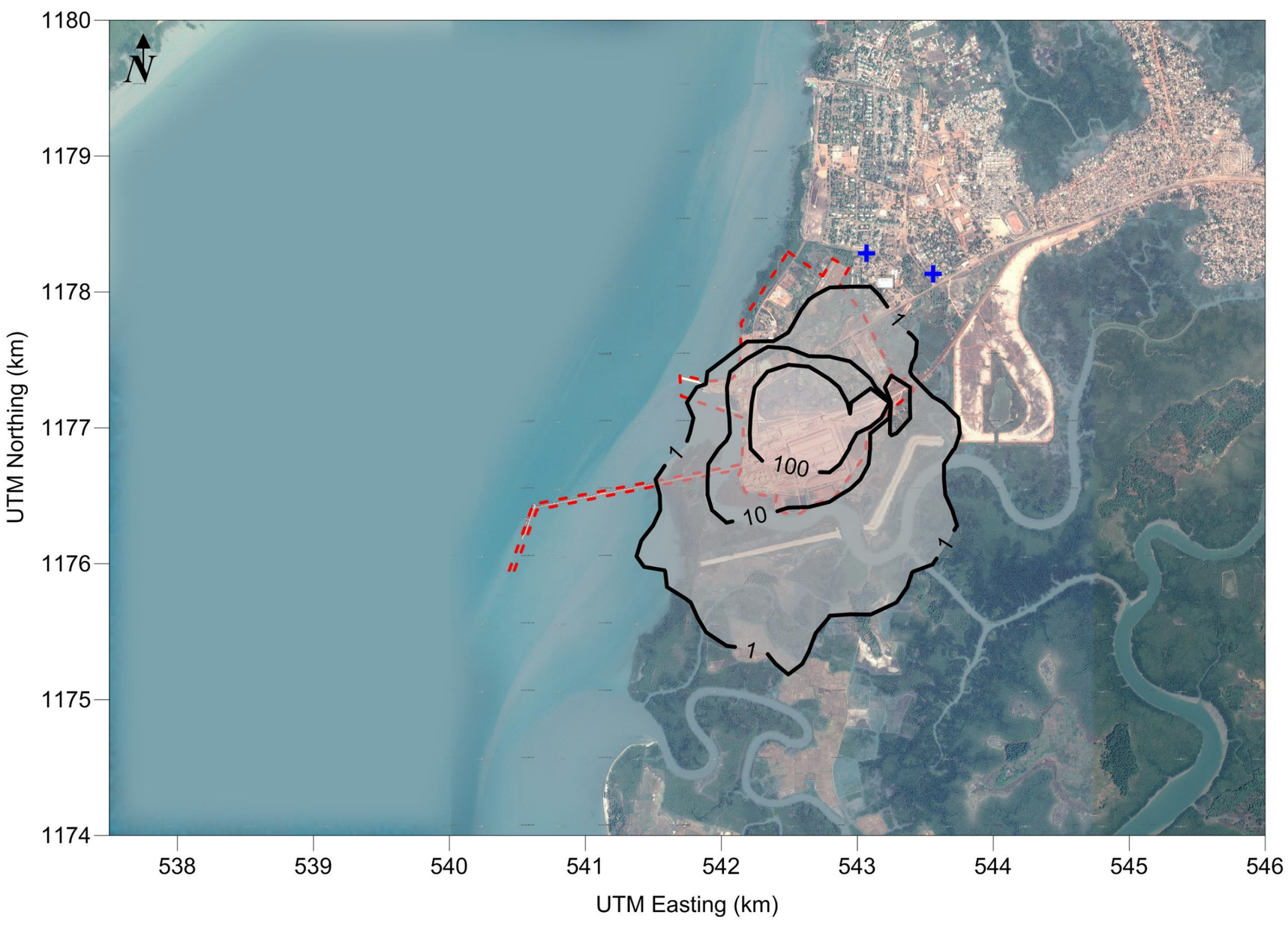
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

18.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 2.5 µm ($PM_{2.5}$)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

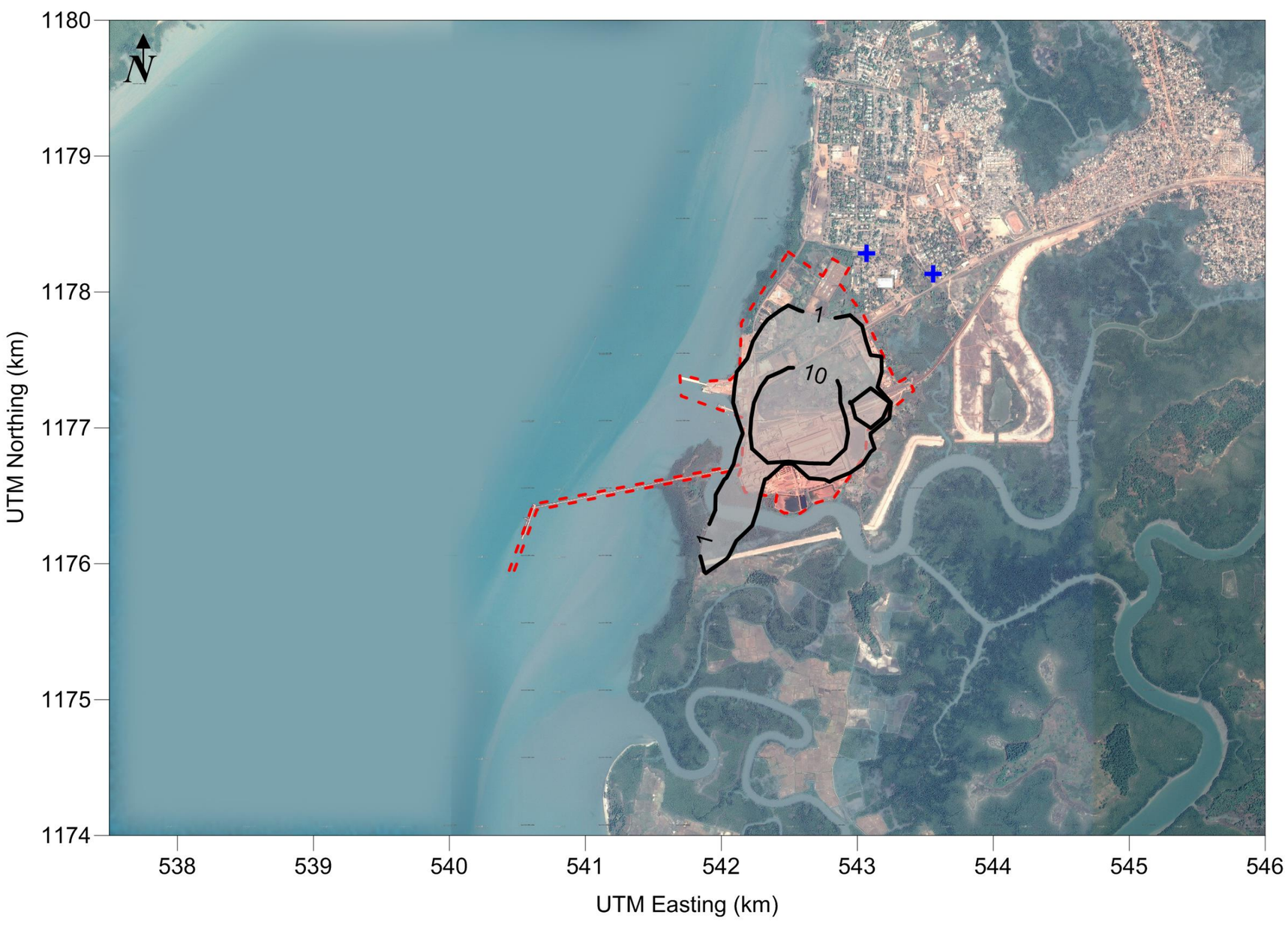
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

18.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 10-minute Guideline for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

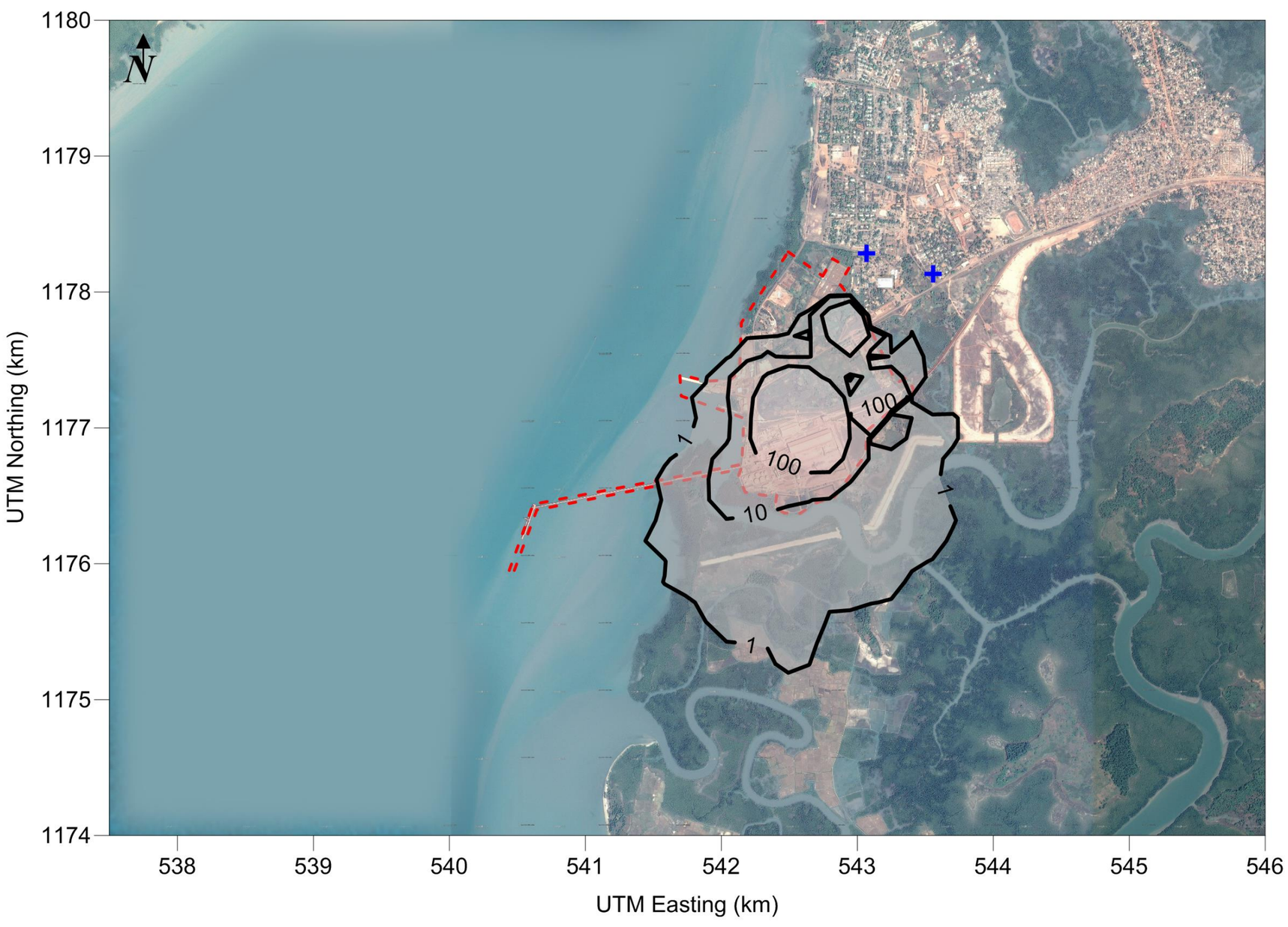
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

18.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

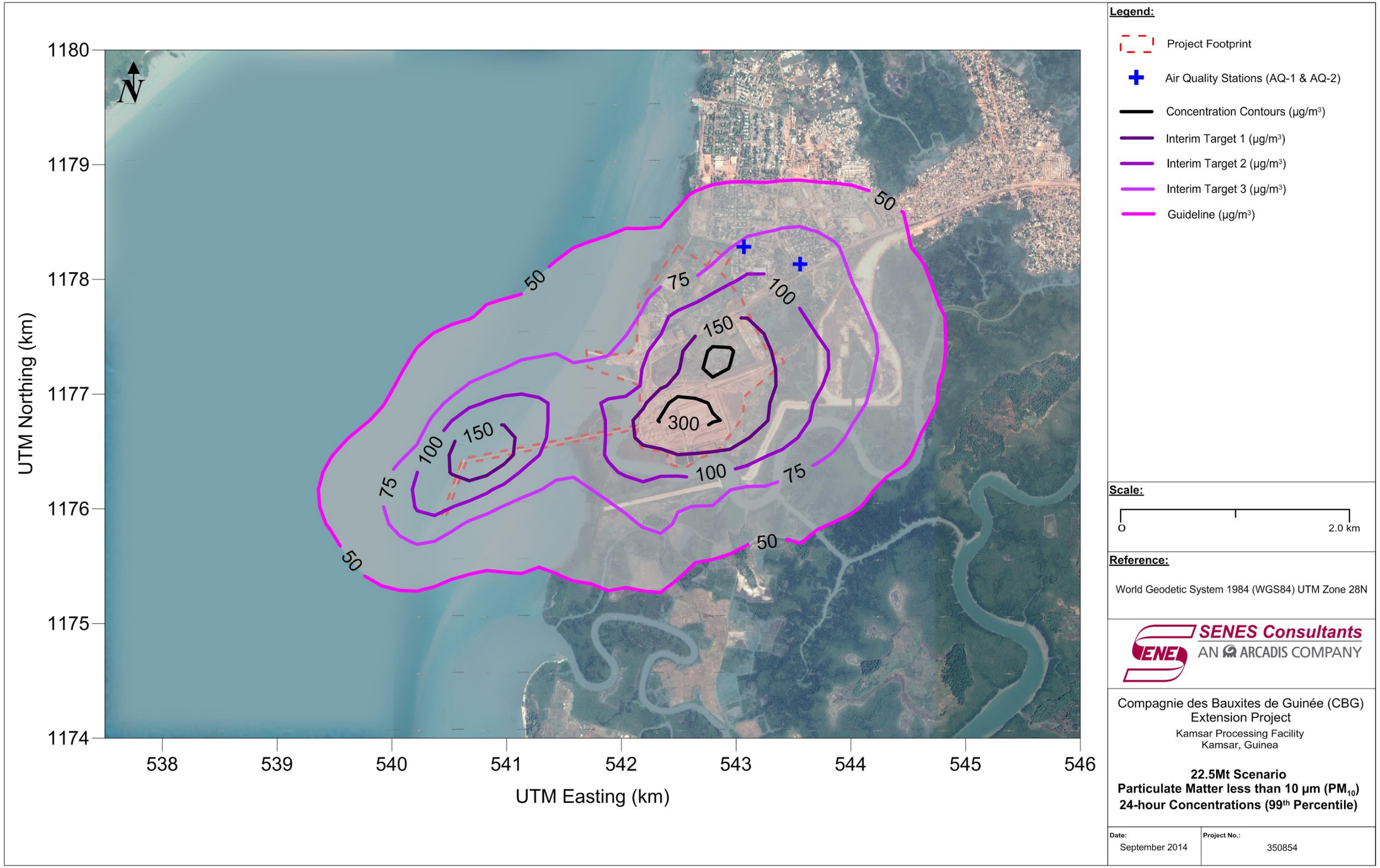
Kamsar Processing Facility
Kamsar, Guinea

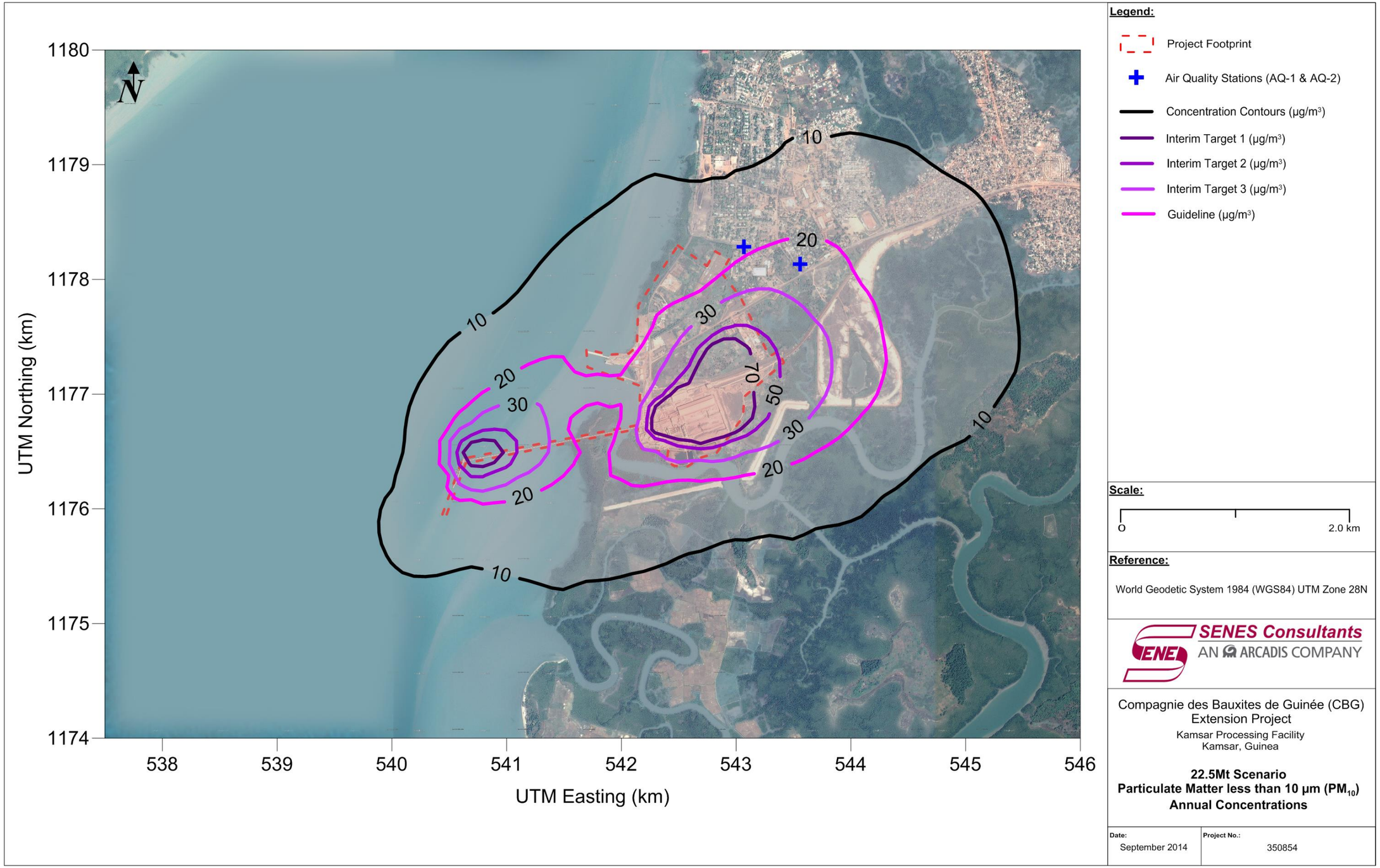
18.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 1-hour Guideline for Nitrogen Dioxide (NO_2)

Date:	Project No.:
September 2014	350854

Kamsar

22.5 MTPY


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
50
75
100
150
300
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Particulate Matter less than 10 µm (PM10)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854


N
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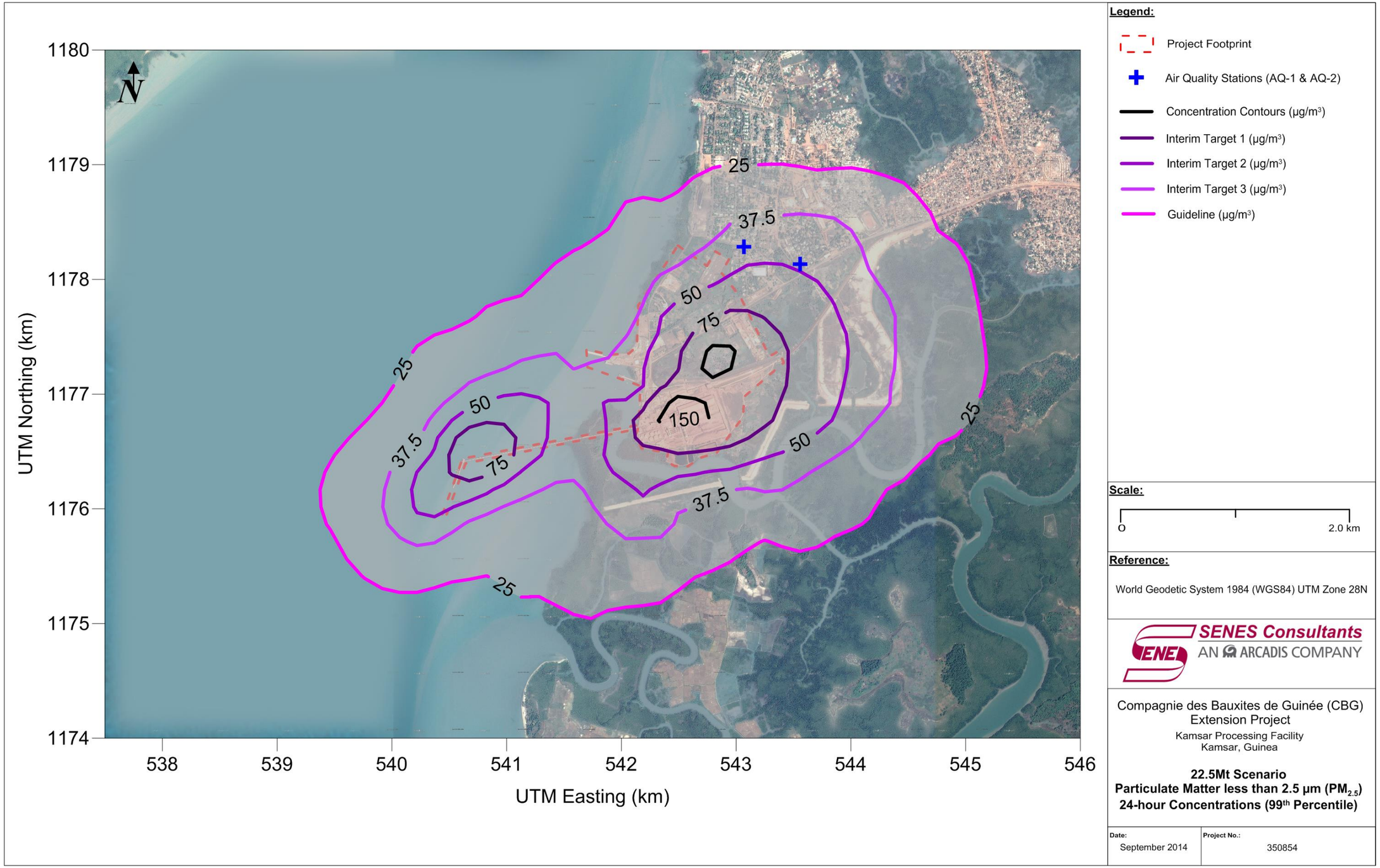
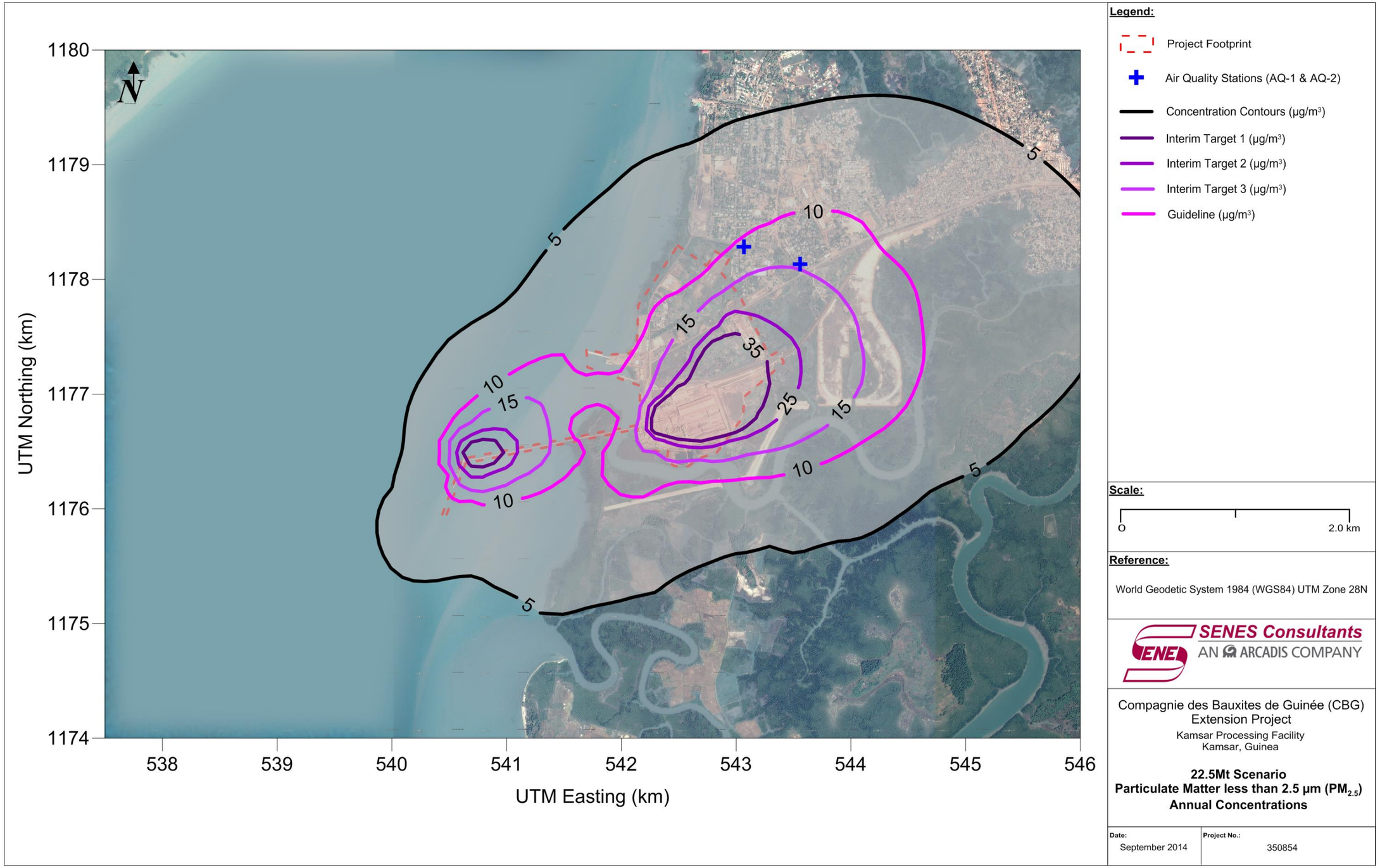
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
10
20
30
50
70
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Particulate Matter less than 10 µm (PM10)
Annual Concentrations
Date:
September 2014
Project No.:
350854


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
25
37.5
50
75
150
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Particulate Matter less than 2.5 µm (PM2.5)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854


N
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1179
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1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
5
10
15
25
35
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
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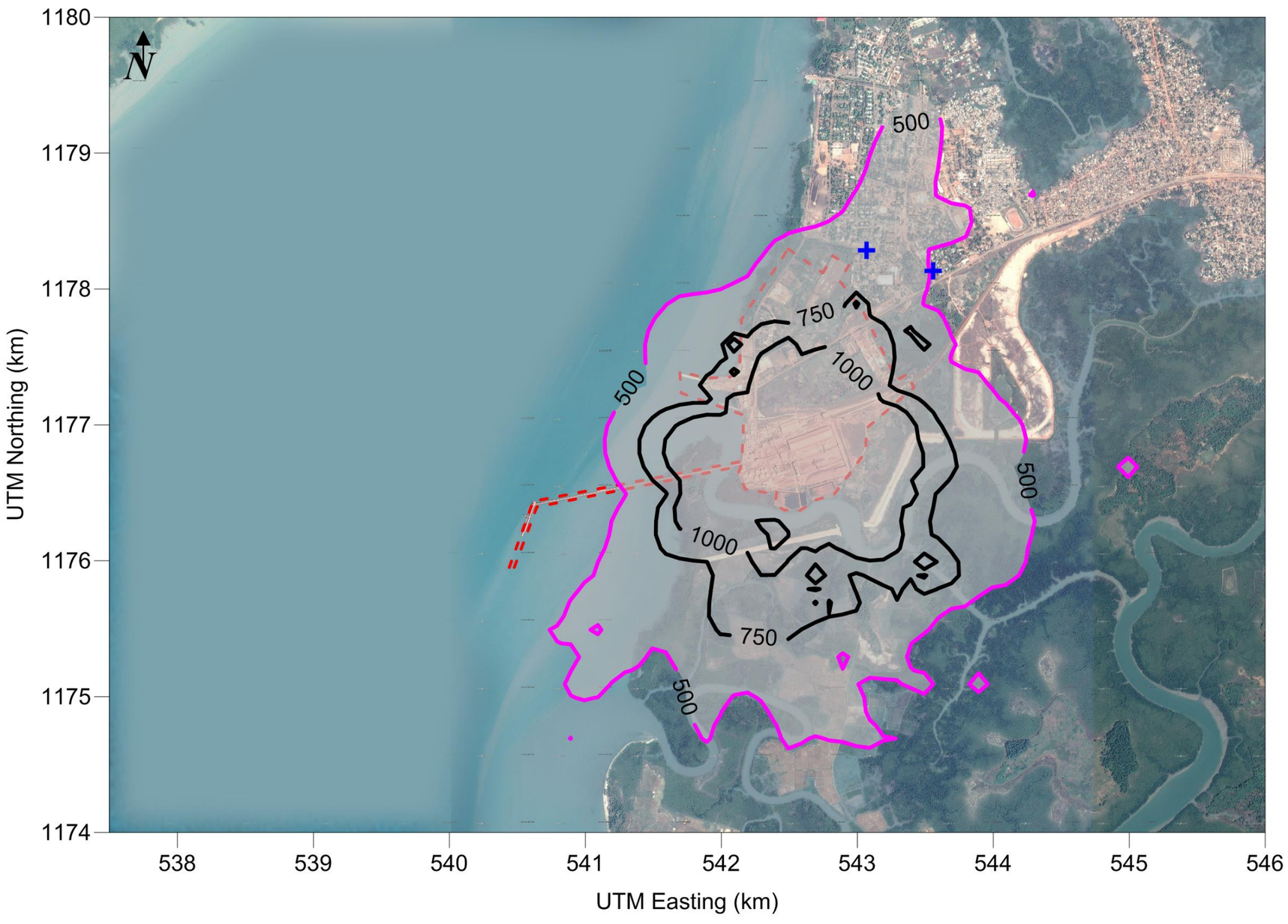
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Particulate Matter less than 2.5 µm (PM2.5)
Annual Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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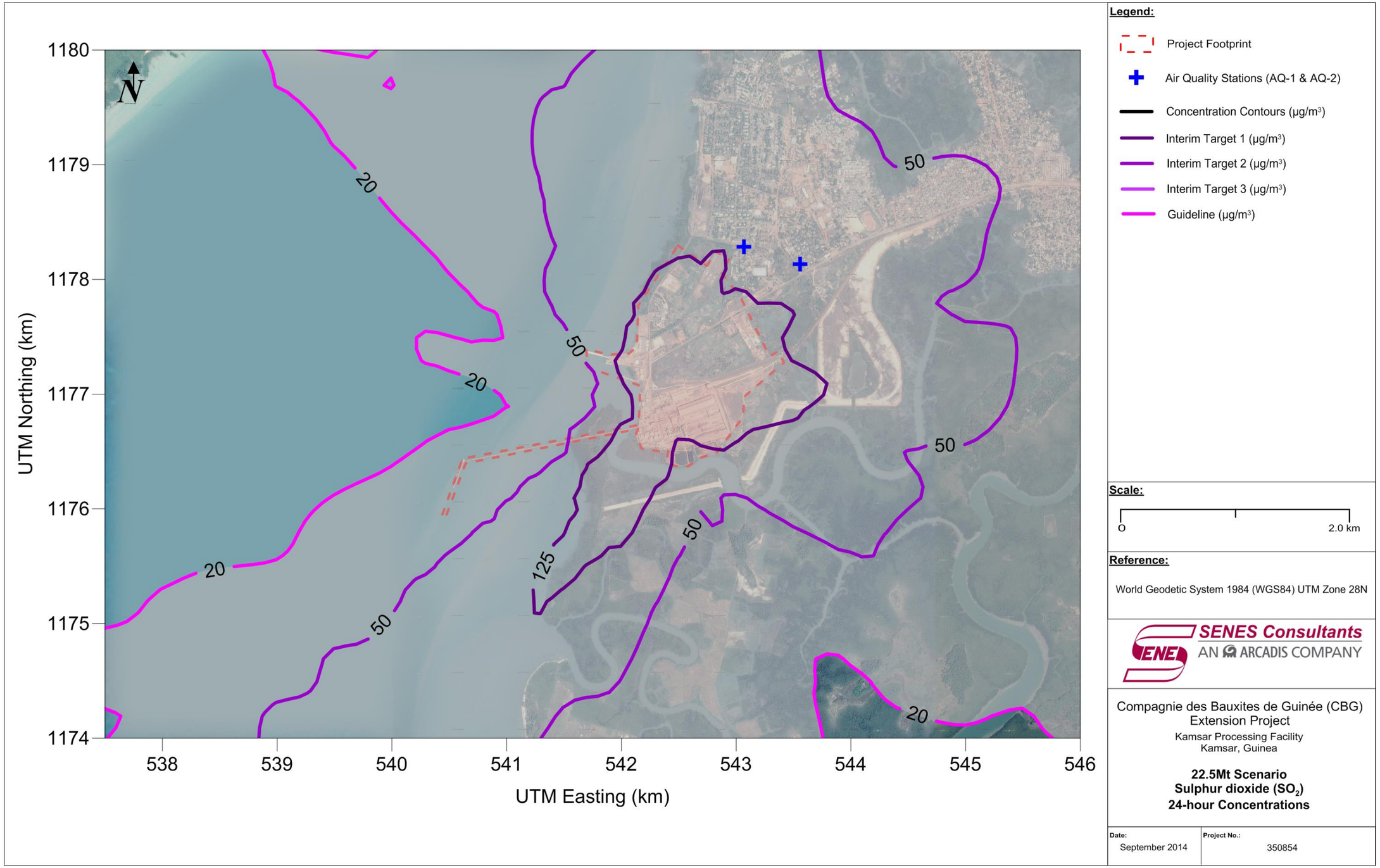
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

22.5Mt Scenario
Sulphur dioxide (SO_2)
10-min Concentrations

Date:	Project No.:
September 2014	350854


1180
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UTM Northing (km)
538
539
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541
542
543
544
545
546
UTM Easting (km)
N
20
50
125
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
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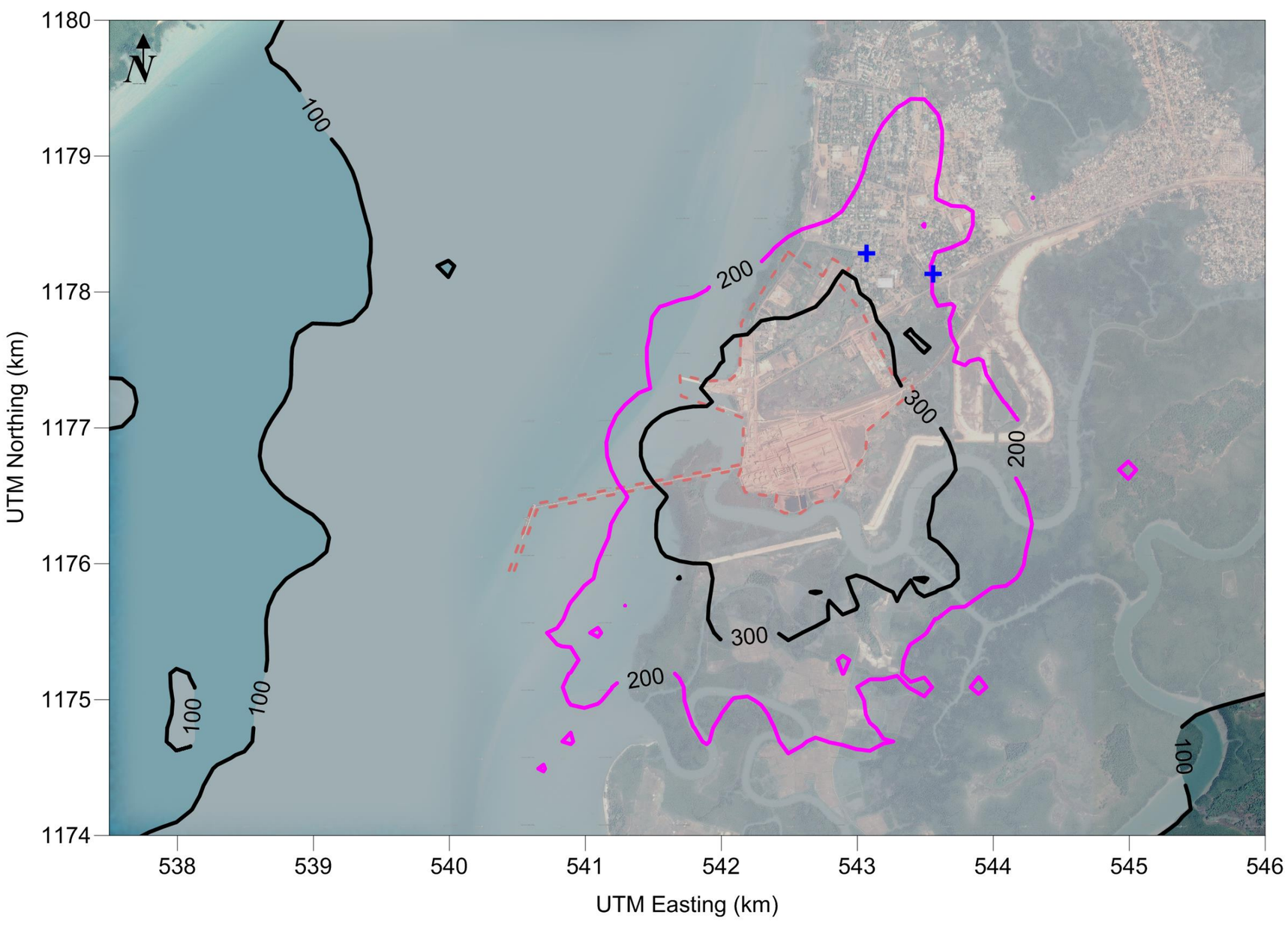
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Sulphur dioxide (SO2)
24-hour Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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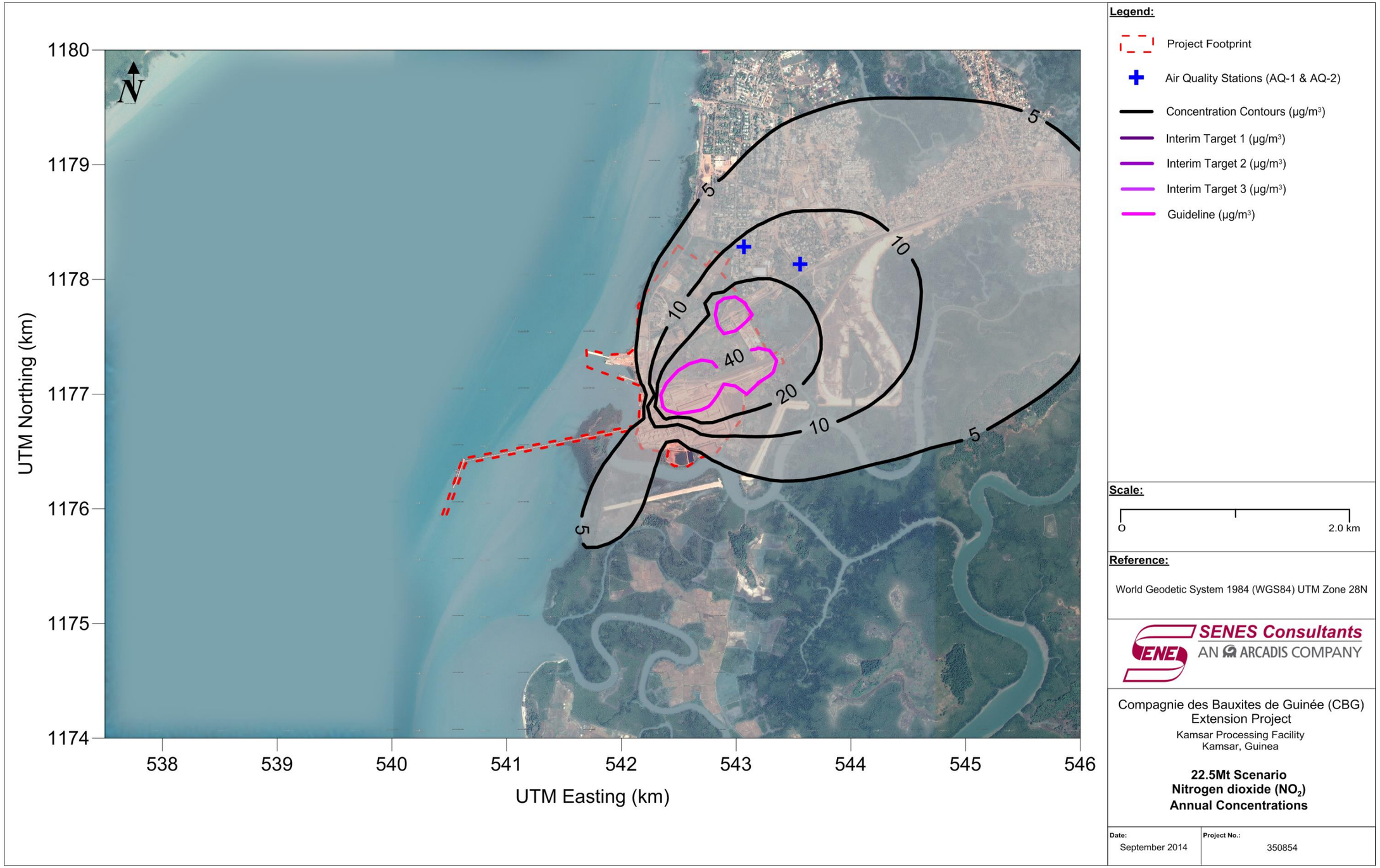
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

22.5Mt Scenario
Nitrogen dioxide (NO_2)
1-hour Concentrations

Date:	Project No.:
September 2014	350854


1180
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UTM Northing (km)
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541
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544
545
546
UTM Easting (km)
N
5
10
20
40
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
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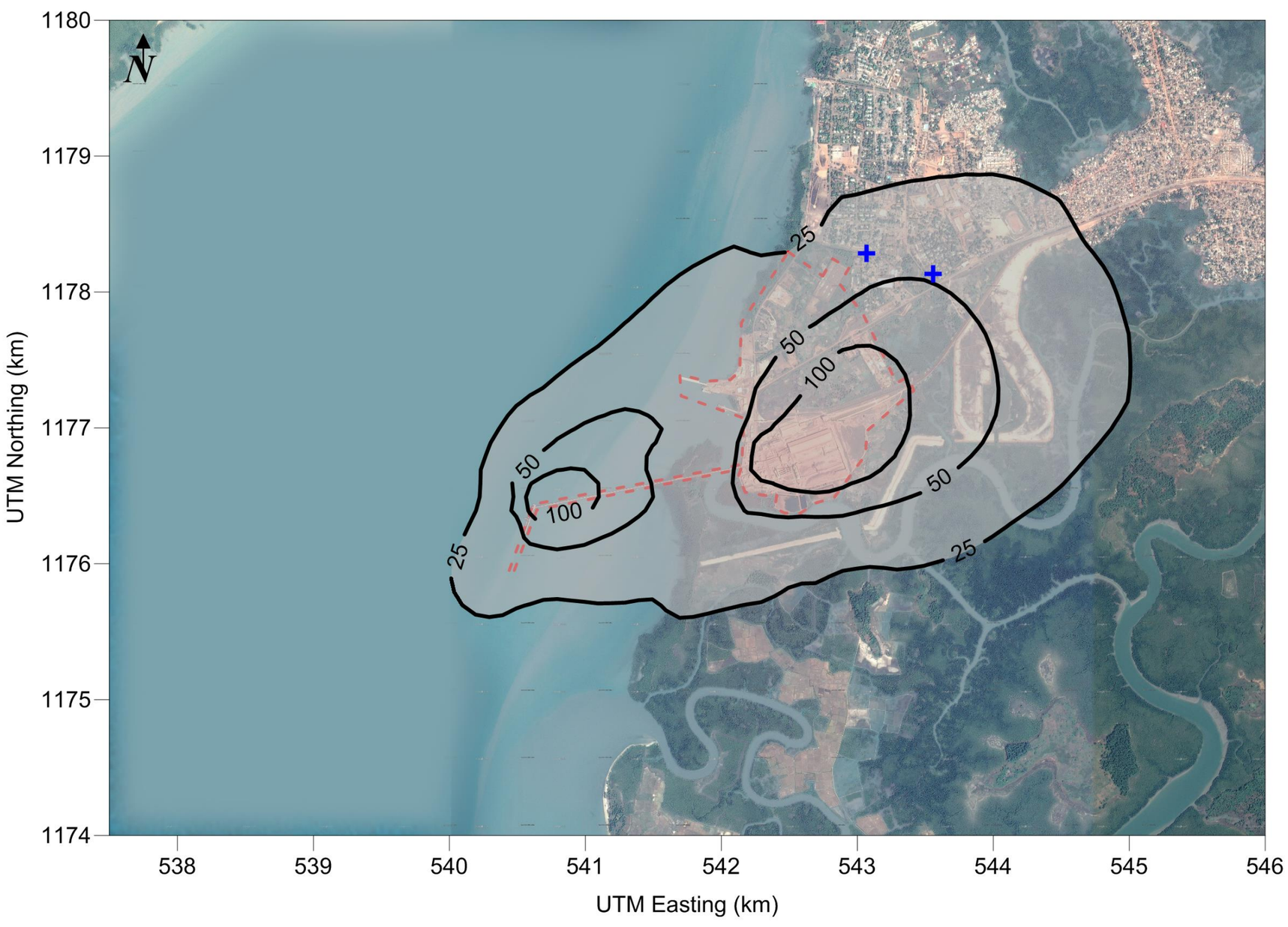
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Nitrogen dioxide (NO_2)
Annual Concentrations
Date:
September 2014
Project No.:
350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Concentration Contours (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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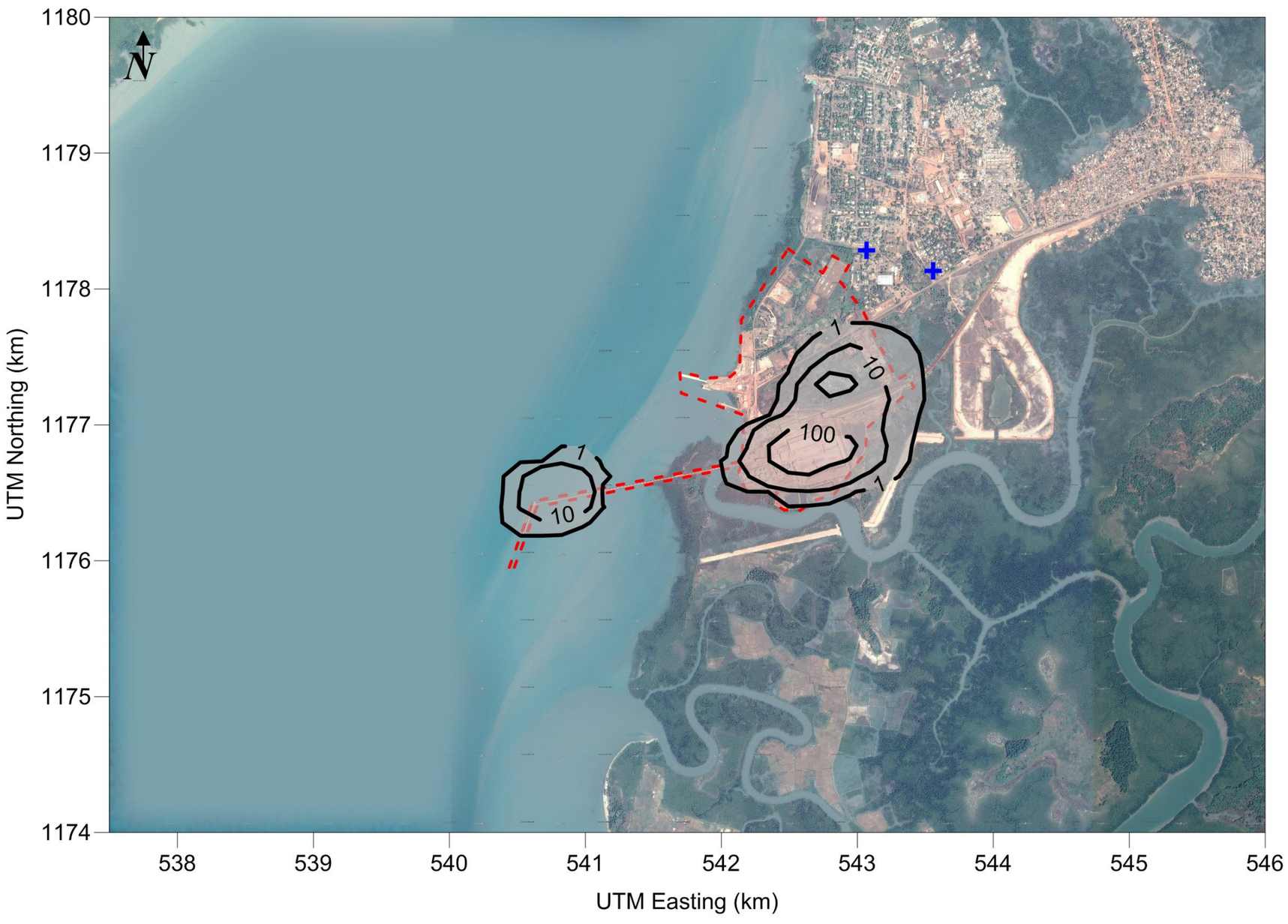
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

22.5Mt Scenario
Total Suspended Particulate (TSP)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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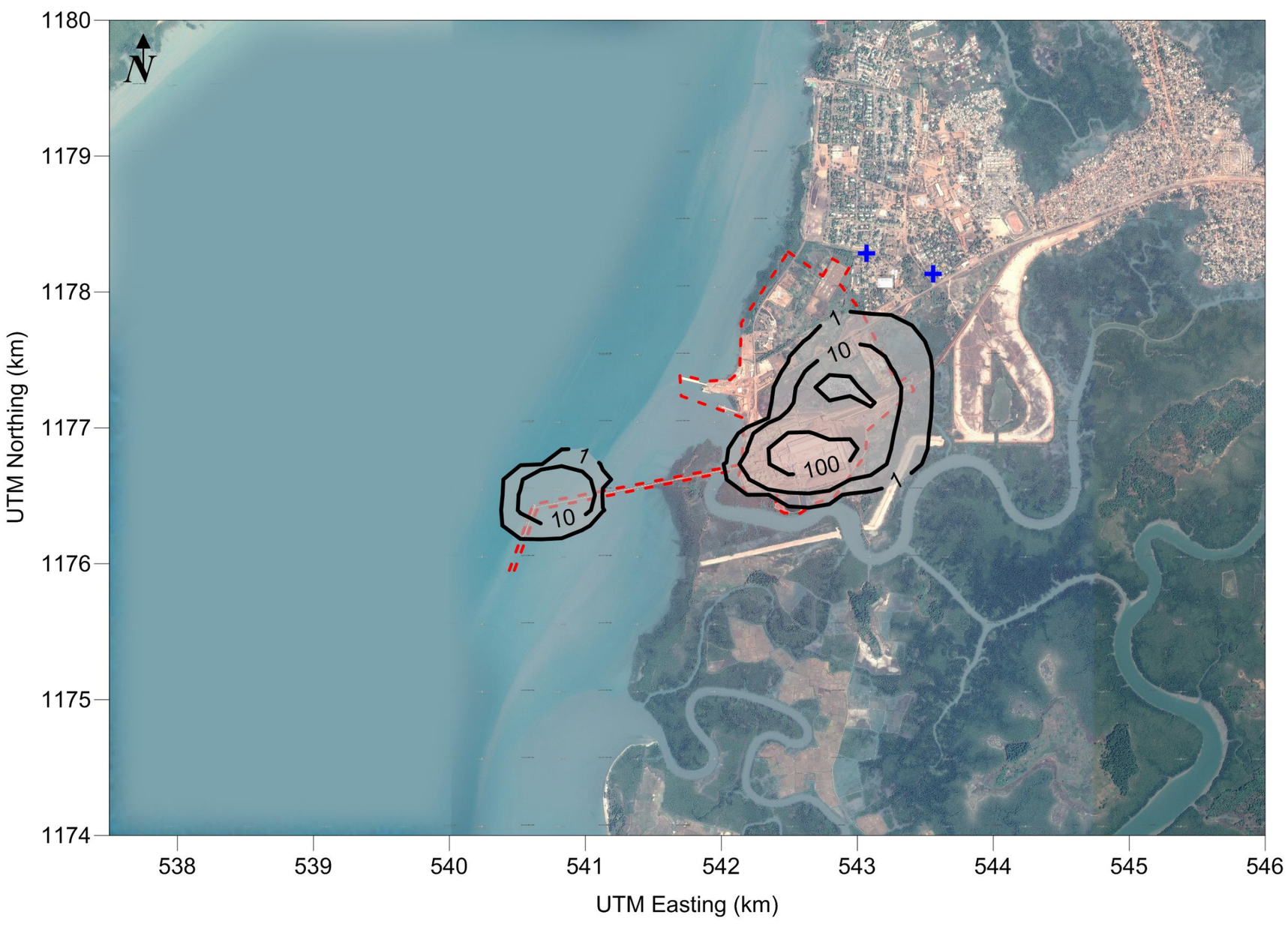
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

22.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 10 µm (PM_{10})

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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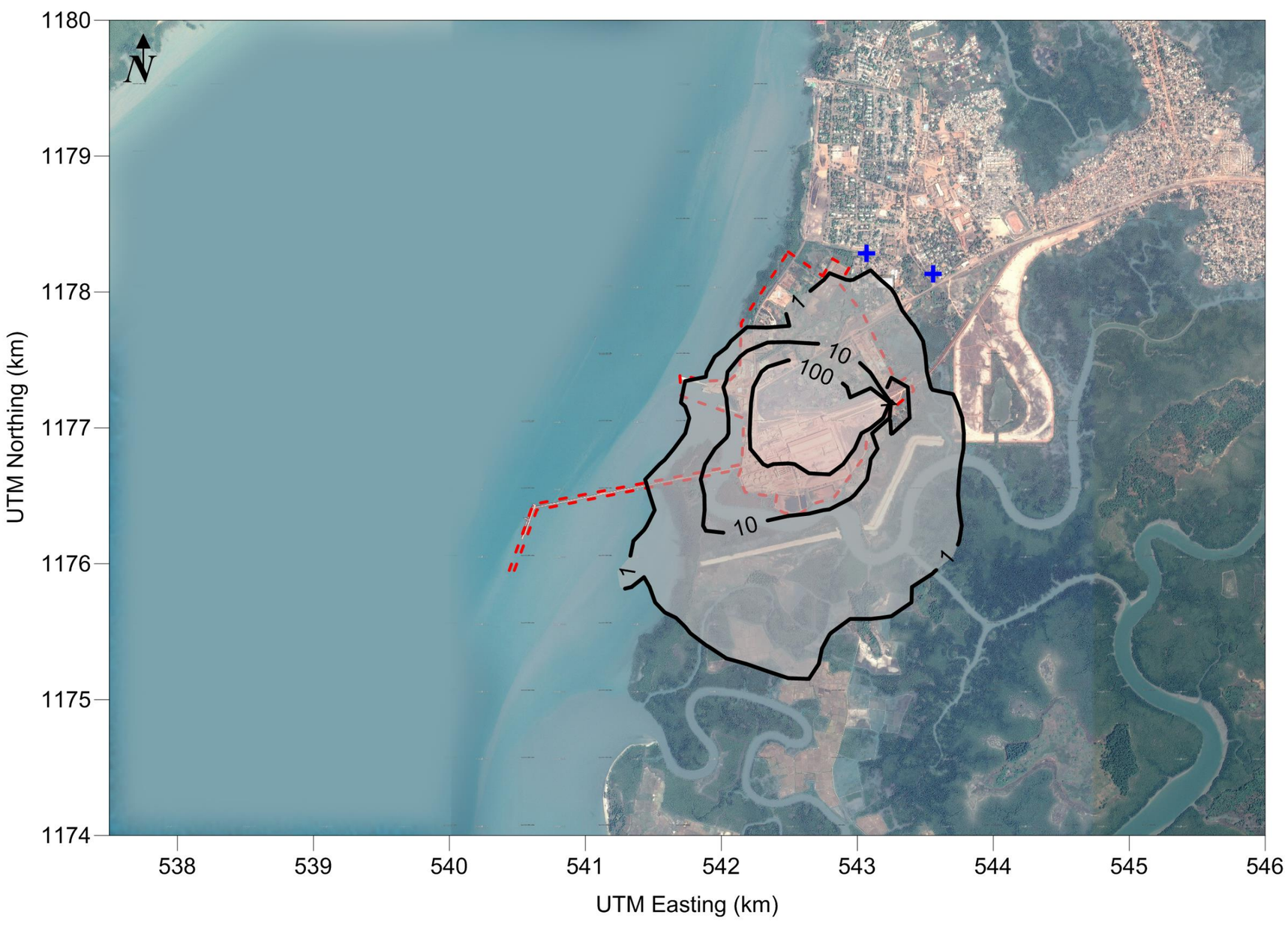
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

22.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 2.5 µm ($PM_{2.5}$)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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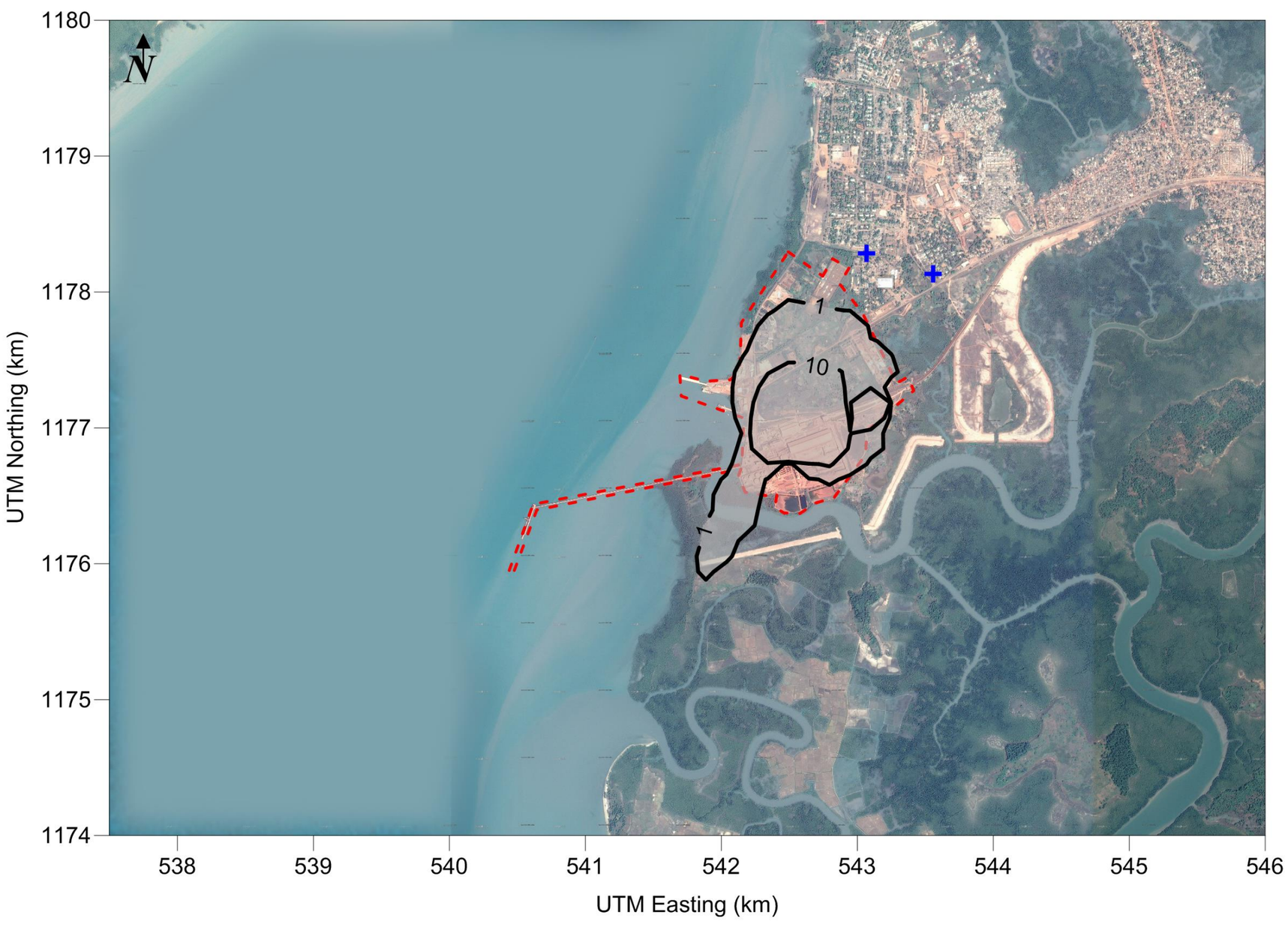
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

22.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 10-minute Guideline for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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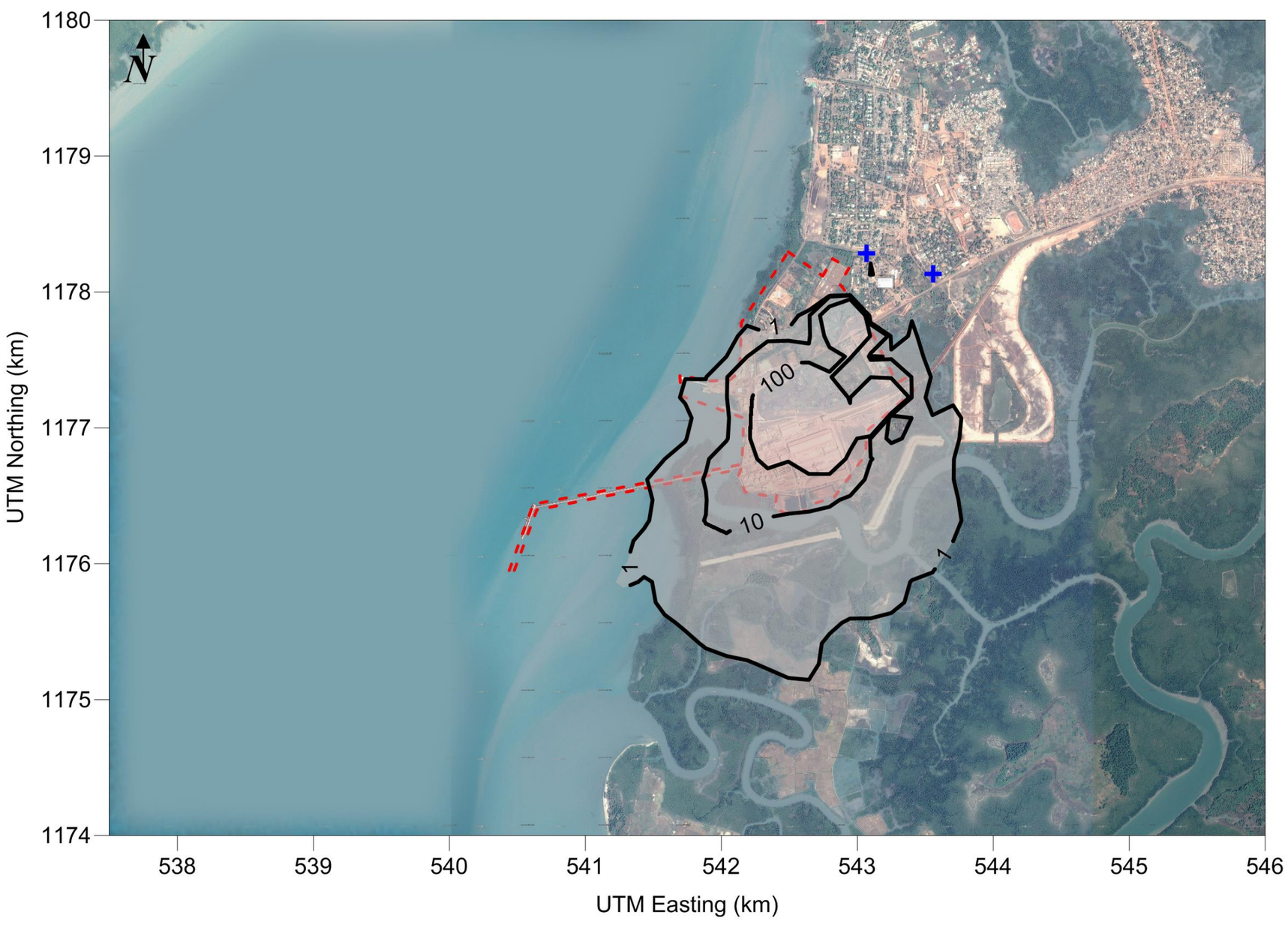
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

22.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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Compagnie des Bauxites de Guinée (CBG)
Extension Project

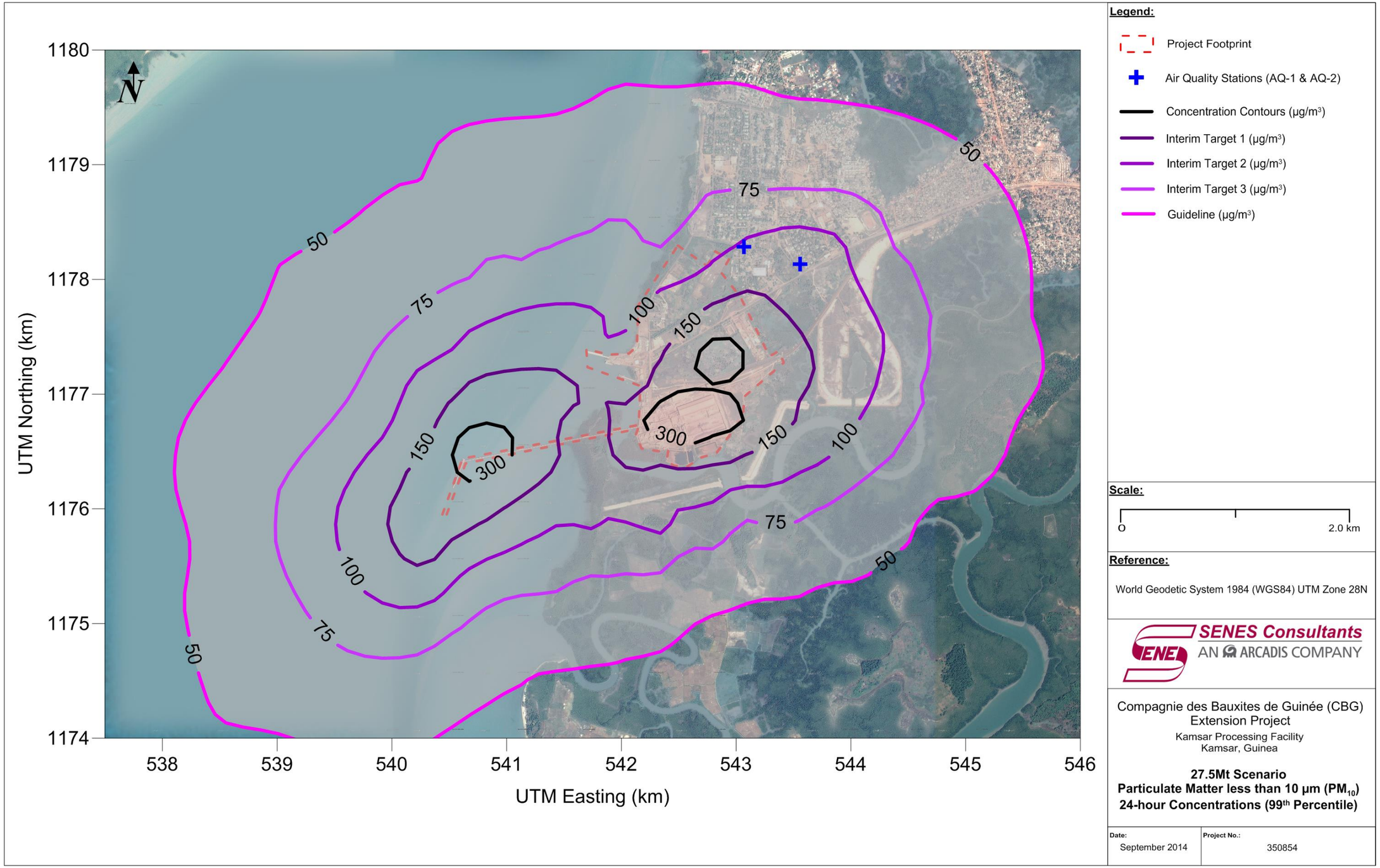
Kamsar Processing Facility
Kamsar, Guinea

22.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 1-hour Guideline for Nitrogen Dioxide (NO_2)

Date:	Project No.:
September 2014	350854

Kamsar

27.5 MTPY


1180
1179
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UTM Northing (km)
538
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541
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546
UTM Easting (km)
N
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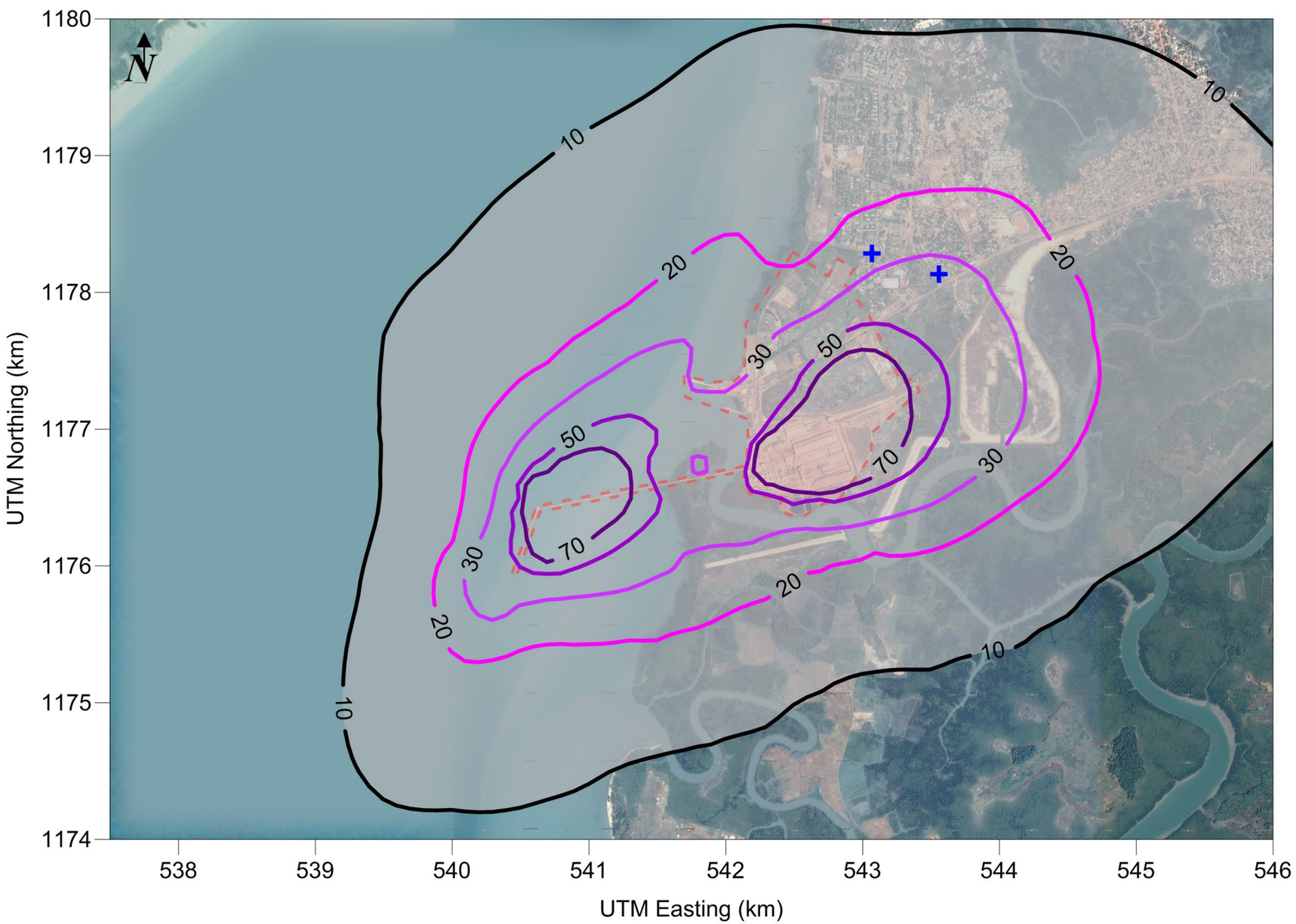
75
100
150
300
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
27.5Mt Scenario
Particulate Matter less than 10 µm (PM10)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

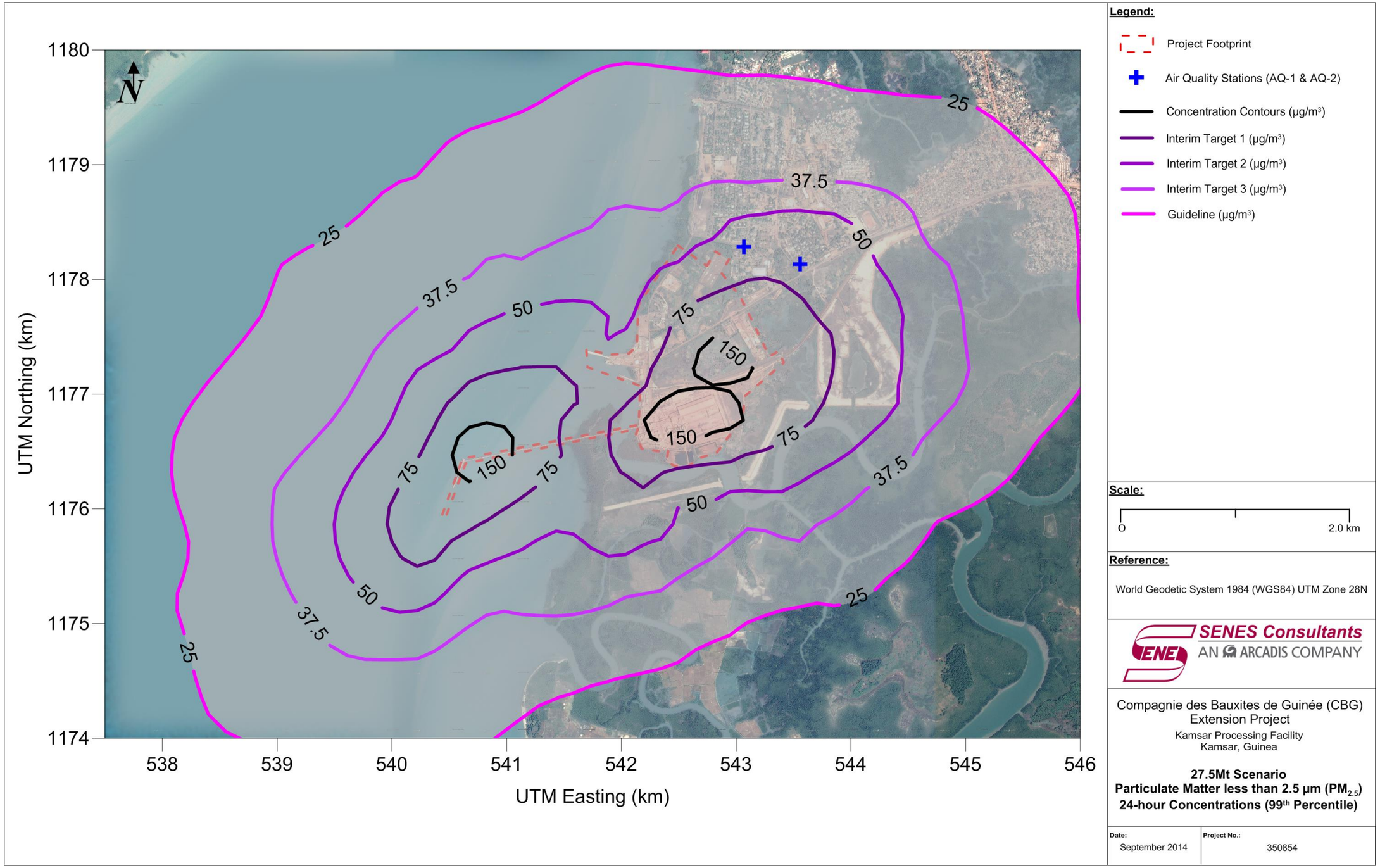
World Geodetic System 1984 (WGS84) UTM Zone 28N

SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

27.5Mt Scenario
Particulate Matter less than 10 µm (PM_{10})
Annual Concentrations

Date:	Project No.:
September 2014	350854


N
1180
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1177
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1174
UTM Northing (km)
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541
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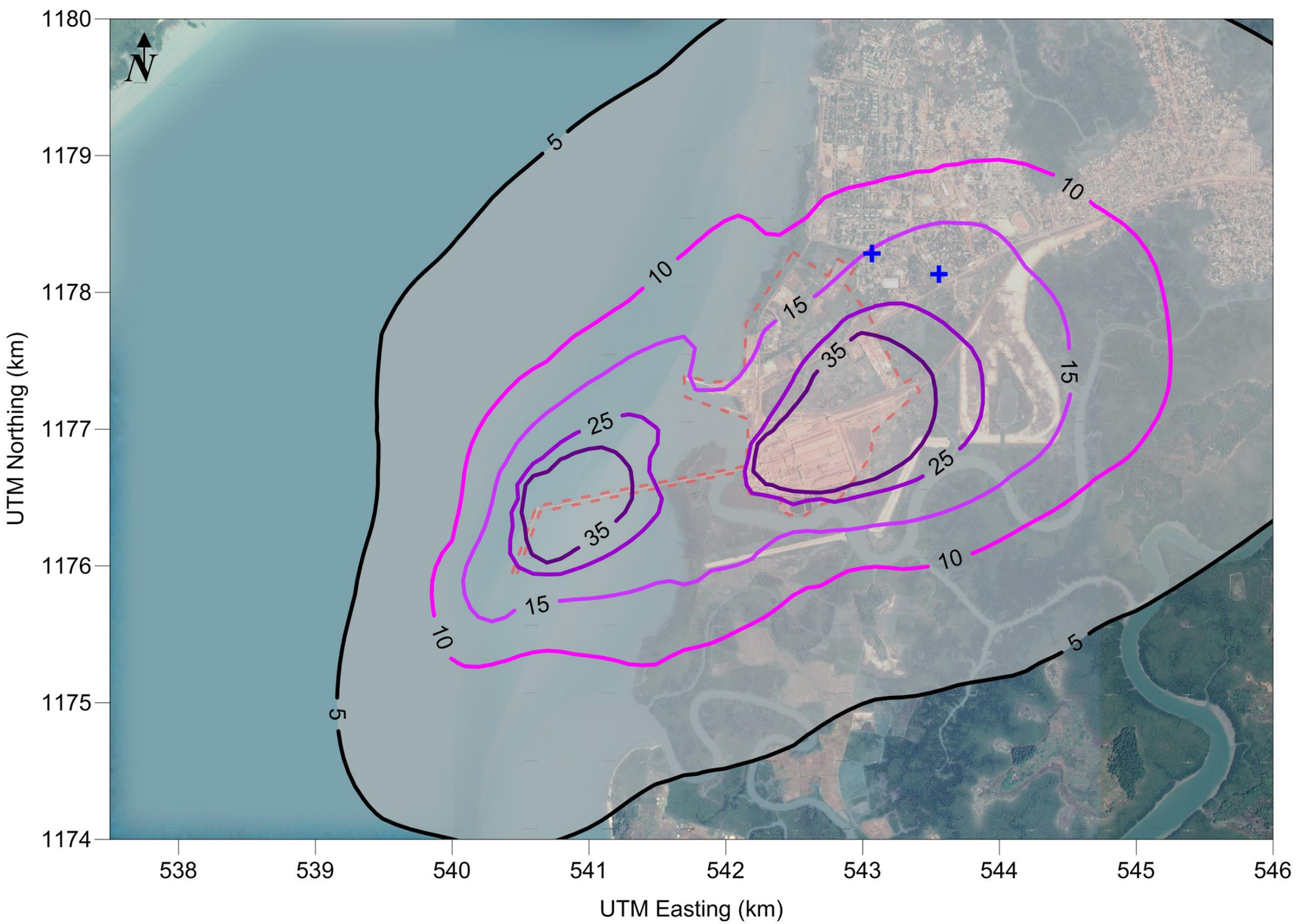
545
546
UTM Easting (km)
25
37.5
50
75
150
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
27.5Mt Scenario
Particulate Matter less than 2.5 µm (PM2.5)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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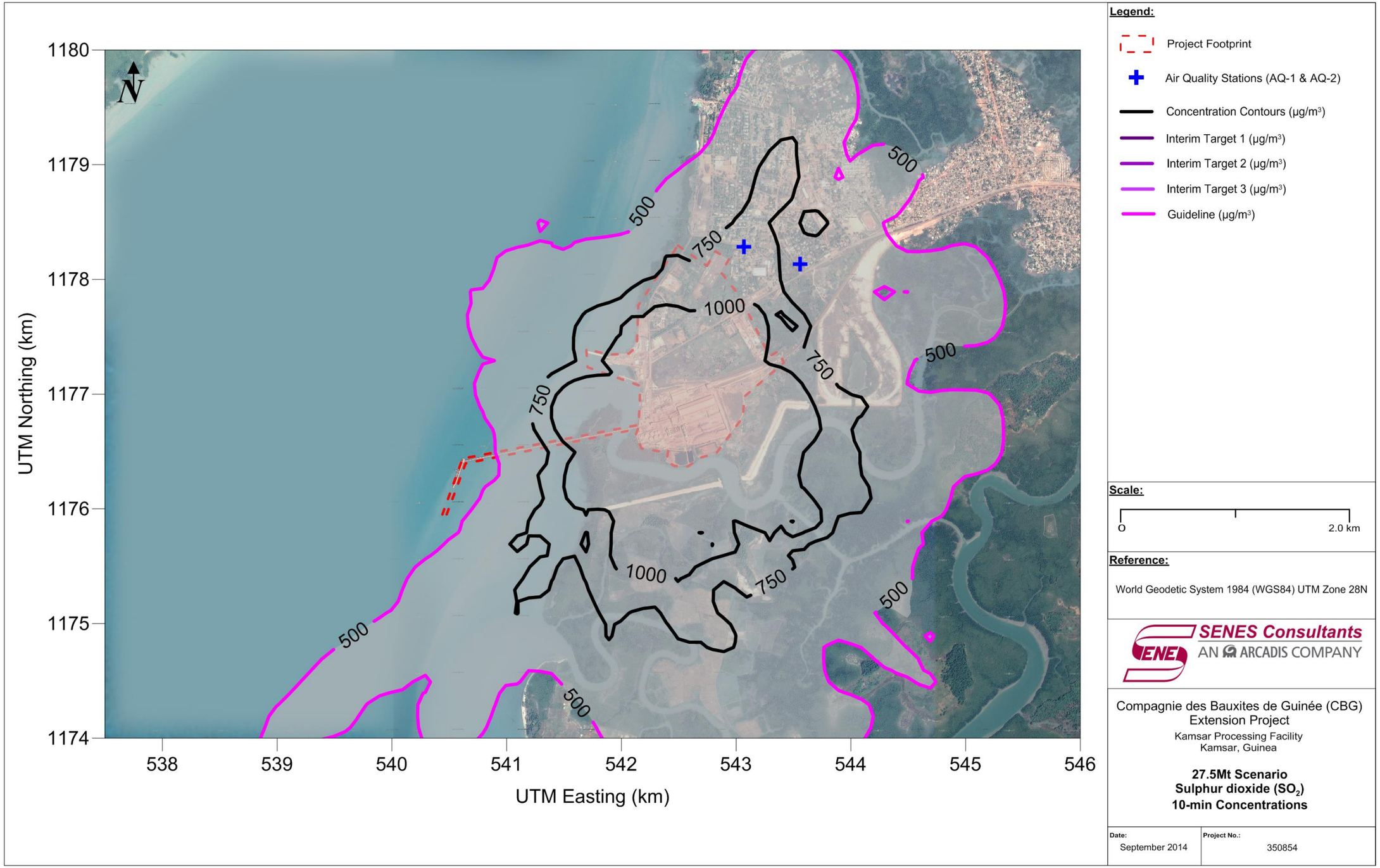
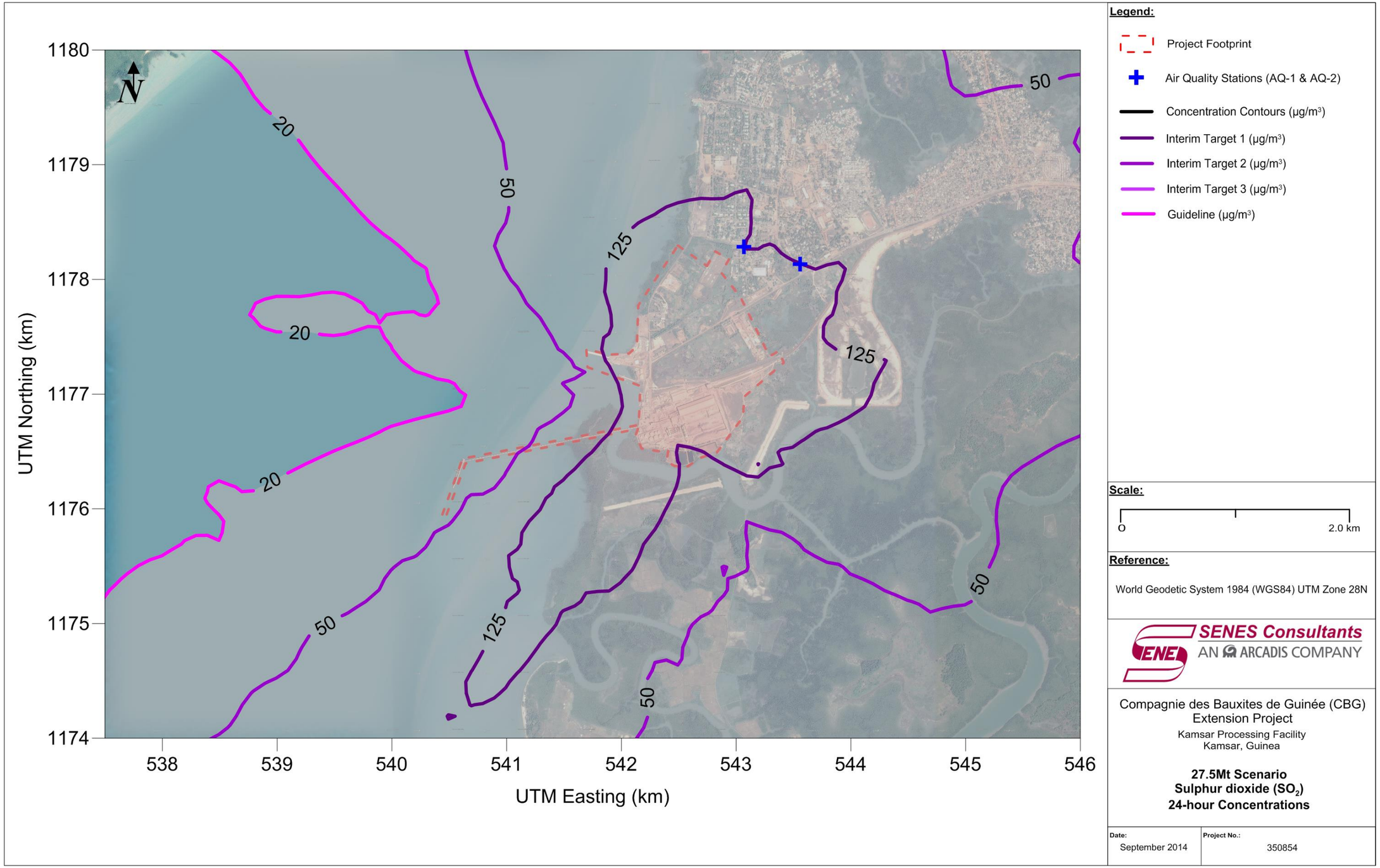
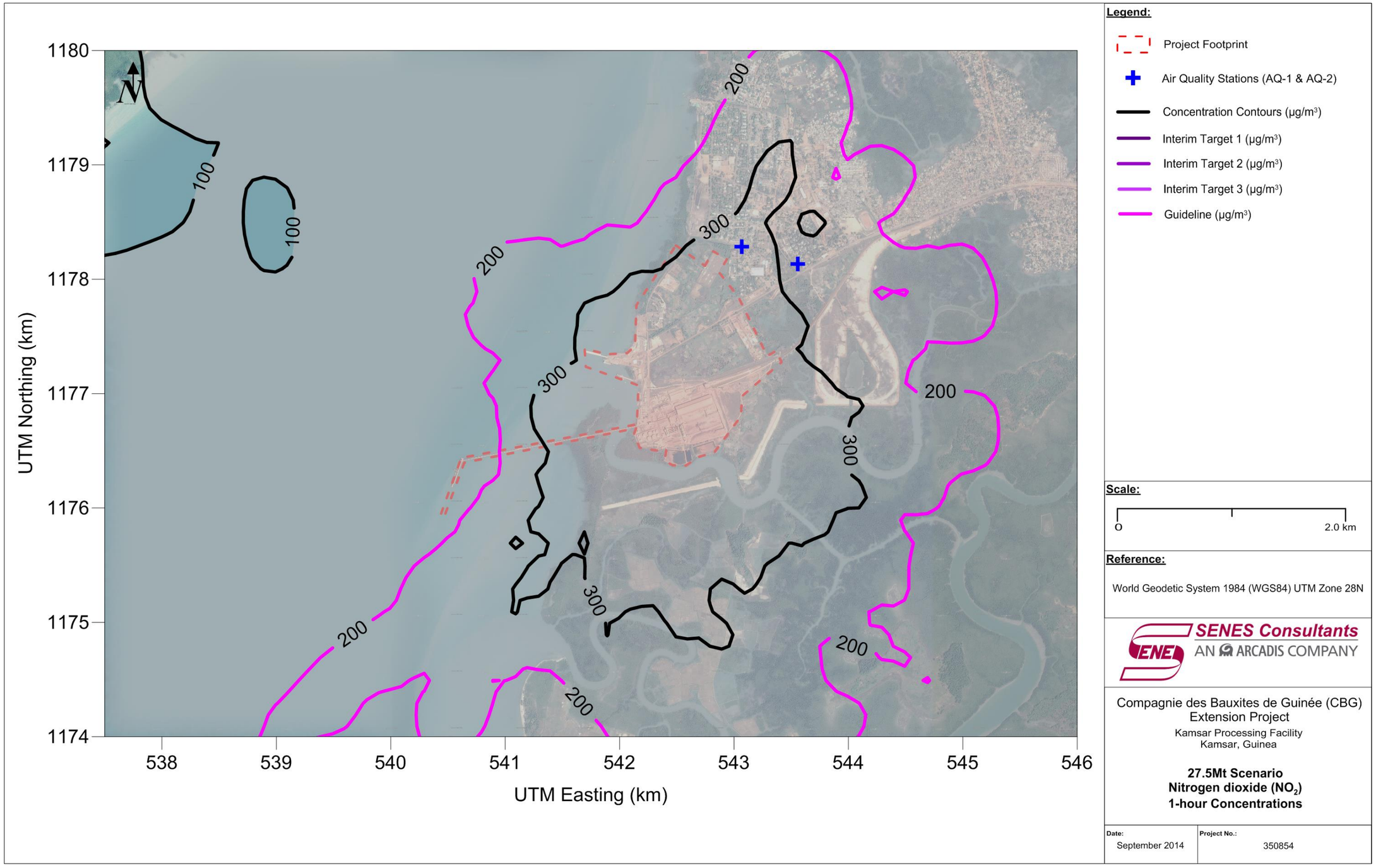
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

27.5Mt Scenario
Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Annual Concentrations

Date:	Project No.:
September 2014	350854


1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
N
500
750
1000
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
27.5Mt Scenario
Sulphur dioxide (SO2)
10-min Concentrations
Date:
September 2014
Project No.:
350854


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
20
50
125
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
27.5Mt Scenario
Sulphur dioxide (SO2)
24-hour Concentrations
Date:
September 2014
Project No.:
350854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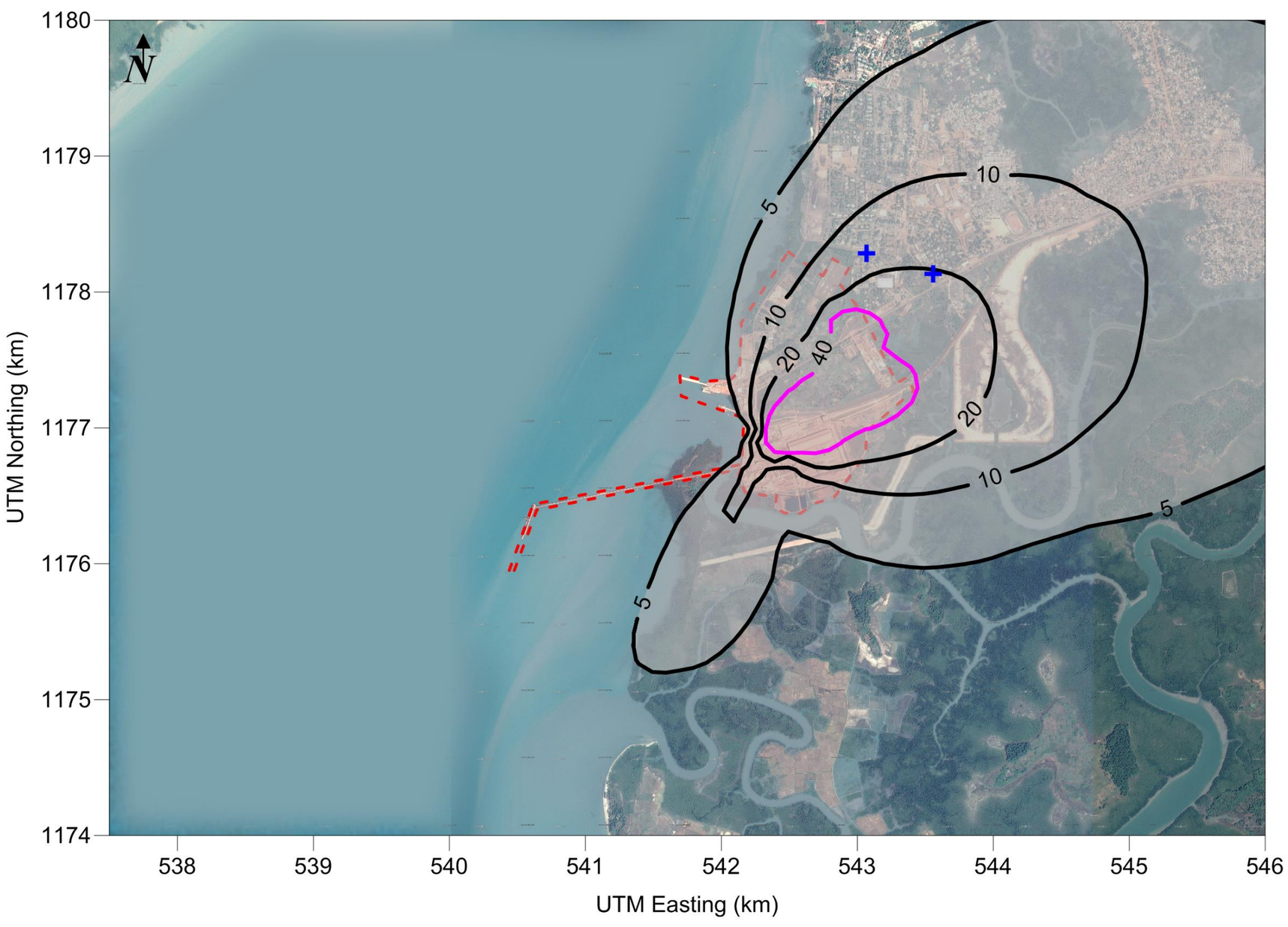
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
N
100
100
200
300
300
200
300
200
200
200
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
27.5Mt Scenario
Nitrogen dioxide (NO_2)
1-hour Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

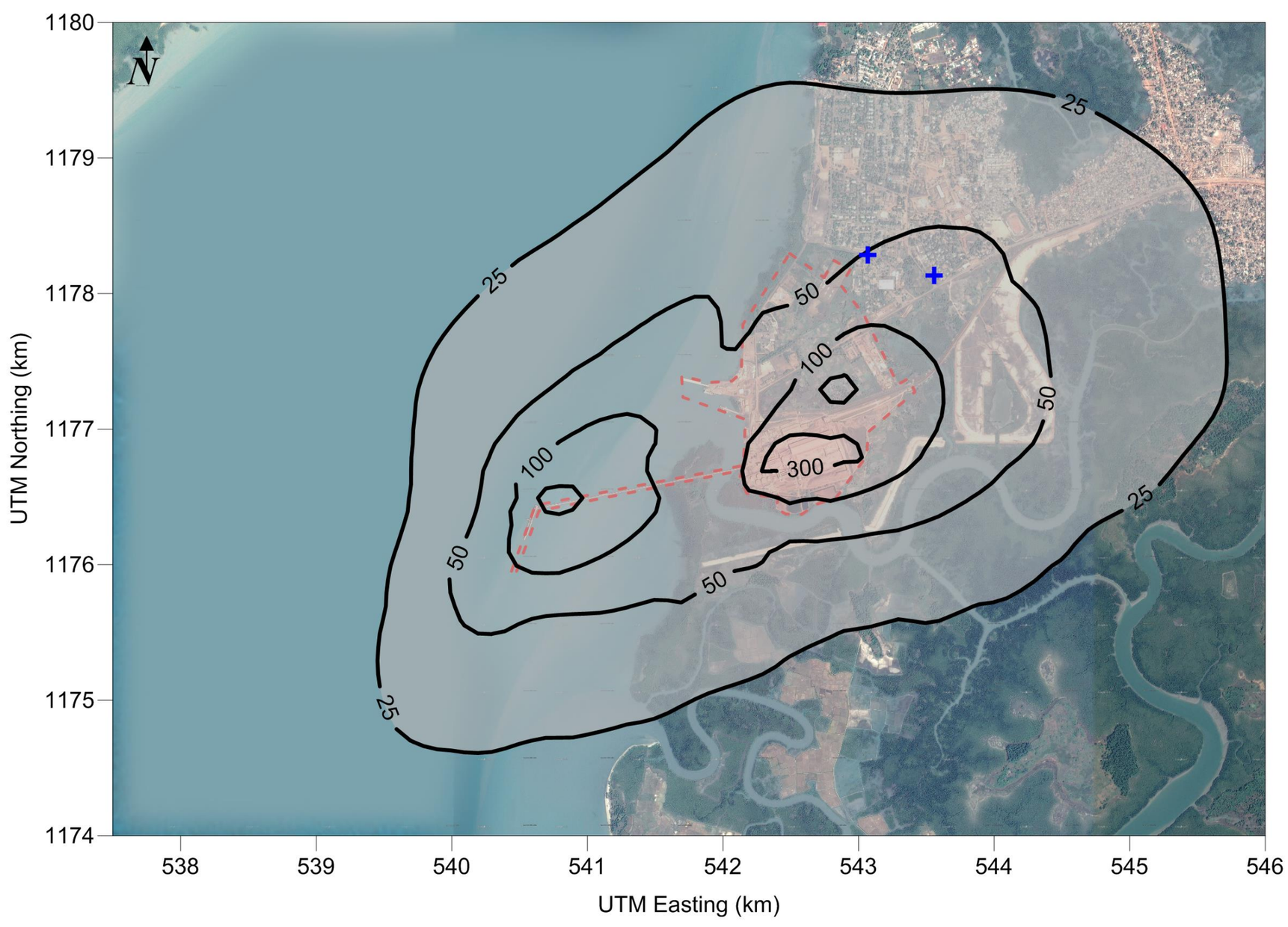
World Geodetic System 1984 (WGS84) UTM Zone 28N

SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

27.5Mt Scenario
Nitrogen dioxide (NO_2)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Concentration Contours (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

SENES Consultants
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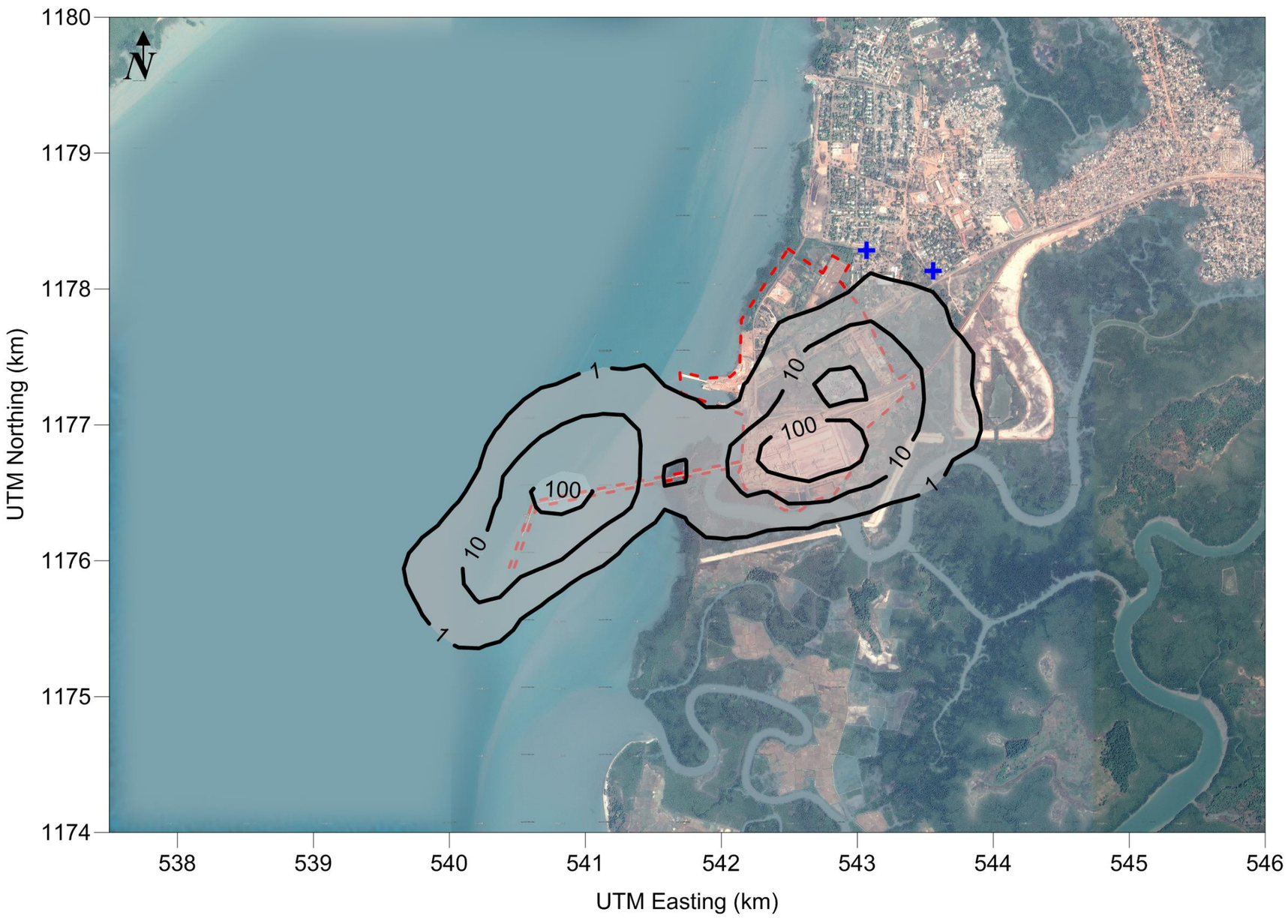
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

27.5Mt Scenario
Total Suspended Particulate (TSP)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

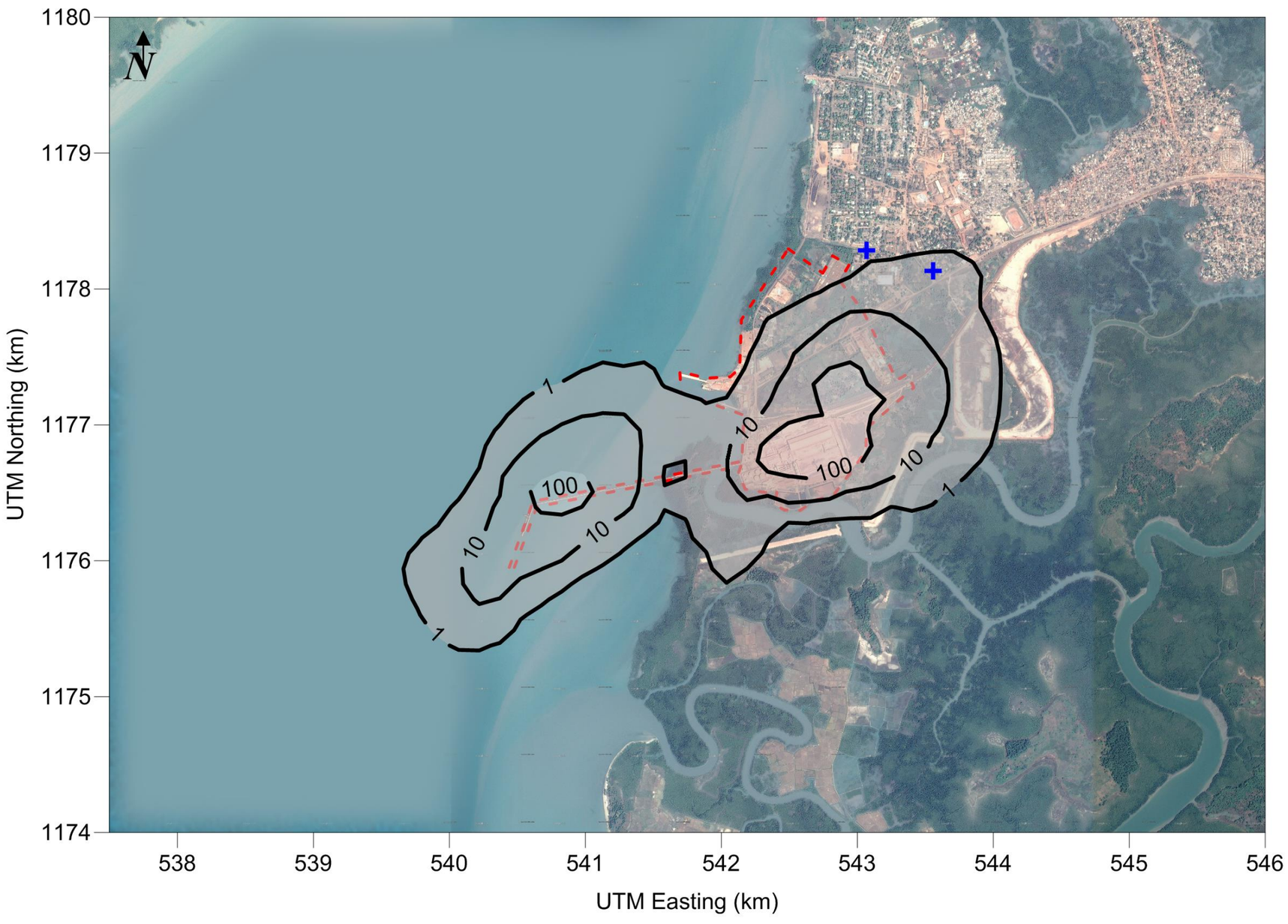
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

27.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 10 µm (PM_{10})

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

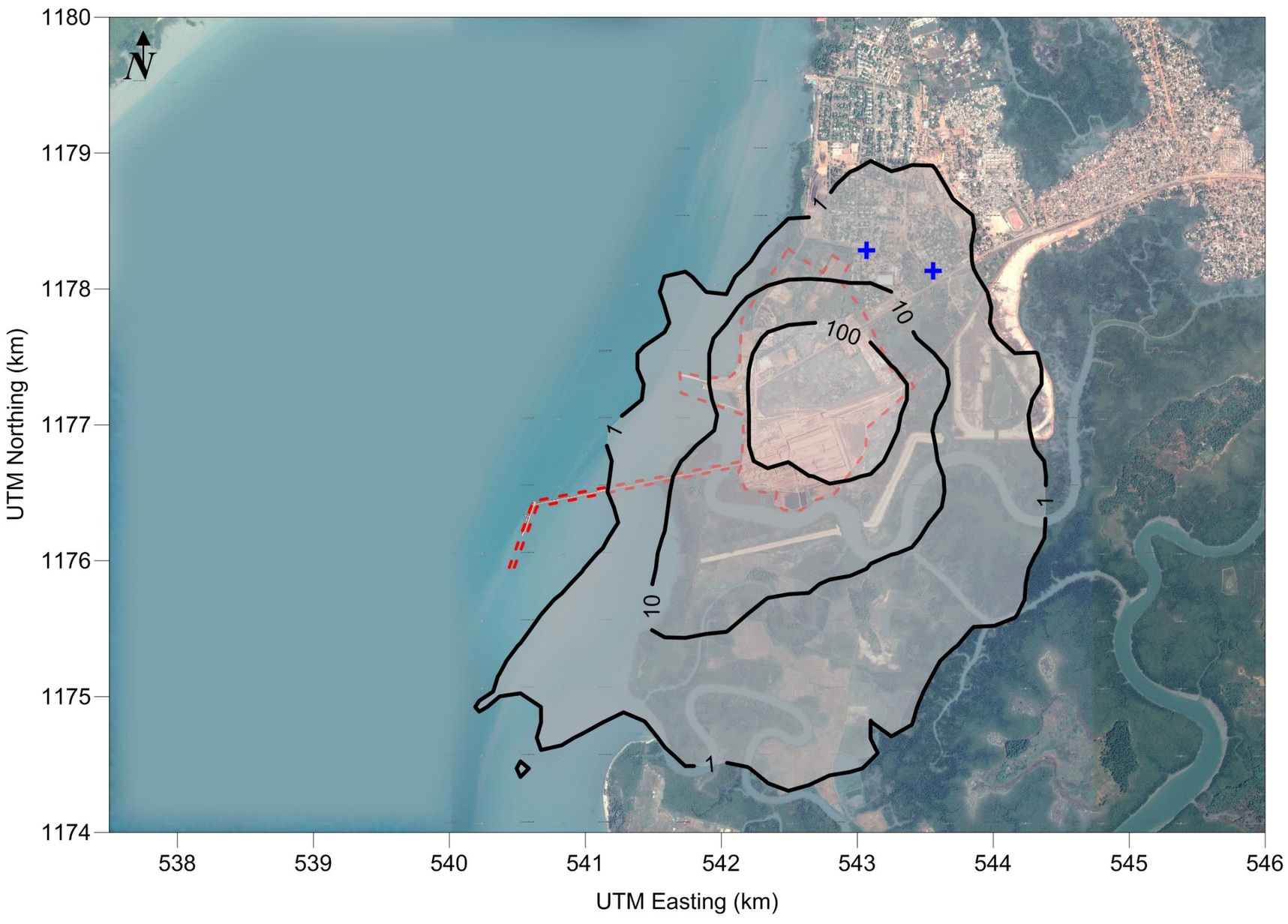
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

27.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 2.5 µm ($PM_{2.5}$)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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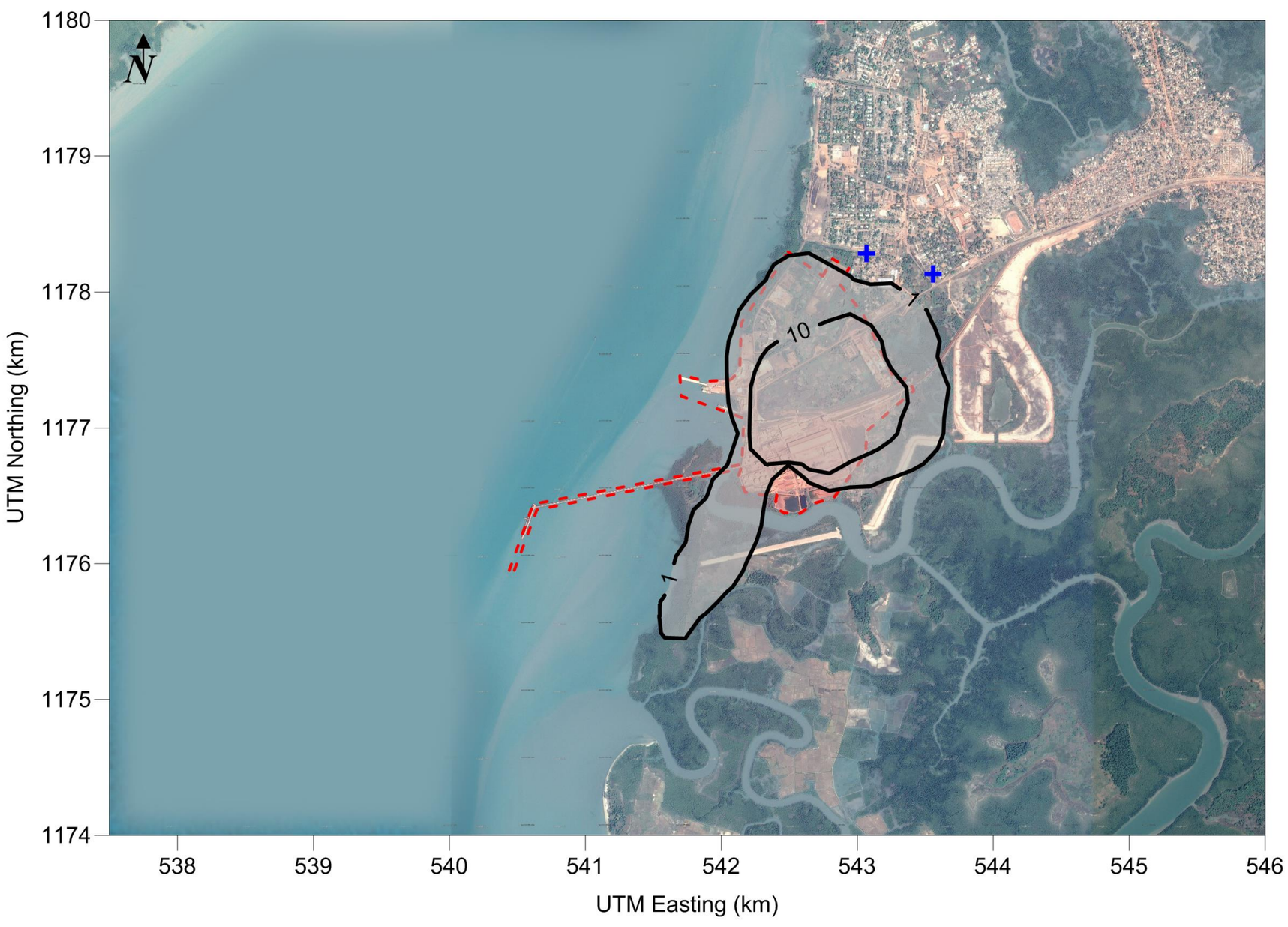
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

27.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 10-minute Guideline for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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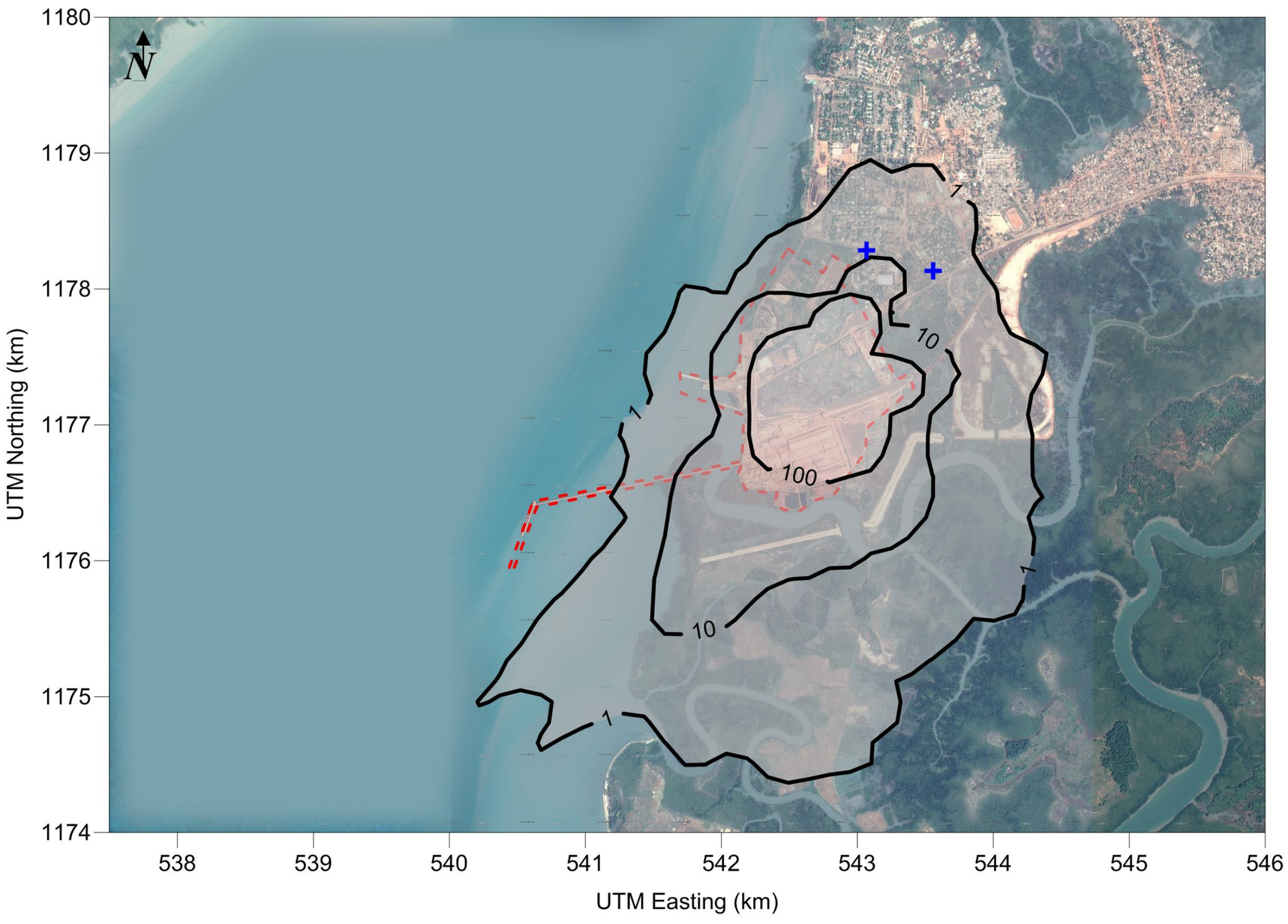
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

27.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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Compagnie des Bauxites de Guinée (CBG)
Extension Project

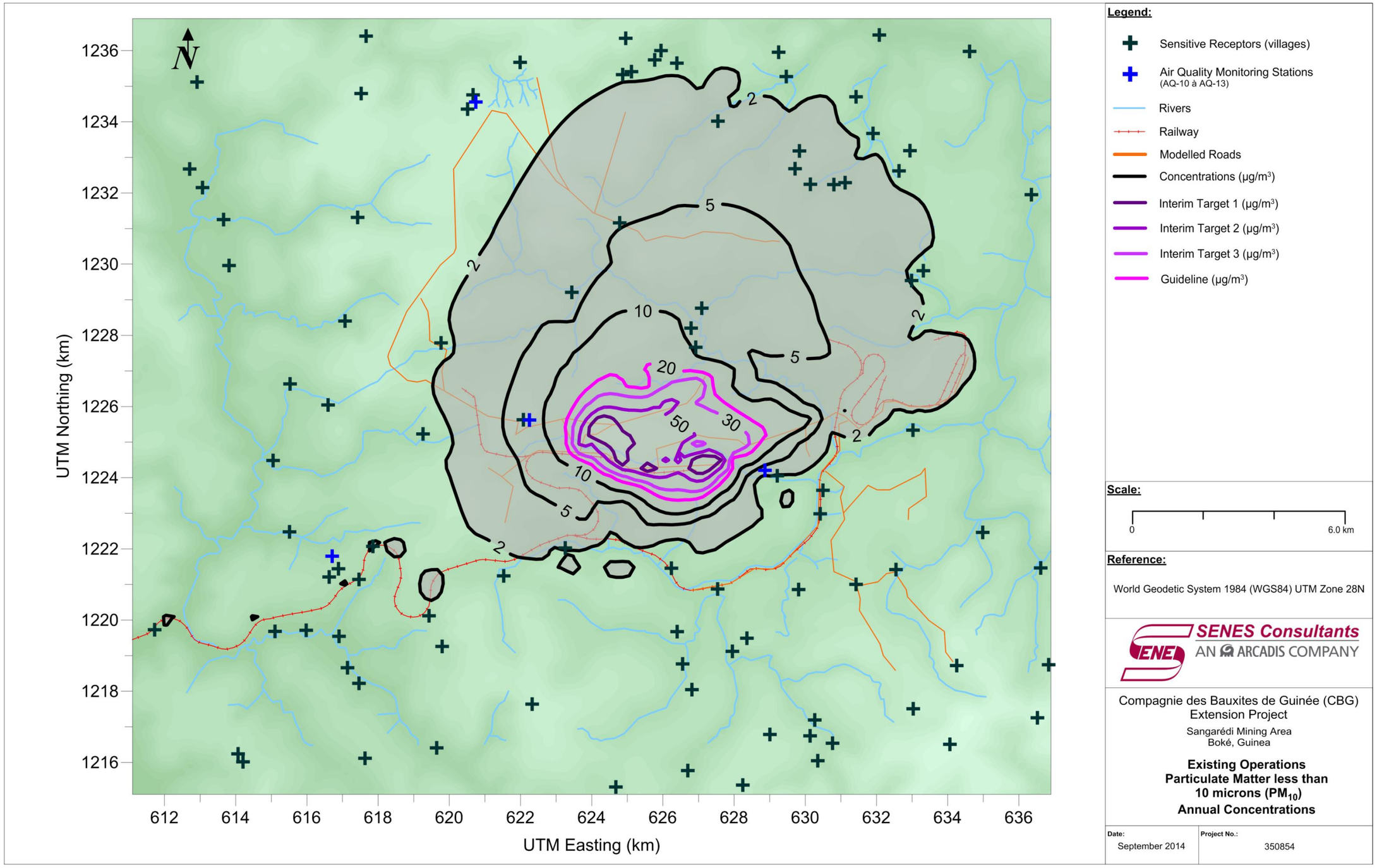
Kamsar Processing Facility
Kamsar, Guinea

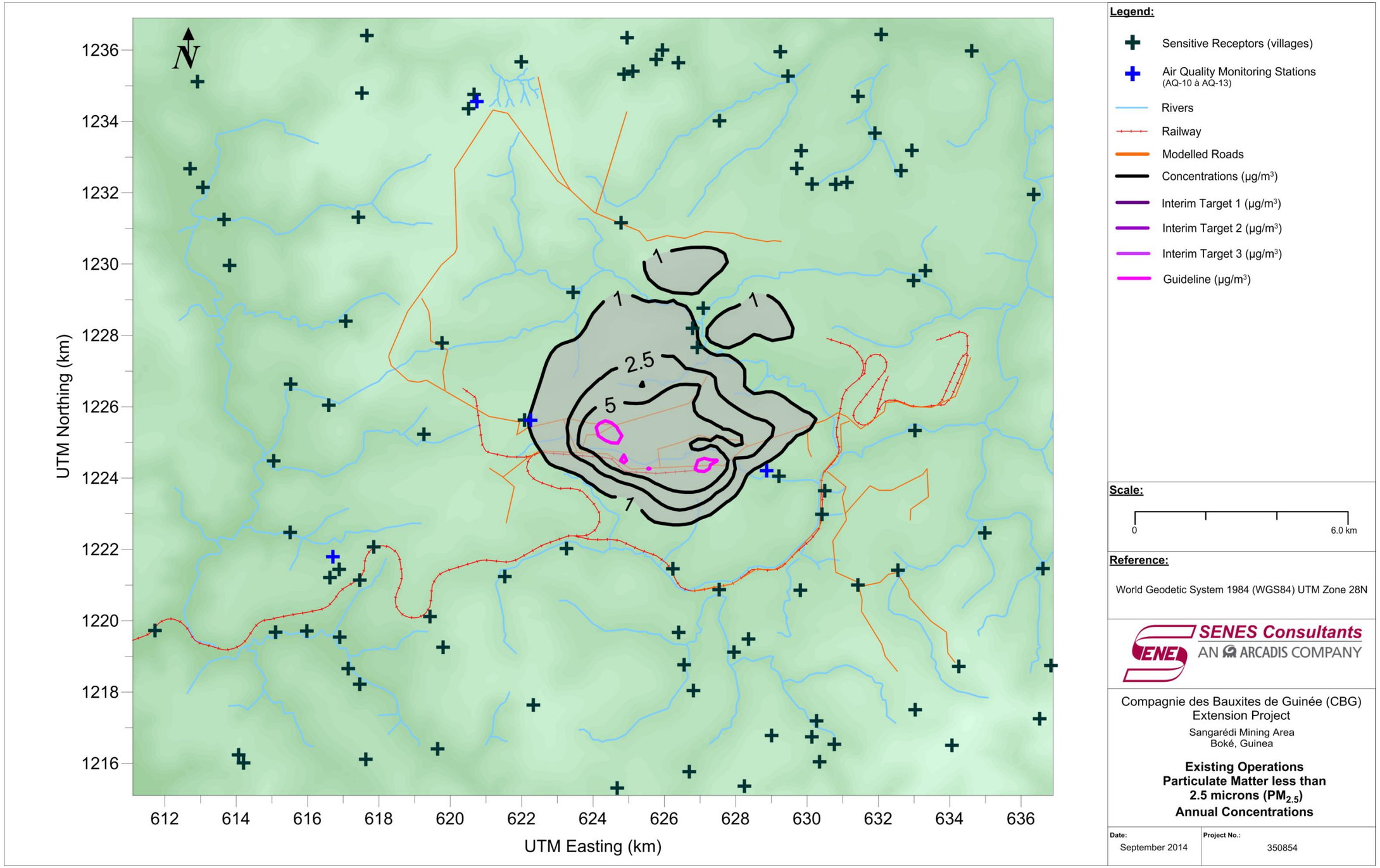
27.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 1-hour Guideline for Nitrogen Dioxide (NO_2)

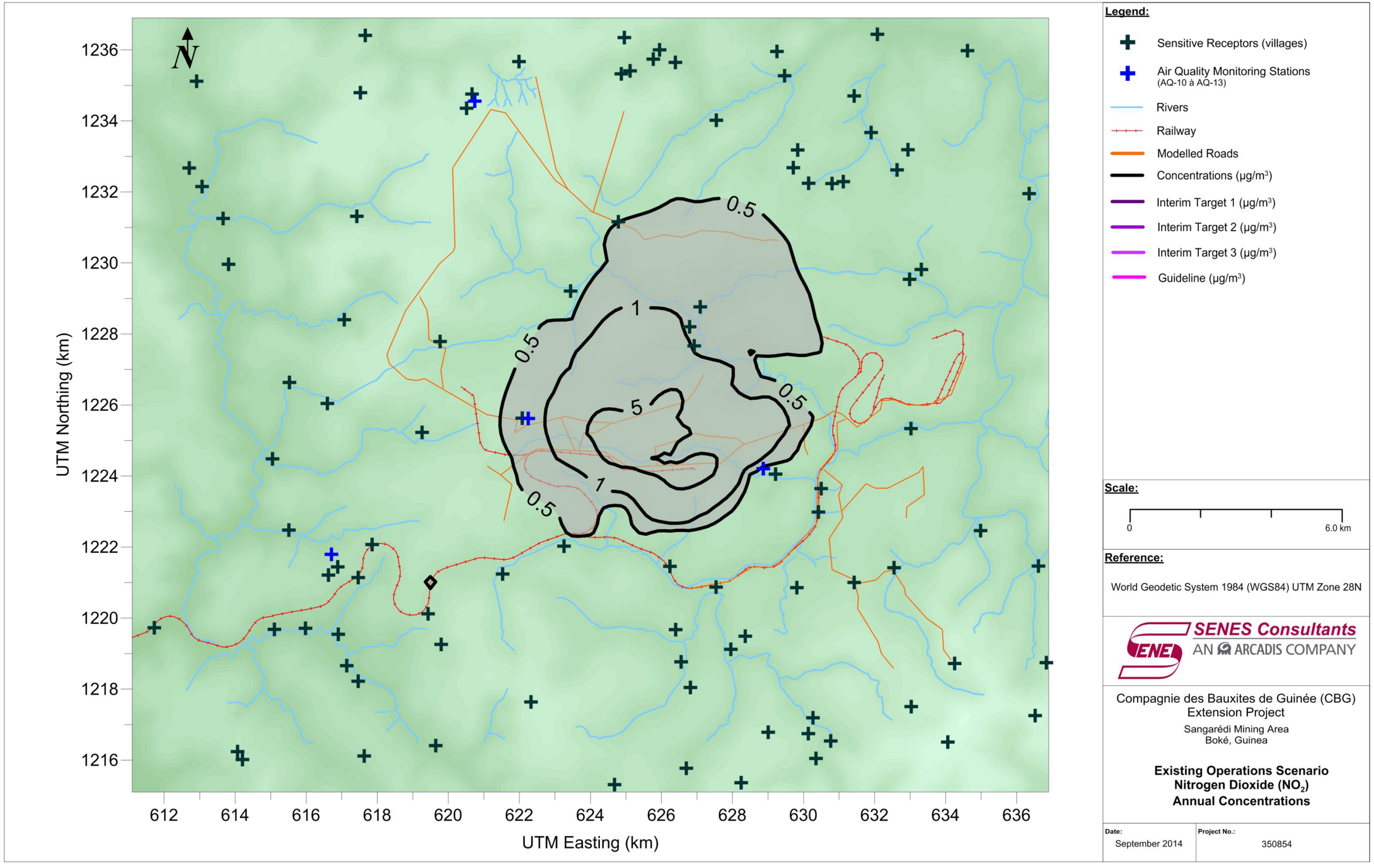
Date:	Project No.:
September 2014	350854

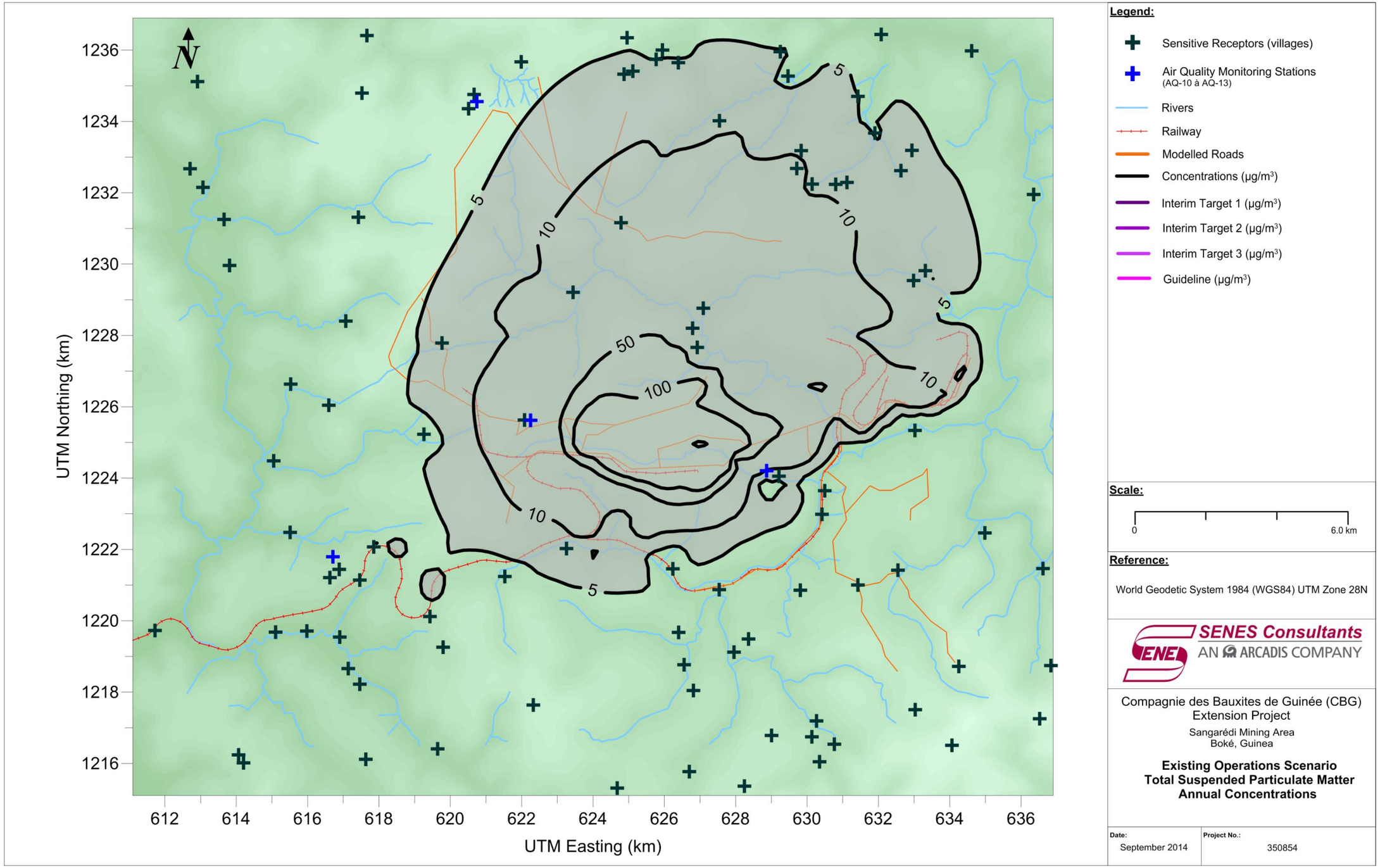
Sangarédi

Existing Operations


N
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
2
5
10
20
30
50
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
Existing Operations
Particulate Matter less than
10 microns (PM10)
Annual Concentrations
Date:
September 2014
Project No.:
350854

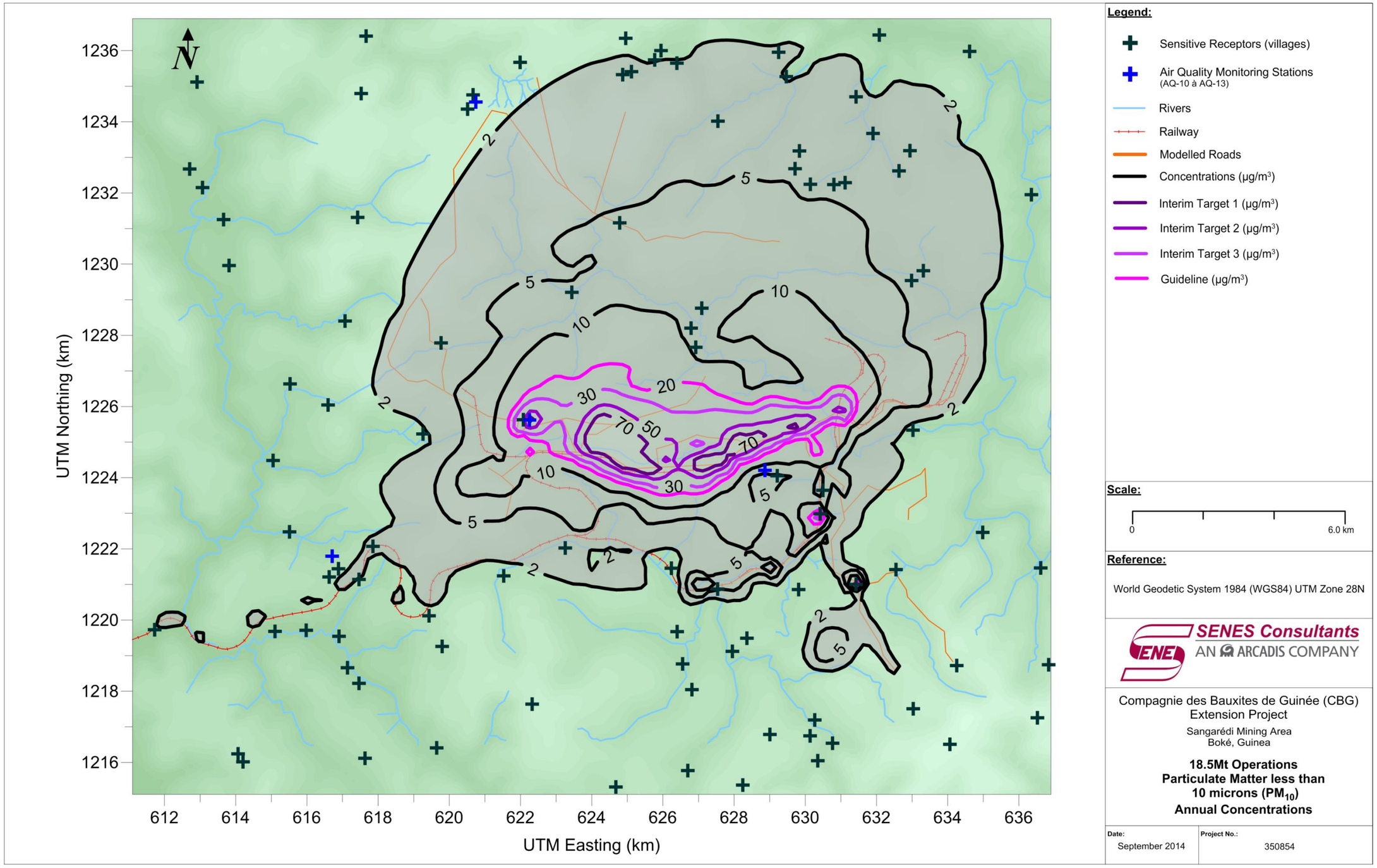

N
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Northing (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
UTM Easting (km)
1
1
1
2.5
5
1
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
Existing Operations
Particulate Matter less than
2.5 microns (PM2.5)
Annual Concentrations
Date:
September 2014
Project No.:
350854

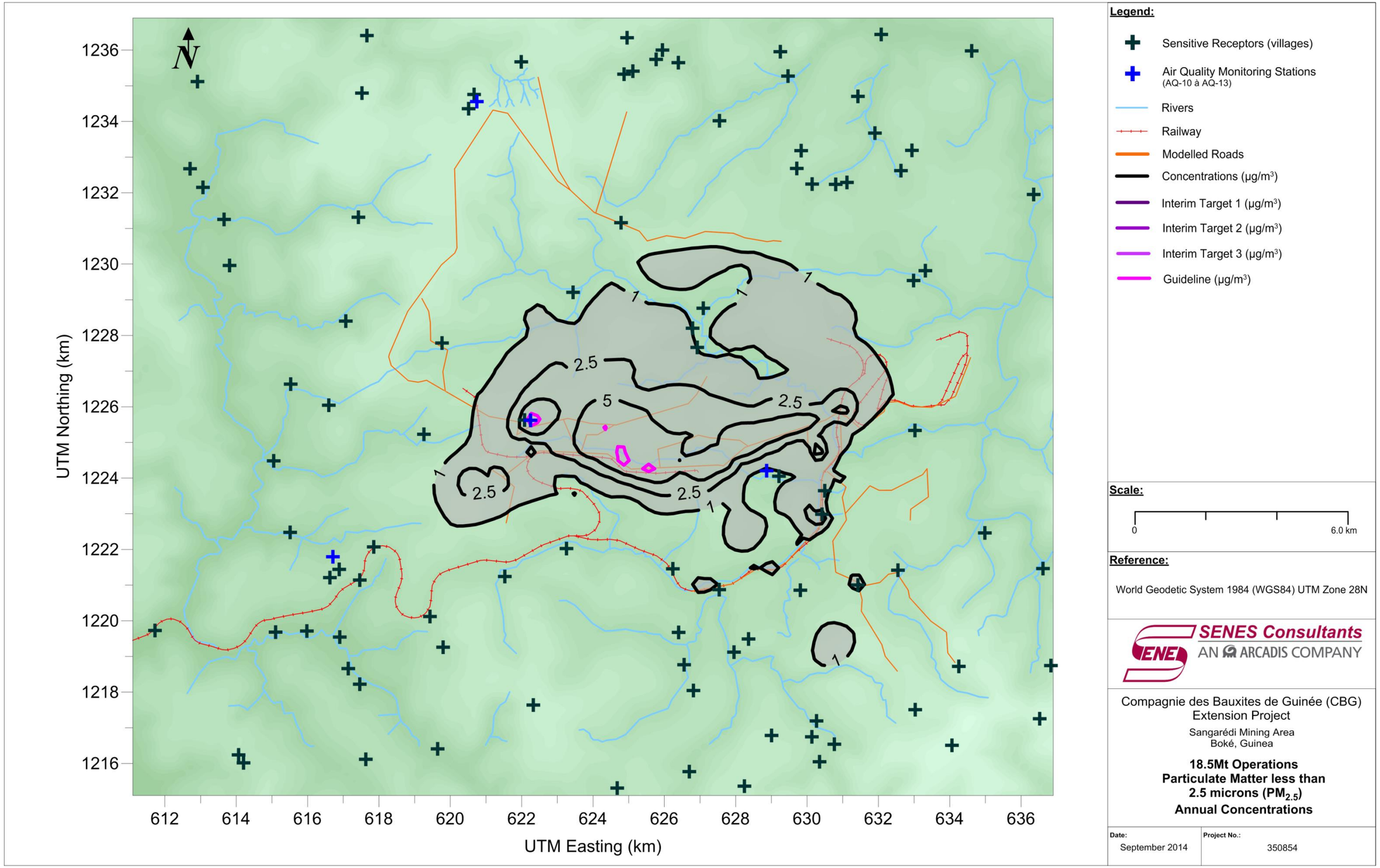

N
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
0.5
1
5
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
Existing Operations Scenario
Nitrogen Dioxide (NO2)
Annual Concentrations
Date:
September 2014
Project No.:
350854


N
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
5
10
50
100
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
Existing Operations Scenario
Total Suspended Particulate Matter
Annual Concentrations
Date:
September 2014
Project No.:
350854

Sangarédi

18.5 MTPY


N
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
2
5
10
20
30
50
70
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
18.5Mt Operations
Particulate Matter less than
10 microns (PM10)
Annual Concentrations
Date:
September 2014
Project No.:
350854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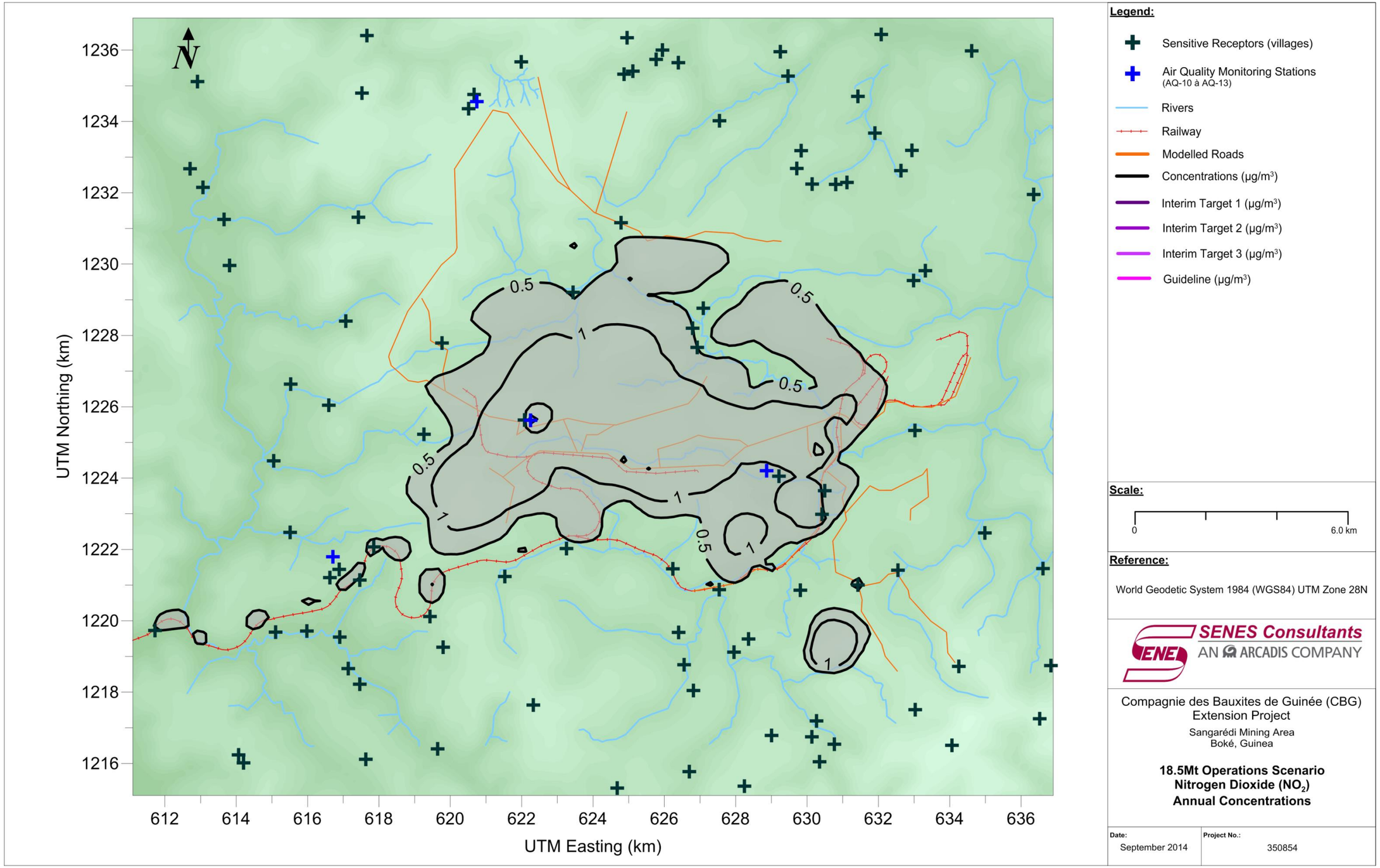
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
1
2.5
5
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
18.5Mt Operations
Particulate Matter less than
2.5 microns (PM2.5)
Annual Concentrations
Date:
September 2014
Project No.:
350854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UTM Northing (km)
1236
1234
1232
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1228
1226
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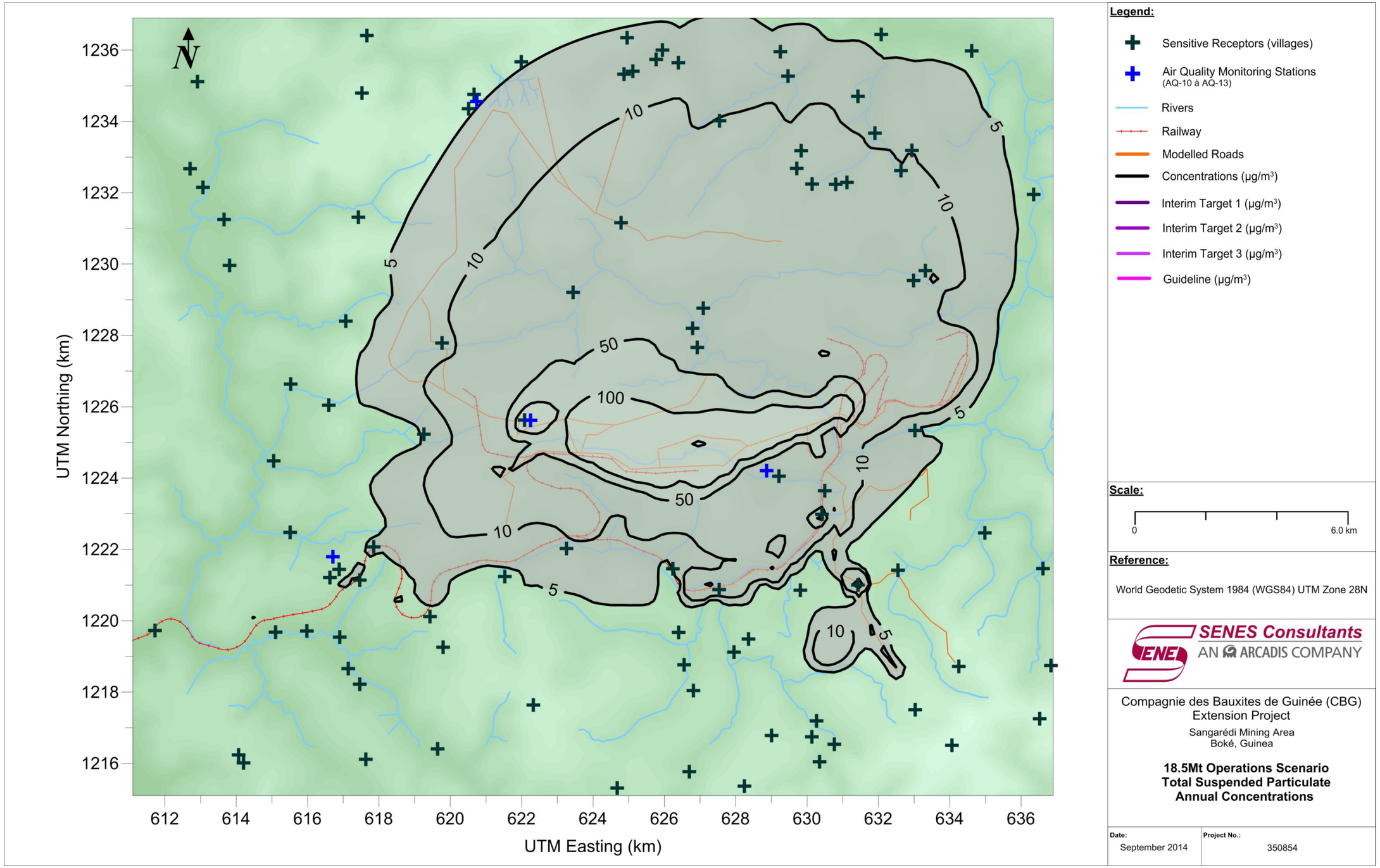
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
0.5
1
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
18.5Mt Operations Scenario
Nitrogen Dioxide (NO2)
Annual Concentrations
Date:
September 2014
Project No.:
350854


N
UTM Northing (km)
1236
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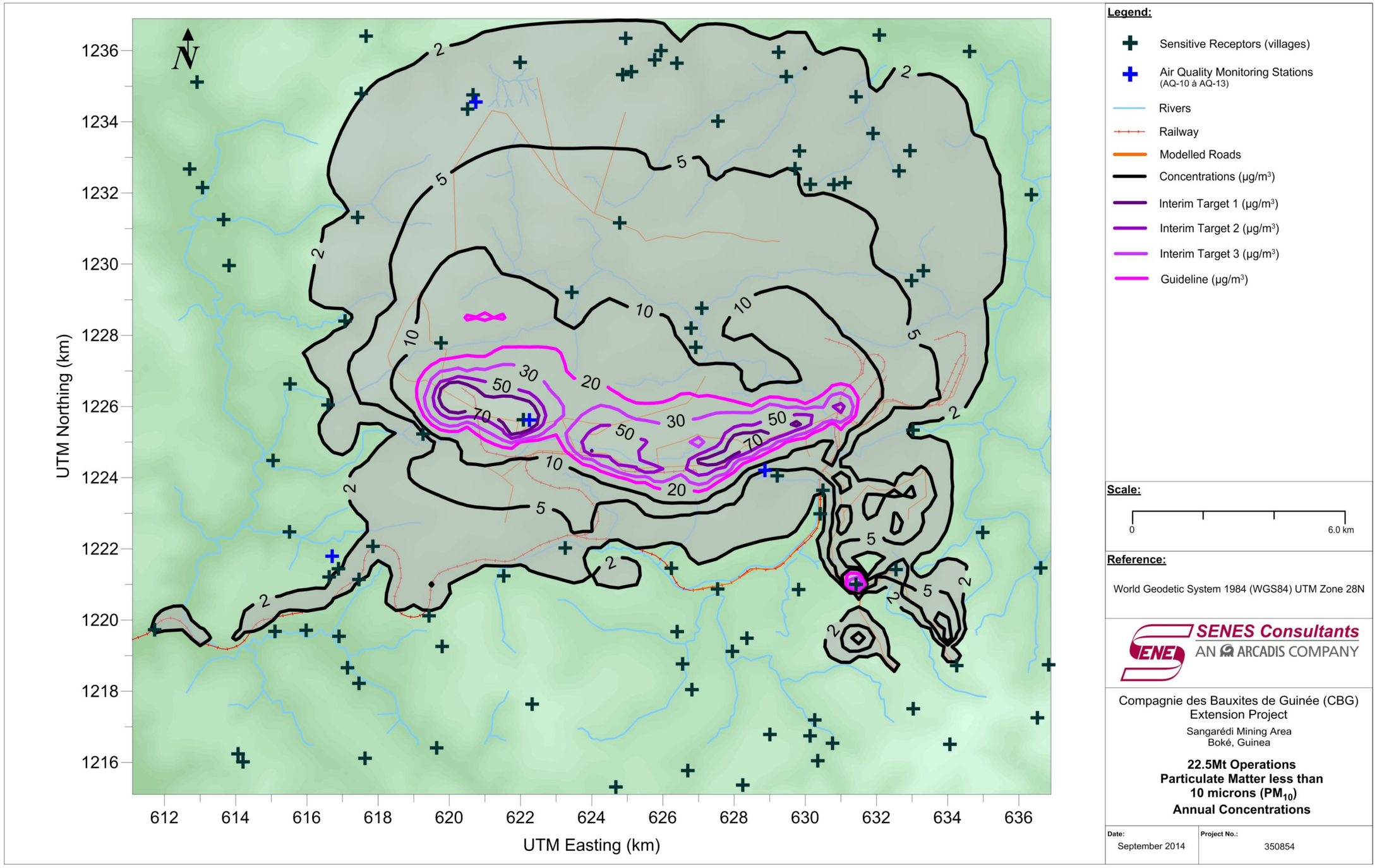
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
5
10
50
100
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
18.5Mt Operations Scenario
Total Suspended Particulate
Annual Concentrations
Date:
September 2014
Project No.:
350854

Sangarédi

22.5 MTPY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1234
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1226
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1220
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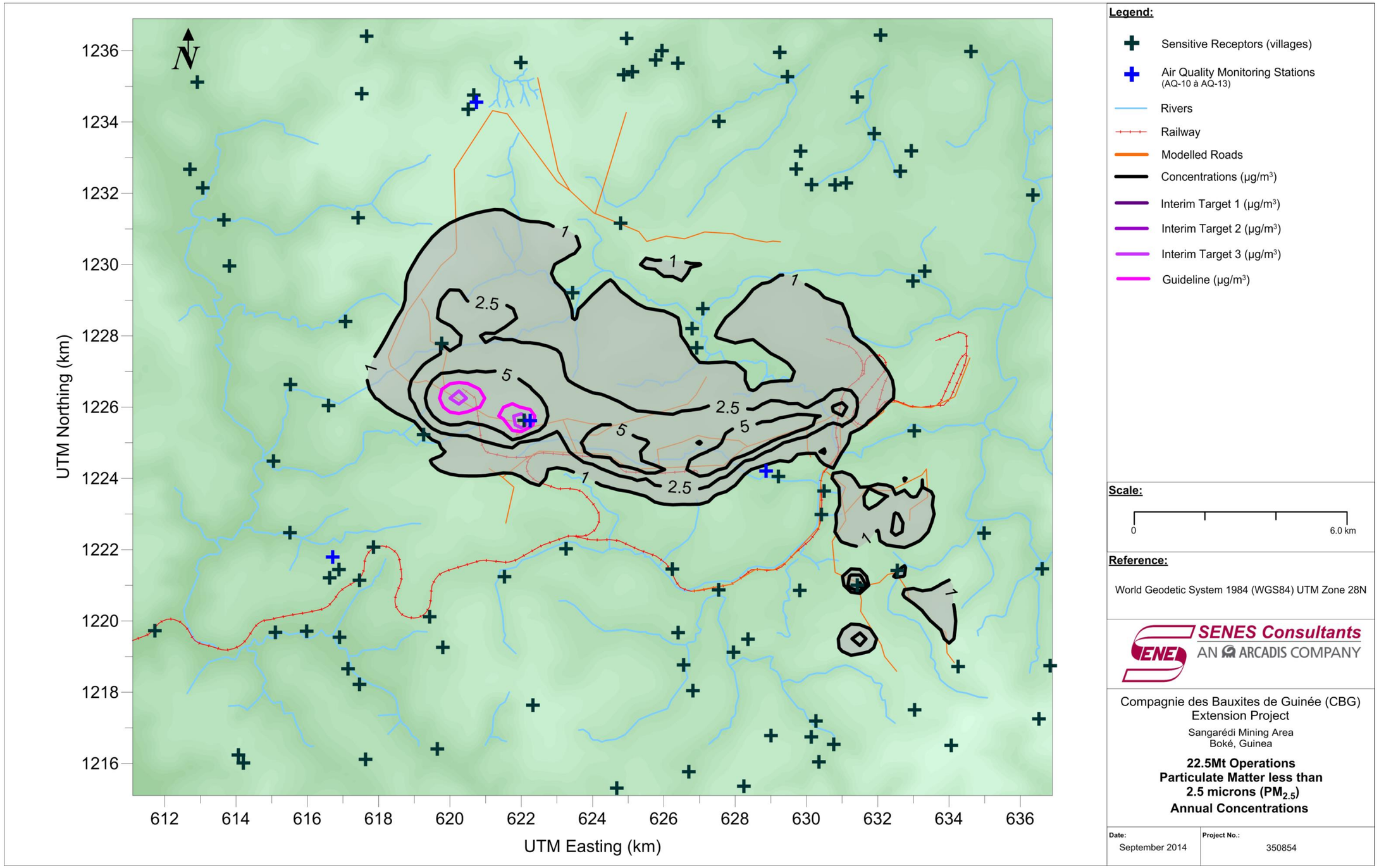
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
2
5
10
20
30
50
70
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
22.5Mt Operations
Particulate Matter less than
10 microns (PM10)
Annual Concentrations
Date:
September 2014
Project No.:
350854


N
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Northing (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
UTM Easting (km)
1
2.5
5
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
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SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
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Particulate Matter less than
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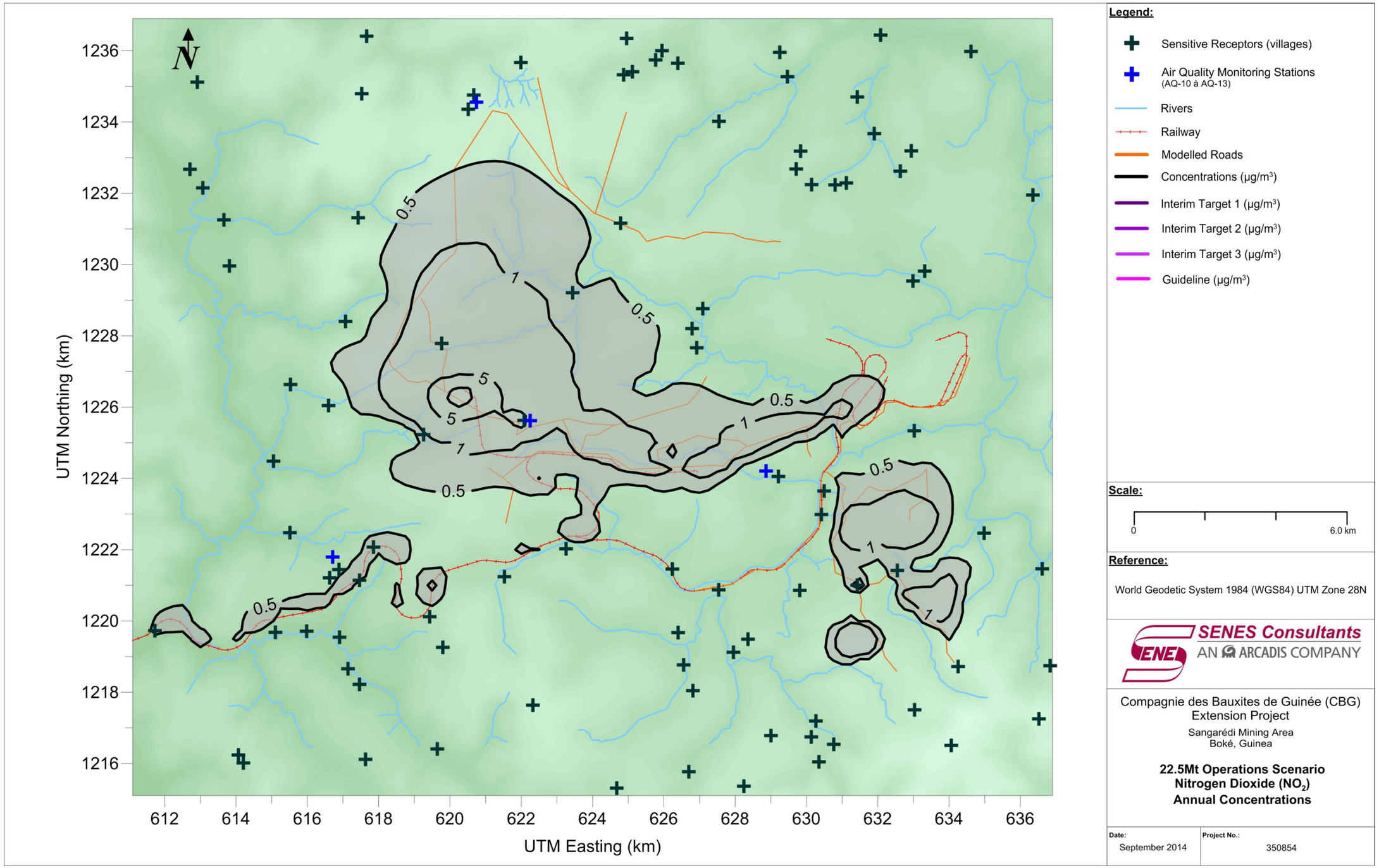
Annual Concentrations
Date:
September 2014
Project No.:
350854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Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
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Interim Target 1 (µg/m³)
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AN ARCADIS COMPANY
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Extension Project
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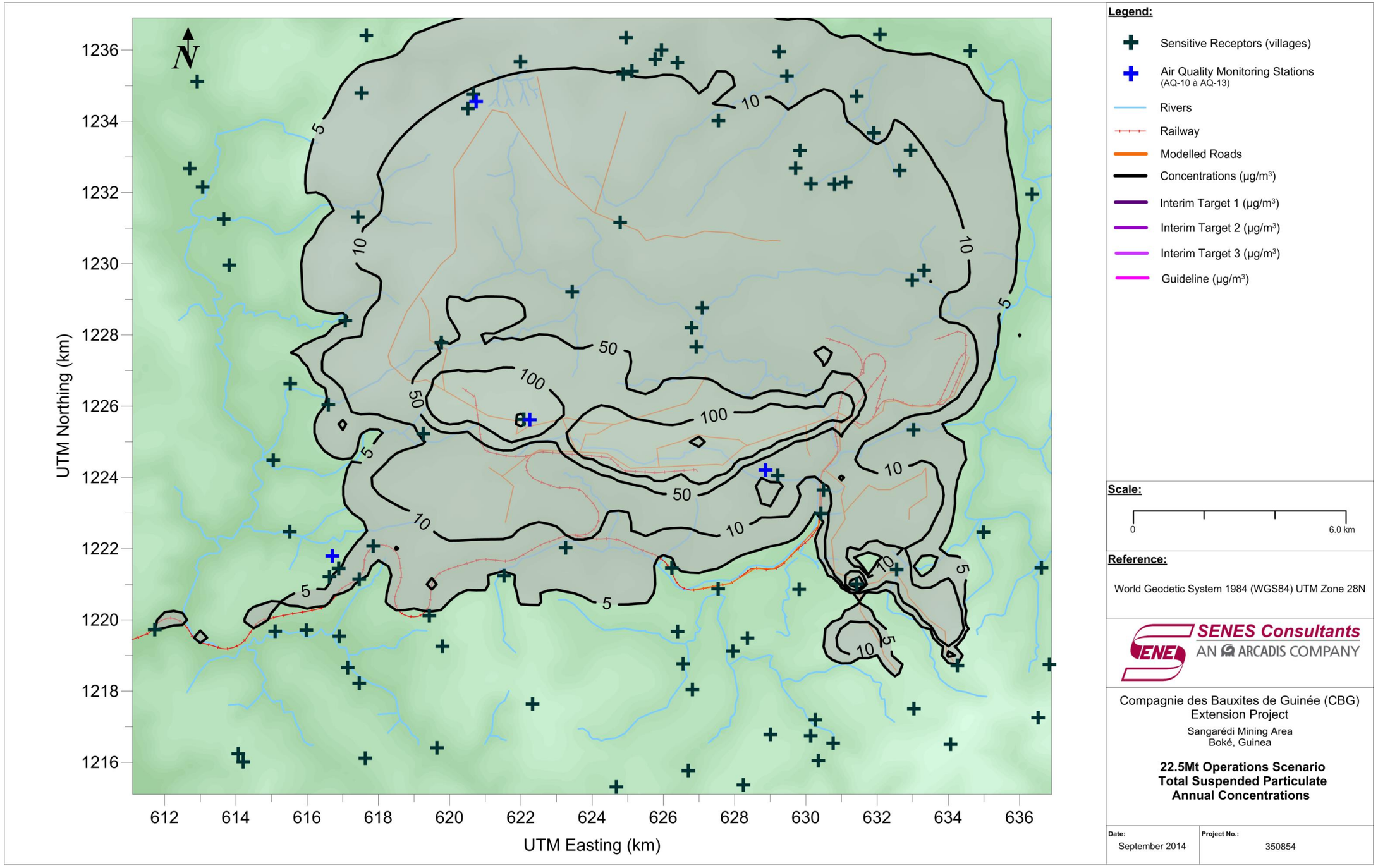
22.5Mt Operations Scenario
Nitrogen Dioxide (NO2)
Annual Concentrations
Date:
September 2014
Project No.:
350854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Legend:
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Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
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AN ARCADIS COMPANY
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Extension Project
Sangarédi Mining Area
Boké, Guinea
22.5Mt Operations Scenario
Total Suspended Particulate
Annual Concentrations
Date:
September 2014
Project No.:
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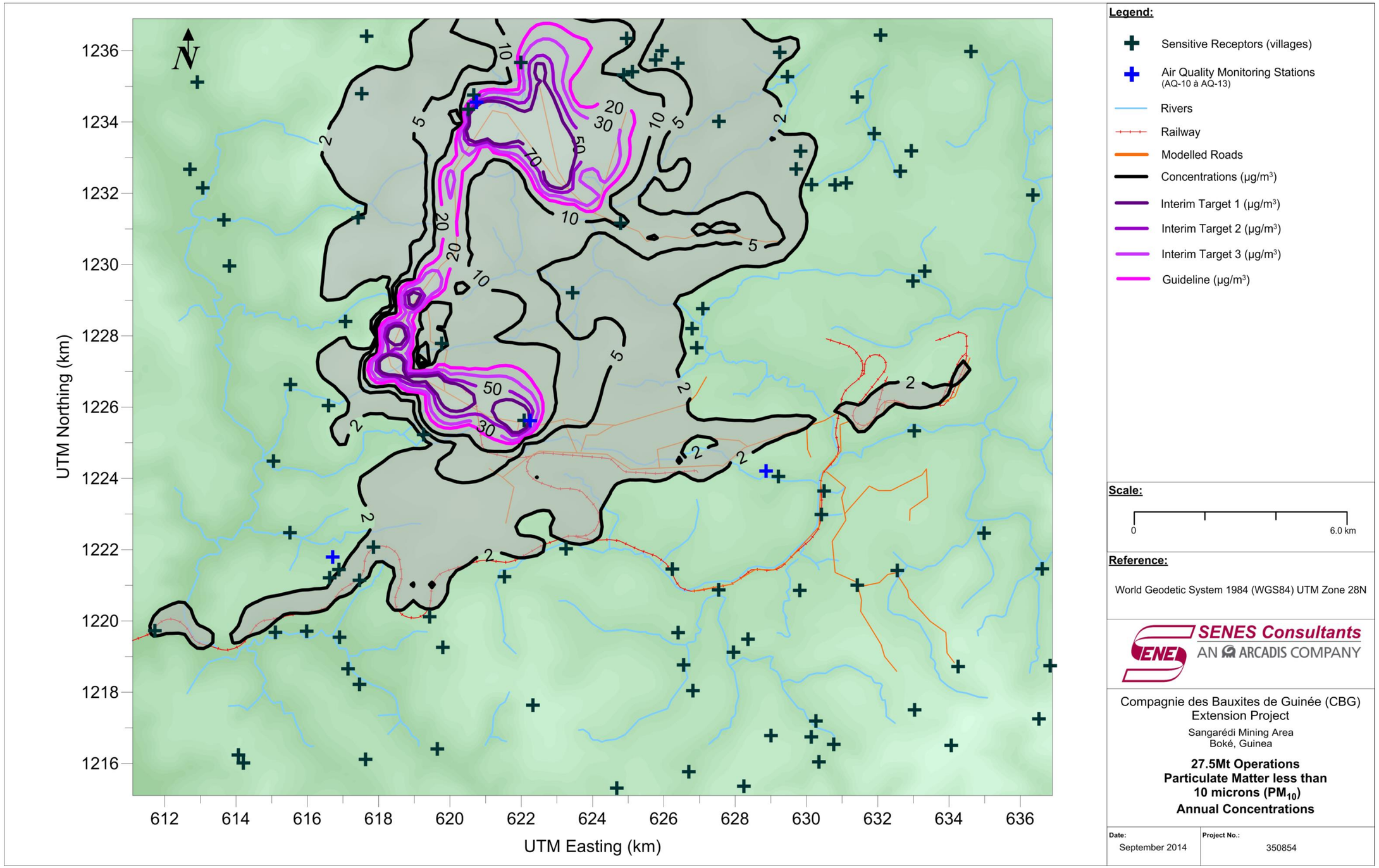
Sangarédi

27.5 MTPY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Legend:
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Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
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Reference:
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AN ARCADIS COMPANY
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Extension Project
Sangarédi Mining Area
Boké, Guinea
27.5Mt Operations
Particulate Matter less than
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Annual Concentrations
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Project No.:
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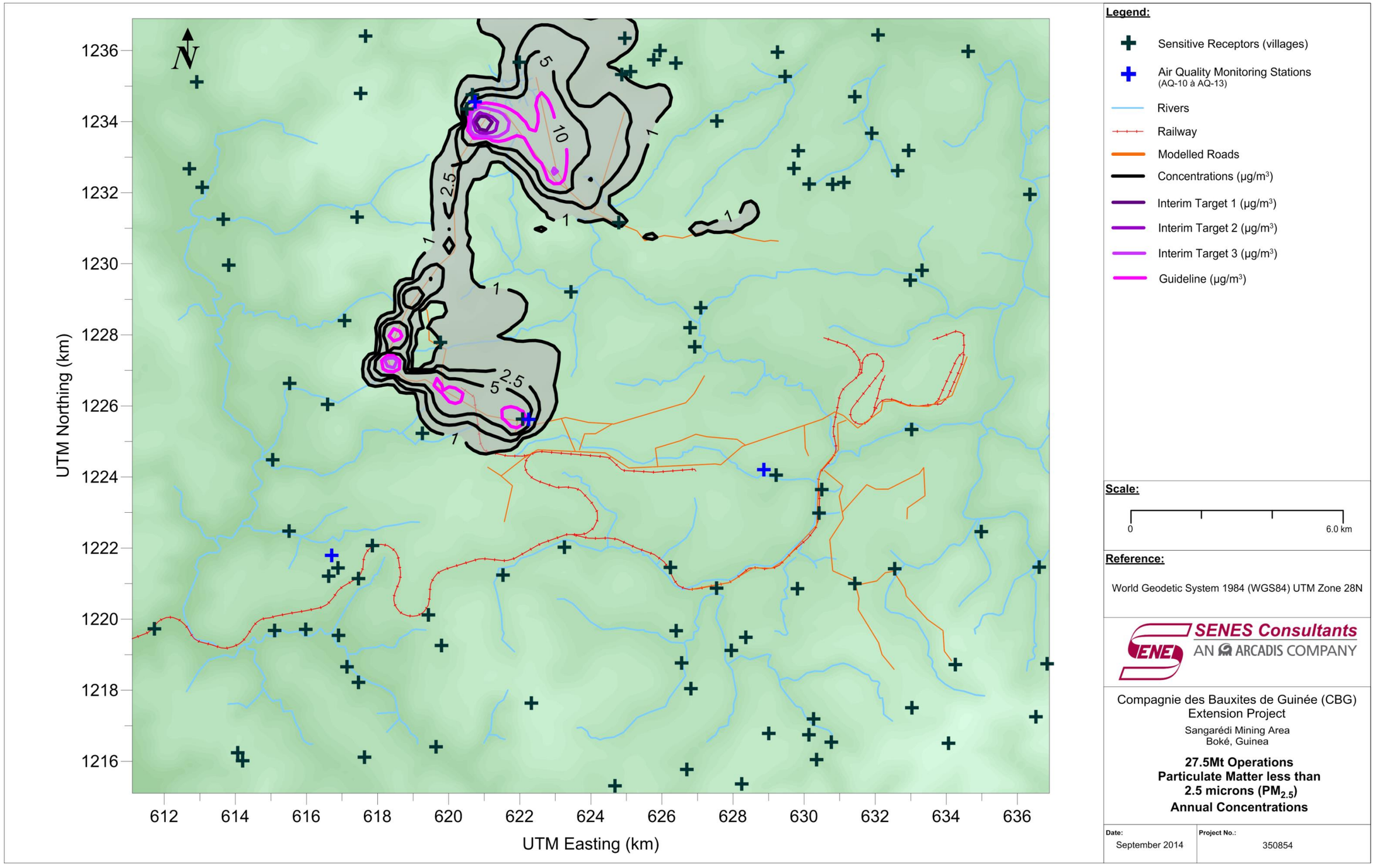
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Legend:
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Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
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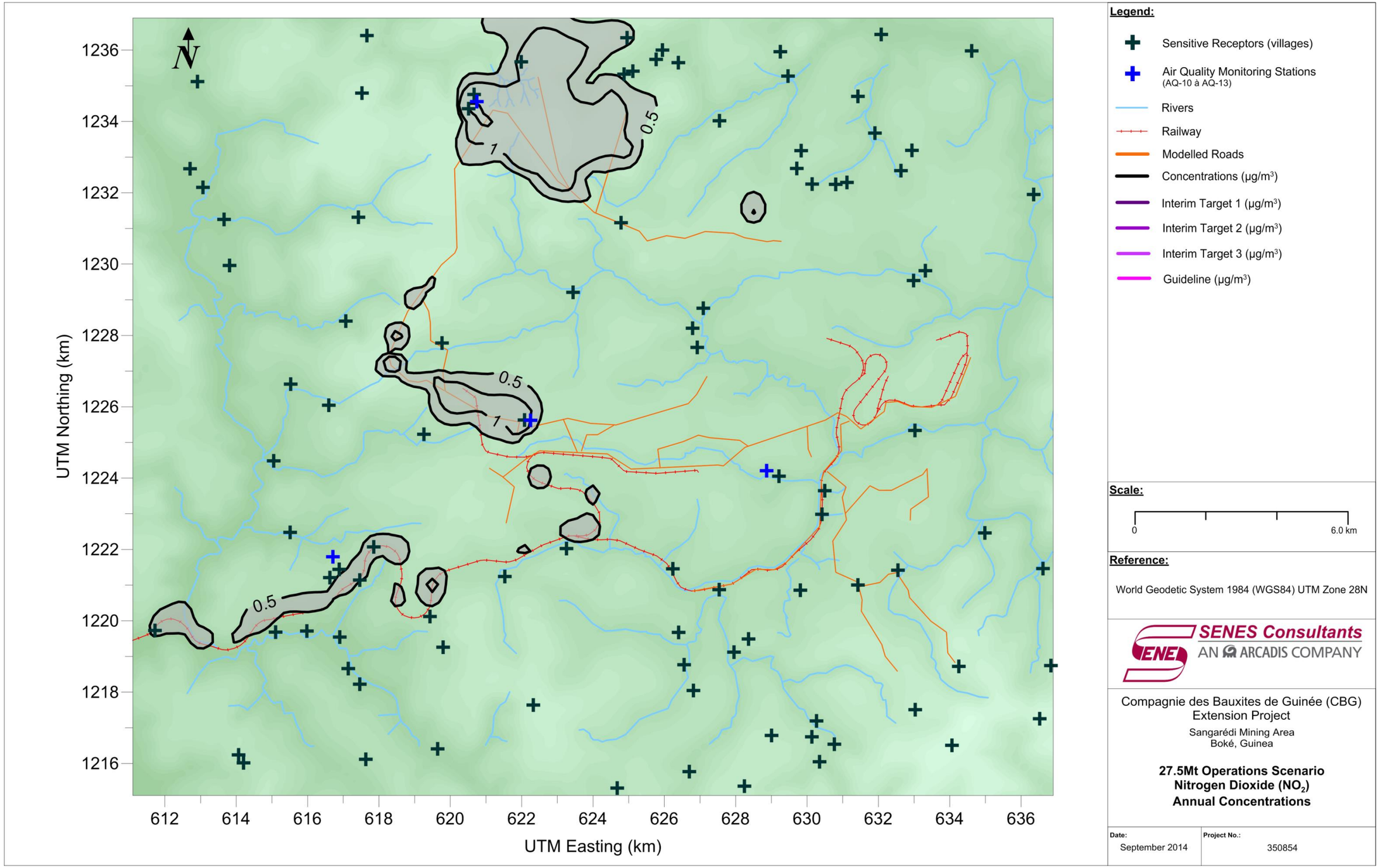
Sangarédi Mining Area
Boké, Guinea
27.5Mt Operations
Particulate Matter less than
2.5 microns (PM2.5)
Annual Concentrations
Date:
September 2014
Project No.:
350854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Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
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Reference:
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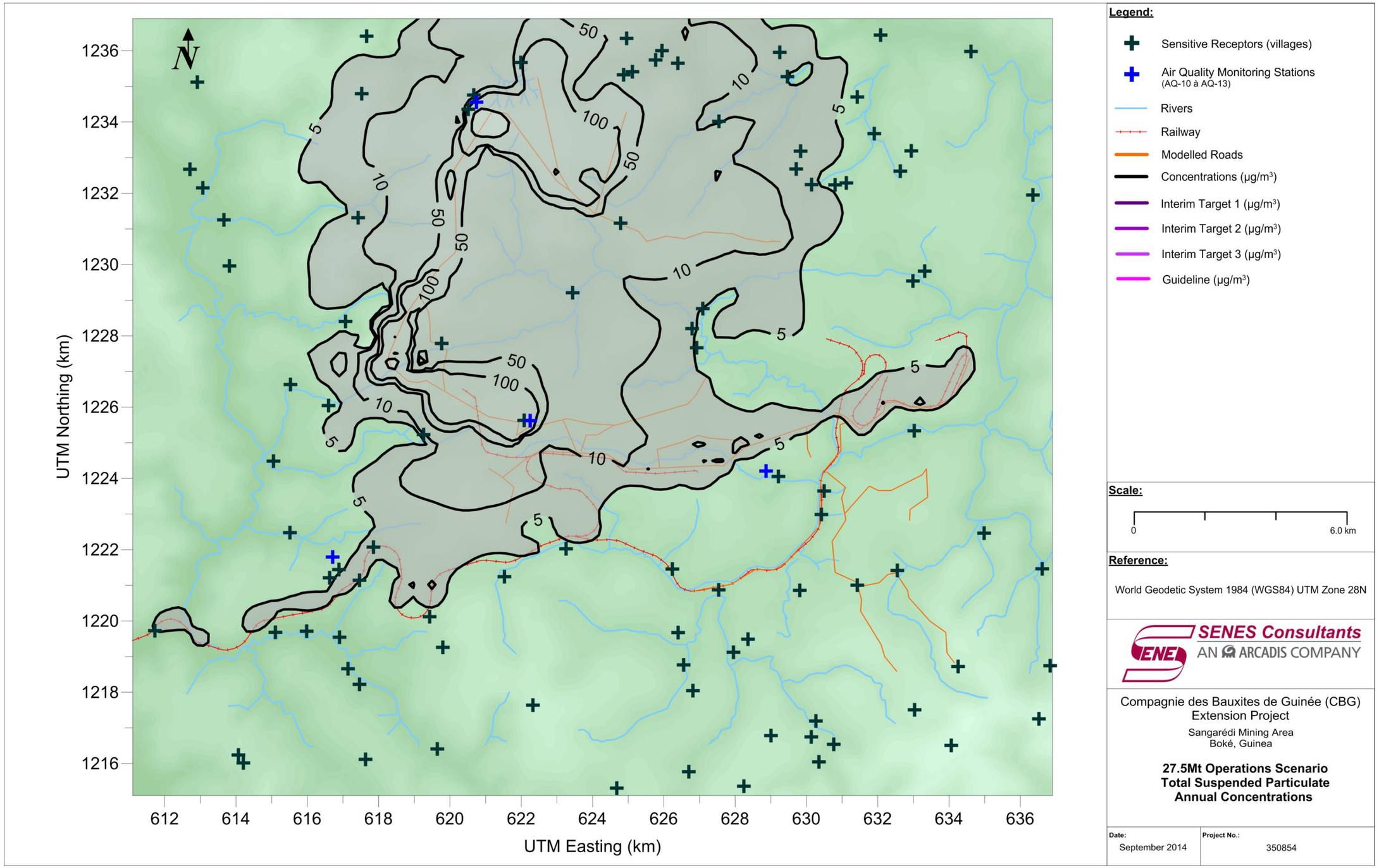
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
27.5Mt Operations Scenario
Nitrogen Dioxide (NO2)
Annual Concentrations
Date:
September 2014
Project No.:
350854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Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
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6.0 km
Reference:
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SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
27.5Mt Operations Scenario
Total Suspended Particulate
Annual Concentrations
Date:
September 2014
Project No.:
350854

ATTACHMENT B:
VARIABLES AND ASSUMPTIONS FOR AIR EMISSIONS CALCULATIONS

Table B.1: Production for Kamsar and Sangarédi

	Units	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY	Comments
Total Annual Production						
Plant throughput @12.5% moisture	million tonnes per yr	14.9	20.5	24.9	30.5	Based on: ▪ AECOM 2011 ▪ Fluor 2014
Plant throughput @6.7% moisture	million tonnes per yr	13.5	19.2	23.4	28.6	
Plant throughput @3% moisture	million tonnes per yr	13.5	18.5	22.5	27.5	

Table B.2: Metal Content of Bauxite Ore and Overburden

	Relative Metal Content (as percent of TSP)						
	Al	**Sb**	**As**	**Cd**	**Cr**	**Cu**	**Ni**
Bauxite Ore [1, 2]	26%	0.0003%	0.003%	0.00002%	0.1%	0.01%	0.01%
Overburden [3]	4%	0.0001%	0.0005%	0.000004%	0.02%	0.002%	0.0009%

Notes:
[1] Relative Al content of bauxite ore is assumed based on an ore quality of 50% Al_2O_3 (i.e., 26% Al by weight).
[2] Relative metallic content of bauxite ore is scaled based on Al content of ore relative to overburden.
[3] Relative metallic content of overburden is based on the average of surface soil samples SI1 (AECOM 2011, page 3-79), SENES S1 & S3.

VARIABLES AND ASSUMPTIONS FOR THE KAMSAR PROCESSING FACILITY

Table B.3: Activity Data for Kamsar

	Units	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY	Comments
Trains per day	#	5.0	5.7	6.9	8.1	Based on: ▪ AECOM 2011 ▪ Fluor 2014
Net wagon capacity	tonnes	82	82	82	82	
Wagons per train	#	120	120	120	126	
Wagons per hour	#	37	44	53	65	
Unloading hours per train	#	3.3	2.7	2.3	1.9	
Locomotives per train	#	2	3	3	3	
Yard locomotives	#	2	2	2	2	Assumed

Table B.4: Fuel Consumption at the Kamsar Processing Facility

Source	Fuel Type	Daily Fuel Consumption (L per day)			
		Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Old Generators [1] (6 units, 2.5MW each)	Fuel Oil (No. 6)	34,333	-	-	-
Old Generator [1] (Unit 9, 3.3MW)	Fuel Oil (No. 6)	7,553	8,829	9,409	12,492
Old Generator [1] (Unit 10, 6MW)	Fuel Oil (No. 6)	13,733	16,052	17,107	22,713
	Diesel	1,616	1,616	1,616	1,616
New Generators [1] (Units 11 and 12, 7.4MW each)	Fuel Oil (No. 6)	33,876	39,596	42,198	56,026
New Generators [1] (Units 13 and 14, 7.4MW each)	Fuel Oil (No. 6)	-	39,596	42,198	56,026
New Generator [1] (Unit 15, 7.4MW)	Fuel Oil (No. 6)	-	19,798	21,099	28,013
Steam Boilers [1] (2 units, 0.9MW total)	Fuel Oil (No. 6)	1,682	2,408	2,566	3,407
Locomotives [2]	Diesel	4,856	8,304	10,053	11,801
Yard Locomotives [2]	Diesel	971	-	-	-

Notes:

[1] Fuel consumption totals for generators and boilers were based on the fuel inventory for Centrale Kamsar in CBG greenhouse gas inventories (2012 and 18.5 MTPY, 22.5 MTPY & 27.5MTPY). Fuel totals were split based on the nominal power of the units (AECOM 2011; Fluor 2014).

[2] Fuel consumption for locomotives was based on a nominal horsepower rating (3,000 hp per locomotive; AECOM 2011, Annex F), the number of locomotives per train (Fluor 2014) and fuel densities in the U.S. EPA document Nonroad Emission Factors for Locomotives.

Table B.5: Material Handling Rates in Kamsar (Existing)

Source Description	Max Operating Feed Rate (tonnes/hr)	Equipment Utilization Rate (%)	Feed Rate (tonnes/hr)	Control (%)	Comments
Primary crusher	3000	65%	1950	80%	Crusher building and transfer towers partially enclosed.
Secondary crusher	3000	65%	1950	80%	
Transfer tower (TAN001)	3000	65%	1950	80%	
Transfer tower (TAN002)	3000	65%	1950	80%	
Transfer tower (TAN003)	3000	65%	1950	80%	
Transfer tower (TAN004)	3000	65%	1950	80%	
Transfer tower (TAN006)	2000	65%	1300	80%	
Transfer tower (TAN007)	5000	65%	3250	80%	
Dry product hopper (TAN010)	5000	65%	3250	80%	
Transfer tower at Corner Island	4500	65%	2925	80%	
Dryer#1 (FOR001)	900	65%	585	99%	Controlled by dryer scrubber (99% efficiency)
Dryer#2 (FOR002)	900	65%	585	99%	
Dryer#3 (FOR003)	900	65%	585	99%	
Microgranulation	27	65%	18	80%	Material handling rate assumed to be 1% of total for existing dryers
Loading activities at dry product storage pile	2000	65%	1300	95%	Indoor source
Ship berth#1	4500	65%	2925	95%	Drop into ship hold

Note: Material handling rates from AECOM 2011 Figure 3.2

Table B.6: Material Handling Rates in Kamsar (18.5 MTPY)

Source Description	Max Operating Feed Rate (tonnes/hr)	Equipment Utilization Rate (%)	Feed Rate (tonnes/hr)	Control (%)	Comments
Primary crusher (CNC301)	3600	65%	2340	96%	New crusher building with dry fogging/dust control system (additional 80% control efficiency)
Secondary crusher (CNC302)	3600	65%	2340	96%	
Transfer tower (TAN001)	4000	65%	2600	96%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Transfer tower (TAN002)	4000	65%	2600	80%	
Transfer tower (TAN003)	4000	65%	2600	80%	Partially enclosed
Transfer tower (TAN004)	5400	65%	3510	96%	
Transfer tower (TAN006)	900	65%	585	80%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Transfer tower (TAN007)	5000	65%	3250	80%	Partially enclosed
Dry product hopper (TAN010)	5000	65%	3250	80%	
Transfer tower at Corner Island	4500	65%	2925	80%	
Transfer tower (TAN301)	4000	65%	2600	96%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Transfer tower (TAN305)	1400	65%	910	96%	
Dryer#1 (FOR001)	900	65%	585	99%	Controlled by dryer scrubber (99% efficiency)
Dryer#2 (FOR002)	900	65%	585	99%	
Dryer#3 (FOR003)	900	65%	585	99%	
Microgranulation	27	65%	18	80%	Partially enclosed
Dryer#4 (FOR004)	1400	65%	910	99%	Controlled by dryer scrubber (99% efficiency)
Loading activities at dry product storage pile	900	65%	585	99%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Ship berth#1	4500	65%	2925	95%	Drop into ship hold

Note: Material handling rates from process flow drawing no. KMH-SK-201 (Fluor 2014).

Table B.7: Material Handling Rates in Kamsar (22.5 MTPY)

Source Description	Max Operating Feed Rate (tonnes/hr)	Equipment Utilization Rate (%)	Feed Rate (tonnes/hr)	Control (%)	Comments
Primary crusher (CNC301)	2200	65%	1430	96%	New crusher building with dry fogging/dust control system (additional 80% control efficiency)
Secondary crusher (CNC302)	2200	65%	1430	96%	
Primary crusher (CNC303)	2200	65%	1430	96%	
Secondary crusher (CNC303)	2200	65%	1430	96%	
Transfer tower (TAN001)	4400	65%	2860	96%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Transfer tower (TAN002)	4400	65%	2860	96%	
Transfer tower (TAN003)	4400	65%	2860	96%	
Transfer tower (TAN004)	5800	65%	3770	96%	
Transfer tower (TAN006)	2900	65%	1885	96%	
Transfer tower (TAN007)	7000	65%	4550	96%	
Dry product hopper (TAN010)	7000	65%	4550	96%	
Transfer tower at Corner Island	6000	65%	3900	96%	
Transfer tower (TAN301)	4400	65%	2860	96%	
Transfer tower (TAN305)	1400	65%	910	96%	
Dryer#1 (FOR001)	900	65%	585	99%	Controlled by dryer scrubber (99% efficiency)
Dryer#2 (FOR002)	900	65%	585	99%	
Dryer#3 (FOR003)	900	65%	585	99%	
Microgranulation	27	65%	18	80%	Partially enclosed
Dryer#4 (FOR004)	1400	65%	910	99%	Controlled by dryer scrubber (99% efficiency)
Loading activities at dry product storage pile	2900	65%	1885	99%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Ship berth#1	6000	65%	3900	95%	Drop into ship hold

Note: Material handling rates from process flow drawing no. KMH-SK-202 (Fluor 2014).

Table B.8: Material Handling Rates in Kamsar (27.5 MTPY)

Source Description	Max Operating Feed Rate (tonnes/hr)	Equipment Utilization Rate (%)	Feed Rate (tonnes/hr)	Control (%)	Comments
Primary crusher (CNC301)	2700	65%	1755	96%	New crusher building with dry fogging/dust control system (additional 80% control efficiency)
Secondary crusher (CNC302)	2700	65%	1755	96%	
Primary crusher (CNC303)	2700	65%	1755	96%	
Secondary crusher (CNC303)	2700	65%	1755	96%	
Transfer tower (TAN001)	5400	65%	3510	96%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Transfer tower (TAN002)	5400	65%	3510	96%	
Transfer tower (TAN003)	5400	65%	3510	96%	
Transfer tower (TAN004)	8200	65%	5330	96%	
Transfer tower (TAN006)	1500	65%	975	96%	
Transfer tower (TAN007)	7000	65%	4550	96%	
Dry product hopper (TAN010)	7000	65%	4550	96%	
Transfer tower at Corner Island	6000	65%	3900	96%	
Transfer tower (TAN301)	5400	65%	3510	96%	
Transfer tower (TAN305)	1400	65%	910	96%	
Transfer tower (TAN306)	1400	65%	910	96%	
Transfer tower (TAN308)	6000	65%	3900	96%	
Transfer tower (TAN309)	6000	65%	3900	96%	
Dry product hopper (TRE303)	7000	65%	4550	96%	
Dryer#1 (FOR001)	900	65%	585	99%	Controlled by dryer scrubber (99% efficiency)
Dryer#2 (FOR002)	900	65%	585	99%	
Dryer#3 (FOR003)	900	65%	585	99%	
Microgranulation	27	65%	18	80%	Partially enclosed
Dryer#4 (FOR004)	1400	65%	910	99%	Controlled by dryer scrubber (99% efficiency)
Dryer#5 (FOR005)	1400	65%	910	99%	
Loading activities at dry product storage pile #1	750	65%	488	99%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Loading activities at dry product storage pile #2	750	65%	488	99%	
Ship berth#1	6000	65%	3900	95%	Drop into ship hold
Ship berth#2	6000	65%	3900	95%	

Note: Material handling rates from process flow drawing no. KMH-SK-203 (Fluor 2014).

Table B.9: Stockpile Characteristics at the Kamsar Processing Facility

	Silt Content [1] (%)	Frequency of Winds >5.4m/s [2] (%)	Active Surface Area (ha) [3]			
			Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Raw storage piles	15%	6.5%	9.1			
Area outside dry storage building	15%	6.5%	0.4			

Notes:

[1] Silt content obtained from Table 13.2.4-1 from AP-42, Chapter 13.2.4 - Aggregate Handling and Storage Piles. Bauxite assumed to be similar to "exposed ground".

[2] Frequency of unobstructed wind speed exceeding 5.4 m/s (at mean pile height) derived from CALMET dataset.

[3] Dimensions based on satellite imagery from Bing Maps (2014). Assumed dimensions for outdoor stockpile of 300 m x 300 m x 1 m.

VARIABLES AND ASSUMPTIONS FOR THE SANGARÉDI MINING AREA

Table B.10: Activity Data for Sangarédi

	Units	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY	Comments
Active Work Areas		*2014*	*2017*	*2019*	*2027*	
No. of work areas	#	33	47	56	56	Based on 2014 CBG mine plan. Assumes: ▪ Working area sizes as shown in Figure 10
Total area covered	ha	112.6	177.1	195.6	199.6	
Drilling & Blasting						
Average size of blast	tonnes of ore per blast	48,609	67,136	81,637	99,804	Based on total annual production. Assumes: ▪ 6.11 blasts per week (AECOM 2011, Annex F) ▪ material density of 1.4 tonnes/m^3 (Fluor 2014) ▪ ore depth of 8 m ▪ hole spacing of 5 m
Average horizontal blast area	m per blast	4,340	5,994	7,289	8,911	
Holes drilled	# per day	152	209	254	311	
Quantity of ANFO	tonnes per blast	9	12	15	18	
Clearing & Dozing						
Area of overburned cleared	m per day	3,788	5,232	6,362	7,778	Based on total annual production. Assumes: ▪ material density of 1.4 tonnes/m^3 (Fluor 2014) ▪ ore depth of 8 m ▪ dozer blade width of 4.65 m and blade capacity of 16.4 m^3 (CAT D9R)
Volume of overburned cleared	m per day	1,894	2,616	3,181	3,889	
One-way dozer trips	movements per day	115	160	194	237	
Length of a Dozer Movement	m per movement	44	51	56	62	
Haul Trucks						
Total one-way haul truck trips	trips per yr	165,000	227,889	277,111	338,778	Based on total annual production. Assumes: ▪ haul truck capacity of 90 tonnes (CAT 777F) ▪ no. of haul trucks listed in CBG GHG inventory
One-way trips per haul truck	trips per truck per yr	8,250	8,765	9,237	9,410	
Haul truck empty weight	tonnes	73	73	73	73	Based on: ▪ typical values for CAT 777F
Length of active haul roads	km	14.8	33.7	33.5	33.6	Based on: ▪ length of roads and active work areas shown in Figure 10
Total VKT of active haul trucks	VKT per day	3,934	10,341	12,986	41,970	

	Units	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY	Comments
Light, Medium & Heavy Vehicles						
Length of active roads	km	12.8	12.8	12.8	12.8	Based on: ▪ length of roads and active work areas shown in Figure 10 Assumes: ▪ vehicles are active on roads between CBG office and train loading areas ▪ no. of vehicles listed in CBG GHG inventory
Total VKT of light vehicles	VKT per day	253	253	253	253	
Total VKT of medium and heavy vehicles	VKT per day	169	169	169	169	
Light vehicle average weight	tonnes	1.55	1.55	1.55	1.55	Based on: ▪ vehicles listed in CBG existing equipment list ▪ typical values for Toyota Land Cruiser (J70) and GMC TopKick
Medium and heavy vehicle average weight	tonnes	5.1	5.1	5.1	5.1	
Train Loading						
Number of switching locomotives	#	1	1	1	1	Assumed
One-way train trips	trains per day	5.0	5.7	6.9	8.1	Based on: ▪ Fluor 2014
Locomotives per train	locomotives per train	2	3	3	3	
Train size	wagons per train	120	120	120	126	
Quantity of ore stockpiled	tonnes of ore	157,500	179,550	217,350	255,150	Based on satellite imagery of existing train loading area available from Bing Maps (2014). Assumes: ▪ stockpile dimensions of 50 m x 450 m x 5 m ▪ material density of 1.4 tonnes/m^3 (Fluor 2014)
Number of active ore stockpiles	#	10	11	14	16	
Total surface area of an ore stockpiles	ha	24.3	27.7	33.5	39.3	

Table B.11: Mobile Vehicle and Equipment Fleet in Sangarédi

Source	Total Number of Units				Comments
	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY	
Mining Equipment					Based on: ▪ no. of vehicles listed in CBG GHG inventory ▪ AECOM 2011 ▪ inventory of existing equipment and vehicles provided by CBG
Loader	11	13	16	18	
Truck 90T	20	26	30	36	
Dozer D9	7	7	7	7	
Dozer D10		2	3	4	
Wheel Dozer	2	3	3	4	
Grader	2	3	3	4	
Small Excavator	3	3	3	4	
Light vehicles	42	42	42	42	
Medium/heavy vehicles	22	22	22	22	

Table B.12: Fuel Consumption in the Sangarédi Mining Area (Short-term Effects Emissions Scenario)

Source	Fuel Type	Daily Fuel Consumption (L per day)			
		Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Centrale Sangarédi [1]	Diesel	19,129	21,261	23,584	24,649
Mobile Equip - Mining machinery [1]	Diesel	448	409	398	446
Mobile Equip - Haul trucks (on site) [2]	Diesel	530	484	468	562
Mobile Equip - Haul trucks (passing) [2]	Diesel	4,578	2,639	3,078	3,677
Mobile Equip - Light vehicles [2]	Diesel	19	19	19	19
Mobile Equip - Heavy vehicles [2]	Diesel	33	33	33	33
Mobile Equip - Track equipment [1]	Diesel	184	285	443	472
Locomotives – Hauling [3]	Diesel	320	547	663	778
Locomotives – Switching [3]	Diesel	34	34	34	34

Notes:

[1] Fuel consumption totals for Centrale Sangarédi and Mining Machinery were based on the fuel inventory in CBG greenhouse gas inventories (2012 and 18.5 MTPY, 22.5 MTPY & 27.5MTPY)

[2] Fuel consumption totals for vehicles were based on the fuel inventory in CBG greenhouse gas inventories (2012 and 18.5 MTPY, 22.5 MTPY & 27.5MTPY) and apportioned based on road length and vehicle trips

[3] Fuel consumption for locomotives was based on a nominal horsepower rating (3,000 hp per locomotive; AECOM 2011, Annex F), the number of locomotives per train (Fluor 2014) and fuel densities in the U.S. EPA document Nonroad Emission Factors for Locomotives.

Table B.13: Fuel Consumption in the Sangarédi Mining Area (Long-term Effects Emissions Scenario)

Source	Fuel Type	Daily Fuel Consumption (L per day)			
		Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Centrale Sangarédi [1]	Diesel	19,129	21,261	23,584	24,649
Mobile Equip - Mining machinery [1]	Diesel	14,781	19,240	22,264	24,995
Mobile Equip - Haul trucks [2]	Diesel	17,486	22,731	26,229	31,474
Mobile Equip - Light vehicles [2]	Diesel	62	62	62	62
Mobile Equip - Heavy vehicles [2]	Diesel	105	105	105	105
Mobile Equip - Track equipment [1]	Diesel	184	285	443	472
Locomotives – Hauling [3]	Diesel	320	547	663	778
Locomotives – Switching [3]	Diesel	34	34	34	34

Notes:

[1] Fuel consumption totals for Centrale Sangarédi and Mining Machinery were based on the fuel inventory in CBG greenhouse gas inventories (2012 and 18.5 MTPY, 22.5 MTPY & 27.5MTPY)

[2] Fuel consumption totals for vehicles were based on the fuel inventory in CBG greenhouse gas inventories (2012 and 18.5 MTPY, 22.5 MTPY & 27.5MTPY) and apportioned based on road lengths and vehicle trips

[3] Fuel consumption for locomotives was based on a nominal horsepower rating (3,000 hp per locomotive; AECOM 2011, Annex F), the number of locomotives per train (Fluor 2014) and fuel densities in the U.S. EPA document Nonroad Emission Factors for Locomotives.

Table B.14: Fuel Consumption in the Sangarédi Mining Area (Rail Siding Emissions Scenario)

Source	Fuel Type	Daily Fuel Consumption (L per day)			
		Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Idling Locomotives at Rail Siding [1]	Diesel	18,155			

Notes:

[1] Fuel consumption for locomotives was based on a nominal horsepower rating (3,000 hp per locomotive; AECOM 2011, Annex F), the number of locomotives per train (Fluor 2014) and fuel densities in the U.S. EPA document Nonroad Emission Factors for Locomotives.

Table B.15: Material Handling Rates in Sangarédi (Existing)

Timeframe	Source Description	Moisture Content (%)	Wind Speed (m/s) [2]	Handling Rate (tonnes/hour)	Control (%) [3]
Short-term Effects Scenario	Drop to haul truck from loader [1]	12.5%	2.80	63	0%
	Drop to stockpile from haul truck			2050	
	Drop to train from loader			2050	
Long-term Effects Scenario	Drop to haul truck from loader	12.5%	2.35	1768	29%
	Drop to stockpile from haul truck			1768	
	Drop to train from loader			1768	

Notes:
[1] In the short-term effects scenario, drops to the haul truck only consider activities at the generic working area. All other material handling rates consider the full Sangarédi study area.
[2] Wind speeds derived from CALMET dataset. Maximum monthly wind speed used for short-term effects scenario; average monthly wind speed used for long-term effects scenario.
[3] Annual emissions account for a natural control efficiency of 29% due to precipitation (i.e., 101 days per year with > 0.25 mm of precipitation; derived from CALMET)

Table B.16: Material Handling Rates in Sangarédi (18.5 MTPY)

Timeframe	Source Description	Moisture Content (%)	Wind Speed (m/s) [2]	Handling Rate (tonnes/hour)	Control (%) [3]
Short-term Effects Scenario	Drop to haul truck from loader [1]	12.5%	2.80	55	0%
	Drop to stockpile from haul truck			2442	
	Drop to train from loader			2442	
Long-term Effects Scenario	Drop to haul truck from loader	12.5%	2.35	2442	29%
	Drop to stockpile from haul truck			2442	
	Drop to train from loader			2442	

Notes:
[1] In the short-term effects scenario, drops to the haul truck only consider activities at the generic working area. All other material handling rates consider the full Sangarédi study area.
[2] Wind speeds derived from CALMET dataset. Maximum monthly wind speed used for short-term effects scenario; average monthly wind speed used for long-term effects scenario.
[3] Annual emissions account for a natural control efficiency of 29% due to precipitation (i.e., 101 days per year with > 0.25 mm of precipitation; derived from CALMET)

Table B.17: Material Handling Rates in Sangarédi (22.5 MTPY)

Timeframe	Source Description	Moisture Content (%)	Wind Speed (m/s) [2]	Handling Rate (tonnes/hour)	Control (%) [3]
Short-term Effects Scenario	Drop to haul truck from loader [1]	12.5%	2.80	61	0%
	Drop to stockpile from haul truck			2969	
	Drop to train from loader			2969	
Long-term Effects Scenario	Drop to haul truck from loader	12.5%	2.35	2969	29%
	Drop to stockpile from haul truck			2969	
	Drop to train from loader			2969	

Notes:
[1] In the short-term effects scenario, drops to the haul truck only consider activities at the generic working area. All other material handling rates consider the full Sangarédi study area.
[2] Wind speeds derived from CALMET dataset. Maximum monthly wind speed used for short-term effects scenario; average monthly wind speed used for long-term effects scenario.
[3] Annual emissions account for a natural control efficiency of 29% due to precipitation (i.e., 101 days per year with > 0.25 mm of precipitation; derived from CALMET)

Table B.18: Material Handling Rates in Sangarédi (27.5 MTPY)

Timeframe	Source Description	Moisture Content (%)	Wind Speed (m/s) [2]	Handling Rate (tonnes/hour)	Control (%) [3]
Short-term Effects Scenario	Drop to haul truck from loader [1]	12.5%	2.80	73	0%
	Drop to stockpile from haul truck			3630	
	Drop to train from loader			3630	
Long-term Effects Scenario	Drop to haul truck from loader	12.5%	2.35	3630	29%
	Drop to stockpile from haul truck			3630	
	Drop to train from loader			3630	

Notes:
[1] In the short-term effects scenario, drops to the haul truck only consider activities at the generic working area. All other material handling rates consider the full Sangarédi study area.
[2] Wind speeds derived from CALMET dataset. Maximum monthly wind speed used for short-term effects scenario; average monthly wind speed used for long-term effects scenario.
[3] Annual emissions account for a natural control efficiency of 29% due to precipitation (i.e., 101 days per year with > 0.25 mm of precipitation; derived from CALMET)

Table B.19: Stockpiles and Wind Erosion Sources in Sangarédi

Timeframe	Source Description	Silt Content [4] (%)	Frequency of Winds >5.4m/s [5] (%)	Active Surface Area (ha)			
				Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Short-term Effects Scenario	Active work areas [1]	15%	2.7%	4.0	4.0	4.0	4.0
	Stockpiles at the train loading area [2]	15%	2.7%	24.3	27.7	33.5	39.3
	Open railcars [3]	15%	100.0%	1.2	1.4	1.7	2.0
Long-term Effects Scenario	Active work areas [1]	15%	2.7%	56.3	88.6	97.8	99.8
	Stockpiles at the train loading area [2]	15%	2.7%	24.3	27.7	33.5	39.3
	Open railcars [3]	15%	100.0%	1.2	1.4	1.7	2.0

Notes:
[1] Work area dimensions based on CALPUFF sources shown in Figure 10 and Figure 11; 50% of total work area assumed to be active wind erosion sources for long-term effects scenario.
[2] Dimensions based on satellite imagery from Bing Maps (2014). Assumed dimensions for outdoor stockpile of 50 m x 450 m x 5 m.
[3] Assumes number of railcars and trains noted in Table B.10; dimensions of railcar based on typical values (2 m x 10 m).
[4] Silt content obtained from Table 13.2.4-1 from AP-42, Chapter 13.2.4 - Aggregate Handling and Storage Piles. Bauxite assumed to be similar to "exposed ground".
[5] Frequency of unobstructed wind speed exceeding 5.4 m/s (at mean pile height) derived from CALMET dataset. Railcars move at speeds >5.4 m/s and are thus susceptible to wind erosion 100% of the time on each train trip.

ATTACHMENT C:
ADDITIONAL INFORMATION FOR
CALMET/CALPUFF

CALMET INFORMATION

CALMET Results

The main CALMET outputs that govern atmospheric dispersion are discussed below. These outputs include different meteorological parameters such as wind speed and direction, temperature, precipitation and mixing height and atmospheric stability.

Wind Speed and Direction

Hourly surface wind speed and direction simulated by CALMET at grid points nearest to Project activities are shown in the form of a wind rose plots in Figure C.1 for each year in the meteorological modelling period (2009 to 2013). Figure C.1 shows that the prevailing winds in Kamsar are out of the southwest followed by the west-southwest. At the mine, the winds are predominately from the south to the west-southwest. The average wind speed in Kamsar over the five year period is 3.3 m/s, while the wind speed in Sangarédi is slightly lower on average at 2.3 m/s. This reflects the fact that Kamsar is located on the shore where winds are expected to be stronger.

Figure C.1 also shows that there is little annual variability in wind direction and wind speed in both Kamsar and Sangarédi. As a result, limited year-to-year variability can also be expected in the dispersion modelling results.

Temperature

Monthly average, minimum and maximum surface temperatures generated by CALMET in Kamsar and Sangarédi are provided in Figure C.2 and Figure C.3, respectively. On average, the temperature in Kamsar and Sangarédi is about 25°C. Average monthly temperature shows little variation, but maximum temperatures are shown to be higher during the dry season in both locations (i.e., October to April). However, maximum modelled temperatures in Sangarédi are higher and more variable than Kamsar.

It is not unexpected that maximum temperatures in Kamsar are less extreme than Sangarédi since nearby waters help to regulate air temperature. Locations further inland tend to experience more intense daytime heating and nighttime cooling events. This is also evident in Figure C.4 which shows the diurnal pattern of average surface temperature from CALMET for both Kamsar and Sangarédi.

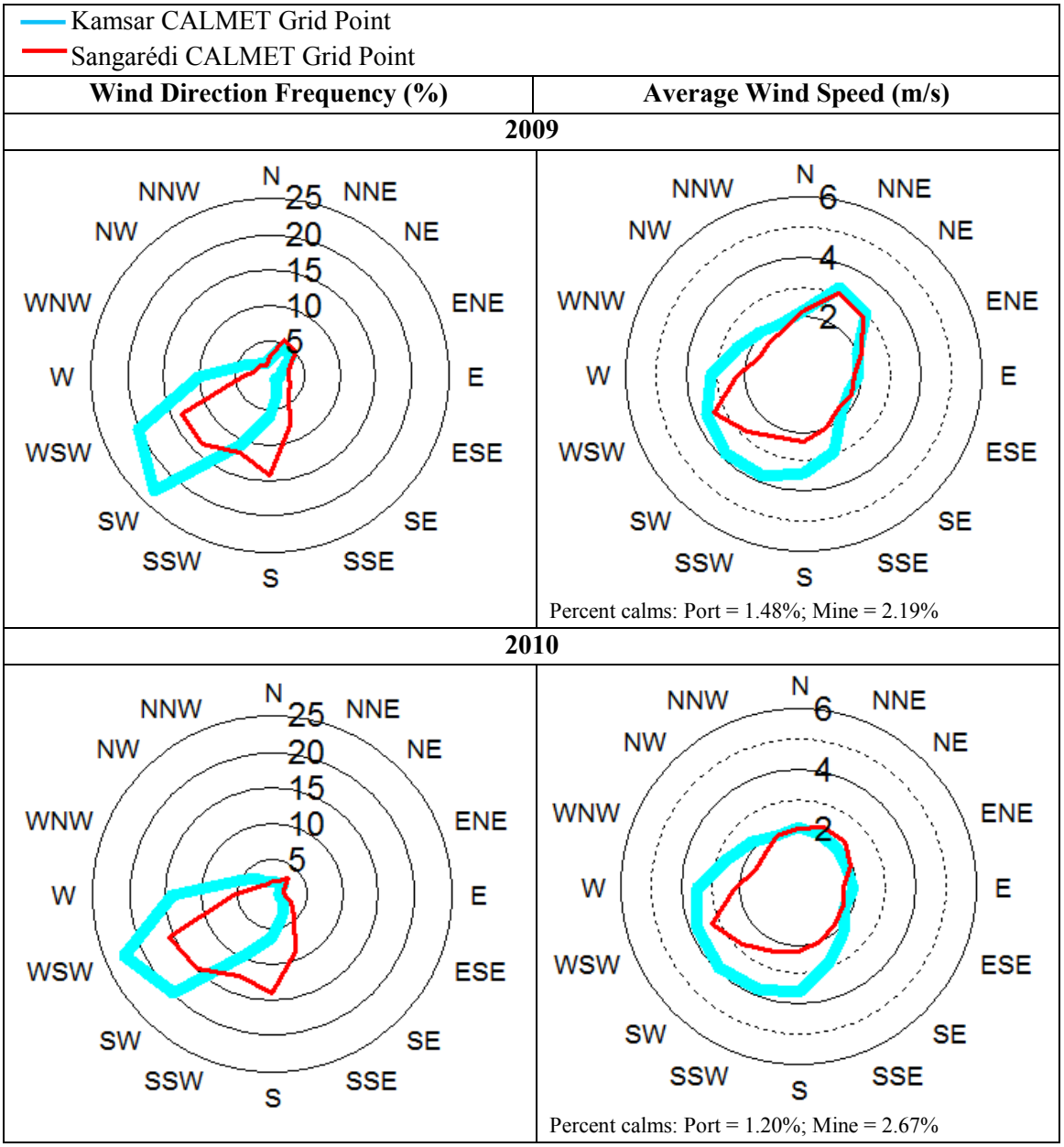
Atmospheric Stability Class and Mixing Height

The frequency of occurrence of each Pasquill-Gifford (Pasquill 1962) stability class as predicted by CALMET for Kamsar and Sangarédi over the 5 year meteorological period is presented in

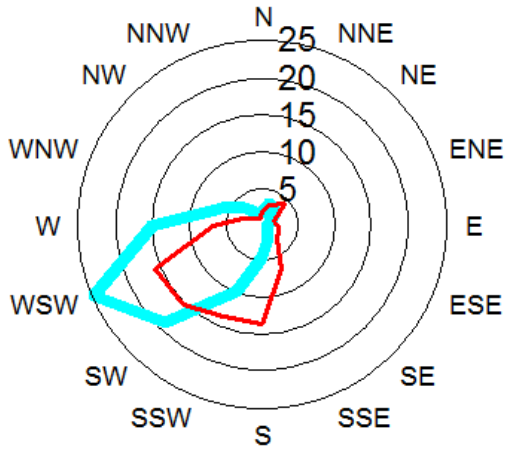
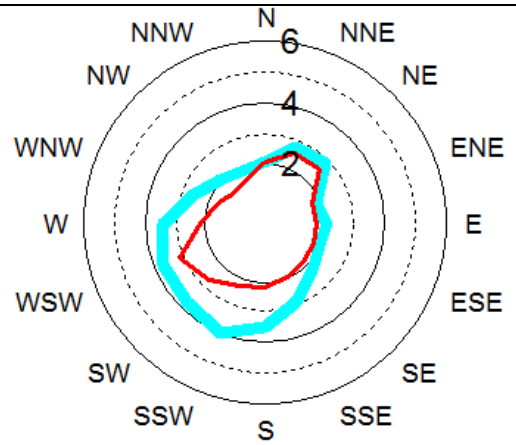
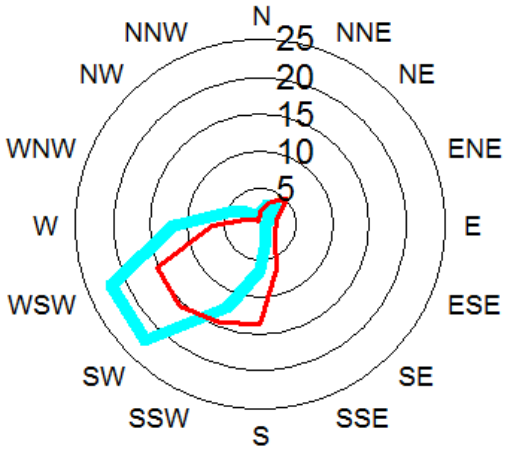
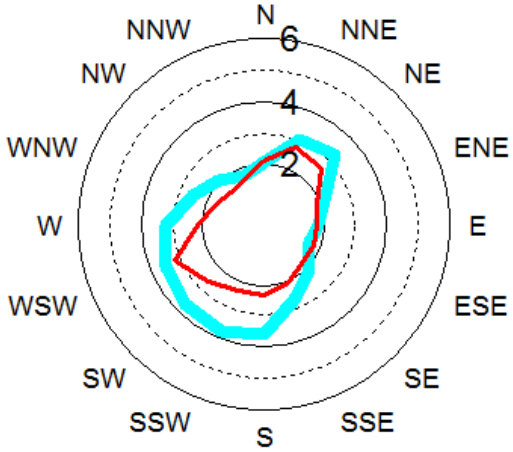
Figure C.5. The results indicate that the stability class with highest frequency is stability class "F". The stability classes "E" and "F" are indicative of stable atmospheric conditions and conducive to moderate to low levels of mechanical mixing. Stability class "B", which represents unstable conditions, was predicted for 20% of the time in Kamsar and 23% of the time in Sangarédi over the 5 year meteorological period.

Mixing height information was also extracted from CALMET for all 5 years and the diurnal variation of the average annual mixing height is illustrated in Figure C.6 for Kamsar and Sangarédi. As can be seen in the Figure, mixing heights tend to increase during the day, reaching a peak in the afternoon and decrease during the nighttime. In addition, Figure C.6 shows the differences in the diurnal variation of mixing height between Kamsar and Sangarédi. The afternoon mixing height in Sangarédi is higher than Kamsar on average. This is a result of stronger daytime heating effects discussed previously and shown in Figure C.4.

Figure C.1: CALMET Wind Roses for the Kamsar Port and Sangarédi Mine, 2009 to 2013



Kamsar CALMET Grid Point
Sangarédi CALMET Grid Point

Wind Direction Frequency (%)	Average Wind Speed (m/s)
2011	
	 Percent calms: Port = 1.22%; Mine = 2.75%
2012	
	 Percent calms: Port = 1.08%; Mine = 2.27%

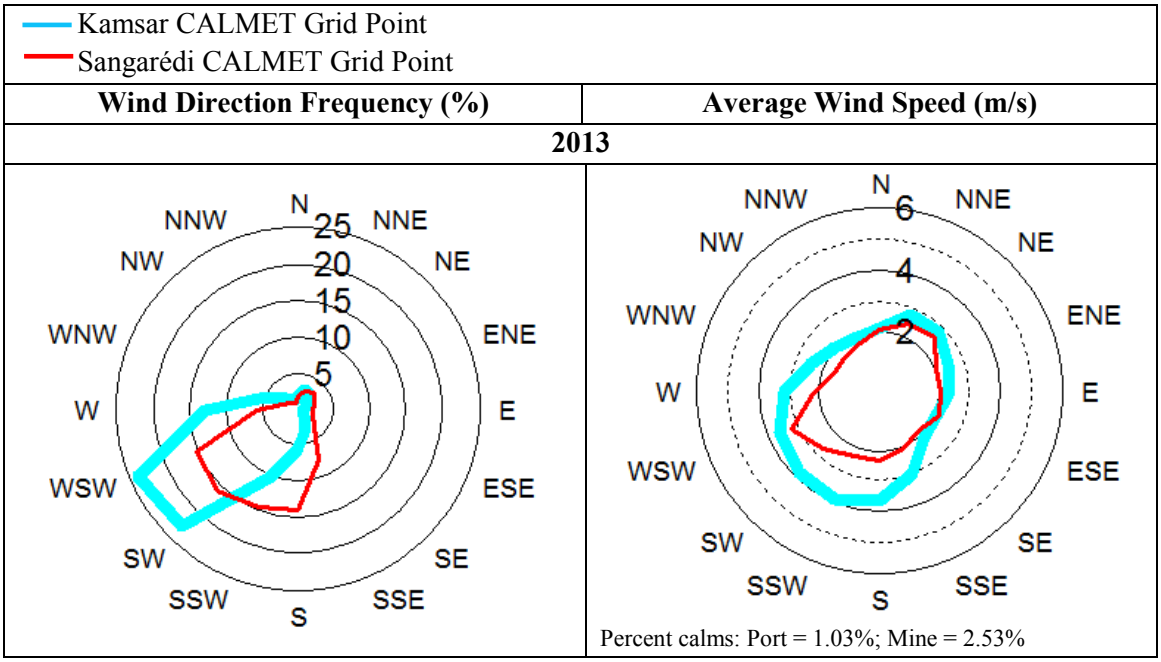


Figure C.2: Kamsar Monthly Temperature Trend, 2009 to 2013

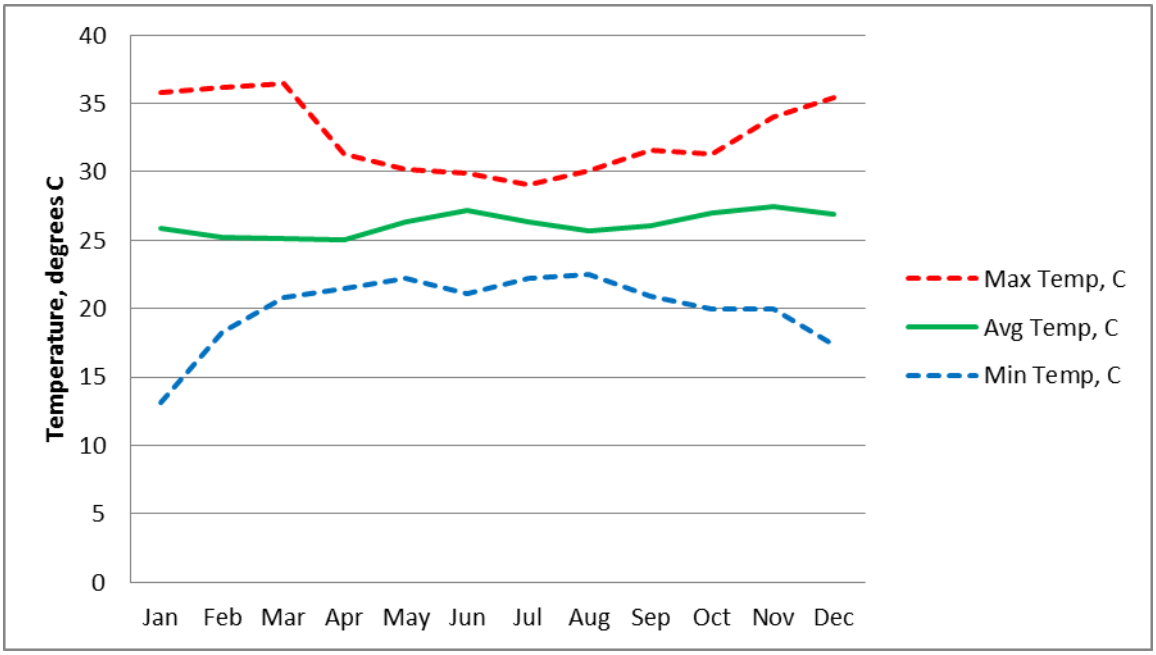


Figure C.3: Sangarédi Monthly Temperature Trend, 2009 to 2013

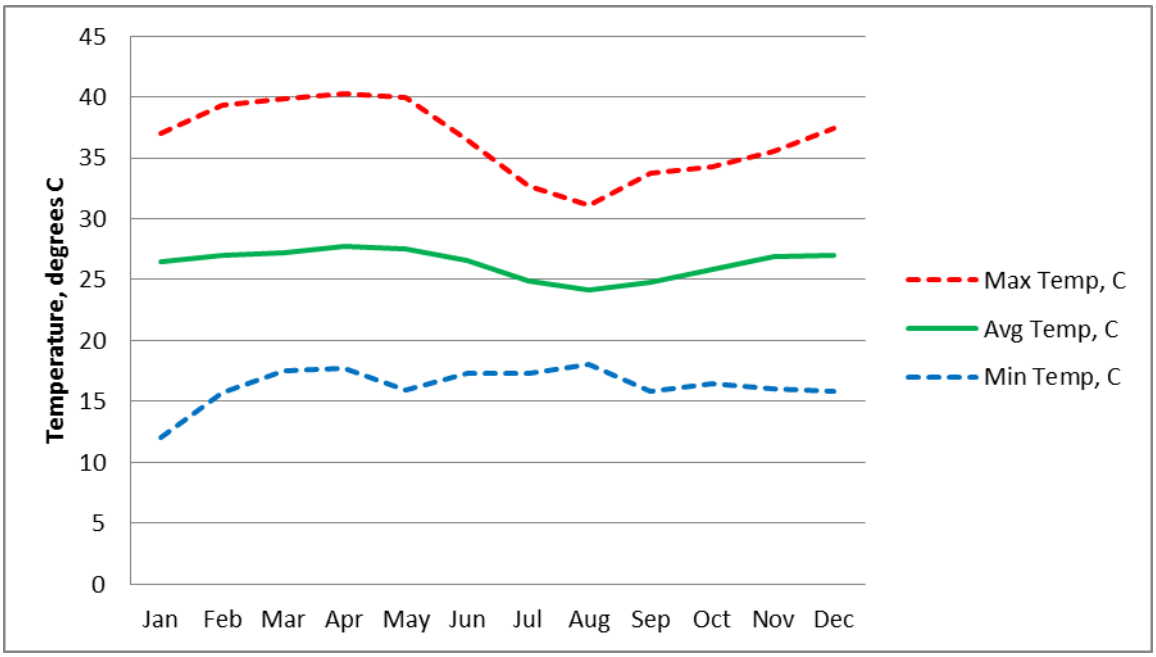


Figure C.4: Kamsar and Sangarédi Diurnal Temperature Trend, 2009 to 2013

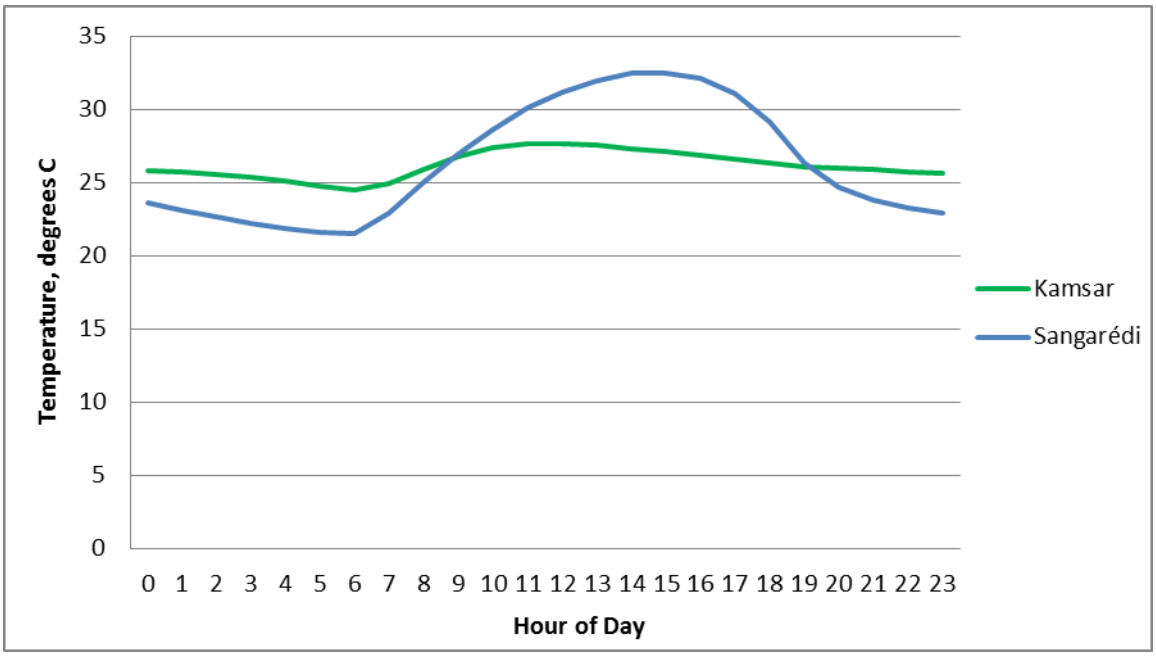
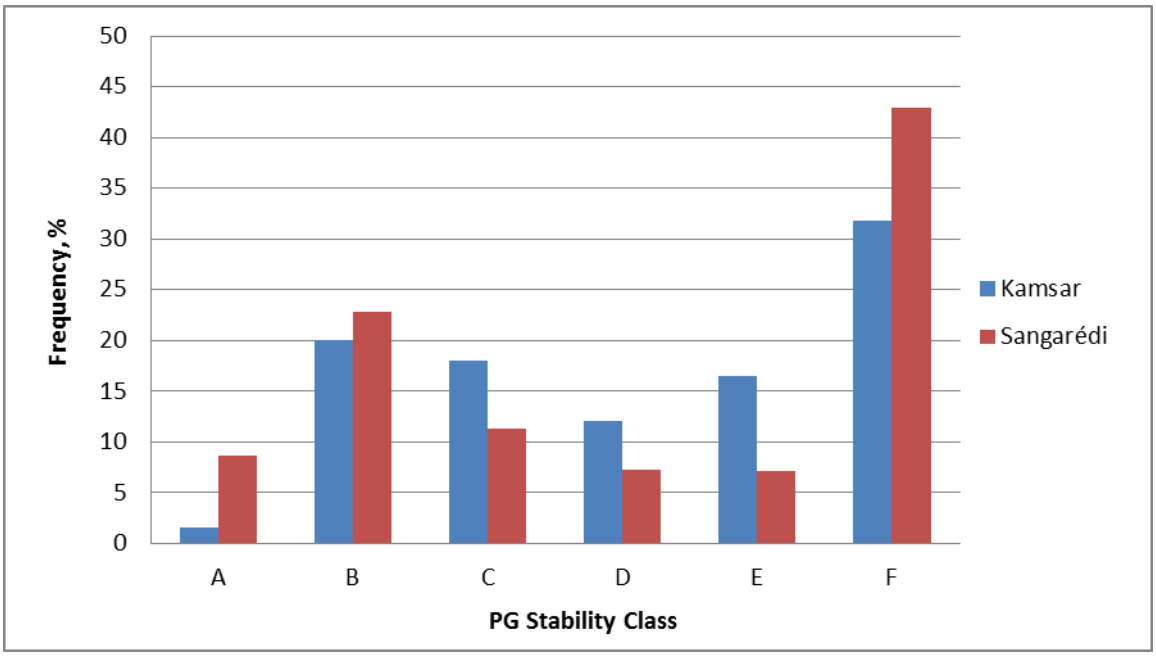
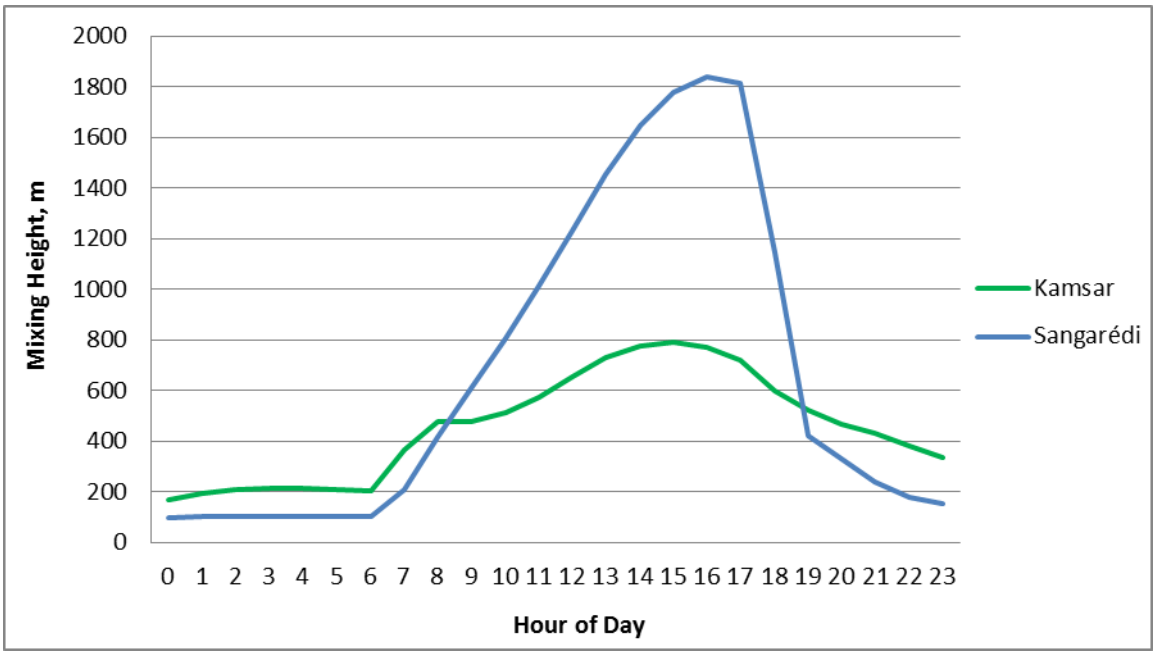


Figure C.5: Kamsar and Sangarédi Stability Class Frequency, 2009 to 2013



Notes:
A = very unstable; B = unstable; C = moderately unstable; D = Neutral; E = Slightly stable; F = Stable

Figure C.6: Kamsar and Sangarédi Diurnal Mixing Height Trend, 2009 to 2013



CALPUFF INFORMATION

CALPUFF Sensitivity Tests

As discussed in Section 6.2 of the main Air Quality Impact Assessment report, the CALPUFF modelling approach was simplified in order to reduce model run times. As discussed in Section 3.3.2, the CALPUFF model runs were performed for a single gaseous contaminant assuming no dry or wet deposition. This approach is conservative for particulate matter since it does not consider the depletion of particulates within a plume. In reality, heavier particles will fall out of a plume close to a source reducing the concentrations of particulate further beyond a source. Consequently the air concentrations of TSP, PM_{10} and $PM_{2.5}$ have been overestimated in the assessment. To understand how conservative the predicted particulate air concentrations are, two sensitivity tests were performed (one in each study area) to determine the differences between modelling particulate matter as a gas with no deposition and modelling particulate matter as a particle with dry deposition. The methodology and results are outlined below.

Model setup

In the Kamsar study area, volume source TAN010 (transfer tower 10) was used to determine the effect of dry deposition on concentrations of TSP. In the Sangarédi study area, a volume source representing a segment of a haul road was used. The same source parameterizations described in Table 6.9 of the main report were used. Both sources were modelled using a 1 g/s emission rate.

In each study area, two (2) model runs were completed:

1. Particulate matter (TSP, PM_{10} and $PM_{2.5}$) was modelled as a gas with no deposition, using the model options outlined in Table 6.3 of the main report.
2. Particulate matter was modelling as a particle with using the dry deposition option (MDRY = 1). All other model options were the same as what is shown in Table 6.3 of the main report.

The dry deposition parameters used in model run #2 were as follows:

Species	Geometric mass mean diameter (µm)	Geometric standard deviation (µm)	NINT
TSP	20.00	1.24	9
PM_{10}	5.00	1.24	9
$PM_{2.5}$	1.25	1.24	9

Sensitivity Test Results

Figure C.7 and Figure C.8 present the resulting concentrations of 24-hour TSP in the Kamsar study area, for model run #1 (no deposition) and run #2 (with deposition), respectively. As can be seen in the Figures, concentrations of TSP are lower when TSP is modelled as a particle with dry deposition. For example, near the air quality monitoring stations, predicted concentrations for model run #1 (as a gas) is about 80 µg/m , whereas for model run #2 (as a particle) the concentration is approximately 60 µg/m .

A contour plot showing the ratio of 24-hour TSP concentrations as a gas vs. concentrations as a particle are also presented in Figure C.9 for Kamsar. Figure C.9 shows that closer to the property, there is little difference in the concentrations. However, as you get further from the source, the ratio decreases. This reflects the fact that heavier particles will fall out of a plume in close proximity to a source so that by the time the plume has travelled some distance, a portion of the particles will have been removed, resulting in lower concentrations further afield. This occurrence is also apparent in the modelling results in Sangarédi, which are discussed below.

Figure C.10 shows how the ratio of TSP concentrations as a gas vs. concentrations as a particle change with distance, both downwind and upwind from the modelled road source. The Figure illustrates that when dry deposition of particles is considered, 24-hour TSP concentrations predicted downwind of a road source are reduced by approximately 20% by about 300 m. Upwind of a road, concentrations are reduced by approximately 16% at 300 m. By 500 m, the model results show that 24-hour concentrations of TSP are reduced by almost 70% on either side of the road.

Estimated TSP deposition rate

The model results from model run #2 at Kamsar described above, were also used to estimate an average TSP deposition rate. The deposition rate was estimated simply by dividing TSP concentrations (in units of µg/m) by the dry deposition fluxes of TSP calculated by CALPUFF (in units of µg/m /s). This resulted in a deposition rate in units of m/s at each receptor within the Kamsar modelling domain. The deposition rates across all receptors were then averaged and found to be about 0.03 m/s or 3 cm/s.

The calculated deposition rate was applied to annual concentrations of TSP and metals within the Kamsar and Sangarédi modelling domains in order to determine the annual average deposition fluxes of TSP and metals. Selected results were provided as inputs to the water quality and biological impact assessments. The results are summarized in Attachment D.

Figure C.7: Kamsar Sensitivity Test: 24-hour Concentrations for TSP modelled as a gas without deposition

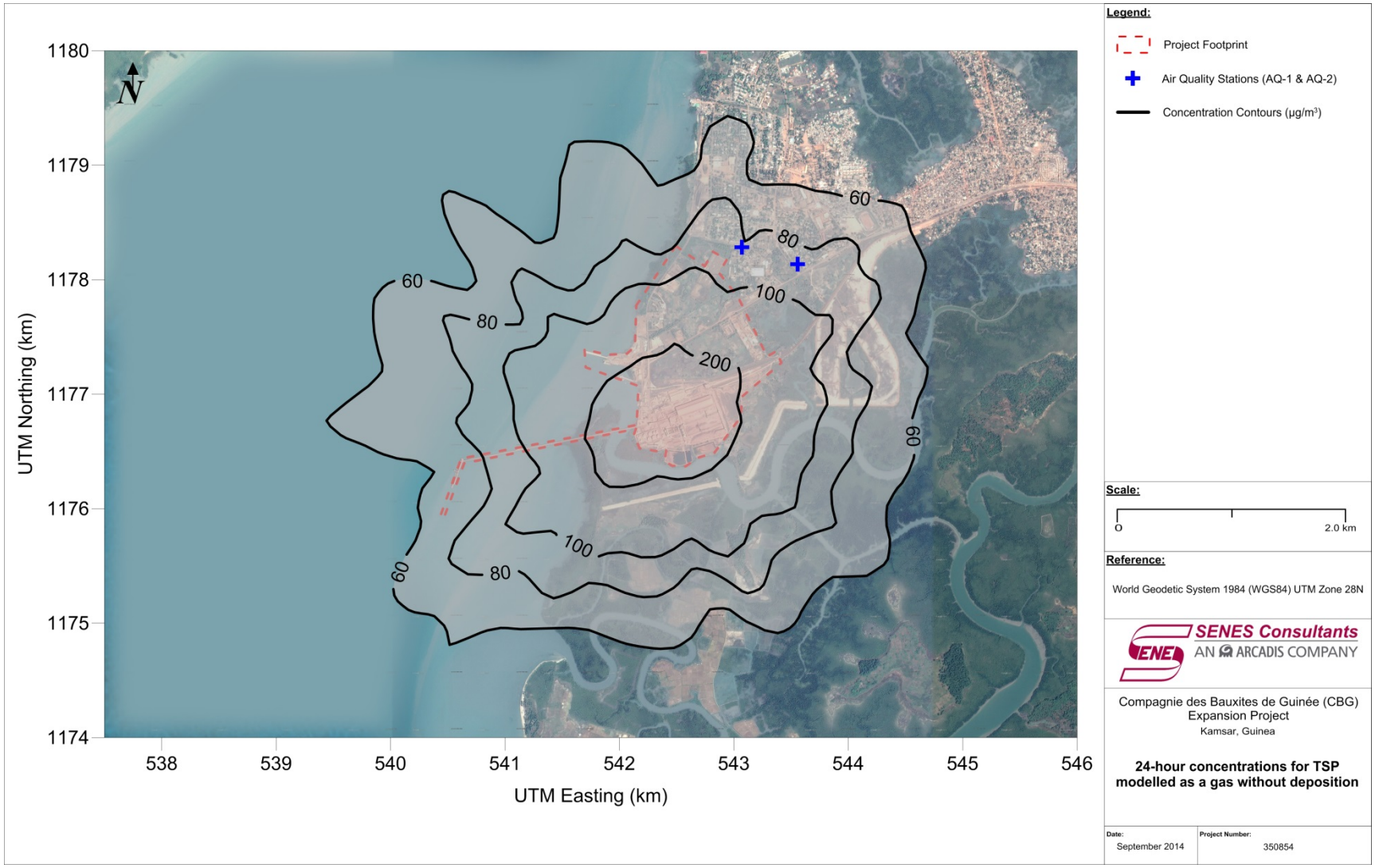


Figure C.8: Kamsar Sensitivity Test: 24-hour Concentrations for TSP modelled as a particle with dry deposition

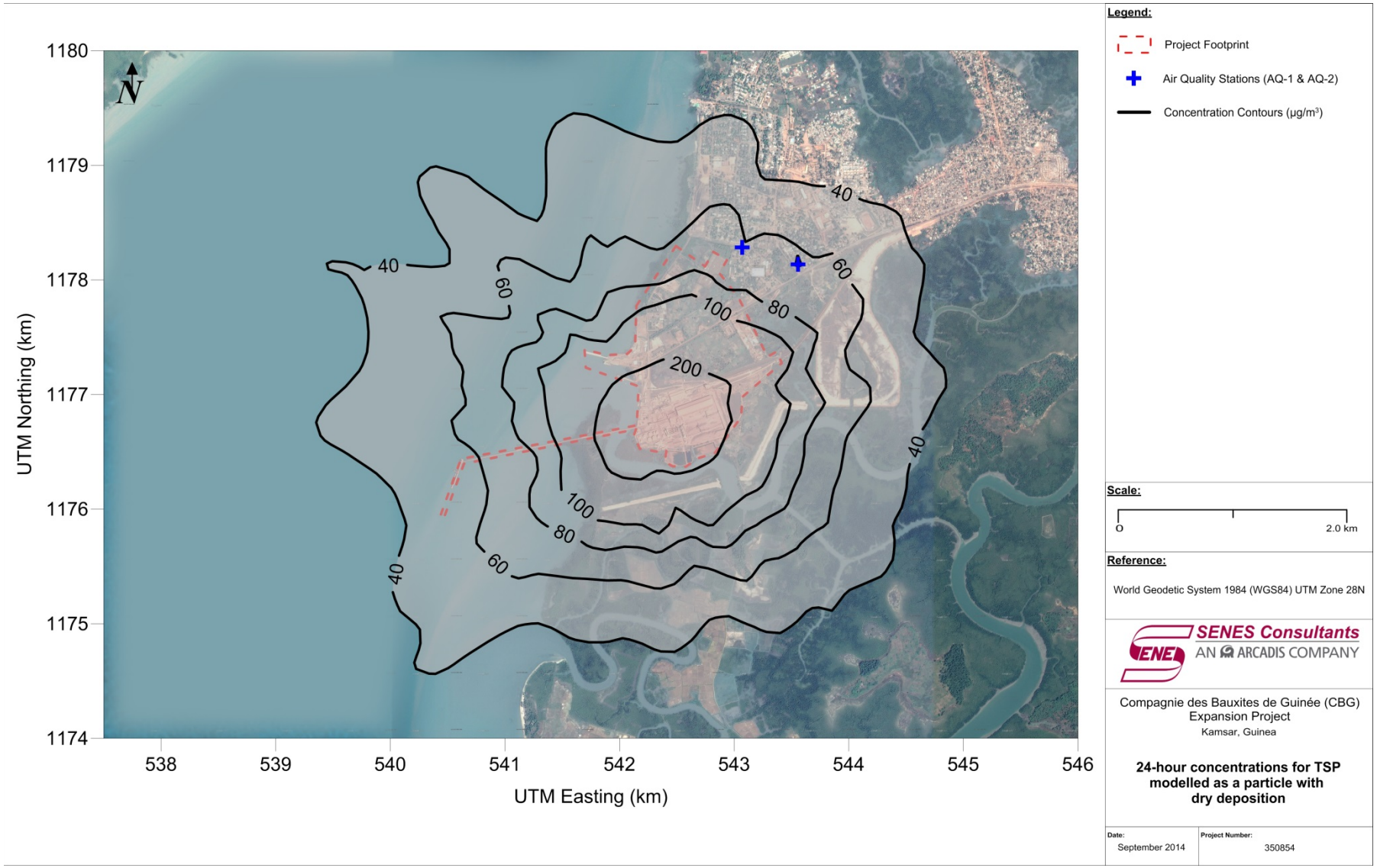


Figure C.9: Kamsar Sensitivity Test: Ratio of TSP concentrations modelled as a gas vs. concentrations modelled as a particle

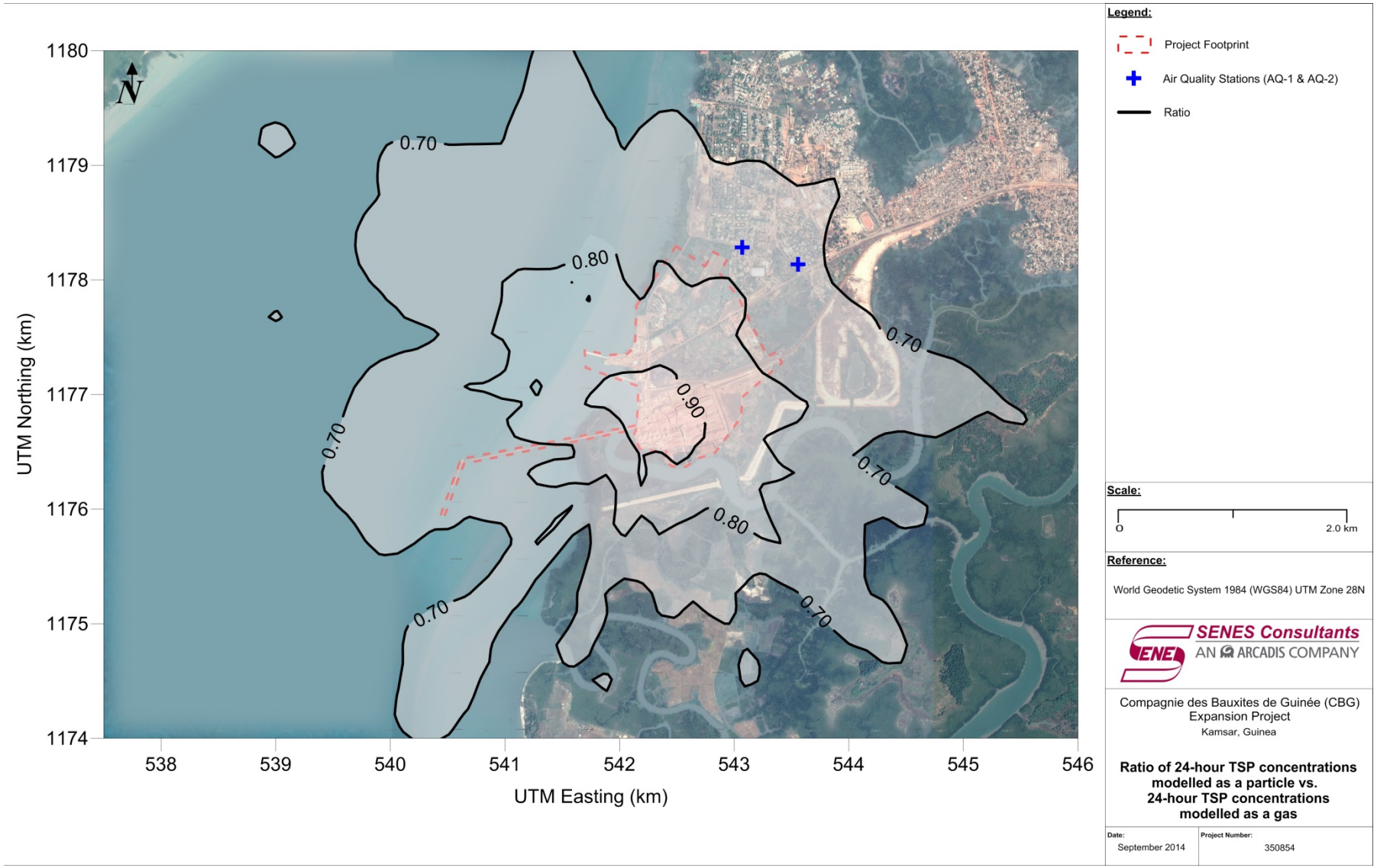
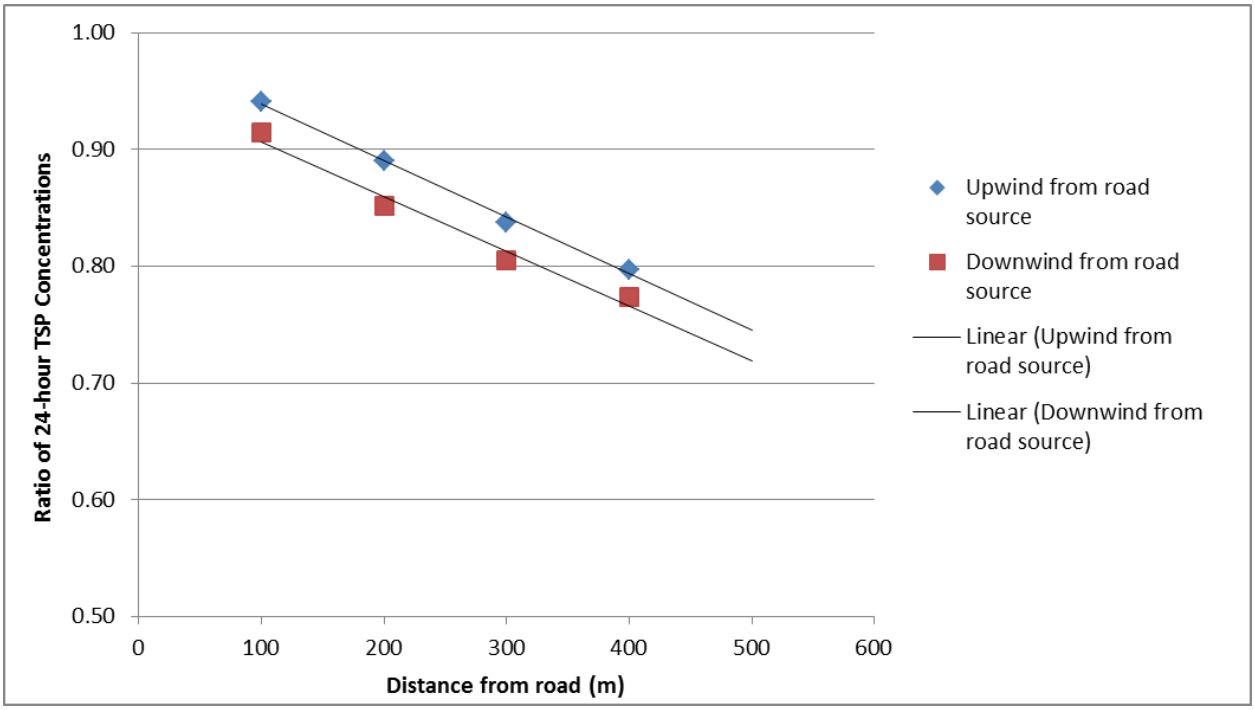


Figure C.10: Sangarédi Sensitivity Test: Ratio of TSP concentrations modelled as a gas vs. concentrations modelled as a particle



ATTACHMENT D:
AIR DISPERSION MODELLING RESULTS TABLES

RESULTS FOR THE SANGARÉDI MINING AREA

Table D. 1: 18.5 MTPY - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
AQ10	AQ-10 Kourawel	620.746	1234.554	1.5	0.2	0.2
AQ11	AQ-11 Hamdallay	622.252	1225.617	83.7	15.2	13.6
AQ12	AQ-12 Petoun BW	628.870	1224.203	5.7	0.8	0.5
AQ13	AQ-13 Paravi	616.710	1221.796	1.0	0.2	0.2
SR1	Boundi Foulasso	612.914	1235.118	0.2	0.02	0.02
SR2	Feto Kewewol	612.704	1232.674	0.2	0.03	0.02
SR3	Pomboniwol	613.069	1232.155	0.2	0.03	0.03
SR4	Sintiourou Nalbewou	613.659	1231.256	0.3	0.04	0.03
SR5	Boullere	613.813	1229.964	0.3	0.05	0.04
SR6	Bandodji Nyalbi	617.423	1231.312	1.1	0.2	0.1
SR7	Daara	617.521	1234.795	0.7	0.1	0.1
SR8	Bossere	617.662	1236.411	0.5	0.08	0.06
SR9	Kourawel	620.668	1234.753	1.5	0.2	0.2
SR10	Sintiourou Kourawel	620.513	1234.360	1.5	0.2	0.2
SR11	Bandodji Touguidje	617.072	1228.404	0.7	0.1	0.1
SR12	Mbourore	619.769	1227.786	2.8	0.4	0.3
SR13	Sintiourou Lenguere	615.527	1226.635	0.5	0.1	0.1
SR14	Gueguere	616.594	1226.045	1.0	0.2	0.1
SR15	Fassely Belendere	615.049	1224.486	0.4	0.06	0.05
SR16	Parawi	615.513	1222.477	0.5	0.1	0.1
SR17	Fassely Fouta Be	619.263	1225.230	2.0	0.3	0.3
SR18	Filo Bowal	611.720	1219.724	1.6	0.3	0.4
SR19	Kalinko Ley	615.105	1219.682	0.6	0.1	0.1
SR20	Sintiourou Madina	615.976	1219.710	0.5	0.1	0.1
SR21	Kankalare	616.622	1221.213	1.3	0.2	0.3
SR22	Kankalare Hacoude	616.889	1221.438	1.4	0.2	0.3
SR23	Telli Bofi	617.465	1221.143	2.1	0.3	0.5
SR24	Madina Kankalare	617.858	1222.070	3.0	0.5	0.7
SR25	Nyangaba	616.903	1219.541	0.5	0.1	0.1
SR26	Kalinko Guessore	617.142	1218.656	0.4	0.06	0.05
SR27	Kalinko Poutai	617.465	1218.221	0.4	0.06	0.05
SR28	Parawol Malassi	619.432	1220.117	1.5	0.2	0.2
SR29	Parawol Kouradje	619.797	1219.260	1.0	0.1	0.1
SR30	Souka	617.634	1216.114	0.4	0.06	0.04
SR31	Wadiya	614.206	1216.016	0.3	0.04	0.03
SR32	Wossou	614.066	1216.241	0.3	0.04	0.03
SR33	Kalinko Rounde	619.642	1216.409	0.4	0.06	0.04
SR34	Hore Lafou	621.524	1221.241	1.7	0.2	0.2
SR35	Kagneka	622.325	1217.638	0.9	0.1	0.1
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	0.4	0.05	0.03
SR37	Lougal	624.677	1215.312	0.4	0.06	0.04
SR38	Djoloun	626.696	1215.772	0.4	0.05	0.04
SR39	Ndiarinde Misside	626.812	1218.047	0.9	0.1	0.1

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR40	Ndiarinde Rounde	626.556	1218.763	0.9	0.1	0.1
SR41	Hafia 1	626.403	1219.671	1.5	0.2	0.2
SR42	Missira	627.949	1219.121	0.8	0.1	0.1
SR43	Wendou Baga	628.243	1215.363	0.3	0.05	0.04
SR44	Sintiourou Missira	628.358	1219.492	1.2	0.2	0.1
SR45	Sakidje	627.540	1220.872	6.1	0.8	0.4
SR46	Hamdalaye	622.082	1225.627	46.6	6.4	3.8
SR47	Lafou Mbayla	623.258	1222.022	2.9	0.4	0.3
SR48	Sintiourou Baladaroul	626.925	1227.663	7.7	1.0	0.5
SR49	Ndantary	626.794	1228.202	8.0	1.0	0.5
SR50	Boundou Wande	629.210	1224.050	4.9	0.8	0.6
SR51	Kare Dabbhel	629.809	1220.856	1.6	0.3	0.2
SR52	Petoum Nyalbi	629.002	1216.784	0.6	0.1	0.1
SR53	Pora Hodho	630.131	1216.744	0.4	0.07	0.06
SR54	Sintiourou Thiewere	630.269	1217.191	0.4	0.06	0.05
SR55	Pora Banla	630.768	1216.534	0.3	0.05	0.03
SR56	Sintiourou Saikou Timbi	630.348	1216.048	0.3	0.04	0.03
SR57	Daroul	630.497	1223.646	15.4	1.9	1.0
SR58	Pora PK130	630.420	1222.985	59.3	6.4	1.9
SR59	Carrefour Parawol	631.430	1221.004	27.8	2.9	0.8
SR60	Kahel Mbody	621.990	1235.671	1.5	0.2	0.1
SR61	Nyale Djaiman	624.955	1236.344	1.8	0.2	0.1
SR62	Nyale Boussoura	625.120	1235.411	2.2	0.3	0.2
SR63	Sintiourou Boussara	624.872	1235.328	2.4	0.3	0.2
SR64	Nyale Moussa	625.947	1236.002	1.8	0.2	0.1
SR65	Nyale Hogo	625.770	1235.742	1.9	0.2	0.1
SR66	Nyale Misside	626.396	1235.647	2.1	0.3	0.2
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	3.2	0.4	0.2
SR68	Thiangui Bonodji	629.255	1235.955	2.2	0.3	0.1
SR69	Thianghe	629.467	1235.269	1.9	0.2	0.1
SR70	Sella Rounde	631.428	1234.702	2.7	0.3	0.2
SR71	Daba Ley	629.833	1233.178	4.4	0.5	0.3
SR72	Daba Dow	629.715	1232.682	4.9	0.6	0.3
SR73	Hore Sella 3	630.141	1232.245	4.5	0.5	0.3
SR74	Hore Sella 2	630.802	1232.233	4.6	0.6	0.3
SR75	Hore Sella 1	631.121	1232.292	4.5	0.5	0.3
SR76	Parawol Aliou	624.789	1231.158	5.7	0.7	0.4
SR77	Paragogo	623.443	1229.209	5.3	0.7	0.5
SR78	Koungnoube	627.093	1228.760	6.2	0.8	0.4
SR79	Doumoun Cogon	632.078	1236.439	1.1	0.1	0.1
SR80	Passago	634.618	1235.978	1.1	0.1	0.1
SR81	Sellawol	631.901	1233.675	2.7	0.3	0.2
SR82	Sambou 1	632.940	1233.190	3.5	0.4	0.2
SR83	Sambou 2	632.633	1232.623	3.5	0.4	0.2
SR84	Cogon Lengue	636.354	1231.950	1.1	0.1	0.1
SR85	Ndanta Fongne Ley	633.318	1229.812	3.9	0.5	0.2
SR86	Ndanta Fongne Dow	632.988	1229.540	4.5	0.5	0.3

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR87	Sintiourou Nyaka	633.023	1225.335	2.2	0.3	0.2
SR88	Bourreti	634.984	1222.464	0.6	0.1	0.1
SR89	Ndantari	636.614	1221.460	0.3	0.04	0.03
SR90	Sitako	634.252	1218.719	0.4	0.06	0.05
SR91	Thiankwe	636.839	1218.743	0.2	0.03	0.02
SR92	Limbiko	633.035	1217.503	0.4	0.06	0.05
SR93	Diandian	634.063	1216.510	0.2	0.03	0.03
SR94	Sintiourou Daroul Diandian	636.520	1217.255	0.2	0.02	0.02
SR95	Sintiourou Kerkere	636.933	1215.577	0.1	0.01	0.01
SR96	Sintiourou Hafia	626.238	1221.457	2.1	0.3	0.2
SR97	Madina Dian	632.551	1221.418	1.1	0.2	0.1

Table D.2: 22.5 MTPY - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
AQ10	AQ-10 Kourawel	620.746	1234.554	3.5	0.5	0.3
AQ11	AQ-11 Hamdallay	622.252	1225.617	121.1	12.8	4.0
AQ12	AQ-12 Petoun BW	628.870	1224.203	5.0	0.5	0.2
AQ13	AQ-13 Paravi	616.710	1221.796	1.7	0.2	0.3
SR1	Boundi Foulasso	612.914	1235.118	0.3	0.04	0.03
SR2	Feto Kewewol	612.704	1232.674	0.4	0.05	0.04
SR3	Pomboniwol	613.069	1232.155	0.4	0.05	0.04
SR4	Sintiourou Nalbewou	613.659	1231.256	0.5	0.1	0.05
SR5	Boullere	613.813	1229.964	0.6	0.1	0.1
SR6	Bandodji Nyalbi	617.423	1231.312	2.7	0.4	0.3
SR7	Daara	617.521	1234.795	1.9	0.3	0.2
SR8	Bossere	617.662	1236.411	1.3	0.2	0.1
SR9	Kourawel	620.668	1234.753	3.4	0.5	0.3
SR10	Sintiourou Kourawel	620.513	1234.360	3.6	0.5	0.3
SR11	Bandodji Touguidje	617.072	1228.404	1.4	0.2	0.2
SR12	Mbourore	619.769	1227.786	18.8	2.6	1.8
SR13	Sintiourou Lenguere	615.527	1226.635	0.8	0.1	0.1
SR14	Gueguere	616.594	1226.045	1.9	0.3	0.2
SR15	Fassely Belendere	615.049	1224.486	0.6	0.1	0.1
SR16	Parawi	615.513	1222.477	0.8	0.1	0.1
SR17	Fassely Fouta Be	619.263	1225.230	5.5	1.0	1.0
SR18	Filo Bowal	611.720	1219.724	2.0	0.3	0.5
SR19	Kalinko Ley	615.105	1219.682	0.8	0.1	0.1
SR20	Sintiourou Madina	615.976	1219.710	0.7	0.1	0.1
SR21	Kankalare	616.622	1221.213	2.0	0.3	0.3
SR22	Kankalare Hacoude	616.889	1221.438	2.1	0.3	0.4
SR23	Telli Bofi	617.465	1221.143	2.8	0.4	0.6
SR24	Madina Kankalare	617.858	1222.070	4.1	0.6	0.9
SR25	Nyangaba	616.903	1219.541	0.6	0.1	0.1
SR26	Kalinko Guessore	617.142	1218.656	0.6	0.1	0.1
SR27	Kalinko Poutai	617.465	1218.221	0.6	0.1	0.05
SR28	Parawol Malassi	619.432	1220.117	1.9	0.2	0.3
SR29	Parawol Kouradje	619.797	1219.260	1.3	0.2	0.1
SR30	Souka	617.634	1216.114	0.5	0.1	0.04
SR31	Wadiya	614.206	1216.016	0.4	0.05	0.04
SR32	Wossou	614.066	1216.241	0.4	0.06	0.04
SR33	Kalinko Rounde	619.642	1216.409	0.5	0.06	0.03
SR34	Hore Lafou	621.524	1221.241	1.8	0.2	0.2
SR35	Kagneka	622.325	1217.638	1.0	0.1	0.1
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	0.4	0.05	0.03
SR37	Lougal	624.677	1215.312	0.4	0.06	0.03
SR38	Djoloun	626.696	1215.772	0.4	0.05	0.03
SR39	Ndiarinde Misside	626.812	1218.047	0.9	0.1	0.06
SR40	Ndiarinde Rounde	626.556	1218.763	0.9	0.1	0.05
SR41	Hafia 1	626.403	1219.671	1.3	0.1	0.1
SR42	Missira	627.949	1219.121	0.8	0.1	0.05

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR43	Wendou Baga	628.243	1215.363	0.4	0.05	0.04
SR44	Sintiourou Missira	628.358	1219.492	1.2	0.2	0.1
SR45	Sakidje	627.540	1220.872	1.2	0.1	0.1
SR46	Hamdalaye	622.082	1225.627	203.8	21.0	7.4
SR47	Lafou Mbayla	623.258	1222.022	2.6	0.3	0.2
SR48	Sintiourou Baladaroul	626.925	1227.663	7.1	0.8	0.3
SR49	Ndantary	626.794	1228.202	7.6	0.8	0.3
SR50	Boundou Wande	629.210	1224.050	4.0	0.4	0.2
SR51	Kare Dabbhel	629.809	1220.856	1.4	0.2	0.1
SR52	Petoum Nyalbi	629.002	1216.784	0.6	0.1	0.1
SR53	Pora Hodho	630.131	1216.744	0.5	0.1	0.06
SR54	Sintiourou Thiewere	630.269	1217.191	0.5	0.1	0.05
SR55	Pora Banla	630.768	1216.534	0.4	0.05	0.04
SR56	Sintiourou Saikou Timbi	630.348	1216.048	0.3	0.05	0.04
SR57	Daroul	630.497	1223.646	2.2	0.3	0.2
SR58	Pora PK130	630.420	1222.985	1.7	0.2	0.1
SR59	Carrefour Parawol	631.430	1221.004	83.1	8.7	2.0
SR60	Kahel Mbody	621.990	1235.671	2.9	0.4	0.3
SR61	Nyale Djaiman	624.955	1236.344	2.4	0.3	0.2
SR62	Nyale Boussoura	625.120	1235.411	2.9	0.4	0.2
SR63	Sintiourou Boussara	624.872	1235.328	3.3	0.4	0.2
SR64	Nyale Moussa	625.947	1236.002	2.2	0.3	0.2
SR65	Nyale Hogo	625.770	1235.742	2.4	0.3	0.2
SR66	Nyale Misside	626.396	1235.647	2.6	0.3	0.2
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	3.5	0.4	0.2
SR68	Thiangui Bonodji	629.255	1235.955	2.5	0.3	0.1
SR69	Thianghe	629.467	1235.269	2.2	0.3	0.1
SR70	Sella Rounde	631.428	1234.702	2.9	0.3	0.1
SR71	Daba Ley	629.833	1233.178	4.7	0.5	0.2
SR72	Daba Dow	629.715	1232.682	5.2	0.6	0.2
SR73	Hore Sella 3	630.141	1232.245	4.7	0.5	0.2
SR74	Hore Sella 2	630.802	1232.233	4.9	0.6	0.2
SR75	Hore Sella 1	631.121	1232.292	4.7	0.5	0.2
SR76	Parawol Aliou	624.789	1231.158	7.0	0.9	0.5
SR77	Paragogo	623.443	1229.209	7.0	0.9	0.6
SR78	Koungnoube	627.093	1228.760	6.1	0.7	0.3
SR79	Doumoun Cogon	632.078	1236.439	1.2	0.1	0.1
SR80	Passago	634.618	1235.978	1.2	0.1	0.1
SR81	Sellawol	631.901	1233.675	2.9	0.3	0.1
SR82	Sambou 1	632.940	1233.190	3.7	0.4	0.2
SR83	Sambou 2	632.633	1232.623	3.7	0.4	0.2
SR84	Cogon Lengue	636.354	1231.950	1.2	0.1	0.1
SR85	Ndanta Fongne Ley	633.318	1229.812	4.1	0.5	0.2
SR86	Ndanta Fongne Dow	632.988	1229.540	4.7	0.5	0.2
SR87	Sintiourou Nyaka	633.023	1225.335	2.4	0.3	0.2
SR88	Bourreti	634.984	1222.464	0.9	0.2	0.2
SR89	Ndantari	636.614	1221.460	0.4	0.1	0.05

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR90	Sitako	634.252	1218.719	1.6	0.2	0.1
SR91	Thiankwe	636.839	1218.743	0.3	0.04	0.03
SR92	Limbiko	633.035	1217.503	0.5	0.1	0.1
SR93	Diandian	634.063	1216.510	0.3	0.04	0.03
SR94	Sintiourou Daroul Diandian	636.520	1217.255	0.2	0.03	0.02
SR95	Sintiourou Kerkere	636.933	1215.577	0.1	0.02	0.01
SR96	Sintiourou Hafia	626.238	1221.457	1.9	0.2	0.1
SR97	Madina Dian	632.551	1221.418	22.0	2.4	0.8

Table D.3: 27.5 MTPY - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
AQ10	AQ-10 Kourawel	620.746	1234.554	47.5	11.0	11.8
AQ11	AQ-11 Hamdallay	622.252	1225.617	53.0	5.4	1.0
AQ12	AQ-12 Petoun BW	628.870	1224.203	0.6	0.1	0.04
AQ13	AQ-13 Paravi	616.710	1221.796	1.5	0.2	0.2
SR1	Boundi Foulasso	612.914	1235.118	0.3	0.03	0.02
SR2	Feto Kewewol	612.704	1232.674	0.3	0.04	0.02
SR3	Pomboniwol	613.069	1232.155	0.3	0.04	0.02
SR4	Sintiourou Nalbewou	613.659	1231.256	0.4	0.05	0.03
SR5	Boullere	613.813	1229.964	0.5	0.1	0.04
SR6	Bandodji Nyalbi	617.423	1231.312	2.2	0.3	0.1
SR7	Daara	617.521	1234.795	2.8	0.4	0.2
SR8	Bossere	617.662	1236.411	1.4	0.2	0.1
SR9	Kourawel	620.668	1234.753	26.4	5.2	4.9
SR10	Sintiourou Kourawel	620.513	1234.360	52.2	12.9	14.4
SR11	Bandodji Touguidje	617.072	1228.404	1.2	0.1	0.1
SR12	Mbourore	619.769	1227.786	9.5	1.0	0.2
SR13	Sintiourou Lenguere	615.527	1226.635	0.7	0.1	0.1
SR14	Gueguere	616.594	1226.045	1.5	0.2	0.1
SR15	Fassely Belendere	615.049	1224.486	0.6	0.1	0.1
SR16	Parawi	615.513	1222.477	0.8	0.1	0.1
SR17	Fassely Fouta Be	619.263	1225.230	2.9	0.3	0.1
SR18	Filo Bowal	611.720	1219.724	2.4	0.4	0.6
SR19	Kalinko Ley	615.105	1219.682	0.8	0.1	0.1
SR20	Sintiourou Madina	615.976	1219.710	0.6	0.1	0.1
SR21	Kankalare	616.622	1221.213	1.8	0.3	0.3
SR22	Kankalare Hacoude	616.889	1221.438	2.0	0.3	0.3
SR23	Telli Bofi	617.465	1221.143	3.0	0.4	0.6
SR24	Madina Kankalare	617.858	1222.070	4.2	0.6	0.9
SR25	Nyangaba	616.903	1219.541	0.6	0.1	0.05
SR26	Kalinko Guessore	617.142	1218.656	0.5	0.1	0.04
SR27	Kalinko Poutai	617.465	1218.221	0.5	0.06	0.04
SR28	Parawol Malassi	619.432	1220.117	1.5	0.2	0.2
SR29	Parawol Kouradje	619.797	1219.260	0.8	0.1	0.1
SR30	Souka	617.634	1216.114	0.4	0.05	0.02
SR31	Wadiya	614.206	1216.016	0.4	0.05	0.02
SR32	Wossou	614.066	1216.241	0.4	0.05	0.03
SR33	Kalinko Rounde	619.642	1216.409	0.3	0.03	0.02
SR34	Hore Lafou	621.524	1221.241	1.0	0.1	0.1
SR35	Kagneka	622.325	1217.638	0.5	0.06	0.03
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	0.2	0.02	0.01
SR37	Lougal	624.677	1215.312	0.2	0.02	0.01
SR38	Djoloun	626.696	1215.772	0.2	0.02	0.01
SR39	Ndiarinde Misside	626.812	1218.047	0.3	0.03	0.02
SR40	Ndiarinde Rounde	626.556	1218.763	0.3	0.03	0.02
SR41	Hafia 1	626.403	1219.671	0.4	0.04	0.02
SR42	Missira	627.949	1219.121	0.3	0.03	0.02

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR43	Wendou Baga	628.243	1215.363	0.2	0.02	0.01
SR44	Sintiourou Missira	628.358	1219.492	0.4	0.04	0.02
SR45	Sakidje	627.540	1220.872	0.3	0.04	0.02
SR46	Hamdalaye	622.082	1225.627	175.0	17.6	2.7
SR47	Lafou Mbayla	623.258	1222.022	1.1	0.1	0.2
SR48	Sintiourou Baladaroul	626.925	1227.663	1.5	0.2	0.1
SR49	Ndantary	626.794	1228.202	1.8	0.2	0.1
SR50	Boundou Wande	629.210	1224.050	0.6	0.1	0.03
SR51	Kare Dabbhel	629.809	1220.856	0.4	0.04	0.02
SR52	Petoum Nyalbi	629.002	1216.784	0.2	0.03	0.01
SR53	Pora Hodho	630.131	1216.744	0.2	0.02	0.01
SR54	Sintiourou Thiewere	630.269	1217.191	0.2	0.02	0.01
SR55	Pora Banla	630.768	1216.534	0.1	0.02	0.01
SR56	Sintiourou Saikou Timbi	630.348	1216.048	0.1	0.02	0.01
SR57	Daroul	630.497	1223.646	0.4	0.05	0.02
SR58	Pora PK130	630.420	1222.985	0.4	0.04	0.02
SR59	Carrefour Parawol	631.430	1221.004	0.4	0.04	0.02
SR60	Kahel Mbody	621.990	1235.671	29.7	4.2	2.4
SR61	Nyale Djaiman	624.955	1236.344	16.8	2.3	1.3
SR62	Nyale Boussoura	625.120	1235.411	6.8	0.9	0.5
SR63	Sintiourou Boussara	624.872	1235.328	10.7	1.4	0.8
SR64	Nyale Moussa	625.947	1236.002	4.4	0.6	0.3
SR65	Nyale Hogo	625.770	1235.742	4.6	0.6	0.3
SR66	Nyale Misside	626.396	1235.647	4.4	0.6	0.3
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	3.3	0.4	0.2
SR68	Thiangui Bonodji	629.255	1235.955	2.7	0.3	0.2
SR69	Thianghe	629.467	1235.269	1.7	0.2	0.1
SR70	Sella Rounde	631.428	1234.702	1.5	0.2	0.1
SR71	Daba Ley	629.833	1233.178	2.9	0.4	0.2
SR72	Daba Dow	629.715	1232.682	3.3	0.4	0.2
SR73	Hore Sella 3	630.141	1232.245	1.9	0.2	0.1
SR74	Hore Sella 2	630.802	1232.233	1.8	0.2	0.1
SR75	Hore Sella 1	631.121	1232.292	1.7	0.2	0.1
SR76	Parawol Aliou	624.789	1231.158	15.8	1.6	0.3
SR77	Paragogo	623.443	1229.209	4.0	0.4	0.1
SR78	Koungnoube	627.093	1228.760	1.6	0.2	0.1
SR79	Doumoun Cogon	632.078	1236.439	0.8	0.1	0.04
SR80	Passago	634.618	1235.978	0.6	0.1	0.03
SR81	Sellawol	631.901	1233.675	1.2	0.1	0.06
SR82	Sambou 1	632.940	1233.190	1.4	0.2	0.1
SR83	Sambou 2	632.633	1232.623	1.2	0.1	0.05
SR84	Cogon Lengue	636.354	1231.950	0.4	0.04	0.02
SR85	Ndanta Fongne Ley	633.318	1229.812	0.8	0.1	0.03
SR86	Ndanta Fongne Dow	632.988	1229.540	0.9	0.1	0.04
SR87	Sintiourou Nyaka	633.023	1225.335	0.4	0.05	0.02
SR88	Bourreti	634.984	1222.464	0.2	0.02	0.01
SR89	Ndantari	636.614	1221.460	0.1	0.01	0.01

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR90	Sitako	634.252	1218.719	0.2	0.02	0.01
SR91	Thiankwe	636.839	1218.743	0.1	0.01	0.01
SR92	Limbiko	633.035	1217.503	0.2	0.02	0.01
SR93	Diandian	634.063	1216.510	0.1	0.01	0.01
SR94	Sintiourou Daroul Diandian	636.520	1217.255	0.1	0.01	0.00
SR95	Sintiourou Kerkere	636.933	1215.577	0.1	0.01	0.00
SR96	Sintiourou Hafia	626.238	1221.457	0.5	0.06	0.03
SR97	Madina Dian	632.551	1221.418	0.3	0.03	0.01

Table D.4: 18.5 MTPY - Model Predicted Maximum Short-term Concentrations in Sangarédi (µg/m^3)

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR1	Boundi Foulasso	612.914	1235.118	7595	4285	0.1	0.0	0	0.0	0.0
SR2	Feto Kewewol	612.704	1232.674	7285	4317	0.1	0.0	0	0.0	0.0
SR3	Pomboniwol	613.069	1232.155	6700	4108	0.1	0.0	0	0.0	0.0
SR4	Sintiourou Nalbewou	613.659	1231.256	5745	4005	0.1	0.0	0	0.0	0.0
SR5	Boullere	613.813	1229.964	5085	2072	0.1	0.0	0	0.0	0.0
SR6	Bandodji Nyalbi	617.423	1231.312	2660	1832	0.3	0.0	0	0.1	0.0
SR7	Daara	617.521	1234.795	3325	298	53.4	5.1	3431	5.6	0.4
SR8	Bossere	617.662	1236.411	4090	1915	0.1	0.0	0	0.0	0.0
SR9	Kourawel	620.668	1234.753	675	232	90.6	8.7	7108	7.3	0.6
SR10	Sintiourou Kourawel	620.513	1234.360	585	100	439.4	42.0	62493	16.1	1.9
SR11	Bandodji Touguidje	617.072	1228.404	1475	549	7.4	0.7	217	2.1	0.1
SR12	Mbourore	619.769	1227.786	100	585	260.4	24.9	146	12.4	1.3
SR13	Sintiourou Lenguere	615.527	1226.635	2845	511	9.9	1.0	329	2.4	0.1
SR14	Gueguere	616.594	1226.045	2065	246	81.1	7.8	6075	7.0	0.5
SR15	Fassely Belendere	615.049	1224.486	4235	485	12.2	1.2	438	2.7	0.1
SR16	Parawi	615.513	1222.477	5385	303	51.8	5.0	3265	5.6	0.4
SR17	Fassely Fouta Be	619.263	1225.230	1340	204	113.9	10.9	9688	8.3	0.7
SR18	Filo Bowal	611.720	1219.724	9945	1962	4.4	0.7	0	0.8	0.2
SR19	Kalinko Ley	615.105	1219.682	7140	1037	1.2	0.2	1	0.6	0.1
SR20	Sintiourou Madina	615.976	1219.710	6350	1189	0.8	0.1	0	0.4	0.0
SR21	Kankalare	616.622	1221.213	5165	191	127.9	12.4	11149	9.3	0.8
SR22	Kankalare Hacoude	616.889	1221.438	4845	353	37.1	3.7	1882	5.2	0.4
SR23	Telli Bofi	617.465	1221.143	4390	989	5.8	0.9	2	1.6	0.3
SR24	Madina Kankalare	617.858	1222.070	3760	1068	7.4	1.2	1	2.1	0.3
SR25	Nyangaba	616.903	1219.541	5650	1570	0.5	0.1	0	0.2	0.0
SR26	Kalinko Guessore	617.142	1218.656	6020	2444	0.4	0.1	0	0.2	0.0
SR27	Kalinko Poutai	617.465	1218.221	6100	2138	0.4	0.1	0	0.2	0.0
SR28	Parawol Malassi	619.432	1220.117	3375	700	6.2	0.9	42	2.5	0.2
SR29	Parawol Kouradje	619.797	1219.260	3905	765	2.2	0.3	20	1.3	0.1
SR30	Souka	617.634	1216.114	7700	2481	0.3	0.0	0	0.1	0.0
SR31	Wadiya	614.206	1216.016	9965	4159	0.3	0.0	0	0.1	0.0
SR32	Wossou	614.066	1216.241	9920	3918	0.3	0.0	0	0.1	0.0
SR33	Kalinko Rounde	619.642	1216.409	6620	1098	0.3	0.0	1	0.4	0.0
SR34	Hore Lafou	621.524	1221.241	1500	627	5.9	0.7	92	2.2	0.1
SR35	Kagneka	622.325	1217.638	5155	172	146.2	14.0	13715	9.4	0.8
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	6570	1144	0.2	0.0	0	0.3	0.0
SR37	Lougal	624.677	1215.312	5910	1579	0.2	0.0	0	0.1	0.0
SR38	Djoloun	626.696	1215.772	5055	2439	0.1	0.0	0	0.1	0.0
SR39	Ndiarinde Misside	626.812	1218.047	2780	1024	0.5	0.1	1	0.4	0.0
SR40	Ndiarinde Rounde	626.556	1218.763	2080	1003	0.5	0.1	1	0.4	0.0
SR41	Hafia 1	626.403	1219.671	1230	1655	0.5	0.1	0	0.3	0.0
SR42	Missira	627.949	1219.121	1880	2357	0.3	0.0	0	0.1	0.0
SR43	Wendou Baga	628.243	1215.363	5355	3638	0.1	0.0	0	0.1	0.0

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR44	Sintiourou Missira	628.358	1219.492	1595	1997	0.4	0.1	0	0.2	0.0
SR45	Sakidje	627.540	1220.872	100	660	260.2	24.9	64	12.5	1.3
SR46	Hamdalaye	622.082	1225.627	145	185	183.5	17.7	11917	10.8	1.0
SR47	Lafou Mbayla	623.258	1222.022	1830	1645	2.2	0.4	0	0.8	0.1
SR48	Sintiourou Baladaroul	626.925	1227.663	845	1740	1.4	0.2	0	0.8	0.0
SR49	Ndantary	626.794	1228.202	1400	1420	0.8	0.1	0	0.2	0.0
SR50	Boundou Wande	629.210	1224.050	1055	336	39.9	3.8	2266	5.1	0.3
SR51	Kare Dabbhel	629.809	1220.856	865	1156	0.9	0.1	0	0.7	0.0
SR52	Petoum Nyalbi	629.002	1216.784	3880	2569	0.2	0.0	0	0.1	0.0
SR53	Pora Hodho	630.131	1216.744	3015	2165	0.2	0.0	0	0.1	0.0
SR54	Sintiourou Thiewere	630.269	1217.191	2625	1684	0.2	0.0	0	0.1	0.0
SR55	Pora Banla	630.768	1216.534	2700	2363	0.1	0.0	0	0.1	0.0
SR56	Sintiourou Saikou Timbi	630.348	1216.048	3345	2849	0.1	0.0	0	0.1	0.0
SR57	Daroul	630.497	1223.646	100	286	260.2	24.9	3931	12.4	1.3
SR58	Pora PK130	630.420	1222.985	100	302	260.2	24.9	3299	12.4	1.3
SR59	Carrefour Parawol	631.430	1221.004	100	486	260.2	24.9	433	12.5	1.3
SR60	Kahel Mbody	621.990	1235.671	625	1166	4.1	0.4	0	1.6	0.1
SR61	Nyale Djaiman	624.955	1236.344	2070	1874	0.2	0.0	0	0.1	0.0
SR62	Nyale Boussoura	625.120	1235.411	1150	928	0.6	0.1	3	0.5	0.0
SR63	Sintiourou Boussara	624.872	1235.328	1055	851	0.9	0.1	8	0.7	0.0
SR64	Nyale Moussa	625.947	1236.002	1995	1741	0.2	0.0	0	0.1	0.0
SR65	Nyale Hogo	625.770	1235.742	1685	1459	0.2	0.0	0	0.1	0.0
SR66	Nyale Misside	626.396	1235.647	1995	1780	0.2	0.0	0	0.1	0.0
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	2600	2226	0.3	0.0	0	0.1	0.0
SR68	Thiangui Bonodji	629.255	1235.955	4620	4127	0.2	0.0	0	0.0	0.0
SR69	Thianghe	629.467	1235.269	4620	3454	0.2	0.0	0	0.0	0.0
SR70	Sella Rounde	631.428	1234.702	4590	3828	0.2	0.0	0	0.1	0.0
SR71	Daba Ley	629.833	1233.178	2590	1630	0.4	0.1	0	0.2	0.0
SR72	Daba Dow	629.715	1232.682	2080	1174	0.5	0.1	0	0.3	0.0
SR73	Hore Sella 3	630.141	1232.245	1815	1341	0.4	0.1	0	0.4	0.0
SR74	Hore Sella 2	630.802	1232.233	2200	1995	0.4	0.1	0	0.1	0.0
SR75	Hore Sella 1	631.121	1232.292	2470	2314	0.4	0.1	0	0.1	0.0
SR76	Parawol Aliou	624.789	1231.158	100	183	260.5	24.9	12128	12.4	1.3
SR77	Paragogo	623.443	1229.209	2290	374	29.6	2.9	1492	4.2	0.3
SR78	Koungnoube	627.093	1228.760	1905	1114	0.7	0.1	0	0.6	0.0
SR79	Doumoun Cogon	632.078	1236.439	6430	4240	0.1	0.0	0	0.0	0.0
SR80	Passago	634.618	1235.978	7545	2770	0.1	0.0	0	0.0	0.0
SR81	Sellawol	631.901	1233.675	4005	2914	0.2	0.0	0	0.1	0.0
SR82	Sambou 1	632.940	1233.190	4460	1778	0.3	0.0	0	0.1	0.0
SR83	Sambou 2	632.633	1232.623	3895	1983	0.3	0.0	0	0.1	0.0
SR84	Cogon Lengue	636.354	1231.950	4890	545	7.5	0.7	227	2.1	0.1
SR85	Ndanta Fongne Ley	633.318	1229.812	2735	754	1.7	0.2	23	1.0	0.0
SR86	Ndanta Fongne Dow	632.988	1229.540	2675	1135	0.4	0.1	0	0.5	0.0
SR87	Sintiourou Nyaka	633.023	1225.335	660	1755	3.2	0.3	0	2.5	0.1

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR88	Bourreti	634.984	1222.464	1875	817	1.0	0.1	11	0.8	0.0
SR89	Ndantari	636.614	1221.460	3235	1627	0.1	0.0	0	0.1	0.0
SR90	Sitako	634.252	1218.719	150	591	174.3	16.7	137	10.2	0.9
SR91	Thiankwe	636.839	1218.743	2685	1832	0.1	0.0	0	0.1	0.0
SR92	Limbiko	633.035	1217.503	1190	2226	0.2	0.0	0	0.2	0.0
SR93	Diandian	634.063	1216.510	2315	2800	0.1	0.0	0	0.1	0.0
SR94	Sintiourou Daroul Diandian	636.520	1217.255	2845	2500	0.1	0.0	0	0.0	0.0
SR95	Sintiourou Kerkere	636.933	1215.577	4275	4140	0.0	0.0	0	0.0	0.0
SR96	Sintiourou Hafia	626.238	1221.457	840	1007	1.3	0.2	1	0.9	0.0
SR97	Madina Dian	632.551	1221.418	100	776	260.1	24.9	18	12.5	1.3

Table D.5: 22.5 MTPY - Model Predicted Maximum Short-term Concentrations in Sangarédi (µg/m^3)

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR1	Boundi Foulasso	612.914	1235.118	7595	4285	0.1	0.0	0	0.0	0.0
SR2	Feto Kewewol	612.704	1232.674	7285	4317	0.1	0.0	0	0.0	0.0
SR3	Pomboniwol	613.069	1232.155	6700	4108	0.1	0.0	0	0.0	0.0
SR4	Sintiourou Nalbewou	613.659	1231.256	5745	4005	0.1	0.0	0	0.0	0.0
SR5	Boullere	613.813	1229.964	5085	2072	0.2	0.0	0	0.1	0.0
SR6	Bandodji Nyalbi	617.423	1231.312	2660	1832	0.6	0.1	0	0.1	0.0
SR7	Daara	617.521	1234.795	3325	298	65.1	6.2	4172	6.8	0.5
SR8	Bossere	617.662	1236.411	4090	1915	0.2	0.0	0	0.1	0.0
SR9	Kourawel	620.668	1234.753	675	232	110.4	10.6	8643	8.9	0.7
SR10	Sintiourou Kourawel	620.513	1234.360	585	100	534.6	51.1	75991	19.6	2.3
SR11	Bandodji Touguidje	617.072	1228.404	1475	549	9.1	0.9	264	2.6	0.1
SR12	Mbourore	619.769	1227.786	100	585	317.9	30.5	177	15.2	1.6
SR13	Sintiourou Lenguere	615.527	1226.635	2845	511	12.1	1.2	400	3.0	0.1
SR14	Gueguere	616.594	1226.045	2065	246	98.7	9.5	7387	8.5	0.7
SR15	Fassely Belendere	615.049	1224.486	4235	485	14.8	1.4	532	3.3	0.2
SR16	Parawi	615.513	1222.477	5385	303	63.0	6.1	3971	6.8	0.5
SR17	Fassely Fouta Be	619.263	1225.230	1340	204	138.7	13.3	11780	10.1	0.9
SR18	Filo Bowal	611.720	1219.724	9945	1962	5.3	0.9	0	1.0	0.2
SR19	Kalinko Ley	615.105	1219.682	7140	1037	1.4	0.2	1	0.7	0.1
SR20	Sintiourou Madina	615.976	1219.710	6350	1189	1.0	0.2	0	0.5	0.0
SR21	Kankalare	616.622	1221.213	5165	191	155.4	15.1	13557	11.3	1.0
SR22	Kankalare Hacoude	616.889	1221.438	4845	353	45.1	4.5	2289	6.3	0.5
SR23	Telli Bofi	617.465	1221.143	4390	989	6.9	1.1	2	2.0	0.3
SR24	Madina Kankalare	617.858	1222.070	3760	1068	8.8	1.4	1	2.5	0.4
SR25	Nyangaba	616.903	1219.541	5650	1570	0.6	0.1	0	0.3	0.0
SR26	Kalinko Guessore	617.142	1218.656	6020	2444	0.5	0.1	0	0.3	0.0
SR27	Kalinko Poutai	617.465	1218.221	6100	2138	0.5	0.1	0	0.3	0.0
SR28	Parawol Malassi	619.432	1220.117	3375	700	7.5	1.1	50	3.0	0.3
SR29	Parawol Kouradje	619.797	1219.260	3905	765	2.8	0.3	25	1.5	0.1
SR30	Souka	617.634	1216.114	7700	2481	0.4	0.1	0	0.2	0.0
SR31	Wadiya	614.206	1216.016	9965	4159	0.4	0.1	0	0.1	0.0
SR32	Wossou	614.066	1216.241	9920	3918	0.4	0.1	0	0.1	0.0
SR33	Kalinko Rounde	619.642	1216.409	6620	1098	0.4	0.1	1	0.4	0.0
SR34	Hore Lafou	621.524	1221.241	1500	627	7.1	0.9	112	2.6	0.2
SR35	Kagneka	622.325	1217.638	5155	172	177.7	17.0	16678	11.4	1.0
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	6570	1144	0.2	0.0	0	0.3	0.0
SR37	Lougal	624.677	1215.312	5910	1579	0.2	0.0	0	0.1	0.0
SR38	Djoloun	626.696	1215.772	5055	2439	0.1	0.0	0	0.1	0.0
SR39	Ndiarinde Misside	626.812	1218.047	2780	1024	0.5	0.1	1	0.5	0.0
SR40	Ndiarinde Rounde	626.556	1218.763	2080	1003	0.5	0.1	2	0.5	0.0
SR41	Hafia 1	626.403	1219.671	1230	1655	0.4	0.1	0	0.4	0.0
SR42	Missira	627.949	1219.121	1880	2357	0.3	0.0	0	0.2	0.0
SR43	Wendou Baga	628.243	1215.363	5355	3638	0.1	0.0	0	0.1	0.0

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR44	Sintiourou Missira	628.358	1219.492	1595	1997	0.3	0.1	0	0.2	0.0
SR45	Sakidje	627.540	1220.872	100	660	316.3	30.2	78	15.2	1.6
SR46	Hamdalaye	622.082	1225.627	145	185	227.2	22.1	14491	13.2	1.3
SR47	Lafou Mbayla	623.258	1222.022	1830	1645	2.6	0.4	0	0.9	0.1
SR48	Sintiourou Baladaroul	626.925	1227.663	845	1740	1.4	0.2	0	0.9	0.0
SR49	Ndantary	626.794	1228.202	1400	1420	0.6	0.1	0	0.3	0.0
SR50	Boundou Wande	629.210	1224.050	1055	336	48.3	4.6	2756	6.2	0.4
SR51	Kare Dabbhel	629.809	1220.856	865	1156	1.0	0.1	0	0.9	0.0
SR52	Petoum Nyalbi	629.002	1216.784	3880	2569	0.2	0.0	0	0.1	0.0
SR53	Pora Hodho	630.131	1216.744	3015	2165	0.2	0.0	0	0.1	0.0
SR54	Sintiourou Thiewere	630.269	1217.191	2625	1684	0.2	0.0	0	0.1	0.0
SR55	Pora Banla	630.768	1216.534	2700	2363	0.1	0.0	0	0.1	0.0
SR56	Sintiourou Saikou Timbi	630.348	1216.048	3345	2849	0.1	0.0	0	0.1	0.0
SR57	Daroul	630.497	1223.646	100	286	316.3	30.2	4780	15.1	1.6
SR58	Pora PK130	630.420	1222.985	100	302	316.3	30.2	4012	15.1	1.6
SR59	Carrefour Parawol	631.430	1221.004	100	486	316.3	30.2	527	15.1	1.6
SR60	Kahel Mbody	621.990	1235.671	625	1166	5.1	0.5	0	1.9	0.1
SR61	Nyale Djaiman	624.955	1236.344	2070	1874	0.3	0.0	0	0.1	0.0
SR62	Nyale Boussoura	625.120	1235.411	1150	928	0.7	0.1	4	0.6	0.0
SR63	Sintiourou Boussara	624.872	1235.328	1055	851	1.1	0.1	10	0.8	0.0
SR64	Nyale Moussa	625.947	1236.002	1995	1741	0.2	0.0	0	0.1	0.0
SR65	Nyale Hogo	625.770	1235.742	1685	1459	0.3	0.0	0	0.1	0.0
SR66	Nyale Misside	626.396	1235.647	1995	1780	0.3	0.0	0	0.1	0.0
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	2600	2226	0.3	0.1	0	0.1	0.0
SR68	Thiangui Bonodji	629.255	1235.955	4620	4127	0.2	0.0	0	0.1	0.0
SR69	Thianghe	629.467	1235.269	4620	3454	0.2	0.0	0	0.0	0.0
SR70	Sella Rounde	631.428	1234.702	4590	3828	0.2	0.0	0	0.1	0.0
SR71	Daba Ley	629.833	1233.178	2590	1630	0.4	0.1	0	0.2	0.0
SR72	Daba Dow	629.715	1232.682	2080	1174	0.5	0.1	0	0.4	0.0
SR73	Hore Sella 3	630.141	1232.245	1815	1341	0.4	0.1	0	0.5	0.0
SR74	Hore Sella 2	630.802	1232.233	2200	1995	0.3	0.1	0	0.2	0.0
SR75	Hore Sella 1	631.121	1232.292	2470	2314	0.3	0.1	0	0.1	0.0
SR76	Parawol Aliou	624.789	1231.158	100	183	316.8	30.3	14747	15.1	1.6
SR77	Paragogo	623.443	1229.209	2290	374	36.2	3.5	1814	5.2	0.3
SR78	Koungnoube	627.093	1228.760	1905	1114	0.6	0.1	1	0.7	0.0
SR79	Doumoun Cogon	632.078	1236.439	6430	4240	0.1	0.0	0	0.0	0.0
SR80	Passago	634.618	1235.978	7545	2770	0.1	0.0	0	0.0	0.0
SR81	Sellawol	631.901	1233.675	4005	2914	0.2	0.0	0	0.1	0.0
SR82	Sambou 1	632.940	1233.190	4460	1778	0.2	0.0	0	0.1	0.0
SR83	Sambou 2	632.633	1232.623	3895	1983	0.2	0.0	0	0.1	0.0
SR84	Cogon Lengue	636.354	1231.950	4890	545	9.1	0.9	276	2.6	0.1
SR85	Ndanta Fongne Ley	633.318	1229.812	2735	754	1.9	0.2	28	1.2	0.0
SR86	Ndanta Fongne Dow	632.988	1229.540	2675	1135	0.4	0.1	0	0.5	0.0
SR87	Sintiourou Nyaka	633.023	1225.335	660	1755	3.8	0.4	0	3.0	0.1

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR88	Bourreti	634.984	1222.464	1875	817	1.2	0.1	14	1.0	0.0
SR89	Ndantari	636.614	1221.460	3235	1627	0.1	0.0	0	0.1	0.0
SR90	Sitako	634.252	1218.719	150	591	211.9	20.3	167	12.4	1.2
SR91	Thiankwe	636.839	1218.743	2685	1832	0.1	0.0	0	0.1	0.0
SR92	Limbiko	633.035	1217.503	1190	2226	0.2	0.0	0	0.3	0.0
SR93	Diandian	634.063	1216.510	2315	2800	0.1	0.0	0	0.1	0.0
SR94	Sintiourou Daroul Diandian	636.520	1217.255	2845	2500	0.1	0.0	0	0.0	0.0
SR95	Sintiourou Kerkere	636.933	1215.577	4275	4140	0.0	0.0	0	0.0	0.0
SR96	Sintiourou Hafia	626.238	1221.457	840	1007	1.4	0.2	2	1.0	0.0
SR97	Madina Dian	632.551	1221.418	100	776	316.2	30.2	22	15.1	1.6

Table D.6: 27.5 MTPY - Model Predicted Maximum Short-term Concentrations in Sangarédi (µg/m^3)

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR1	Boundi Foulasso	612.914	1235.118	7595	4285	0.1	0.0	0	0.0	0.0
SR2	Feto Kewewol	612.704	1232.674	7285	4317	0.1	0.0	0	0.0	0.0
SR3	Pomboniwol	613.069	1232.155	6700	4108	0.1	0.0	0	0.0	0.0
SR4	Sintiourou Nalbewou	613.659	1231.256	5745	4005	0.2	0.0	0	0.0	0.0
SR5	Boullere	613.813	1229.964	5085	2072	0.2	0.0	0	0.1	0.0
SR6	Bandodji Nyalbi	617.423	1231.312	2660	1832	0.7	0.1	0	0.2	0.0
SR7	Daara	617.521	1234.795	3325	298	79.5	7.6	5101	8.4	0.6
SR8	Bossere	617.662	1236.411	4090	1915	0.3	0.0	0	0.1	0.0
SR9	Kourawel	620.668	1234.753	675	232	134.9	12.9	10566	10.9	0.9
SR10	Sintiourou Kourawel	620.513	1234.360	585	100	653.5	62.5	92901	23.9	2.8
SR11	Bandodji Touguidje	617.072	1228.404	1475	549	11.1	1.1	323	3.1	0.1
SR12	Mbourore	619.769	1227.786	100	585	388.6	37.3	217	18.6	1.9
SR13	Sintiourou Lenguere	615.527	1226.635	2845	511	14.8	1.4	489	3.6	0.2
SR14	Gueguere	616.594	1226.045	2065	246	120.7	11.6	9031	10.4	0.8
SR15	Fassely Belendere	615.049	1224.486	4235	485	18.1	1.8	651	4.0	0.2
SR16	Parawi	615.513	1222.477	5385	303	77.0	7.4	4854	8.4	0.6
SR17	Fassely Fouta Be	619.263	1225.230	1340	204	169.6	16.3	14402	12.3	1.1
SR18	Filo Bowal	611.720	1219.724	9945	1962	6.6	1.1	0	1.1	0.2
SR19	Kalinko Ley	615.105	1219.682	7140	1037	1.8	0.3	2	0.8	0.1
SR20	Sintiourou Madina	615.976	1219.710	6350	1189	1.3	0.2	0	0.6	0.1
SR21	Kankalare	616.622	1221.213	5165	191	190.1	18.4	16573	13.8	1.3
SR22	Kankalare Hacoude	616.889	1221.438	4845	353	55.2	5.5	2798	7.7	0.6
SR23	Telli Bofi	617.465	1221.143	4390	989	8.7	1.4	3	2.3	0.4
SR24	Madina Kankalare	617.858	1222.070	3760	1068	10.9	1.7	1	2.9	0.5
SR25	Nyangaba	616.903	1219.541	5650	1570	0.8	0.1	0	0.3	0.0
SR26	Kalinko Guessore	617.142	1218.656	6020	2444	0.7	0.1	0	0.3	0.0
SR27	Kalinko Poutai	617.465	1218.221	6100	2138	0.6	0.1	0	0.3	0.0
SR28	Parawol Malassi	619.432	1220.117	3375	700	9.4	1.3	62	3.6	0.3
SR29	Parawol Kouradje	619.797	1219.260	3905	765	3.4	0.4	30	1.9	0.1
SR30	Souka	617.634	1216.114	7700	2481	0.5	0.1	0	0.2	0.0
SR31	Wadiya	614.206	1216.016	9965	4159	0.4	0.1	0	0.2	0.0
SR32	Wossou	614.066	1216.241	9920	3918	0.5	0.1	0	0.2	0.0
SR33	Kalinko Rounde	619.642	1216.409	6620	1098	0.5	0.1	1	0.5	0.0
SR34	Hore Lafou	621.524	1221.241	1500	627	8.8	1.0	137	3.2	0.2
SR35	Kagneka	622.325	1217.638	5155	172	217.2	20.8	20389	14.0	1.3
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	6570	1144	0.3	0.0	0	0.4	0.0
SR37	Lougal	624.677	1215.312	5910	1579	0.2	0.0	0	0.1	0.0
SR38	Djoloun	626.696	1215.772	5055	2439	0.2	0.0	0	0.1	0.0
SR39	Ndiarinde Misside	626.812	1218.047	2780	1024	0.6	0.1	2	0.6	0.0
SR40	Ndiarinde Rounde	626.556	1218.763	2080	1003	0.6	0.1	2	0.7	0.0
SR41	Hafia 1	626.403	1219.671	1230	1655	0.5	0.1	0	0.4	0.0
SR42	Missira	627.949	1219.121	1880	2357	0.3	0.1	0	0.2	0.0
SR43	Wendou Baga	628.243	1215.363	5355	3638	0.2	0.0	0	0.1	0.0

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR44	Sintiourou Missira	628.358	1219.492	1595	1997	0.4	0.1	0	0.3	0.0
SR45	Sakidje	627.540	1220.872	100	660	386.7	37.0	96	18.5	1.9
SR46	Hamdalaye	622.082	1225.627	145	185	277.5	27.0	17715	16.0	1.6
SR47	Lafou Mbayla	623.258	1222.022	1830	1645	3.2	0.5	0	1.1	0.1
SR48	Sintiourou Baladaroul	626.925	1227.663	845	1740	1.7	0.2	0	1.1	0.0
SR49	Ndantary	626.794	1228.202	1400	1420	0.8	0.1	0	0.3	0.0
SR50	Boundou Wande	629.210	1224.050	1055	336	59.0	5.7	3369	7.5	0.5
SR51	Kare Dabbhel	629.809	1220.856	865	1156	1.2	0.1	0	1.1	0.0
SR52	Petoum Nyalbi	629.002	1216.784	3880	2569	0.2	0.0	0	0.1	0.0
SR53	Pora Hodho	630.131	1216.744	3015	2165	0.2	0.0	0	0.1	0.0
SR54	Sintiourou Thiewere	630.269	1217.191	2625	1684	0.2	0.0	0	0.1	0.0
SR55	Pora Banla	630.768	1216.534	2700	2363	0.2	0.0	0	0.1	0.0
SR56	Sintiourou Saikou Timbi	630.348	1216.048	3345	2849	0.1	0.0	0	0.1	0.0
SR57	Daroul	630.497	1223.646	100	286	386.7	37.0	5844	18.4	1.9
SR58	Pora PK130	630.420	1222.985	100	302	386.7	37.0	4905	18.4	1.9
SR59	Carrefour Parawol	631.430	1221.004	100	486	386.6	37.0	644	18.5	1.9
SR60	Kahel Mbody	621.990	1235.671	625	1166	6.3	0.6	0	2.3	0.1
SR61	Nyale Djaiman	624.955	1236.344	2070	1874	0.3	0.1	0	0.1	0.0
SR62	Nyale Boussoura	625.120	1235.411	1150	928	0.9	0.1	5	0.7	0.0
SR63	Sintiourou Boussara	624.872	1235.328	1055	851	1.4	0.2	12	1.0	0.0
SR64	Nyale Moussa	625.947	1236.002	1995	1741	0.3	0.0	0	0.1	0.0
SR65	Nyale Hogo	625.770	1235.742	1685	1459	0.3	0.1	0	0.1	0.0
SR66	Nyale Misside	626.396	1235.647	1995	1780	0.3	0.1	0	0.1	0.0
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	2600	2226	0.4	0.1	0	0.1	0.0
SR68	Thiangui Bonodji	629.255	1235.955	4620	4127	0.3	0.0	0	0.1	0.0
SR69	Thianghe	629.467	1235.269	4620	3454	0.2	0.0	0	0.1	0.0
SR70	Sella Rounde	631.428	1234.702	4590	3828	0.3	0.0	0	0.1	0.0
SR71	Daba Ley	629.833	1233.178	2590	1630	0.4	0.1	0	0.2	0.0
SR72	Daba Dow	629.715	1232.682	2080	1174	0.6	0.1	0	0.4	0.0
SR73	Hore Sella 3	630.141	1232.245	1815	1341	0.5	0.1	0	0.5	0.0
SR74	Hore Sella 2	630.802	1232.233	2200	1995	0.4	0.1	0	0.2	0.0
SR75	Hore Sella 1	631.121	1232.292	2470	2314	0.4	0.1	0	0.1	0.0
SR76	Parawol Aliou	624.789	1231.158	100	183	387.3	37.1	18029	18.5	1.9
SR77	Paragogo	623.443	1229.209	2290	374	44.3	4.3	2218	6.3	0.4
SR78	Koungnoube	627.093	1228.760	1905	1114	0.7	0.1	1	0.8	0.0
SR79	Doumoun Cogon	632.078	1236.439	6430	4240	0.1	0.0	0	0.0	0.0
SR80	Passago	634.618	1235.978	7545	2770	0.1	0.0	0	0.0	0.0
SR81	Sellawol	631.901	1233.675	4005	2914	0.3	0.0	0	0.1	0.0
SR82	Sambou 1	632.940	1233.190	4460	1778	0.3	0.0	0	0.1	0.0
SR83	Sambou 2	632.633	1232.623	3895	1983	0.3	0.0	0	0.1	0.0
SR84	Cogon Lengue	636.354	1231.950	4890	545	11.1	1.1	338	3.1	0.1
SR85	Ndanta Fongne Ley	633.318	1229.812	2735	754	2.4	0.2	34	1.5	0.0
SR86	Ndanta Fongne Dow	632.988	1229.540	2675	1135	0.4	0.1	1	0.6	0.0
SR87	Sintiourou Nyaka	633.023	1225.335	660	1755	4.6	0.5	0	3.5	0.1

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR88	Bourreti	634.984	1222.464	1875	817	1.4	0.1	17	1.2	0.0
SR89	Ndantari	636.614	1221.460	3235	1627	0.1	0.0	0	0.1	0.0
SR90	Sitako	634.252	1218.719	150	591	259.1	24.8	204	15.1	1.4
SR91	Thiankwe	636.839	1218.743	2685	1832	0.1	0.0	0	0.1	0.0
SR92	Limbiko	633.035	1217.503	1190	2226	0.2	0.0	0	0.3	0.0
SR93	Diandian	634.063	1216.510	2315	2800	0.1	0.0	0	0.1	0.0
SR94	Sintiourou Daroul Diandian	636.520	1217.255	2845	2500	0.1	0.0	0	0.1	0.0
SR95	Sintiourou Kerkere	636.933	1215.577	4275	4140	0.1	0.0	0	0.0	0.0
SR96	Sintiourou Hafia	626.238	1221.457	840	1007	1.8	0.2	2	1.3	0.1
SR97	Madina Dian	632.551	1221.418	100	776	386.6	36.9	27	18.5	1.9

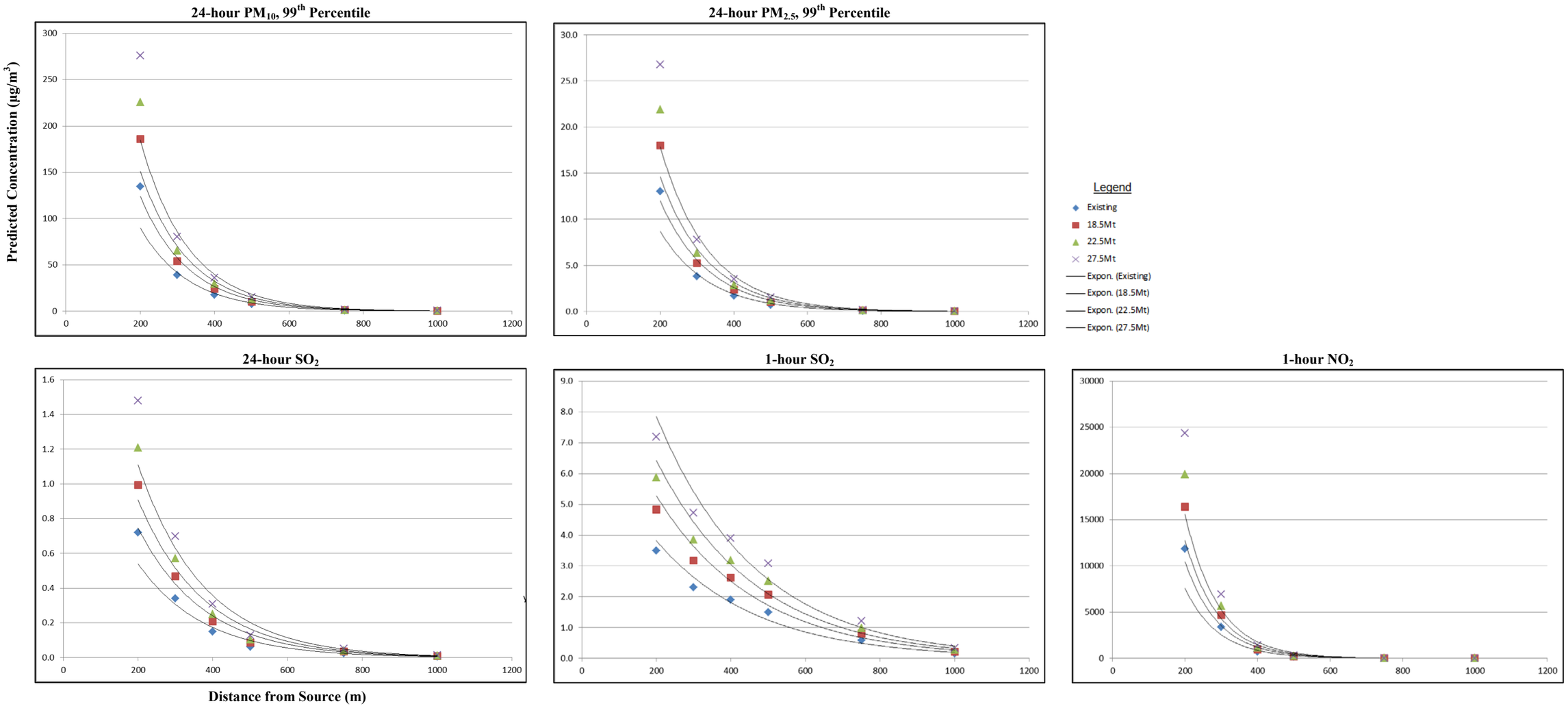
Table D. 7: Regression Parameters for Short-term Concentration Curves

COPC	Averaging Period	Parameter	Existing	18.5MTPY	22.5 MTPY	27.5 MTPY
PM_{10}, 99th Percentile	24-hour	C_0	418.7	578.3	703.3	859.8
		a	0.008	0.008	0.008	0.008
		r^2	0.976	0.976	0.976	0.976
$PM_{2.5}$, 99th Percentile	24-hour	C_0	40.0	55.2	67.2	82.1
		a	0.008	0.008	0.008	0.008
		r^2	0.976	0.976	0.976	0.976
SO_2	24-hour	C_0	1.7	2.3	2.8	3.5
		a	0.006	0.006	0.006	0.006
		r^2	0.977	0.977	0.977	0.977
	1-hour	C_0	8.1	11.1	13.5	16.6
		a	0.004	0.004	0.004	0.004
		r^2	0.979	0.979	0.979	0.979
NO_2	1-hour	C_0	66071	91254	110964	135658
		a	0.011	0.011	0.011	0.011
		r^2	0.978	0.978	0.978	0.978

Note:
Concentrations of COPCs decrease exponentially with distance from a source(s) according to the following relationship:

$$C(x) = C_0 * e^{-a * x}$$

where, $C(x)$ = concentration at distance x
x = distance in metres
C_0 = regression parameter
a = regression parameter
r^2 = coefficient of determination


24-hour PM10, 99th Percentile
24-hour PM2.5, 99th Percentile
24-hour SO2
1-hour SO2
1-hour NO2
Predicted Concentration (µg/m3)
Distance from Source (m)
Legend
Existing
18.5Mt
22.5Mt
27.5Mt
Expon. (Existing)
Expon. (18.5Mt)
Expon. (22.5Mt)
Expon. (27.5Mt)

RESULTS FOR METALLIC CONSTITUENTS OF TSP

While not considered to be a measure of the impact to air quality, average deposition rates of annual TSP and its metallic constituents were calculated in order to inform the biological and water quality impacts assessments. These results are presented in Table D.8 and Table D.9 below.

Table D.8: Average Over-water Deposition Rates ($g/m^2/s$) in Kamsar for TSP and its Metallic Constituents

Scenario	TSP	Al	Sb	As	Cd	Cr	Cu	Ni
Existing	1.22E-06	3.22E-07	4.52E-12	3.54E-11	3.04E-13	1.36E-09	1.53E-10	7.41E-11
18.5MT	1.10E-06	2.91E-07	4.09E-12	3.18E-11	2.78E-13	1.22E-09	1.37E-10	6.74E-11
22.5MT	6.41E-07	1.68E-07	2.57E-12	1.86E-11	1.76E-13	7.06E-10	8.02E-11	4.22E-11
27.5MT	1.24E-06	3.25E-07	4.70E-12	3.60E-11	3.20E-13	1.37E-09	1.55E-10	7.65E-11

Note:
[1] Deposition rates are presented as an average across the over-water area (42 km^2) within the Kamsar study area (see Figure 1). These results were used as input to the water quality impact assessment.
[2] Deposition rates are developed from the TSP concentration contours (presented in Attachment A) with an assumed settling velocity of 3 cm/s.

Table D.9: Average Deposition Rates ($g/m^2/s$) in Sangarédi for TSP and its Metallic Constituents

Scenario	TSP	Al	Sb	As	Cd	Cr	Cu	Ni
Existing	3.52E-07	2.40E-08	3.07E-13	2.64E-12	2.04E-14	1.02E-10	1.14E-11	5.04E-12
18.5MT	5.20E-07	3.37E-08	4.30E-13	3.71E-12	2.89E-14	1.42E-10	1.61E-11	7.04E-12
22.5MT	6.08E-07	3.76E-08	4.80E-13	4.14E-12	3.22E-14	1.60E-10	1.79E-11	7.92E-12
27.5MT	5.07E-07	2.70E-08	3.44E-13	2.98E-12	2.31E-14	1.15E-10	1.29E-11	5.65E-12

Note:
[1] Deposition rates are presented as an average across the Sangarédi study area (572 km^2; see Figure 1). These results were used as input to the water quality impact assessment.
[2] Deposition rates are developed from the TSP concentration contours (presented in Attachment A) with an assumed settling velocity of 3 cm/s.

ATTACHMENT E:
MAXXAM LABORATORY REPORTS

Mini-Vol Particulate Sampling

Certificates of Analysis

Maxxam

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Your C.O.C. #: 15707

Attention:Paul Kirby

SENES Consultants Limited
121 Granton Dr
Unit 12
Richmond Hill, ON
CANADA L4B 3N4

Report Date: 2014/05/05
Report #: R3019943
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B462845
Received: 2014/04/17, 13:35

Sample Matrix: Filter
Samples Received: 84

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Hexavalent Chromium (modified CARB039)	12	2014/04/29	2014/04/30	BRL SOP-00106	Modified CARB 039
Total Metals on Lo-Vol Filter (6010Cmod)	12	2014/05/01	2014/05/01		EPA 6010Cmod
Total Metals (6010Cmod)	12	2014/04/28	2014/04/29	CAM SOP-00408 / BRL SOP-00102	EPA 6010Cmod
Particulates on Lo-Vol Filters	84	N/A	2014/05/01		
Total Particulate	84	N/A	2014/04/24	BRL SOP-00109	
Air Volume from LoVol Sampling	84	N/A	2014/04/24		

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Theresa Stephenson, Project Manager
Email: TStephenson@maxxam.ca
Phone# (905)817-5763
==========
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Maxxam Job #: B462845
Report Date: 2014/05/05

SENES Consultants Limited
Sampler Initials: SD

RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0603	VP0604	VP0605	VP0606		
Sampling Date		2014/03/15 14:40	2014/03/15 14:40	2014/03/15 14:40	2014/03/15 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14020715-AQ1-PM10**	**14020713-AQ1-PM25**	**14021001-AQ2-TSP**	**14020711-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	106	59	253	147	14	3590893
Particulate Weight on Filter	mg	0.75	0.42	1.82	1.06	0.10	3581747
Volume	m3	7.100	7.100	7.200	7.200	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam ID		VP0607		VP0608		VP0609		
Sampling Date		2014/03/15 14:40				2014/04/11 14:40		
COC Number		15707		15707		15707		
	Units	**14020712-AQ2-PM25**	**RDL**	**14020716-BLANK**	**RDL**	**14021060-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	73	14	ND	5000	99	14	3590893
Particulate Weight on Filter	mg	0.52	0.10	0.34	0.10	0.70	0.10	3581747
Volume	m3	7.100	N/A	0	N/A	7.100	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0610	VP0611	VP0612	VP0613		
Sampling Date		2014/04/11 14:40	2014/04/11 14:40	2014/04/11 14:40	2014/04/11 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021061-AQ1-PM10**	**14021062-AQ1-PM25**	**13092301-AQ2-TSP**	**14021051-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	66	46	117	93	14	3590893
Particulate Weight on Filter	mg	0.47	0.33	0.83	0.66	0.10	3581747
Volume	m3	7.100	7.100	7.100	7.100	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0614	VP0615	VP0616	VP0617		
Sampling Date		2014/04/11 14:40	2014/04/03 14:40	2014/04/03 14:40	2014/04/03 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021052-AQ2-PM25**	**13082223-AQ1-TSP**	**13082224-AQ1-PM10**	**13082225-AQ1-PM25**	**RDL**	**QC Batch**
Particulate	ug/m3	63	53	28	ND	14	3590893
Particulate Weight on Filter	mg	0.45	0.38	0.20	ND	0.10	3581747
Volume	m3	7.100	7.200	7.200	7.200	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug		ND			0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0618	VP0619	VP0620		VP0621		
Sampling Date		2014/04/03 14:40	2014/04/03 14:40	2014/04/03 14:40				
COC Number		15707	15707	15707		15707		
	Units	**13082226-AQ2-TSP**	**13082227-AQ2-PM10**	**14020701-AQ2-PM25**	**RDL**	**13092302-BLANK**	**RDL**	**QC Batch**
Particulate	ug/m3	85	43	55	14	ND	5000	3590893
Particulate Weight on Filter	mg	0.61	0.31	0.39	0.10	0.51	0.10	3581747
Volume	m3	7.200	7.200	7.100	N/A	0	N/A	ONSITE
Metals								
Hexavalent Chromium (Cr 6+)	ug	ND			0.01			3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0622	VP0623	VP0624	VP0625		
Sampling Date		2014/04/04 14:40	2014/04/04 14:40	2014/04/04 14:40	2014/04/04 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14020703-AQ1-TSP**	**14020704-AQ1-PM10**	**14020705-AQ1-PM25**	**14020702-AQ2-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	189	127	72	165	14	3590893
Particulate Weight on Filter	mg	1.34	0.90	0.51	1.17	0.10	3581747
Volume	m3	7.100	7.100	7.100	7.100	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0626	VP0627		VP0628	VP0629		
Sampling Date		2014/04/04 14:40						
COC Number		15707	15707		15707	15707		
	Units	**14020706-AQ2-PM10**	**14021059-AQ2-PM25**	**RDL**	**13092304-BLANK**	**13092303-BLANK**	**RDL**	**QC Batch**
Particulate	ug/m3	118	47	14	ND	ND	5000	3590893
Particulate Weight on Filter	mg	0.84	0.34	0.10	0.46	0.44	0.10	3581747
Volume	m3	7.100	7.200	N/A	0	0	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0630	VP0631	VP0632		VP0633		
Sampling Date						2014/04/07 14:40		
COC Number		15707	15707	15707		15707		
	Units	**13092305-BLANK**	**13092306-BLANK**	**13092307-BLANK**	**RDL**	**14021046-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	ND	ND	ND	5000	124	14	3590893
Particulate Weight on Filter	mg	0.42	0.38	0.41	0.10	0.88	0.10	3581747
Volume	m3	0	0	0	N/A	7.100	N/A	ONSITE
Metals								
Hexavalent Chromium (Cr 6+)	ug					ND (1)	0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable
(1) 1/2 filter extracted in 10ml Rodi water. Results are total ug/filter.

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0634	VP0635	VP0636	VP0637		
Sampling Date		2014/04/07 14:40	2014/04/07 14:40	2014/04/07 14:40	2014/04/07 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021047-AQ1-PM10**	**14021048-AQ1-PM25**	**14021049-AQ2-TSP**	**14021050-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	70	42	134	85	14	3590893
Particulate Weight on Filter	mg	0.50	0.30	0.95	0.60	0.10	3581747
Volume	m3	7.100	7.100	7.100	7.100	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

Maxxam ID		VP0638	VP0639	VP0640	VP0641		
Sampling Date		2014/04/07 14:40	2014/04/04 14:40	2014/04/05 14:40	2014/04/05 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021056-AQ2-PM25**	**14020710-AQ2-PM25**	**14020707-AQ1-TSP**	**14020708-AQ1-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	69	48	136	114	14	3590893
Particulate Weight on Filter	mg	0.49	0.34	0.98	0.82	0.10	3581747
Volume	m3	7.100	7.100	7.200	7.200	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0642		VP0643	VP0644		
Sampling Date		2014/04/05 14:40		2014/04/05 14:40	2014/04/05 14:40		
COC Number		15707		15707	15707		
	Units	**14020709-AQ1-PM25**	**QC Batch**	**14021063-AQ2-TSP**	**14021064-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	61	3590893	143	108	14	3590894
Particulate Weight on Filter	mg	0.44	3581747	1.03	0.78	0.10	3581749
Volume	m3	7.200	ONSITE	7.200	7.200	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug		3587398	ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

Maxxam ID		VP0645	VP0646	VP0647	VP0648		
Sampling Date		2014/04/05 14:40	2014/04/06 14:40	2014/04/06 14:40	2014/04/06 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021065-AQ2-PM25**	**14021053-AQ1-TSP**	**14021054-AQ1-PM10**	**14021055-AQ1-PM25**	**RDL**	**QC Batch**
Particulate	ug/m3	61	176	114	63	14	3590894
Particulate Weight on Filter	mg	0.43	1.27	0.82	0.45	0.10	3581749
Volume	m3	7.100	7.200	7.200	7.200	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam ID		VP0649	VP0650		VP0651	VP0652		
Sampling Date		2014/04/06 14:40	2014/04/06 14:40		2014/03/11 14:40	2014/03/11 14:40		
COC Number		15707	15707		15707	15707		
	Units	**14021057-AQ2-TSP**	**14021058-AQ2-PM10**	**RDL**	**14021025-AQ2-TSP**	**14021026-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	164	106	14	139	123	13	3590894
Particulate Weight on Filter	mg	1.18	0.76	0.10	1.06	0.92	0.10	3581749
Volume	m3	7.200	7.200	N/A	7.600	7.500	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0653		VP0654		VP0655		
Sampling Date		2014/03/11 14:40				2014/03/13 14:40		
COC Number		15707		15707		15707		
	Units	**14021030-AQ2-PM25**	**RDL**	**14021043-BLANK**	**RDL**	**14021003-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	62	13	ND	5000	151	14	3590894
Particulate Weight on Filter	mg	0.47	0.10	0.38	0.10	1.07	0.10	3581749
Volume	m3	7.600	N/A	0	N/A	7.100	N/A	ONSITE
Metals								
Hexavalent Chromium (Cr 6+)	ug					ND	0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0656	VP0657	VP0658	VP0659		
Sampling Date		2014/03/13 14:40	2014/03/13 14:40	2014/03/13 14:40	2014/03/13 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021004-AQ1-PM10**	**14021005-AQ1-PM25**	**14021045-AQ2-TSP**	**14021006-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	119	79	153	131	14	3590894
Particulate Weight on Filter	mg	0.86	0.56	1.10	0.93	0.10	3581749
Volume	m3	7.200	7.100	7.200	7.100	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0660		VP0661		VP0662	VP0663		
Sampling Date		2014/03/13 14:40				2014/03/15 14:40	2014/03/05 14:40		
COC Number		15707		15707		15707	15707		
	Units	**14021002-AQ2-PM25**	**RDL**	**14021007-BLANK**	**RDL**	**14020714-AQ1-TSP**	**14021032-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	80	14	ND	5000	204	304	14	3590894
Particulate Weight on Filter	mg	0.57	0.10	0.54	0.10	1.43	2.13	0.10	3581749
Volume	m3	7.100	N/A	0	N/A	7.000	7.000	N/A	ONSITE
Metals									
Hexavalent Chromium (Cr 6+)	ug		0.01				ND	0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0664	VP0665	VP0666	VP0667		
Sampling Date		2014/03/05 14:40	2014/03/05 14:40	2014/03/05 14:40	2014/03/05 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021019-AQ1-PM10**	**14021034-AQ1-PM25**	**14021035-AQ2-TSP**	**14021031-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	247	118	318	249	14	3590894
Particulate Weight on Filter	mg	1.73	0.84	2.26	1.74	0.10	3581749
Volume	m3	7.000	7.100	7.100	7.000	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

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Maxxam Job #: B462845
Report Date: 2014/05/05

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Sampler Initials: SD

RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0668		VP0669		VP0670		
Sampling Date		2014/03/05 14:40				2014/03/07 14:40		
COC Number		15707		15707		15707		
	Units	**14021033-AQ2-PM25**	**RDL**	**14021036-BLANK**	**RDL**	**14021017-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	124	14	ND	5000	200	14	3590894
Particulate Weight on Filter	mg	0.87	0.10	0.38	0.10	1.44	0.10	3581749
Volume	m3	7.000	N/A	0	N/A	7.200	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0671	VP0672	VP0673	VP0674		
Sampling Date		2014/03/07 14:40	2014/03/07 14:40	2014/03/07 14:40	2014/03/07 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021018-AQ1-PM10**	**14021021-AQ1-PM25**	**14021022-AQ2-TSP**	**14021023-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	156	92	230	163	14	3590894
Particulate Weight on Filter	mg	1.12	0.66	1.63	1.17	0.10	3581749
Volume	m3	7.200	7.200	7.100	7.200	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam ID		VP0675		VP0676		VP0677		
Sampling Date		2014/03/07 14:40				2014/03/09 14:40		
COC Number		15707		15707		15707		
	Units	**14021024-AQ2-PM25**	**RDL**	**14021016-BLANK**	**RDL**	**14021037-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	92	14	ND	5000	143	14	3590894
Particulate Weight on Filter	mg	0.66	0.10	0.44	0.10	1.03	0.10	3581749
Volume	m3	7.200	N/A	0	N/A	7.200	N/A	ONSITE
Metals								
Hexavalent Chromium (Cr 6+)	ug					ND	0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

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Maxxam Job #: B462845
Report Date: 2014/05/05

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Sampler Initials: SD

RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0678	VP0679	VP0680	VP0681		
Sampling Date		2014/03/09 14:40	2014/03/09 14:40	2014/03/09 14:40	2014/03/09 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021038-AQ1-PM10**	**14021039-AQ1-PM25**	**14021040-AQ2-TSP**	**14021041-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	107	72	150	117	14	3590894
Particulate Weight on Filter	mg	0.76	0.52	1.08	0.84	0.10	3581749
Volume	m3	7.100	7.200	7.200	7.200	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

Maxxam ID		VP0682			VP0683		VP0684		
Sampling Date		2014/03/09 14:40					2014/03/11 14:40		
COC Number		15707			15707		15707		
	Units	**14021044-AQ2-PM25**	**RDL**	**QC Batch**	**14021042-BLANK**	**RDL**	**14021027-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	75	14	3590894	ND	5000	ND	13	3590895
Particulate Weight on Filter	mg	0.54	0.10	3581749	0.38	0.10	1.21	0.10	3581751
Volume	m3	7.200	N/A	ONSITE	0	N/A	7.600	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0685	VP0686		
Sampling Date		2014/03/11 14:40	2014/03/11 14:40		
COC Number		15707	15707		
	Units	**14021028-AQ1-PM10**	**14021029-AQ1-PM25**	**RDL**	**QC Batch**
Particulate	ug/m3	ND	ND	13	3590895
Particulate Weight on Filter	mg	0.81	0.58	0.10	3581751
Volume	m3	7.500	7.600	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

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Maxxam Job #: B462845
Report Date: 2014/05/05

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Sampler Initials: SD

CALCULATED ELEMENTS (FILTER)

Maxxam ID		VP0615	VP0618		VP0633	VP0636		
Sampling Date		2014/04/03 14:40	2014/04/03 14:40		2014/04/07 14:40	2014/04/07 14:40		
COC Number		15707	15707		15707	15707		
	Units	13082223-AQ1-TSP	13082226-AQ2-TSP	RDL	14021046-AQ1-TSP	14021049-AQ2-TSP	RDL	QC Batch
Metals								
Total Aluminum (Al)	ug/m3	1.57	1.79	0.69	2.71	2.01	0.70	3591040
Total Antimony (Sb)	ug/m3	ND	ND	0.14	ND	ND	0.14	3591040
Total Arsenic (As)	ug/m3	ND	ND	0.083	ND	ND	0.085	3591040
Total Cadmium (Cd)	ug/m3	ND	ND	0.028	ND	ND	0.028	3591040
Total Chromium (Cr)	ug/m3	ND	ND	0.069	ND	ND	0.070	3591040
Total Copper (Cu)	ug/m3	ND	ND	0.069	ND	0.088	0.070	3591040
Total Nickel (Ni)	ug/m3	ND	ND	0.042	ND	ND	0.042	3591040

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

Maxxam ID		VP0640	VP0643		VP0655		VP0658		
Sampling Date		2014/04/05 14:40	2014/04/05 14:40		2014/03/13 14:40		2014/03/13 14:40		
COC Number		15707	15707		15707		15707		
	Units	14020707-AQ1-TSP	14021063-AQ2-TSP	RDL	14021003-AQ1-TSP	RDL	14021045-AQ2-TSP	RDL	QC Batch
Metals									
Total Aluminum (Al)	ug/m3	2.88	2.65	0.69	2.39	0.70	2.43	0.69	3591040
Total Antimony (Sb)	ug/m3	ND	ND	0.14	ND	0.14	ND	0.14	3591040
Total Arsenic (As)	ug/m3	ND	ND	0.083	ND	0.085	ND	0.083	3591040
Total Cadmium (Cd)	ug/m3	ND	ND	0.028	ND	0.028	ND	0.028	3591040
Total Chromium (Cr)	ug/m3	ND	ND	0.069	ND	0.070	ND	0.069	3591040
Total Copper (Cu)	ug/m3	ND	ND	0.069	ND	0.070	ND	0.069	3591040
Total Nickel (Ni)	ug/m3	ND	ND	0.042	ND	0.042	ND	0.042	3591040

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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Report Date: 2014/05/05

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CALCULATED ELEMENTS (FILTER)

Maxxam ID		VP0663		VP0666		VP0677	VP0680		
Sampling Date		2014/03/05 14:40		2014/03/05 14:40		2014/03/09 14:40	2014/03/09 14:40		
COC Number		15707		15707		15707	15707		
	Units	**14021032-AQ1-TSP**	**RDL**	**14021035-AQ2-TSP**	**RDL**	**14021037-AQ1-TSP**	**14021040-AQ2-TSP**	**RDL**	**QC Batch**
Metals									
Total Aluminum (Al)	ug/m3	7.16	0.71	8.31	0.70	1.74	1.79	0.69	3591040
Total Antimony (Sb)	ug/m3	ND	0.14	ND	0.14	ND	ND	0.14	3591040
Total Arsenic (As)	ug/m3	ND	0.086	ND	0.085	ND	ND	0.083	3591040
Total Cadmium (Cd)	ug/m3	ND	0.029	ND	0.028	ND	ND	0.028	3591040
Total Chromium (Cr)	ug/m3	ND	0.071	ND	0.070	ND	ND	0.069	3591040
Total Copper (Cu)	ug/m3	ND	0.071	ND	0.070	ND	ND	0.069	3591040
Total Nickel (Ni)	ug/m3	ND	0.043	ND	0.042	ND	ND	0.042	3591040

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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Maxxam Job #: B462845
Report Date: 2014/05/05

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Sampler Initials: SD

MISCELLANEOUS (FILTER)

Maxxam ID		VP0615	VP0618	VP0633	VP0636		
Sampling Date		2014/04/03 14:40	2014/04/03 14:40	2014/04/07 14:40	2014/04/07 14:40		
COC Number		15707	15707	15707	15707		
	Units	**13082223-AQ1-TSP**	**13082226-AQ2-TSP**	**14021046-AQ1-TSP**	**14021049-AQ2-TSP**	**RDL**	**QC Batch**
Metals							
Aluminum (Al)	ug	11.3	12.9	19.3	14.3	5.0	3586795
Antimony (Sb)	ug	ND	ND	ND	ND	1.0	3586795
Arsenic (As)	ug	ND	ND	ND	ND	0.60	3586795
Cadmium (Cd)	ug	ND	ND	ND	ND	0.20	3586795
Chromium (Cr)	ug	ND	ND	ND	ND	0.50	3586795
Copper (Cu)	ug	ND	ND	ND	0.63	0.50	3586795
Nickel (Ni)	ug	ND	ND	ND	ND	0.30	3586795

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

Maxxam ID		VP0640	VP0643	VP0655	VP0658		
Sampling Date		2014/04/05 14:40	2014/04/05 14:40	2014/03/13 14:40	2014/03/13 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14020707-AQ1-TSP**	**14021063-AQ2-TSP**	**14021003-AQ1-TSP**	**14021045-AQ2-TSP**	**RDL**	**QC Batch**
Metals							
Aluminum (Al)	ug	20.7	19.1	17.0	17.5	5.0	3586795
Antimony (Sb)	ug	ND	ND	ND	ND	1.0	3586795
Arsenic (As)	ug	ND	ND	ND	ND	0.60	3586795
Cadmium (Cd)	ug	ND	ND	ND	ND	0.20	3586795
Chromium (Cr)	ug	ND	ND	ND	ND	0.50	3586795
Copper (Cu)	ug	ND	ND	ND	ND	0.50	3586795
Nickel (Ni)	ug	ND	ND	ND	ND	0.30	3586795

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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Report Date: 2014/05/05

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MISCELLANEOUS (FILTER)

Maxxam ID		VP0663	VP0666	VP0677	VP0680		
Sampling Date		2014/03/05 14:40	2014/03/05 14:40	2014/03/09 14:40	2014/03/09 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021032-AQ1-TSP**	**14021035-AQ2-TSP**	**14021037-AQ1-TSP**	**14021040-AQ2-TSP**	**RDL**	**QC Batch**
Metals							
Aluminum (Al)	ug	50.1	59.0	12.5	12.9	5.0	3586795
Antimony (Sb)	ug	ND	ND	ND	ND	1.0	3586795
Arsenic (As)	ug	ND	ND	ND	ND	0.60	3586795
Cadmium (Cd)	ug	ND	ND	ND	ND	0.20	3586795
Chromium (Cr)	ug	ND	ND	ND	ND	0.50	3586795
Copper (Cu)	ug	ND	ND	ND	ND	0.50	3586795
Nickel (Ni)	ug	ND	ND	ND	ND	0.30	3586795

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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Maxxam Job #: B462845
Report Date: 2014/05/05

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GENERAL COMMENTS

Half filters were digested for metals. Results are total ug/filter.

RESULTS OF ANALYSES OF FILTER

Total Particulate: VP0659-01R *FT**LFT*
VP0668-01R *FT**LFT*

LFT Loose filter material in the petri dish
FT Filter torn

Results relate only to the items tested.

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Maxxam Job #: B462845
Report Date: 2014/05/05

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Sampler Initials: SD

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3586795	APT	Spiked Blank	Aluminum (Al)	2014/04/29		103	%	85 - 115
			Cadmium (Cd)	2014/04/29		107	%	85 - 115
			Chromium (Cr)	2014/04/29		108	%	85 - 115
			Copper (Cu)	2014/04/29		103	%	85 - 115
			Nickel (Ni)	2014/04/29		104	%	85 - 115
			Antimony (Sb)	2014/04/29		117 (1)	%	85 - 115
			Arsenic (As)	2014/04/29		105	%	85 - 115
3586795	APT	RPD	Aluminum (Al)	2014/04/29	1.8		%	20
			Cadmium (Cd)	2014/04/29	1.1		%	20
			Chromium (Cr)	2014/04/29	0.9		%	20
			Copper (Cu)	2014/04/29	1.6		%	20
			Nickel (Ni)	2014/04/29	1		%	20
			Antimony (Sb)	2014/04/29	2.2		%	20
			Arsenic (As)	2014/04/29	1.1		%	20
3586795	APT	Method Blank	Aluminum (Al)	2014/04/29	ND , RDL=5.0		ug	
			Cadmium (Cd)	2014/04/29	ND , RDL=0.20		ug	
			Chromium (Cr)	2014/04/29	ND , RDL=0.50		ug	
			Copper (Cu)	2014/04/29	ND , RDL=0.50		ug	
			Nickel (Ni)	2014/04/29	ND , RDL=0.30		ug	
			Antimony (Sb)	2014/04/29	ND , RDL=1.0		ug	
			Arsenic (As)	2014/04/29	ND , RDL=0.60		ug	
3587398	LLE	Reagent Blank	Hexavalent Chromium (Cr 6+)	2014/04/30	ND , RDL=0.01		ug	
3587398	LLE	Matrix Spike [VP0633-01]	Hexavalent Chromium (Cr 6+)	2014/04/30		106	%	80 - 120
3587398	LLE	Spiked Blank	Hexavalent Chromium (Cr 6+)	2014/04/30		95	%	90 - 110
3587398	LLE	Method Blank	Hexavalent Chromium (Cr 6+)	2014/04/30	ND , RDL=0.01		ug	
3587398	LLE	RPD [VP0633-01]	Hexavalent Chromium (Cr 6+)	2014/04/30	NC		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Reagent Blank: A blank matrix containing all reagents used in the analytical procedure. Used to determine any analytical contamination.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

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Maxxam Job #: B462845
Report Date: 2014/05/05

SENES Consultants Limited
Sampler Initials: SD

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Brenda Moore

Brenda Moore, Team Lead

Frank Mo, B.Sc., Inorganic Lab. Manager

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Chain of Custody Form - AIR

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Page 1 of ____

ANALYSIS REQUESTED

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Granton Dr Unit 12
Richmond Hill, ON L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: Stephane Dallaire, CBE

17-Apr-14 13:35
Keshani Vijh
B462845

NNA

AIR-001

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)
14020715-AQ1-PM10	7153.7	5.0	14-03-15	1440	✓
14020713-AQ1-PM25	7174.6	5.0	14-03-15	1440	✓
14021001-AQ2-TSP	7223.6	5.0	14-03-15	1440	✓
14020711-AQ2-PM10	7216.1	5.0	14-03-15	1440	✓
14020712-AQ2-PM25	7152.4	5.0	14-03-15	1440	✓
14020716-BLANK	—	—	—	—	✓
14021060-AQ1-TSP	7154.8	5.0	14-04-11	1440	✓
14021061-AQ1-PM10	7165.2	5.0	14-04-11	1440	✓
14021062-AQ1-PM25	7156.5	5.0	14-04-11	1440	✓
13092301-AQ2-TSP	7147.2	5.0	14-04-11	1440	✓
14021051-AQ2-PM10	7147.8	5.0	14-04-11	1440	✓
14021052-AQ2-PM25	7149.0	5.0	14-04-11	1440	✓

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBE
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

COC-1031 (04/13) - Air

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CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Granton Dr Suite 12
Richmond Hill, ON, L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: STEPHANE DALAIRE CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
13082223 - AQ1 - TSP	7213.4	5.0	14-04-03	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13082224 - AQ1 - PM10	7212.2	5.0	14-04-03	1440	✓												
13082225 - AQ1 - PM25	7229.7	5.0	14-04-03	1440	✓												
13082226 - AQ2 - TSP	7213.9	5.0	14-04-03	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13082227 - AQ2 - PM10	7204.0	5.0	14-04-03	1440	✓												
14020701 - AQ2 - PM25	7194.1	5.0	14-04-03	1440	✓												
13092302 - BLANK	—	—	—	—	✓												
14020703 - AQ1 - TSP	7190.9	5.0	14-04-04	1440	✓												
14020704 - AQ1 - PM10	7152.2	5.0	14-04-04	1440	✓												
14020705 - AQ1 - PM25	7169.8	5.0	14-04-04	1440	✓												
14020702 - AQ2 - TSP	7123.1	4.9	14-04-04	1440	✓												
14020706 - AQ2 - PM10	7132.9	5.0	14-04-04	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐

Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

COC-1031 (04/13) - Air

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CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Granton Dr Suite 12, Richmond Hill, ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: Stephane Dallaire CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel
14021059 - AQ2 - PM25	7207.4	5.0		1440	✓								
13092304 - BLANK	—	—	—	—	✓								
13092303 - BLANK	—	—	—	—	✓								
13092305 - BLANK	—	—	—	—	✓								
13092306 - BLANK	—	—	—	—	✓								
13092307 - BLANK	—	—	—	—	✓								
14021046 - AQ1 - TSP	7179.8	5.0	14-04-07	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021047 - AQ1 - PM10	7179.2	5.0	14-04-07	1440	✓								
14021048 - AQ1 - PM25	7188.6	5.0	14-04-07	1440	✓								
14021049 - AQ2 - TSP	7174.0	5.0	14-04-07	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021050 - AQ2 - PM10	7172.8	5.0	14-04-07	1440	✓								
14021056 - AQ2 - PM25	7181.6	5.0	14-04-07	1440	✓								

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

COC-1031 (04/13) - Air

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Page 4 of ___

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121, Granton Dr Suite 12
Richmond Hill ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: Stephane Dallaire CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Air)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
14020710-AQ2-PM25	7160.5	5.0	14-04-04	1440	✓												
14020707-AQ1-TSP	7260.7	5.0	14-04-05	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14020708-AQ1-PM10	7224.2	5.0	14-04-05	1440	✓												
14020709-AQ1-PM25	7249.7	5.0	14-04-05	1440	✓												
14021063-AQ2-TSP	7270.4	5.0	14-04-05	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14021064-AQ2-PM10	7287.9	5.1	14-04-05	1440	✓												
14021065-AQ2-PM25	7140.8	5.0	14-04-05	1440	✓												
14021053-AQ1-TSP	7219.0	5.0	14-04-06	1440	✓												
14021054-AQ1-PM10	7219.6	5.0	14-04-06	1440	✓												
14021055-AQ1-PM25	7238.9	5.0	14-04-06	1440	✓												
14021057-AQ2-TSP	7208.0	5.0	14-04-06	1440	✓												
14021058-AQ2-PM10	7207.4	5.0	14-04-06	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
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PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

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EDD ☐

Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

COC-1031 (04/13) - Air

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Page 5 of ____

ANALYSIS REQUESTED

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: Paul Kirby
e-mail: pkirby@senes.ca
Address: 121 Mryton Dr Suite 12
Richmond Hill ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: STEPHANE DALLAIRE C&C

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
14021025-AQ2-TSP	7645.9	5.3	14-03-11	1440	✓												
14021026-AQ2-PM10	7533.3	5.2	14-03-11	1440	✓												
14021030-AQ2-PM25	7620.1	5.3	14-03-11	1440	✓												
14021043-BLANK	—	—	—	—	✓												
14021003-AQ1-TSP	7106.2	4.9	14-03-13	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14021004-AQ1-PM10	7219.0	5.0	14-03-13	1440	✓												
14021005-AQ1-PM25	7162.9	5.0	14-03-13	1440	✓												
14021045-AQ2-TSP	7215.8	5.0	14-03-13	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14021006-AQ2-PM10	7139.1	5.0	14-03-13	1440	✓												
14021002-AQ2-PM25	7157.3	5.0	14-03-13	1440	✓												
14021007-BLANK	—	—	—	—	✓												
14020714-AQ1-TSP	7068.6	4.9	14-03-15	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
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PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

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Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: C&C
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

COC-1031 (04/13) - Air

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CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Bramton Dr Suite 12
Richmond Hill ON L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: Stephane Dallaire CBB

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled (L)	Flow Rate (L/min)	Collection Date	Sample Collection Time (min)	GRAVIMETRIC (DUST)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel
14021032-AQ1-TSP	7094.9	4.9	14-03-05	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021019-AQ1-PM10	7079.3	4.9	14-03-05	1440	✓								
14021034-AQ1-PM25	7139.3	5.0	14-03-05	1440	✓								
14021035-AQ2-TSP	7112.4	4.9	14-03-05	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021031-AQ2-PM10	7093.5	4.9	14-03-05	1440	✓								
14021033-AQ2-PM25	7047.0	4.9	14-03-05	1440	✓								
14021036-BLANK	–	–	–	–	✓								
14021017-AQ1-TSP	7257.7	5.0	14-03-07	1440	✓								
14021018-AQ1-PM10	7295.4	5.1	14-03-07	1440	✓								
14021021-AQ1-PM25	7269.8	5.0	14-03-07	1440	✓								
14021022-AQ2-TSP	7187.0	5.0	14-03-07	1440	✓								
14021023-AQ2-PM10	7281.3	5.1	14-03-07	1440	✓								

TAT Requirement

STD 10 Business day ☐
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Rush 2 Business day * ☐
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PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

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Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBC
Date/Time: 14-04-17

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35.

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Page 7 of ___

CLIENT INFORMATION

Company Name: SENES CONSULTANT LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121, Beaver Dr. Suite 12
Richmond Hill ON L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: Stephane Dallaire CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetry (Dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel
14021024-AQ2-PM25	7255.6	5.0	14-03-07	1440	✓								
14021016-BLANK	—	—	—	—	✓								
14021037-AQ1-TSP	7218.8	5.0	14-03-09	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021038-AQ1-PM10	7166.2	5.0	14-03-09	1440	✓								
14021039-AQ1-PM25	7222.3	5.0	14-03-09	1440	✓								
14021040-AQ2-TSP	7216.1	5.0	14-03-09	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021041-AQ2-PM10	7281.7	5.1	14-03-09	1440	✓								
14021044--AQ2-PM25	7247.0	5.0	14-03-09	1440	✓								
14021042-BLANK	—	—	—	—	✓								
14021027-AQ1-TSP	7627.3	5.3	14-03-11	1440	✓								
14021028-AQ1-PM10	7528.2	5.2	14-03-11	1440	✓								
14021029-AQ1-PM25	7612.2	5.3	14-03-11	1440	✓								

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
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PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

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Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

COC-1031 (04/13) - Air

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Your C.O.C. #: 17030

Attention: Paul Kirby
SENES Consultants Limited
121 Granton Dr
Unit 12
Richmond Hill, ON
CANADA L4B 3N4

Report Date: 2014/06/17
Report #: R3061262
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B492435
Received: 2014/06/02, 11:39

Sample Matrix: Filter
Samples Received: 12

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Hexavalent Chromium (modified CARB039)	2	2014/06/09	2014/06/16	BRL SOP-00106	Modified CARB 039
Total Metals on Lo-Vol Filter (6010Cmod)	2	2014/06/16	2014/06/16		EPA 6010Cmod
Total Metals (6010Cmod)	2	2014/06/10	2014/06/12	CAM SOP-00408 / BRL SOP-00102	EPA 6010Cmod
Particulates on Lo-Vol Filters	12	N/A	2014/06/09		
Total Particulate	12	N/A	2014/06/09	BRL SOP-00109	
Air Volume from LoVol Sampling	11	N/A	2014/06/03		
Air Volume from LoVol Sampling	1	N/A	2014/06/13		

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Theresa Stephenson, Project Manager
Email: TStephenson@maxxam.ca
Phone# (905) 817-5763

==========

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Total cover pages: 1

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SENES Consultants Limited

Maxxam Job #: B492435
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5614	WD5615	WD5616			
Sampling Date		2014/03/18	2014/03/18	2014/03/18			
COC Number		17030	17030	17030			
	Units	**14020719-AQ10-TSP**	**14020721-AQ10-PM10**	**14020720-AQ10-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	137	106	71	14	3627286	N/A
Particulate Weight on Filter	mg	1.00	0.78	0.52	0.10	3632367	N/A
Volume	m3	7.311	7.356	7.339	N/A	ONSITE	N/A
Metals							
Hexavalent Chromium (Cr 6+)	ug	ND			0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5617		WD5618	WD5619			
Sampling Date		2014/03/18		2014/03/18	2014/03/18			
COC Number		17030		17030	17030			
	Units	**14020717-AQ13-TSP**	**RDL**	**14020718-AQ13-PM10**	**14021008-AQ13-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	142	13	90	117	14	3627286	N/A
Particulate Weight on Filter	mg	1.13	0.10	0.66	0.86	0.10	3632367	N/A
Volume	m3	7.943	N/A	7.360	7.379	N/A	ONSITE	N/A
Metals								
Hexavalent Chromium (Cr 6+)	ug	ND	0.01				3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492435
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5620		WD5621	WD5622			
Sampling Date				2014/03/19	2014/03/19			
COC Number		17030		17030	17030			
	Units	**14021011-BLANK**	**RDL**	**14021009-AQ10-TSP**	**14021010-AQ10-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	160	140	14	3627286	N/A
Particulate Weight on Filter	mg	0.46	0.10	1.17	1.03	0.10	3632367	N/A
Volume	m3	0	N/A	7.322	7.341	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5623	WD5624	WD5625			
Sampling Date		2014/03/19	2014/03/19	2014/03/19			
COC Number		17030	17030	17030			
	Units	**14020722-AQ10-PM25**	**14020723-AQ13-TSP**	**14020725-AQ13-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	109	163	432	14	3627286	N/A
Particulate Weight on Filter	mg	0.80	1.19	3.15	0.10	3632367	N/A
Volume	m3	7.329	7.306	7.296	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492435
Report Date: 2014/06/17

CALCULATED ELEMENTS (FILTER)

Maxxam ID		WD5614		WD5617			
Sampling Date		2014/03/18		2014/03/18			
COC Number		17030		17030			
	Units	**14020719-AQ10-TSP**	**RDL**	**14020717-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals							
Total Aluminum (Al)	ug/m3	0.93	0.68	0.83	0.63	3642485	N/A
Total Antimony (Sb)	ug/m3	ND	0.14	ND	0.13	3642485	N/A
Total Arsenic (As)	ug/m3	ND	0.082	ND	0.076	3642485	N/A
Total Cadmium (Cd)	ug/m3	ND	0.027	ND	0.025	3642485	N/A
Total Chromium (Cr)	ug/m3	ND	0.068	ND	0.063	3642485	N/A
Total Copper (Cu)	ug/m3	ND	0.068	ND	0.063	3642485	N/A
Total Nickel (Ni)	ug/m3	ND	0.041	ND	0.038	3642485	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492435
Report Date: 2014/06/17

MISCELLANEOUS (FILTER)

Maxxam ID		WD5614	WD5617			
Sampling Date		2014/03/18	2014/03/18			
COC Number		17030	17030			
	Units	**14020719-AQ10-TSP**	**14020717-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals						
Aluminum (Al)	ug	6.8	6.6	5.0	3635627	N/A
Antimony (Sb)	ug	ND	ND	1.0	3635627	N/A
Arsenic (As)	ug	ND	ND	0.60	3635627	N/A
Cadmium (Cd)	ug	ND	ND	0.20	3635627	N/A
Chromium (Cr)	ug	ND	ND	0.50	3635627	N/A
Copper (Cu)	ug	ND	ND	0.50	3635627	N/A
Nickel (Ni)	ug	ND	ND	0.30	3635627	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492435
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5614 **Collected** 2014/03/18
Sample ID 14020719-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3642485	2014/06/16	2014/06/16	Brenda Moore
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5615 **Collected** 2014/03/18
Sample ID 14020721-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5616 **Collected** 2014/03/18
Sample ID 14020720-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5617 **Collected** 2014/03/18
Sample ID 14020717-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3642485	2014/06/16	2014/06/16	Brenda Moore
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5617 Dup **Collected** 2014/03/18
Sample ID 14020717-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/16	2014/06/16	Lang Le

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SENES Consultants Limited

Maxxam Job #: B492435
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5618 **Collected** 2014/03/18
Sample ID 14020718-AQ13-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5619 **Collected** 2014/03/18
Sample ID 14021008-AQ13-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5620 **Collected**
Sample ID 14021011-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5621 **Collected** 2014/03/19
Sample ID 14021009-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5622 **Collected** 2014/03/19
Sample ID 14021010-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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SENES Consultants Limited

Maxxam Job #: B492435
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5623 **Collected** 2014/03/19
Sample ID 14020722-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5624 **Collected** 2014/03/19
Sample ID 14020723-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5625 **Collected** 2014/03/19
Sample ID 14020725-AQ13-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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Maxxam Job #: B492435
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Hexavalent Chromium (modified CARB039): 1/2 filter extracted in 10ml of Rodi water

Results relate only to the items tested.

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SENES Consultants Limited
Attention: Paul Kirby
Client Project #:
P.O. #:
Site Location:

Quality Assurance Report

Maxxam Job Number: GB492435

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	%Recovery	Units	QC Limits
3634795 LLE	Reagent Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	Matrix Spike (WD5617)	Hexavalent Chromium (Cr 6+)	2014/06/16		105	%	80 - 120
	Spiked Blank	Hexavalent Chromium (Cr 6+)	2014/06/16		99	%	90 - 110
	Method Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	RPD - Sample/Sample Dup	Hexavalent Chromium (Cr 6+)	2014/06/16	NC		%	20
3635627 APT	Spiked Blank	Aluminum (Al)	2014/06/12		98	%	85 - 115
	RPD	Aluminum (Al)	2014/06/12	2.6		%	20
	Spiked Blank	Antimony (Sb)	2014/06/12		107	%	85 - 115
	RPD	Antimony (Sb)	2014/06/12	2.6		%	20
	Spiked Blank	Arsenic (As)	2014/06/12		103	%	85 - 115
	RPD	Arsenic (As)	2014/06/12	1.1		%	20
	Spiked Blank	Cadmium (Cd)	2014/06/12		104	%	85 - 115
	RPD	Cadmium (Cd)	2014/06/12	1.5		%	20
	Spiked Blank	Chromium (Cr)	2014/06/12		102	%	85 - 115
	RPD	Chromium (Cr)	2014/06/12	0		%	20
	Spiked Blank	Copper (Cu)	2014/06/12		100	%	85 - 115
	RPD	Copper (Cu)	2014/06/12	0.4		%	20
	Spiked Blank	Nickel (Ni)	2014/06/12		101	%	85 - 115
	RPD	Nickel (Ni)	2014/06/12	1		%	20
	Method Blank	Aluminum (Al)	2014/06/12	ND, RDL=5.0		ug	
		Antimony (Sb)	2014/06/12	ND, RDL=1.0		ug	
		Arsenic (As)	2014/06/12	ND, RDL=0.60		ug	
		Cadmium (Cd)	2014/06/12	ND, RDL=0.20		ug	
		Chromium (Cr)	2014/06/12	ND, RDL=0.50		ug	
		Copper (Cu)	2014/06/12	ND, RDL=0.50		ug	
		Nickel (Ni)	2014/06/12	ND, RDL=0.30		ug	

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Reagent Blank: A blank matrix containing all reagents used in the analytical procedure. Used to determine any analytical contamination.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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2-Jun-14 11:39
Mike Challis
B492435

Chain of Custody Form - AIR

15778

Page 1 of 1

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CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: Paul Kirby
e-mail: pkirby@senes.ca
Address: 121 Granton Dr. Suite 12
Richmond Hill, ON L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9886
Sampled by: Stephane Dallaire CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
14020719-AQ10-TSP	7311.3	5.1	14-03-18	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14020721-AQ10-PM10	7356.4	5.1	14-03-18	1440	✓												
14020720-AQ10-PM25	7338.5	5.1	14-03-18	1440	✓												
14020717-AQ13-TSP	7942.8	5.5	14-03-18	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14020718-AQ13-PM10	7360.0	5.1	14-03-18	1440	✓												
14021008-AQ13-PM25	7379.0	5.1	14-03-18	1440	✓												
14021011-BLANK	—	—	—	—	✓												
14021009-AQ10-TSP	7321.5	5.08	14-03-19	1440	✓												
14021010-AQ10-PM10	7340.6	5.10	14-03-19	1440	✓												
14020722-AQ10-PM25	7329.3	5.09	14-03-19	1440	✓												
14020723-AQ13-TSP	7305.6	5.07	14-03-19	1440	✓												
14020725-AQ13-PM10	7296.1	5.07	14-03-19	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 21-05-2014

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25°C

Maxxam

Success Through Science®

Your C.O.C. #: NA

Attention: Paul Kirby
SENES Consultants Limited
121 Granton Dr
Unit 12
Richmond Hill, ON
CANADA L4B 3N4

Report Date: 2014/06/17
Report #: R3061229
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B492441
Received: 2014/06/02, 13:10

Sample Matrix: Filter
Samples Received: 11

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Hexavalent Chromium (modified CARB039)	2	2014/06/09	2014/06/16	BRL SOP-00106	Modified CARB 039
Total Metals on Lo-Vol Filter (6010Cmod)	2	2014/06/16	2014/06/16		EPA 6010Cmod
Total Metals (6010Cmod)	2	2014/06/10	2014/06/12	CAM SOP-00408 / BRL SOP-00102	EPA 6010Cmod
Total Particulate	2	N/A	2014/06/09	BRL SOP-00109	Method IO-3.1
Particulates on Lo-Vol Filters	11	N/A	2014/06/09		
Total Particulate	9	N/A	2014/06/09	BRL SOP-00109	
Air Volume from LoVol Sampling	9	N/A	2014/06/03		
Air Volume from LoVol Sampling	2	N/A	2014/06/13		

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Theresa Stephenson, Project Manager
Email: TStephenson@maxxam.ca
Phone# (905) 817-5763

==========

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Total cover pages: 1

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5626	WD5627	WD5628			
Sampling Date		2014/03/22	2014/03/22	2014/03/22			
COC Number		NA	NA	NA			
	Units	**13082216-AQ13-TSP**	**13082217-AQ13-PM10**	**13082218-AQ13-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	111	75	33	14	3627286	N/A
Particulate Weight on Filter	mg	0.82	0.55	0.24	0.10	3632700	N/A
Volume	m3	7.376	7.356	7.355	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5629			WD5630			
Sampling Date					2014/03/24			
COC Number		NA			NA			
	Units	**13092309-BLANK**	**RDL**	**QC Batch**	**13082211-AQ10-TSP**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	3627286	117	9.0	3627286	N/A
Particulate Weight on Filter	mg	0.4	0.3	3632406	1.29	0.10	3632700	N/A
Volume	m3	0	N/A	ONSITE	11.07	N/A	ONSITE	N/A
Metals								
Hexavalent Chromium (Cr 6+)	ug				ND	0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5631		WD5632		WD5633			
Sampling Date		2014/03/24		2014/03/24		2014/03/24			
COC Number		NA		NA		NA			
	Units	**13082212-AQ10-PM10**	**RDL**	**13082219-AQ10-PM25**	**RDL**	**13082220-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	76.1	5.0	9.8	7.6	99	14	3627286	N/A
Particulate Weight on Filter	mg	1.53	0.10	0.13	0.10	0.72	0.10	3632700	N/A
Volume	m3	20.11	N/A	13.23	N/A	7.242	N/A	ONSITE	N/A
Metals									
Hexavalent Chromium (Cr 6+)	ug					ND	0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5634		WD5635			
Sampling Date		2014/03/24		2014/03/24			
COC Number		NA		NA			
	Units	**13082221-AQ13-PM10**	**RDL**	**13082222-AQ13-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	28	21	14	3627286	N/A
Particulate Weight on Filter	mg	ND	0.10	0.15	0.10	3632700	N/A
Volume	m3	3.621	N/A	7.233	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5636			
Sampling Date					
COC Number		NA			
	Units	**13092310-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	3627286	N/A
Particulate Weight on Filter	mg	0.6	0.3	3632406	N/A
Volume	m3	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492441
Report Date: 2014/06/17

CALCULATED ELEMENTS (FILTER)

Maxxam ID		WD5630		WD5633			
Sampling Date		2014/03/24		2014/03/24			
COC Number		NA		NA			
	Units	**13082211-AQ10-TSP**	**RDL**	**13082220-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals							
Total Aluminum (Al)	ug/m3	1.10	0.45	1.10	0.69	3642485	N/A
Total Antimony (Sb)	ug/m3	ND	0.090	ND	0.14	3642485	N/A
Total Arsenic (As)	ug/m3	ND	0.054	ND	0.083	3642485	N/A
Total Cadmium (Cd)	ug/m3	ND	0.018	ND	0.028	3642485	N/A
Total Chromium (Cr)	ug/m3	ND	0.045	ND	0.069	3642485	N/A
Total Copper (Cu)	ug/m3	ND	0.045	ND	0.069	3642485	N/A
Total Nickel (Ni)	ug/m3	ND	0.027	ND	0.041	3642485	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

MISCELLANEOUS (FILTER)

Maxxam ID		WD5630	WD5633			
Sampling Date		2014/03/24	2014/03/24			
COC Number		NA	NA			
	Units	**13082211-AQ10-TSP**	**13082220-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals						
Aluminum (Al)	ug	12.2	8.0	5.0	3635627	N/A
Antimony (Sb)	ug	ND	ND	1.0	3635627	N/A
Arsenic (As)	ug	ND	ND	0.60	3635627	N/A
Cadmium (Cd)	ug	ND	ND	0.20	3635627	N/A
Chromium (Cr)	ug	ND	ND	0.50	3635627	N/A
Copper (Cu)	ug	ND	ND	0.50	3635627	N/A
Nickel (Ni)	ug	ND	ND	0.30	3635627	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492441
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5626 **Collected** 2014/03/22
Sample ID 13082216-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5627 **Collected** 2014/03/22
Sample ID 13082217-AQ13-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5628 **Collected** 2014/03/22
Sample ID 13082218-AQ13-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5629 **Collected**
Sample ID 13092309-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632406	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5630 **Collected** 2014/03/24
Sample ID 13082211-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3642485	2014/06/16	2014/06/16	Brenda Moore
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5631 **Collected** 2014/03/24
Sample ID 13082212-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5632 **Collected** 2014/03/24
Sample ID 13082219-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5633 **Collected** 2014/03/24
Sample ID 13082220-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3642485	2014/06/16	2014/06/16	Brenda Moore
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5634 **Collected** 2014/03/24
Sample ID 13082221-AQ13-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5635 **Collected** 2014/03/24
Sample ID 13082222-AQ13-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5636
Sample ID 13092310-BLANK
Matrix Filter

Collected
Shipped
Received 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632406	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/13	

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Hexavalent Chromium (modified CARB039): 1/2 filter extracted in 10ml of Rodi water

Results relate only to the items tested.

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SENES Consultants Limited
Attention: Paul Kirby
Client Project #:
P.O. #:
Site Location:

Quality Assurance Report

Maxxam Job Number: GB492441

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	%Recovery	Units	QC Limits
3634795 LLE	Reagent Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	Matrix Spike	Hexavalent Chromium (Cr 6+)	2014/06/16		105	%	80 - 120
	Spiked Blank	Hexavalent Chromium (Cr 6+)	2014/06/16		99	%	90 - 110
	Method Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	RPD - Sample/Sample Dup	Hexavalent Chromium (Cr 6+)	2014/06/16	NC		%	20
3635627 APT	Spiked Blank	Aluminum (Al)	2014/06/12		98	%	85 - 115
	RPD	Aluminum (Al)	2014/06/12	2.6		%	20
	Spiked Blank	Antimony (Sb)	2014/06/12		107	%	85 - 115
	RPD	Antimony (Sb)	2014/06/12	2.6		%	20
	Spiked Blank	Arsenic (As)	2014/06/12		103	%	85 - 115
	RPD	Arsenic (As)	2014/06/12	1.1		%	20
	Spiked Blank	Cadmium (Cd)	2014/06/12		104	%	85 - 115
	RPD	Cadmium (Cd)	2014/06/12	1.5		%	20
	Spiked Blank	Chromium (Cr)	2014/06/12		102	%	85 - 115
	RPD	Chromium (Cr)	2014/06/12	0		%	20
	Spiked Blank	Copper (Cu)	2014/06/12		100	%	85 - 115
	RPD	Copper (Cu)	2014/06/12	0.4		%	20
	Spiked Blank	Nickel (Ni)	2014/06/12		101	%	85 - 115
	RPD	Nickel (Ni)	2014/06/12	1		%	20
	Method Blank	Aluminum (Al)	2014/06/12	ND, RDL=5.0		ug	
		Antimony (Sb)	2014/06/12	ND, RDL=1.0		ug	
		Arsenic (As)	2014/06/12	ND, RDL=0.60		ug	
		Cadmium (Cd)	2014/06/12	ND, RDL=0.20		ug	
		Chromium (Cr)	2014/06/12	ND, RDL=0.50		ug	
		Copper (Cu)	2014/06/12	ND, RDL=0.50		ug	
		Nickel (Ni)	2014/06/12	ND, RDL=0.30		ug	

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Reagent Blank: A blank matrix containing all reagents used in the analytical procedure. Used to determine any analytical contamination.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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2-Jun-14 13:10
Mike Challis
B492441
FW AIR-RmTmp

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CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL Kirby
e-mail: pkirby@senes.ca
Address: 121 Brandon Dr Suite 12
Richmond Hill, ON L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: Stephane Dallaire CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel
13082216-AQ13-TSP	7376.0	5.12	14-03-22	1440	✓								
13082217-AQ13-PM10	7355.8	5.11	14-03-22	1440	✓								
13082218-AQ13-PM25	7355.2	5.11	14-03-22	1440	✓								
13092309-BLANK	—	—	—	—	✓								
13082211-AQ10-TSP	11072.9	5.00	14-03-24	2214	✓	✓	✓	✓	✓	✓	✓	✓	✓
13082212-AQ10-PM10	20111.9	5.00	14-03-24	4020	✓								
13082219-AQ10-PM25	13229.1	5.01	14-03-24	2640	✓								
13082220-AQ13-TSP	7242.4	5.03	14-03-24	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
13082221-AQ13-PM10	3620.5	5.03	14-03-24	720	✓								
13082222-AQ13-PM25	7232.9	5.02	14-03-24	1440	✓								
13092310-BLANK	—	—	—	—	✓								

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: C136
Date/Time: 21-05-2014

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25 C

Maxxam

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Your C.O.C. #: 15778

Attention: Paul Kirby
SENES Consultants Limited
121 Granton Dr
Unit 12
Richmond Hill, ON
CANADA L4B 3N4

Report Date: 2014/06/17
Report #: R3061269
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B492442
Received: 2014/06/02, 13:10

Sample Matrix: Filter
Samples Received: 12

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Hexavalent Chromium (modified CARB039)	2	2014/06/09	2014/06/16	BRL SOP-00106	Modified CARB 039
Total Metals on Lo-Vol Filter (6010Cmod)	2	2014/06/03	2014/06/09		EPA 6010Cmod
Total Metals (6010Cmod)	2	2014/06/10	2014/06/12	CAM SOP-00408 / BRL SOP-00102	EPA 6010Cmod
Total Particulate	1	N/A	2014/06/09	BRL SOP-00109	Method IO-3.1
Particulates on Lo-Vol Filters	12	N/A	2014/06/09		
Total Particulate	11	N/A	2014/06/09	BRL SOP-00109	
Air Volume from LoVol Sampling	10	N/A	2014/06/03		
Air Volume from LoVol Sampling	2	N/A	2014/06/13		

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Theresa Stephenson, Project Manager
Email: TStephenson@maxxam.ca
Phone# (905) 817-5763

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Total cover pages: 1

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5637		WD5638		WD5639			
Sampling Date		2014/03/19 14:40				2014/03/21 14:40			
COC Number		15778		15778		15778			
	Units	**14020724-AQ13-PM25**	**RDL**	**14021012-BLANK**	**RDL**	**14021013-AQ10-TSP**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	14	ND	5000	211	14	3627286	N/A
Particulate Weight on Filter	mg	ND	0.10	0.56	0.10	1.55	0.10	3632700	N/A
Volume	m3	7.313	N/A	0	N/A	7.344	N/A	ONSITE	N/A
Metals									
Hexavalent Chromium (Cr 6+)	ug					ND	0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5640	WD5641	WD5642			
Sampling Date		2014/03/21 14:40	2014/03/21 14:40	2014/03/21 14:40			
COC Number		15778	15778	15778			
	Units	**14021014-AQ10-PM10**	**14021015-AQ10-PM25**	**13082228-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	195	153	107	14	3627286	N/A
Particulate Weight on Filter	mg	1.43	1.12	0.79	0.10	3632700	N/A
Volume	m3	7.333	7.338	7.375	N/A	ONSITE	N/A
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND	0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5643	WD5644			WD5645			
Sampling Date		2014/03/21 14:40	2014/03/21 14:40						
COC Number		15778	15778			15778			
	Units	**13082229-AQ13-PM10**	**13082230-AQ13-PM25**	**RDL**	**QC Batch**	**13092308-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	78	54	14	3627286	ND	5000	3627286	N/A
Particulate Weight on Filter	mg	0.57	0.40	0.10	3632700	0.8	0.3	3632406	N/A
Volume	m3	7.345	7.356	N/A	ONSITE	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5646		WD5647	WD5648			
Sampling Date		2014/03/22 14:40		2014/03/22 14:40	2014/03/22 14:40			
COC Number		15778		15778	15778			
	Units	**13082215-AQ10-TSP**	**RDL**	**13082214-AQ10-PM10**	**13082213-AQ10-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	128	14	105	38	13	3627286	N/A
Particulate Weight on Filter	mg	0.95	0.10	0.78	0.28	0.10	3632700	N/A
Volume	m3	7.410	N/A	7.415	7.427	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

CALCULATED ELEMENTS (FILTER)

Maxxam ID		WD5639		WD5642			
Sampling Date		2014/03/21 14:40		2014/03/21 14:40			
COC Number		15778		15778			
	Units	**14021013-AQ10-TSP**	**RDL**	**13082228-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals							
Total Aluminum (Al)	ug/m3	1.52	0.68	1.60	0.68	3627285	N/A
Total Antimony (Sb)	ug/m3	ND	0.14	ND	0.14	3627285	N/A
Total Arsenic (As)	ug/m3	ND	0.082	ND	0.081	3627285	N/A
Total Cadmium (Cd)	ug/m3	ND	0.027	ND	0.027	3627285	N/A
Total Chromium (Cr)	ug/m3	ND	0.068	ND	0.068	3627285	N/A
Total Copper (Cu)	ug/m3	ND	0.068	ND	0.068	3627285	N/A
Total Nickel (Ni)	ug/m3	ND	0.041	ND	0.041	3627285	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

MISCELLANEOUS (FILTER)

Maxxam ID		WD5639	WD5642			
Sampling Date		2014/03/21 14:40	2014/03/21 14:40			
COC Number		15778	15778			
	Units	**14021013-AQ10-TSP**	**13082228-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals						
Aluminum (Al)	ug	11.2	11.8	5.0	3635627	N/A
Antimony (Sb)	ug	ND	ND	1.0	3635627	N/A
Arsenic (As)	ug	ND	ND	0.60	3635627	N/A
Cadmium (Cd)	ug	ND	ND	0.20	3635627	N/A
Chromium (Cr)	ug	ND	ND	0.50	3635627	N/A
Copper (Cu)	ug	ND	ND	0.50	3635627	N/A
Nickel (Ni)	ug	ND	ND	0.30	3635627	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492442
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5637 **Collected** 2014/03/19
Sample ID 14020724-AQ13-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5638 **Collected**
Sample ID 14021012-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5639 **Collected** 2014/03/21
Sample ID 14021013-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/09	2014/06/09	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5640 **Collected** 2014/03/21
Sample ID 14021014-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5641 **Collected** 2014/03/21
Sample ID 14021015-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5642 **Collected** 2014/03/21
Sample ID 13082228-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/09	2014/06/09	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5643 **Collected** 2014/03/21
Sample ID 13082229-AQ13-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5644 **Collected** 2014/03/21
Sample ID 13082230-AQ13-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5645 **Collected**
Sample ID 13092308-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632406	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5646 **Collected** 2014/03/22
Sample ID 13082215-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5647 **Collected** 2014/03/22
Sample ID 13082214-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5648 **Collected** 2014/03/22
Sample ID 13082213-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Hexavalent Chromium (modified CARB039): 1/2 filter extracted in 10ml of Rodi water

Results relate only to the items tested.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

SENES Consultants Limited
Attention: Paul Kirby
Client Project #:
P.O. #:
Site Location:

Quality Assurance Report

Maxxam Job Number: GB492442

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	%Recovery	Units	QC Limits
3634795 LLE	Reagent Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	Matrix Spike	Hexavalent Chromium (Cr 6+)	2014/06/16		105	%	80 - 120
	Spiked Blank	Hexavalent Chromium (Cr 6+)	2014/06/16		99	%	90 - 110
	Method Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	RPD - Sample/Sample Dup	Hexavalent Chromium (Cr 6+)	2014/06/16	NC		%	20
3635627 APT	Spiked Blank	Aluminum (Al)	2014/06/12		98	%	85 - 115
	RPD	Aluminum (Al)	2014/06/12	2.6		%	20
	Spiked Blank	Antimony (Sb)	2014/06/12		107	%	85 - 115
	RPD	Antimony (Sb)	2014/06/12	2.6		%	20
	Spiked Blank	Arsenic (As)	2014/06/12		103	%	85 - 115
	RPD	Arsenic (As)	2014/06/12	1.1		%	20
	Spiked Blank	Cadmium (Cd)	2014/06/12		104	%	85 - 115
	RPD	Cadmium (Cd)	2014/06/12	1.5		%	20
	Spiked Blank	Chromium (Cr)	2014/06/12		102	%	85 - 115
	RPD	Chromium (Cr)	2014/06/12	0		%	20
	Spiked Blank	Copper (Cu)	2014/06/12		100	%	85 - 115
	RPD	Copper (Cu)	2014/06/12	0.4		%	20
	Spiked Blank	Nickel (Ni)	2014/06/12		101	%	85 - 115
	RPD	Nickel (Ni)	2014/06/12	1		%	20
	Method Blank	Aluminum (Al)	2014/06/12	ND, RDL=5.0		ug	
		Antimony (Sb)	2014/06/12	ND, RDL=1.0		ug	
		Arsenic (As)	2014/06/12	ND, RDL=0.60		ug	
		Cadmium (Cd)	2014/06/12	ND, RDL=0.20		ug	
		Chromium (Cr)	2014/06/12	ND, RDL=0.50		ug	
		Copper (Cu)	2014/06/12	ND, RDL=0.50		ug	
		Nickel (Ni)	2014/06/12	ND, RDL=0.30		ug	

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Reagent Blank: A blank matrix containing all reagents used in the analytical procedure. Used to determine any analytical contamination.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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Chain of Custody Form - AIR

15778

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Page 1 of 1

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED

Project Manager: PAUL Kirby

e-mail: pkirby@senes.ca

Address: 121 Granton Dr. Suite 12
Richmond Hill, ON L4B 3N4

Phone: (905) 764-9380 Fax: (905) 764-9386

Sampled by: Stephane Dallaire CBG

SECTION

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminum	Arsenic	Antimony	Cadmium	Chromium	Chromium VI	Copper	Nickel
14020724-AQ13-PM25	7312.6	5.08	14-03-19	1440	✓								
14021012-BLANK	–	–	–	–	✓								
14021013-AQ10-TSP	7344.3	5.10	14-03-21	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021014-AQ10-PM10	7332.6	5.09	14-03-21	1440	✓								
14021015-AQ10-PM25	7337.9	5.10	14-03-21	1440	✓								
13082228-AQ13-TSP	7374.9	5.12	14-03-21	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
13082229-AQ13-PM10	7344.7	5.10	14-03-21	1440	✓								
13082230-AQ13-PM25	7355.9	5.11	14-03-21	1440	✓								
13092308-BLANK	–	–	–	–	✓								
13082215-AQ10-TSP	7410.0	5.15	14-03-22	1440	✓								
13082214-AQ10-PM10	7415.3	5.15	14-03-22	1440	✓								
13082213-AQ10-PM25	7427.2	5.16	14-03-22	1440	✓								

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐

Regulation

Notes

PROJECT SPECI

2-Jun-14 13:10
Mike Challis
B492442
AAF AIR-RmTmp

Client Signature:
Affiliation: CBG
Date/Time: 21-05-2014

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25°C

Maxxam

Success Through Science®

Your C.O.C. #: 15778

Attention: Paul Kirby
SENES Consultants Limited
121 Granton Dr
Unit 12
Richmond Hill, ON
CANADA L4B 3N4

Report Date: 2014/06/18
Report #: R3062403
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B492443
Received: 2014/06/02, 13:10

Sample Matrix: Filter
Samples Received: 42

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Hexavalent Chromium (modified CARB039)	6	2014/06/09	2014/06/16	BRL SOP-00106	Modified CARB 039
Total Metals on Lo-Vol Filter (6010Cmod)	6	2014/06/03	2014/06/03		EPA 6010Cmod
Total Metals (6010Cmod)	6	2014/06/10	2014/06/12	CAM SOP-00408 / BRL SOP-00102	EPA 6010Cmod
Total Particulate	20	N/A	2014/06/09	BRL SOP-00109	Method IO-3.1
Particulates on Lo-Vol Filters	42	N/A	2014/06/09		
Total Particulate	22	N/A	2014/06/09	BRL SOP-00109	
Air Volume from LoVol Sampling	36	N/A	2014/06/03		
Air Volume from LoVol Sampling	2	N/A	2014/06/13		
Air Volume from LoVol Sampling	4	N/A	2014/06/18		

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Theresa Stephenson, Project Manager
Email: TStephenson@maxxam.ca
Phone# (905) 817-5763

==========

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Total cover pages: 1

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SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5649	WD5650	WD5651			
Sampling Date		2014/04/17	2014/04/17	2014/04/17			
COC Number		15778	15778	15778			
	Units	**13092314-AQ10-TSP**	**13092312-AQ10-PM10**	**13092313-AQ10-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	110	110	41	41	3627286	N/A
Particulate Weight on Filter	mg	0.8	0.8	0.3	0.3	3632726	N/A
Volume	m3	7.297	7.299	7.274	N/A	ONSITE	N/A
Metals							
Hexavalent Chromium (Cr 6+)	ug	ND			0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5652			WD5653			
Sampling Date		2014/04/17			2014/04/17			
COC Number		15778			15778			
	Units	**13092311-AQ12-TSP**	**RDL**	**QC Batch**	**13090913-AQ12-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	109	41	3627286	109	14	3627286	N/A
Particulate Weight on Filter	mg	0.8	0.3	3632726	0.80	0.10	3632717	N/A
Volume	m3	7.356	N/A	ONSITE	7.355	N/A	ONSITE	N/A
Metals								
Hexavalent Chromium (Cr 6+)	ug	ND	0.01	3634795				1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5654		WD5655			
Sampling Date		2014/04/17					
COC Number		15778		15778			
	Units	**13090914-AQ12-PM25**	**RDL**	**13090921-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	83	14	ND	5000	3627602	N/A
Particulate Weight on Filter	mg	0.61	0.10	0.39	0.10	3632717	N/A
Volume	m3	7.350	N/A	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5656	WD5657	WD5658			
Sampling Date		2014/04/18	2014/04/18	2014/04/18			
COC Number		15778	15778	15778			
	Units	**13092322-AQ10-TSP**	**13092321-AQ10-PM10**	**13092320-AQ10-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	150	96	55	41	3627602	N/A
Particulate Weight on Filter	mg	1.1	0.7	0.4	0.3	3632726	N/A
Volume	m3	7.328	7.325	7.298	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5659	WD5660	WD5661			
Sampling Date		2014/04/18	2014/04/18	2014/04/18			
COC Number		15778	15778	15778			
	Units	**13092316-AQ12-TSP**	**13092317-AQ12-PM10**	**13092318-AQ12-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	162	108	68	41	3627602	N/A
Particulate Weight on Filter	mg	1.2	0.8	0.5	0.3	3632726	N/A
Volume	m3	7.408	7.380	7.376	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5662		WD5663	WD5664			
Sampling Date				2014/05/08	2014/05/08			
COC Number		15778		15778	15778			
	Units	**13092324-BLANK**	**RDL**	**13092328-AQ10-TSP**	**13092329-AQ10-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	137	ND	41	3627602	N/A
Particulate Weight on Filter	mg	0.4	0.3	1.0	0.3	0.3	3632726	N/A
Volume	m3	0	N/A	7.309	7.317	N/A	ONSITE	N/A
Metals								
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5665	WD5666	WD5667			
Sampling Date		2014/05/08	2014/05/08	2014/05/08			
COC Number		15778	15778	15778			
	Units	**13092330-AQ10-PM25**	**13092325-AQ12-TSP**	**13092326-AQ12-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	55	82	96	41	3627602	N/A
Particulate Weight on Filter	mg	0.4	0.6	0.7	0.3	3632726	N/A
Volume	m3	7.297	7.309	7.317	N/A	ONSITE	N/A
Metals							
Hexavalent Chromium (Cr 6+)	ug		ND		0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5668		WD5669			
Sampling Date		2014/05/08					
COC Number		15778		15778			
	Units	**13092327-AQ12-PM25**	**RDL**	**13092323-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	55	41	ND	5000	3627602	N/A
Particulate Weight on Filter	mg	0.4	0.3	0.4	0.3	3632726	N/A
Volume	m3	7.288	N/A	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5670	WD5671	WD5672			
Sampling Date		2014/05/09	2014/05/09	2014/05/09			
COC Number		15778	15778	15778			
	Units	**13090906-AQ10-TSP**	**13090905-AQ10-PM10**	**13090903-AQ10-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	134	115	247	14	3627602	N/A
Particulate Weight on Filter	mg	0.99	0.85	1.82	0.10	3632717	N/A
Volume	m3	7.374	7.381	7.372	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5673	WD5674	WD5675			
Sampling Date		2014/05/09	2014/05/09	2014/05/09			
COC Number		15778	15778	15778			
	Units	**13090901-AQ12-TSP**	**13090902-AQ12-PM10**	**13090904-AQ12-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	158	133	ND	14	3627602	N/A
Particulate Weight on Filter	mg	1.16	0.98	ND	0.10	3632717	N/A
Volume	m3	7.362	7.370	7.340	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5676		WD5677	WD5678			
Sampling Date				2014/05/10	2014/05/10			
COC Number		15778		15778	15778			
	Units	**13090922-BLANK**	**RDL**	**13090907-AQ10-TSP**	**13090908-AQ10-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	121	101	14	3627602	N/A
Particulate Weight on Filter	mg	0.28	0.10	0.89	0.74	0.10	3632717	N/A
Volume	m3	0	N/A	7.351	7.349	N/A	ONSITE	N/A
Metals								
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5679	WD5680	WD5681			
Sampling Date		2014/05/10	2014/05/10	2014/05/10			
COC Number		15778	15778	15778			
	Units	**13090909-AQ10-PM25**	**13090910-AQ12-TSP**	**13090911-AQ12-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	77	124	103	14	3627602	N/A
Particulate Weight on Filter	mg	0.57	0.91	0.76	0.10	3632717	N/A
Volume	m3	7.368	7.342	7.344	N/A	ONSITE	N/A
Metals							
Hexavalent Chromium (Cr 6+)	ug		ND		0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5682			WD5683			
Sampling Date		2014/05/10						
COC Number		15778			15778			
	Units	**13090912-AQ12-P25**	**RDL**	**QC Batch**	**13092315-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	72	14	3627602	ND	5000	3627602	N/A
Particulate Weight on Filter	mg	0.53	0.10	3632717	0.3	0.3	3632726	N/A
Volume	m3	7.314	N/A	ONSITE	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5684	WD5685	WD5686			
Sampling Date		2014/05/11	2014/05/11	2014/05/11			
COC Number		15778	15778	15778			
	Units	**13090915-AQ10-TSP**	**13090916-AQ10-PM10**	**13090917-AQ10-P25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	126	112	85	14	3627602	N/A
Particulate Weight on Filter	mg	0.92	0.82	0.62	0.10	3632717	N/A
Volume	m3	7.300	7.299	7.298	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5687	WD5688	WD5689			
Sampling Date		2014/05/11	2014/05/11	2014/05/11			
COC Number		15778	15778	15778			
	Units	**13090918-AQ12-TSP**	**13090919-AQ12-PM10**	**13090920-AQ12-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	131	101	85	14	3627602	N/A
Particulate Weight on Filter	mg	0.96	0.74	0.62	0.10	3632717	N/A
Volume	m3	7.305	7.307	7.276	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5690			
Sampling Date					
COC Number		15778			
	Units	**13092319-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	3627602	N/A
Particulate Weight on Filter	mg	0.5	0.3	3632726	N/A
Volume	m3	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

CALCULATED ELEMENTS (FILTER)

Maxxam ID		WD5649		WD5652	WD5663			
Sampling Date		2014/04/17		2014/04/17	2014/05/08			
COC Number		15778		15778	15778			
	Units	**13092314-AQ10-TSP**	**RDL**	**13092311-AQ12-TSP**	**13092328-AQ10-TSP**	**RDL**	**QC Batch**	**MDL**
Metals								
Total Aluminum (Al)	ug/m3	1.80	0.69	1.26	ND	0.68	3627285	N/A
Total Antimony (Sb)	ug/m3	ND	0.14	ND	ND	0.14	3627285	N/A
Total Arsenic (As)	ug/m3	ND	0.082	ND	ND	0.082	3627285	N/A
Total Cadmium (Cd)	ug/m3	ND	0.027	ND	ND	0.027	3627285	N/A
Total Chromium (Cr)	ug/m3	ND	0.069	ND	ND	0.068	3627285	N/A
Total Copper (Cu)	ug/m3	ND	0.069	ND	ND	0.068	3627285	N/A
Total Nickel (Ni)	ug/m3	ND	0.041	ND	ND	0.041	3627285	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5666	WD5677	WD5680			
Sampling Date		2014/05/08	2014/05/10	2014/05/10			
COC Number		15778	15778	15778			
	Units	**13092325-AQ12-TSP**	**13090907-AQ10-TSP**	**13090910-AQ12-TSP**	**RDL**	**QC Batch**	**MDL**
Metals							
Total Aluminum (Al)	ug/m3	0.78	ND	0.81	0.68	3627285	N/A
Total Antimony (Sb)	ug/m3	ND	ND	ND	0.14	3627285	N/A
Total Arsenic (As)	ug/m3	ND	ND	ND	0.082	3627285	N/A
Total Cadmium (Cd)	ug/m3	ND	ND	ND	0.027	3627285	N/A
Total Chromium (Cr)	ug/m3	ND	ND	ND	0.068	3627285	N/A
Total Copper (Cu)	ug/m3	ND	ND	ND	0.068	3627285	N/A
Total Nickel (Ni)	ug/m3	ND	ND	ND	0.041	3627285	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

MISCELLANEOUS (FILTER)

Maxxam ID		WD5649	WD5652	WD5663	WD5666			
Sampling Date		2014/04/17	2014/04/17	2014/05/08	2014/05/08			
COC Number		15778	15778	15778	15778			
	Units	**13092314-AQ10-TSP**	**13092311-AQ12-TSP**	**13092328-AQ10-TSP**	**13092325-AQ12-TSP**	**RDL**	**QC Batch**	**MDL**
Metals								
Aluminum (Al)	ug	13.1	9.2	ND	5.7	5.0	3635627	N/A
Antimony (Sb)	ug	ND	ND	ND	ND	1.0	3635627	N/A
Arsenic (As)	ug	ND	ND	ND	ND	0.60	3635627	N/A
Cadmium (Cd)	ug	ND	ND	ND	ND	0.20	3635627	N/A
Chromium (Cr)	ug	ND	ND	ND	ND	0.50	3635627	N/A
Copper (Cu)	ug	ND	ND	ND	ND	0.50	3635627	N/A
Nickel (Ni)	ug	ND	ND	ND	ND	0.30	3635627	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5677	WD5680			
Sampling Date		2014/05/10	2014/05/10			
COC Number		15778	15778			
	Units	**13090907-AQ10-TSP**	**13090910-AQ12-TSP**	**RDL**	**QC Batch**	**MDL**
Metals						
Aluminum (Al)	ug	ND	6.0	5.0	3635627	N/A
Antimony (Sb)	ug	ND	ND	1.0	3635627	N/A
Arsenic (As)	ug	ND	ND	0.60	3635627	N/A
Cadmium (Cd)	ug	ND	ND	0.20	3635627	N/A
Chromium (Cr)	ug	ND	ND	0.50	3635627	N/A
Copper (Cu)	ug	ND	ND	0.50	3635627	N/A
Nickel (Ni)	ug	ND	ND	0.30	3635627	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492443
Report Date: 2014/06/18

Test Summary

Maxxam ID WD5649 **Collected** 2014/04/17
Sample ID 13092314-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5650 **Collected** 2014/04/17
Sample ID 13092312-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5651 **Collected** 2014/04/17
Sample ID 13092313-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5652 **Collected** 2014/04/17
Sample ID 13092311-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5653 **Collected** 2014/04/17
Sample ID 13090913-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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Test Summary

Maxxam ID WD5654 **Collected** 2014/04/17
Sample ID 13090914-AQ12-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5655 **Collected**
Sample ID 13090921-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5656 **Collected** 2014/04/18
Sample ID 13092322-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5657 **Collected** 2014/04/18
Sample ID 13092321-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5658 **Collected** 2014/04/18
Sample ID 13092320-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

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Report Date: 2014/06/18

Test Summary

Maxxam ID WD5659 **Collected** 2014/04/18
Sample ID 13092316-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5660 **Collected** 2014/04/18
Sample ID 13092317-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5661 **Collected** 2014/04/18
Sample ID 13092318-AQ12-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5662 **Collected**
Sample ID 13092324-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5663 **Collected** 2014/05/08
Sample ID 13092328-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

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Maxxam ID WD5664 **Collected** 2014/05/08
Sample ID 13092329-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5665 **Collected** 2014/05/08
Sample ID 13092330-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5666 **Collected** 2014/05/08
Sample ID 13092325-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5667 **Collected** 2014/05/08
Sample ID 13092326-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5668 **Collected** 2014/05/08
Sample ID 13092327-AQ12-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

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Test Summary

Maxxam ID WD5669 **Collected**
Sample ID 13092323-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/18	

Maxxam ID WD5670 **Collected** 2014/05/09
Sample ID 13090906-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5671 **Collected** 2014/05/09
Sample ID 13090905-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5672 **Collected** 2014/05/09
Sample ID 13090903-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5673 **Collected** 2014/05/09
Sample ID 13090901-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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Test Summary

Maxxam ID WD5674 **Collected** 2014/05/09
Sample ID 13090902-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5675 **Collected** 2014/05/09
Sample ID 13090904-AQ12-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5676 **Collected**
Sample ID 13090922-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/18	

Maxxam ID WD5677 **Collected** 2014/05/10
Sample ID 13090907-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5678 **Collected** 2014/05/10
Sample ID 13090908-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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Test Summary

Maxxam ID WD5679 **Collected** 2014/05/10
Sample ID 13090909-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5680 **Collected** 2014/05/10
Sample ID 13090910-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5681 **Collected** 2014/05/10
Sample ID 13090911-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5682 **Collected** 2014/05/10
Sample ID 13090912-AQ12-P25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5683 **Collected**
Sample ID 13092315-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/18	

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Test Summary

Maxxam ID WD5684 **Collected** 2014/05/11
Sample ID 13090915-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5685 **Collected** 2014/05/11
Sample ID 13090916-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5686 **Collected** 2014/05/11
Sample ID 13090917-AQ10-P25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5687 **Collected** 2014/05/11
Sample ID 13090918-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5688 **Collected** 2014/05/11
Sample ID 13090919-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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Test Summary

Maxxam ID WD5689 **Collected** 2014/05/11
Sample ID 13090920-AQ12-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5690 **Collected**
Sample ID 13092319-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/18	

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Hexavalent Chromium (modified CARB039): 1/2 filter extracted in 10ml of Rodi water

Results relate only to the items tested.

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SENES Consultants Limited
Attention: Paul Kirby
Client Project #:
P.O. #:
Site Location:

Quality Assurance Report

Maxxam Job Number: GB492443

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	%Recovery	Units	QC Limits
3634795 LLE	Reagent Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	Matrix Spike	Hexavalent Chromium (Cr 6+)	2014/06/16		105	%	80 - 120
	Spiked Blank	Hexavalent Chromium (Cr 6+)	2014/06/16		99	%	90 - 110
	Method Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	RPD - Sample/Sample Dup	Hexavalent Chromium (Cr 6+)	2014/06/16	NC		%	20
3635627 APT	Spiked Blank	Aluminum (Al)	2014/06/12		98	%	85 - 115
	RPD	Aluminum (Al)	2014/06/12	2.6		%	20
	Spiked Blank	Antimony (Sb)	2014/06/12		107	%	85 - 115
	RPD	Antimony (Sb)	2014/06/12	2.6		%	20
	Spiked Blank	Arsenic (As)	2014/06/12		103	%	85 - 115
	RPD	Arsenic (As)	2014/06/12	1.1		%	20
	Spiked Blank	Cadmium (Cd)	2014/06/12		104	%	85 - 115
	RPD	Cadmium (Cd)	2014/06/12	1.5		%	20
	Spiked Blank	Chromium (Cr)	2014/06/12		102	%	85 - 115
	RPD	Chromium (Cr)	2014/06/12	0		%	20
	Spiked Blank	Copper (Cu)	2014/06/12		100	%	85 - 115
	RPD	Copper (Cu)	2014/06/12	0.4		%	20
	Spiked Blank	Nickel (Ni)	2014/06/12		101	%	85 - 115
	RPD	Nickel (Ni)	2014/06/12	1		%	20
	Method Blank	Aluminum (Al)	2014/06/12	ND, RDL=5.0		ug	
		Antimony (Sb)	2014/06/12	ND, RDL=1.0		ug	
		Arsenic (As)	2014/06/12	ND, RDL=0.60		ug	
		Cadmium (Cd)	2014/06/12	ND, RDL=0.20		ug	
		Chromium (Cr)	2014/06/12	ND, RDL=0.50		ug	
		Copper (Cu)	2014/06/12	ND, RDL=0.50		ug	
		Nickel (Ni)	2014/06/12	ND, RDL=0.30		ug	

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Reagent Blank: A blank matrix containing all reagents used in the analytical procedure. Used to determine any analytical contamination.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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Chain of Custody Form - AIR

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Toll Free: 1-800-668-0639
Phone: (905) 817-5700
Fax: (905) 817-5777

ANALYSIS REQUESTED

2-Jun-14 13:10
Mike Challis
B492443
MAF AIR-RmTmp

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Megaton Dr Suite 12
Richmond Hill, ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: Stéphane Dallaire CBG

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
13092314-AQ10-TSP	7297.1	5.07	14-04-17	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13092312-AQ10-PM10	7299.3	5.07	14-04-17	1440	✓												
13092313-AQ10-PM25	7274.0	5.05	14-04-17	1440	✓												
13092311-AQ12-TSP	7355.6	5.11	14-04-17	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13090913-AQ12-PM10	7355.0	5.11	14-04-17	1440	✓												
13090914-AQ12-PM25	7349.7	5.10	14-04-17	1440	✓												
13090921-BLANK	–	–	–	–	✓												
13092322-AQ10-TSP	7327.7	5.09	14-04-18	1440	✓												
13092321-AQ10-PM10	7325.3	5.09	14-04-18	1440	✓												
13092320-AQ10-PM25	7297.6	5.07	14-04-18	1440	✓												
13092316-AQ12-TSP	7407.6	5.14	14-04-18	1440	✓												
13092317-AQ12-PM10	7380.1	5.13	14-04-18	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-05-21

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10

25/25/25 C

B492443 MAX

Chain of Custody Form - AIR

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AIR Maxxam

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Toll Free: 1-800-668-0639
Phone: (905) 817-5700
Fax: (905) 817-5777

ANALYSIS REQUESTED

CLIENT INFORMATION

Company Name: SENES CONSULTANT LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Granton Dr Suite 12
Richmond Hill (ON) L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: Stéphane Dallaire CBG

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminium	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
13092318-AQ12-PM25	7376.0	5.12	14-04-18	1440	✓												
13092324-BLANK	–	–	–	–	✓												
13092328-AQ10-TSP	7309.1	5.08	14-05-08	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13092329-AQ10-PM10	7317.4	5.08	14-05-08	1440	✓												
13092330-AQ10-PM25	7297.2	5.07	14-05-08	1440	✓												
13092325-AQ12-TSP	7309.3	5.08	14-05-08	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13092326-AQ12-PM10	7317.0	5.08	14-05-08	1440	✓												
13092327-AQ12-PM25	7288.0	5.06	14-05-08	1440	✓												
13092323-BLANK	–	–	–	~~MAX~~	✓												
13090906-AQ10-TSP	7374.3	5.12	14-05-09	1440	✓												
13090905-AQ10-PM10	7380.6	5.13	14-05-09	1440	✓												
13090903-AQ10-PM25	7371.7	5.12	14-05-09	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-05-21

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25°C

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Phone: (905) 817-5700
Fax: (905) 817-5777

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Granton Dr Suite 12
Richmond Hill, ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: Stéphane Dallaire, CBE

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminium	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
13090901-AQ12-TSP	7361.5	5.11	14-05-09	1440	✓												
13090902-AQ12-PM10	7369.8	5.12	14-05-09	1440	✓												
13090904-AQ12-PM25	7340.1	5.10	14-05-09	1440	✓												
13090922-BLANK	–	–	–	–	✓												
13090907-AQ10-TSP	7350.7	5.10	14-05-10	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13090908-AQ10-PM10	7348.5	5.10	14-05-10	1440	✓												
13090909-AQ10-PM25	7367.6	5.12	14-05-10	1440	✓												
13090910-AQ12-TSP	7341.9	5.10	14-05-10	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13090911-AQ12-PM10	7344.1	5.10	14-05-10	1440	✓												
13090912-AQ12-PM25	7313.8	5.08	14-05-10	1440	✓												
13092315-BLANK	–	–	–	–	✓												
13090915-AQ10-TSP	7300.4	5.07	14-05-11	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-05-21

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25 C

B492443 MAC.

Chain of Custody Form - AIR

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Mississauga Ontario ,L5N 2L8
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Toll Free: 1-800-668-0639
Phone: (905) 817-5700
Fax: (905) 817-5777

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: Paul Kirby
e-mail: pkirby@senes.ca
Address: 121, Granton Dr Suite 12
Richmond Hill, ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: Stephane Dallaire, CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminium	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel
13090916-AQ10-PM10	7299.2	5.07	14-05-11	1440	✓								
13090917-AQ10-PM25	7297.6	5.07	14-05-11	1440	✓								
13090918-AQ12-TSP	7305.0	5.07	14-05-11	1440	✓								
13090919-AQ12-PM10	7306.9	5.07	14-05-11	1440	✓								
13090920-AQ12-PM25	7275.9	5.05	14-05-11	1440	✓								
13092319-BLANK	–	–	–	–	✓								

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-05-21

Received by: RACHEL DELLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25 C

Passive Sampling

Certificates of Analysis

Maxxam

Success Through Science®

Your Project #: 2014/02/28 - 2014/04/02

Attention:JENNIFER KIRKALDY

SENES CONSULTANTS LIMITED
121 GRANTON DRIVE, UNIT 12
RICHMOND HILL, ON
CANADA T4B 3N4

Report Date: 2014/07/03
Report #: R1596445
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B432816
Received: 2014/04/25, 15:42

Sample Matrix: Air
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
NO2 Passive Analysis (1)	1	2014/05/08	2014/07/03	PTC SOP-00148	Passive NO2 in ATM
NO2 Passive Analysis (1)	1	2014/07/03	2014/07/03	PTC SOP-00148	Passive NO2 in ATM
NOx Passive Analysis (1)	2	2014/05/08	2014/07/03	PTC SOP-00148	Tang Passive NO2 in
SO2 Passive Analysis (1)	2	2014/05/08	2014/07/03	PTC SOP-00149	Tang Passive SO2 in

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) The detection limit is based on a 30 day sampling period.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Levi Manchak, Customer Service
Email: LManchak@maxxam.ca
Phone# (780) 378-8500
==========
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Maxxam Job #: B432816
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/02/28 - 2014/04/02

RESULTS OF CHEMICAL ANALYSES OF AIR

Maxxam ID		JL9659	JN4539	JN4540	JN4541	JN4542	JN4543		
Sampling Date		2014/02/28 11:42	2014/02/28 11:40	2014/02/28 11:41	2014/02/28 11:47	2014/02/28 11:45	2014/02/28 11:46		
	Units	**001-AQ-1**	**002-AQ-1**	**003-AQ-1**	**011-AQ-1**	**012-AQ-1**	**013-AQ-1**	**RDL**	**QC Batch**
Passive Monitoring									
Calculated NO2	ppb	2.9			2.7			0.1	7478595
Calculated NOx	ppb		8.1			6.8		0.1	7478640
Calculated SO2	ppb			1.3			2.7	0.1	7478717
RDL = Reportable Detection Limit									

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Maxxam Job #: B432816
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/02/28 - 2014/04/02

GENERAL COMMENTS

Samples received at Maxxam Campobello with water in sample containers.
No Blanks returned with samples.
Meteorological data provided incomplete; met. data from Conakry, Guinea combined with provided data for calculation of results.

Results relate only to the items tested.

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Maxxam Job #: B432816
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/02/28 - 2014/04/02

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7478595	DF4	Spiked Blank	Calculated NO2	2014/05/08		99	%	90 - 110
7478595	DF4	Method Blank	Calculated NO2	2014/05/08	<0.1		ppb	
7478640	DF4	Spiked Blank	Calculated NOx	2014/05/08		99	%	N/A
7478640	DF4	Method Blank	Calculated NOx	2014/05/08	<0.1		ppb	
7478717	DF4	Spiked Blank	Calculated SO2	2014/05/08		100	%	90 - 110
7478717	DF4	Method Blank	Calculated SO2	2014/05/08	<0.1		ppb	

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 6744 - 50th Street T6B 3M9 Telephone(780) 378-8500 FAX(780) 378-8699

Maxxam Job #: B432816
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/02/28 - 2014/04/02

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Carmen Toker, CT, Manager Air Laboratory Services

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Your Project #: 2014/03/17 - 2014/04/17

Attention:JENNIFER KIRKALDY

SENES CONSULTANTS LIMITED
121 GRANTON DRIVE, UNIT 12
RICHMOND HILL, ON
CANADA T4B 3N4

Report Date: 2014/07/03
Report #: R1596442
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B446018
Received: 2014/06/05, 10:24

Sample Matrix: Air
Samples Received: 12

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
NO2 Passive Analysis (1)	4	2014/06/17	2014/07/03	PTC SOP-00148	Passive NO2 in ATM
NOx Passive Analysis (1)	4	2014/06/17	2014/07/03	PTC SOP-00148	Tang Passive NO2 in
SO2 Passive Analysis (1)	4	2014/06/17	2014/07/03	PTC SOP-00149	Tang Passive SO2 in

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The detection limit is based on a 30 day sampling period.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Levi Manchak, Customer Service
Email: LManchak@maxxam.ca
Phone# (780) 378-8500
==========
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 6744 - 50th Street T6B 3M9 Telephone(780) 378-8500 FAX(780) 378-8699

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Maxxam Job #: B446018
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/03/17 - 2014/04/17

RESULTS OF CHEMICAL ANALYSES OF AIR

Maxxam ID		JT5998	JT5999	JT6000	JT6001	JT6002	JT6003	JT6054		
Sampling Date		2014/03/17 14:00	2014/03/17 14:02	2014/03/17 14:04	2014/03/17 14:08	2014/03/17 14:10	2014/03/17 14:06	2014/03/17 16:50		
	Units	**KOUR1**	**KOUR2**	**KOUR3**	**KOUR11**	**KOUR12**	**KOUR13**	**BWD01**	**RDL**	**QC Batch**
Passive Monitoring										
Calculated NO2	ppb	0.5			0.5			1.2	0.1	7528208
Calculated NOx	ppb		0.6			1.1			0.1	7528210
Calculated SO2	ppb			0.2			0.2		0.1	7528233
RDL = Reportable Detection Limit										

Maxxam ID		JT6055	JT6056	JT6219	JT6225	JT6226		
Sampling Date		2014/03/17 16:52	2014/03/17 16:48	2014/03/17 16:54	2014/03/17 16:56	2014/03/17 16:58		
	Units	**BWD03**	**BWD02**	**BWD11**	**BWD13**	**BWD13**	**RDL**	**QC Batch**
Passive Monitoring								
Calculated NO2	ppb			1.4			0.1	7528208
Calculated NOx	ppb	1.9			2.8		0.1	7528210
Calculated SO2	ppb		<0.1			<0.1	0.1	7528233
RDL = Reportable Detection Limit								

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 6744 - 50th Street T6B 3M9 Telephone(780) 378-8500 FAX(780) 378-8699

Maxxam Job #: B446018
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/03/17 - 2014/04/17

GENERAL COMMENTS

Sample ID labels differ from those listed on Chain of Custody.
No blanks returned. Default lab blanks use. - DF

Results relate only to the items tested.

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 6744 - 50th Street T6B 3M9 Telephone(780) 378-8500 FAX(780) 378-8699

Maxxam

Success Through Science®

Maxxam Job #: B446018
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/03/17 - 2014/04/17

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7528208	DF4	Spiked Blank	Calculated NO2	2014/06/17		96	%	90 - 110
7528208	DF4	Method Blank	Calculated NO2	2014/06/17	<0.1		ppb	
7528210	DF4	Spiked Blank	Calculated NOx	2014/06/17		96	%	N/A
7528210	DF4	Method Blank	Calculated NOx	2014/06/17	<0.1		ppb	
7528233	DF4	Spiked Blank	Calculated SO2	2014/06/17		101	%	90 - 110
7528233	DF4	Method Blank	Calculated SO2	2014/06/17	<0.1		ppb	

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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Carmen Toker, CT, Manager Air Laboratory Services

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Success Through Science®

Your Project #: 2014/04/17 - 2014/06/14
Site Location: ALCOA

Attention:JENNIFER KIRKALDY

SENES CONSULTANTS LIMITED
121 GRANTON DRIVE, UNIT 12
RICHMOND HILL, ON
CANADA T4B 3N4

Report Date: 2014/07/08
Report #: R1599137
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B455190
Received: 2014/07/02, 10:53

Sample Matrix: Air
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
NO2 Passive Analysis (1)	2	2014/07/07	2014/07/08	PTC SOP-00148	Passive NO2 in ATM
NOx Passive Analysis (1)	2	2014/07/07	2014/07/08	PTC SOP-00148	Tang Passive NO2 in
SO2 Passive Analysis (1)	2	2014/07/04	2014/07/08	PTC SOP-00149	Tang Passive SO2 in

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) The detection limit is based on a 30 day sampling period.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Levi Manchak, Customer Service
Email: LManchak@maxxam.ca
Phone# (780) 378-8500
==========
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Maxxam Job #: B455190
Report Date: 2014/07/08

SENES CONSULTANTS LIMITED
Client Project #: 2014/04/17 - 2014/06/14
Site Location: ALCOA

RESULTS OF CHEMICAL ANALYSES OF AIR

Maxxam ID		JZ4447	JZ4500		
Sampling Date		2014/05/14	2014/05/14		
	Units	**AQ-1-ALCOA A**	**AQ-1-ALCOA B**	**RDL**	**QC Batch**
Passive Monitoring					
Calculated NO2	ppb	2.4	2.7	0.1	7554488
Calculated NOx	ppb	7.5	6.6	0.1	7554506
Calculated SO2	ppb	1.7	1.9	0.1	7552247
RDL = Reportable Detection Limit					

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Maxxam Job #: B455190
Report Date: 2014/07/08

SENES CONSULTANTS LIMITED
Client Project #: 2014/04/17 - 2014/06/14
Site Location: ALCOA

GENERAL COMMENTS

Meteorological data provided incomplete; met. data from Conakry, Guinea combined with provided data for calculation of results.
SO2 Travel blank <JZ4501> outside QA acceptability criteria, default lab blank value used in the calculation of final results. SS

Results relate only to the items tested.

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Maxxam Job #: B455190
Report Date: 2014/07/08

SENES CONSULTANTS LIMITED
Client Project #: 2014/04/17 - 2014/06/14
Site Location: ALCOA

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7552247	SS6	Spiked Blank	Calculated SO2	2014/07/04		102	%	90 - 110
7552247	SS6	Method Blank	Calculated SO2	2014/07/04	<0.1		ppb	
7554488	SS6	Spiked Blank	Calculated NO2	2014/07/07		102	%	90 - 110
7554488	SS6	Method Blank	Calculated NO2	2014/07/07	<0.1		ppb	
7554506	SS6	Spiked Blank	Calculated NOx	2014/07/07		102	%	N/A
7554506	SS6	Method Blank	Calculated NOx	2014/07/07	<0.1		ppb	

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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CBG EXTENSION PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT

AIR QUALITY IMPACT ASSESSMENT

Prepared for:

Compagnie des bauxites de Guinée (CBG)

Prepared by:

SENES Consultants
AN ARCADIS COMPANY

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December 2014

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1.0 INTRODUCTION

CBG (Compagnie des bauxites de Guinée) is a mining company jointly owned by the Government of Guinea and Halco Mining (Alcoa, Rio Tinto Alcan and Dadco). CBG currently mines, rails, processes and ships about 13.5 MTPA of bauxite material at 3% moisture from its operations, which are located in Kamsar and Sangarédi in northwest Guinea, as shown in Figure 1. These facilities have been operating since 1973.

CBG is currently considering the expansion of its bauxite production of shipped material starting with 18.5 MPTA, to a plant capacity of 22.5 MTPA at 3% moisture by January 2017 and a further increase of 5 MTPA to a plant capacity of 27.5 MTPA by 2022.

In support of the planned Project, SENES Consultants (SENES) was retained by EEM to complete an air dispersion modelling study to assess the potential effects of CBG's expansion activities on ambient air quality. Various activities have the potential to generate emissions of Constituents of Potential Concern (COPCs), which include airborne dust (and its metallic components) and gaseous products of combustion (e.g., NO_x). The purpose of this report is to characterize the sources of COPCs at both Kamsar and Sangarédi, outline the approach used for air dispersion modelling, and evaluate the model predicted COPC concentrations using applicable ambient air quality criteria, standards, objectives or guidelines. The specific objectives of the air dispersion modelling assessment are:

1. To discuss background or baseline air quality conditions within the study areas;
2. To identify the principal sources of Constituents of Potential Concern (COPCs) and complete an emissions inventory for the Project including the expansion of the Kamsar Processing Facility and Sangarédi mining operations;
3. To evaluate the various COPC emissions sources using air dispersion modelling; and,
4. To assess the potential effects of the Project on ambient air quality for selected COPCs.

Selected outputs from the air dispersion model runs were also used as inputs to the water quality, biological, and socio economic effects assessments.

1.1 OVERVIEW OF THE REPORT

In addition to this introductory section, this report includes the following seven sections. Section 2.0 describes the assessment methodology including the spatial, temporal and technical boundaries, as well as the air quality criteria used to evaluate the model predictions. Section 3.0 discusses the existing air quality and climate, and Section 4.0 describes the assessment scenarios. Section 5.0 provides details of the emissions inventories and Section 6.0 describes the air dispersion modelling methods. Finally, Section 7.0 details the dispersion modelling results and Section 8.0 provides a summary and recommendations for additional mitigation and monitoring.

2.0 ASSESSMENT METHODOLOGY

Bauxite mining, raw material transportation, processing and product shipping activities associated with the Project have the potential to affect ambient air concentrations. This section describes the air quality impact assessment methodology including the Project-environment interactions, the spatial, temporal and technical boundaries as well as the air quality criteria, standards or guidelines applicable to the Project.

2.1 SPATIAL BOUNDARIES

2.1.1 Study Areas

Two (2) study areas have been defined for the purpose of this air quality effects assessment. These areas are the maximum areas within which Project-related air quality effects can be predicted or measured with a reasonable degree of accuracy and confidence. The study areas include the Project Footprint and any adjacent areas where Project-related air quality effects may be reasonably expected to occur. The study areas are as follows:

- The Kamsar study area encompasses a region approximately 10 km by 16 km centred on the Kamsar Processing Facility; and
- The Sangarédi study area encompasses a region approximately 22 km by 26 km which is roughly centred on CBG's existing rail loading facility, south of the Town of Sangarédi. This study area includes active, formerly active and planned bauxite mining areas.

Both study areas considered in this assessment are illustrated in Figure 1.

2.1.2 Project Footprint

The Project Footprint is the most immediate area of the Project that includes the area of direct physical disturbance associated with the construction or operation of the Project. The Project Footprint consists of three main components: the Kamsar Processing Facility, the Sangarédi mine (including mine haul roads) and the interconnecting rail network between the mine and Kamsar. The Project Footprint of the Kamsar Processing Facility is shown in Figure 2 and the Project Footprint of the Sangarédi mine is shown in Figure 3. Note that the Sangarédi Project Footprint includes approximately 21 km of the existing rail network, the mine haul roads as well as CBG offices.

2.2 TEMPORAL BOUNDARIES

The temporal boundaries for the assessment are defined based on the timing and duration of potential effects from activities associated with the Project. The assessment covers all major Project operating phases, each delineated by the anticipated maximum production rate, which is proposed to increase at various intervals through the life of the Project. The total life of the Project where air quality effects could occur from Project-related activities is expected to be approximately thirteen (13) years, and completed in three (3) production phases. Since the level of activity from each of the production phases differs, the extent of any related potential effects will also differ. For this reason, potential air quality effects from the Project were assessed for three separate production scenarios:

- Maximum phase I (18.5 MTPA) operation scenario (2.5 years);
- Maximum phase II (22.5 MTPA) operation scenario (4.5 years); and
- Maximum phase III (27.5 MTPA) operation scenario (6 years).

Additional details on the development of the above scenarios are provided in Section 4.0.

2.3 TECHNICAL BOUNDARIES

The air quality impact assessment is subject to some technical limitations due to a lack of information with which to predict air concentrations. These technical limitations have been considered in the assessment and pertain to the following:

- Many of the air contaminant emissions estimates from mining operations are based on US EPA AP-42 emission factors (US EPA 1995a) (e.g., drilling, blasting, material handling, processing/crushing and unpaved road dust). Most of these emission factors require further site-specific or activity-specific data that were not available at this time. For example, parameters such as material silt and moisture content and daily vehicle counts, among other parameters, were often unavailable. In such cases, professional judgement based on information from similar mining assessments, or default values from AP-42 were used in place of the site-specific data.
- At the time this assessment was prepared, the planned network of haul roads was not available. As a result, the road sources were based on existing roads visible in satellite imagery provided by CBG and the road shapefiles provided in the draft Insuco social impact assessment.

These technical limitations were overcome by using highly conservative estimation techniques and professional judgement. Attachment B provides a detailed account of assumptions that have been used in the assessment.

2.4 CONSTITUENTS OF POTENTIAL CONCERN

Ambient air quality is described by measurable air concentrations of Constituents of Potential Concern (COPCs). As previously mentioned, Project activities have the potential to generate emissions of COPCs including suspended particulate matter and gaseous products of combustion such as NO_x. As a result, the following COPCs are considered to be indicators of air quality:

- Particulate matter less than 10 microns (PM_{10})
- Particulate matter less than 2.5 microns ($PM_{2.5}$)
- Nitrogen dioxide (NO_2)
- Sulphur dioxide (SO_2)

In addition to COPCs, annual air concentrations of total suspended particulate (TSP) and its metallic constituents were determined in order to inform assessments carried out by other related disciplines such as the biological and water quality impact assessments. The trace metallic constituents of dust were selected based on the results of geochemical analysis of surficial soil samples collected the during baseline studies. Specifically, the following additional compounds were considered:

- Total suspended particulate (TSP) and its metallic constituents; including:
  - Aluminum (Al)
  - Antimony (Sb)
  - Arsenic (As)
  - Cadmium (Cd)
  - Chromium (Cr)
  - Copper (Cu)
  - Nickel (Ni)

2.5 REGULATORY FRAMEWORK

Air quality effects are assessed quantitatively by comparing model predicted COPC concentrations to air quality regulatory guidelines, which are typically based human health effects. There are currently no local air quality guidelines in Guinea. As funding for the Project is being sought from the International Finance Corporation (IFC), air quality guidelines from this organization have been applied in this assessment and are described below.

2.5.1 IFC General EHS Guidelines: Environmental (Air Emissions and Ambient Air Quality)

The methodology applied for the development of the air quality impact assessment conforms to the requirements of the Bureau Guinéen des Evaluations Environnementales (BGÉE) and its relevant legal framework. Concordance with the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability will also be assured. The IFC Environmental, Health and Safety Guidelines for Air Emissions and Ambient Air Quality, specify that: *"Projects should prevent or minimize impacts by ensuring that emissions do not result in pollution concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines* (Table 2.1) *or other internationally recognized sources"* (IFC 2007).

The WHO guidelines recognize the need for a staged approach to achieving the recommended guidelines and consequently provide interim targets for SO_2, PM_{10} and $PM_{2.5}$. The existing air quality environment in Kamsar and Sangarédi is already burdened by CBG's current bauxite processing, mining and transportation activities, in addition to activities undertaken by the local population. Local emission sources include activities such as local traffic, cooking fires, refuse fires and burning to clear brush. Other sources, particularly in the dry season, that will contribute to the air quality environment are hot dry winds (the Harmattan) that blow out of the east and northeast, carrying warm air and dust from the Sahara Desert to the Gulf of Guinea. Further, wind-blown dust from open exposed areas and brush fires also contribute greatly to the elevated local air concentrations. As such, for this Project, WHO Interim Target 1 is generally applied and referenced in this assessment.

Table 2.1: World Health Organization Ambient Air Quality Guidelines[1,2]

Contaminant	Averaging Period	Guideline Value (µg/m^3)			
		Interim Target 1	Interim Target 2	Interim Target 3	Guideline
SO_2	24 hour	125	50		20
	10 minute				500
NO_2	1 year				40
	1 hour				200
PM_{10}	1 year	70	50	30	20
	24 hour	150	100	75	50
$PM_{2.5}$	1 year	35	25	15	10
	24 hour	75	50	37.5	25

Notes:
[1] World Health Organization (WHO). Air Quality Guidelines Global Update, 2005. PM 24-hour value is the 99th percentile
[2] Interim targets are provided in recognition of the need for a staged approach to achieving the recommended guidelines

It is important note that the discussion herein focuses on air quality impacts on humans, as the WHO guidelines used in this assessment are based on health and nuisance effects relating to human exposure.

2.5.2 IFC EHS Guidelines for Mining

In addition to the air quality guidelines summarized in Section 2.5.1 from the IFC General EHS Guidelines, the IFC also provides a guideline specifically for mining operations which include additional air quality considerations. The *EHS Guidelines for Mining* (IFC 2007) outlines that the air emissions should be managed by meeting the WHO guidelines outlined in the General EHS Guidelines, and outlines mining-specific dust control techniques. These include:

- dust suppression techniques (e.g. wetting down, surfaces, use of agglomeration additives) for roads and work areas, optimization of traffic patterns, and reduction of travel speeds;
- prompt re-vegetation of exposed soils and other erodible materials, especially when areas are inactive;
- limits on clearing and opening up of new areas (i.e., only to be done when absolutely necessary);
- enclosure and/or efficient dust suppression of storage areas for dusty materials;
- loading, transfer, and discharge of materials should take place with a minimum height of fall, and be shielded against the wind, and consider use of dust suppression spray systems; and,
- conveyor systems for dusty materials should be covered and equipped with measures for cleaning return belts.

3.0 EXISTING ENVIRONMENT

3.1 METHODOLOGY

3.1.1 Ambient Air Quality Baseline Measurements

In an effort to characterize the existing ambient air quality within the Project area (both Kamsar and Sangarédi), an ambient air quality monitoring program was completed at the Project sites between February and May 2014. Air quality monitoring was completed in accordance with the IFC *Environmental, Health, and Safety (EHS) Guidelines – General EHS Guidelines: Environmental* (IFC 2007) requirements. The baseline monitoring was completed by CBG staff in accordance with detailed US EPA-based methods and procedures. Sample analysis was completed by Maxxam Analytics, an accredited Canadian laboratory. The basic procedure consisted of:

- selecting representative monitoring locations;
- collecting measurements of ambient air concentrations of both particulate matter (and its metallic constituents) and gaseous Contaminants of Potential Concern (COPCs) at the identified locations over a period of 24 hours (for particulates) or 30 days (for gaseous contaminants); and,
- validating and correcting the sample analysis data, and field notes to remove anomalous values.

The results of the ambient air quality monitoring program were also compared to ambient air quality data collected for the previous air quality impact assessment (AECOM 2011).

3.1.2 Air Quality Baseline Modelling

In addition to the measurement activities described in Section 3.1.1, air dispersion modelling of the baseline conditions for CBG's operations in Kamsar and Sangarédi was conducted. This allows for a direct comparison between the baseline model predictions and the predictions of potential future effects (Section 7.0). The ambient baseline monitoring data was also used to validate the baseline model.

Air dispersion modelling was undertaken using the CALMET/CALPUFF modelling system (Scire et. al. 1999, 2000a,b) to predict the incremental concentrations of TSP (and its metallic constituents), PM_{10}, $PM_{2.5}$, SO_2 and NO_2 within a modelling region or domain. As discussed in Section 6.0, the CALPUFF model has the ability to handle both complex meteorology and an array of multiple emissions sources from facilities and activities located over a large area. The CALPUFF modelling system is superior to AERMOD in areas with significant local terrain relief (i.e., hilly or mountainous areas with valley channelled air flows) or shoreline effects due

to the proximity of a large water body (i.e., the Atlantic Ocean) that alters the meteorological flow regime.

In general, the recommended methodologies outlined in the IFC *Environmental, Health, and Safety (EHS) Guidelines – General EHS Guidelines: Environmental* (IFC 2007) document were followed when completing the atmospheric dispersion modelling. The details of the modelling methodology are provided in Section 6.0.

Modelling baseline air quality is important where there is an existing facility that will be expanded as it will provide a meaningful benchmark against which the model predictions for the future expansion scenarios can be compared. In this manner, the incremental change resulting from implementation of the project can be reliably determined. Section 5.0 provides a summary of the emission estimates used in the baseline modelling assessment.

3.2 CLIMATE AND METEOROLOGY

3.2.1 Climate

Maritime Guinea is characterized by a tropical and humid climate that has two seasons:

- The dry season (mid-November through to May) is typified by hot dry winds (the Harmattan) that blow out of the east and northeast, carrying warm air and dust from the Sahara Desert to the Gulf of Guinea; and,
- The rainy season (lasting the balance of the year) brings heavy monsoon rains, high humidity and winds from the southwest. Rainfall is heaviest in the south of Guinea, diminishing towards northern coastal areas and the eastern interior.

Due to its proximity to the equator, the day-night cycle in Guinea varies little throughout the year. Average daily temperatures also vary only slightly throughout the year. There are no long term climate stations in the vicinity of Kamsar or Sangarédi. Boké, located approximately, 45 km inland, north-east of Kamsar, and 70 km southwest of Sangarédi has a long term climate data. Summary statistics based on data collected by the World Meteorological Organization are provided in Table 3.1.

Table 3.1: Boké Climate Normals (1961-1990)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Temp. 30 yr. Mean (^oC)	26.3	27.9	29.1	29.7	28.3	27.1	27.4	25.4	24	26.8	28.2	27.2	27.28
High Temp. 30 yr. Mean (^oC)	39.7	38.4	40.5	40.1	38.5	35	32.8	32.4	33.1	33.9	35.5	35.7	36.3
Low Temp. 30 yr. Mean (^oC)	14.4	15.7	17.7	19.9	20.9	20.4	20.7	20.5	19.7	20.1	18.1	14.4	18.54
Precip. Mean (mm)	0	0.1	0.2	9	105	258	485	424	545	317	67	2	184.36
Relative Humidity Mean (%)	53	58	53	55	67	76	75	82	92	78	69	58	68

Source: World Climate (2014)

Detailed historical weather and climate data are generally unavailable for Kamsar and Sangarédi, with the exception of a limited precipitation record in Sangarédi, which has been collected by CBG (Table 3.2). The monthly rainfall statistics for Boké located approximately 50 km northeast of Kamsar are also provided.

Table 3.2: Monthly Precipitation in Sangarédi and Boké

Month	Monthly Precipitation (mm)			
	Sangarédi (1974 to 1978 & 1980 to 2000)		Boké (1974 to 1978 & 1980 to 200)	
	Average	Maximum	Average	Maximum
Jan	2.3	31.0	0.5	7.1
Feb	0.8	19.8	1.0	22.1
Mar	1.8	35.8	0.3	4.7
Apr	18.6	95.0	5.0	42.6
May	111.3	222.2	89.3	217.0
Jun	270.9	514.2	240.7	440.1
Jul	427.4	711.2	463.7	691.2
Aug	447.1	648.5	522.1	789.1
Sep	437.8	745.5	456.5	807.6
Oct	316.2	498.6	313.0	468.0
Nov	71.9	195.9	59.5	232.3
Dec	0.5	10.8	1.2	14.3
Annual	2105.2	2995.8	2152.8	2990.8

Source: SNC Lavalin (2005)

3.2.2 Meteorological Modelling

In order to overcome the limited observing record in Kamsar and Sangarédi, five years of site-specific meteorology was developed for both sites for the 2009 to 2013 period. Hourly

meteorology was developed as described in Section 6.1. This meteorological data set was used as input to the air dispersion model.

3.3 AMBIENT AIR QUALITY

3.3.1 Ambient Air Quality Monitoring in Kamsar

Table 3.3 and Select TSP filters were also analyzed for metals including: aluminum; antimony; arsenic; cadmium; chromium; copper; and nickel. Aluminum was the only metal that was found to be above the detection limit of the laboratory instrumentation and is summarized in Table 3.3. All other results can be found in Attachment E. In general, aluminum concentrations were found to be low (less than 10 µg/m³).

Table 3.4 present a summary of the monitoring results for the two ambient air quality monitoring stations (AQ-1 and AQ-2) located in Kamsar for the spring 2014 monitoring campaign. Complete laboratory results are provided in Attachment E. Table 3.3 also presents the results of the ambient air quality PM_{10} and $PM_{2.5}$ monitoring undertaken in January 2011 around the CBG Bauxite Processing Facility in Kamsar (AECOM 2011). The locations of the ambient air quality monitoring stations are shown in Figure 2. The ambient monitoring locations for the 2011 particulate monitoring were further away from the CBG property than the 2014 measurement locations. Sample location AA1 was selected by AECOM to be representative of a background air concentration located on farmland north of Kamsar and sample location AA7 was selected to be representative of the Kamsar urban environment.

Table 3.3: Results of Baseline Particulate Monitoring in Kamsar (µg/m³)

Sample Location	No. Sample Days	Average Daily Concentration (µg/m³)				Max Daily Concentration (µg/m³)			
		TSP	PM_{10}	$PM_{2.5}$	Al	TSP	PM_{10}	$PM_{2.5}$	Al
AQ-1 Alcoa (2014)	12	160.3	112.6	70.5	3.0	300.2	244.4	117.7	7.1
AQ-2 Ecole (2014)	12	170.0	122.5	70.3	3.2	317.8	245.3	123.5	8.3
AA1 (North Kamsar) (2011)[a]	2	-	218.0	48.6	-	-	223.5	57.5	-
AA7 (CBG Garage) (2011)[a]	1	-	134.2	34.0	-	-	134.2	34.0	-
WHO Interim Target 1		-	150	75	-	-	150	75	-
WHO Interim Target 2		-	100	50	-	-	100	50	-
WHO Interim Target 3		-	75	37.5	-	-	75	37.5	-
WHO Guideline		-	50	25	-	-	50	25	-

Notes:
TSP: total suspended particulate; PM_{10}: fine particulate < 10 µm; $PM_{2.5}$: fine particulate < 2.5 µm.
[a] AECOM (2011)

The results of the ambient air quality monitoring campaign indicate that the Kamsar airshed is already burdened with fine particulates. While the observed average daily concentrations of PM_{10} and $PM_{2.5}$ measurements conducted in 2014 are below the WHO Interim Target 1, maximum daily concentrations of PM_{10} and $PM_{2.5}$ at AQ-1 and AQ-2 are approximately 60% higher than the WHO Interim Target 1. The results at AQ-1 and AQ-2 are generally consistent with the limited sampling conducted for the previous assessment of ambient air quality in Kamsar (AECOM 2011).

Select TSP filters were also analyzed for metals including: aluminum; antimony; arsenic; cadmium; chromium; copper; and nickel. Aluminum was the only metal that was found to be above the detection limit of the laboratory instrumentation and is summarized in Table 3.3. All other results can be found in Attachment E. In general, aluminum concentrations were found to be low (less than 10 µg/m³).

Table 3.4: Results of Baseline Gaseous Contaminant Monitoring in Kamsar (µg/m³) (30 Day Average)

Sample Location	No. of Samples	Average Monthly Concentration (µg/m³)			Maximum Monthly Concentration (µg/m³)		
		NO_2	NO_x	SO_2	NO_2	NO_x	SO_2
AQ-1 Alcoa	4	5.0	13.6	5.0	5.5	15.2	7.1

Notes:
NO_2: nitrogen dioxide; NO_x: oxides of nitrogen; SO_2: sulphur dioxide.

Ambient NO_2 and SO_2 measurements at AQ-1 are approximately 10% of applicable WHO guidelines, even after converting the 30-day measurements to common (i.e., 10-mintue, 24-hour and annual) averaging times.

3.3.2 Modelling of Existing Air Quality in Kamsar

As described previously, air dispersion modelling was conducted in order to evaluate the success of the ambient air quality monitoring campaign and to characterize existing air quality conditions in Kamsar. Contour plots for contaminants having WHO guidelines are presented in Attachment A and tabular results for all contaminants are provided in Attachment D.

The contour plots show maximum model predicted concentrations resulting from emissions from the Kamsar Processing Facility. It is important to note that the maximum predicted concentrations (for 10 min, 1-hour or 24-hour timeframes) shown in the figures represent the single highest concentration predicted to occur at each location, at any time during the 5-year modelling period. Therefore, the contours shown do not represent a “snapshot” in time as these maxima may occur on different days, under different meteorological conditions. Further, as

discussed in Section 6.0, all COPCs were modelled as a gas which does not consider plume depletion for particulate. Consequently the TSP, PM_{10} and $PM_{2.5}$ air concentrations are overestimated.

Maximum daily modelling results at AQ-1 and AQ-2 are presented in Table 3.5 and annual results in Table 3.6. Table 3.7 presents model results for 10 minute SO_2, and 1-hour NO_2.

Table 3.5: Predicted Maximum Daily Concentrations in Kamsar (µg/m^3)

Receptor Location	Predicted Maximum Daily Concentration (µg/m^3)			
	PM_{10}	$PM_{2.5}$	NO_2	SO_2
AQ-1 Alcoa - Maximum	243	122	48	66
AQ-1 Alcoa – 99th percentile[a]	186	93		
AQ-2 Ecole – Maximum	246	120	53	71
AQ-2 Ecole – 99th percentile[a]	160	80		
WHO Interim Target 1	150	75	-	125
WHO Interim Target 2	100	50	-	50
WHO Interim Target 3	75	37.5	-	-
WHO Guideline	50	25	-	20

a – 99th percentile of modelled data to compare to WHO guidelines

Model-predicted air concentrations of fine particulate (PM_{10} and $PM_{2.5}$) are above the WHO Interim Target 1. However, the model results show good agreement with ambient particulate and gaseous measurements shown in Section 3.3.1. The close agreement between the modelling predictions and the maximum observed baseline concentrations supports the inference that the CBG Bauxite Processing Facility at Kamsar is a primary source of fine particulate at AQ-1 and AQ-2. However, as previously mentioned, it is likely that other local sources of fine particulate are contributing to the baseline totals and only a portion of the measurements can be attributed to emissions from the Kamsar Processing Facility.

Table 3.6: Predicted Average Annual Concentrations in Kamsar (µg/m^3)

Receptor Location	Predicted Average Annual Concentration (µg/m^3)			
	PM_{10}	$PM_{2.5}$	NO_2	SO_2
AQ-1 Alcoa	44	23	11	14
AQ-2 Ecole	34	18	8	11
WHO Interim Target 1	70	35	-	-
WHO Interim Target 2	50	25	-	-
WHO Interim Target 3	30	15	-	-
WHO Guideline	20	10	40	-

Table 3.7: Predicted Concentrations for Other Averaging Periods in Kamsar (µg/m^3)

Receptor Location	Predicted Average Annual Concentration (µg/m^3)	
	NO_2	SO_2
	1-hour	10-minute[a]
AQ-1 Alcoa	141	347
AQ-2 Ecole	176	410
WHO Guideline	200	500

a – Converted from 1 hour average using the time averaging calculation noted in Section 4.2.1.

While the predicted annual concentrations of NO_2 are higher than the observed 30-day average values, this is explained by the limited monitoring period, the difference in averaging times (i.e., annual versus 30-day) and the conservative assumption of a 70% conversion of NO_x to NO_2 (see Section 6.4). After taking these considerations into account, predicted and monitored concentrations of gaseous COPCs agreed well (i.e., within a factor of 2, which is considered acceptable for air dispersion modelling).

3.3.3 Ambient Air Quality Monitoring in Sangarédi

Table 3.8 present a summary of the particulate monitoring results for the four ambient air quality monitoring stations (AQ-10, AQ-11, AQ-12 and AQ-13) located in Sangarédi for the spring 2014 monitoring campaign. The locations or the ambient air quality monitoring stations are shown in Figure 3. The results at AQ-10, AQ-11, AQ-12 and AQ-13 are broadly consistent with the limited sampling conducted for the previous assessment of ambient air quality in Sangarédi (AECOM 2011). In the previous assessment, daily concentrations of PM_{10} and $PM_{2.5}$ were measured only once at three locations (AA-1, AA-2, AA-3) Table 3.8.

Table 3.8: Results of Baseline Particulate Monitoring in Sangarédi (µg/m³)

Sample Location	No. of Sample Days	Average Daily Concentration (µg/m³)				Max Daily Concentration (µg/m³)			
		TSP	PM_{10}	$PM_{2.5}$	Al	TSP	PM_{10}	$PM_{2.5}$	Al
AQ-10 Kourawel (2014)	5	150.5	124.5	76.0	1.2	211.0	195.0	152.6	1.5
AQ-11 Hamdallay (2014)	6	129.7	95.7	62.6	1.8	150.1	115.2	85.0	1.8
AQ-12 Petoun BW (2014)	6	127.6	111.0	72.7	0.9	162.0	133.0	85.2	1.3
AQ-13 Paravi (2014)	5	124.6	80.7	35.9	1.2	162.9	89.7	54.4	1.6
AA-1 Sangarédi – (2011)[a]	1	1	116.3	34.5	-	1	116.3	34.5	-
AA-2 Hamdalaye – (2011)[a]	1	1	66.5	14.0	-	1	66.5	14.0	-
AA-3 BW – (2011)[a]	1	1	75.4	15.8	-	1	75.4	15.8	-
WHO Interim Target 1		-	150	75	-	-	150	75	-
WHO Interim Target 2		-	100	50	-	-	100	50	-
WHO Interim Target 3		-	75	37.5	-	-	75	37.5	-
Guideline		-	50	25	-	-	50	25	-

Notes:
TSP: total suspended particulate; PM_{10}: fine particulate < 10 µm; $PM_{2.5}$: fine particulate < 2.5 µm.
[a] –AECOM (2011)

Similar to Kamsar, the results of the ambient air quality monitoring campaign indicate that the Sangarédi airshed is already burdened with fine particulates. The maximum measurements from the 2014 sampling conducted at AQ-10, AQ-11 and AQ-12 exceeded the WHO Interim Target 1 for both PM_{10} and $PM_{2.5}$. During the 2014 sampling campaign, CBG staff noted that all four ambient air quality monitoring stations were influenced to some degree by local sources of dust that are unrelated to CBG activities (e.g., brush fires and from charcoal cooking fires). At AQ-10, which is not currently affected by mining activities, the average and maximum daily concentrations of PM_{10} and $PM_{2.5}$ were approximately 30 to 100% above the WHO Interim Target 1. By contrast, PM_{10} and $PM_{2.5}$ concentrations at AQ-13 are 30 to 40% below WHO guidelines, showing the least influence from local sources of dust and CBG activities.

Select TSP filters in Sangarédi were also analyzed for metals. With the exception of aluminum, all metals were below the method detection limit of the laboratory instrumentation. As can be seen in Table 3.8, the measured concentrations of aluminum are quite low and similar across all monitoring locations, even those locations which are far from current CBG operations. This suggests that CBG operations do not significantly contribute to existing concentrations of aluminum in air.

Similar to Kamsar, ambient NO_2 and SO_2 measurements at AQ-12 and AQ-13 (Table 3.10) were less than 10% of applicable WHO guidelines, even after converting the 30-day measurements to common (i.e., 10-mintue, 24-hour and annual) averaging times.

Table 3.9: Results of Baseline Gaseous Contaminant Monitoring in Sangarédi (µg/m³)

Sample Location	No. of Samples	Average Monthly Concentration (µg/m³)			Max Monthly Concentration (µg/m³)		
		NO_2	NO_x	SO_2	NO_2	NO_x	SO_2
AQ-12 Petoun BW	2	2.4	4.4	0.3	2.6	5.3	0.3
AQ-13 Paravi	2	0.9	1.6	0.5	0.9	2.1	0.5

Notes:
NO_2: nitrogen dioxide; NO_x: oxides of nitrogen; SO_2: sulphur dioxide.

3.3.4 Modelling of Existing Air Quality in Sangarédi

As described previously, air dispersion modelling was conducted to characterize existing air quality conditions in Sangarédi. Annual contour plots for contaminants having WHO guidelines are presented in Attachment A and tabular results for all contaminants are provided in Attachment D. Average annual modelling results at AQ-10, AQ-11, AQ-12 and AQ-13 are presented in Table 3.10.

Table 3.10: Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	1.0	0.1	0.1
AQ11	AQ-11 Hamdallay	622.252	1225.617	8.1	1.0	0.8
AQ12	AQ-12 Petoun BW	628.870	1224.203	2.9	0.5	0.4
AQ13	AQ-13 Paravi	616.710	1221.796	0.8	0.1	0.1
SR9	Kourawel	620.668	1234.753	1.0	0.1	0.1
SR10	Sintiourou Kourawel	620.513	1234.360	1.0	0.1	0.1
SR46	Hamdalaye	622.082	1225.627	7.3	0.9	0.7
SR58	Pora PK130	630.420	1222.985	0.9	0.1	0.1
SR59	Carrefour Parawol	631.430	1221.004	0.8	0.1	0.1
SR60	Kahel Mbody	621.990	1235.671	1.1	0.1	0.1
SR97	Madina Dian	632.551	1221.418	0.6	0.1	0.1
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40

3.3.5 Selected COPC Baseline Concentrations

Given the variability of background concentrations as well as local source contributions (i.e., domestic cooking, local roads and open burning), the model predicted COPC concentrations presented in this baseline assessment are generally considered to be reflective of the increment from the Project plus these local sources. As a result, baseline or background COPC concentrations were not added to model predicted concentrations.

3.4 GREENHOUSE GASES

Emissions of greenhouse gases (GHG) from existing CBG operations, including mining, rail, mobile equipment and vehicles, and bauxite processing, were estimated by CBG and are provided in the Environmental Management Plan.

4.0 ASSESSMENT SCENARIOS

For each production level described in Section 2.2, air quality effects were evaluated for the following scenarios:

- CBG Bauxite Processing Facility at Kamsar;
- the mining activities at Sangarédi;
- a proposed rail siding; and,
- construction activities.

In addition, emissions of COPCs (in both Kamsar and Sangarédi) were considered for two time scales:

- Long-term (or annual) potential effects, where sources were assumed to be operating at average production rates across a broad spatial extent; and,
- Short-term potential effects, where operation levels were close to the maximum daily production rate and sources were spatially concentrated, in order to capture worst-case, localized effects.

A description of each assessment scenario is provided in the following sections while details of the emissions inventories for each scenario are provided in Section 5.0.

4.1 KAMSAR PROCESSING FACILITY

Emissions of COPCs are expected from the crushing and processing activities at the Kamsar bauxite processing facility. The main sources of COPC emissions include the following:

- Dust emissions (and its metallic constituents) generated by bauxite processing, including:
  - Rail unloading (i.e., ore handling);
  - Primary and secondary crushing;
  - Material conveyor transfers;
  - Drying; and,
  - Wind erosion of stockpiles and open areas.
- Emissions of fuel combustion products (i.e., NO_x, SO_2 and fine particulate matter) from the following equipment:
  - Dryers;
  - Generators;
  - Boilers;
  - Line-haul and switching locomotives; and,
  - Idling shipping vessels.

Both short-term (maximum 1- and 24-hour) and long term (average annual) emissions were generated for the existing (13.5 MTPY – Section 3.3.2) and the three future production levels (i.e., 18.5 MTPY, 22.5 MTPY and 27.5 MTPY) at the Kamsar Processing Facility. These emission rates were then carried through and evaluated using air dispersion modelling.

4.2 SANGARÉDI MINING OPERATIONS

Emissions of COPCs are expected from mining and supporting activities at the Sangarédi mine. The main sources of COPC emissions include the following:

- Dust emissions (and its metallic constituents) generated by bauxite mining and shipping activities, including:
  - Drilling;
  - Blasting;
  - Ore handling;
  - Land clearing (i.e., dozing);
  - Road maintenance (i.e., grading);
  - Wind erosion of stockpiles and open areas; and,
  - Haul road traffic.
- Emissions of fuel combustion products (i.e., NO_x, SO_2 and fine particulate matter) from power generation and from the operation of diesel-powered mining equipment and vehicles.
- Emissions of wind-blown dust and gaseous COPCs from rail transportation.

In air dispersion modelling, it is generally not practical to model every year of scheduled production due to the excessive amount of computational time involved in carrying out the model runs and in processing the outputs, particularly for an area as large as the proposed Sangarédi mine expansion. Hence, it is common practice to select certain years for modelling that are considered to be representative of activities at the Project site over consecutive periods spanning the operating life of the Project. As a result, in order to assess the long-term (i.e., annual) potential effects to air quality for each future production level, specific years were selected to represent each level of production.

To select representative years for modelling, SENS used shapefiles provided by CBG which outlined the mining plan. The mine plan spanned 14 years of operations (2014 through 2027) across four production levels (13.5 MTPY, 18.5 MTPY, 22.5 MTPY and 27.5 MTPY). Further, the Project Description (dated June 2014) provided a breakdown of these 14 years as follows:

- Existing operations: 2014
- 18.5 MTPY: 2015 to 2017

- 22.5 MTPY: 2017 to 2021
- 27.5 MTPY: 2022 to 2027

Based on these ranges, SENES selected the following years to represent each production level:

- Existing operations (13.5 MTPY) represented by 2014
- 18.5 MTPY: represented by 2017
- 22.5 MTPY: represented by 2019
- 27.5 MTPY: represented by 2027

The years selected to assess annual air quality effects were generally chosen based on the proximity of the mining areas to nearby sensitive receptors (Figure 3). This approach assumes a consecutive progression through the mining plan (i.e., extraction areas will be decommissioned and rehabilitated in each subsequent year). Note that the modelled areas shown in Figure 3 are an approximation of the corresponding footprints shown in the CBG mine plan. The corresponding haul road network is also shown in Figure 3. This road network was assumed based on the locations of existing roads visible in satellite imagery and the road shapefiles provided in the draft Insuco social impact assessment. As a conservative measure, the longest route between a mining area and rail loading area was selected. Additional details are provided in Section 6.0.

Given the spatial extent of the proposed mining areas and haul road network, it was not possible to complete a separate model run for each individual mining area in order to assess nearby short-term effects, as the areas are interspersed over a large domain that is more than 400 km^2. Instead, a generic modelling approach was used to represent typical daily mining activities occurring within an extraction area of 200 m by 200 m. In addition, the effects of an unpaved haul road were also evaluated using a generic road stretching 2 km on either side of the mining area, which was modelled concurrently with extraction activities. A separate model run was also completed to assess the NO_2 impacts of blasting (1-hour average concentrations). Details of these approaches are provided in Section 6.0.

4.3 PROPOSED RAIL SIDING OPERATIONS

The proposed expansion of the Kamsar Processing Facility and Sangarédi mining operations will require additional rail sidings along the existing rail network. To optimize shipping for the expansion, two new rail sidings are proposed at 14 km and 118 km as described in the Project Description.

The assessment of potential effects from increased rail traffic with no siding was included in the assessment scenarios for Sangarédi mining operations (Section 4.2). The effects of the proposed

rail sidings were assessed using a separate, generic model run which included an idling train with three locomotives on a siding. The expected emissions are combustion products (i.e., gases and fine particulate) from the locomotives. The results from this modelled scenario were compared to applicable WHO guidelines to determine the effect of a rail siding on local ambient air quality.

4.4 CONSTRUCTION

On-land construction activities have the potential to result in Project-related environmental effects that could result in increased concentrations of ambient COPCs. Construction activities are anticipated at both the Kamsar Processing Facility and the Sangarédi mining operations, and are described in brief below.

Expansion of the Kamsar Processing Facility will require the following construction activities:

- modification to the existing rail yard;
- installation of the new rotary rail car dumper, primary and secondary crushers and dryer(s);
- modifications/upgrades to the conveyor system; and,
- construction of a new storage building additions and modifications.

Expansion of the Sangarédi mining operations will require the following construction activities:

- construction of a new rail siding and a new rail loading area near Parawi (applicable to 22.5 MTPY or 27.5 MTPY production levels only); and,
- development of new haul roads.

The construction emissions will be generated within the same footprint as site operations at the Kamasar Processing Facility and Sangarédi mine operations. At Kamsar, the construction activities are largely limited to building construction, and there are no major earthworks planned. Consequently, the emissions the COPCs during construction at Kamsar will be much less than during the operations phase. Although minor earthworks are planned at Sangarédi, the spatial and temporal extents of the construction activities are much smaller than the operational activities, which are major earthworks themselves. In all, the maximum emission scenarios are considered to adequately capture the effects of construction for both Kamsar and Sangarédi. Consequently, detailed dispersion modelling was not undertaken for construction.

5.0 EMISSIONS INVENTORY

5.1 COPC EMISSIONS

COPC emissions resulting from Project activities (in both Kamsar and Sangarédi) were primarily calculated using the US EPA's *Compilation of Air Pollutant Emissions Factors* (commonly known as AP-42 emission factors). These emission factors were used to estimate the maximum emission rates of the specified COPCs for each source and/or activity in each of the production expansion scenarios.

The methods used to calculate COPC emissions from the Project activities described previously in Section 4.0 are summarized below. The specific emission sources that have been included in the emissions inventories are:

- Bauxite dryers/kilns;
- Diesel generators;
- Material handling of bauxite;
- Drilling;
- Blasting;
- Explosives detonation;
- Grading;
- Wind erosion of stockpiles and open railcars;
- Unpaved road dust; and
- Fuel combustion by container ships at berth, locomotives, on-road vehicles and non-road mobile equipment.

Where appropriate, mitigation measures considered to be inherently part of the Project plans have been incorporated into the emissions scenarios. At the Kamsar Processing Facility, the following mitigation measures were considered:

- Enclosure and/or efficient dust suppression of storage areas for dusty materials;
- Loading, transfer, and discharge of materials is shielded against the wind;
- Loading, transfer, and discharge of materials employs additional dust suppression systems, including dry fogging or dust collectors (future scenarios only, does not exist as part of the existing controls);
- Conveyor systems for dusty materials are covered; and,
- Dryer stacks are equipped with wet scrubbers operating at 99% efficiency.

In the Sangarédi mining area, the following mitigation measures have been incorporated into the emissions inventories:

- Dust suppression techniques (e.g., watering, chemical dust suppressants) are applied to unpaved haul roads to achieve 80% control;
- Vehicle speed in the vicinity of rail loading areas and active mining areas will be restricted to 40 km/hour; and
- Prompt re-vegetation of exposed soils and other erodible materials, especially when areas are inactive.

As outlined in Section 4.0, emissions of COPCs (in both Kamsar and Sangarédi) were considered for two time scales: long-term (or annual) potential effects; and short-term potential effects. At the Kamsar Processing Facility, emission estimates for the long-term and short-term emissions scenarios differed little. The dominant sources of particulate and gaseous COPCs (e.g., dryer stacks, transfer towers and conveyors, diesel generators) in Kamsar were assumed to operate at close to maximum rates throughout the year. For example, while outdoor stockpiles were assumed to be the same size in both the long-term and short-term effects assessments, annual wind erosion emissions account for a natural control efficiency of 29% due to precipitation (i.e., 101 days per year with > 0.25 mm of precipitation; derived from CALMET).

By contrast, mining operations in Sangarédi vary considerably in both spatial and temporal extent. In order to address this variability, emissions were estimated separately for typical annual scenarios across the study area, as well as for a generic working area to evaluate short-term effects (see Section 4.2). As a result of these contrasting emissions scenarios, it is difficult to make direct comparisons between short-term and long-term emission rates in Sangarédi.

5.1.1 Bauxite Dryers

Emissions of TSP, NO_x and SO_2 from the existing Kamsar bauxite dryers (FOR001, FOR002, FOR003) were based on stack testing conducted at the Kamsar Processing Facility in 2006 (Table 5.1). The emission rates were then scaled up to account for the difference between the measured stack flow rate at the time of testing and the maximum flow rate of the three existing dryers at full production (510,000 m^3 per dryer per hour; Drytech International [2011]). PM_{10} emissions were conservatively assumed to be 50% of TSP emissions; $PM_{2.5}$ emissions were conservatively assumed to be equal to PM_{10}. Metallic constituents of particulate emissions were estimated based on geochemical analyses of the bauxite ore, as outlined in Attachment B.

Table 5.1: Bauxite Dryer Stack Testing Results

Dryer	Emission Rate (kg/hour)			Volumetric Flow Rate (m^3/hour)	Exhaust Temperature (K)
	TSP	NO_x	SO_2		
FOR001	103	25.3	29.3	444,563	329.7
FOR002	50	4.1	4.1	369,959	325.4
FOR003	63	29.9	34.7	502,113	322.5

Source: AECOM (2011), Annex F.

Emissions of COPCs from the future Kamsar bauxite dryers (FOR004, FOR005) were estimated by assuming equivalent COPC concentrations as in the existing dryers, with flow rates scaled up to account for the larger throughput of the new dryers. All emission rate estimates (for existing and future dryers) assume that the dryer exhaust stacks are controlled by wet scrubbers having at least 99% control efficiency of all COPCs.

5.1.2 Diesel Generators

Diesel electric generators are used to supply electricity at the Kamsar Processing Facility (Centrale Kamsar) and at the main CBG facility in Sangarédi (Centrale Sangarédi). Emissions from the generators were estimated based on the fuel consumption totals outlined in Attachment B and emission factors from AP-42, Chapter 3.4, Large Stationary Diesel and All Stationary Dual-fuel Engines and AP-42, Chapter 1.3, Fuel Oil Combustion (see Table 5.2). The generators at Centrale Kamsar consume both diesel and No. 6 (Bunker C) fuel oil, whereas the generators at Centrale Sangarédi consume only diesel. Daily average emission rates were calculated assuming generators operate 365 days per year in Kamsar and 350 days per year in Sangarédi.

Table 5.2: Generator Emission Factors

COPC	Diesel Emission Factor (lb/MMBtu)	No. 6 Fuel Oil Emission Factor [1] (lb/1000 gal.)
TSP	0.062	30.8 [2]
PM_{10}	0.0496	21.9 [3]
$PM_{2.5}$	0.0479	16.0 [3]
Antimony	–	0.00525
Arsenic	–	0.00132
Cadmium	–	0.000398
Chrome	–	0.000845
Copper	–	0.00176
Nickel	–	0.0845
NOx	3.2	55
SO_2	0.333 [4]	471 [5]

Notes:
[1] Conservatively assumed maximum of emission rates for all units at Centrale Kamsar burning No. 6 fuel oil
[2] TSP = 9.19S + 3.2; where S = 3% sulphur, based on Kamsar Dryer Inspection Report (Drytech International [2011])
[3] PM_{10} assumed to be 71% of TSP; $PM_{2.5}$ assumed to be 52% of TSP, based on AP-42 Table 1.3-4.
[4] SO_2 = 1.01S; where S = 0.33% sulphur, based on typical values from U.S EPA. Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling Compression-Ignition, page 14.
[5] SO_2 = 157S; where S = 3% sulphur, based on Kamsar Dryer Inspection Report (Drytech International [2011])

5.1.3 Material Handling

Material handling includes activities such as unloading ore to stockpiles at the train loading area in Sangarédi and conveyor transfer of wet and dry ore at the Kamsar Processing Facility. The specific material drops or transfers that were included in this assessment for each production scenario (both in Kamsar and Sangarédi) are outlined in Attachment B.

The emission factor equation for material drops from the US EPA AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles (US EPA 2006a) was used to the estimate emissions from outdoor material handling activities (e.g., loading/unloading of ore to/from haul trucks):

$$TSP = 0.74 \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \; kg / tonne$$

$$PM_{10} = 0.35 \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \; kg / tonne$$

$$PM_{2.5} = 0.053 \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \; kg / tonne$$

Where,

U = mean wind speed (m/s)

M = moisture content (%)

Outdoor material handling emissions depend on the average wind speed, as well as the moisture content of the material being handled. The moisture contents of the various materials considered in this assessment are outlined in Attachment B. Where site-specific moisture contents were not known, default AP-42 values were used and are also noted in Attachment B. The annual average wind speeds in Kamsar and Sangarédi were, respectively, 3.3 m/s and 2.8 m/s, based on the CALMET meteorology developed for this assessment (Section 6.1.3). The wind speed applied to indoor material handling was assumed to be 1 m/s. Annual emissions from outdoor material handling also account for a natural control efficiency of 29% due to precipitation.

At the Kamsar Processing Facility, material processing and handling activities predominately take place inside structures, as bauxite is moved along a network of material conveyors and transfer towers. Emission factors for material processing and handling at the Kamsar Processing Facility are shown in Table 5.3 and were drawn from AP-42, Chapter 11.24, Metallic Minerals Processing (US EPA 1995b). The existing transfer towers are partially enclosed and/or have dust control systems (with an assumed 80% control efficiency), while conveyors themselves are covered and are assumed not to be a significant source of dust emissions.

Table 5.3: Material Handling Emission Factors

Source	Material Handling Emission Factors (kg per Mg of material throughput)		
	TSP	**PM_{10}**	**$PM_{2.5}$**
Primary Crushing	0.01	0.004	0.002
Secondary Crushing	0.03	0.012	0.006
Material Handling and Transfer (Bauxite/Alumina)	0.06	0.03	0.015

Notes:

1 Primary and secondary crushing emission factors assume high moisture content in the ore (i.e., 12.5%)

2 Emissions of $PM_{2.5}$ conservatively assumed to be equal to 50% of PM_{10}, based on the AP-42 background document for Chapter 11.24.

As Project expansion activities progress at the Kamsar Processing Facility, the system of transfer towers and conveyors will be incrementally upgraded to increase material handling rates and improve dust controls. Upgraded material handling equipment will be partially enclosed with an

assumed 80% control efficiency, and employ dry fogging or upgraded dust collection systems with an assumed additional 80% dust control efficiency, for a total control efficiency of 96%.

The maximum amount of ore handled per hour during processing activities in Kamsar and mining activities in Sangarédi is outlined in Attachment B, along with the assumed dust control efficiencies for material handling at the Kamsar Processing Facility. Note that no controls were applied to material handling emissions in Sangarédi.

5.1.4 Drilling

Emissions of TSP and PM_{10} from development/exploration drilling were estimated using the emission factor provided in US EPA AP-42, Chapter 11.9 -Western Surface Coal Mining (US EPA 1998). $PM_{2.5}$ emissions were conservatively assumed to be equal to PM_{10}. All factors assume wet drilling operations:

$TSP = 0.59\ kg/hole$

$PM_{10} = 0.31\ kg/hole$

$PM_{2.5} = 0.31\ kg/hole$

This method requires an estimate of the number of holes drilled. The maximum number of holes drilled per day during the different production scenarios is outlined in Attachment B. Note that drilling was not considered concurrently with blasting and explosives detonation (i.e., drilling emissions were not part of the worst case short-term effects scenario).

5.1.5 Blasting

Emissions from blasting were estimated using the emission factors in US EPA AP-42, Chapter 11.9 – Western Surface Coal Mining (US EPA 1998):

$TSP = 0.00022(A)^{1.5}\ kg/blast$

$PM_{10} = 0.52 \times 0.00022(A)^{1.5}\ kg/blast$

$PM_{2.5} = 0.03 \times 0.00022(A)^{1.5}\ kg/blast$

Where,

A = area of the blast face (m^2)

This method requires an estimate of the horizontal area displaced by blasting as well as the frequency of blasting which is outlined in Attachment B for the various production scenarios. As a conservative measure, the frequency of blasting was assumed to be the same for each of the production levels. Consequently, the size of the blast increased relative to the increase in production.

5.1.6 Explosives Detonation

Blasting was assumed to use 100% ammonium nitrate/fuel oil (ANFO) explosive. Emission factors were drawn from US EPA AP-42, Chapter 13.3 – Explosives Detonation (US EPA 1995c):

CO = 34 kg/tonne emulsion

NOx = 8 kg/tonne emulsion

This method requires an estimate of the amount of ANFO required for blasting, which was calculated based on a generic powder factor for "soft" material of 0.25 kg ANFO per m³ of ore (Dyno Nobel 2010) and the volume of material removed per blast which is provided in Attachment B.

5.1.7 Grading

Emissions of dust (TSP, PM_{10}, $PM_{2.5}$) from grading unpaved haul roads in Sangarédi were estimated using the emission factor equation provided in US EPA AP-42, Chapter 11.9 - Western Surface Coal Mining (US EPA 1998):

$$TSP = 0.0034 \times S^{2.5}\ kg/VKT$$

$$PM_{10} = 0.60 \times 0.0056 \times S^{2.0}\ kg/VKT$$

$$PM_{2.5} = 0.031 \times 0.0034 \times S^{2.5}\ kg/VKT$$

Where,

S = mean vehicle speed (km/h)
VKT = vehicle kilometres travelled

This method requires an estimate of the speed of the grader (assumed to be 10 km per hour) as well as the number of kilometres travelled, which was calculated based on the length of each of the unpaved roads. For the short-term emissions scenarios, a grader was conservatively assumed

to complete a single trip per day along the generic road. For the long-term emissions scenarios, a grader was assumed to travel only on active haul roads and a natural control efficiency of 29% (due to precipitation) was assumed. Additional details are provided in Attachment B.

5.1.8 Wind Erosion from Stockpiles and Railcars

Wind erosion emissions from outdoor stockpiles, open areas, open railcars and active working areas in Sangarédi were estimated following the methodology outlined in the Western Regional Air Partnership (WRAP) Fugitive Dust Handbook (WRAP 2006):

$$TSP = 1.0 \times 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{F}{15}\right) kg / ha / day$$

$$PM_{10} = 0.5 \times 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{F}{15}\right) kg / ha / day$$

$$PM_{2.5} = 0.075 \times 1.7 \times \left(\frac{s}{1.5}\right) \times \left(\frac{F}{15}\right) kg / ha / day$$

Where,

s = average silt content of storage pile (%)

F = percentage of time in the year with unobstructed wind speed >5.4 m/s in percent (%) at the mean pile height

According to the WRAP Handbook, this methodology is applicable to short-term (i.e., 24-hour) averaging periods. It results in a conservative estimate of particulate matter emissions when applied on an annual basis.

Average monthly frequencies of wind speeds greater than 5.4 m/s were calculated for each stockpile using the CALMET dispersion meteorology and the mean pile heights as described in Attachment B. The silt contents of the various stockpiles considered in the assessment along with the surface areas used are also outlined in Attachment B. In the absence of site-specific information, the silt contents were based on default AP-42 values.

To calculate wind erosion emissions, one hundred percent of the surface area of each stockpile or working area was considered to be exposed to the wind, except for the long-term effect scenario at Sangarédi, where only 50% of the active extraction areas were considered to be exposed to the wind.

5.1.9 Unpaved Road Dust

For the Sangarédi mining activities, emissions of road dust from unpaved haul roads were estimated using the emission factor equations from US EPA AP-42, Chapter 13.2.2 (US EPA 2006b):

$$TSP = 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W}{3}\right)^{0.45} lb/VMT$$

$$PM_{10} = 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W}{3}\right)^{0.45} lb/VMT$$

$$PM_{2.5} = 0.15 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W}{3}\right)^{0.45} lb/VMT$$

Where,

s = silt content (%)
W = vehicle weight (tons)
VMT = vehicle miles travelled

To estimate emissions from industrial unpaved roads, silt content, average fleet weight, and the number of vehicle miles travelled is required. In the absence of site-specific information, an average silt content of 10% was assumed based on typical values in AP-42, Chapter 13.2.2. Vehicle weights were based on the list of existing mining equipment provided by CBG. The number and length vehicle trips was based on the capacity of haul trucks (90 tonnes; CAT 777F) and an analysis of the modelled road network connecting the planned extraction sites (see Figure 3). Additional details are provided in Attachment B.

The generation of dust from unpaved roads can be controlled through operational practices such as watering, applying chemical dust suppressants or driving at lower speeds. For this assessment it has been assumed that vehicle speeds within the active extraction areas and at the rail loading sites will be kept at or below 25 mph (44 km/h). This controls dust emissions by about 44% as suggested by the *WRAP Fugitive Dust Handbook* (WRAP 2006). It was also assumed that additional controls such as watering will be applied on an as needed basis to all roads such that dust emissions are controlled by an additional 80% at all times of the year. It is anticipated that frequency of application of dust controls for the haul roads will vary throughout the year, accounting for considerable natural dust control during the rainy season.

5.1.10 Fuel Combustion by Ships, Locomotives, Vehicles and Non-Road Mobile Equipment

The existing and future equipment fleet for both Kamsar and Sangarédi is provided in Attachment B, along with estimated fuel consumption for the different production scenarios. Fuel estimates were based on the fuel inventory completed for the CBG greenhouse gas inventories and split among the existing equipment fleet using assumed typical fuel efficiencies. Emissions were estimated using emission factors from the following US EPA documents:

- Ships at berth in Kamsar: *Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories* (US EPA 2009a);
- Locomotives: *Emission Factors for Locomotives* (US EPA 2009b); and,
- Vehicles and non-road mobile equipment: *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition* (US EPA 2010).

For this assessment, it was conservatively assumed that all locomotives, vehicle and mining equipment meet Tier 0 standards which are based on engine model years prior to 2001. A diesel sulphur content of 0.33% was assumed based on typical values for Tier 0 vehicles and equipment (US EPA 2010). Emission factors for these sources are summarized in Table 5.4.

Table 5.4: Locomotive, Vehicle and Non-Road Mobile Equipment Emission Factors

Source	Emission Factors						Conversion [3]
	TSP [1]	PM_{10}	$PM_{2.5}$ [1]	NO_x	SO_2 [2]	Units	
Tier 0 Vehicles & Non-road Equipment (>75 to 100 hp)	0.722	0.722	0.700	6.9	1.19	g/hp-hr	*BSFC:* 0.408 lb/hp-hr
Tier 0 Vehicles & Non-road Equipment (>100 to 750 hp)	0.402	0.402	0.390	8.38	1.19		*BSFC:* 0.367 lb/hp-hr
Tier 0 Locomotives (Line-haul)	0.32	0.32	0.31	8.6	1.0	g/bhp-hr	*Fuel density:* 20.8 bhp-hr/gal
Tier 0 Locomotives (Switching)	0.44	0.44	0.43	12.6	1.0		*Fuel density:* 15.2 bhp-hr/gal

Notes:
[1] PM_{10} assumed equal to TSP; $PM_{2.5}$ assumed equal to 97% of PM_{10}.
[2] SO_2 emission factors assume diesel fuel density of 7.1 lb per gal and sulphur content of 0.33% (US EPA 2010).
[3] BSFC: brake-specific fuel consumption in units of pounds per horsepower-hour (lb/hp-hr).

Emission factors for ships at berth in Kamsar are provided in Table 5.5. Emissions were based on typical values for a Kamsarmax type ships operating at berth at the Kamsar Processing Facility, while drawing power from its auxiliary engine at 10% load (US EPA 2009a).

Table 5.5: Ships at Berth Emission Factors

Source	Emission Factors						Conversion [2]
	TSP [1]	PM_{10}	$PM_{2.5}$ [1]	NO_x	SO_2	Units	
Kamsarmax Auxiliary Engine	0.49	0.49	0.45	13.9	4.2	g/kWh	*BSFC:* 217

Notes:
[1] PM_{10} assumed equal to TSP; $PM_{2.5}$ assumed equal to 92% of PM_{10}.
[2] BSFC: brake-specific fuel consumption.

5.1.11 Air Emission Rate Summary

A summary of emission rates for all sources in Kamsar and Sangarédi is provided in Table 5.6, Table 5.7 and Table 5.8 for emissions from the CBG Processing Facility in Kamsar, the mining activities in Sangarédi and the blasting activities in Sangarédi, respectively.

At the Kamsar Processing Facility, particulate emissions from the dryer stacks and material handling dominate the emissions inventory. Under existing conditions, dryer and material handling emissions are split evenly; however, as production increases and dust controls are upgraded for the network of transfer towers and conveyors, particulate emissions become dominated by the dryer stacks. The main source of gaseous emissions is fuel combustion, particularly in the dryers. As production increases, fuel requirements also increase which increase the emissions of NO_x and SO_2.

In the Sangarédi mining area, the mining haul roads are the dominant source of particulate emissions. As production increases and shifts north to the Kourawel area, the number and the average length of daily haul truck trips increase significantly, leading to a tenfold growth in annual dust emissions from haul road traffic compared to existing operations.

Table 5.6: Emission Estimates Used in Dispersion Modelling – Kamsar

Scenario	COPC	24 hour Average (g/s)				Annual Average (tonnes/year)			
		Dryers	Boilers & Electric Generators	Material Handling & Processing	Misc.	Dryers	Boilers & Electric Generators	Material Handling & Processing[1]	Misc.
Existing	TSP	70.9	3.9	70.5	0.2	2236	123	2217	6
	PM_{10}	35.5	2.8	34.8	0.2	1120	88	1094	6
	$PM_{2.5}$	35.2	2	17.3	0.1	1110	63	542	3
	NO_x	19.1	55.5	--	4	602	1750	--	126
	SO_2	22	59.7	--	0.6	694	1883	--	19
18.5 MTPY	TSP	107.8	5.4	54.5	0.2	3400	170	1709	6
	PM_{10}	53.9	3.8	27.1	0.2	1700	120	851	6
	$PM_{2.5}$	53.4	2.8	13.4	0.2	1684	88	423	6
	NO_x	29.1	76.5	--	5.5	918	2413	--	173
	SO_2	33.4	82.7	--	0.7	1053	2608	--	22
22.5 MTPY	TSP	107.8	5.8	27.4	0.3	3400	183	855	9
	PM_{10}	53.9	4.1	13.6	0.3	1700	129	423	9
	$PM_{2.5}$	53.4	3	6.6	0.2	1684	95	208	6
	NO_x	29.1	81.4	--	6.5	918	2567	--	205
	SO_2	33.4	88.1	--	0.8	1053	2778	--	25
27.5 MTPY	TSP	145	7.7	42	0.3	4573	243	1315	9
	PM_{10}	72.5	5.4	20.8	0.3	2286	170	653	9
	$PM_{2.5}$	71.8	4	10.3	0.3	2264	126	322	9
	NO_x	39	107.8	--	8.1	1230	3400	--	255
	SO_2	44.8	117	--	1.1	1413	3690	--	35

Notes:

[1] Annual emissions of dust (TSP, PM_{10}, $PM_{2.5}$) for outside material handling and processing sources (e.g., outdoor storage piles) have been assumed to have 28% natural dust control (i.e., from precipitation).

Table 5.7: Emission Estimates Used in Dispersion Modelling – Sangarédi

Scenario	COPC	24 hour Average (g/s)				Annual Average (tonnes/year)			
		Ore Extraction Areas	Haul Roads	Rail Loading Area & Stockpiles	Misc.	Ore Extraction Areas[1]	Haul Roads	Rail Loading Area & Stockpiles[1]	Misc.
Existing	TSP	7	60.3	1.1	2	246	1680	24	47
	PM_{10}	2.3	17.8	0.5	1.1	97	498	12	26
	$PM_{2.5}$	0.2	1.8	0.1	0.3	29	53	2	9
	NOx	0.9	0.3	0.01	11.8	53	37	0.4	373
	SO_2	0.01	0.05	0.002	1.2	5	6	0.1	39
18.5 MTPY	TSP	9.7	82.3	1.3	2.3	355	4605	28	53
	PM_{10}	3.2	24.3	0.6	1.2	141	1362	14	29
	$PM_{2.5}$	0.3	2.4	0.1	0.4	40	140	2	10
	NOx	1.2	0.2	0.02	13.2	71	49	0.6	418
	SO_2	0.01	0.03	0.003	1.4	7	8	0.1	44
22.5 MTPY	TSP	11.9	99.6	1.5	2.7	427	5573	34	64
	PM_{10}	3.9	29.4	0.8	1.5	169	1649	17	35
	$PM_{2.5}$	0.4	3	0.1	0.4	48	169	3	11
	NOx	1.4	0.2	0.03	14.7	84	56	0.9	464
	SO_2	0.01	0.04	0.01	1.5	8	10	0.2	49
27.5 MTPY	TSP	14.8	121.2	1.8	3.3	511	19294	40	77
	PM_{10}	4.9	35.8	0.9	1.7	201	5699	20	41
	$PM_{2.5}$	0.5	3.6	0.1	0.5	58	575	3	13
	NOx	1.7	0.3	0.03	15.4	98	67	1	487
	SO_2	0.01	0.04	0.01	1.6	9	11	0.2	51

Notes:

[1] Annual emissions of dust (TSP, PM_{10}, $PM_{2.5}$) for outside material handling and processing sources (e.g., outdoor storage piles) have been assumed to have 29% natural dust control (i.e., from precipitation).

Table 5.8: Maximum 1 Hour NO_x Emission Estimates (g/s) for Blasting – Sangarédi

Emissions Source	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Blasting	115.7	159.8	194.4	237.6

5.2 GREENHOUSE GASES

Greenhouse gas (GHG) emissions associated with the Project's expansion to 18.5 MTPY, 22.5 MTPY and 27.5 MTPY were estimated by CBG and are provided in the Environmental Management Plan.

6.0 AIR DISPERSION MODELLING

Air dispersion modelling was undertaken using the CALMET/CALPUFF modelling package (Scire et. al. 1999, 2000a,b) - a current state-of-the-art dispersion model.

CALMET is an advanced non-steady-state diagnostic meteorological model that produces hourly three-dimensional gridded wind fields from available meteorological, terrain and land use data (Scire et al. 2000a,b). The CALPUFF model has ability to handle both complex meteorology and an array of multiple emissions sources from facilities and activities located over a large area and is the US EPA regulatory model for long range transport studies. It is a multi-layer, multi-species, non-steady-state puff dispersion model that can simulate the effects of varying meteorological conditions in time and space on pollutant transport (Scire et al. 2000a,b). CALPUFF runs in conjunction with CALMET to estimate pollutant concentration for each source-receptor combination for each hour of input meteorology. The maximum predicted 1-hour, 24-hour and average annual concentrations are then determined from the hourly CALPUFF model outputs at each receptor point.

The main reasons for choosing a sophisticated modelling system like CALMET/CALPUFF are:

- it is applicable to spatial scales ranging from a few kilometres to more than 100 km;
- wind speed and wind direction vary in three spatial dimensions and in time, providing a more realistic simulation of plume movements;
- its ability to handle shoreline dispersion (and potential shoreline fumigation);
- its ability to handle calm wind conditions (wind speeds less than 0.5 m/s);
- it is based on sound, openly documented physical principles that have undergone independent review; and,
- the full three dimensional meteorology produced by CALMET allows for better simulation of local wind patterns, which are very important when assessing location specific predictions, such as sensitive receptor locations.

Air dispersion modelling can be used to predict the incremental concentrations of pollutants within a modelling region or domain; however, there are often uncertainties with respect to a model's ability to predict concentrations accurately. Many assumptions and simplifications are required to describe real phenomena using mathematical equations, and the processes of atmospheric motions and turbulence are simplified in dispersion models which introduce uncertainties. It is important to note the sources of this uncertainty:

- simplification and accuracy limitations related to source data (i.e., emissions and modelled source characteristics);
- limitations in the meteorological data input; and/or

- simplification of model physics to replicate the random nature of atmospheric dispersion processes.

The items noted above limit a model's ability to accurately predict time-averaged atmospheric concentrations for a given set of meteorological conditions. This means that dispersion modelling may over- or under-estimate measured ground-level concentrations at any specific time or place. However, models are reasonably reliable in estimating the magnitude of the overall maximum concentration occurring irrespective of time and space. For example, an error of ±10 to 40% for the highest estimated concentration is typical (Rhoads, 1981, and Hanna, 1993). However, a model is considered to perform well if the model predicted concentrations are within a factor of two of monitored values.

6.1 AIR DISPERSION METEOROLOGY

6.1.1 Review of Available Meteorological Data Sets

Available meteorological data near the Project study areas was reviewed and assessed for its representativeness of the meteorological conditions within the study areas.

Historical meteorological data from the nearest airport stations were examined including: Kawass airport (about 8 km east of Kamsar); Boké Baralande airport (about 50 km northeast of Kamsar); and Sangarédi airport. Upon examining the data at each station, it was found that the stations had incomplete meteorological data records and were not suitable for air dispersion modelling. As a result, meteorological modelling was used to develop representative site-specific surface and upper air meteorological data set for a five year period (2009 to 2013). Details of the meteorological modelling are provided in the following sections.

6.1.2 WRF-NMM Meteorological Modelling

The meteorological data set used for air dispersion modelling was derived using the Weather Research Forecast Non-hydrostatic Mesoscale Model (WRF-NMM)[1] for a five year period (2009 to 2013). WRF-NMM is a fully compressible, non-hydrostatic mesoscale meteorological model with a hydrostatic option. Version 3.4.1 of the WRF-NMM model was used in this study. A more detailed description of the WRF-NMM model can be found online[2].

In this study, WRF-NMM was run over a period of five years in so-called "hindcast" mode. It was initialised using Global mesoscale analyses available from the National Centre for

[1] The Weather Research and Forecasting Non-hydrostatic Mesoscale Model (WRF-NMM) is a state-of-the-art numerical prediction model developed at the US National Center for Environmental Prediction (NCEP).
[2] http://www.dtcenter.org/wrf-nmm/users/docs/user_guide/V3/users_guide_nmm_chap1-7.pdf

Environmental Prediction (NCEP). Global analyses have 0.5 degree horizontal grid resolution and 6-hour temporal resolution (i.e., data are available every 6 hours). The Global mesoscale analyses assimilate various available observations collected over the world, including land surface measurements, marine surface measurements, radiosonde, aircraft reports, profiler radar derived winds and satellite wind data[3]. The WRF-NMM model used Global analyses as both the initial conditions (updated every 24 hours) and the boundary conditions (updated every 6 hours). Updating the initial and boundary fields with the analysis that is based on actual observations provides a more realistic simulation of past meteorology.

The WRF-NMM model was applied over a large domain that extends more than 300 km east to west and 300 km north to south, in order to capture the large-scale (i.e., synoptic scale) meteorological characteristics in this region (see Figure 4). A grid spacing of 3 degrees was applied in order to better resolve realistic mesoscale meteorological features. The outputs from the WRF-NMM model were then used to drive the CALMET model, discussed in the following section.

6.1.3 CALMET Model

The CALMET meteorological model was used to simulate the meteorological conditions in the study areas shown in Figure 1 from January 1, 2009 to December 31, 2013 using a horizontal grid spacing of 200 m. The CALMET simulation was run in "No-Obs" mode and initialized using the three dimensional data outputs from the WRF-NMM model. This means that the 3D.DAT file which is used as the input to CALMET contains three dimensional profiles of wind speed, wind direction, temperature, humidity, pressure, ceiling height and cloud cover derived from WRF-NMM. The 3D.DAT data is then further refined using CALMET to adjust the winds for fine-scale terrain effects within the CALMET grid.

The "No-Obs" approach offers an advantage over using point (i.e., observation) measurements in terms of its ability to represent both the horizontal and vertical spatial variability of the meteorological fields. Specifically, the use of a mesoscale model facilitates the generation of three dimensional profiles and properly simulates wind fields at upper levels in the atmosphere. It also better defines the boundary layer heights (i.e., mixing heights) which results in a better simulation of plume dispersion.

The resulting CALMET meteorological fields have been evaluated to ensure that they capture the key meteorological features that govern atmospheric dispersion. Details of this evaluation are provided in Attachment C.

[3] http://www.nco.ncep.noaa.gov/pmb/products/gfs/

6.1.4 CALMET Geophysical Parameters

To properly simulate pollutant transport and atmospheric dispersion in CALPUFF, it is important to be able to accurately simulate the typical log-linear vertical profile of wind speed, temperature, turbulence intensity and wind direction within the atmospheric boundary layer (i.e., within about 2 km above the Earth's surface). In order to capture this vertical structure, a total of ten vertical layers were used in CALMET. The layer heights and depths are shown in Table 6.1. The center of the lowest 20 m layer (i.e., 10 m) should provide a reasonable comparison with winds at surface weather stations since anemometers are typically placed a height of 10 m.

Table 6.1: CALMET Wind Field Layer Heights

Depth of CALMET Layer (m)	Height of CALMET Layer (m)	Representative Layer
20	20	10-meter meteorology
20	40	30-meter meteorology
40	80	60-meter meteorology
80	160	120-meter meteorology
140	300	230-meter meteorology
300	600	450-meter meteorology
400	1000	800-meter meteorology
500	1500	1250-meter meteorology
700	2200	1850-meter meteorology
800	3000	2600-meter meteorology

The CALMET model requires a physical description of the surface in order to characterize the meteorological parameters near the surface. The geophysical parameters are:

- Terrain elevation data;
- Land use data;
- Surface roughness length;
- Albedo;
- Bowen ratio;
- Soil heat flux;
- Vegetation leaf area index; and,
- Anthropogenic heat flux.

The terrain elevation and land use data used in CALMET are outlined below. All other geophysical parameters listed above are based on default values outlined in the CALMET modelling guidelines (Scire *et al.* 2000a).

6.1.4.1 Terrain Elevation Data

Gridded terrain elevations for the modelling domain were derived from Digital Elevation Models (DEM) produced by the NASA's Shuttle Radar Topography Mission (SRTM)4. The spacing of the elevations is 3-arc seconds or approximately 90 m. The raw terrain data was processed in each gridded cell (i.e., 200 m by 200 m) within the CALMET modelling domain and the resulting terrain elevations are presented in Figure 5 (Kamsar study area) and Figure 6 (Sangarédi study area). This terrain field effectively resolves all major land features within the modelling domains.

6.1.4.2 Land Use Data

Land use and land cover data from the GlobCover Land Cover v2 dataset5 was processed for each CALMET grid cell to produce a 200 m resolution field of fractional land use categories and weighted land use values of surface and vegetation properties. CALMET defines 14 default land use categories (Table 6.2). Surface properties, such as albedo, Bowen ratio, roughness length, and soil heat flux and leaf area index are computed proportionately to the fractional land use category within each grid cell. The default values for these land use related parameters are listed in Table 6.2. The generated land use categories for each CALMET grid cell are also shown in Figure 7 (Kamsar study area) and Figure 8 (Sangarédi study area).

[4] http://dds.cr.usgs.gov/srtm/
[5] http://due.esrin.esa.int/globcover/

Table 6.2: CALMET Land Use Categories

Land Use	Description	Surface Roughness (m)	Albedo	Bowen Ratio	Soil Heat Flux Parameter	Anthropogenic Heat Flux (m)	Leaf Area Index
10	Urban or Built-up Land	1	0.18	1.5	0.25	0	0.2
20	Agricultural Land – Unirrigated	0.25	0.15	1	0.15	0	3
-20*	Agricultural Land – Irrigated	0.25	0.15	0.5	0.15	0	3
30	Rangeland	0.05	0.25	1	0.15	0	0.5
40	Forest Land	1	0.1	1	0.15	0	7
50	Water	0.001	0.1	0	1	0	0
54	Small Water Body	0.001	0.1	0	1	0	0
55	Large Water Body	0.001	0.1	0	1	0	0
60	Wetland	1	0.1	0.5	0.25	0	2
61	Forested Wetland	1	0.1	0.5	0.25	0	2
62	Nonforested Wetland	0.2	0.1	0.1	0.25	0	1
70	Barren Land	0.05	0.3	1	0.15	0	0.05
80	Tundra	0.2	0.3	0.5	0.15	0	0
90	Perennial Snow or Ice	0.05	0.7	0.5	0.15	0	0

6.2 CALPUFF MODELLING APPROACH

CALPUFF (version 6.42) dispersion modelling was performed using a "unit emission rate" approach. This means that the CALPUFF model was run separately for each individual source or groups of like sources (e.g., roads) using an emission rate of 1 g/s. Where multiple sources like roads were modelled together, a unit emission rate was applied to the aggregate of all sources in each CALPUFF model run. For example, in the case of 10 sources, a 1 g/s emission rate was divided evenly across those 10 sources. The results from each model run were then merged using CALSUM (version 1.5) which scaled the outputs from each model run using the emission rates outlined in Section 5.1.11. The model results were then processed by CALPOST (version 6.292) to estimate maximum 1-hour, 24-hour or annual concentrations at each receptor for each contaminant described in Section 2.4. To estimate 99th percentile 24-hour concentrations of PM_{10} and $PM_{2.5}$, the CALAVE/CALRANK (version 1.1/1.2) software package was used.

The CALPUFF model options used are outlined in Table 6.3. The CALPUFF model runs were performed for a single gaseous contaminant assuming no dry or wet deposition. This approach is conservative for particulate matter since is does not consider the depletion of particulates within a plume. In reality, heavier particles will fall out of a plume close to a source reducing the concentrations of particulate further beyond a source. Consequently the air concentrations of TSP, PM_{10} and $PM_{2.5}$ have been overestimated in this assessment. Two sensitivity tests were performed (one in each study area) to demonstrate the conservativeness of this approach. The results are outlined in Attachment C.

The CALPUFF model setup for each of the assessment scenarios outlined in Section 4.0 is described below. Recall that construction emissions were not carried through to dispersion modelling since the maximum emission scenarios assessed for both Kamsar and Sangarédi are considered to adequately capture the effects of construction.

Table 6.3: CALPUFF Model Options

Flag	Default	Used Value	Comments
MGAUSS	1	1	Vertical distribution used in the near field
MCTADJ	3	3	Terrain adjustment method (3 used for partial plume path adjustment)
MCTSG	0	0	Subgrid-Scale complex terrain flag
MSLUG	0	0	Near-field puffs modelled as elongated areas
MTRANS	1	1	Transitional Plume Rise modelled
MTIP	1	1	Stack-tip downwash
MRISE	1	1	Plume rise for point sources not subject to building downwash 1 = Birggs plume rise, 2 = Numerical plume rise
MBDW	1	2	Method used to simulate building downwash 1 = ISC method; 2 = PRIME method
MSHEAR	0	0	Vertical wind shear modelled above stack top
MSPLIT	0	0	Puff splitting allowed 0 = No; 1 = Yes
MCHEM	1	0	Chemical Transformation Scheme 0 = chemical transformation not modelled 1 = transformation rates computed internally (MESOPUFF II scheme)
MAQCHEM	0	0	Aqueous phase transformation flag (only used if MCHEM =1 or 3)
MWET	1	0	Wet removal modelled 0 = No; 1 = Yes
MDRY	1	0	Dry deposition modelled 0 = No; 1 = Yes
MTILT	0	0	Gravitational settling (plume tilt) modelled
MDISP	3	2	Methods used to compute dispersion coefficients 2 = (dispersion coefficients from internally calculated sigma v, sigma w using micrometeorological variables (u*, w*, L, etc.) 3 = PG dispersion coefficient for RURAL areas (computed using the ISCST multi-segment approximation) and MP coefficients in urban areas)
MTURBVW	3	3	Sigma measurements used (Used only if MDISP = 1or 5)
MDISP2	3	3	Back-up method used to compute dispersion when measured turbulence data are missing (Used only if MDISP=1 or 5)
MTAULY	0	0	[DIAGNOSTIC FEATURE] Method used for Lagrangian timescale for Sigma-y (used only if MDISP=1,2 or MSIDP2=1,2)
MTAUADV	0	0	[DIAGNOSTIC FEATURE] Method used for Advective-Decay timescale for Turbulence (used only if MDISP=2 or MDISP2=2)
MCTURB	1	1	Method used to compute turbulence sigma-v & sigma-w using micrometeorological variables (Used only if MDISP = 2 or MDISP2 = 2)
MROUGH	0	0	PG sigma y,z adjusted for roughness
MPARTL	1	1	Partial plume penetration of elevated inversion modeled for point sources; 0 = No, 1 = Yes
MPARTLBA	1	1	Partial plume penetration of elevated inversion modeled for buoyant area sources; 0 = No, 1 = Yes
MTINV	0	0	Strength of temp inversion provided in PROFILE.DAT extended records
MPDF	0	1	Probability Distribution Function used for dispersion under convective conditions 0 = No; 1 = Yes
MSGTIBL	0	0	Sub-grid TIBL module used for shore line
MBCON	0	0	Boundary conditions (concentration) modeled
MFOG	0	0	Configure for FOG Model output
MREG	1	0	Test options specified to see if they conform to regulatory values

6.2.1 Kamsar Processing Facility

In general, COPC emission sources at the Kamsar processing facility were characterized using information in the *Expansion Project FEL2 Study Preliminary Engineering Report* (Fluor 2014), which provided detailed descriptions of each stage of processing as well as equipment lists and process flow diagrams for each proposed phase of expansion. If required information was not found within Fluor (2014), model parameters from the AECOM (2011) air dispersion modelling assessment were used, if available. In their absence, professional judgement was used. In general, the operations at the Kamsar facility include:

- Rail unloading and crushing;
- Stockyard – material conveyance;
- Material drying and associated conveyance;
- Dry storage and ship loading; and
- Support services (e.g., power generation)

The model setup for these operations is discussed in the following sections according to the modelled source type used to parameterize each source (i.e., point, volume or area).

6.2.1.1 Point Sources

Point sources were used to represent emissions from the dryers, generators, boilers, locomotives and shipping vessels. The physical characteristics these sources are shown in Table 6.4. While most point source parameters were developed based on information from the Fluor (2014) and AECOM (2011) reports, the stack parameters for the locomotives were obtained from ENVIRON (2008) based on EMD GP-4X type engines (Model No. 16-645E3B). The parameters used to model emissions from ships at berth were based on professional judgement.

Buildings or other solid structures may affect the flow of air in the vicinity of a source and cause eddies to form on the downwind side of a building requiring the use of building downwash algorithms for point sources. In this assessment, the Plume Rise Model Enhancements algorithm (PRIME) was used as a building downwash option in CALPUFF. PRIME is designed to incorporate the fundamental features associated with building downwash: enhanced plume dispersion coefficients due to turbulent wake, reduced plume rise caused by a combination of the descending streamlines in the lee of the building, and the increased entrainment in the wake. Figure 9 shows the locations of the modelled point sources as well the building layout used in CALPUFF.

6.2.1.2 Area Sources

Area sources are typically used to represent ground-based emission sources such as open area wind erosion. As a result, area sources were used to represent emissions of windblown dust in and around the raw storage piles as well as the open area in front of the existing dry product storage building. In addition, an area source was used to represent emissions resulting from the transfer of dry product to the shipping vessels. The source parameters including elevation, effective release height and vertical initial dispersion factor (sigma-Y) are shown in Table 6.5 for all area sources modelled at Kamsar. Note that multiple area sources were necessary to model emissions from the raw storage pile area. Due to a limitation in CALPUFF, polygonal area sources must not cross a meteorological grid square, which is only 200 m by 200 m in this assessment (see Section 6.1.3).

6.2.1.3 Volume Sources

Volume sources are typically used to represent emissions released from sources having a vertical depth (e.g., a material transfer or drop) and are characterized as equal-sided areas with the release height typically set equal to half of the vertical depth. All material transfer points including transfer towers or pile stackers, as well as crushing and screening were modelled as volume sources. The source parameters including elevation, effective release height, and horizontal and vertical initial dispersion factors (sigma-Y and sigma-Z) are shown in Table 6.6 for all volume sources modelled at Kamsar.

Table 6.4: Physical Characteristics of Modelled Point Sources at Kamsar

Source Description	Source ID	UTM Coordinates		Base Elevation (m)	Release Height (m)	Exit Velocity (m/s)	Exit Temperature (°K)	Applicable Production Scenario			
		Easting (m)	Northing (m)					Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Existing dryer stack	OLDDRY	542513	1176686	9.4	64.0	15	326	✓	✓	✓	✓
New dryer stack	NEWDRY	542442	1176728	8.5	30.5	40	326		✓	✓	✓
Old generators	GENOLD	542415	1176901	7.2	14.6	0.1	698	✓			
Generator 9	GEN9	542381	1176890	6.0	22.0	25	743	✓	✓	✓	✓
Generator 10	GEN10	542364	1176877	5.5	22.0	25	743	✓	✓	✓	✓
Generators 11 and 12	GEN11_12	542328	1176868	4.4	22.0	50	743		✓	✓	✓
Generators 13 and 14	GEN13_14	542324	1176866	4.4	22.0	50	743		✓	✓	✓
Generator 15	GEN15	542319	1176865	4.4	22.0	25	743		✓	✓	✓
Boilers stacks 1-3	BOIL	542338	1176897	4.4	5.7	0.1	673	✓	✓	✓	✓
Yard locomotive	LOCOYD	542560	1176730	5.1	5.2	13.8	374	✓			
Locomotive	LOCO	542790	1177071	4.6	5.2	3.7	351	✓			
Locomotive 1	LOCO1	543105	1177220	4.4	5.2	3.7	351		✓	✓	✓
Locomotive 2	LOCO2	542488	1177227	3.7	5.2	3.7	351		✓	✓	✓
Locomotive 3	LOCO3	542950	1177673	3.3	5.2	3.7	351		✓	✓	✓
Ship 1 stack	SHIPSTK1	540569	1176397	0.1	28.0	16	621	✓	✓	✓	✓
Ship 2 stack	SHIPSTK2	540476	1176117	0	28.0	16	621				✓

Table 6.5: Physical Characteristics of Modelled Area Sources at Kamsar

Source Description	Source ID	UTM Coordinates		Base Elevation (m)	Release Height (m)	Initial Vertical Dimension (m)	Applicable Production Scenario			
		Easting (m)	Northing (m)				Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Area outside dry storage building (wind erosion)	DSA1	542414	1176853	7.4	0	0	✓	✓	✓	✓
Raw storage pile activities (area 1)	RPL1	542601	1176601	7.0	1	1	✓	✓	✓	✓
Raw storage pile activities (area 2)	RPL2	542801	1176603	5.7	1	1	✓	✓	✓	✓
Raw storage pile activities (area 3)	RPL3	542800	1176902	7.5	1	1	✓	✓	✓	✓
Raw storage pile activities (area 4)	RPL4	542601	1176830	12.7	1	1	✓	✓	✓	✓
Ship 1 loading particulate emissions	SHIP1	540502	1176226	0.0	8	0	✓	✓	✓	✓
Ship 2 loading particulate emissions	SHIP2	540410	1175946	0.0	8	0				✓

Table 6.6: Physical Characteristics of Modelled Volume Sources at Kamsar

Source Description	Source ID	UTM Coordinates		Base Elevation (m)	Release Height (m)	Initial Horizontal Dimension (m)	Initial Vertical Dimension (m)	Applicable Production Scenario			
		Easting (m)	Northing (m)					Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Primary crusher (existing)	PCRUSH	542756	1177058	4.8	1.0	2.3	4.7	✓			
Secondary crusher (existing)	SCRUSH	542601	1176830	4.4	15.0	3.5	9.3	✓			
Primary crusher 1 (future)	PCRUSH1	542904	1177165	4.6	5.9	2.3	5.4		✓	✓	✓
Primary crusher 2 (future)	PCRUSH2	542890	1177161	4.5	5.9	2.3	5.4		✓	✓	✓
Secondary crusher 1 (future)	SCRUSH1	542858	1177297	5.8	8.7	2.3	4.8		✓	✓	✓
Secondary crusher 2 (future)	SCRUSH2	542837	1177289	5.3	8.7	2.3	4.8		✓	✓	✓
Transfer tower 001	TAN001	542870	1176841	7.0	15.4	2.3	4.8	✓	✓	✓	✓
Transfer tower 002	TAN002	542902	1176746	6.2	10.1	1.6	3.1	✓	✓	✓	✓
Transfer tower 003	TAN003	542590	1176631	7.5	10.1	1.4	3.1	✓	✓	✓	✓
Transfer tower 004	TAN004	542560	1176730	9.5	15.8	2.3	4.9	✓	✓	✓	✓
Transfer tower 006	TAN006	542502	1176814	9.5	10.1	1.6	3.1	✓	✓	✓	✓
Transfer tower 007	TAN007	542424	1176791	7.9	10.1	2.3	3.1	✓	✓	✓	✓
Transfer tower 008	TAN008	542415	1176813	8.0	10.1	1.6	3.1	✓	✓	✓	✓
Transfer tower 010	TAN010	542282	1176733	5.9	12.5	2.3	11.6	✓	✓	✓	✓
Transfer tower 301	TAN301	542749	1177254	3.3	5.6	2.3	2.6	✓	✓	✓	✓
Transfer tower 305	TAN305	542449	1176727	8.7	3.3	1.6	1.5	✓	✓	✓	✓
Transfer tower 306	TAN306	542446	1176734	8.6	3.3	1.6	1.5				✓
Transfer tower 308	TAN308	540652	1176409	0.4	9.2	2.3	4.3				✓

Source Description	Source ID	UTM Coordinates		Base Elevation (m)	Release Height (m)	Initial Horizontal Dimension (m)	Initial Vertical Dimension (m)	Applicable Production Scenario			
		Easting (m)	Northing (m)					Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Transfer tower 309	TAN309	540571	1176149	0.0	23.6	1.7	7.3				✓
Corner island transfer tower (existing)	TANCI	540642	1176409	0.4	15.0	2.3	7.0				✓
Transfer tower TRE303	TRE303	542298	1176728	6.0	12.5	2.3	11.6				✓
Micogranulation	MICRO	542445	1176760	8.5	6.5	4.7	12.1	✓	✓	✓	✓
Dry product storage pile stacker (RPL003)	RPL003	542498	1176844	9.4	2.5	7.0	2.3	✓	✓	✓	✓
New dry product storage pile stacker (RPL003)	RPL301	542849	1176969	6.5	2.5	7.0	2.3				✓

6.2.2 Sangarédi Mining Operations

As discussed previously in Section 4.2, long-term and short-term effects to air quality from Sangarédi mining operations were assessed using two different modelling approaches. Long-term or annual effects were assessed by modelling emissions from extraction areas and supporting activities (e.g., haul roads, rail loading, etc.) corresponding to specific years of CBG's mine plan: 2017 representing 18.5 MTPY, 2019 representing 22.5 MTPY and 2027 representing 27.5 MTPY. For these model runs, emission sources at the Sangarédi mine were characterized using information provided by CBG, where available. Where information was not available, professional judgement based on similar mining assessments was used. In general, the operations at the Sangarédi mine include:

- Extracting bauxite using drill and blast methods;
- Transporting bauxite via truck to rail loading areas;
- Loading bauxite into rail cars;
- Transporting bauxite to Kamsar via rail; and
- Support services (e.g., power generation)

The sources modelled at the Sangarédi mine are illustrated in Figure 10 and are discussed in more detail in Sections 6.2.2.1 through 6.2.2.3 according to the modelled source type (i.e., point, volume or area). The approach used for modelling short-term effects is discussed in Section 6.2.2.4.

6.2.2.1 Point Sources

Similar to the Kamsar Processing Facility, point sources were used to represent the generator located at CBG's offices in Sangarédi (also known as Centrale Sangarédi), as well as a switching locomotive located in the vicinity of the existing rail loading area (see Figure 10). Table 6.7 shows the physical characteristics of these point sources. Table 6.7 also shows the parameters used to assess a proposed rail siding as described in Section 4.3, and illustrated in Figure 10.

6.2.2.2 Area Sources

Area sources were used to characterize the activities within the extraction areas since majority of the emissions within an extraction area will be emitted at grade. The areas encompass all emissions within an extraction area including clearing (i.e., bulldozing), drilling, blasting, loading bauxite into trucks, and vehicle/equipment movement within the extraction area itself.

As shown in Figure 10, multiple area sources were used to represent the extraction areas due to a limitation in CALPUFF which does not allow area sources to be bigger than a meteorological grid square (200 m by 200 m). In addition, as discussed in Section 4.2, these areas are considered to be an approximation of the corresponding footprints in the CBG mining plan as illustrated in Figure 3.

In general, area sources are 200 m by 200 m (a meteorological grid square), having a release height of 0 m and an initial vertical dispersion factor of 1 m. Some area sources in the 27.5 MTPY scenario in the vicinity of Kourawel had a slightly smaller area (120 m by 200 m) in order to better match the planned footprint of the extraction areas within this region.

6.2.2.3 Volume Sources

Volume sources were used to represent emissions from rail loading activities, the rail line and the unpaved haul roads. The locations of each of these sources are shown in Figure 10.

Since the current and future rail loading areas are quite large (approximately 1000 m long by 200 m wide) (see Figure 10), it was necessary to use multiple volume sources in order to represent emissions across the entire loading area. Emissions from unloading bauxite to stockpiles, wind erosion of stockpiles, loading bauxite to trains as well as vehicle/equipment travel within the rail loading areas were distributed evenly across the volume sources. Table 6.9 shows the modelled source characteristics for these volume sources.

In addition, a series of volume sources was also used to represent emissions from a moving train. The parameters used for modelling were based on the methods used in ENVIRON (2008). Emissions of combustion products from the locomotive(s) as well as windblown dust from the open cars of the train were distributed evenly across the volume sources.

Unpaved haul roads were also modelled as a series of volume sources following guidance published by the US EPA Haul Road Working Group (US EPA 2012). The separated volume source configuration was used and is based on the following parameterization:

- Top of Plume Height – 1.7 x Vehicle Height;
- Volume Source Release Height – 0.5 x Top of Plume height;
- Width of Plume – Vehicle Width + 6m;
- Initial Sigma Z – Top of Plume / 2.15 for use when modelling multiple volumes; and
- Initial Sigma Y – 2 x Vehicle Width / 2.15.

In order to have more reasonable model run times, a volume spacing of approximately 200 m was used to represent the unpaved haul roads. Table 6.9 shows the modelled source characteristics for the road volume sources.

Table 6.7: Physical Characteristics of Modelled Point Sources at Sangarédi

Source Description	Source ID	UTM Coordinates		Base Elevation (m)	Release Height (m)	Exit Velocity (m/s)	Exit Temperature (ºK)
		Easting (m)	Northing (m)				
Centrale Sangarédi	GEN	631682	1226294	201.6	14.6	0.1	698
Switching locomotive	LOCO_LD1	624.823	1224.246	201.2	5.2	13.8	374
Rail siding locomotive 1	GENOLD	542415	1176901	7.2	14.6	0.1	698
Rail siding locomotive 2	GEN9	542381	1176890	6.0	22.0	25	743
Rail siding locomotive 3	GEN10	542364	1176877	5.5	22.0	25	743

Table 6.8: Physical Characteristics of Modelled Area Sources at Sangarédi

Source Description	Total Number of Sources	Total Modelled Area (ha)	Release Height (m)	Initial Vertical Dimension (m)
Existing mining areas	33	132	0	1
18.5 MTPY mining areas	47	188	0	1
22.5 MTPY mining areas	56	224	0	1
27.5 MTPY mining areas	56	214	0	1

Table 6.9: Physical Characteristics of Modelled Volume Sources at Sangarédi

Source Description	Number of Sources	Release Height (m)	Initial Horizontal Dimension (m)	Initial Vertical Dimension (m)
Existing haul roads	65	4.0	10.42	3.72
18.5 MTPY haul roads	94	4.0	10.42	3.72
22.5 MTPY haul roads	108	4.0	10.42	3.72
27.5 MTPY haul roads	130	4.0	10.42	3.72
CBG access road between CBG offices and existing loading area (applies to all scenarios)	60	2.98	24.19	2.77
Moving rail source	105	2.38	9.30	1.11
Existing rail loading area[1]	13	2.5	69.77	1.16
Future rail loading area[2]	10	2.5	69.77	1.16

Notes:
[1] Applicable to the existing and 18.5 MTPY scenarios.
[2] Applicable to the 22.5 and 27.5 MTPY scenarios.

6.2.2.4 Short-Term Modelling Approach

As discussed in Section 4.2, a generic modelling approach was used to represent typical daily mining activities. Typical extraction activities (excluding blasting) were represented using a 200 m by 200 m area source with the same source parameters as described in Section 6.2.2.2. In addition, the effects of an unpaved haul road were also evaluated using a generic road stretching 2 km on either side of the mining area. The same source parameters used for unpaved haul roads described in Section 6.2.2.3 were applied to the generic road. Figure 11 illustrates the generic model setup.

In addition, the impact of blasting on 1-hour NO_2 concentrations was assessed using a separate model run which used a volume source to parameterize the initial dimensions of a blast. The horizontal dimension of a blast was assumed to be approximately 70 m wide and 20 m tall, with a release height of 10 m. Since the emissions from a blast are relatively instantaneous, CALPUFF was run used a 10-minute calculation time step, rather than a 1-hour time step in order to simulate such an event.

Both the generic and blasting model setups were evaluated for three separate locations within the Sangarédi modelling domain in order to assess the impact (if any) of local terrain or meteorological features on resulting concentrations (see Figure 10). The location having the highest maximum concentration based on a unit emission rate was selected to develop unit concentration curves in the direction of maximum predicted incremental concentrations (i.e., the change in concentration with distance). It was found that Location 2 resulted in the highest maximum concentrations and was used to develop unit concentration curves for the generic extraction area/road model setup and the blasting model setup.

The unit concentration curves were scaled using the emission rates outlined in Section 5.1.11 for each production level. This resulted in a series of concentrations curves for each COPC and applicable averaging periods. Note that this approach conservatively applied emissions representative of the maximum daily production rate and the maximum daily traffic count (see Attachment B) in order to assess the worst-case short-term effects to nearby villages. The resulting concentration curves are provided in Attachment D which shows that concentrations decrease exponentially with distance from a source(s) according to the following relationship:

$$C(x) = C_0 * e^{-a*x}$$

Equation 1

Where:
$C(x)$ = Concentration at distance x
x = distance in metres
C_0 = constant
$-a$ = constant

Attachment D also provides the mathematical relationships for each concentration curve presented. Using the equations provided Attachment D, concentrations of short-term COPCs were calculated for each sensitive receptor based on the separation distance between the villages and the nearest existing or planned extraction area. Distances were measured using CBG's 2014 mining plan.

In general, the equations presented in Attachment D can be applied directly to villages in order to estimate short-term concentrations of COPCs. However near some villages, there are other persistent Project activities (e.g., rail loading, trains, etc.) which may also contribute to ambient air concentrations of COPCs. For example, Hamdalaye (SR46) is within 1.5 km of the future train loading area and may be exposed to dust from activities at the planned rail loading area as well as emissions from nearby extraction area and unpaved roads. As a result, a "base" model run was also completed using maximum daily emission rates for the following sources: rail loading area activities, including ore handling, wind erosion and mobile equipment; a switching locomotive; moving trains; and Centrale Sangarédi. For each village, the resulting 1- or 24-hour "base" concentrations were added to concentrations estimated using the concentration curves in Attachment D such that Equation 1 becomes:

$$C(x) = C_0 * e^{-a*x} + C_{Base}$$ ***Equation 2***

Where:
$C(x)$ = Total concentration at distance x
C_{base} = concentration from "base" model run
x = distance in metres
C_0 = constant
$-a$ = constant

The total concentration ($C_{(x)}$) determined using Equation 2 can then compared to applicable WHO guidelines (Section 7.2.2).

To provide additional context to the short-term modelling assessment, the concentration curves can also be used to determine the setback distance required between a village and mining activities in order to meet applicable WHO guidelines. As a result, Section 7.2.2 discusses short-term impacts related to mining from the perspective of both setback distances as well as maximum predicted concentrations.

6.3 CALPUFF RECEPTOR GRID

Ground-level concentrations were modelled at defined receptor locations within each study area. A multi-nested grid approach was applied to the Kamsar study area, centred on the existing dryer stack. The finest receptor grid used was 100 m which extends 1 km beyond the dryer stack in order to better resolve concentrations near the site. The next tier has a grid spacing of 200 m and was applied to a distance of 2.2 km, while a coarser 500 m grid was applied to the remainder of the study area. Receptors were also placed along the property line using a spacing of 50 m.

For the annual model runs in the Sangarédi mining area, a receptor spacing of 500 m was used across the entire modelling domain. In addition, receptors were placed every 500 m along the haul roads at distances of 100 m and 200 m from the edge of the roadway. This helps to ensure that the predicted effects of dust emissions from the unpaved roads are better represented. Also, as recommended by the Haul Road Working Group (US EPA 2012), receptors should not be placed too close to a roadway (about 50 m).

For the generic model runs, a multi-nested grid approach was applied. The finest receptor grid used was 100 m and extends 500 m beyond the edge of the modelled sources. The next tier had a 250 m grid spacing and was applied to a distance of 1 km, while a coarser 500 m grid was applied to a distance of 2 km out from the sources. Receptor points with 1 km spacing were applied to the remainder of the modelling domain out to 4 km. In addition, receptors were placed every 250 m along the generic road at distances of 100, 200 and 500 m from the edge of the roadway.

Air quality concentrations were also predicted at sensitive receptor locations illustrated in Figure 3 and described in tabular format in Attachment C.

6.4 NO_X TO NO_2 CONVERSION

NO_x consists of both NO (nitric acid) and NO_2 (nitrogen dioxide). When generated in combustion sources, most of the NO_x is in the form of NO rather than NO_2. Since the WHO guidelines apply to NO_2 rather than NO_x, a conversion must be applied to NO_x in order to determine a concentration of NO_2.

To estimate concentrations of NO_2, the ambient ratio method (ARM) was used. This method involves the use of an empirical NO_2/NO_x ratio that is used to represent the conversion of NO_x to NO_2 in ambient air. For this assessment a NO_2/NO_x ratio of 0.7 was applied, which was developed based on the data collected for the baseline assessment (Section 3.0).

6.5 NON-STANDARD AVERAGING TIMES

Most of the COPCs assessed have WHO guidelines with standard averaging times (i.e., 1-hour, 24-hour or annual). However, SO_2 has a 10-minute WHO guideline which is considered to be a non-standard averaging period. As a result, a conversion factor of 1.65 was applied to 1-hour SO_2 model outputs in order to determine 10-minute concentrations. This factor is recommended in the *Air Dispersion Modelling Guideline for Ontario* (MOE 2009).

7.0 EFFECTS ASSESSMENT

The following sections outline the potential effects of the Project for each project phase and each production scenario. Where applicable, the results from the CALPUFF dispersion modelling have been presented in both graphical format showing the results in the study areas, and in tabular format at specific receptor locations. Complete graphical results are provided in Attachment A while complete tabular results are provided in Attachment D. Where exceedances of short-term WHO guidelines have been predicted, a frequency of exceedance analysis has been completed and the results are also presented graphically in Attachment A.

It is important to note that the maximum predicted short-term concentrations (for 10-min, 1-hour or 24-hour timeframes) shown on the contour plots represent the single highest concentration predicted to occur at each location, at any time during the 5-year modelling period. Therefore, the contours shown do not represent a "snapshot" in time as these maxima may occur on different days, and under different meteorological conditions.

While not considered to be a measure of the impact to air quality, contour plots showing annual TSP concentrations are also provided in Attachment A for completeness. In addition, the average deposition rates of annual TSP and its metallic constituents were calculated in order to inform the biological and water quality impacts assessments. Deposition values are provided in Attachment D.

7.1 KAMSAR PROCESSING FACILITY OPERATIONS

Graphical results for maximum predicted concentrations of COPCs for the 18.5, 22.5 and 27.5 MTPY production scenarios are presented in Attachment A. As discussed below, the concentrations of all COPCs exceed their respective WHO guidelines beyond the Project Footprint into a limited area of the study area for all levels of production. The exceedances of the PM_{10} and $PM_{2.5}$ criteria can largely be attributed to emissions of particulate matter from the transfer towers, followed by the dryer stacks. In contrast, predicted exceedances of the NO_2 and SO_2 WHO guidelines are due to fuel combustion. In particular, elevated concentrations of SO_2 can be linked to the sulphur content in the fuel (3%).

7.1.1 18.5 MTPY Production Scenario

The maximum predicted concentrations of COPCs for the 18.5 MTPY scenario are presented graphically in Attachment A along with plots showing the frequencies of exceedances of short-term WHO guidelines. The figures demonstrate that there are few exceedances of the WHO guidelines for $PM_{10,}$ $PM_{2.5}$, NO_2 and SO_2 beyond the Project Footprint. In particular, there are no more than 10 days of exceedances per year within 800 m of the Project Footprint for any

of the COPCs. The exceedance plots also show that exceedances of the WHO guidelines only occur up to about 1 km beyond the Project Footprint for any of the COPCs assessed.

7.1.2 22.5 MTPY Production Scenario

The maximum predicted concentrations of COPCs for the 22.5 MTPY scenario are presented graphically in Attachment A along with plots showing the frequencies of exceedances of short-term WHO guidelines. The figures demonstrate that there are very few exceedances of the WHO guidelines for PM_{10} and $PM_{2.5}$ beyond the Project Footprint. In particular, there are no more than 10 days of exceedances per year within 300 m of the Project Footprint for 24-hour concentrations of both PM_{10} and $PM_{2.5}$. The plots also show that exceedances of the 24-hour PM_{10} and $PM_{2.5}$ WHO guidelines only occur within about 500 m of the Project Footprint.

In addition, the figures in Attachment A show that there are no more than 10 exceedances per year of the 1-hour NO_2 or 10-minute SO_2 WHO guideline within 400 m of the Project Footprint. In addition, exceedances of the NO_2 or SO_2 WHO guidelines are only predicted to occur within about 1.1 km of the Project Footprint.

7.1.3 27.5 MTPY Production Scenario

The maximum predicted concentrations of COPCs for the 27.5 MTPY scenario are presented as graphically in Attachment A along with plots showing the frequencies of exceedances of short-term WHO guidelines. The figures demonstrate that there are very few exceedances of the WHO guidelines for PM_{10} and $PM_{2.5}$ beyond the Project Footprint. In particular, there are no more than 10 days of exceedances per year within 600 m of the project Footprint for either 24-hour concentrations PM_{10} and $PM_{2.5}$. The exceedance plots also show that exceedances of the 24-hour PM_{10} and $PM_{2.5}$ WHO guidelines occur up to about 1 km beyond the Project Footprint.

In addition, the figures in Attachment A show that there are no more than 10 exceedances per year of the 1-hour NO_2 or 10-minute SO_2 WHO guidelines within 1.2 km of the Project Footprint. The exceedance plots also show that exceedances of the NO_2 or SO_2 WHO guideline are only predicted to occur within about 2.5 km of the Project Footprint.

7.1.4 Comparison to Existing Operations

Table 7.1 shows the maximum predicted concentrations COPCs for each future production level at the Air Quality Monitoring locations, with the percent change in concentration from existing operations shown in Table 7.2. As can be seen in Table 7.2, there is a significant increase in NO_2 and SO_2 concentrations for each future production level relative to existing operations. For example, concentrations of NO_2 and SO_2 more than double in the 27.5 MTPY scenario relative

to existing operations. This increase can be attributed to increased consumption of No. 6 fuel oil and diesel required to support the planned production increases.

Despite the increase in production level, Table 7.2 shows that there is a decrease in predicted particulate matter concentrations between existing and all future production levels. The decreases can be attributed to the increased level of dust control assumed to be installed on new processing equipment. The most significant change is between existing and 22.5 MPTY, when all of the existing equipment is finally upgraded to include additional dust suppression such as dry fogging.

Table 7.1: 18.5, 22.5 and 27.5 MTPY Model Predicted COPC Concentrations in Kamsar (µg/m^3)

	18.5 MTPY				22.5 MTPY				27.5 MTPY			
	PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$	
	24-hour	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**
AQ-1	154	38	79	22	89	24	48	14	119	33	65	20
AQ-2	141	30	70	17	79	18	43	11	104	26	58	15

	18.5 MTPY				22.5 MTPY				27.5 MTPY			
	NO_2		SO_2		NO_2		SO_2		NO_2		SO_2	
	1-hour	**Annual**	**10-min**	**24-hour**	**1-hour**	**Annual**	**10-min**	**24-hour**	**1-hour**	**Annual**	**10-min**	**24-hour**
AQ-1	187	15	465	88	197	16	488	93	263	21	655	124
AQ-2	265	11	634	88	284	11	672	93	380	15	914	126

Table 7.2: Change in Future Model Predicted COPC Concentrations in Kamsar Compared to Existing Conditions

	18.5 MTPY				22.5 MTPY				27.5 MTPY			
	PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$	
	24-hour	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**
AQ-1	-17%	-14%	-15%	-4%	-52%	-45%	-48%	-39%	-36%	-25%	-30%	-13%
AQ-2	-12%	-12%	-13%	-6%	-51%	-47%	-46%	-39%	-35%	-24%	-28%	-17%

	18.5 MTPY				22.5 MTPY				27.5 MTPY			
	NO_2		SO_2		NO_2		SO_2		NO_2		SO_2	
	1-hour	**Annual**	**10-min**	**24-hour**	**1-hour**	**Annual**	**10-min**	**24-hour**	**1-hour**	**Annual**	**10-min**	**24-hour**
AQ-1	33%	36%	34%	33%	40%	45%	41%	41%	87%	91%	89%	88%
AQ-2	51%	38%	55%	24%	61%	38%	64%	31%	116%	88%	123%	77%

7.2 SANGARÉDI MINING OPERATIONS

7.2.1 Annual Air Quality Effects

Graphical results for predicted annual concentrations of COPCs for the 18.5, 22.5 and 27.5 MTPY production scenarios are presented Attachment A and summarized in sections 7.2.1.1, 7.2.1.2 and 7.2.1.3, respectively. As discussed below, the predicted annual concentrations of NO_2 and SO_2 are well within applicable WHO guidelines. Annual concentrations of $PM_{2.5}$ are only predicted to exceed the WHO guidelines into a limited area of the study area for the 22.5 MTPY and 27.5 MTPY production levels. The largest effects are predicted for annual PM_{10} concentrations which are shown to exceed the WHO Interim Target 1 guideline for all levels of production. The exceedances of the PM_{10} and $PM_{2.5}$ guidelines can largely be attributed to emissions of particulate matter from unpaved road dust.

7.2.1.1 18.5 MTPY Production Scenario

The annual predicted concentrations of COPCs for the 18.5 MTPY scenario are presented graphically in the figures provided in Attachment A. As the figures demonstrate, there is a limited area within the vicinity of the modelled road network where the annual WHO guidelines for PM_{10} are exceeded. Specifically, the WHO Interim Target 1 criteria for annual PM_{10} is predicted to be exceeded within about 1 km of the road network. All other COPCs are predicted to be below their applicable annual WHO guidelines.

In addition to the contour plots provided in Attachment A, Table 7.3 presents the model predicted annual COPC concentrations for those villages where annual WHO guidelines are predicted to be exceeded. The air quality monitoring locations are also provided in the Table for completeness. As can be seen in the Table, there are three sensitive receptors where any of the annual WHO guidelines for PM_{10} are exceeded: Hamdalaye, Pora PK130 and Carrefour Parawol. However, there are no village locations where the WHO Interim Target 1 guideline for PM_{10} is exceeded. There are also no village locations that have predicted annual $PM_{2.5}$ concentrations above the WHO guidelines.

Table 7.3: 18.5 MTPY Production Scenario - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	1.5	0.2	0.2
AQ11	AQ-11 Hamdallay	622.252	1225.617	**83.7**	**15.2**	13.6
AQ12	AQ-12 Petoun BW	628.870	1224.203	5.7	0.8	0.5
AQ13	AQ-13 Paravi	616.710	1221.796	1.0	0.2	0.2
SR46	Hamdalaye	622.082	1225.627	**46.6**	6.4	3.8
SR58	Pora PK130	630.420	1222.985	**59.3**	6.4	1.9
SR59	Carrefour Parawol	631.430	1221.004	**27.8**	2.9	0.8
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40

Notes:
Concentrations in **bold** exceed an applicable WHO Target or Guideline

7.2.1.2 22.5 MTPY Production Scenario

The annual predicted concentrations of COPCs for the 22.5 MTPY scenario are presented graphically in the figures provided in Attachment A. As the figures demonstrate, there is a limited area within the vicinity of the modelled road network and proposed rail loading location near Hamdalaye where the annual WHO guidelines for PM_{10} and $PM_{2.5}$ are predicted to be exceeded. In particular the WHO Interim Target 1 guideline for annual PM_{10} is predicted to be exceeded within about 600 m of the road network/proposed rail loading area near Hamdalaye. Additionally, the WHO Interim Target 3 guideline for annual $PM_{2.5}$ is predicted to be exceeded within about 200 m of the road network/proposed rail loading area near Hamdalaye. In contrast, annual NO_2 concentrations are predicted to be well below the applicable WHO guideline.

In addition to the contour plots, Table 7.4 presents the model predicted annual COPC concentrations for those villages where the annual WHO guidelines are predicted to be exceeded. In addition, concentrations predicted at the air quality monitoring locations are shown. As can be seen in the Table, there are three villages where an annual WHO guideline for PM_{10} is predicted to be exceeded: Hamdalaye, Carrefour Parawol, and Madina Dian. The highest predicted concentrations occur at Hamdalaye where the annual WHO Interim Target 1 level for PM_{10} and the annual Interim Target 3 level for $PM_{2.5}$ are predicted to be exceeded. This is a result of Hamdalaye's proximity to both a modelled road network (the main emissions source) and the proposed rail loading area.

Table 7.4: 22.5 MTPY Production Scenario - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	3.5	0.5	0.3
AQ11	AQ-11 Hamdallay	622.252	1225.617	**121.1**	**12.8**	4.0
AQ12	AQ-12 Petoun BW	628.870	1224.203	5.0	0.5	0.2
AQ13	AQ-13 Paravi	616.710	1221.796	1.7	0.2	0.3
SR46	Hamdalaye	622.082	1225.627	**203.8**	**21.0**	7.4
SR59	Carrefour Parawol	631.430	1221.004	**83.1**	8.7	2.0
SR97	Madina Dian	632.551	1221.418	**22.0**	2.4	0.8
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40

Notes:
Concentrations in **bold** exceed an applicable WHO Target or Guideline

7.2.1.3 27.5 MTPY Production Scenario

The annual predicted concentrations of COPCs for the 27.5 MTPY scenario are presented graphically in figures provided in Attachment A. As the figures demonstrate, there is a limited area within the vicinity of the modelled road network where the annual WHO guidelines for PM_{10} and $PM_{2.5}$ are predicted to be exceeded. The WHO Interim Target 1 guideline for annual PM_{10} is limited to within about 800 m of the road network and has the highest concentrations predicted in the vicinity of Kourawel. Additionally, the WHO Interim Target 1 guideline for annual $PM_{2.5}$ is predicted to be exceeded within about 250 m of the road network near Kourawel. Annual NO_2 concentrations are predicted to be below the applicable annual WHO guideline.

In addition to the contour plots, Table 7.5 presents the model predicted annual COPC concentrations for those villages where an annual WHO guidelines is predicted to be exceeded, in addition to concentrations predicted at the air quality monitoring locations. As can be seen in the Table, there are four villages where the annual WHO guideline for PM_{10} is exceeded in the 27.5 MTPY scenario: Kourawel, Sintiourou Kourawel, Hamdalaye, and Kahel Mbody. The highest predicted concentrations occur at Hamdalaye where the annual Interim Target 1 guideline for PM_{10} and the annual WHO Interim Target 3 guideline for $PM_{2.5}$ are predicted to be exceeded. Similar to the 22.5 MTPY scenario, this is a result of Hamdalaye's proximity to both a modelled road network and the proposed rail loading area in the 27.5 MTPY scenario.

Table 7.5: 27.5 MTPY Production Scenario - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
	Project Effects Criteria			70	35	40
AQ10	AQ-10 Kourawel	620.746	1234.554	**47.5**	**11.0**	11.8
AQ11	AQ-11 Hamdallay	622.252	1225.617	**53.0**	5.4	1.0
AQ12	AQ-12 Petoun BW	628.870	1224.203	0.6	0.1	0.04
AQ13	AQ-13 Paravi	616.710	1221.796	1.5	0.2	0.2
SR9	Kourawel	620.668	1234.753	**26.4**	5.2	4.9
SR10	Sintiourou Kourawel	620.513	1234.360	**52.2**	**12.9**	14.4
SR46	Hamdalaye	622.082	1225.627	**175.0**	**17.6**	2.7
SR60	Kahel Mbody	621.990	1235.671	**29.7**	4.2	2.4
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40

Notes:
Concentrations in **bold** exceed an applicable WHO Target or Guideline

7.2.1.4 Comparison to Existing Operations

Table 7.6 to Table 7.8 show the percent change in concentration from existing operations for each future production level at each of the air quality monitoring locations, along with the villages identified in Table 7.3 to Table 7.5. As can be seen in the tables, the predicted change in concentration relative to existing operations is highly variable. The change in concentration not only reflects the change in quantity of bauxite being mined, but the change in proximity of each receptor to mining activities, particularly the roads. This is evident in the contour plots provided in Attachment A which show how the shapes of the contours closely follow the road network, especially for particulate matter concentrations.

Table 7.6: Percent Change in Annual Predicted COPC Concentrations from Existing to 18.5MTPY Sangarédi Mining Operations

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Percent Change from Existing		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	43%	42%	-17%
AQ11	AQ-11 Hamdallay	622.252	1225.617	937%	1356%	674%
AQ12	AQ-12 Petoun BW	628.87	1224.203	99%	76%	-40%
AQ13	AQ-13 Paravi	616.710	1221.796	23%	66%	-36%
SR46	Hamdalaye	622.082	1225.627	539%	576%	137%
SR58	Pora PK130	630.420	1222.985	6559%	4886%	740%
SR59	Carrefour Parawol	631.430	1221.004	3575%	2636%	336%

Table 7.7: Percent Change in Annual Predicted COPC Concentrations from Existing to 22.5MTPY: Sangarédi Mining Operations

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Percent Change from Existing		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	234%	255%	25%
AQ11	AQ-11 Hamdallay	622.252	1225.617	1400%	1126%	128%
AQ12	AQ-12 Petoun BW	628.870	1224.203	74%	10%	-76%
AQ13	AQ-13 Paravi	616.710	1221.796	110%	66%	-4%
SR46	Hamdalaye	622.082	1225.627	2693%	2119%	362%
SR59	Carrefour Parawol	631.430	1221.004	10884%	8109%	990%
SR97	Madina Dian	632.551	1221.418	3570%	2784%	458%

Table 7.8: Percent Change in Annual Predicted COPC Concentrations from Existing to 27.5MTPY: Sangarédi Mining Operations

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Percent Change from Existing		
				PM_{10}	$PM_{2.5}$	NO_2
AQ10	AQ-10 Kourawel	620.746	1234.554	4427%	7703%	4799%
AQ11	AQ-11 Hamdallay	622.252	1225.617	556%	417%	-43%
AQ12	AQ-12 Petoun BW	628.870	1224.203	-79%	-78%	-95%
AQ13	AQ-13 Paravi	616.710	1221.796	85%	66%	-36%
SR9	Kourawel	620.668	1234.753	2556%	3793%	2046%
SR10	Sintiourou Kourawel	620.513	1234.360	4989%	9256%	5997%
SR46	Hamdalaye	622.082	1225.627	2298%	1759%	69%
SR60	Kahel Mbody	621.990	1235.671	2619%	2760%	865%

7.2.2 Short-Term Air Quality Effects

As described previously, short-term air quality effects to ambient concentrations of particulate matter and SO_2 were assessed by modelling a generic working (or extraction) area together with a generic road, in order to represent a worst-case daily emissions scenario. Short-term effects of NO_2 are dominated by emissions from blasting and explosives detonation. For NO_2, an additional generic blasting scenario was considered separately from the generic extraction area, as described in Section 6.2.2.4.

For each village, the combined influence of all sources was considered as described in Section 6.2.2.4. Table 7.9 provides the predicted particulate concentrations for all villages where exceedances of 24-hour WHO guidelines for PM_{10} and $PM_{2.5}$ are predicted. The bold values are

those which exceed the WHO Interim Target 1 at least 1 time in the 5 year modelling period. Note that there are no predicted exceedances of the WHO Interim Target 1 guideline for $PM_{2.5}$. There were no exceedances of the 10-minute or 24-hour SO_2 WHO guidelines. As a result, these results are not presented here but can be found in Attachment D.

Similarly, Table 7.10 presents the maximum predicted 1-hour NO_2 concentrations resulting from blasting for those villages where an exceedance is predicted. The bold values are those which exceed the WHO guideline at least 1 time in the 5 year modelling period.

While it is possible to achieve additional control of emissions of particulate and gaseous COPCs in order to meet short-term WHO guidelines, it may be necessary to maintain minimum setback distances between mining activities (including blasting) and villages. As a result, setback distances for PM_{10}, $PM_{2.5}$, SO_2 and NO_2 for each of the production levels have also been determined (Table 7.11). In the vicinity of a typical unpaved road, the model results indicate that the largest setback distance required to meet the 24-hour WHO Interim Target 1 guideline for PM_{10} is 220 m. The largest setback distance required to meet the 24-hour WHO Interim Target 2 level for $PM_{2.5}$ in the vicinity of a road is 60 m. The largest setback distance required from a blast is 600 m in order to meet the 1-hour WHO guideline for NO_2.

In general, the setback distances shown in Table 7.11, can be applied directly to village locations within the modelling domain in order to assess whether the Project results in an exceedance of a WHO guideline. However as mentioned in Section 6.2.2.4, near some villages there are other persistent Project activities which contribute to ambient air concentrations of COPCs and increase these setback distance. For example, in the 27.5 MTPY scenario, the train loading area and rail network contributes an additional 8 $\mu g/m^3$ of PM_{10} to Hamdalaye on a 24-hour basis. When considered in conjunction with the generic extraction area and road that was modelled, this results in a setback distance of 375 m for the WHO guideline of 50 $\mu g/m^3$ (instead of 355 m as shown in Table 7.11). As can be seen, this incremental adjustment is minimal.

Table 7.9: Predicted 99th Percentile 24-hour PM_{10} and $PM_{2.5}$ Concentrations at Villages Exceeding WHO Guidelines

ID	Description	UTM Easting (km)	UTM Northing (km)	99th 24h PM_{10} Concentration (µg/m³)				99th 24h $PM_{2.5}$ Concentration (µg/m³)			
				Existing	18.5MTPY	22.5MTPY	27.5MTPY	Existing	18.5MTPY	22.5MTPY	27.5MTPY
SR7	Daara	617.521	1234.795	38.7	53.4	65.1	79.5	3.7	5.1	6.2	7.6
SR9	Kourawel	620.668	1234.753	65.6	90.6	110.4	134.9	6.3	8.7	10.6	12.9
SR10	Sintiourou Kourawel	620.513	1234.36	**188.4**	**439.4**	**534.6**	**653.5**	18.0	42.0	51.1	62.5
SR12	Mbourore	619.769	1227.786	**188.6**	**260.4**	**317.9**	**388.6**	18.0	24.9	30.5	37.3
SR14	Gueguere	616.594	1226.045	58.8	81.1	98.7	120.7	5.6	7.8	9.5	11.6
SR16	Parawi	615.513	1222.477	37.6	51.8	63.0	77.0	3.6	5.0	6.1	7.4
SR17	Fassely Fouta Be	619.263	1225.23	82.6	113.9	138.7	**169.6**	7.9	10.9	13.3	16.3
SR21	Kankalare	616.622	1221.213	93.0	127.9	**155.4**	**190.1**	9.0	12.4	15.1	18.4
SR22	Kankalare Hacoude	616.889	1221.438	27.3	37.1	45.1	55.2	2.8	3.7	4.5	5.5
SR35	Kagneka	622.325	1217.638	105.9	146.2	**177.7**	**217.2**	10.1	14.0	17.0	20.8
SR45	Sakidje	627.54	1220.872	**188.4**	**260.2**	**316.3**	**386.7**	18.0	24.9	30.2	37.0
SR46	Hamdalaye	622.082	1225.627	133.2	**183.5**	**227.2**	**277.5**	12.8	17.7	22.1	27.0
SR50	Boundou Wande	629.21	1224.05	29.0	39.9	48.3	59.0	2.8	3.8	4.6	5.7
SR57	Daroul	630.497	1223.646	**188.4**	**260.2**	**316.3**	**386.7**	18.0	24.9	30.2	37.0
SR58	Pora PK130	630.42	1222.985	**188.4**	**260.2**	**316.3**	**386.7**	18.0	24.9	30.2	37.0
SR59	Carrefour Parawol	631.43	1221.004	**188.4**	**260.2**	**316.3**	**386.6**	18.0	24.9	30.2	37.0
SR76	Parawol Aliou	624.789	1231.158	**188.7**	**260.5**	**316.8**	**387.3**	18.1	24.9	30.3	37.1
SR90	Sitako	634.252	1218.719	126.2	174.3	211.9	259.1	12.1	16.7	20.3	24.8
SR97	Madina Dian	632.551	1221.418	**188.4**	**260.1**	**316.2**	**386.6**	18.0	24.9	30.2	36.9
			WHO Interim Target 1	150				75			
			WHO Interim Target 2	100				50			
			WHO Interim Target 3	75				37.5			
			WHO Guideline	50				25			

Notes:

Bold values are predicted to exceed WHO Interim Target 1 (at least one time in 5 years)

Table 7.10: Predicted 1-hour NO_2 Concentrations at Villages Exceeding WHO Guidelines

ID	Description	UTM Easting (km)	UTM Northing (km)	1h NO_2 (µg/m³)			
				Existing	18.5MTPY	22.5MTPY	27.5MTPY
SR7	Daara	617.52	1234.80	**2484**	**3431**	**4172**	**5101**
SR9	Kourawel	620.67	1234.75	**5146**	**7108**	**8643**	**10566**
SR10	Sintiourou Kourawel	620.51	1234.36	**21993**	**62493**	**75991**	**92901**
SR11	Bandodji Touguidje	617.07	1228.40	157	**217**	**264**	**323**
SR12	Mbourore	619.77	1227.79	106	146	177	**217**
SR13	Sintiourou Lenguere	615.53	1226.64	**238**	**329**	**400**	**489**
SR14	Gueguere	616.59	1226.05	**4398**	**6075**	**7387**	**9031**
SR15	Fassely Belendere	615.05	1224.49	**317**	**438**	**532**	**651**
SR16	Parawi	615.51	1222.48	**2364**	**3265**	**3971**	**4854**
SR17	Fassely Fouta Be	619.26	1225.23	**7014**	**9688**	**11780**	**14402**
SR21	Kankalare	616.62	1221.21	**8072**	**11149**	**13557**	**16573**
SR22	Kankalare Hacoude	616.89	1221.44	**1363**	**1882**	**2289**	**2798**
SR35	Kagneka	622.33	1217.64	**9930**	**13715**	**16678**	**20389**
SR46	Hamdalaye	622.08	1225.63	**8628**	**11917**	**14491**	**17715**
SR50	Boundou Wande	629.21	1224.05	**1641**	**2266**	**2756**	**3369**
SR57	Daroul	630.50	1223.65	**2846**	**3931**	**4780**	**5844**
SR58	Pora PK130	630.42	1222.99	**2389**	**3299**	**4012**	**4905**
SR59	Carrefour Parawol	631.43	1221.00	**314**	**433**	**527**	**644**
SR76	Parawol Aliou	624.79	1231.16	**8781**	**12128**	**14747**	**18029**
SR77	Paragogo	623.44	1229.21	**1080**	**1492**	**1814**	**2218**
SR84	Cogon Lengue	636.35	1231.95	165	**227**	**276**	**338**
SR90	Sitako	634.25	1218.72	99	137	167	**204**
			WHO Guideline	200			

Notes:

Bold values are predicted to exceed the WHO guideline (at least one time in 5 years)

Table 7.11: Setback Distances Required to Meet Short-Term WHO Guidelines

COPC	Averaging Period	Criteria (µg/m³)		Corresponding Setback Distance (m)			
				Existing	18.5MTPY	22.5MTPY	27.5MTPY
PM_{10} (99th Percentile)	24-hour	Interim Target-1	150	130	170	195	220
		Interim Target-2	100	180	220	245	270
		Interim Target-3	75	215	255	280	305
		Guideline	50	265	305	330	355
$PM_{2.5}$ (99th Percentile)	24-hour	Interim Target-1	75	--	--	--	--
		Interim Target-2	50	--	--	35	60
		Interim Target-3	37.5	--	50	75	100
		Guideline	25	60	100	125	150
NO_2	1-hour	Guideline	200	525	555	575	595

7.3 PROPOSED RAIL SIDING

A generic model setup was used to assess an idling train with three locomotives idling on a rail siding. For the rail siding which is isolated from mining or processing activities (i.e., PK 14), the model results indicate that under the worst-case meteorological conditions, the 1-hour NO_2 WHO guideline is exceeded within approximately 625 m of the siding. None of the other WHO guidelines are exceeded.

Unlike PK 14, the proposed PK 118 siding is located in the Sangarédi mining area and within about 1 km of future extraction areas. As a result, there are some villages which may be influenced by NO_2 emissions from both the rail siding and emissions from regular mining activities and blasting in particular. Therefore, nearby villages located downwind from both a mining area and the proposed PK 118 rail siding (e.g., SR34 or SR47) may experience 1-hour NO_2 concentrations above WHO guidelines if both emission sources are present concurrently. However, it is unlikely that both activities will occur concurrently under worst-case meteorological conditions. Therefore, the number of exceedances is also likely to be limited.

8.0 CONCLUSION

As discussed in the preceding sections, exceedances of WHO guidelines were predicted for all COPCs at the Kamsar Processing Facility for all planned production increases. However, the predicted effects to air quality are limited around the Processing Facility, and generally only occur at locations within 1 km of the Project Footprint. Consequently, exceedances are expected to occur very infrequently within the town of Kamsar. In addition, planned upgrades to the processing equipment and new dust control systems are predicted to actually decrease particulate matter concentrations over time. The lowest particulate concentrations were predicted for the 22.5 MTPY scenario.

Similarly, the predicted effects to air quality from activities at the Sangarédi mine site are limited, and are related to occasional exceedances of WHO guidelines at locations in close proximity to the road network. Specifically, exceedances of the annual PM_{10} WHO Interim Target 1 guideline are predicted to be limited to about 1 km from a modelled road whereas exceedances of the $PM_{2.5}$ Interim Target 1 guideline are limited to 250 m from a road. While there are also exceedances predicted for 24-hour PM_{10} and $PM_{2.5}$ as well as 1-hour NO_2 from blasting, these effects will be also be limited to areas in close proximity (less than 1 km) to mining activities or roads. Furthermore, for most villages, exceedances of WHO guidelines will be limited to the amount of time it takes to finish extracting bauxite in a nearby mining. The exception will be for those villages which are also located near unpaved haul roads. In such cases, increased concentrations of particulate matter can be expected so long as the nearby haul road is in use.

8.1 MITIGATION AND MONITORING

8.1.1 Kamsar Processing Facility

In order to reduce off site concentrations of particulate matter and gaseous COPCs in the future, the following measures should be considered:

- Implement planned dust management systems during material processing;
- Reduce or eliminate the use of Bunker C fuel in favour of diesel; and
- Ensure dryer scrubbers are in good working order.

One real-time gas monitoring station should be placed to the north of the CBG plant where access to power is possible. The preferred location would be at the baseline air monitoring location AQ-2 école. Use of a standby generator for power is not recommended as emissions from the generator can affect the measurements. A real-time station would be housed in an air conditioned trailer and would contain the following instrumentation (or equivalent):

- chemiluminescence NO-NO_2-NO_X analyzer

- pulsed fluorescence SO_2 gas analyzer
- Beta Attenuation Mass (BAM) monitor(s) for PM_{10} and $PM_{2.5}$

However, if power is not available at this location and it is necessary to move the station closer to the CBG plant, it should be placed along the northern boundary where power is available in an area with good exposure. If the location is close to roads and other sources which generate large volumes of dust, it is recommended that mini-vol samplers be placed at the AQ-2 to periodically collect dust (TSP, PM_{10} and $PM_{2.5}$) samples at this location.

Sampling should be initiated in advance of expansion activities to confirm the existing conditions and continue through the operational period.

8.1.2 Sangarédi Mining Operations

In order to reduce off site concentrations of PM_{10}, $PM_{2.5}$ and NO_2 from haul roads and blasting activities in the future, the following measures should be considered:

- Commit to achieve at least 80% control of road dust via watering, or through the application of a chemical dust suppressant (e.g., calcium chloride);
- Reduce vehicle speeds on roads to 40 km/hr or less where possible;
- If feasible, consider paving the roads, particularly in the vicinity of villages;
- Optimise the haul roads to avoid villages, trying to keep 2 km away;
- Evaluate the option of using larger trucks to limit the total number of truck trips per day;
- Eliminate the new rail siding in the vicinity of Hamdalaye (this would have the most impact in the 22.MTPY scenario);
- Do a feasibility study to evaluate using conveyors to transport bauxite; and,
- Investigate feasibility of expanding the rail network to transport bauxite in lieu of using an extended road network.

Mini-vol samplers should be used to periodically collect TSP, PM_{10} and $PM_{2.5}$ samples in locations proximate to haul roads and mining areas to validate the results of the air quality assessment. Passive NO_X and samplers should also be used in locations proximate to the mining areas to confirm the results of the air quality assessment. As mining activities move, similarly the monitoring locations should be moved.

Sampling should be initiated in advance of expansion activities to confirm the existing conditions and continue through the operational period.

9.0 REFERENCES

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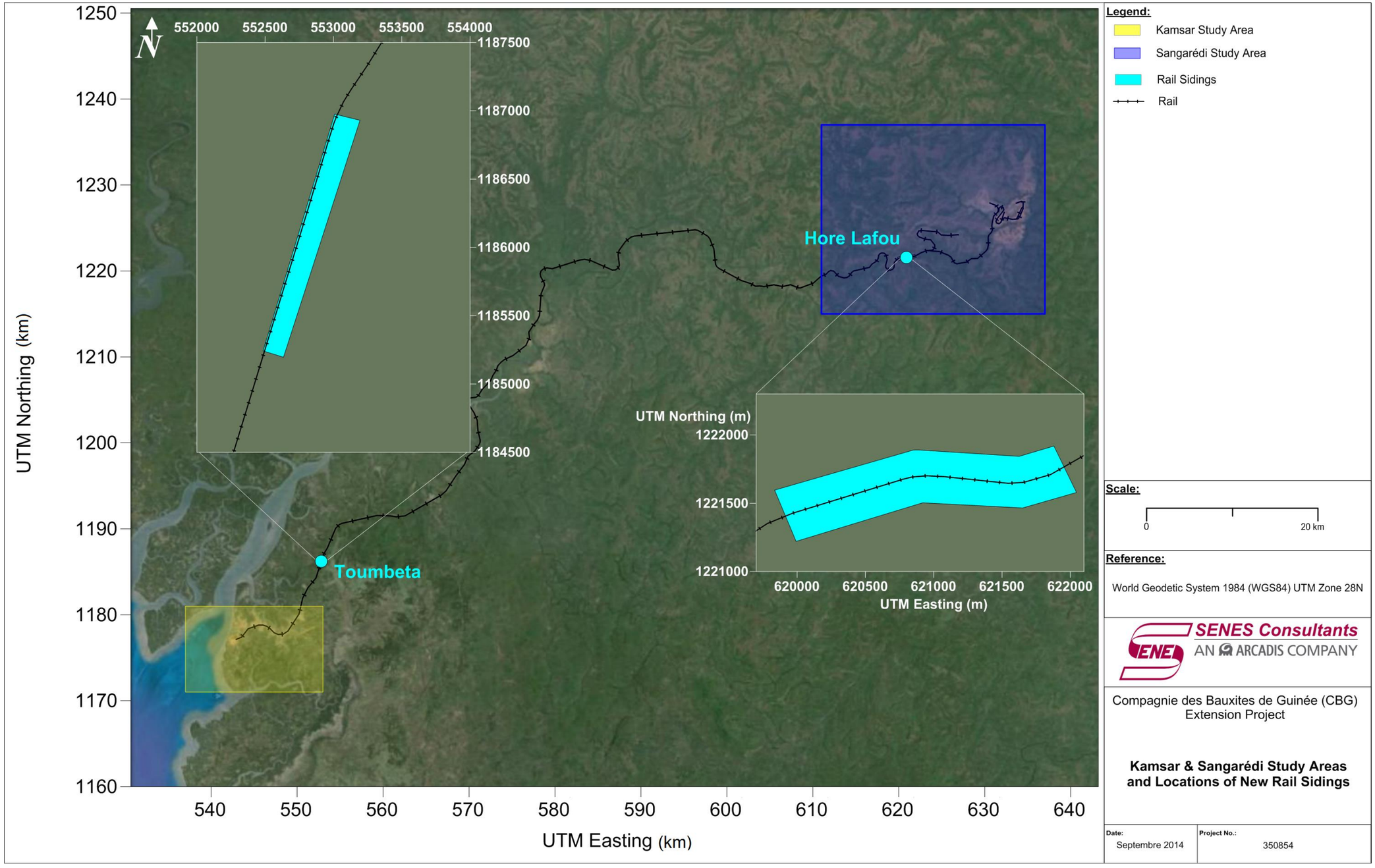
ATTACHMENT A:
FIGURES

Figure 1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1221500
1221000
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620500
621000
621500
622000
UTM Easting (m)
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1170
1160
UTM Northing (km)
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550
560
570
580
590
600
610
620
630
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Kamsar Study Area
Sangarédi Study Area
Rail Sidings
Rail
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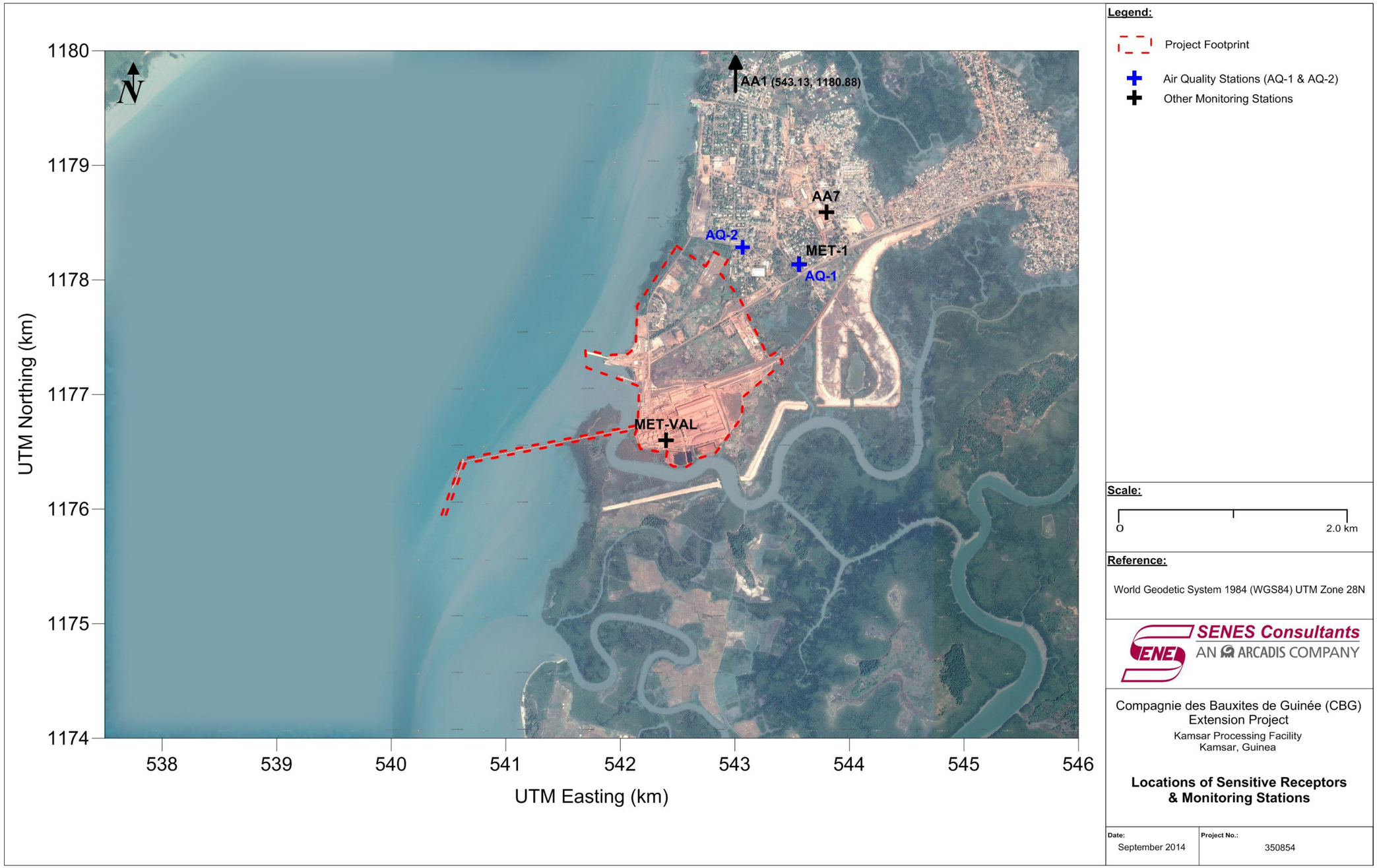
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar & Sangarédi Study Areas
and Locations of New Rail Sidings
Date:
Septembre 2014
Project No.:
350854

Figure 2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MET-1
AQ-1
MET-VAL
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1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
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Air Quality Stations (AQ-1 & AQ-2)
Other Monitoring Stations
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World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
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Kamsar, Guinea
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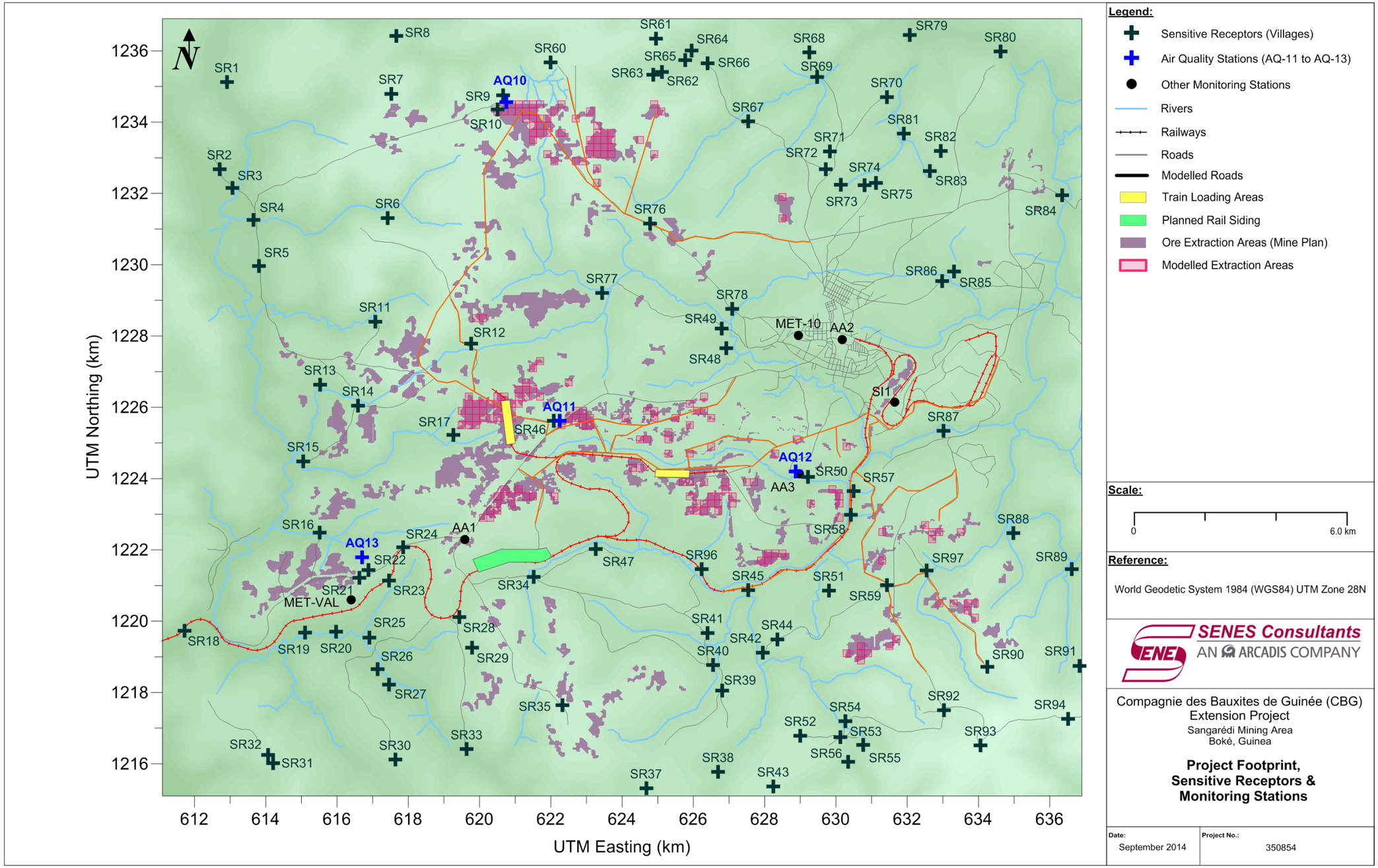
September 2014
Project No.:
350854

Figure 3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UTM Easting (km)
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614
616
618
620
622
624
626
628
630
632
634
636
AQ10
AQ11
AQ12
AQ13
AA1
AA2
AA3
MET-10
MET-VAL
SI1
Legend:
Sensitive Receptors (Villages)
Air Quality Stations (AQ-11 to AQ-13)
Other Monitoring Stations
Rivers
Railways
Roads
Modelled Roads
Train Loading Areas
Planned Rail Siding
Ore Extraction Areas (Mine Plan)
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SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
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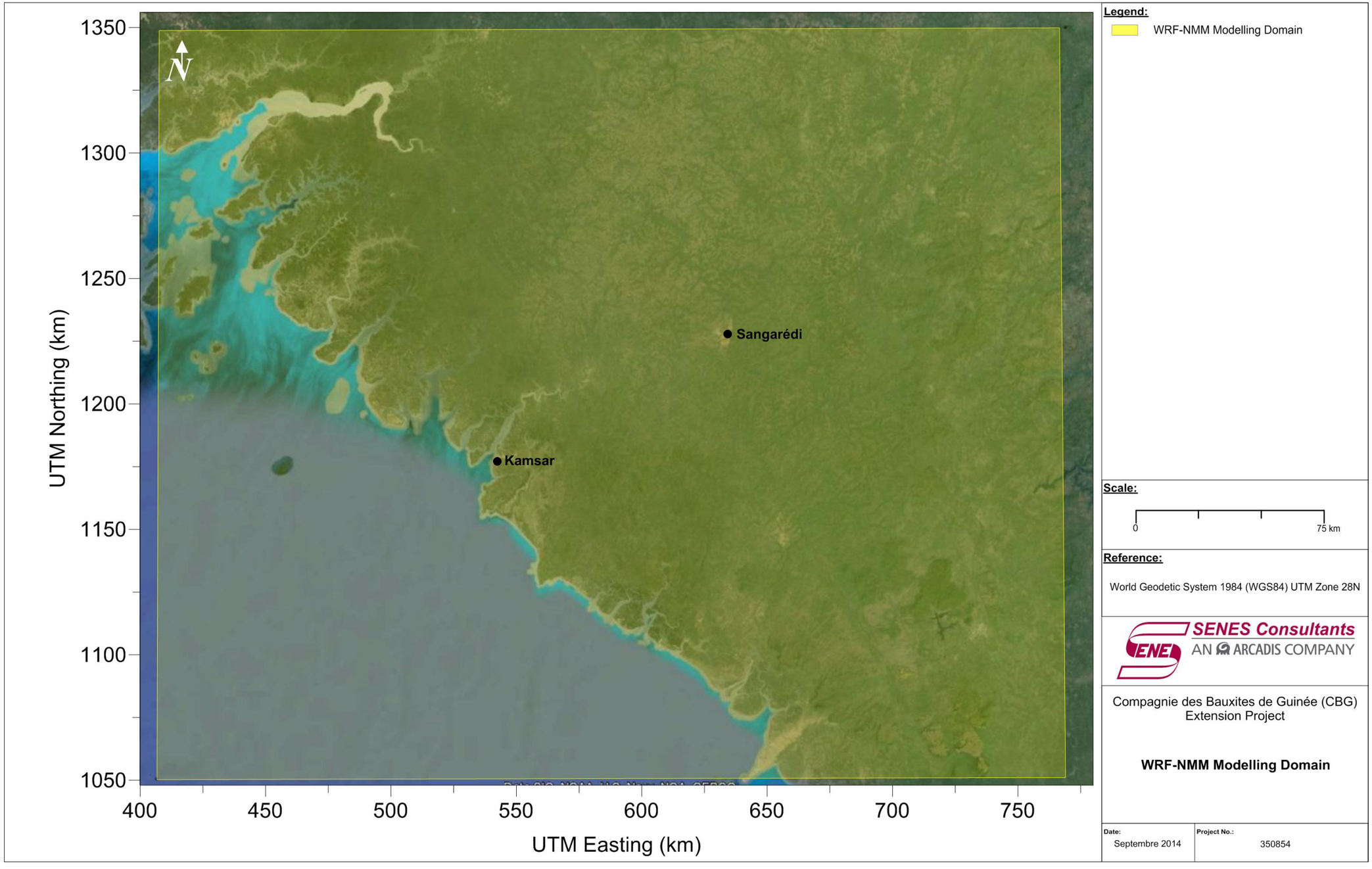
Date:
September 2014
Project No.:
350854

Figure 4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600
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UTM Easting (km)
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Sangarédi
Kamsar
Legend:
WRF-NMM Modelling Domain
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SENES Consultants
AN ARCADIS COMPANY
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Date:
Septembre 2014
Project No.:
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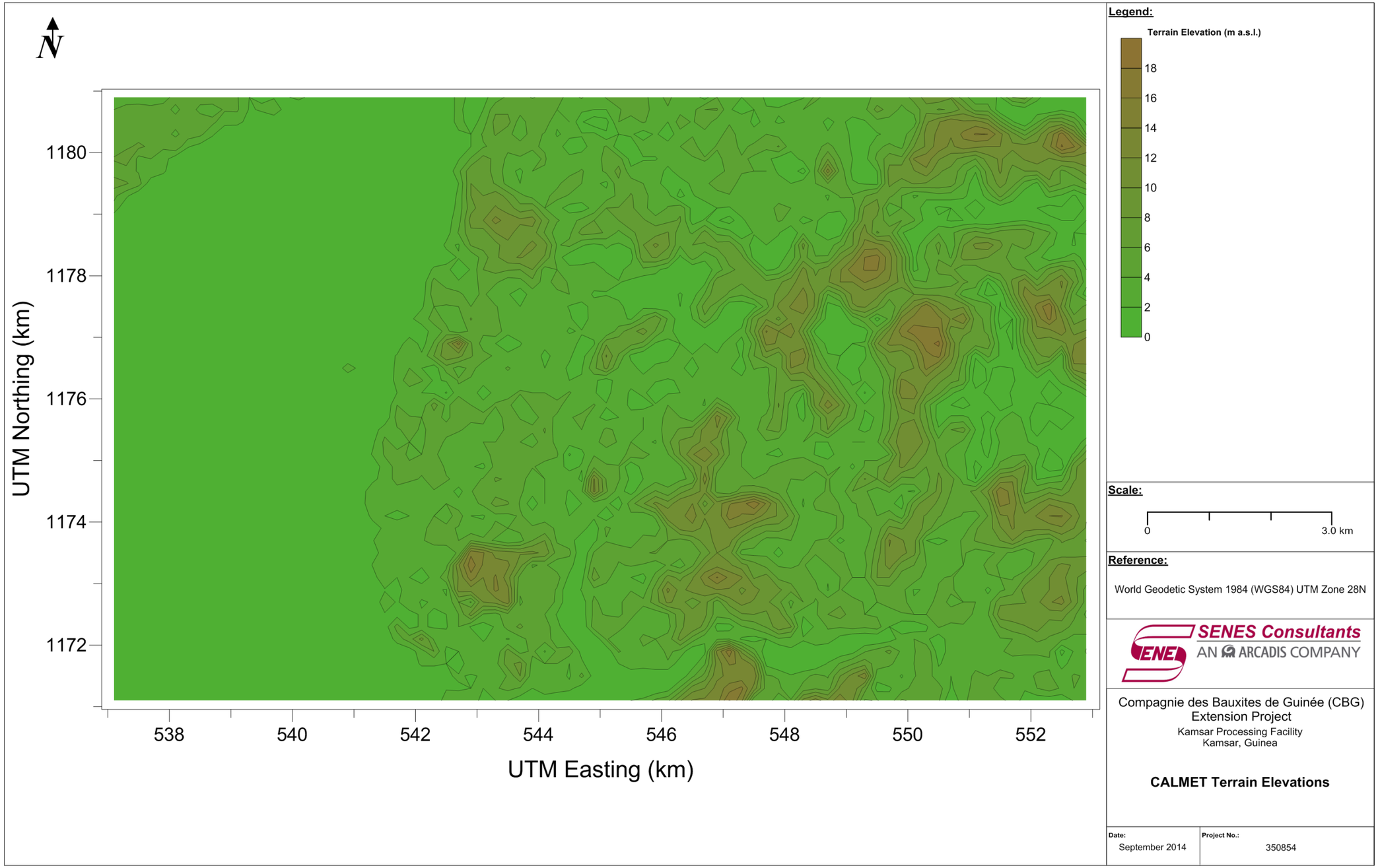
Figure 5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UTM Northing (km)
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540
542
544
546
548
550
552
UTM Easting (km)
Legend:
Terrain Elevation (m a.s.l.)
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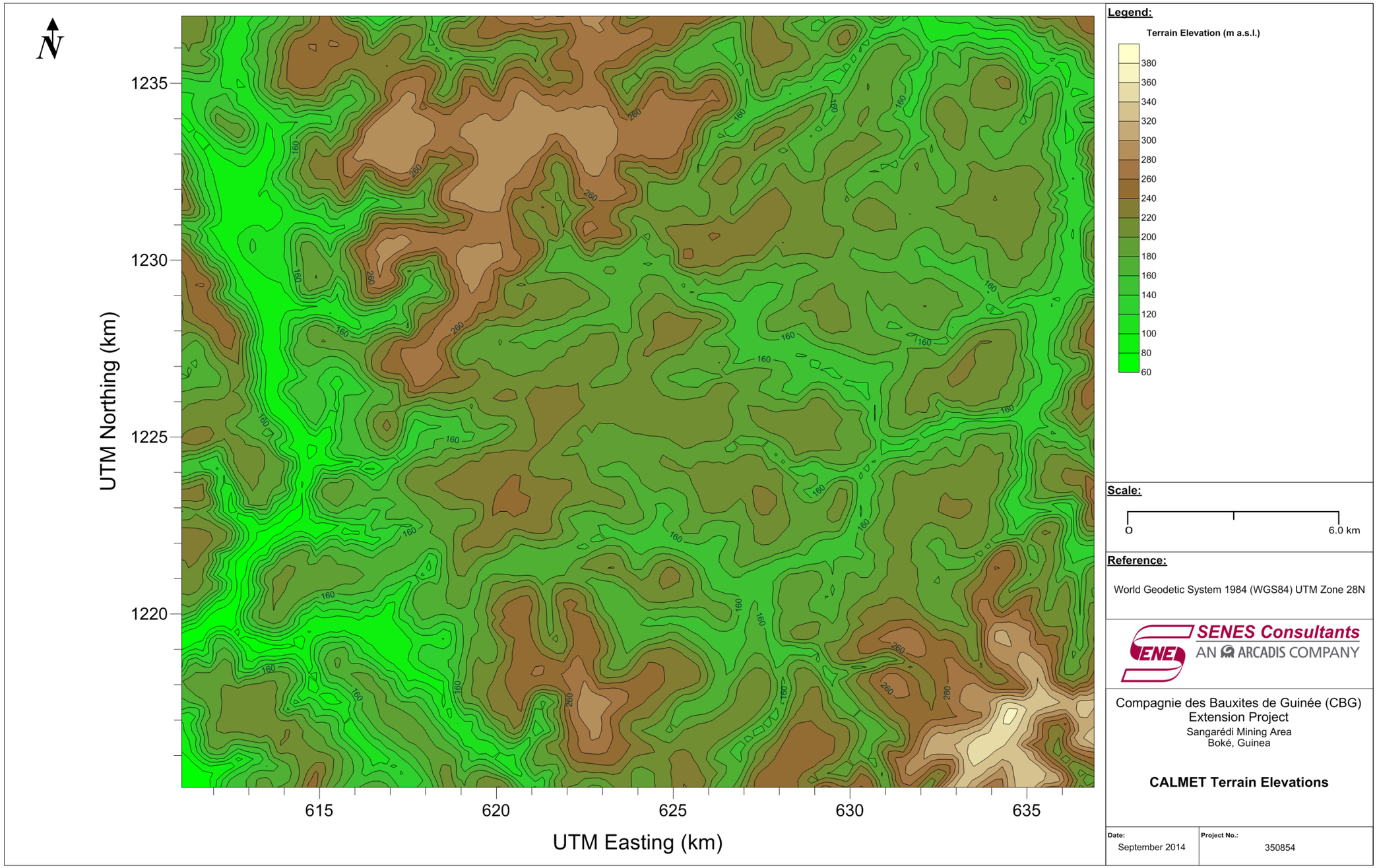
16
14
12
10
8
6
4
2
0
Scale:
0
3.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
CALMET Terrain Elevations
Date:
September 2014
Project No.:
350854

Figure 6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1225
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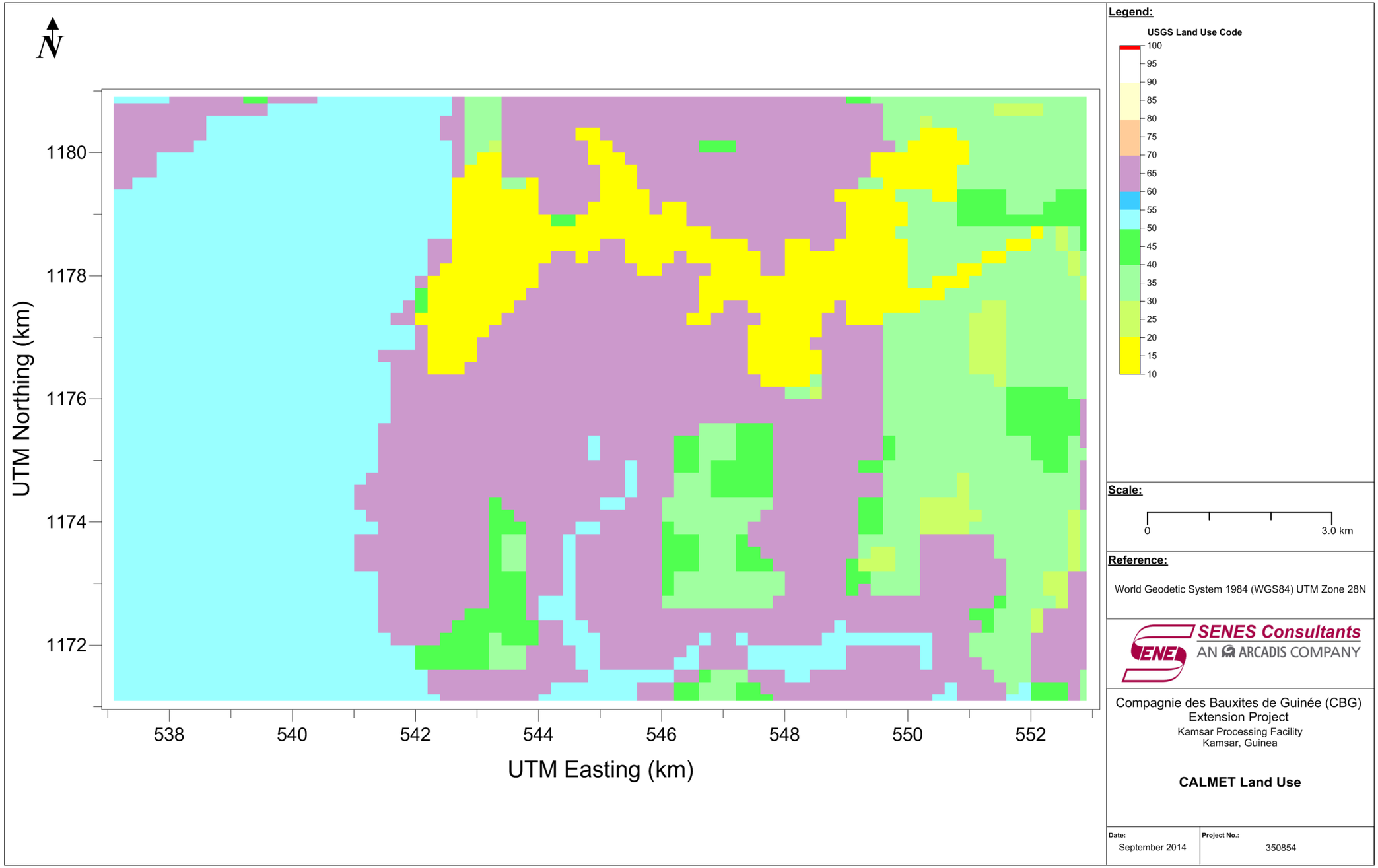
UTM Northing (km)
615
620
625
630
635
UTM Easting (km)
Legend:
Terrain Elevation (m a.s.l.)
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
CALMET Terrain Elevations
Date:
September 2014
Project No.:
350854

Figure 7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1174
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UTM Northing (km)
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540
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UTM Easting (km)
Legend:
USGS Land Use Code
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
Scale:
0
3.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
CALMET Land Use
Date:
September 2014
Project No.:
350854

Figure 8

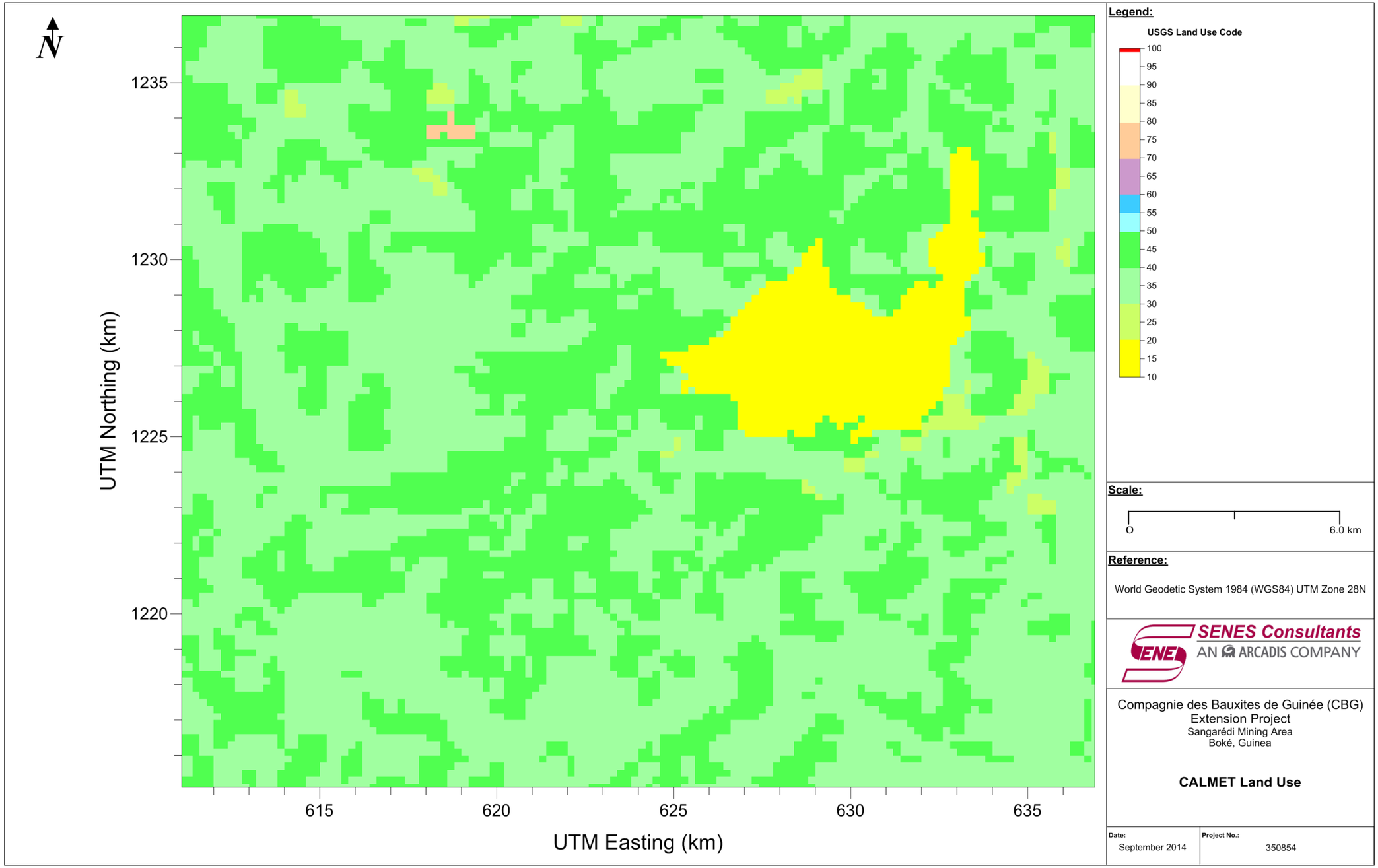
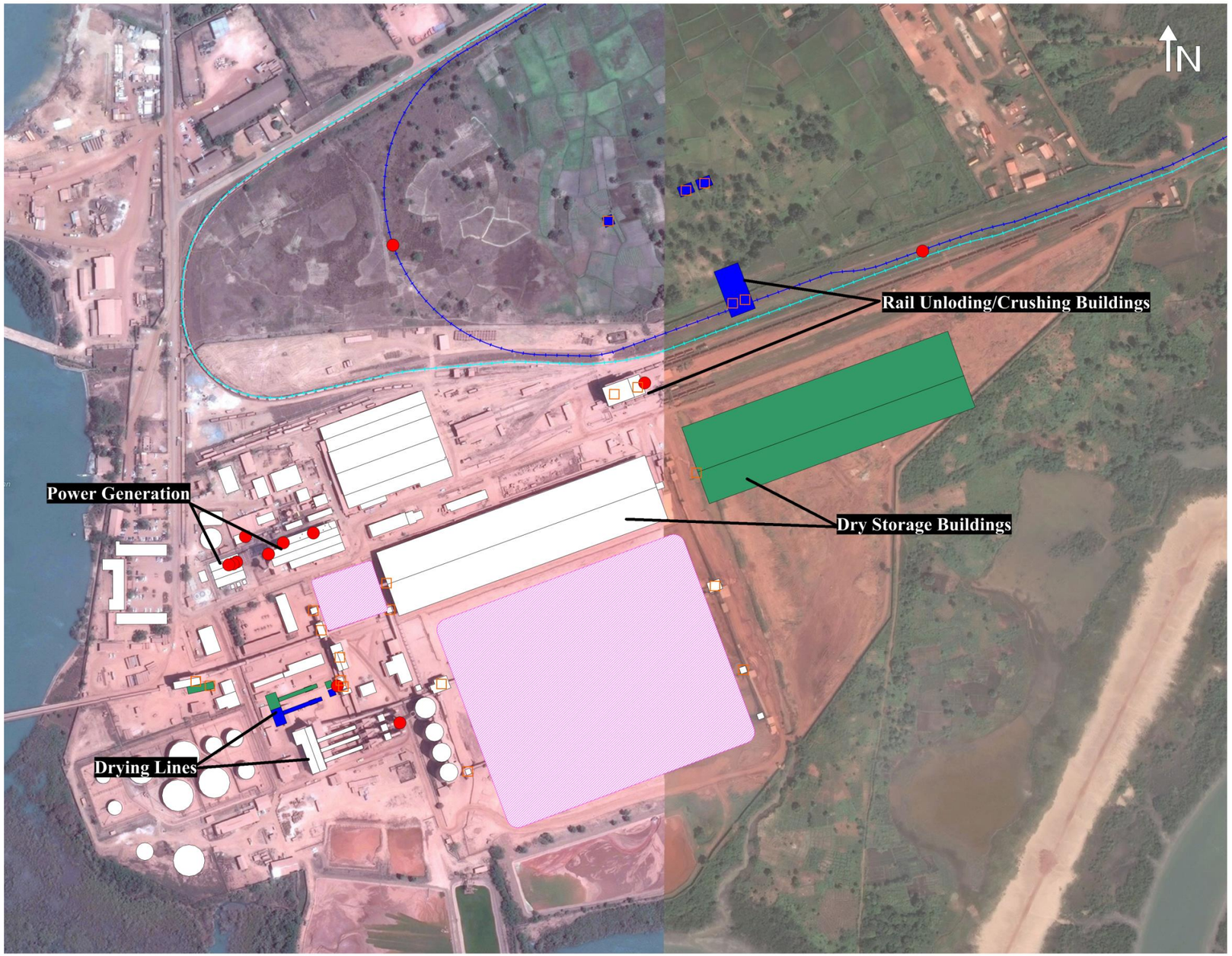

N
1235
1230
1225
1220
UTM Northing (km)
615
620
625
630
635
UTM Easting (km)
Legend:
USGS Land Use Code
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
CALMET Land Use
Date:
September 2014
Project No.:
350854

Figure 9



LEGEND:

- Point source
- Volume source
- Area source
- Existing building
- New building (18.5 MTPA)
- New building (27.5 MTPA)
- Existing rail line
- Future rail line

NOTES:

SCALE:

0 m 100 m 200 m

REFERENCE:

Basemap: Bing Maps 2014

SENES Consultants
AN ARCADIS COMPANY

Compagnie des bauxites de Guinée (CBG)
Extension Project
Kamsar, Guinea

Kamsar Model Setup

Drawn By:	Approved By:	Figure No.:
KT	JLK	
Date: Sept. 2014	Project Number: 350854	

Figure 10

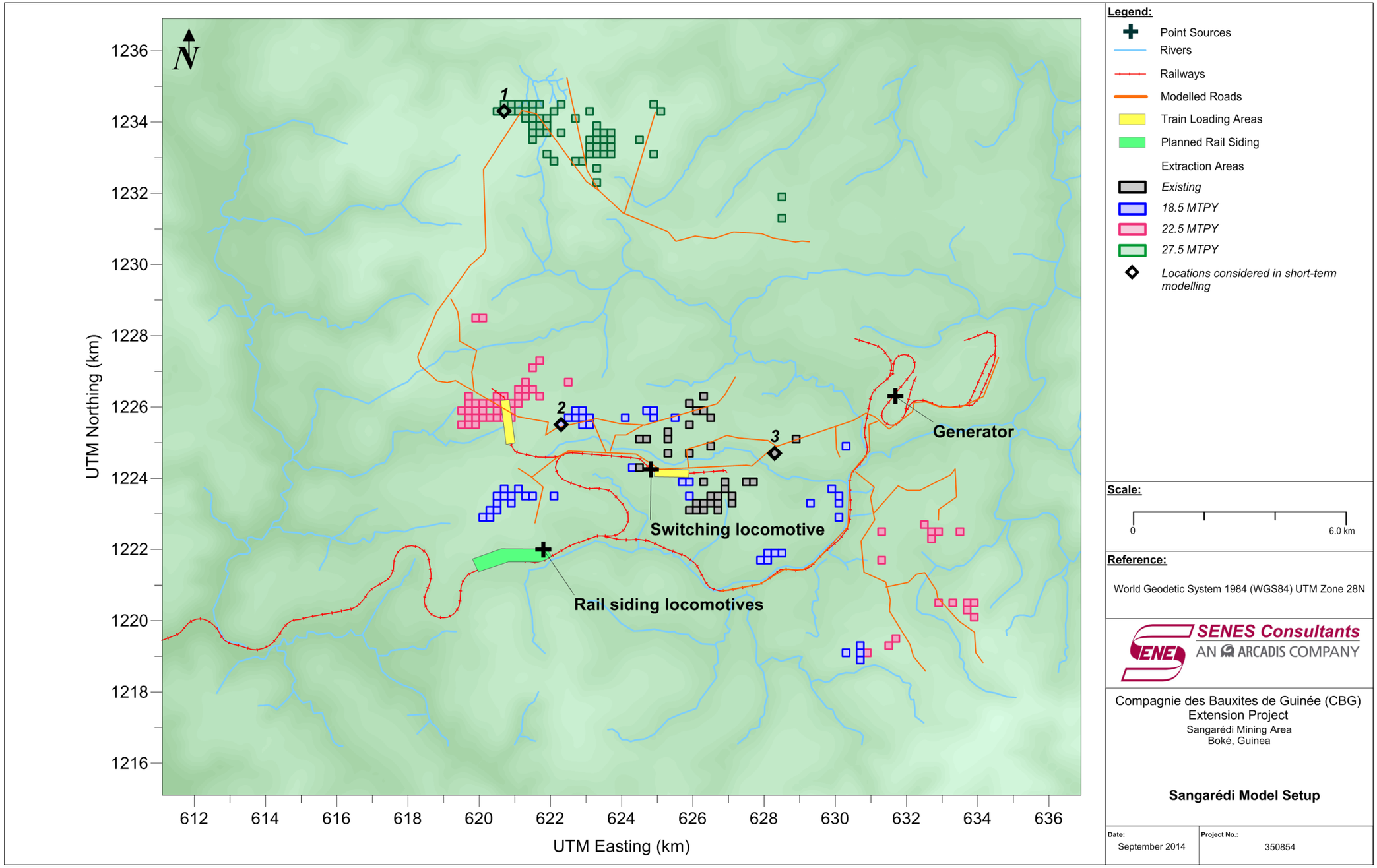
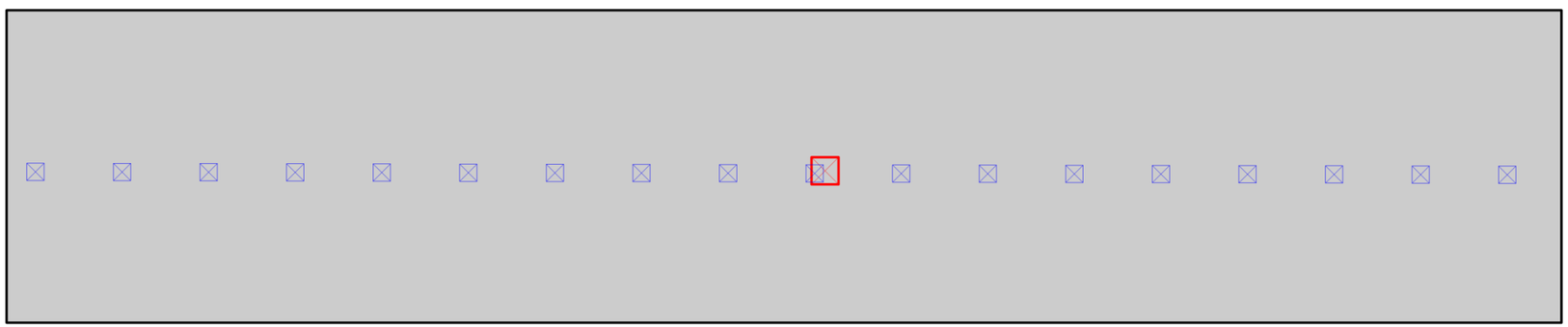

N
1
2
3
Generator
Switching locomotive
Rail siding locomotives
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
Legend:
Point Sources
Rivers
Railways
Modelled Roads
Train Loading Areas
Planned Rail Siding
Extraction Areas
Existing
18.5 MTPY
22.5 MTPY
27.5 MTPY
Locations considered in short-term modelling
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
Sangarédi Model Setup
Date:
September 2014
Project No.:
350854

Figure 11



Legend:

Generic Area Source (extraction area)

Generic Volume Source (haul road)

Scale:

0 600 m

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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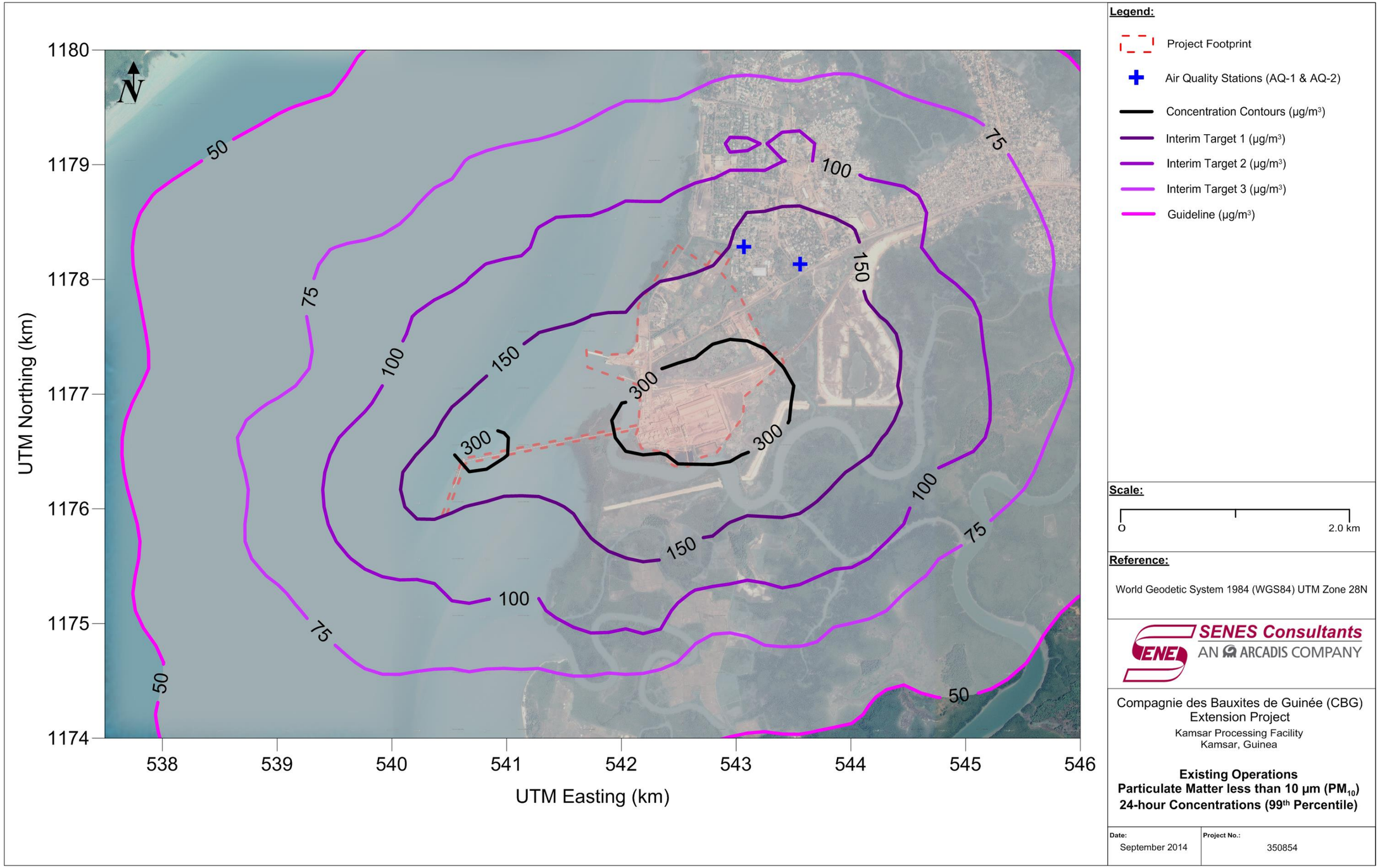
Compagnie des Bauxites de Guinée (CBG)
Extension Project

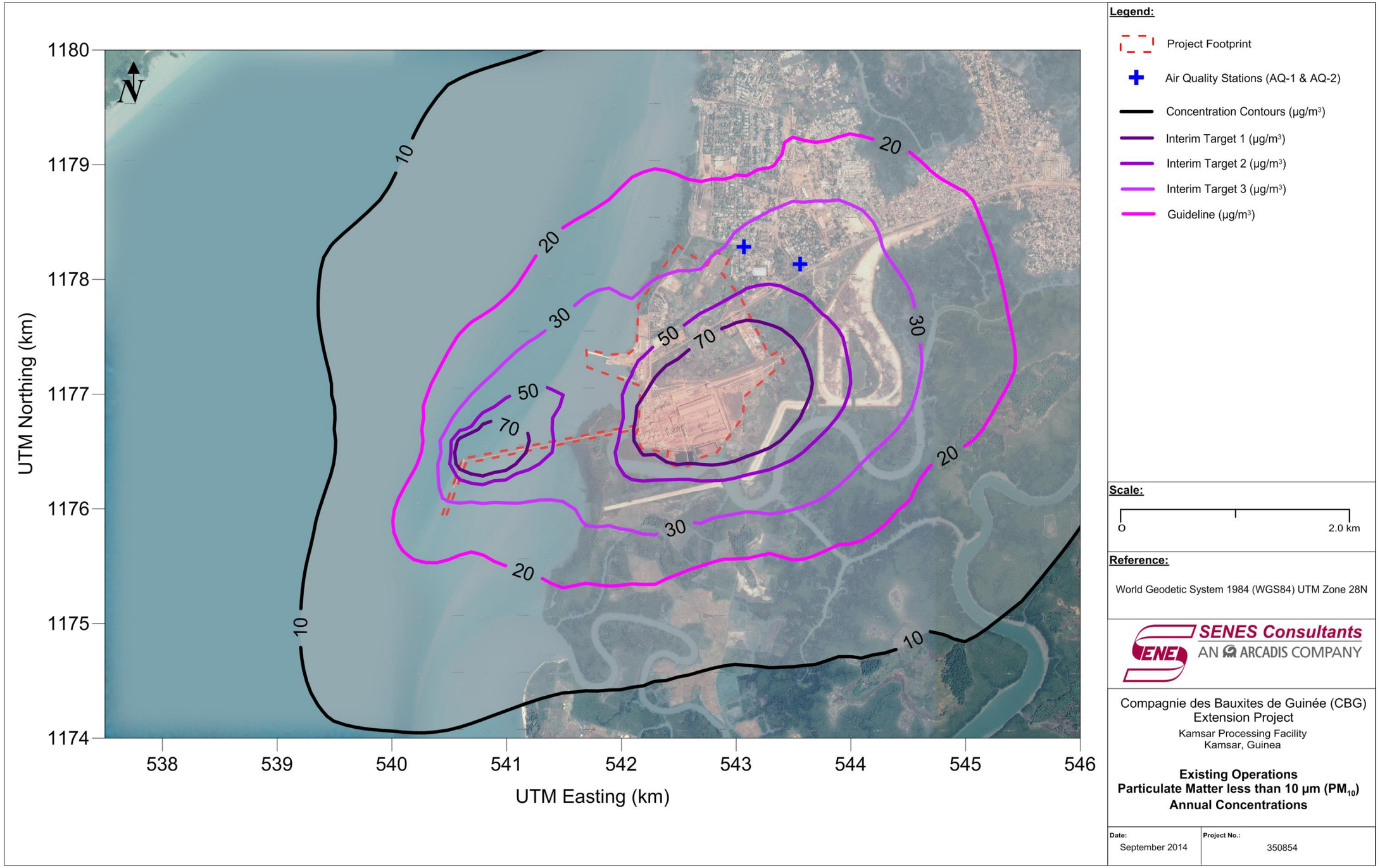
Sangarédi Generic 24-hour Model Setup

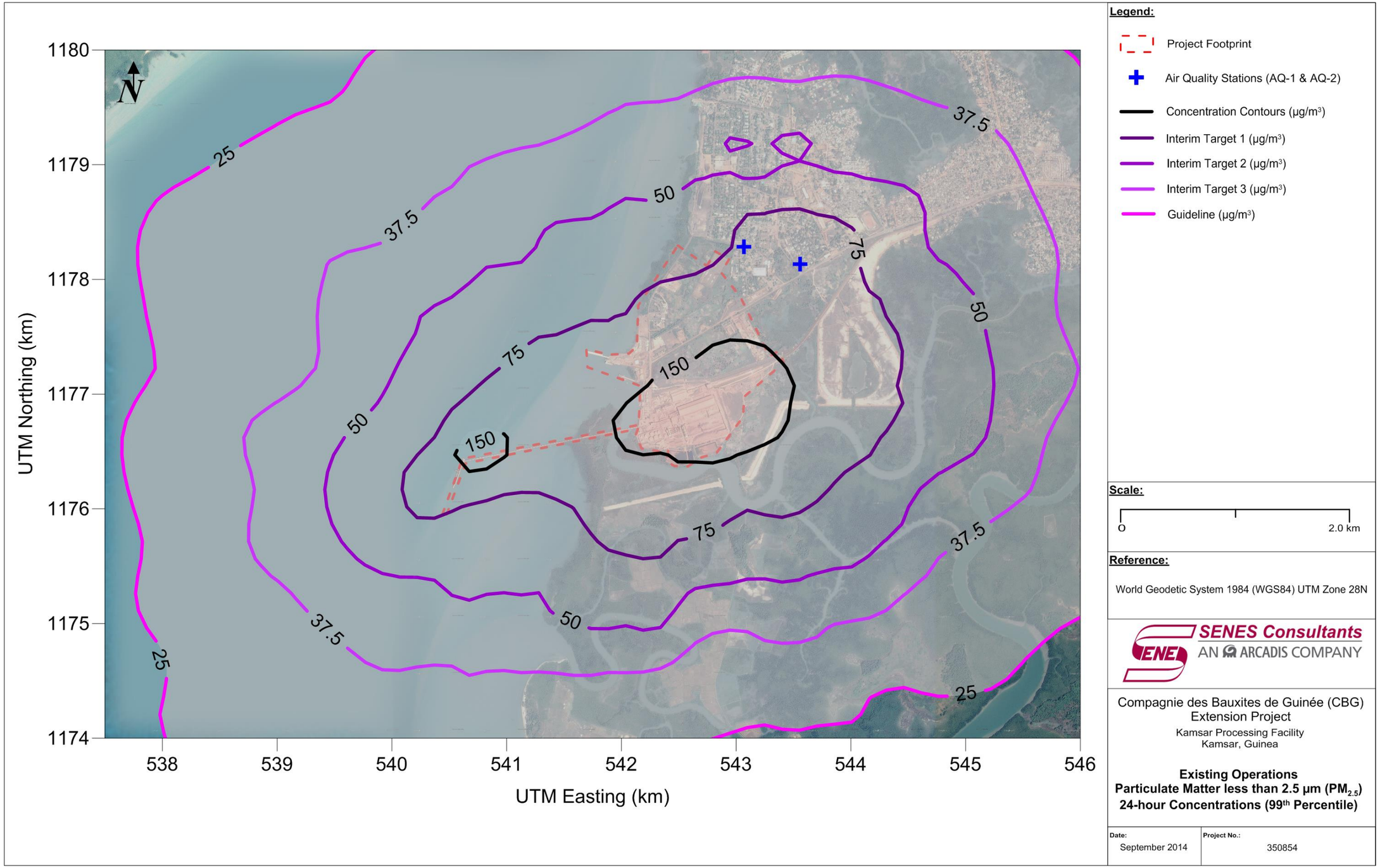
Date:	Project No.:
Septembre 2014	350854

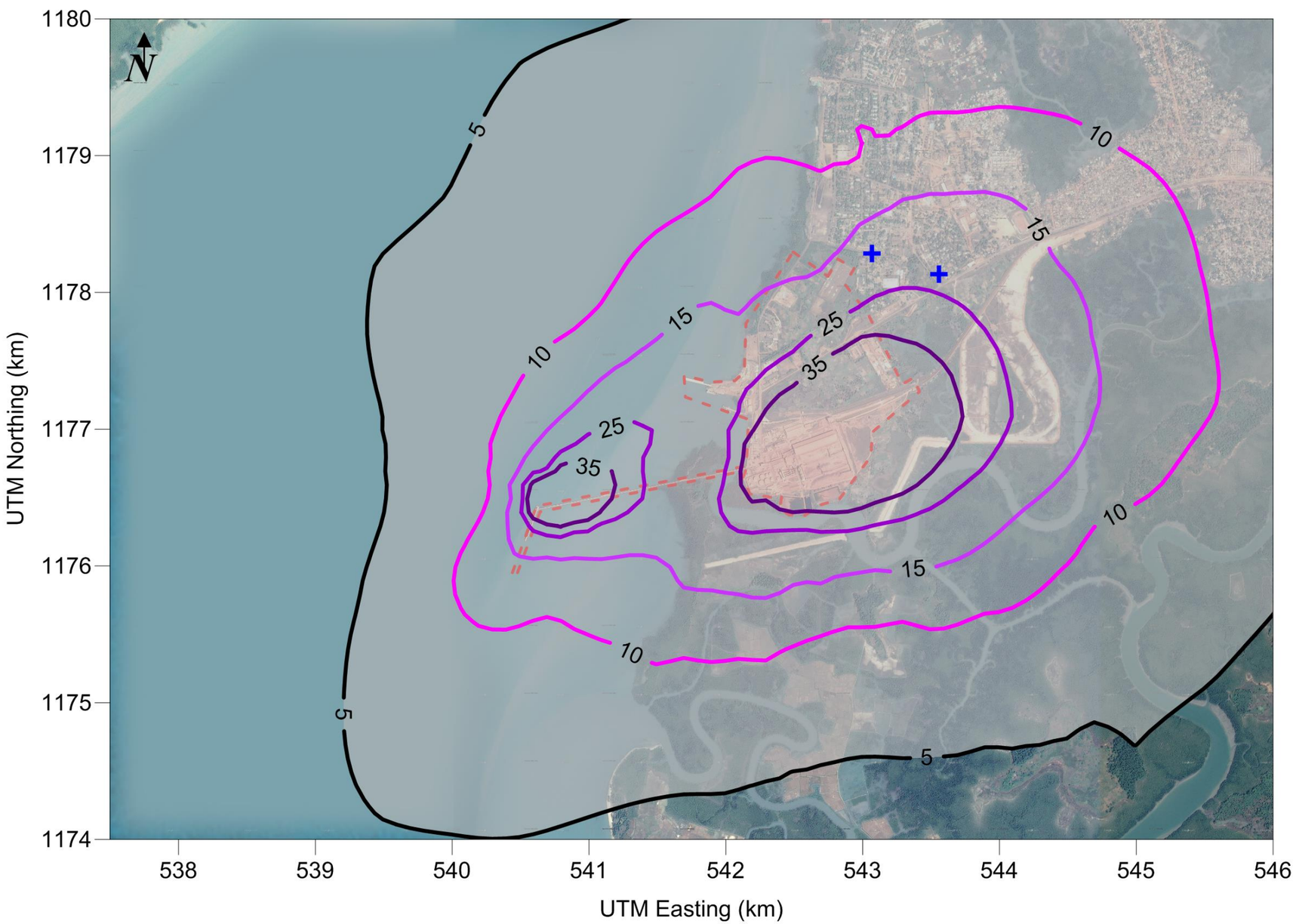
Kamsar

Existing Operations


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
50
75
100
150
300
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
Existing Operations
Particulate Matter less than 10 µm (PM10)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
10
20
30
50
70
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
Existing Operations
Particulate Matter less than 10 µm (PM10)
Annual Concentrations
Date:
September 2014
Project No.:
350854


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
25
37.5
50
75
150
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
Existing Operations
Particulate Matter less than 2.5 µm (PM2.5)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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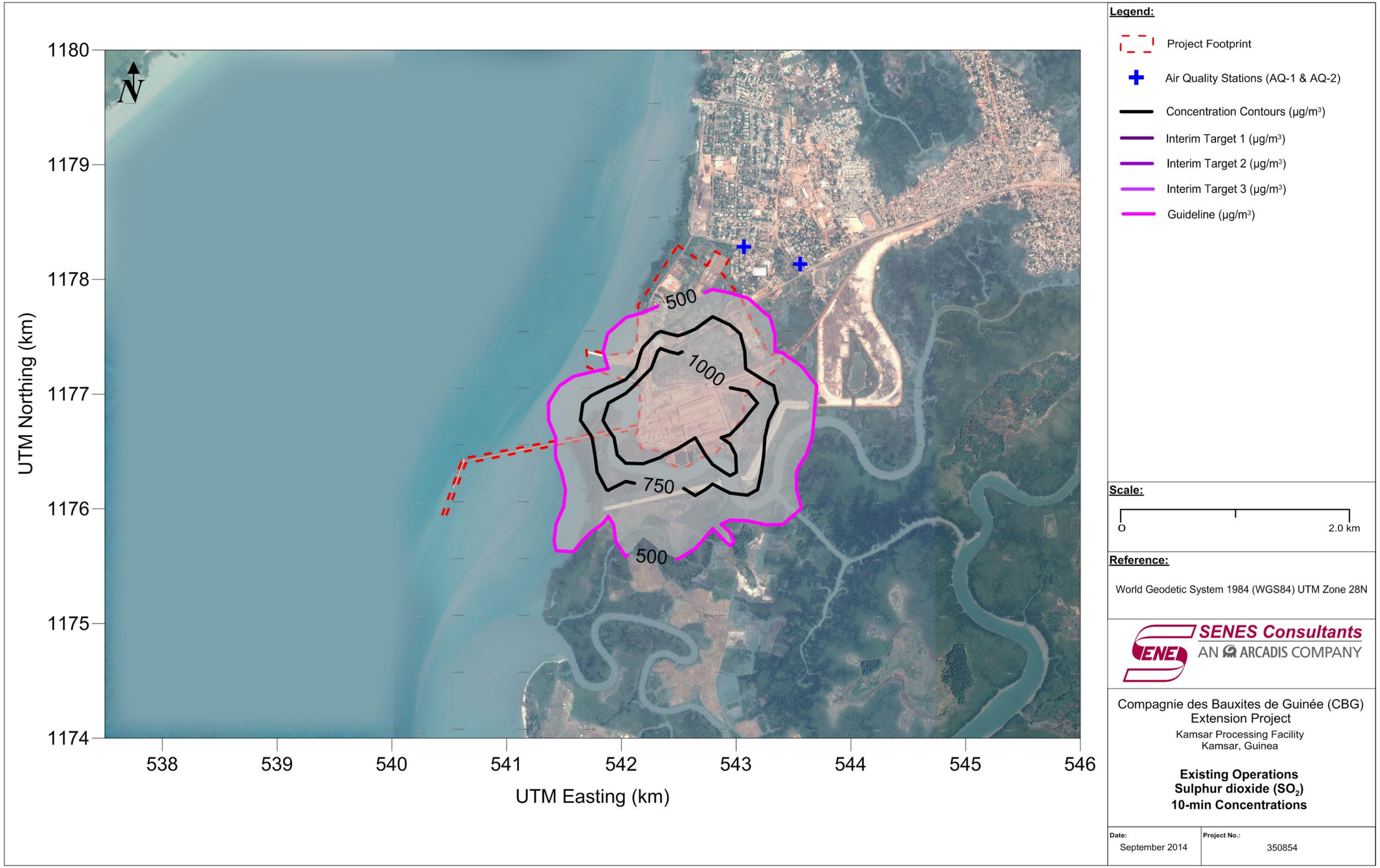
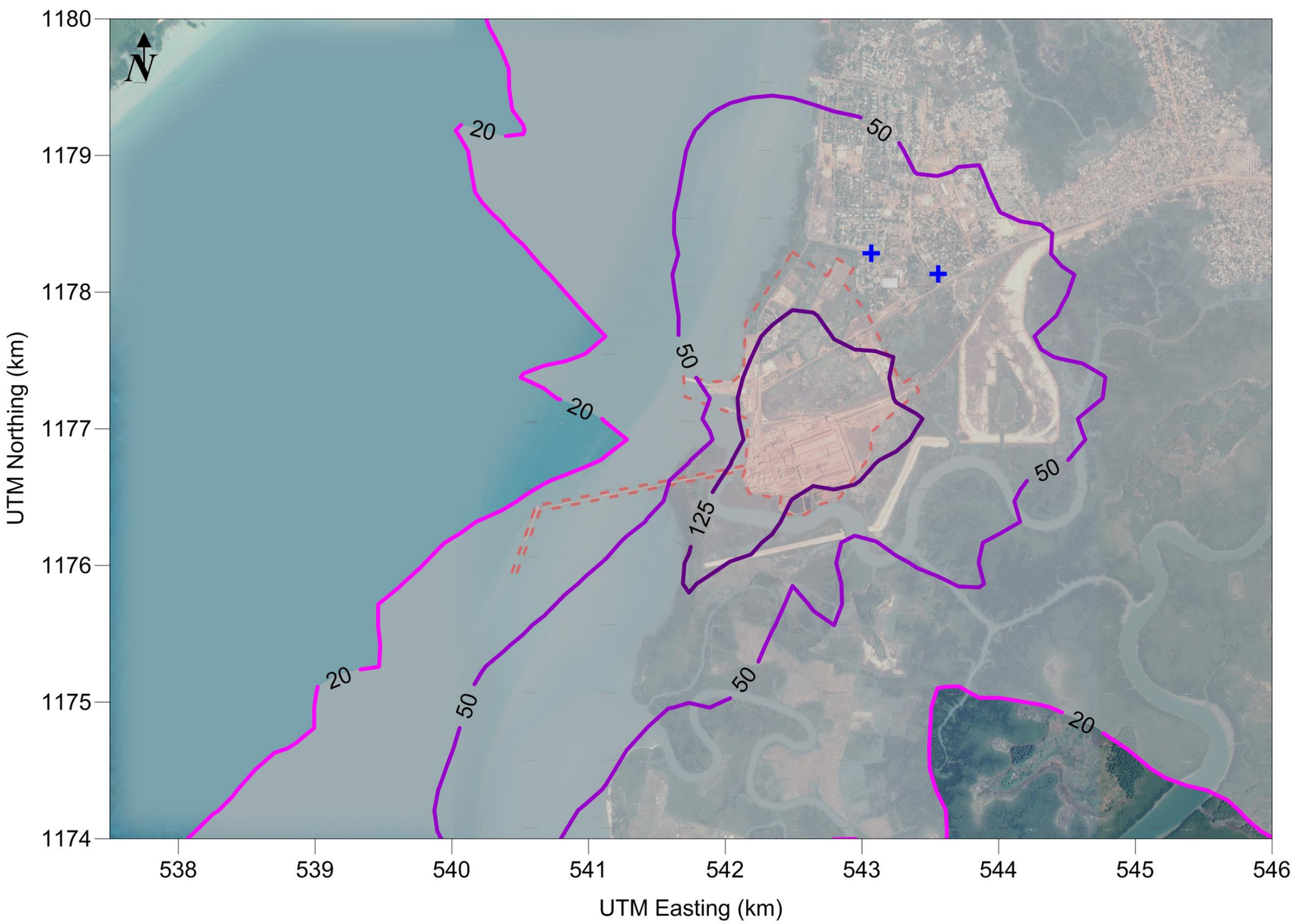
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Annual Concentrations

Date:	Project No.:
September 2014	350854


1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
N
500
1000
750
500
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
Existing Operations
Sulphur dioxide (SO2)
10-min Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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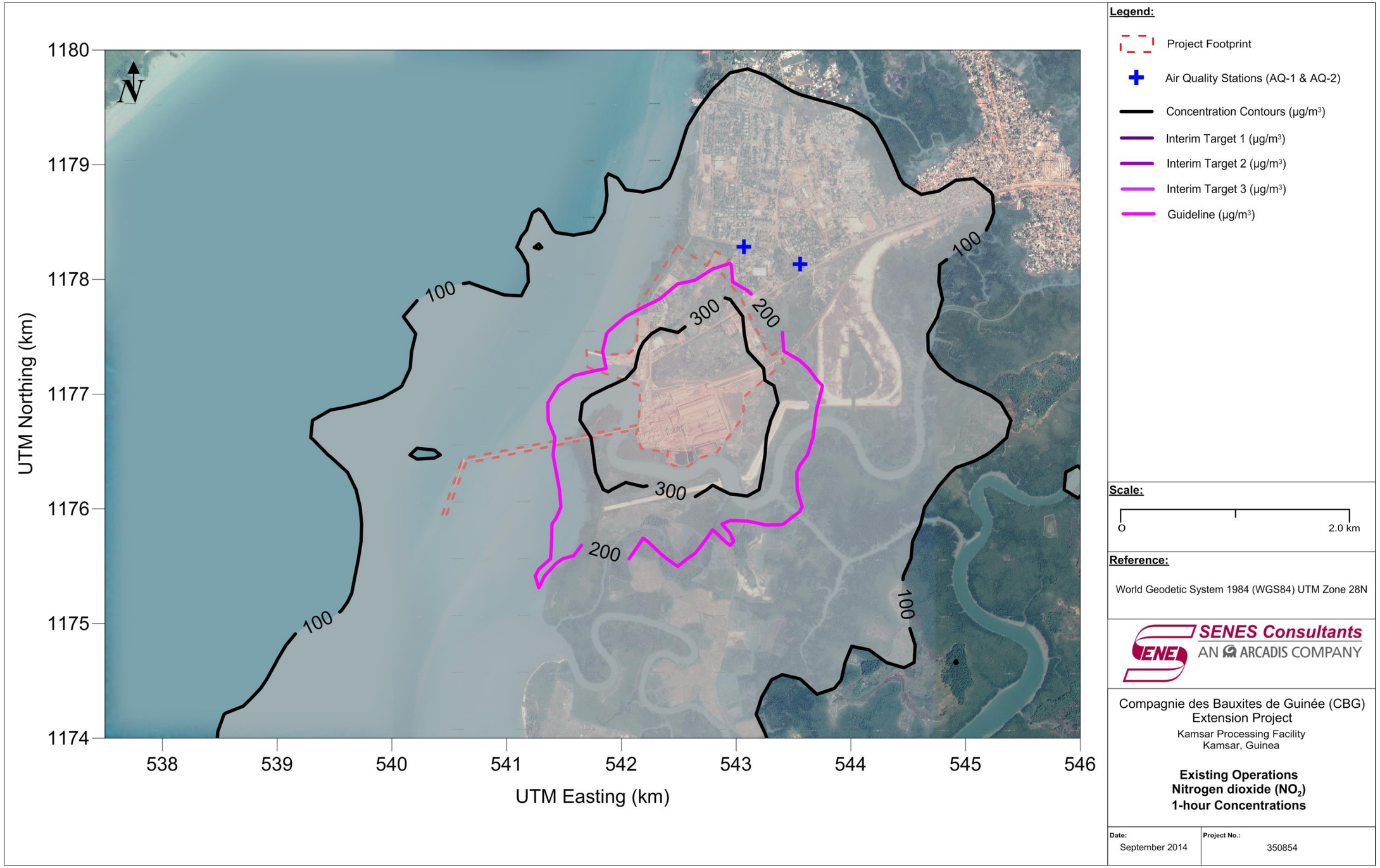
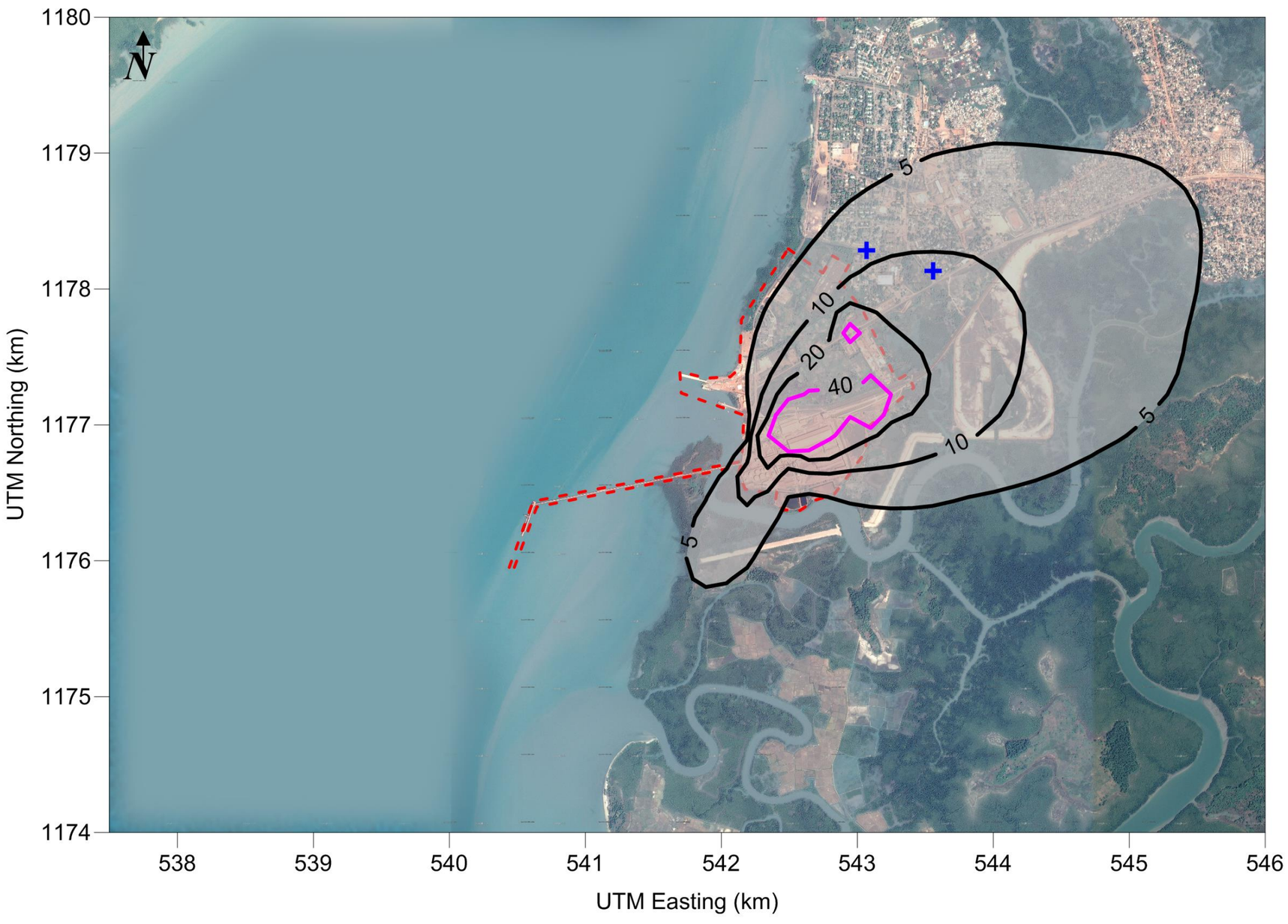
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Sulphur dioxide (SO_2)
24-hour Concentrations

Date:	Project No.:
September 2014	350854


1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
N
100
300
200
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
Existing Operations
Nitrogen dioxide (NO2)
1-hour Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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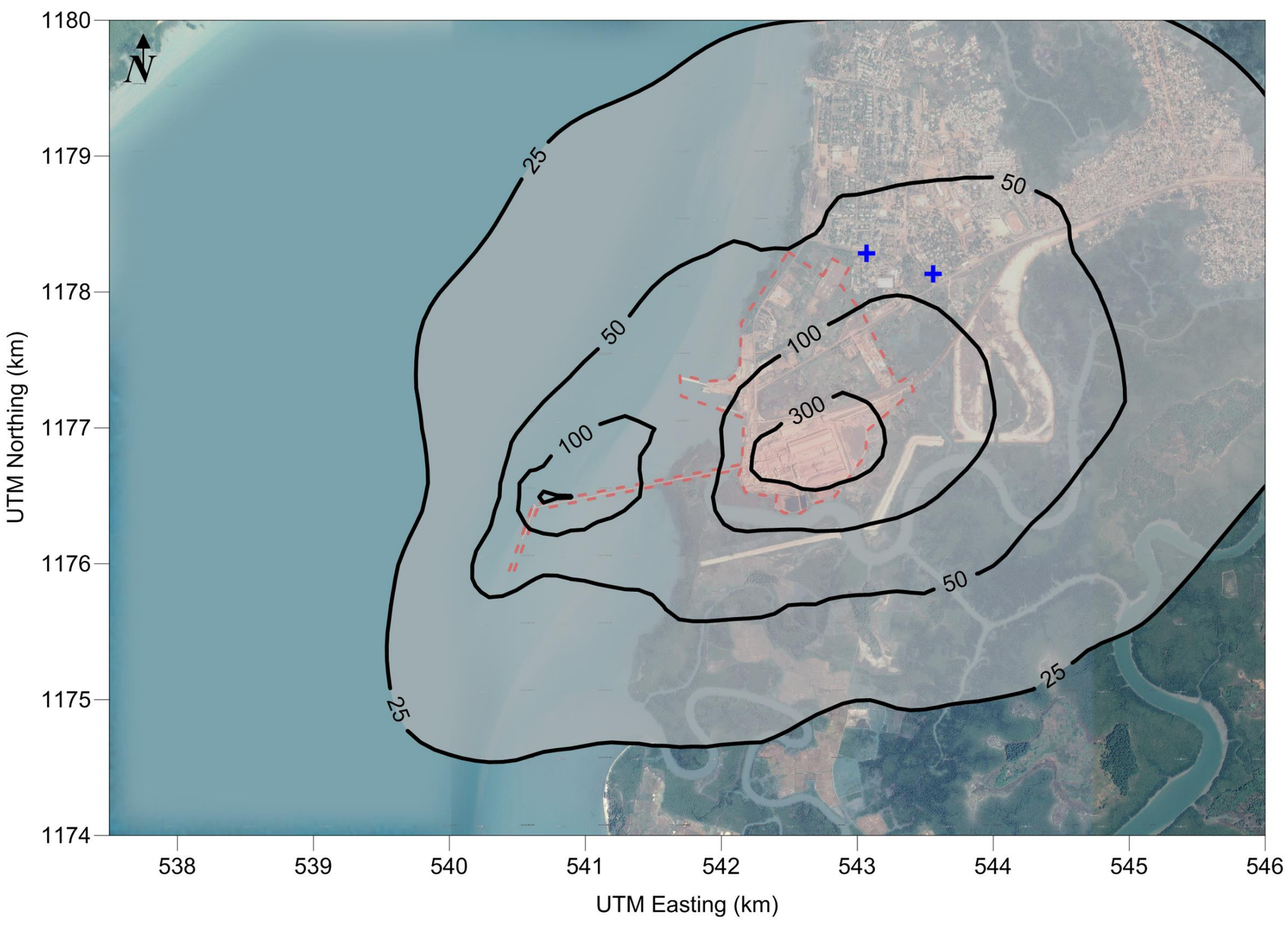
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Nitrogen dioxide (NO_2)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Concentration Contours (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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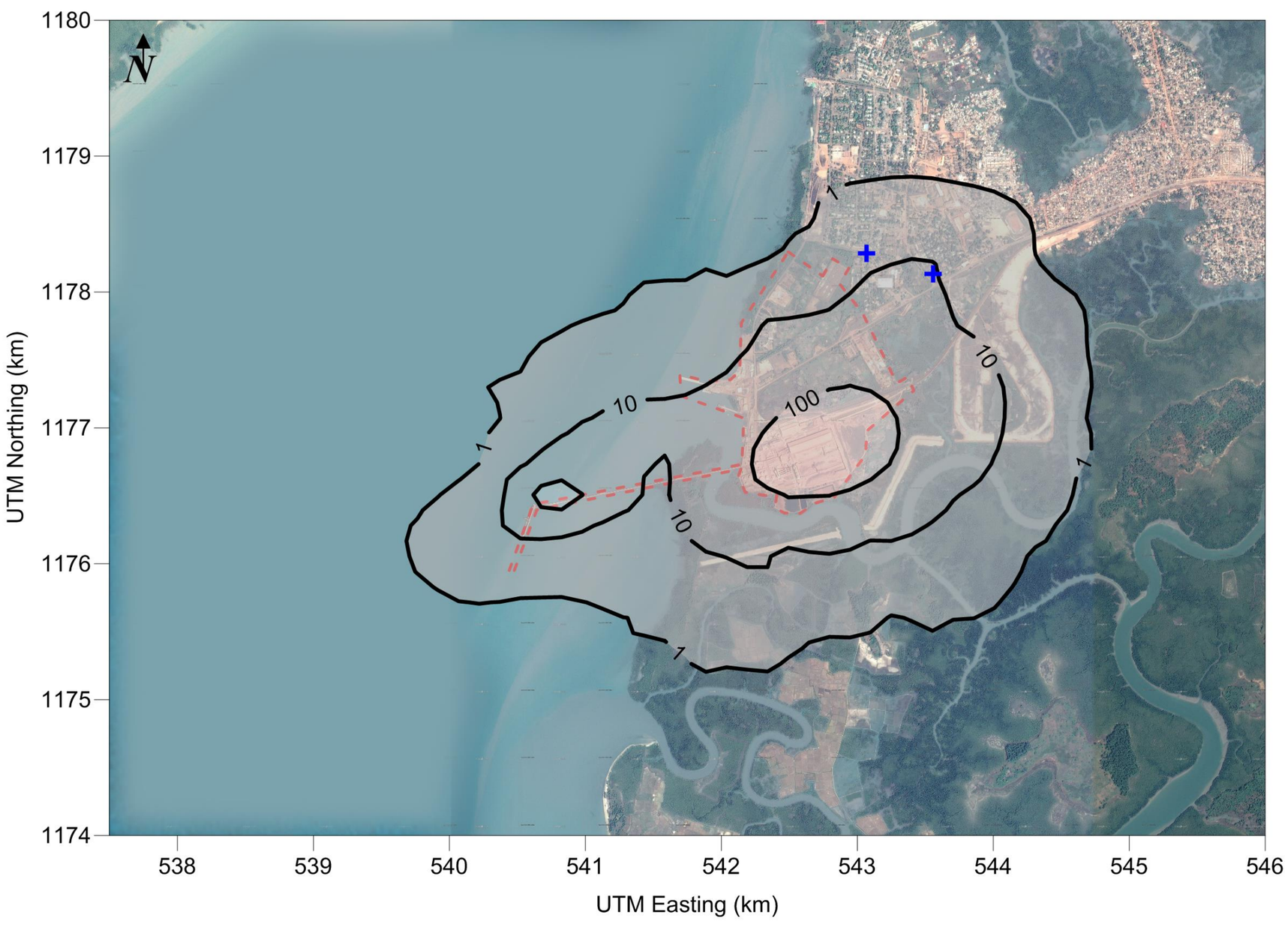
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Total Suspended Particulate (TSP)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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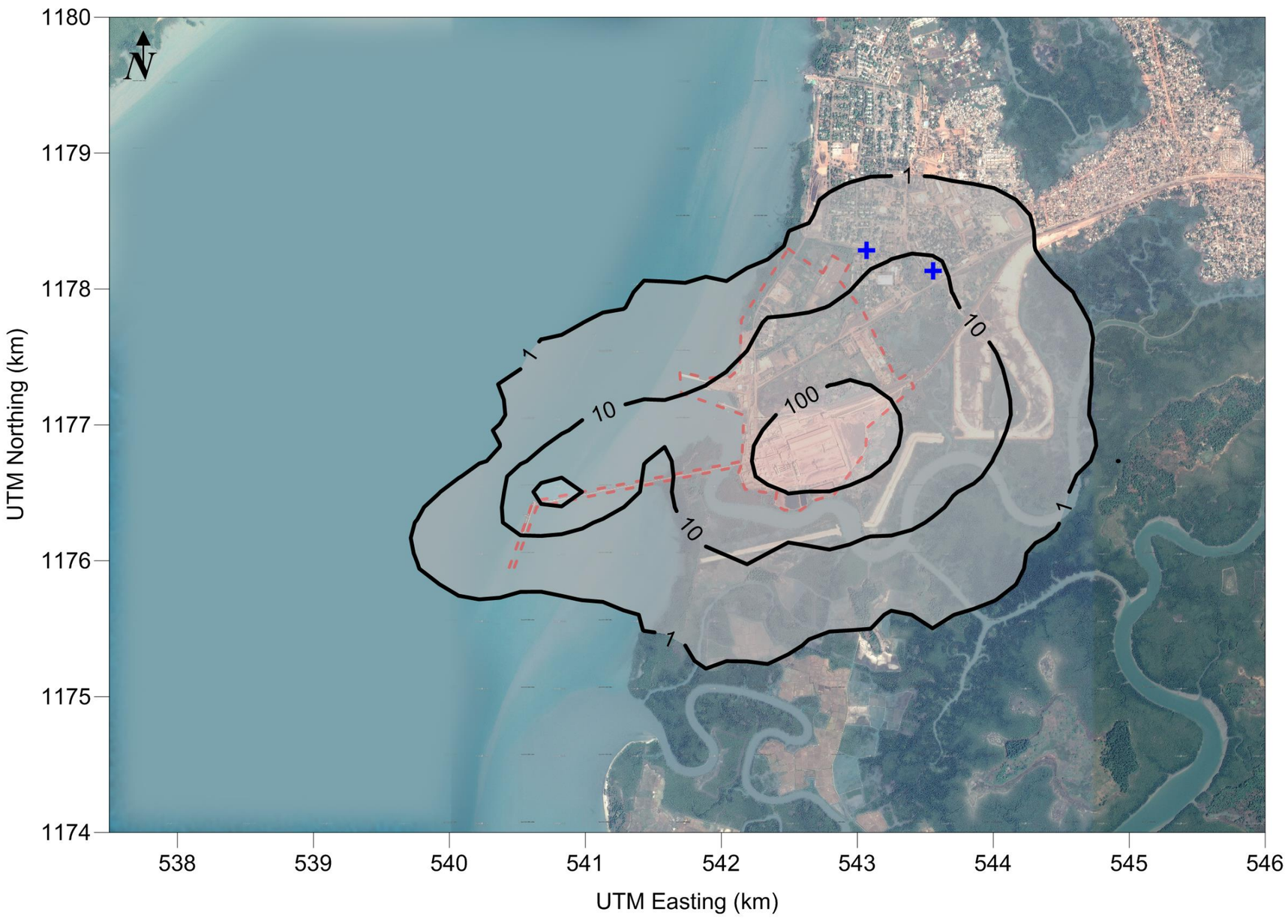
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 10 µm (PM_{10})

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

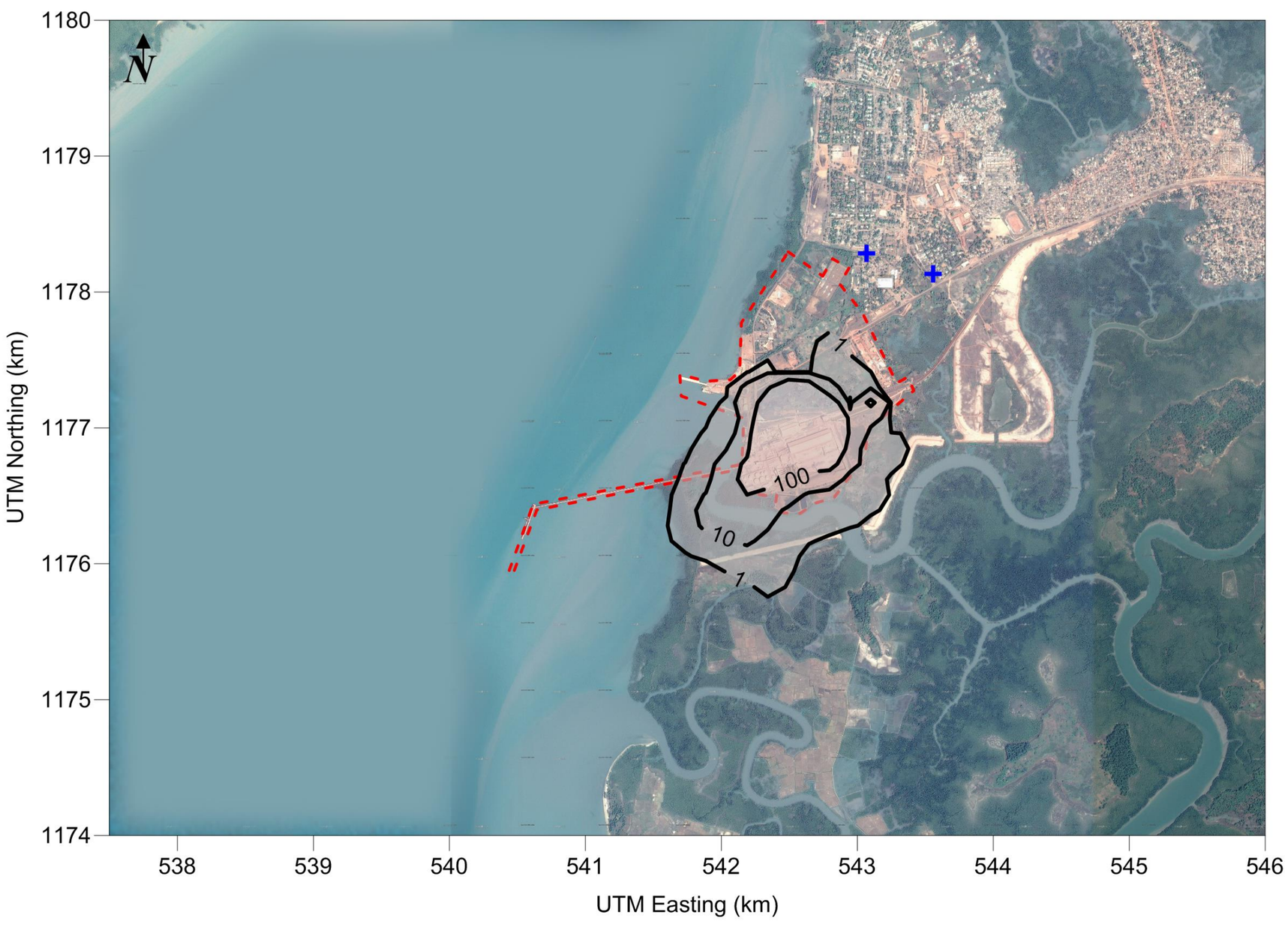
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Frequency of Exceedances (days per year)
of WHO 24-hour Interim Target-1 for
Particulate Matter less than 2.5 µm ($PM_{2.5}$)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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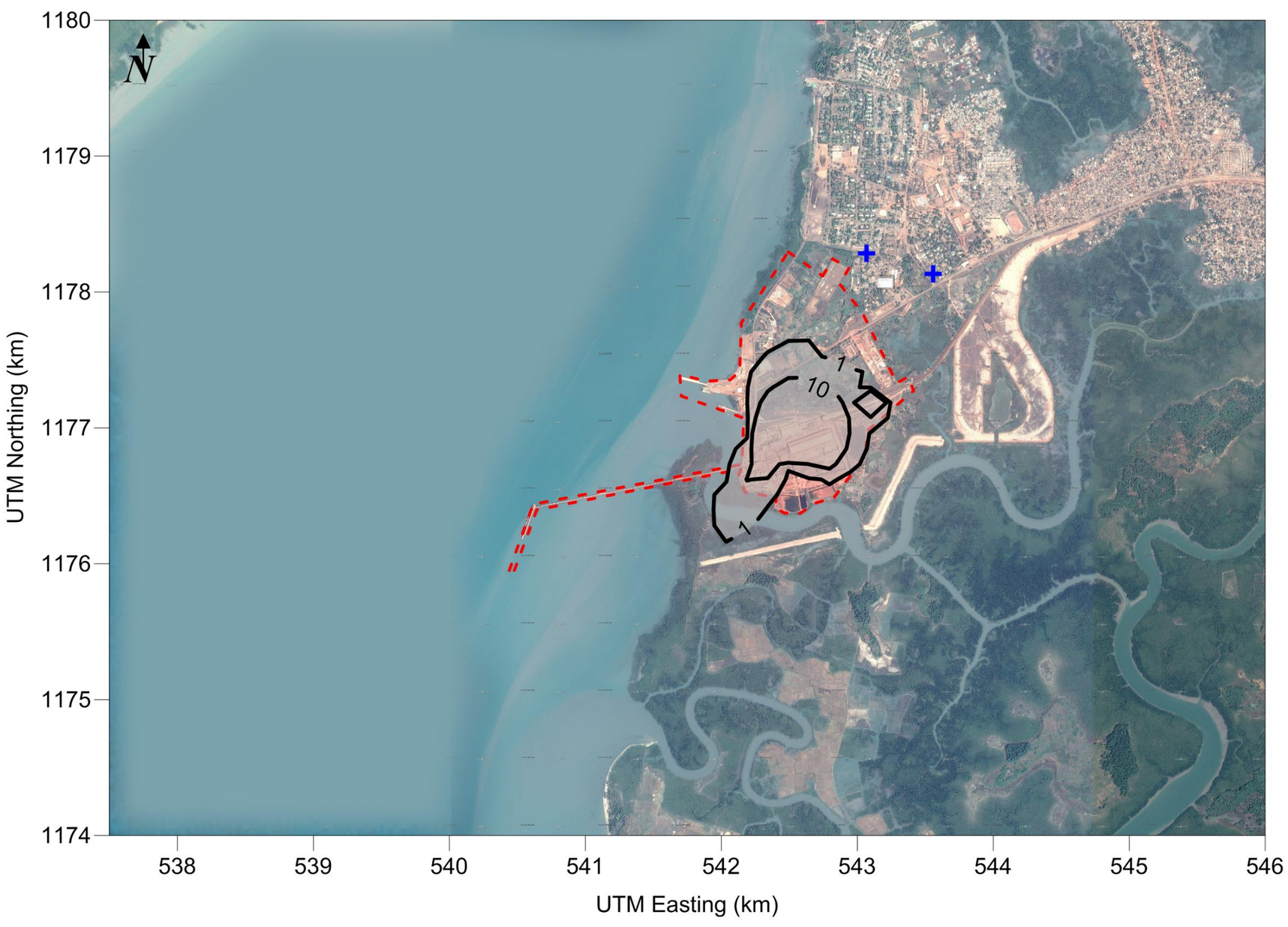
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Frequency of Exceedances (hours per year) of WHO 10-minute Guideline for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

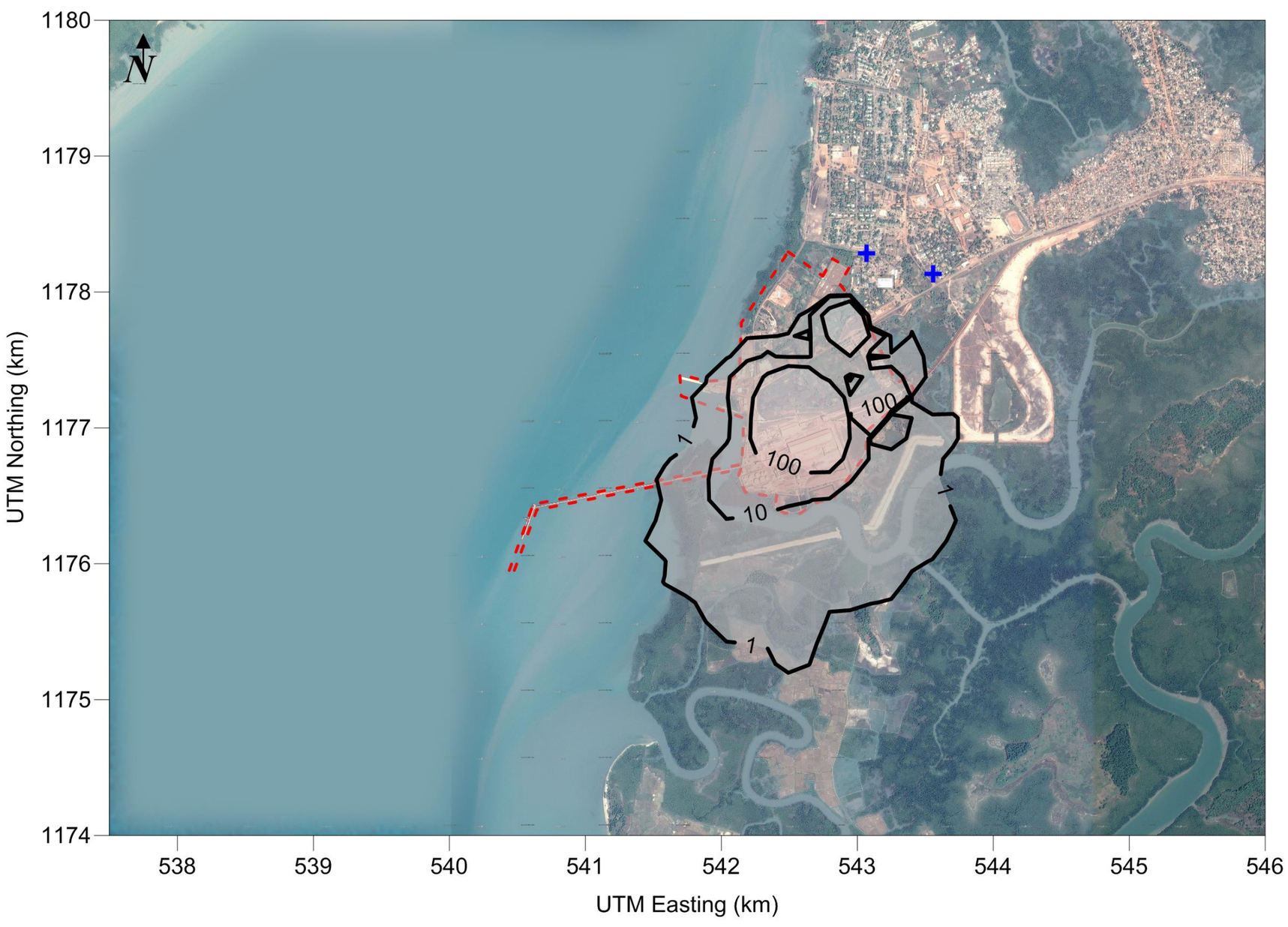
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

Existing Operations
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

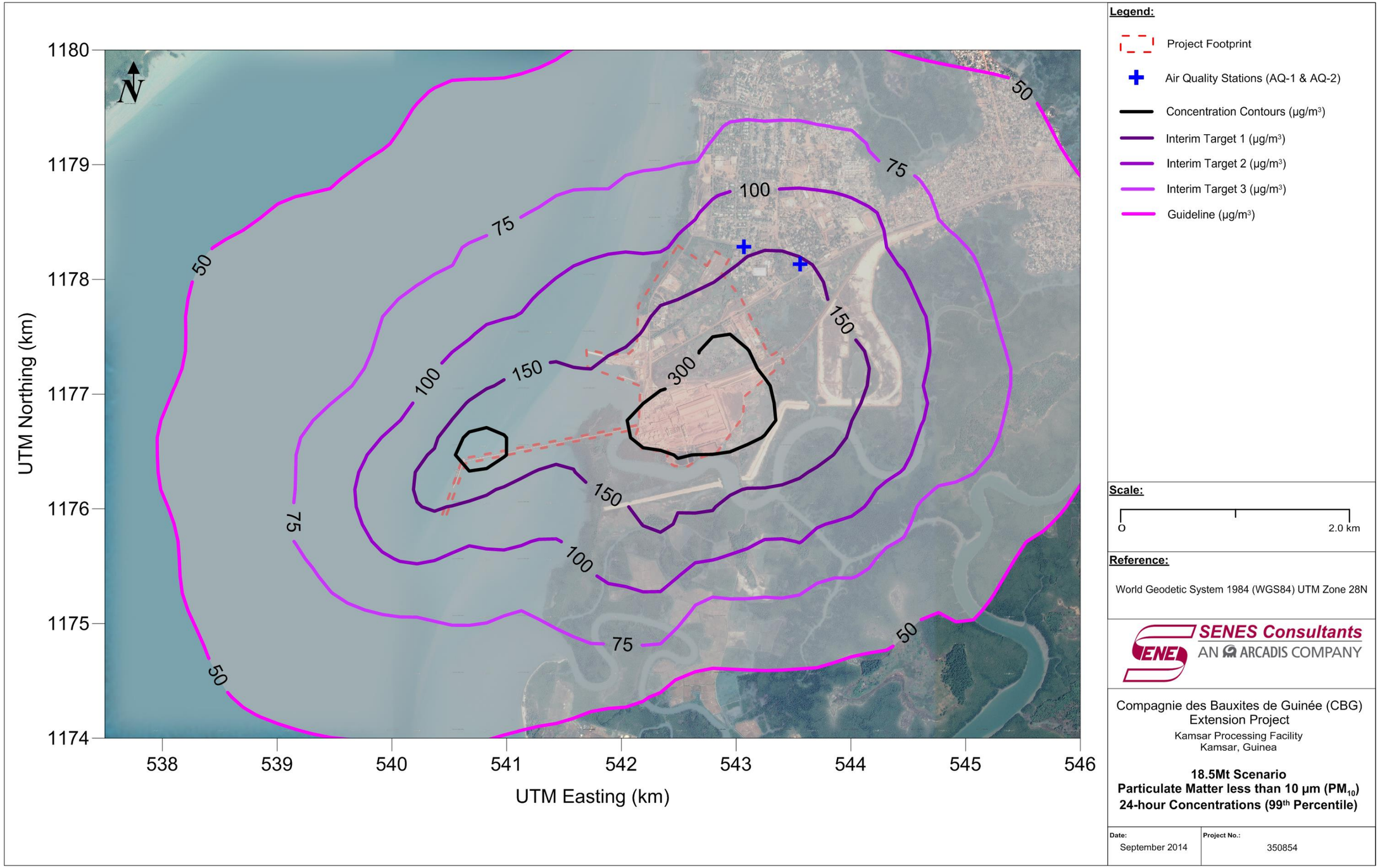
Kamsar Processing Facility
Kamsar, Guinea

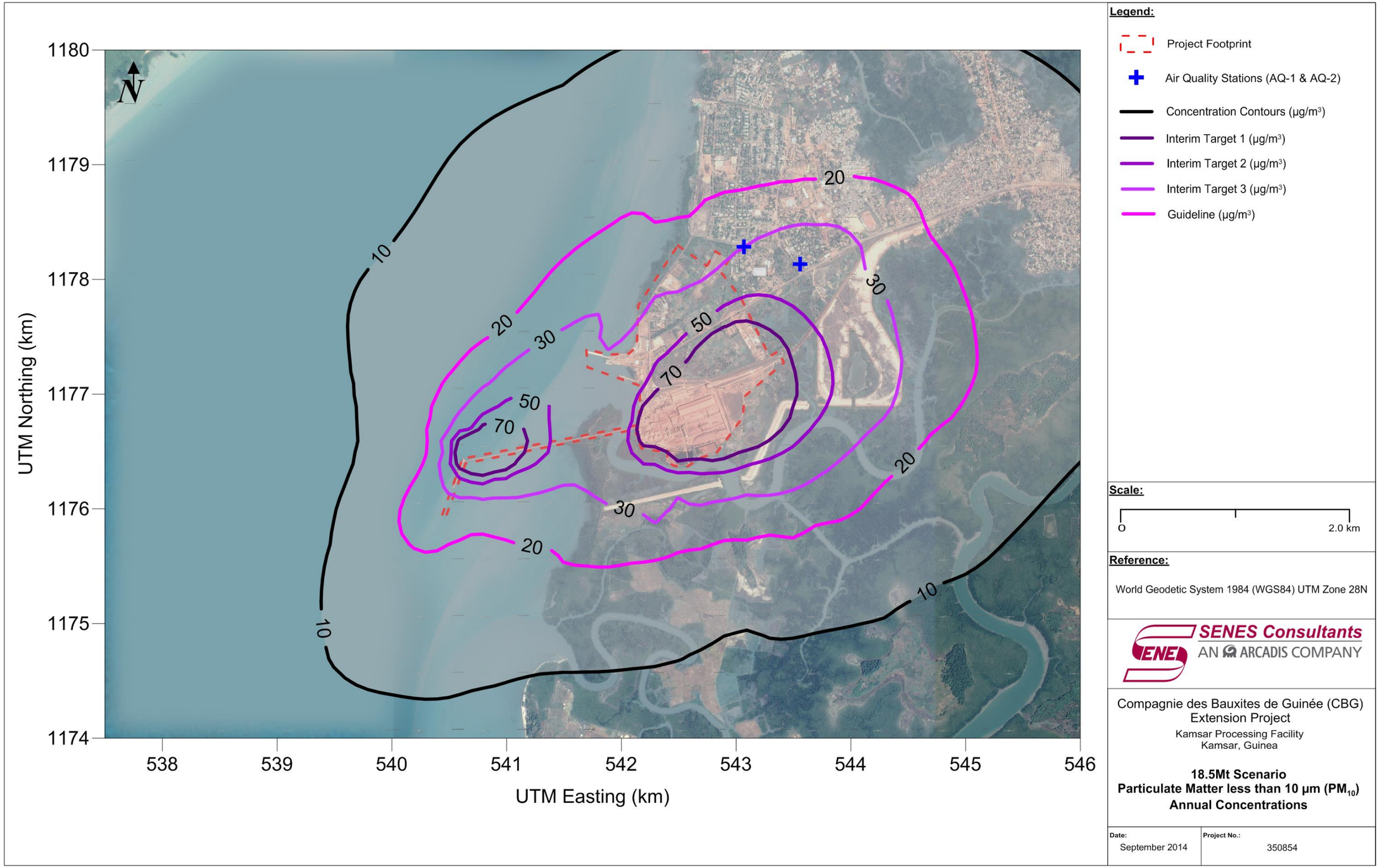
18.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 1-hour Guideline for Nitrogen Dioxide (NO_2)

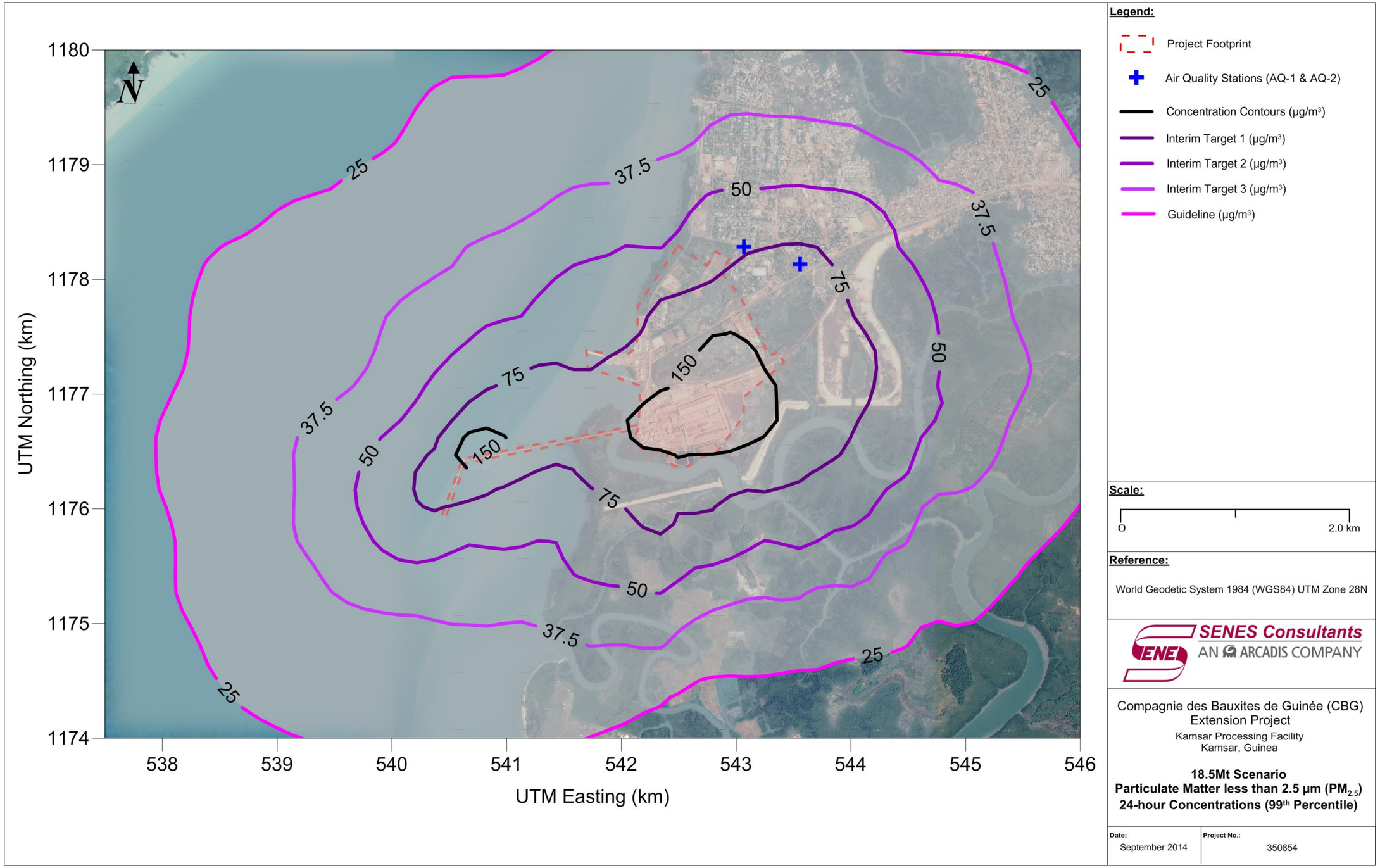
Date:	Project No.:
September 2014	350854

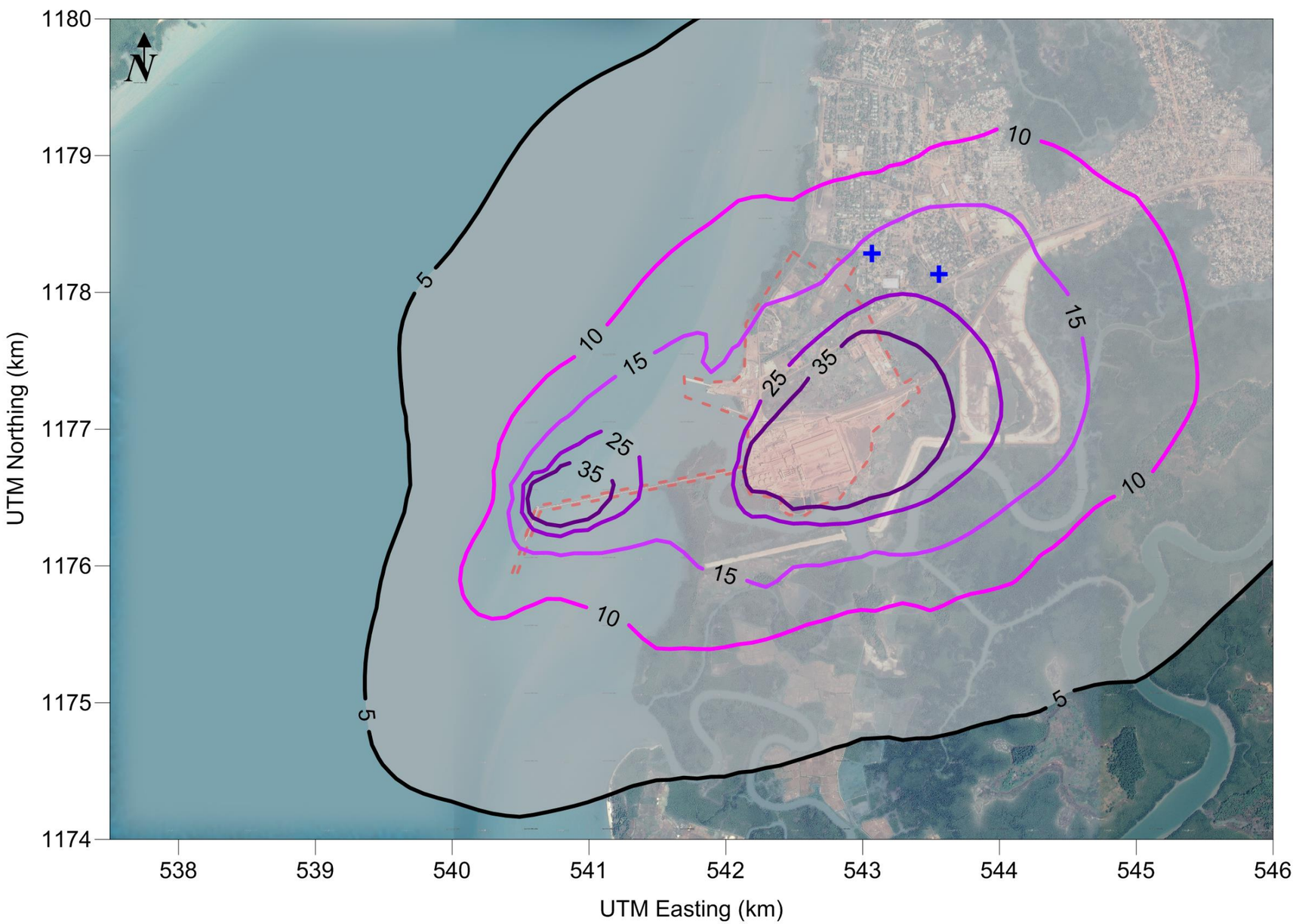
Kamsar

18.5 MTPY


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
50
75
100
150
300
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Particulate Matter less than 10 µm (PM10)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
10
20
30
50
70
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Particulate Matter less than 10 µm (PM10)
Annual Concentrations
Date:
September 2014
Project No.:
350854


N
UTM Northing (km)
1180
1179
1178
1177
1176
1175
1174
UTM Easting (km)
538
539
540
541
542
543
544
545
546
25
37.5
50
75
150
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Particulate Matter less than 2.5 µm (PM2.5)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

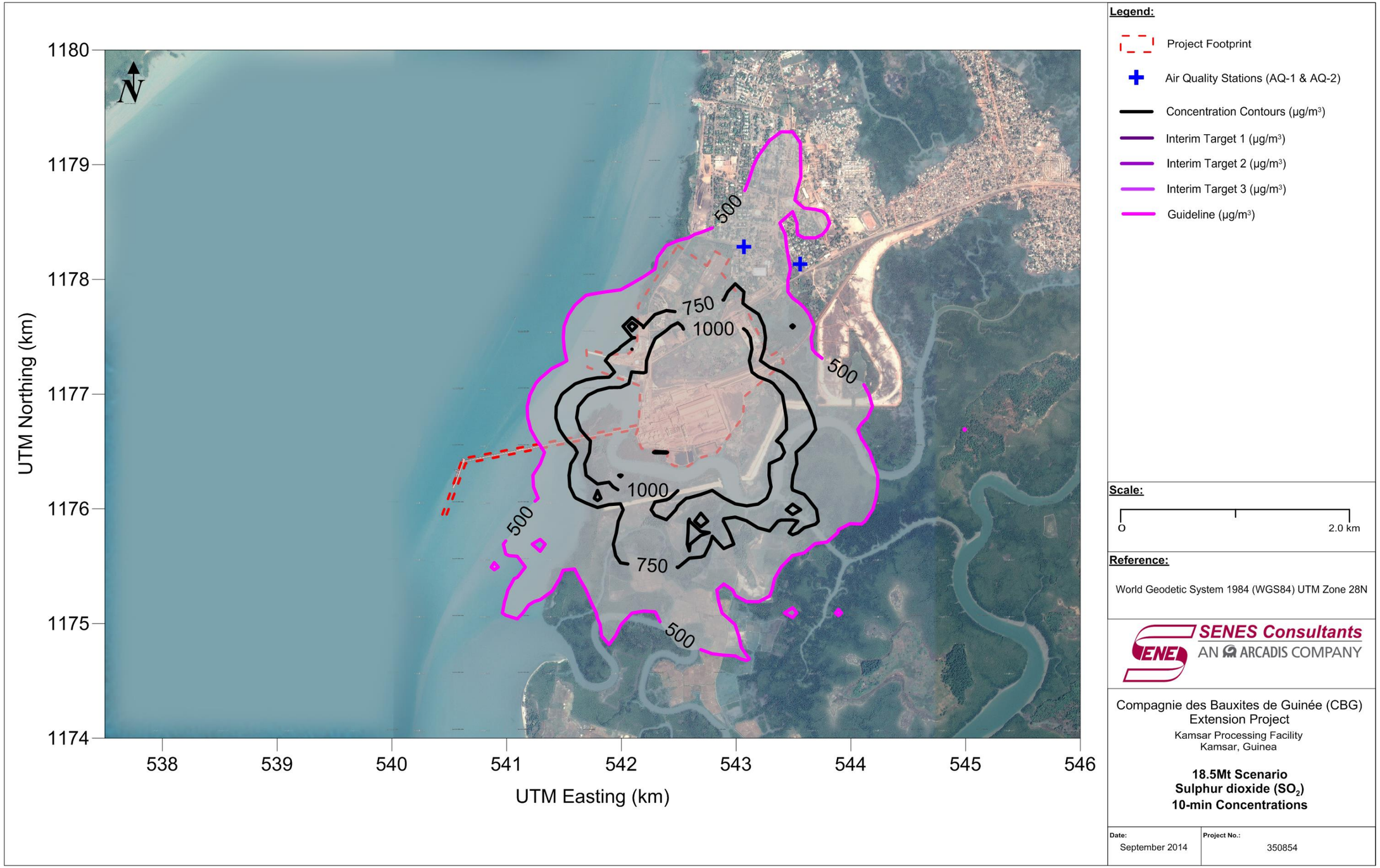
World Geodetic System 1984 (WGS84) UTM Zone 28N

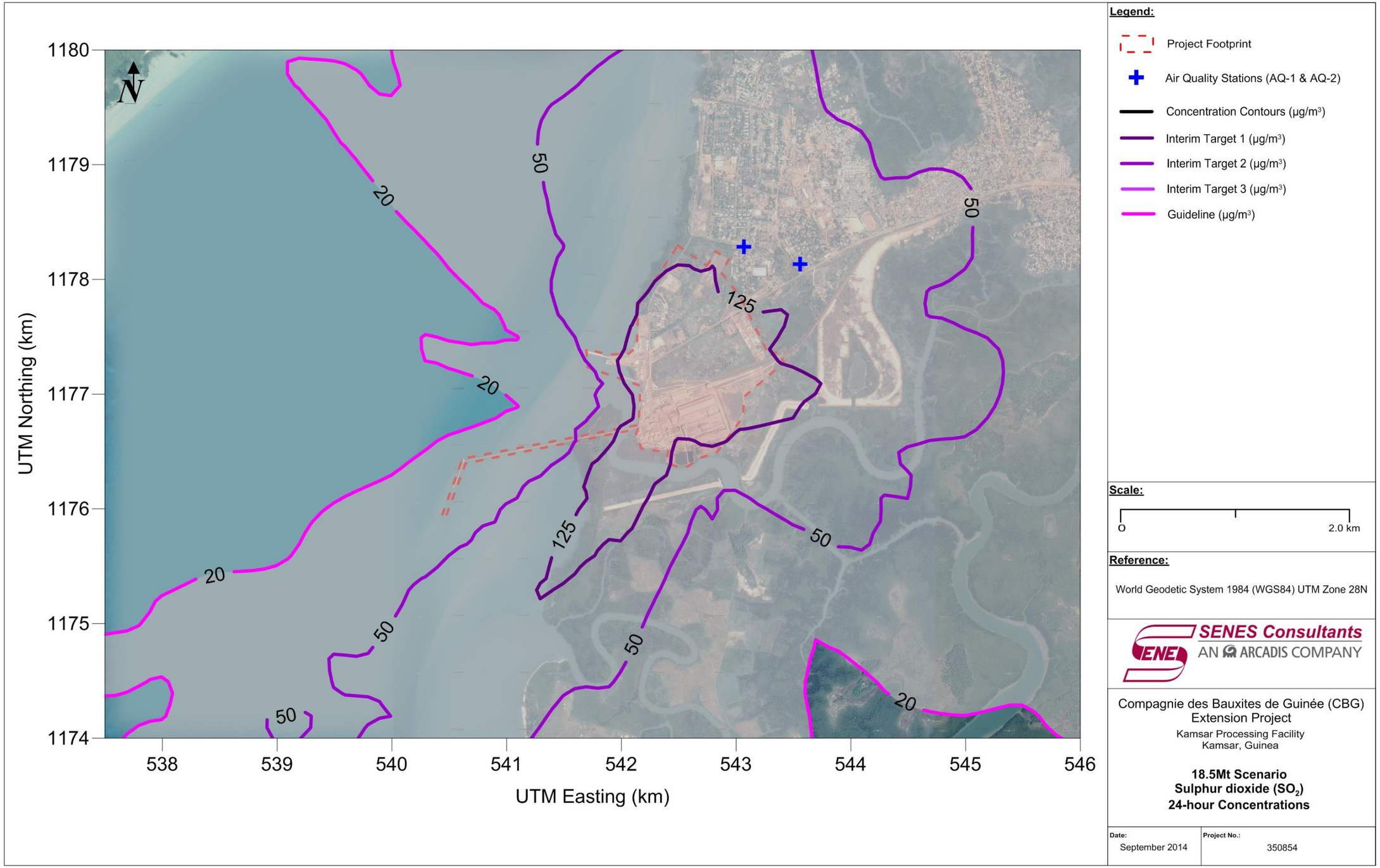
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

18.5Mt Scenario
Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Annual Concentrations

Date:	Project No.:
September 2014	350854


1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
N
500
750
1000
500
1000
500
750
500
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Sulphur dioxide (SO_2)
10-min Concentrations
Date:
September 2014
Project No.:
350854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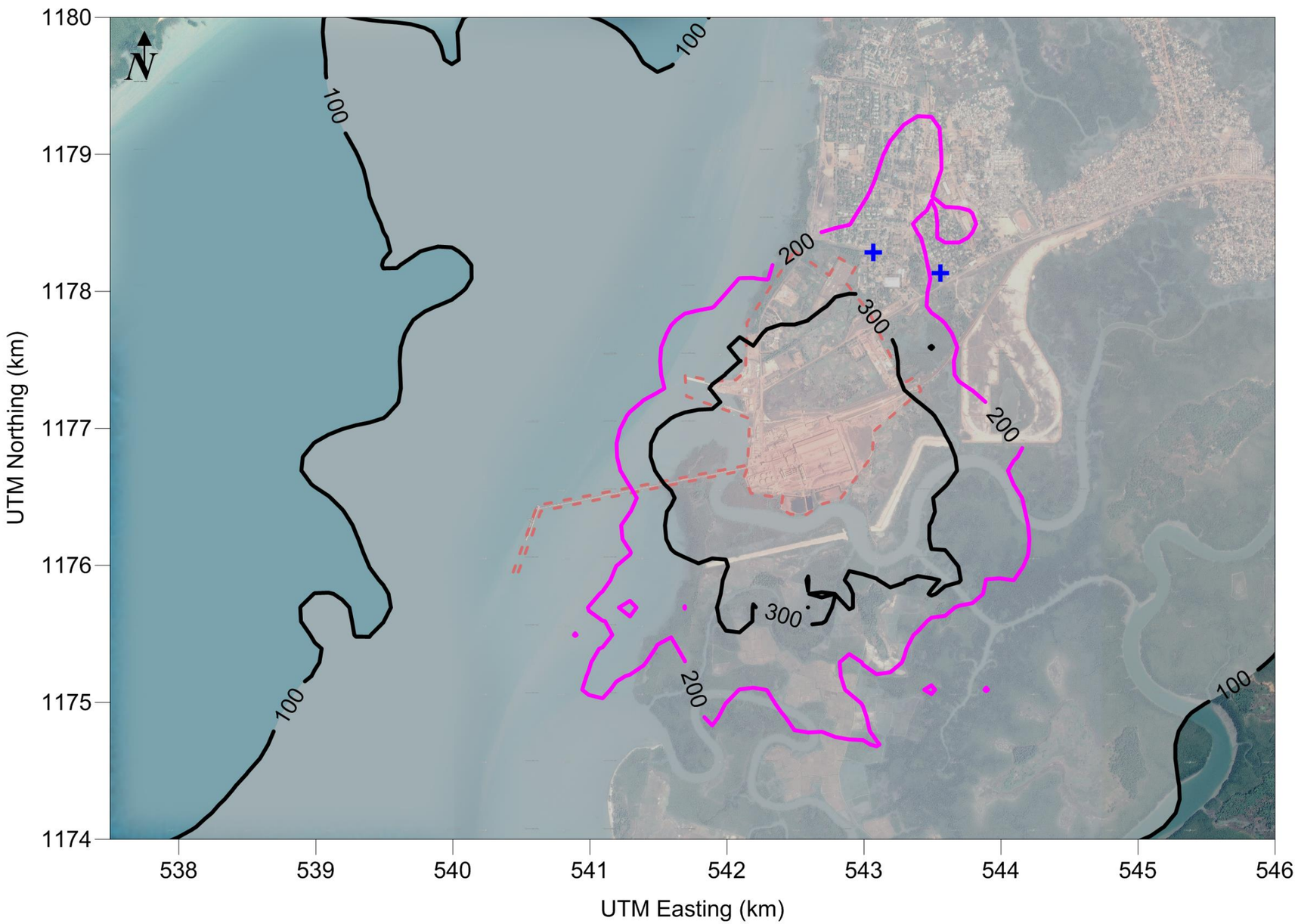
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
N
20
50
125
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Sulphur dioxide (SO_2)
24-hour Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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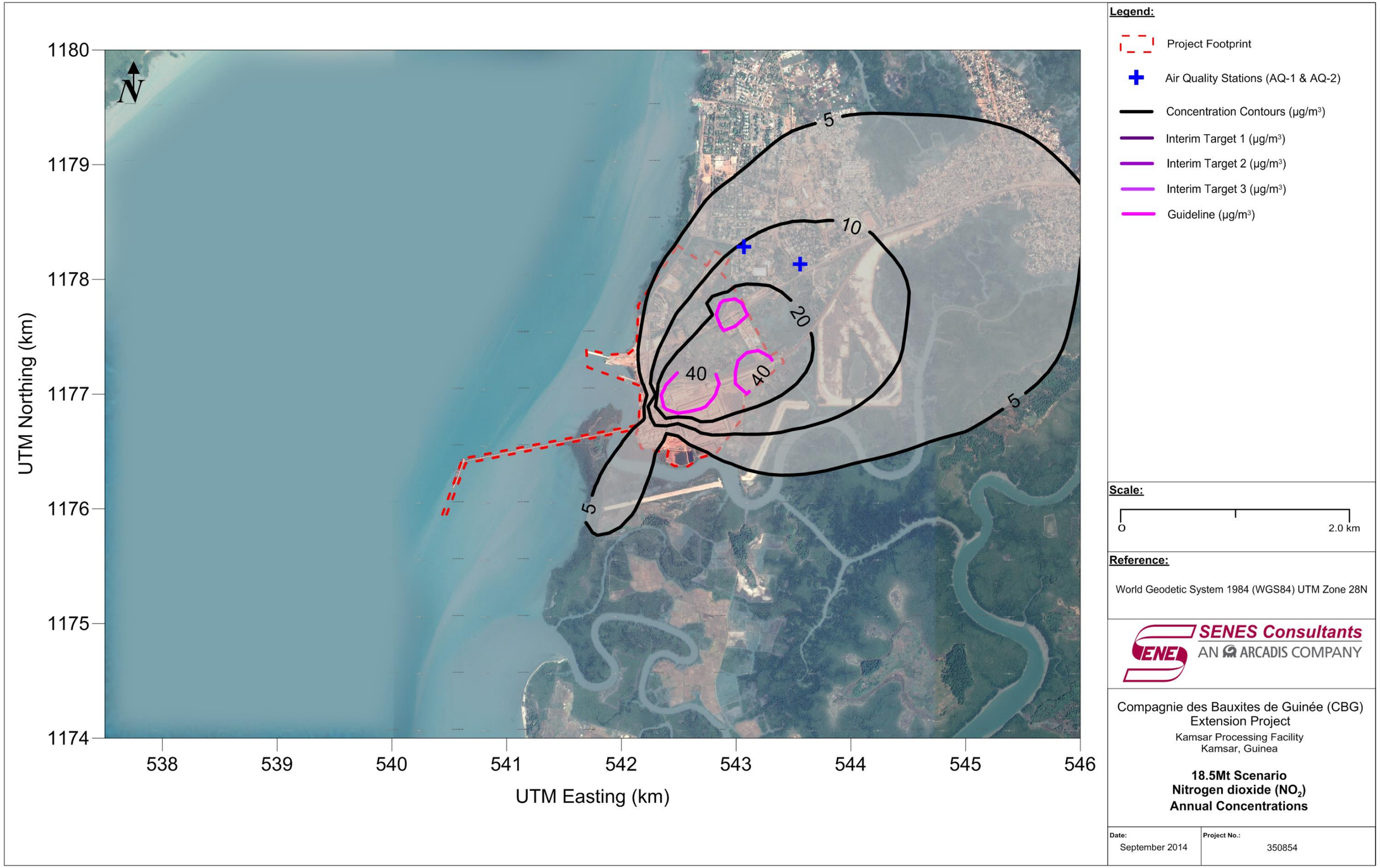
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

18.5Mt Scenario
Nitrogen dioxide (NO_2)
1-hour Concentrations

Date:	Project No.:
September 2014	350854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1174
UTM Northing (km)
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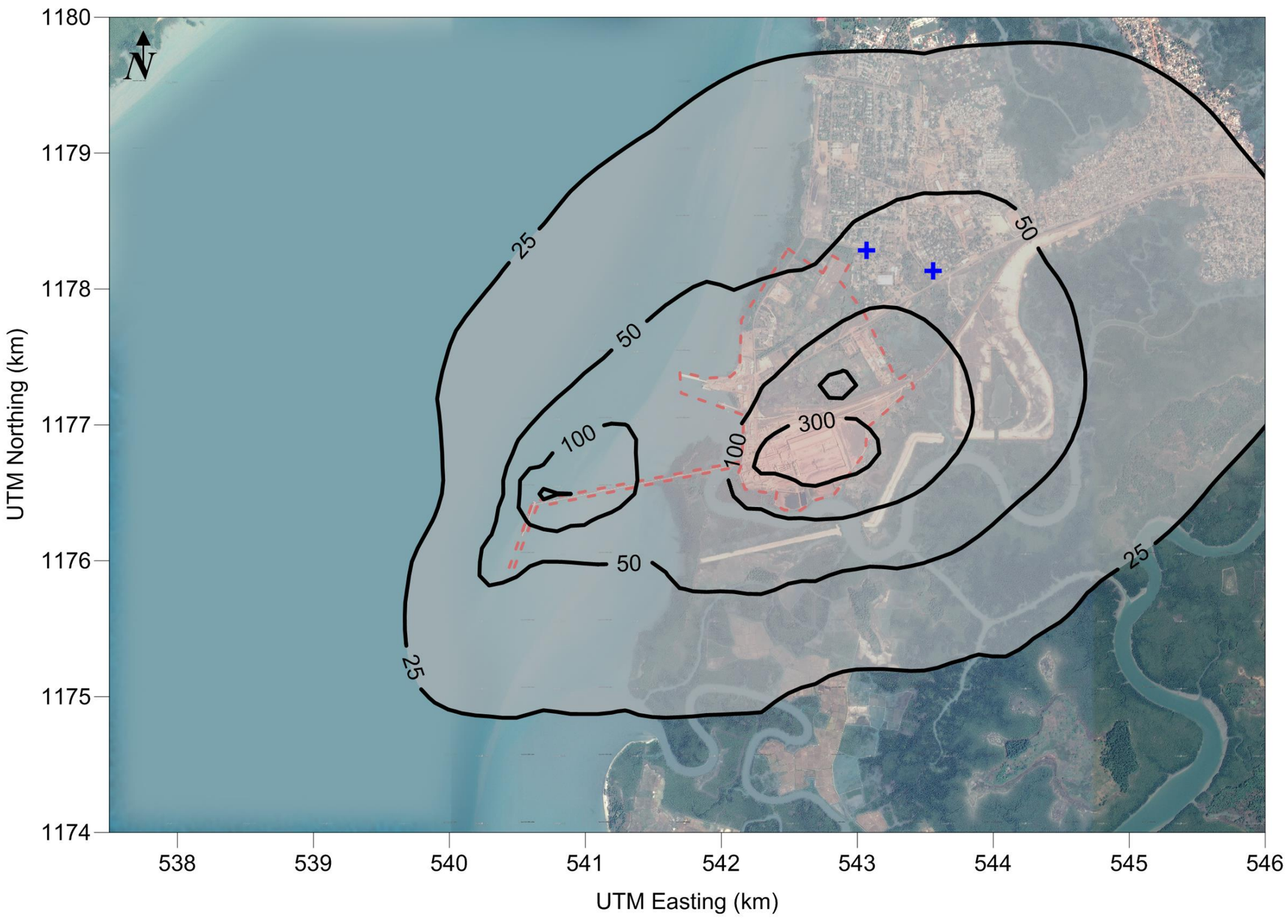
540
541
542
543
544
545
546
UTM Easting (km)
N
5
10
20
40
40
5
5
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
18.5Mt Scenario
Nitrogen dioxide (NO2)
Annual Concentrations
Date:
September 2014
Project No.:
350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Concentration Contours (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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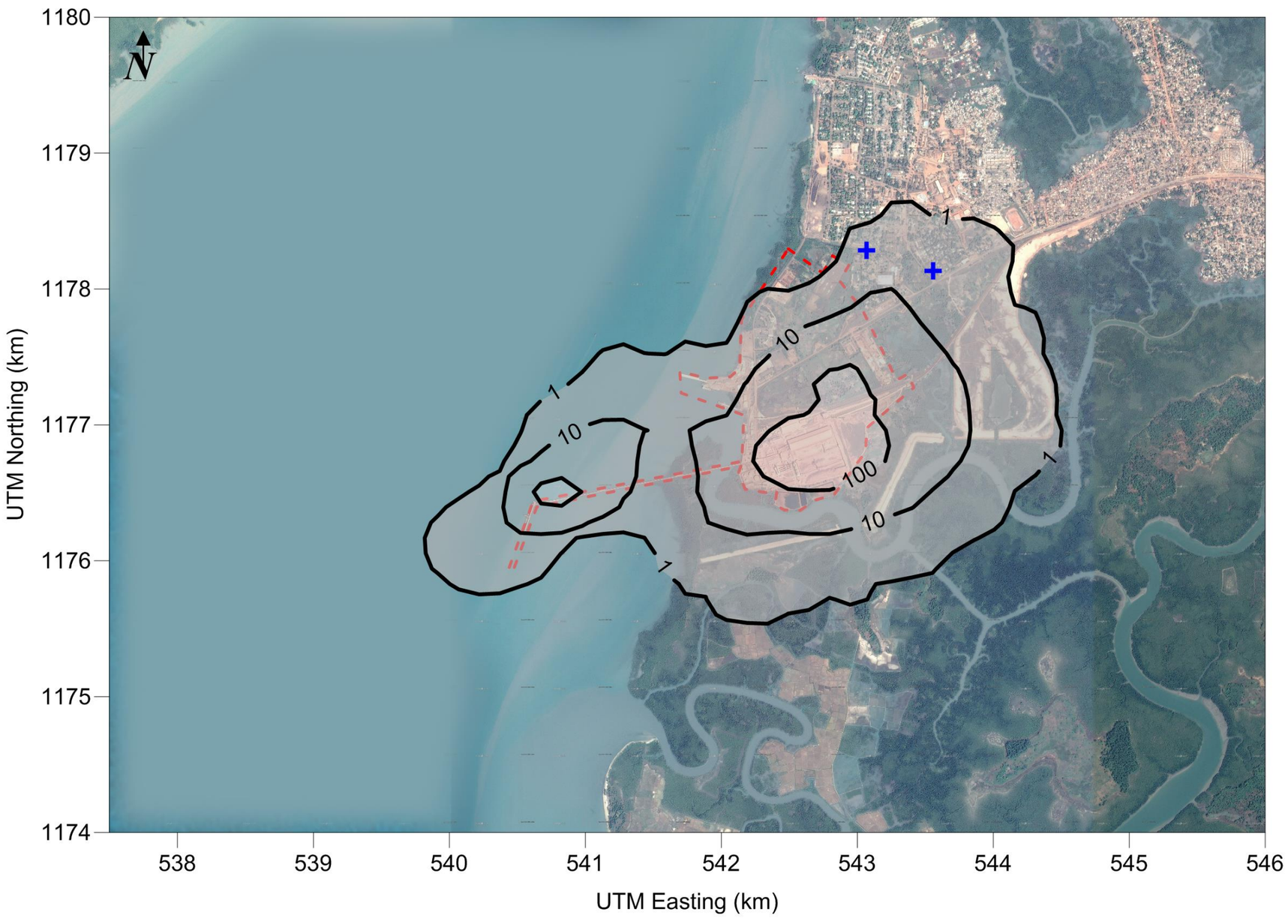
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

18.5Mt Scenario
Total Suspended Particulate (TSP)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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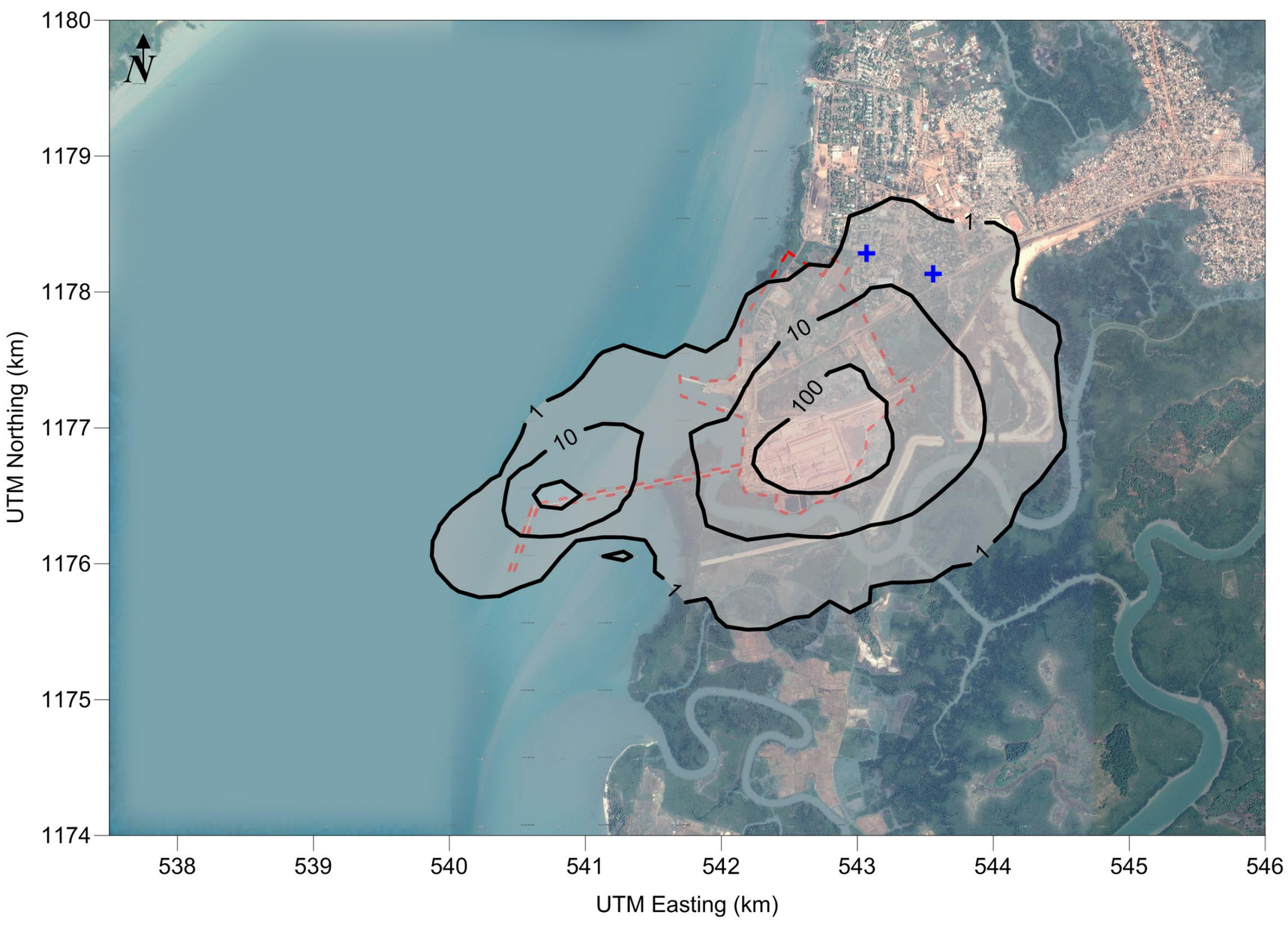
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

18.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 10 µm (PM_{10})

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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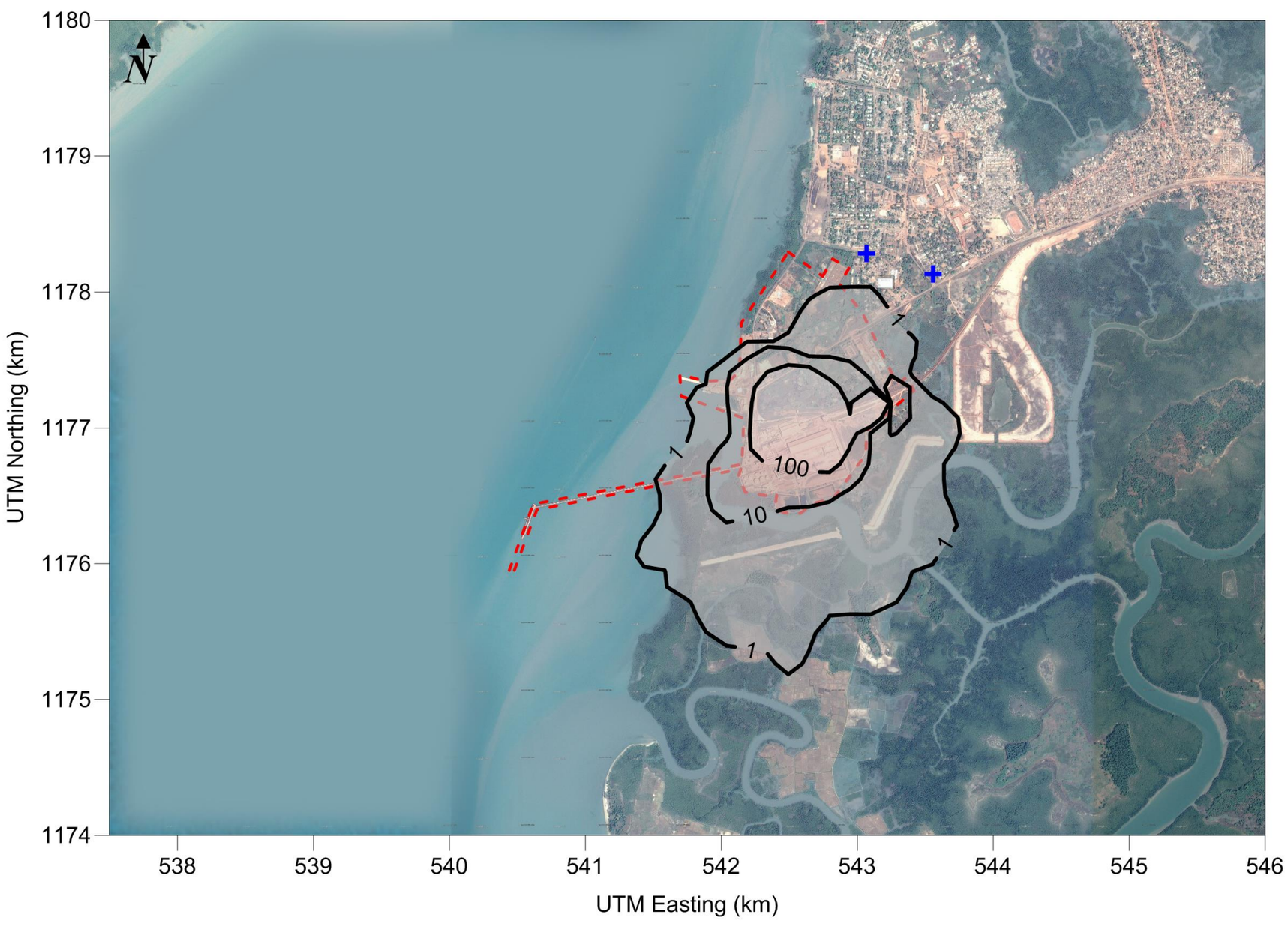
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

18.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 2.5 µm ($PM_{2.5}$)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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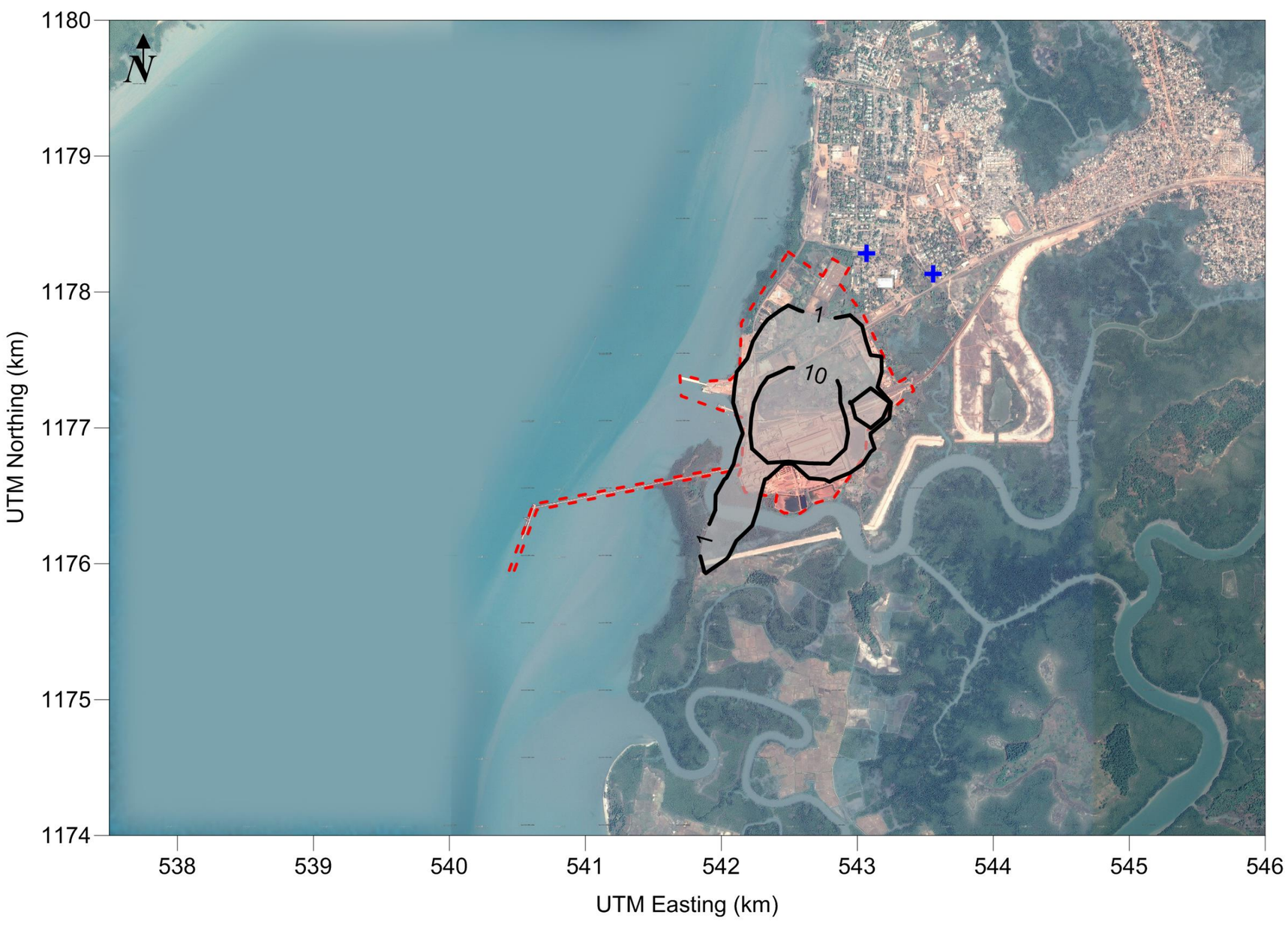
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

18.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 10-minute Guideline for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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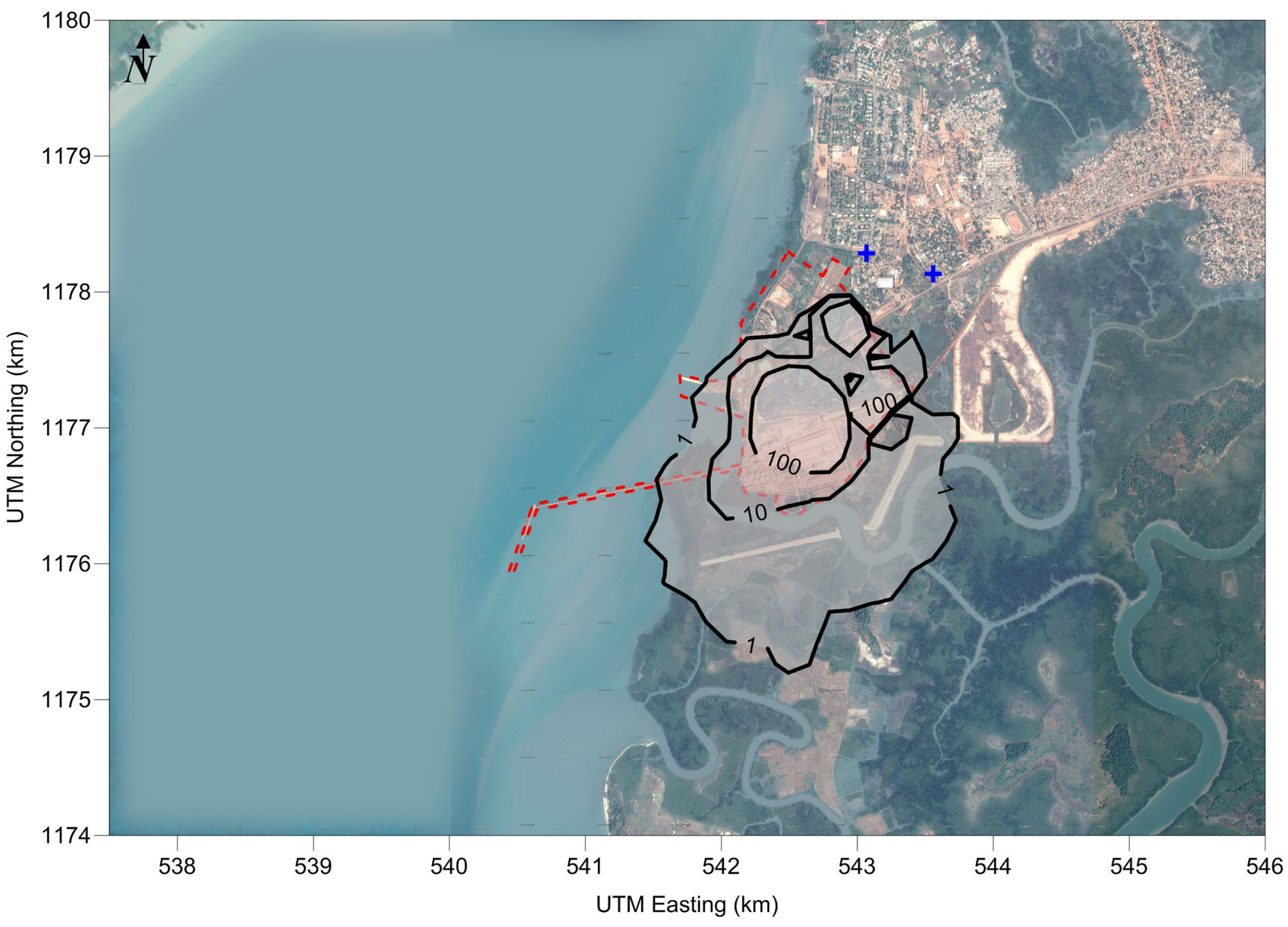
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

18.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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Compagnie des Bauxites de Guinée (CBG)
Extension Project

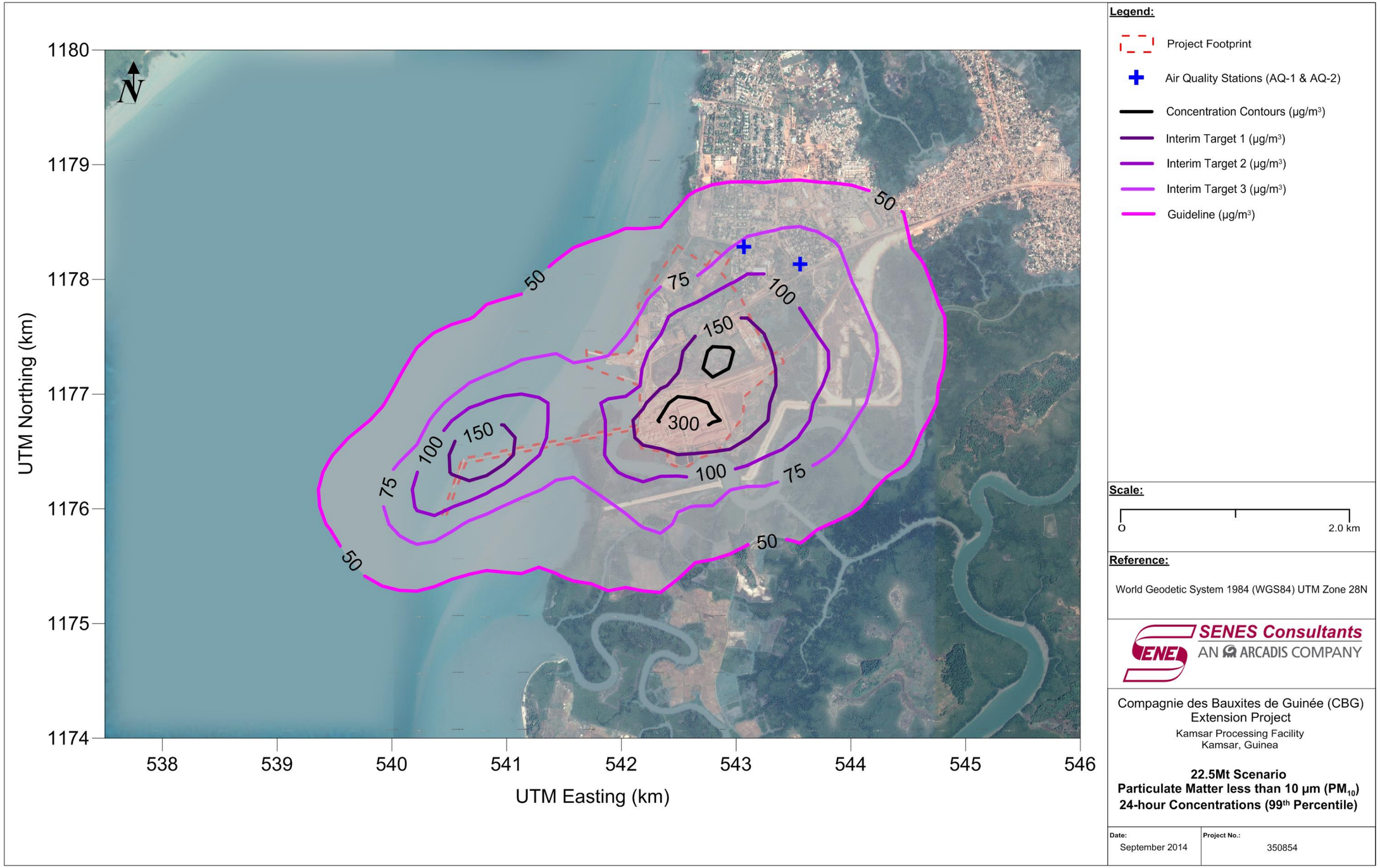
Kamsar Processing Facility
Kamsar, Guinea

18.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 1-hour Guideline for Nitrogen Dioxide (NO_2)

Date:	Project No.:
September 2014	350854

Kamsar

22.5 MTPY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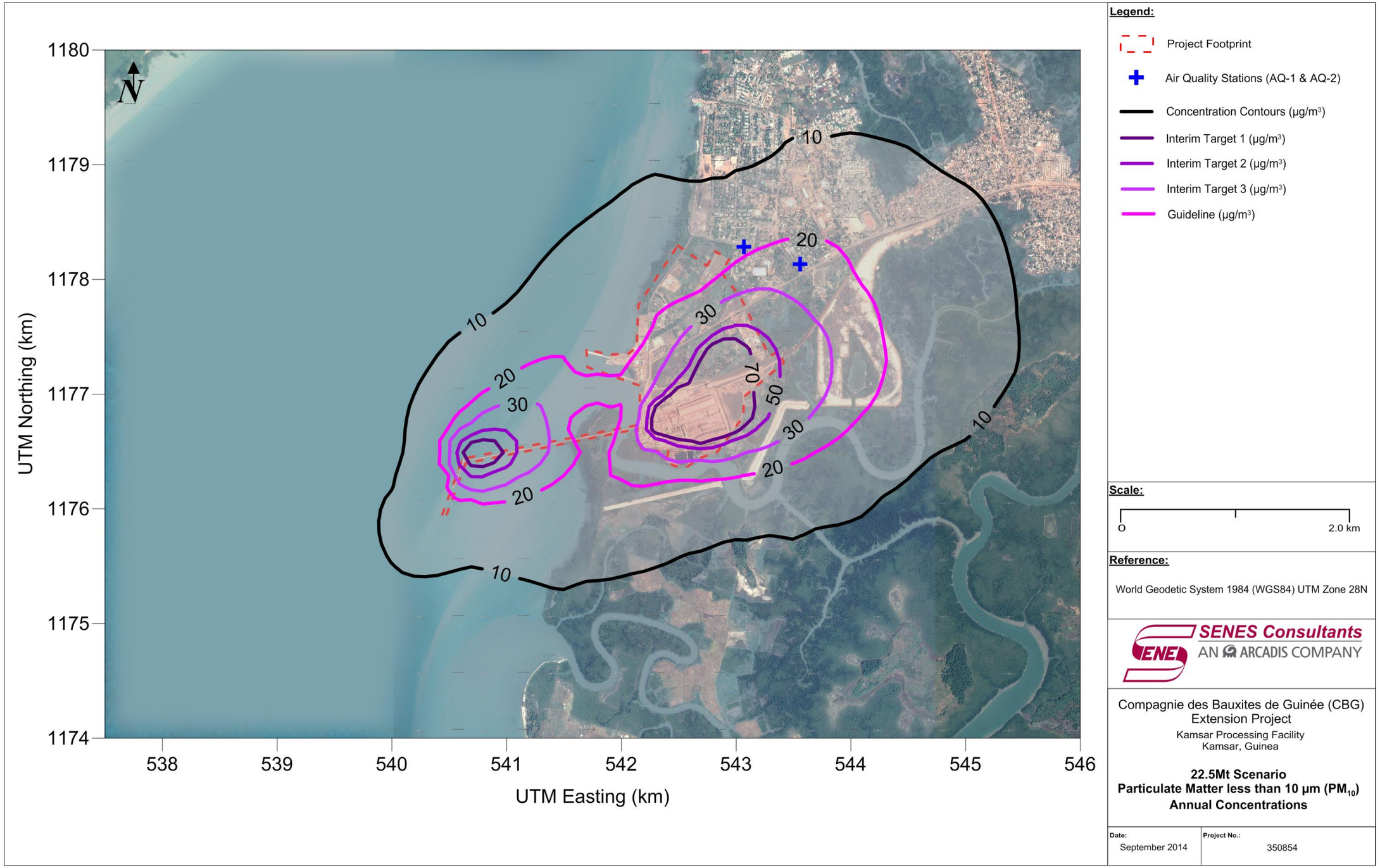
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
50
75
100
150
300
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Particulate Matter less than 10 µm (PM10)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854


N
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1177
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1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
10
20
30
50
70
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
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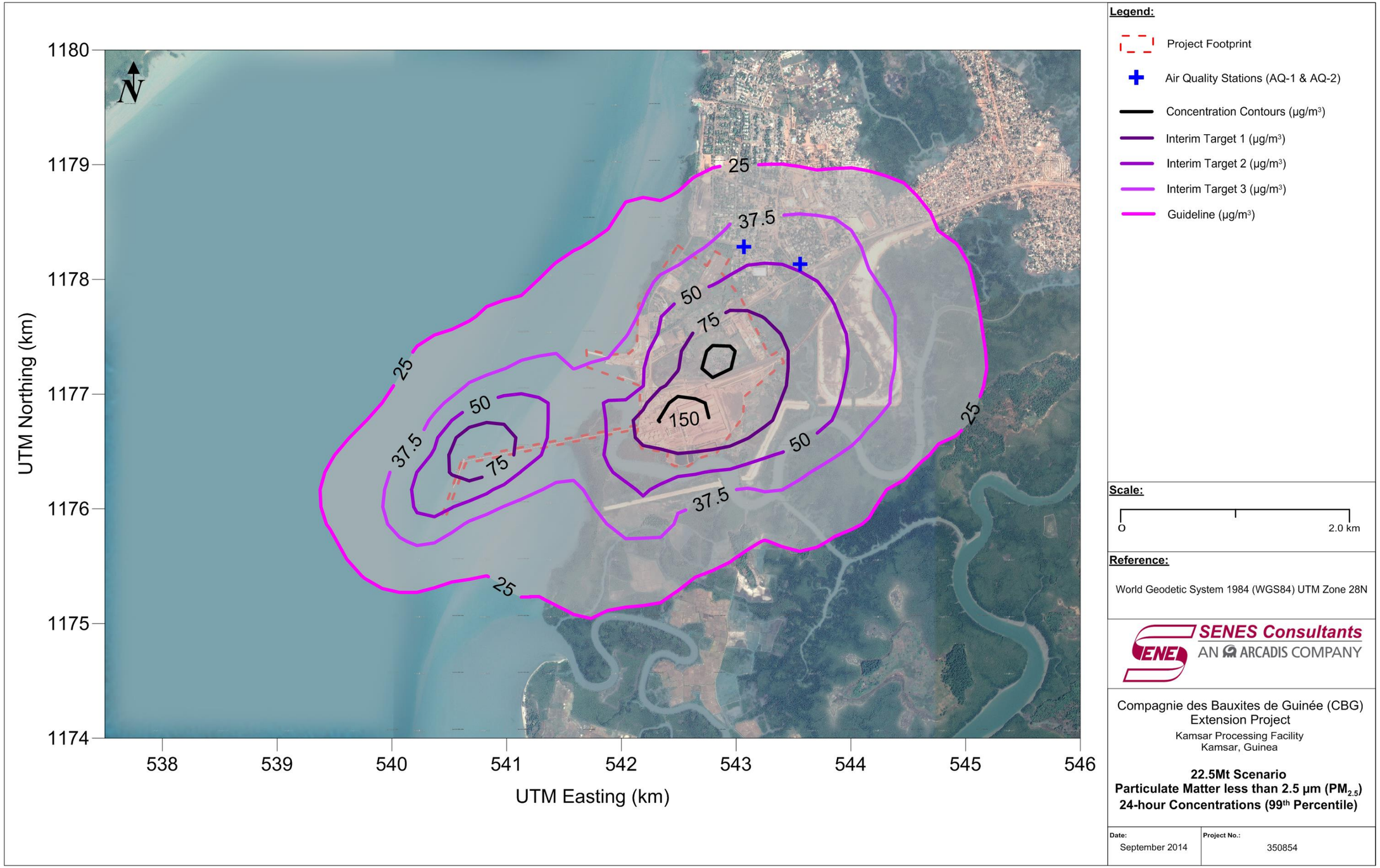
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Particulate Matter less than 10 µm (PM10)
Annual Concentrations
Date:
September 2014
Project No.:
350854


N
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1176
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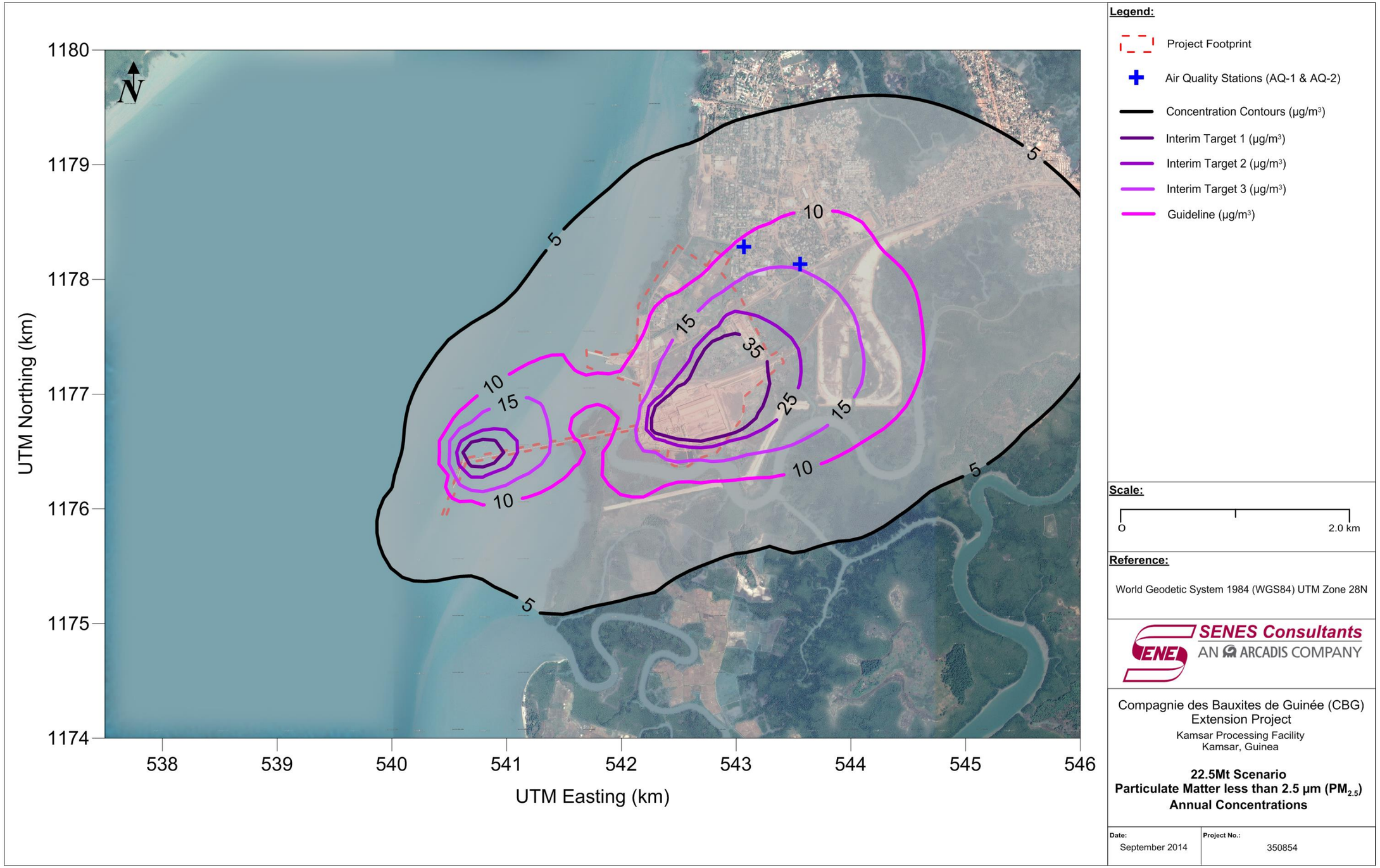
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
25
37.5
50
75
150
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Particulate Matter less than 2.5 µm (PM2.5)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854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1174
UTM Northing (km)
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541
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544
545
546
UTM Easting (km)
5
10
15
25
35
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
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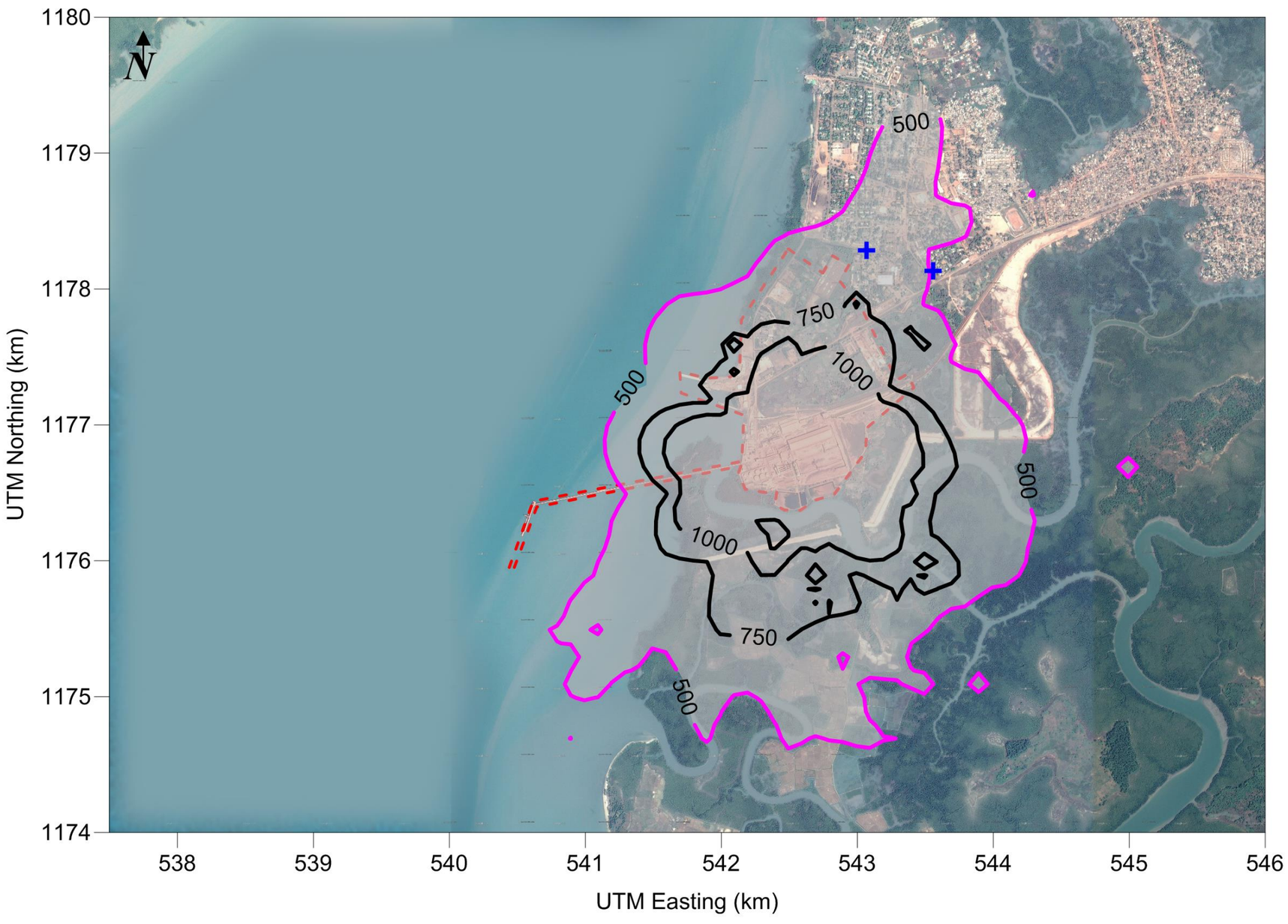
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Particulate Matter less than 2.5 µm (PM2.5)
Annual Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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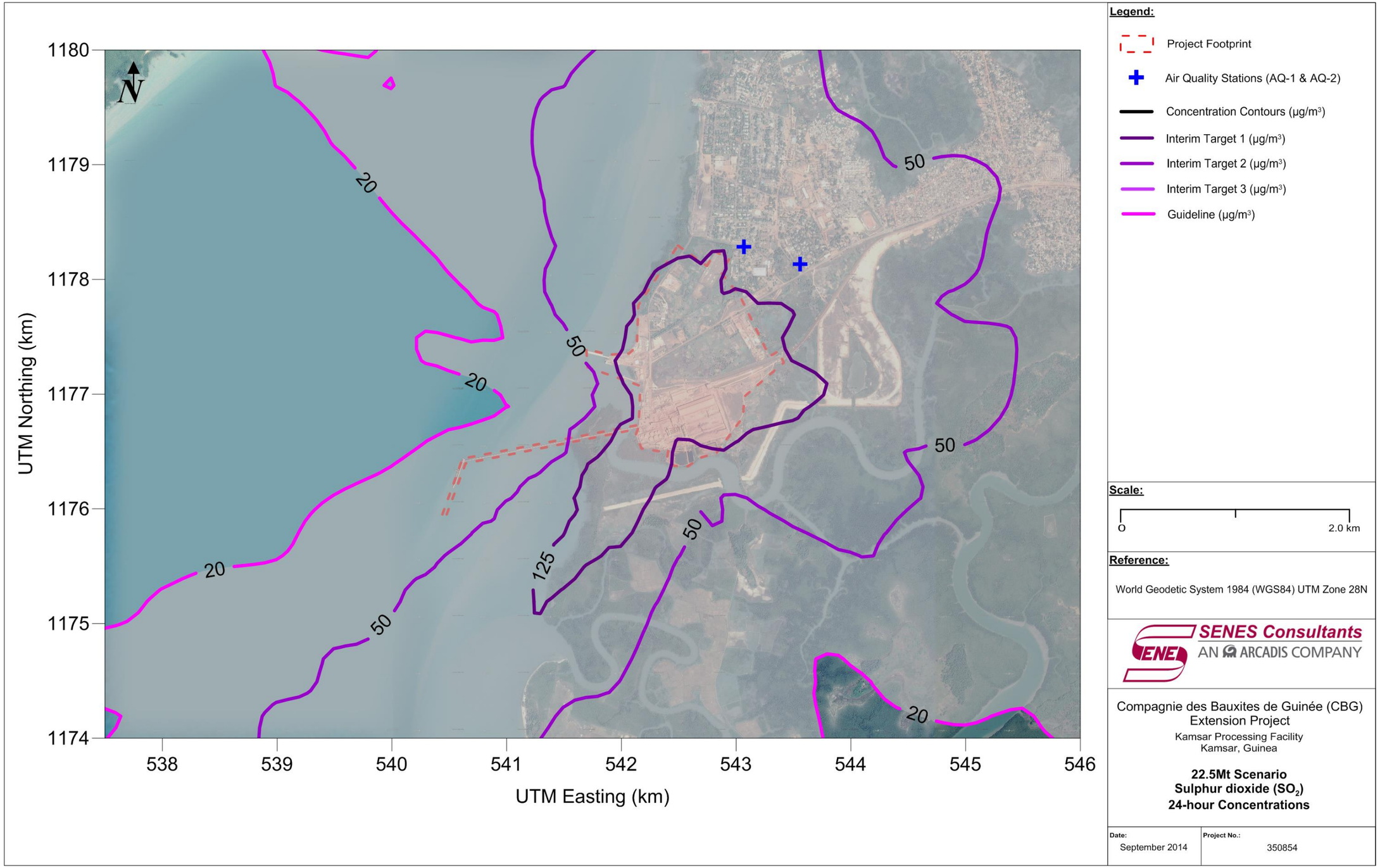
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

22.5Mt Scenario
Sulphur dioxide (SO_2)
10-min Concentrations

Date:	Project No.:
September 2014	350854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UTM Northing (km)
538
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541
542
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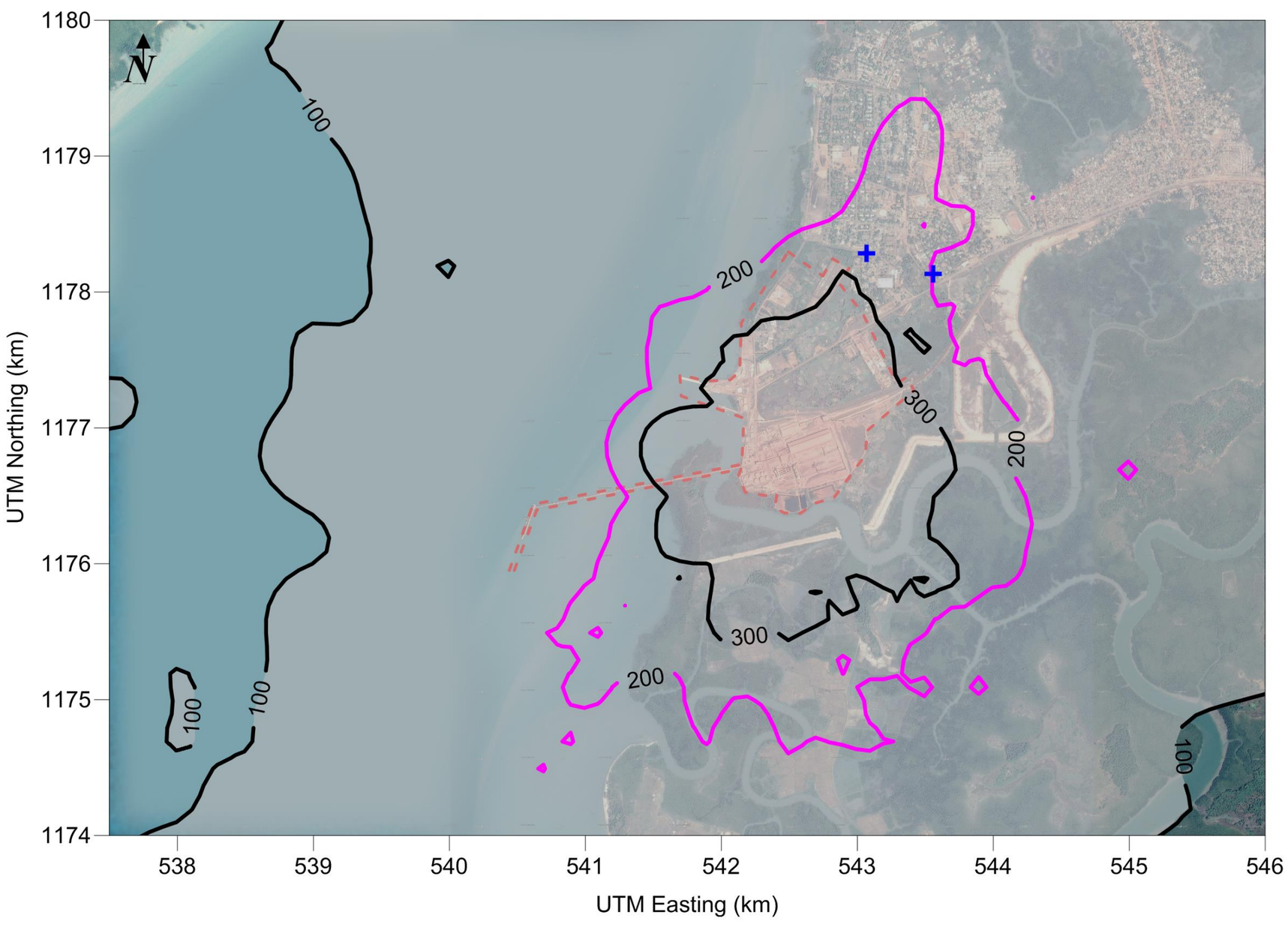
544
545
546
UTM Easting (km)
N
20
50
125
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Sulphur dioxide (SO2)
24-hour Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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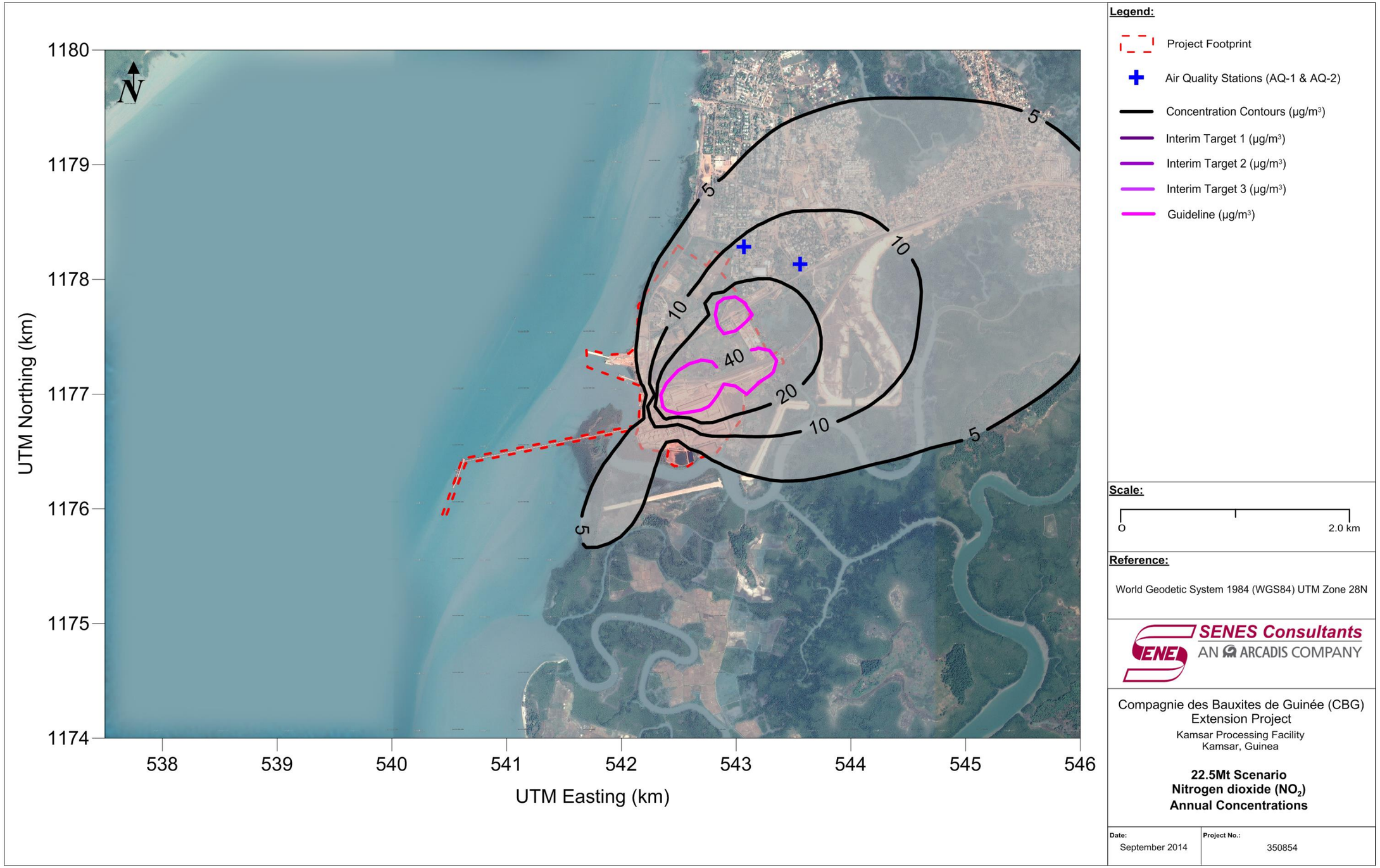
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

22.5Mt Scenario
Nitrogen dioxide (NO_2)
1-hour Concentrations

Date:	Project No.:
September 2014	350854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UTM Northing (km)
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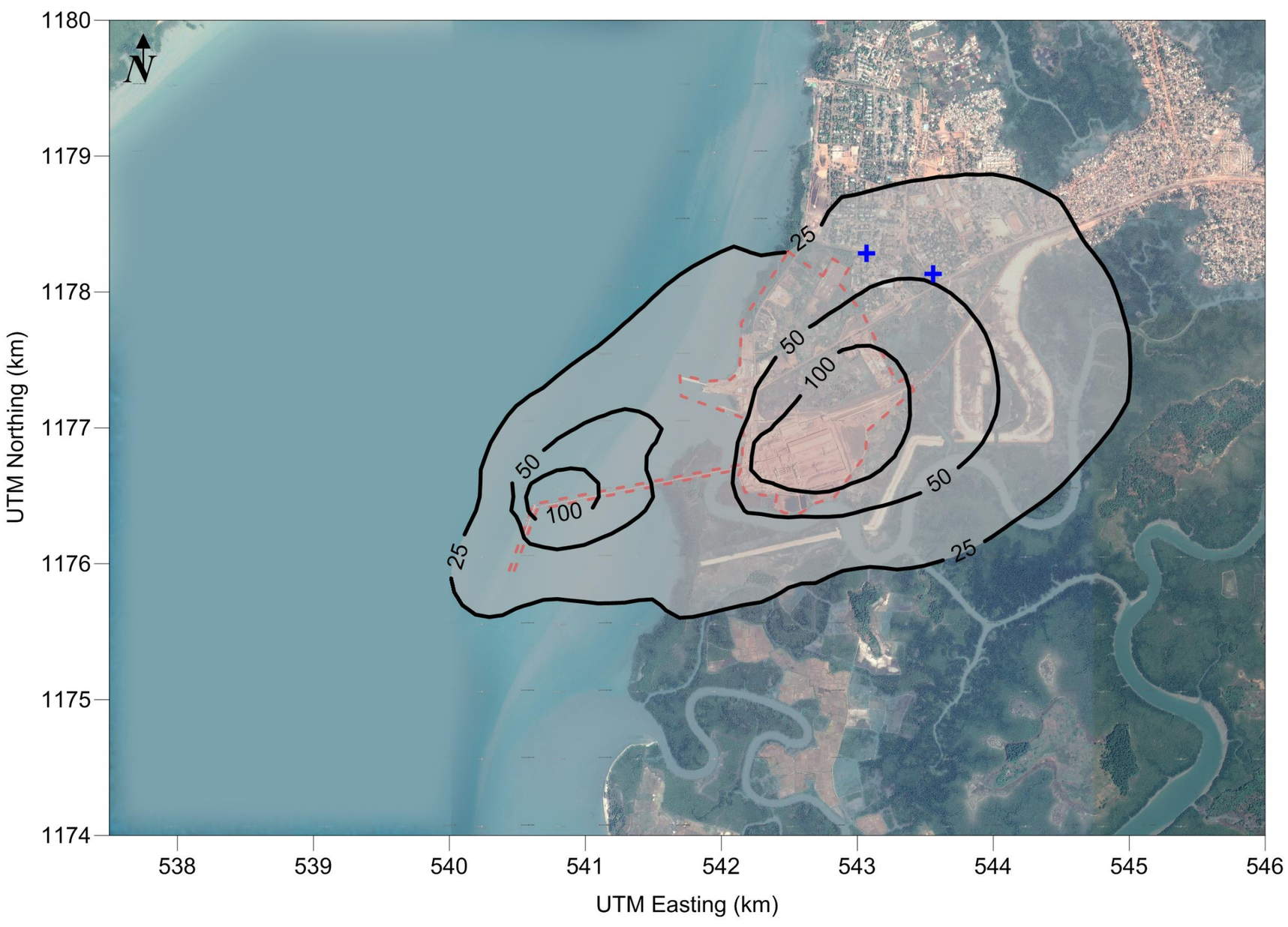
545
546
UTM Easting (km)
N
5
10
20
40
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
22.5Mt Scenario
Nitrogen dioxide (NO_2)
Annual Concentrations
Date:
September 2014
Project No.:
350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Concentration Contours (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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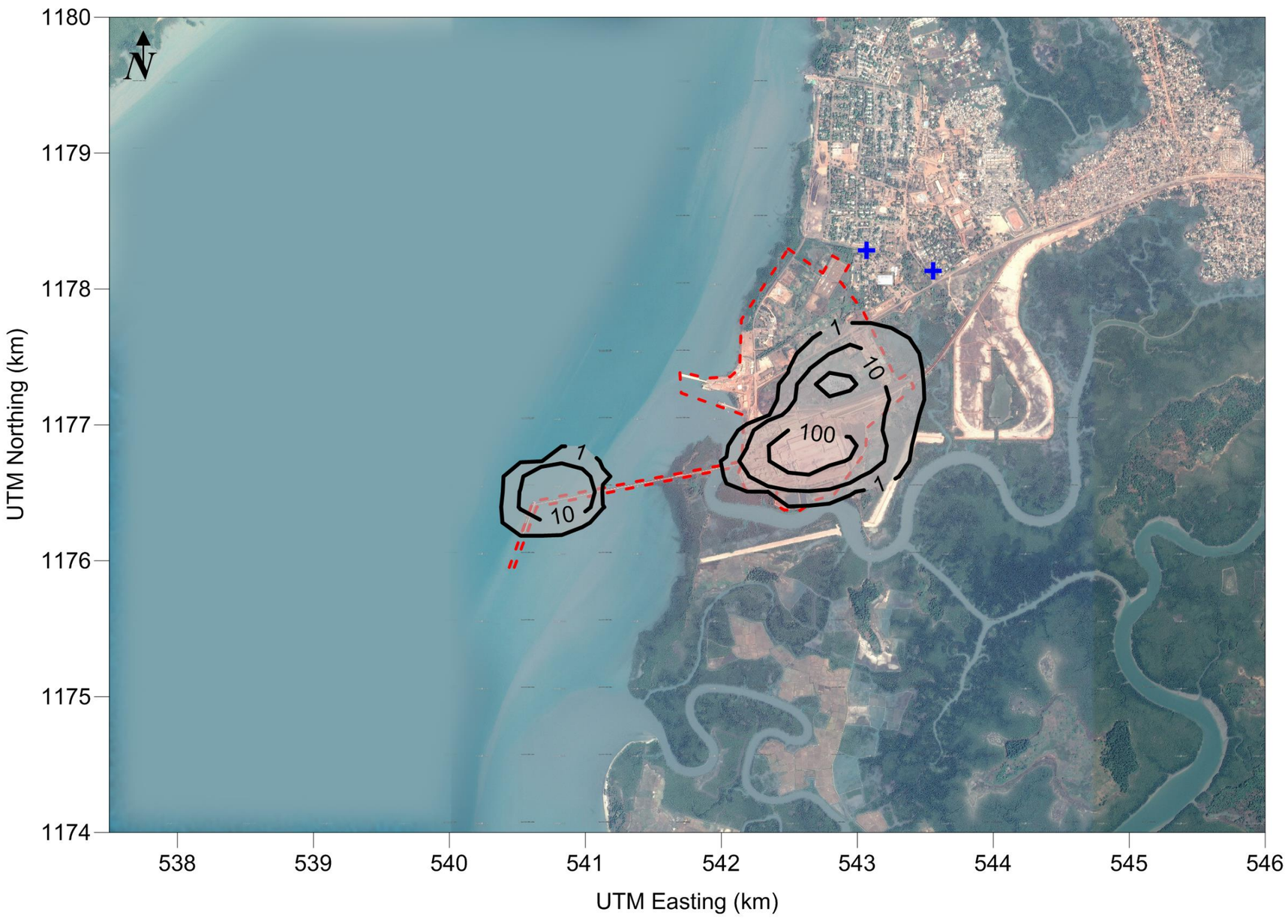
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

22.5Mt Scenario
Total Suspended Particulate (TSP)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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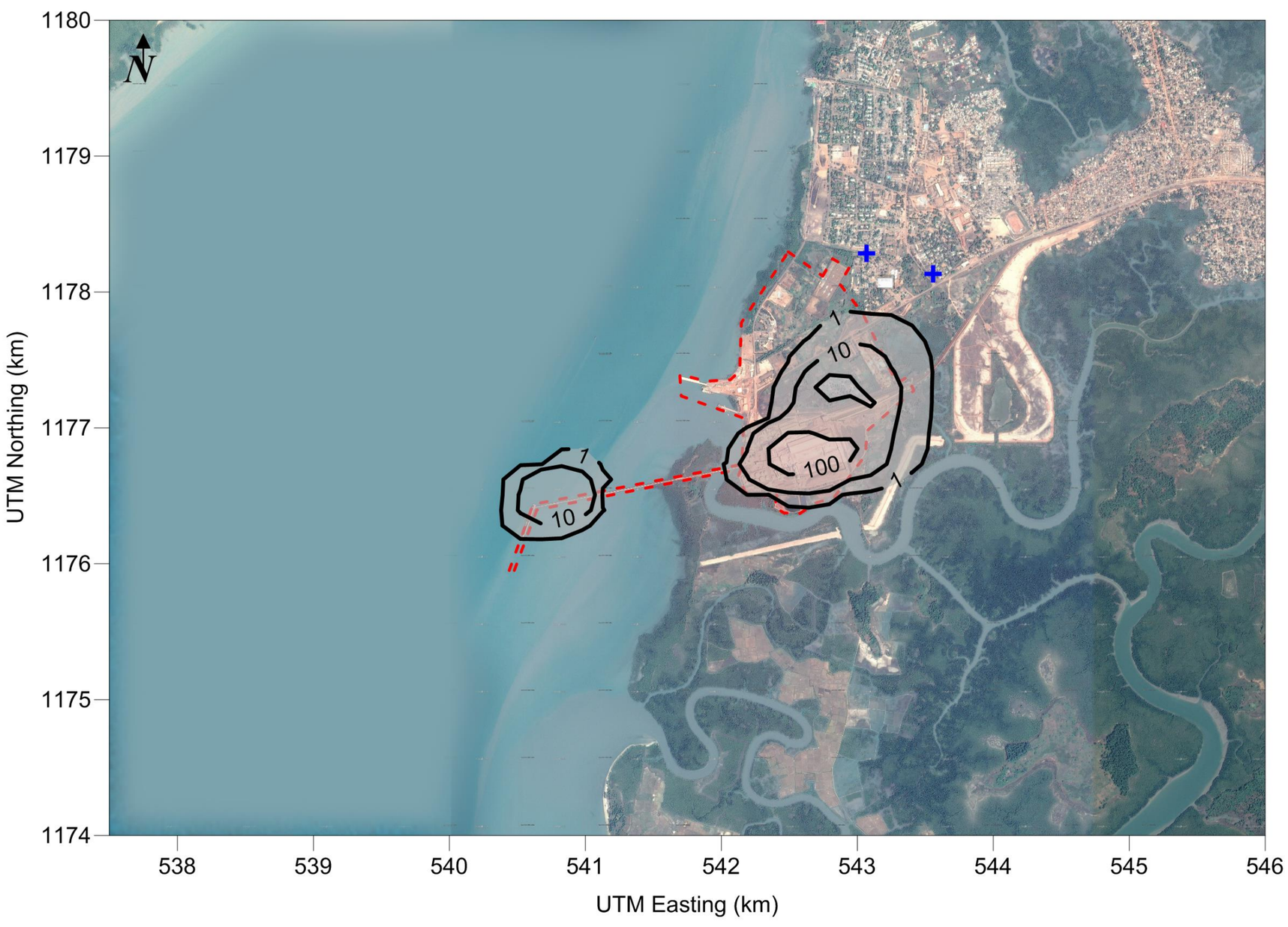
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

22.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 10 µm (PM_{10})

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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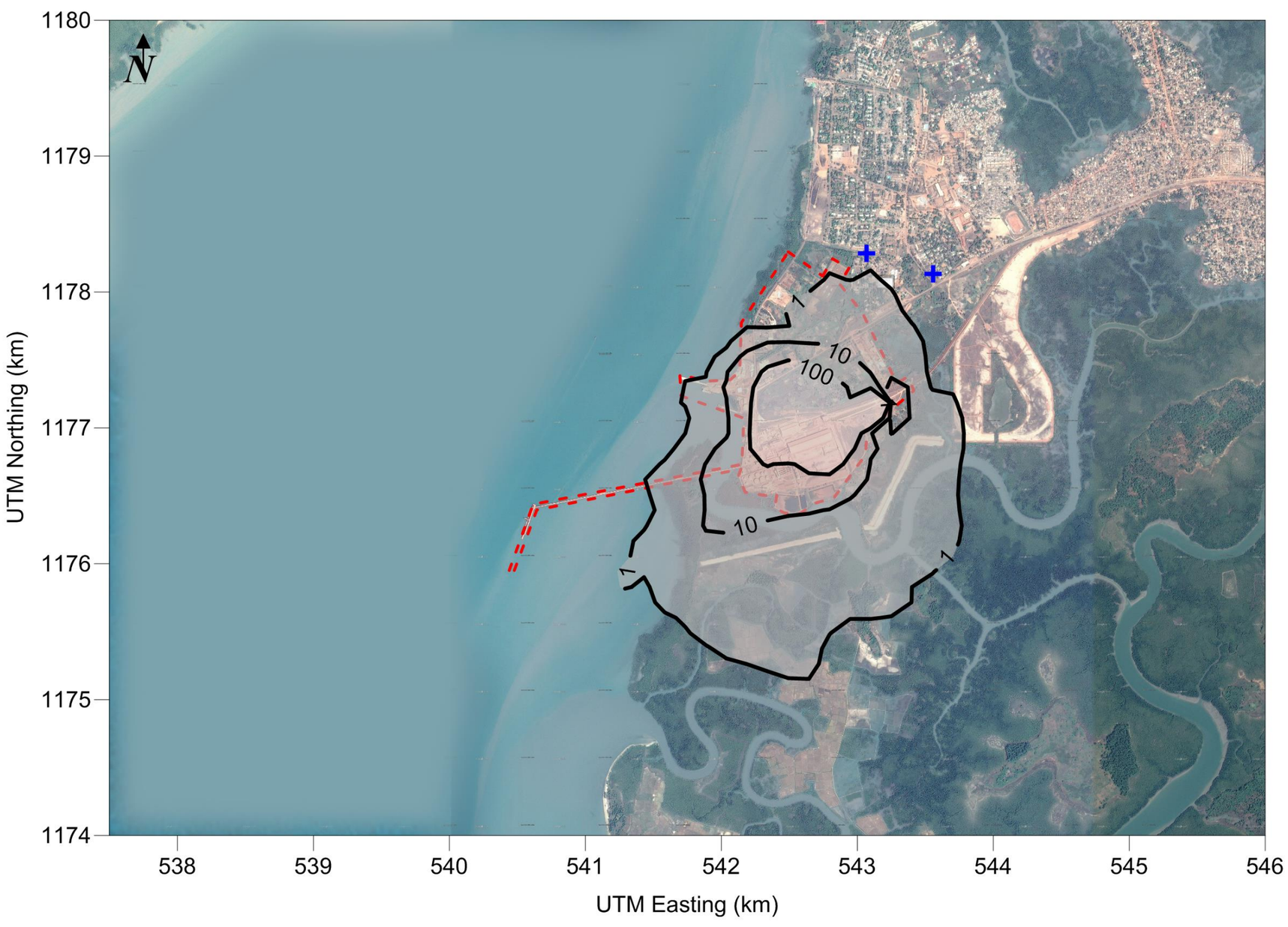
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

22.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 2.5 µm ($PM_{2.5}$)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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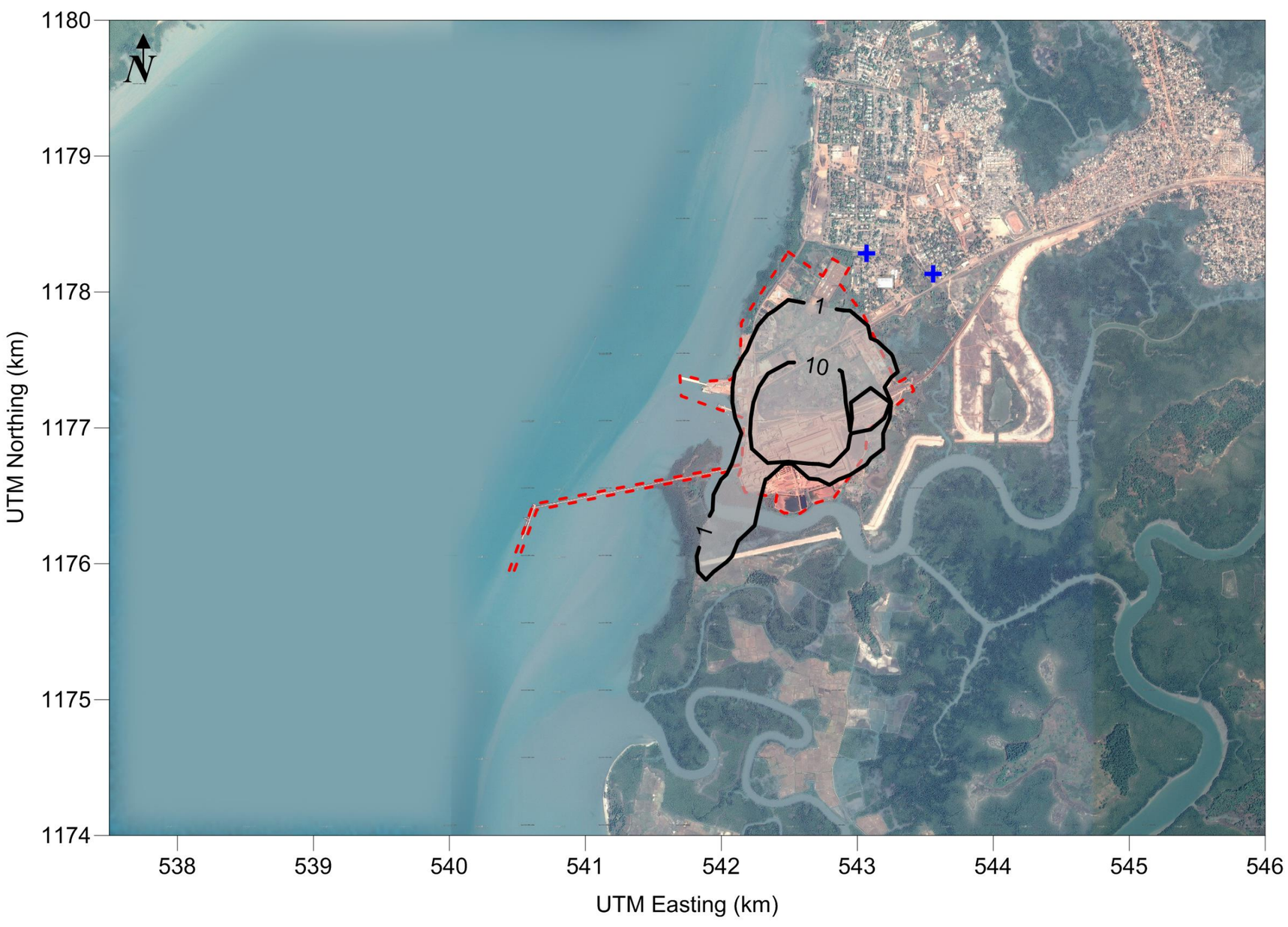
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

22.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 10-minute Guideline for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

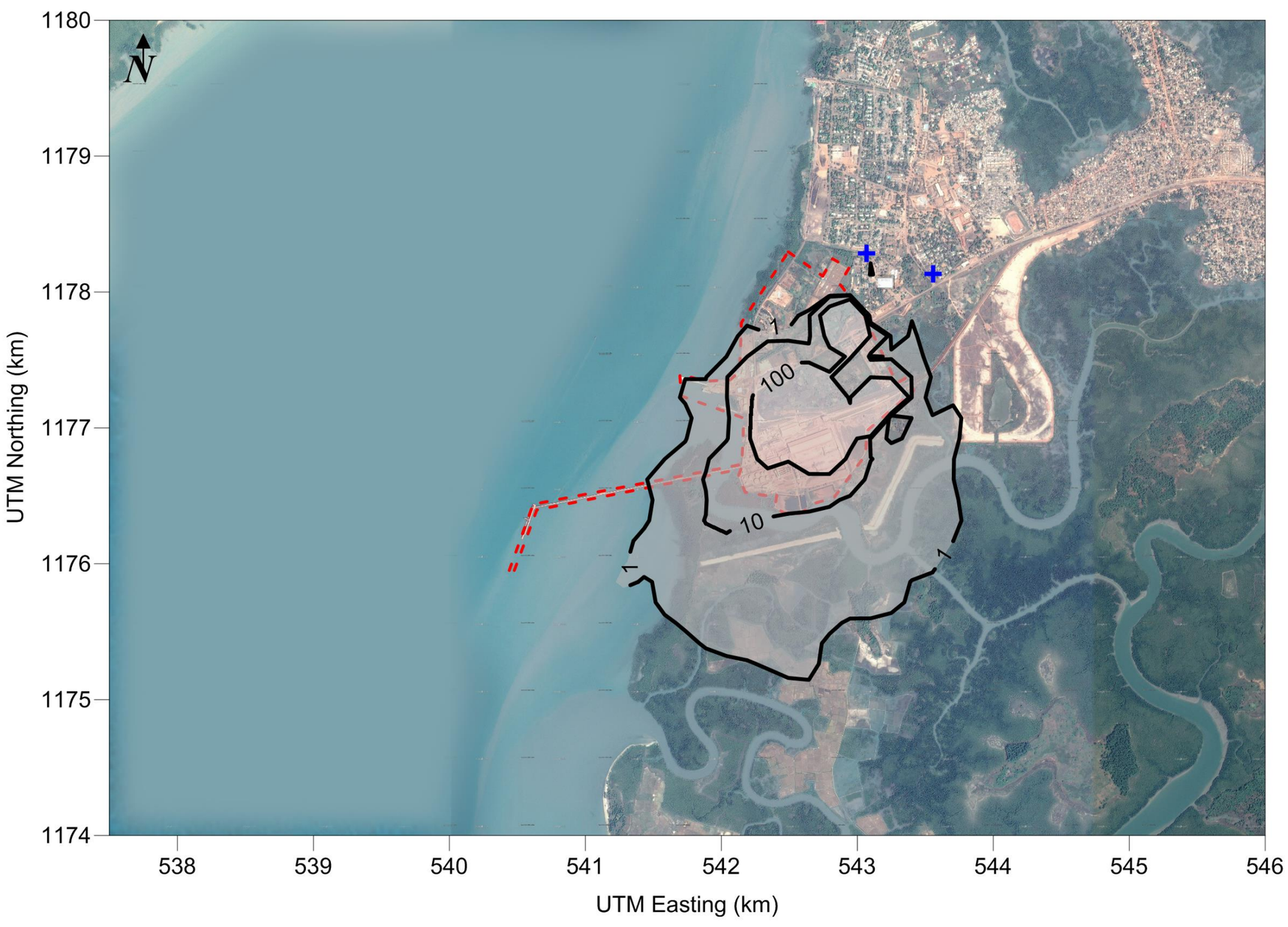
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

22.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

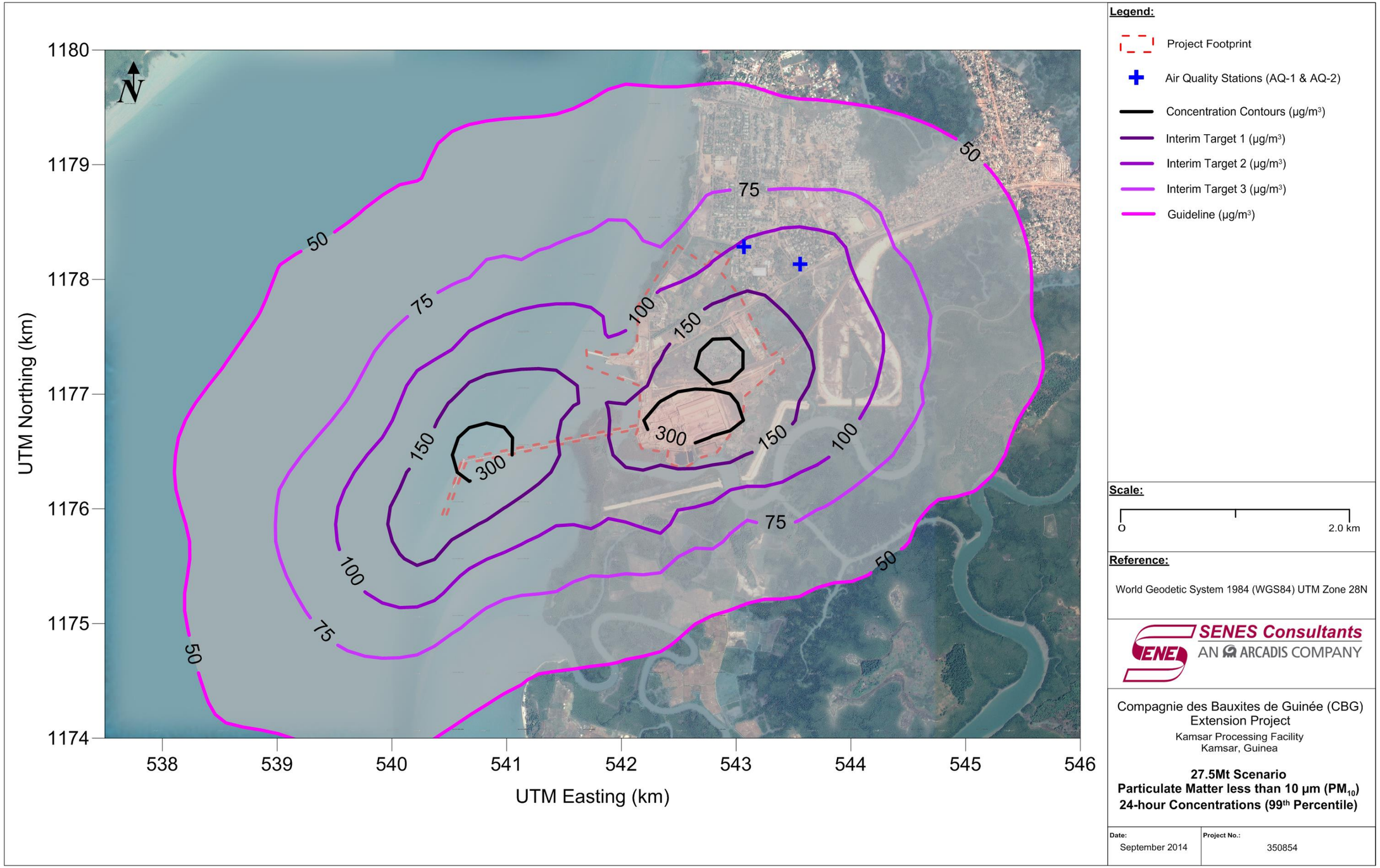
Kamsar Processing Facility
Kamsar, Guinea

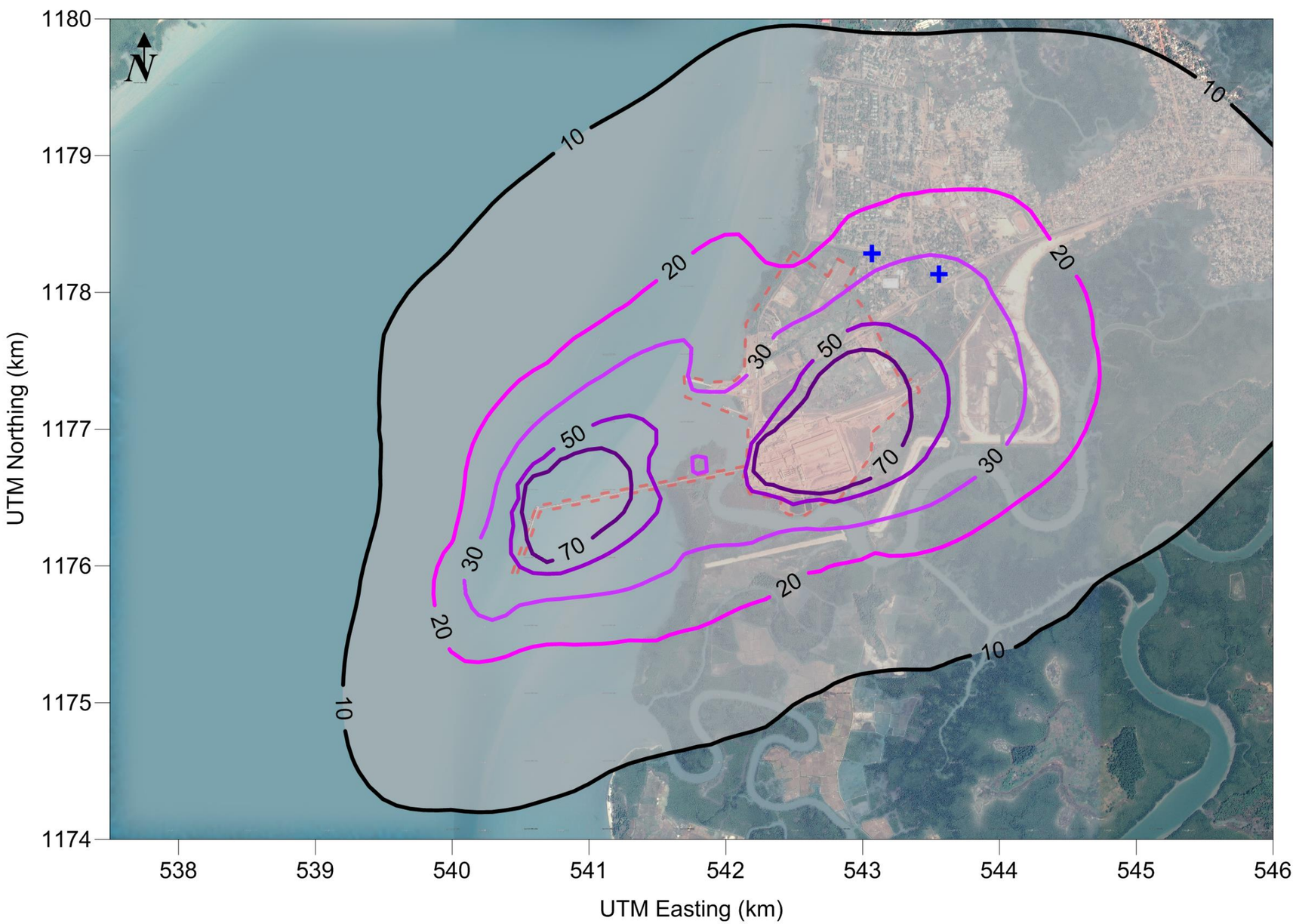
22.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 1-hour Guideline for Nitrogen Dioxide (NO_2)

Date:	Project No.:
September 2014	350854

Kamsar

27.5 MTPY


1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
N
50
75
100
150
300
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
27.5Mt Scenario
Particulate Matter less than 10 µm (PM10)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

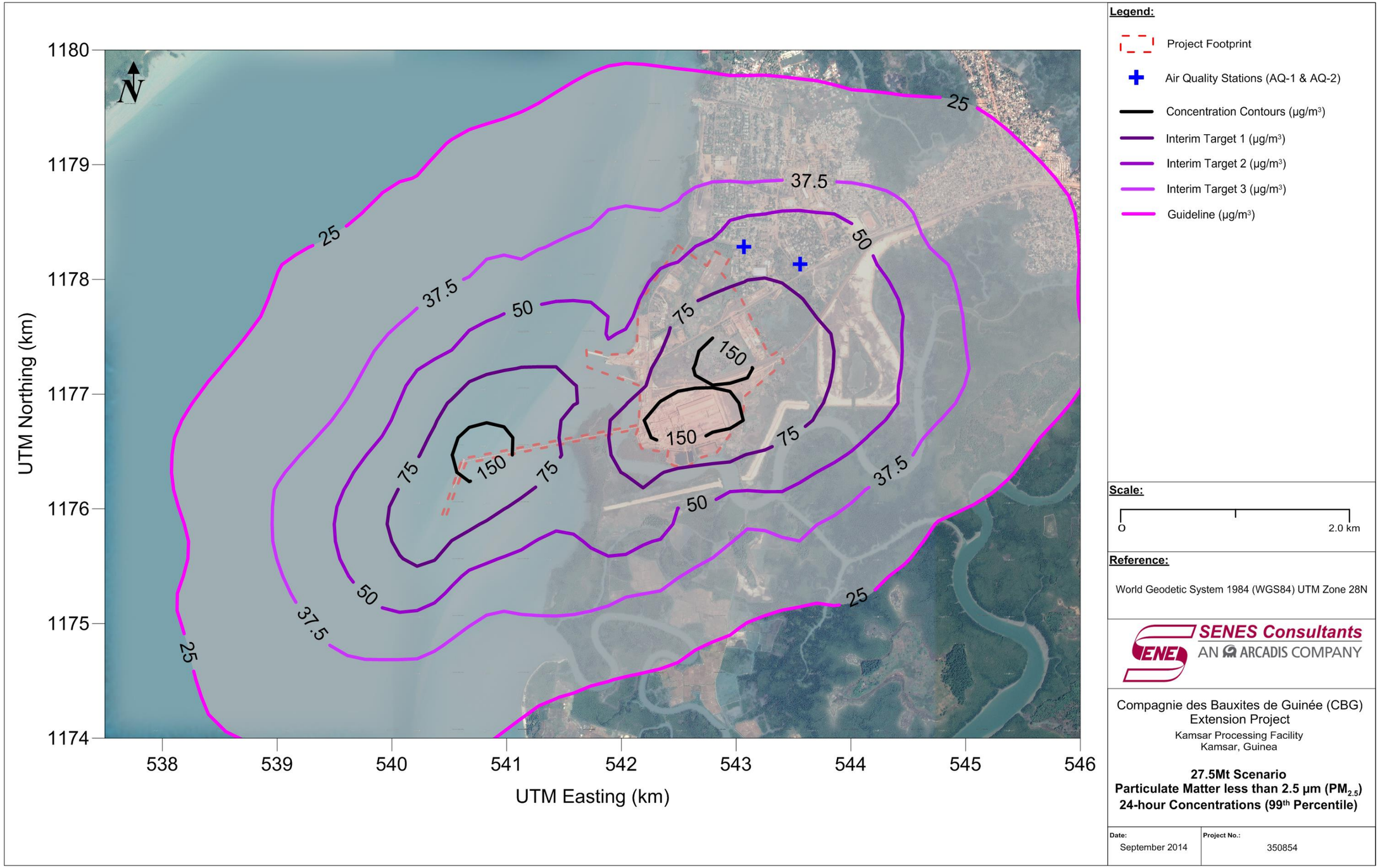
World Geodetic System 1984 (WGS84) UTM Zone 28N

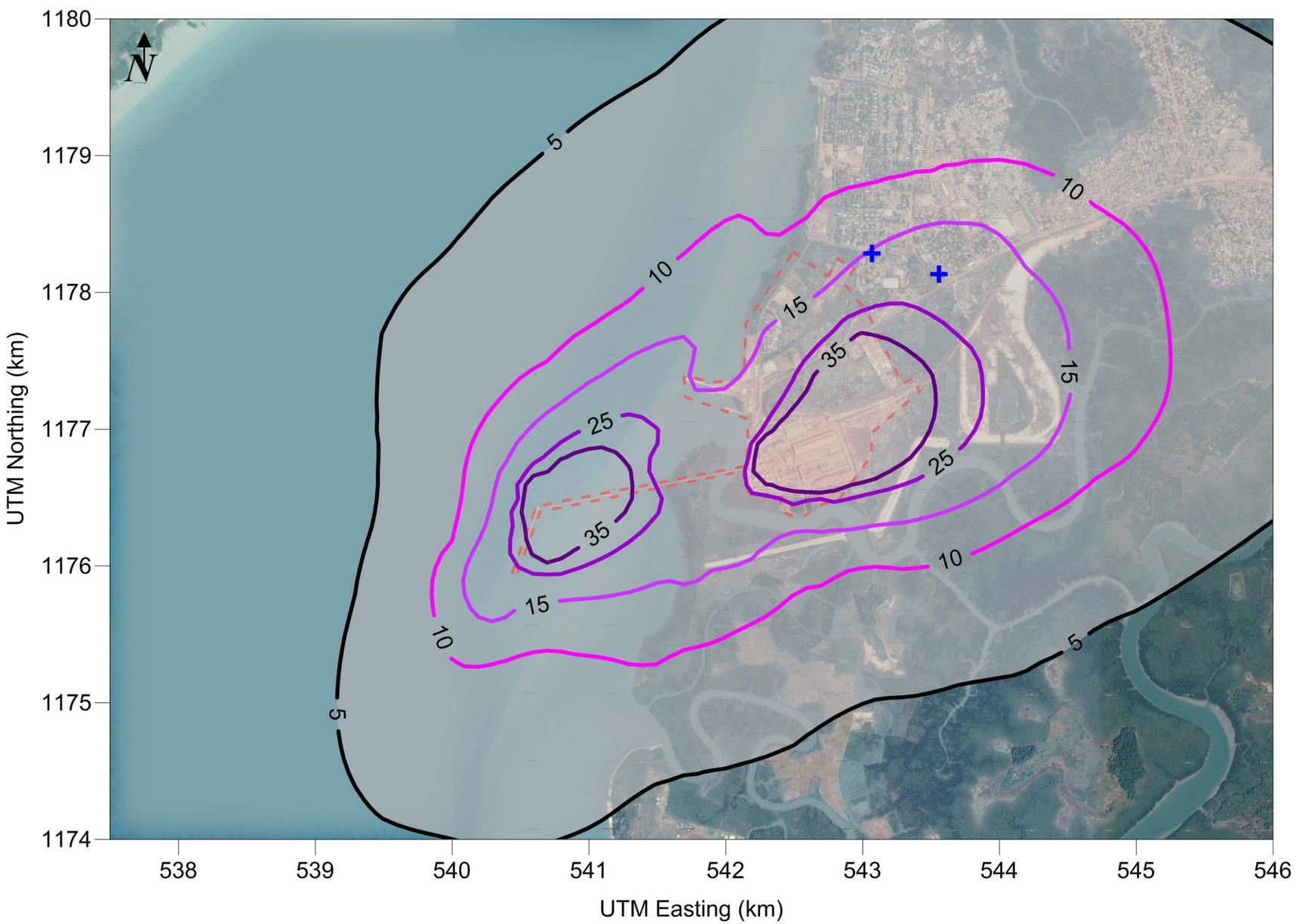
SENES Consultants
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

27.5Mt Scenario
Particulate Matter less than 10 µm (PM_{10})
Annual Concentrations

Date:	Project No.:
September 2014	350854


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
25
37.5
50
75
150
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
27.5Mt Scenario
Particulate Matter less than 2.5 µm (PM2.5)
24-hour Concentrations (99th Percentile)
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

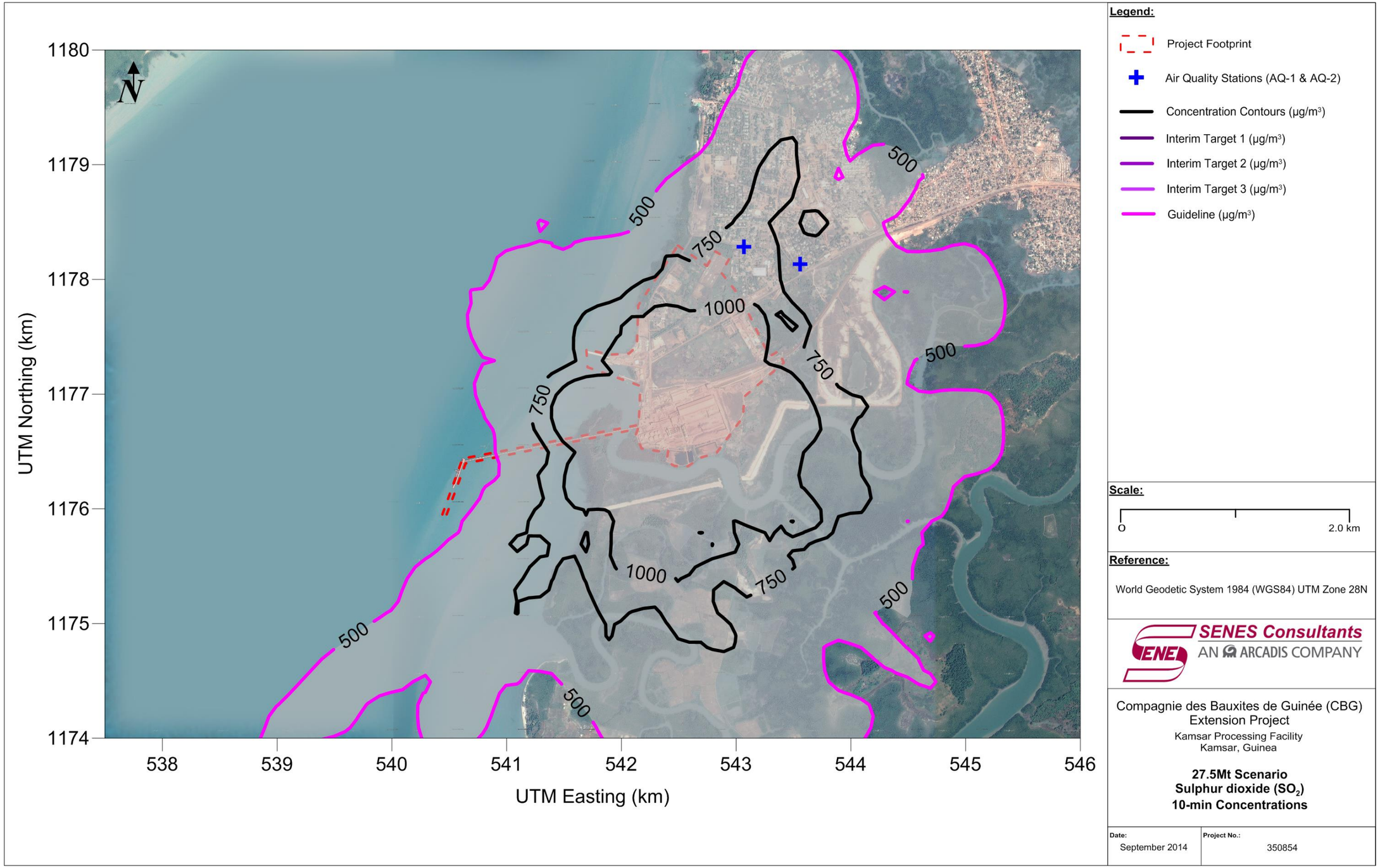
World Geodetic System 1984 (WGS84) UTM Zone 28N

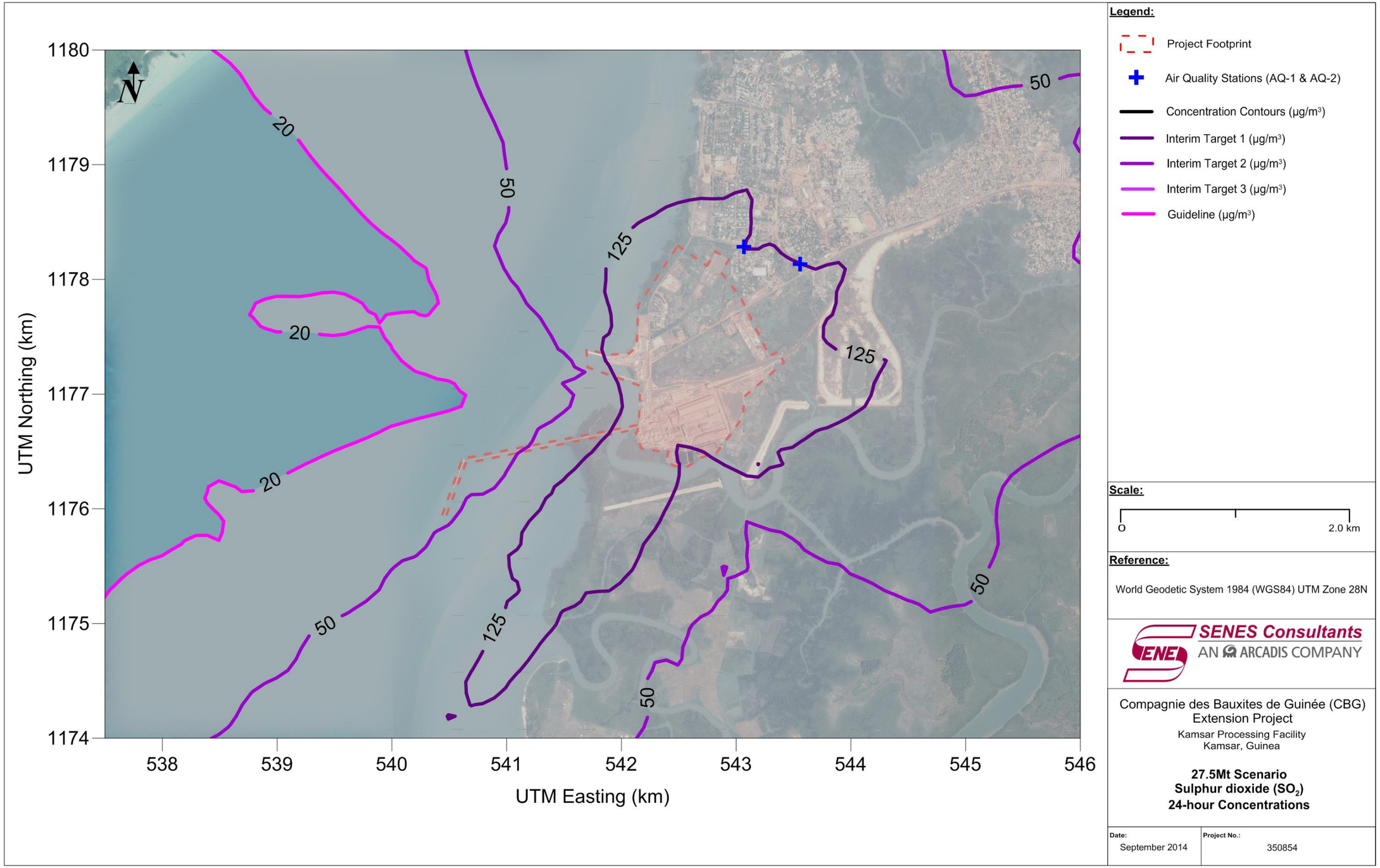
SENES Consultants
AN ARCADIS COMPANY

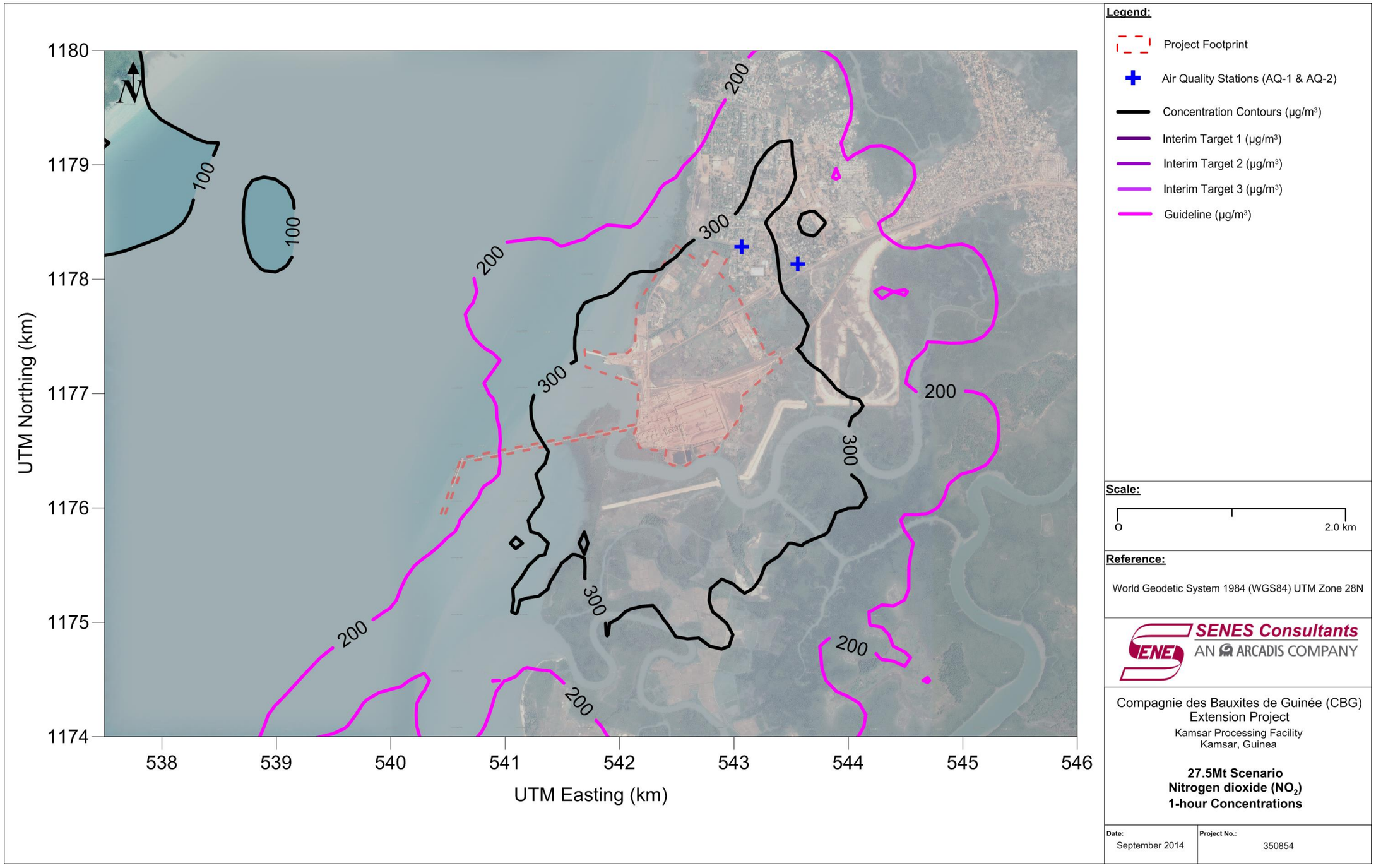
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

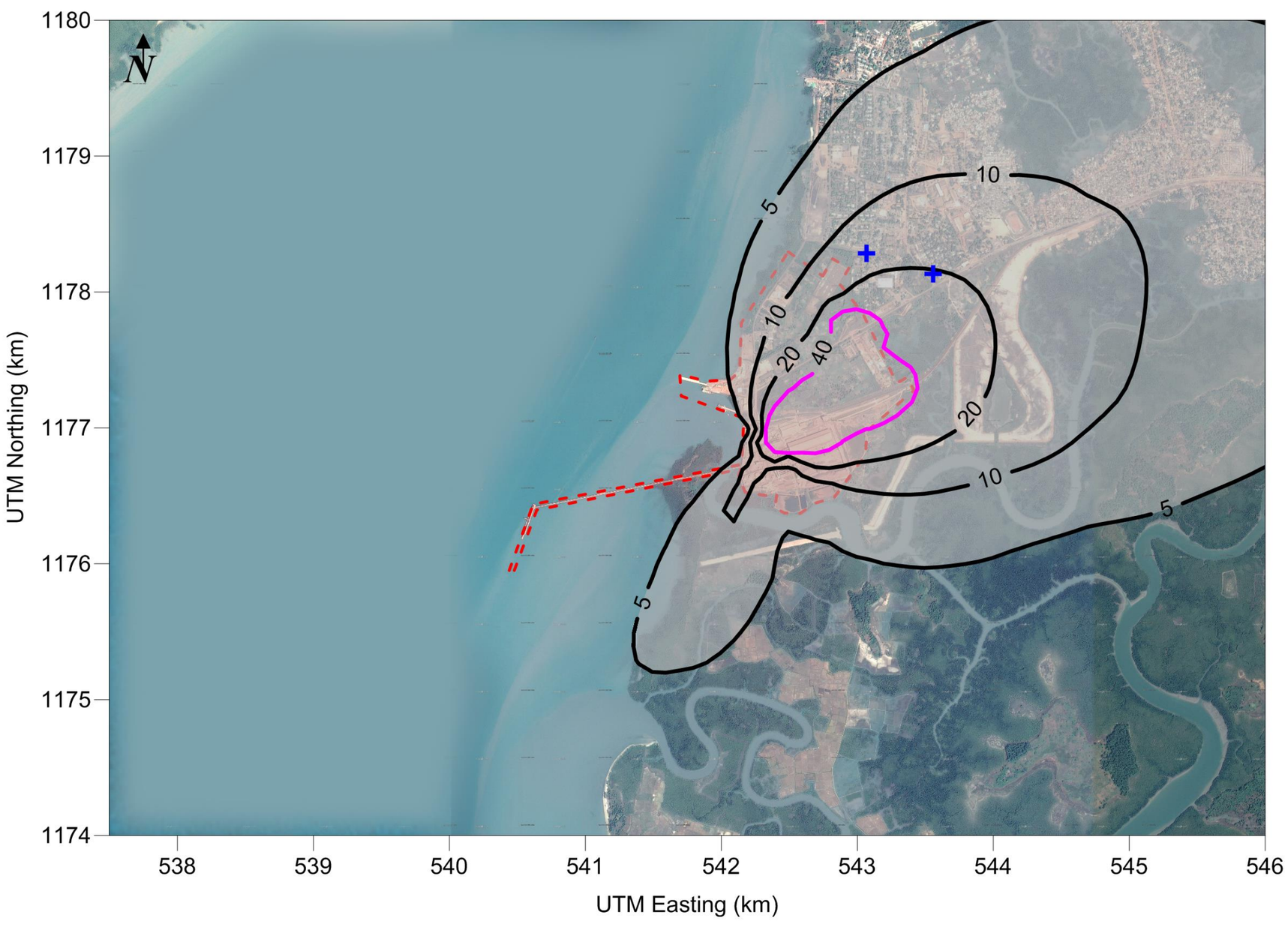
27.5Mt Scenario
Particulate Matter less than 2.5 µm ($PM_{2.5}$)
Annual Concentrations

Date:	Project No.:
September 2014	350854


1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
N
500
750
1000
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
27.5Mt Scenario
Sulphur dioxide (SO2)
10-min Concentrations
Date:
September 2014
Project No.:
350854


N
1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
20
50
125
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
27.5Mt Scenario
Sulphur dioxide (SO2)
24-hour Concentrations
Date:
September 2014
Project No.:
350854


1180
1179
1178
1177
1176
1175
1174
UTM Northing (km)
538
539
540
541
542
543
544
545
546
UTM Easting (km)
N
100
100
200
300
300
200
300
200
200
200
Legend:
Project Footprint
Air Quality Stations (AQ-1 & AQ-2)
Concentration Contours (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
2.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea
27.5Mt Scenario
Nitrogen dioxide (NO_2)
1-hour Concentrations
Date:
September 2014
Project No.:
350854



Legend:

- Project Footprint
- Air Quality Stations (AQ-1 & AQ-2)
- Concentration Contours (µg/m³)
- Interim Target 1 (µg/m³)
- Interim Target 2 (µg/m³)
- Interim Target 3 (µg/m³)
- Guideline (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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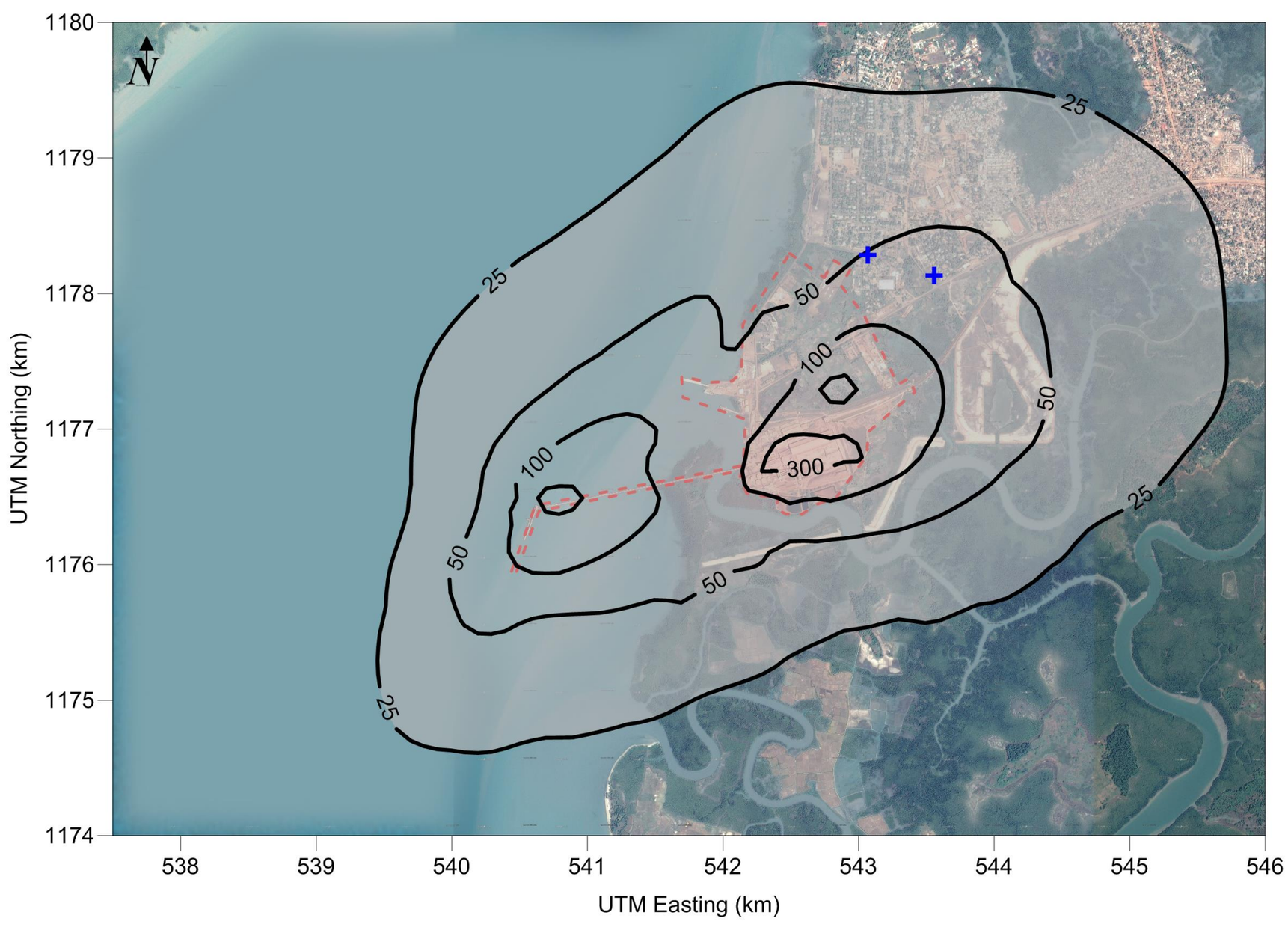
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

27.5Mt Scenario
Nitrogen dioxide (NO_2)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Concentration Contours (µg/m³)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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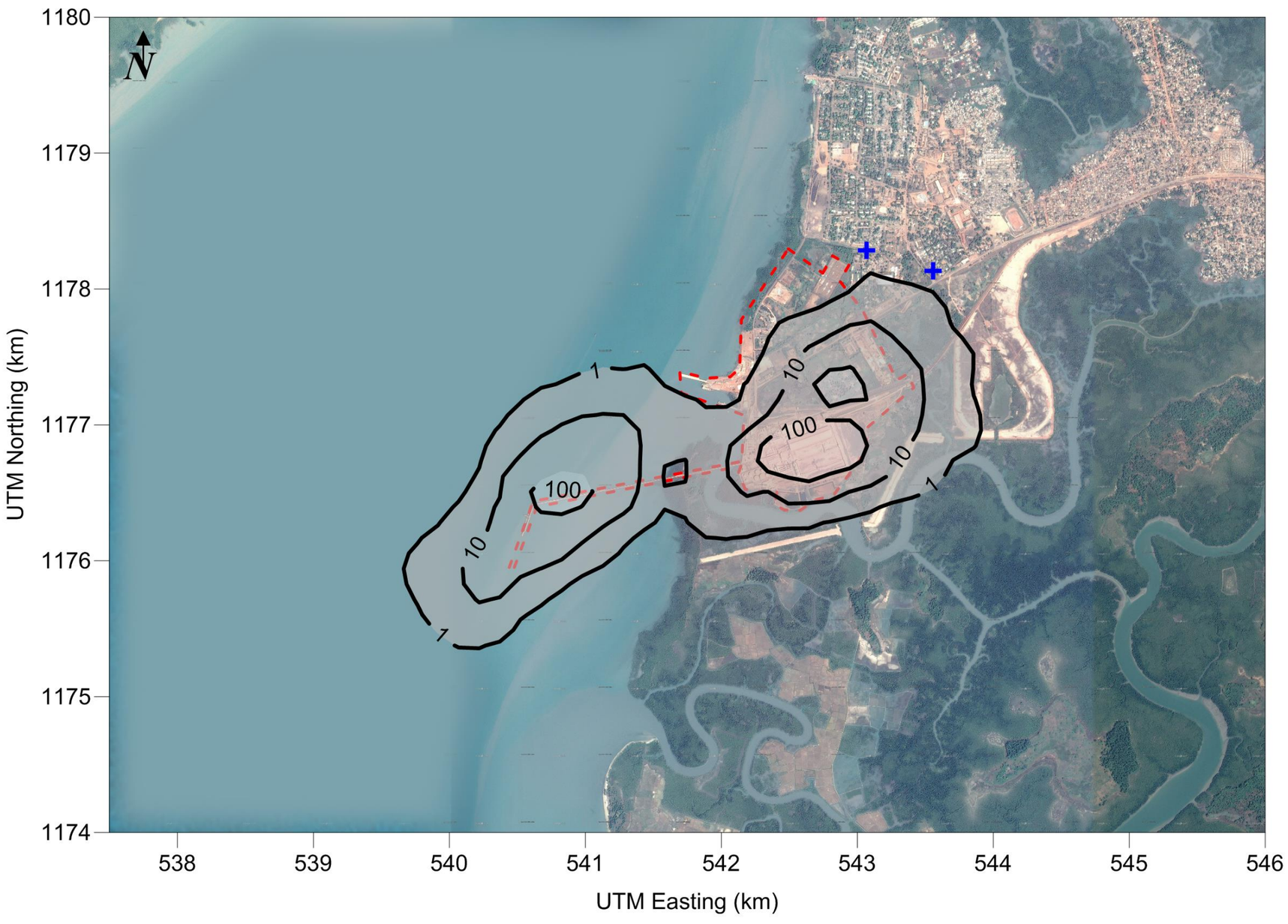
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Kamsar Processing Facility
Kamsar, Guinea

27.5Mt Scenario
Total Suspended Particulate (TSP)
Annual Concentrations

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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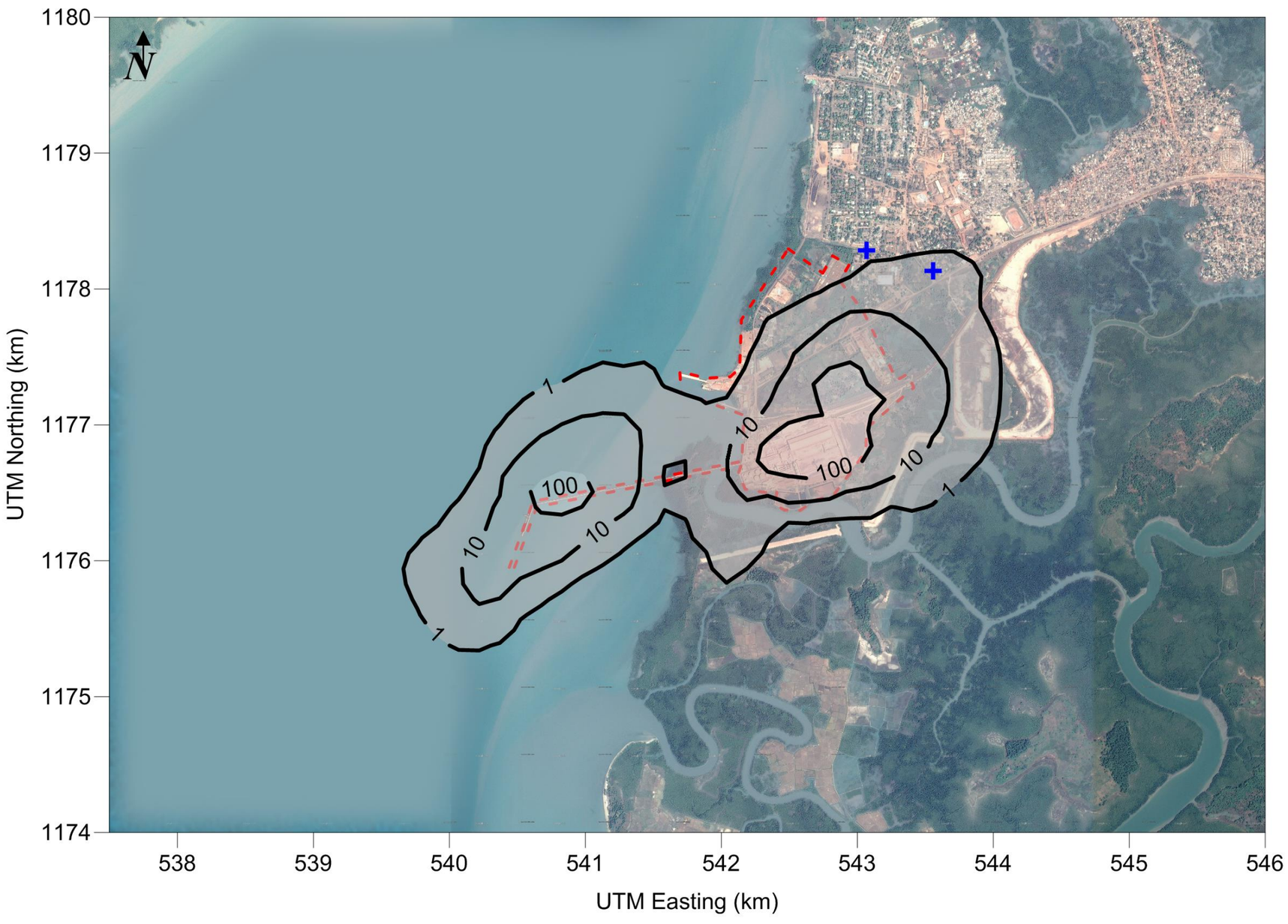
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

27.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 10 µm (PM_{10})

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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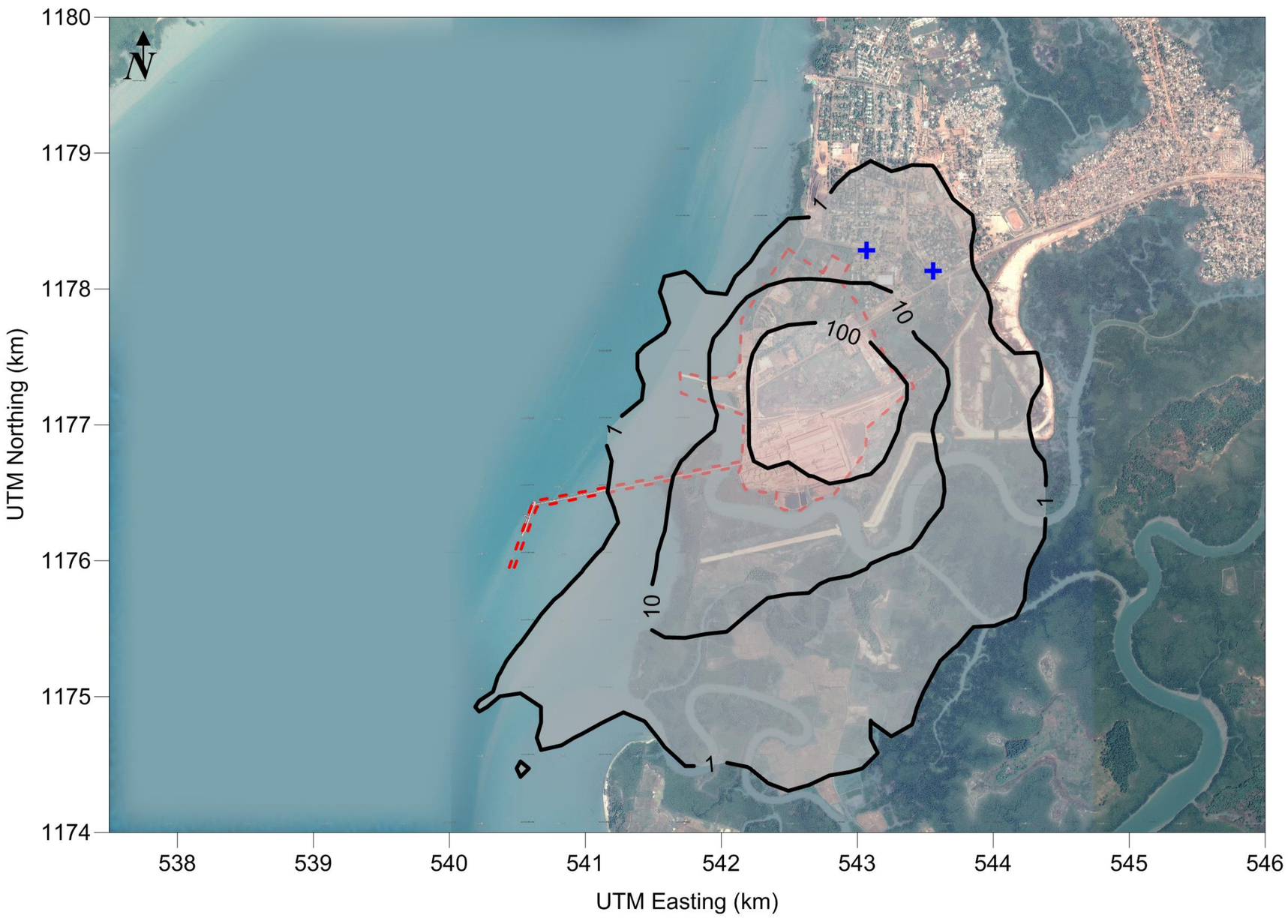
AN ARCADIS COMPANY

Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

27.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Particulate Matter less than 2.5 µm ($PM_{2.5}$)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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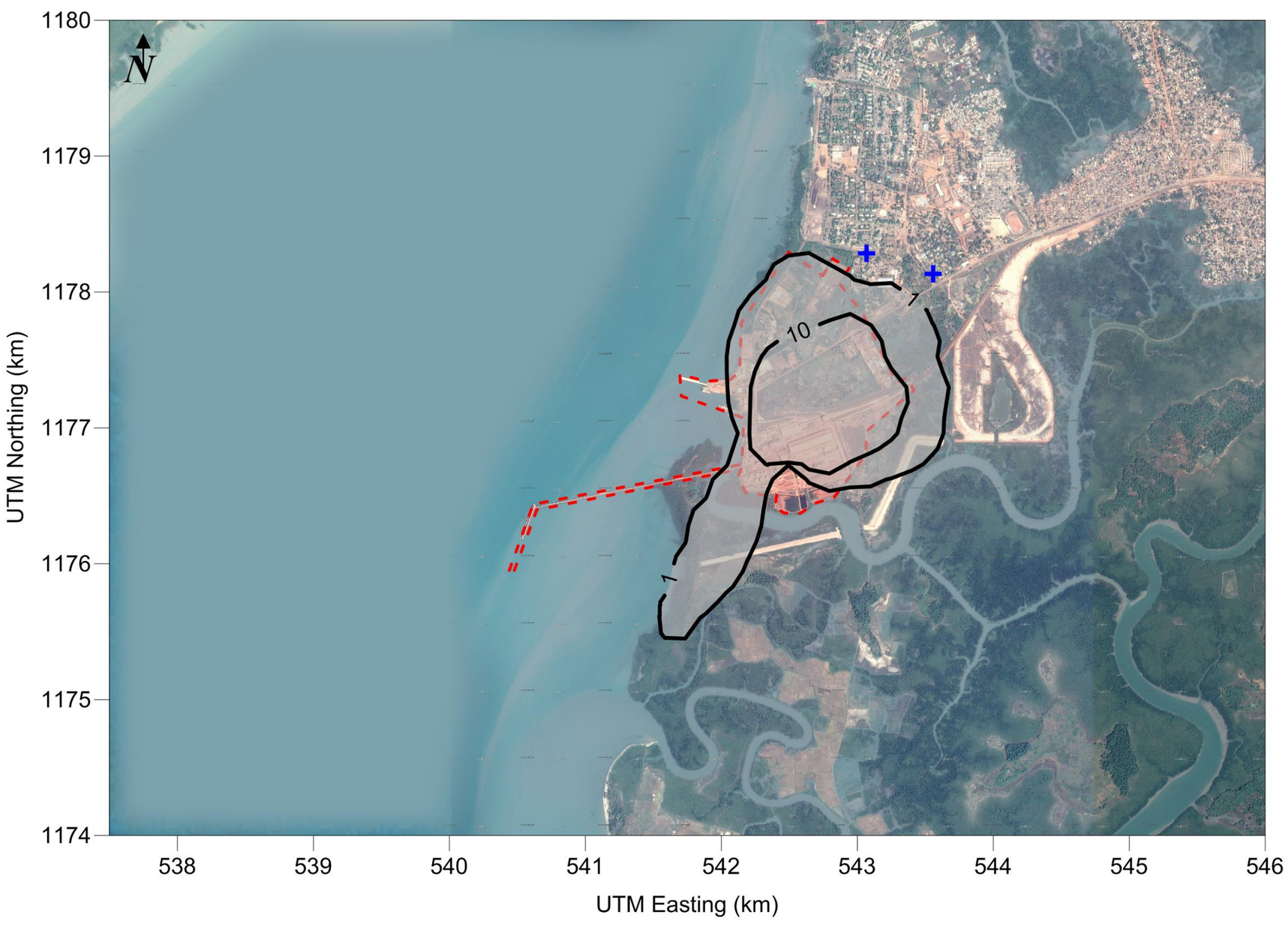
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

27.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 10-minute Guideline for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (days per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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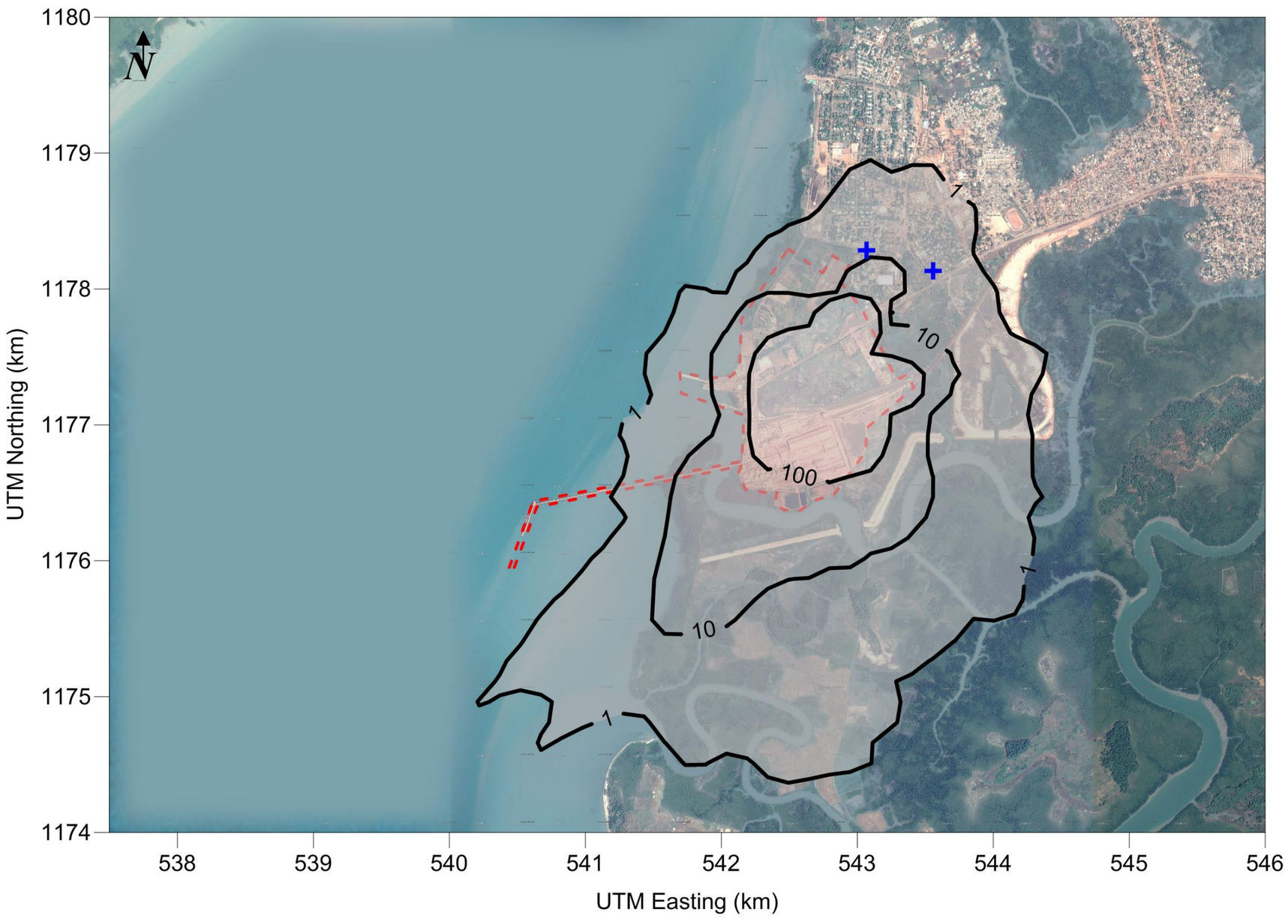
Compagnie des Bauxites de Guinée (CBG)
Extension Project

Kamsar Processing Facility
Kamsar, Guinea

27.5 Mt Scenario
Frequency of Exceedances (days per year) of WHO 24-hour Interim Target-1 for Sulphur Dioxide (SO_2)

Date:	Project No.:
September 2014	350854



Legend:

Project Footprint

Air Quality Stations (AQ-1 & AQ-2)

Exceedances (hours per year)

Scale:

0 — 2.0 km

Reference:

World Geodetic System 1984 (WGS84) UTM Zone 28N

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Compagnie des Bauxites de Guinée (CBG)
Extension Project

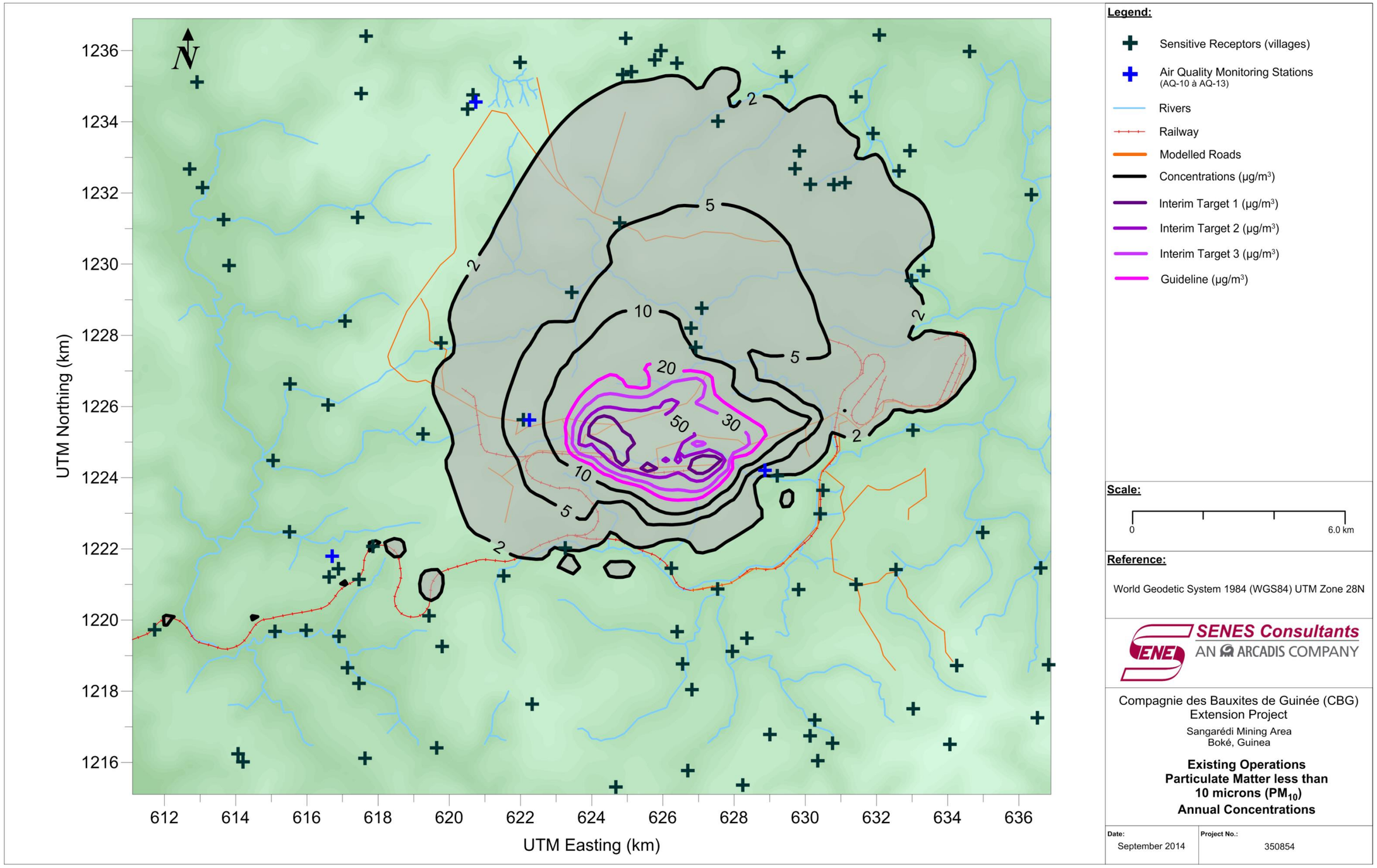
Kamsar Processing Facility
Kamsar, Guinea

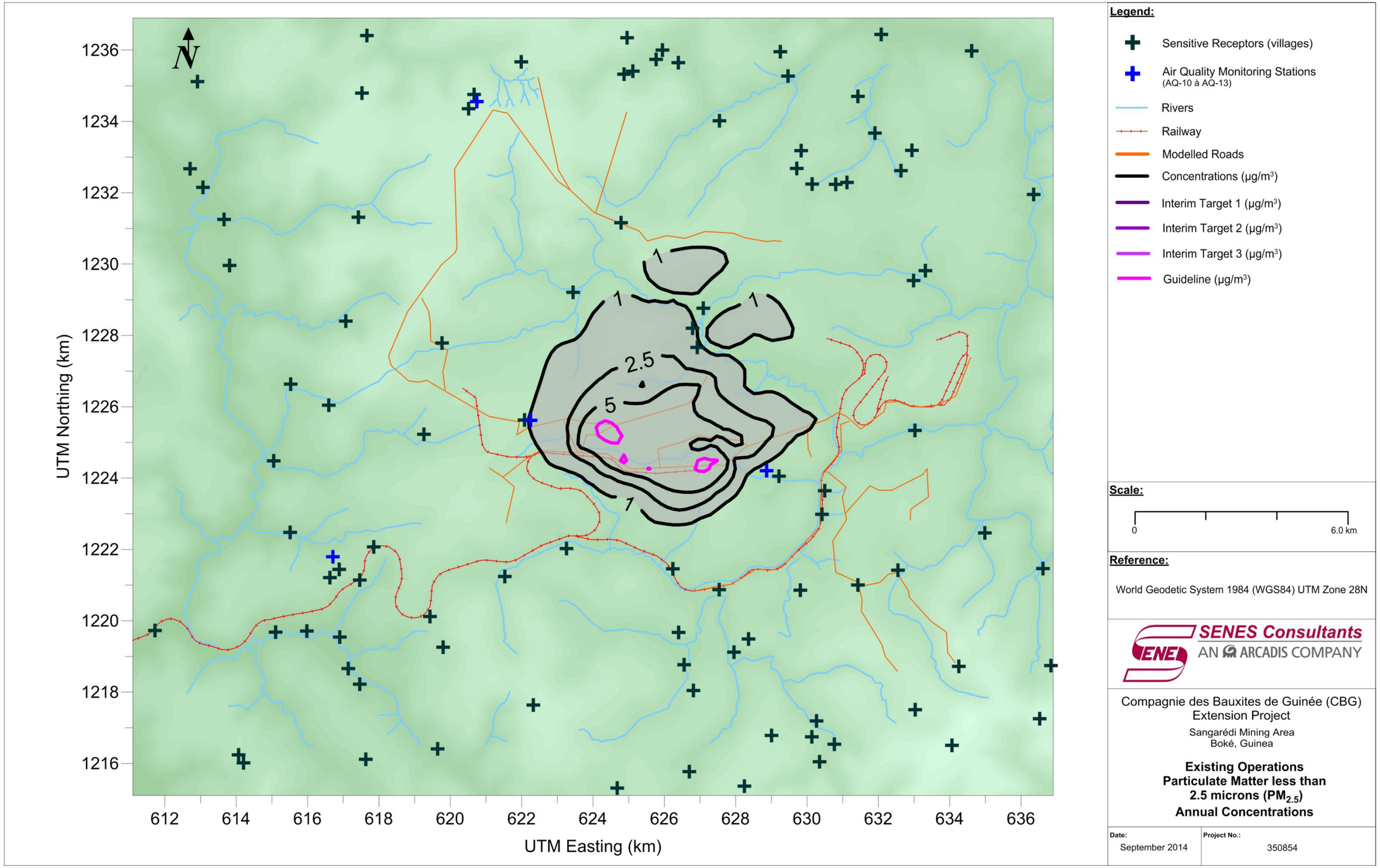
27.5 Mt Scenario
Frequency of Exceedances (hours per year) of WHO 1-hour Guideline for Nitrogen Dioxide (NO_2)

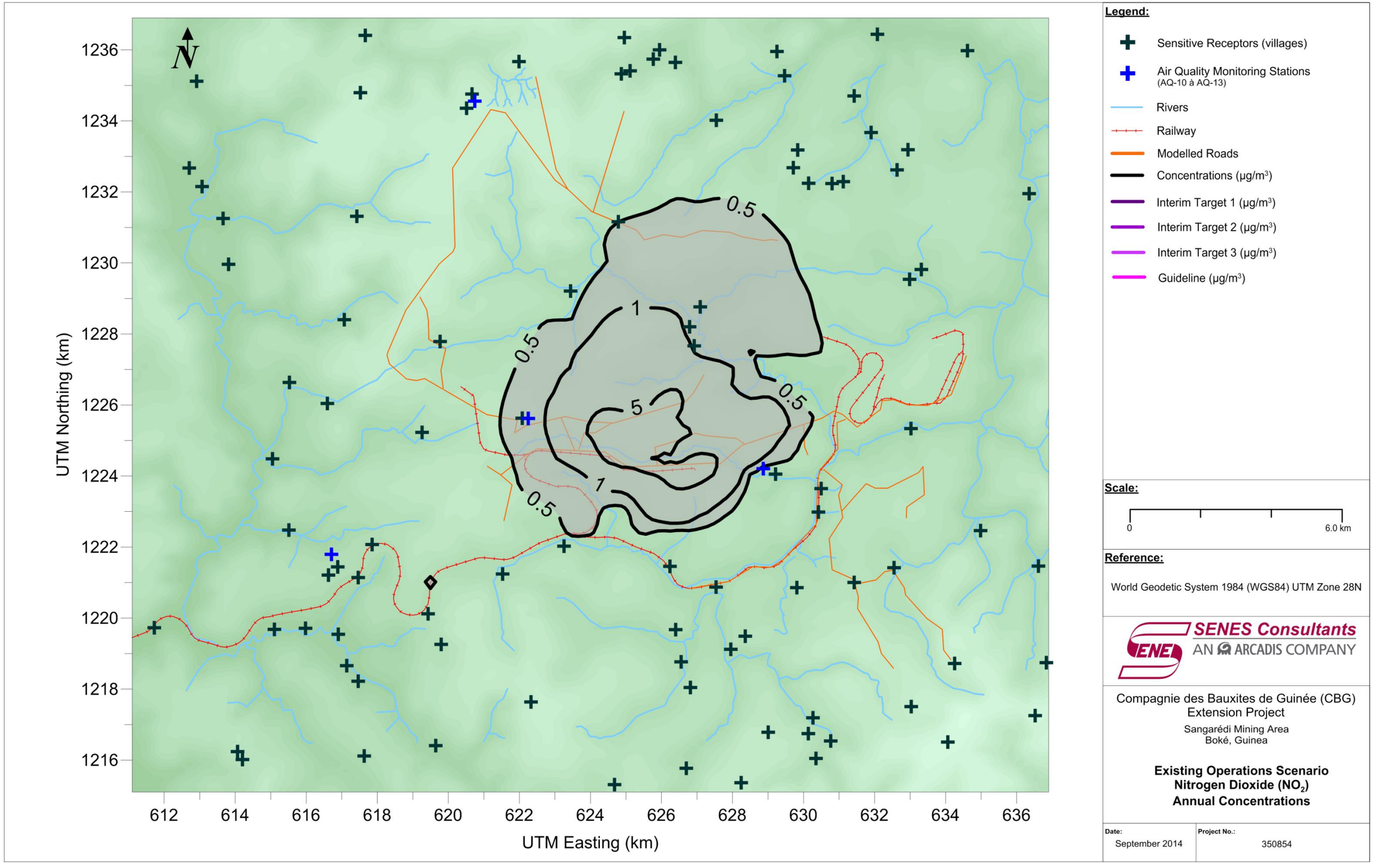
Date:	Project No.:
September 2014	350854

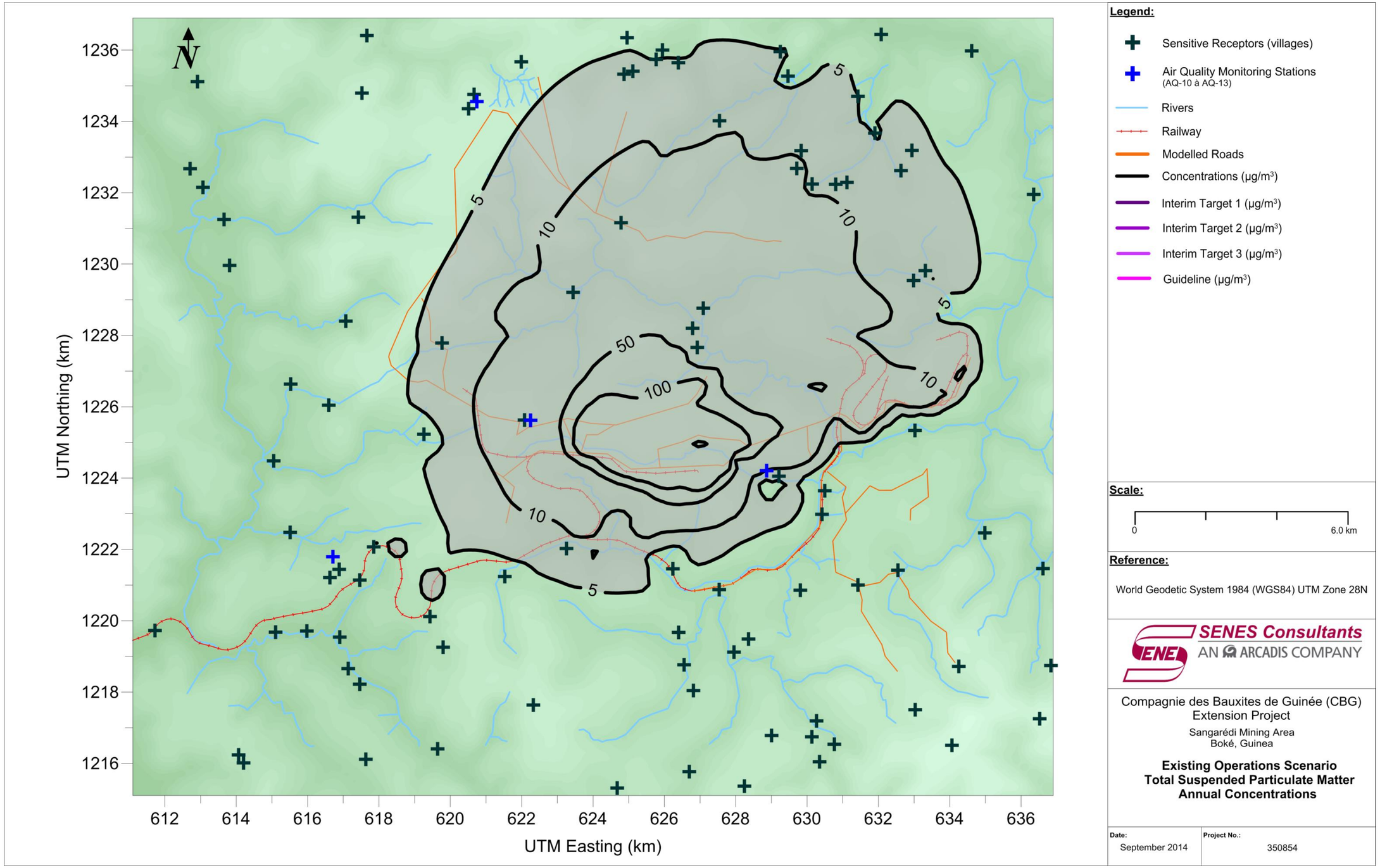
Sangarédi

Existing Operations


N
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
2
5
10
20
30
50
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
Existing Operations
Particulate Matter less than
10 microns (PM10)
Annual Concentrations
Date:
September 2014
Project No.:
350854

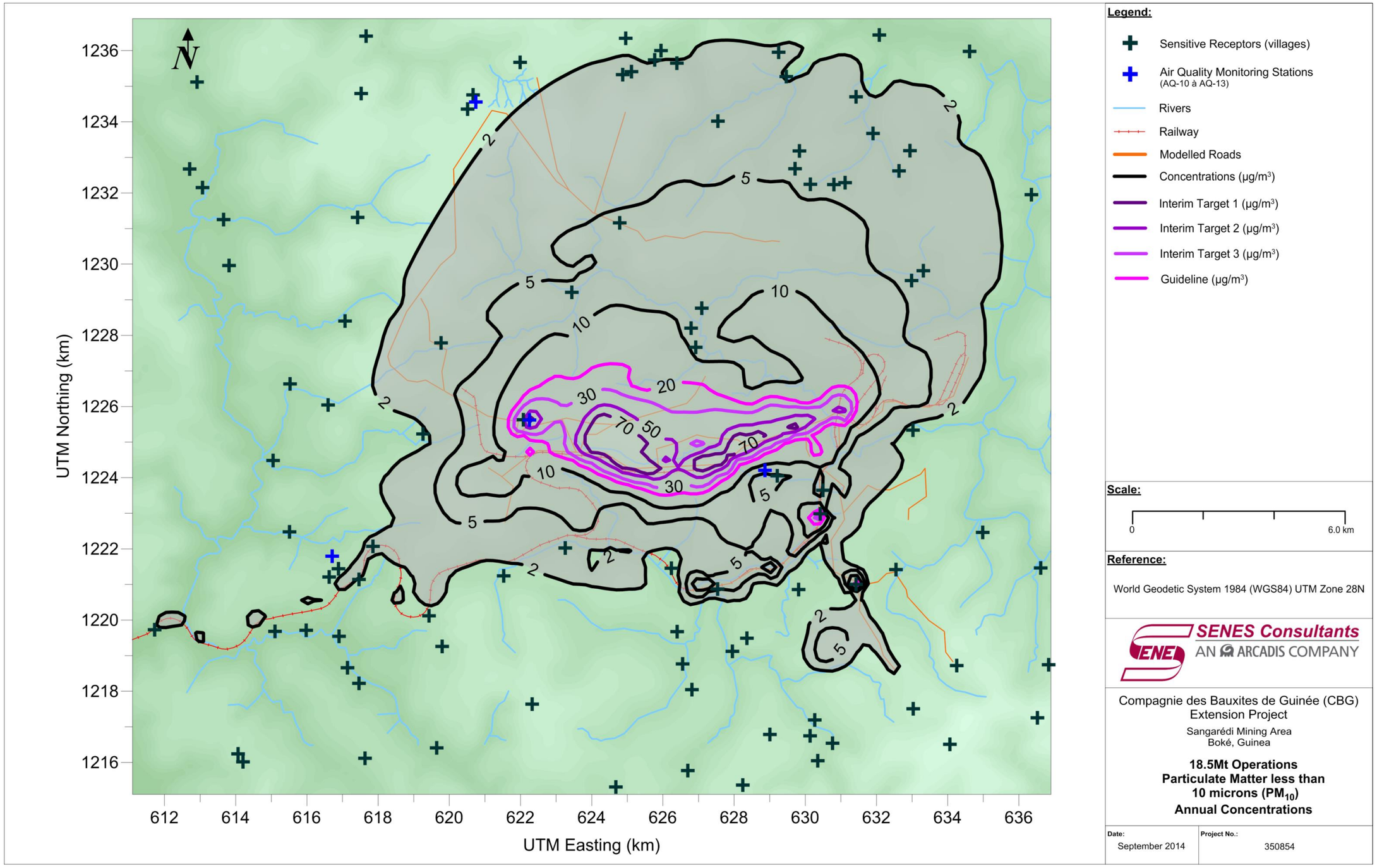

N
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Northing (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
UTM Easting (km)
1
1
1
2.5
5
1
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
Existing Operations
Particulate Matter less than
2.5 microns (PM2.5)
Annual Concentrations
Date:
September 2014
Project No.:
350854

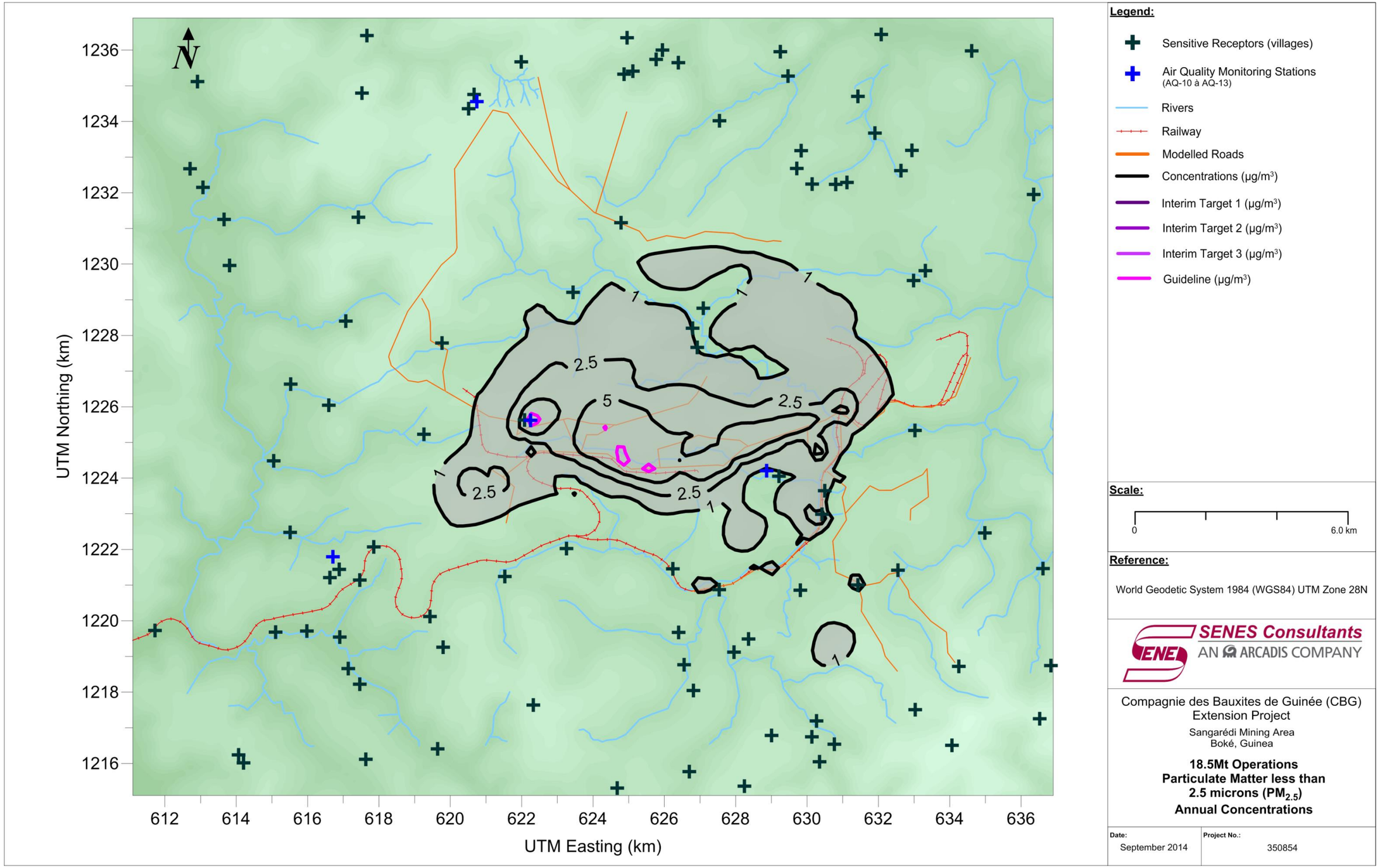

N
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
0.5
1
5
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
Existing Operations Scenario
Nitrogen Dioxide (NO2)
Annual Concentrations
Date:
September 2014
Project No.:
350854


N
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
5
10
50
100
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
Existing Operations Scenario
Total Suspended Particulate Matter
Annual Concentrations
Date:
September 2014
Project No.:
350854

Sangarédi

18.5 MTPY


N
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
634
636
2
5
10
20
30
50
70
Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
Railway
Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
0
6.0 km
Reference:
World Geodetic System 1984 (WGS84) UTM Zone 28N
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
18.5Mt Operations
Particulate Matter less than
10 microns (PM10)
Annual Concentrations
Date:
September 2014
Project No.:
350854


N
UTM Northing (km)
1236
1234
1232
1230
1228
1226
1224
1222
1220
1218
1216
UTM Easting (km)
612
614
616
618
620
622
624
626
628
630
632
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Legend:
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Air Quality Monitoring Stations
(AQ-10 à AQ-13)
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Modelled Roads
Concentrations (µg/m³)
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Interim Target 2 (µg/m³)
Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
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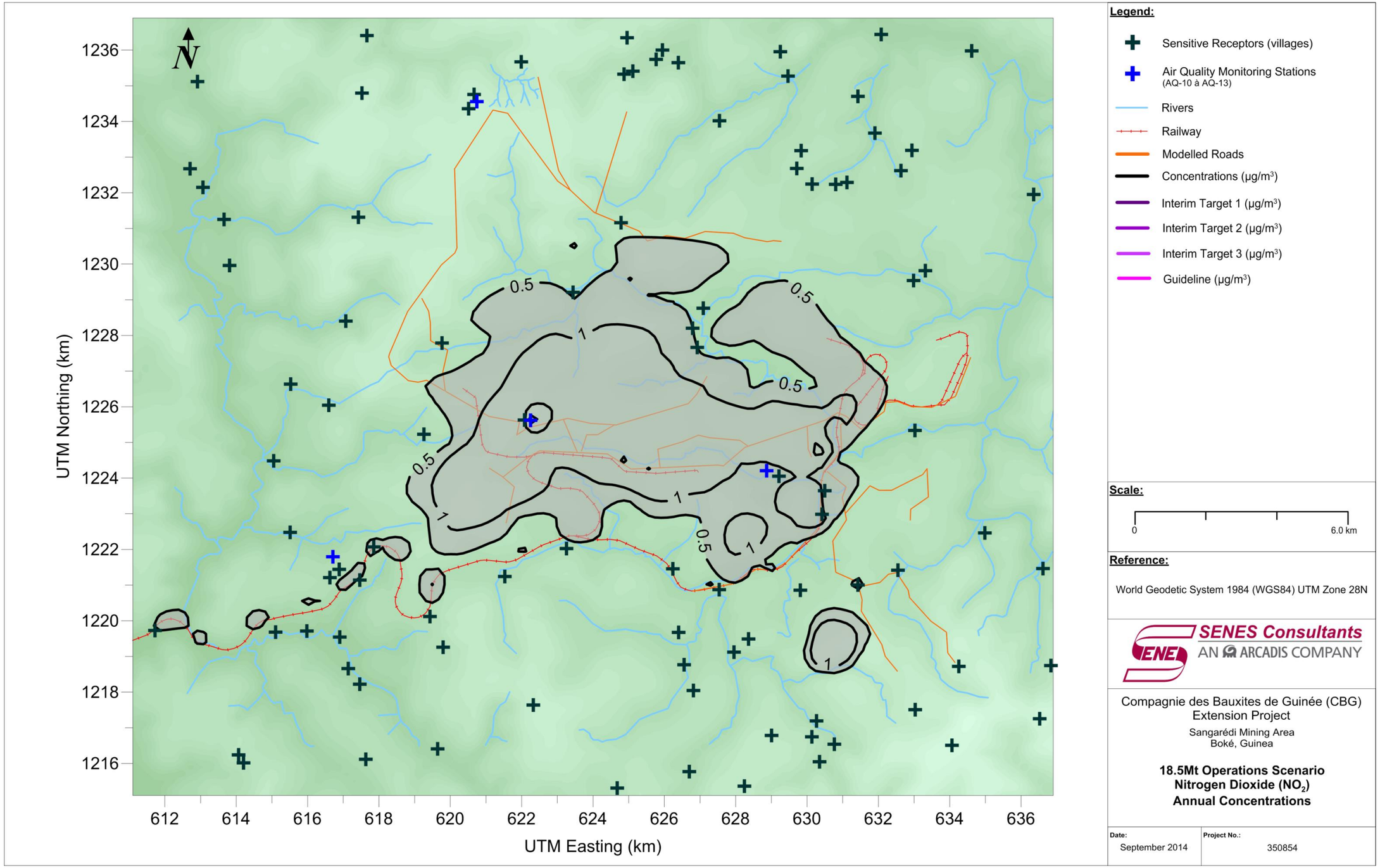
SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
18.5Mt Operations
Particulate Matter less than
2.5 microns (PM2.5)
Annual Concentrations
Date:
September 2014
Project No.:
350854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Extension Project
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18.5Mt Operations Scenario
Nitrogen Dioxide (NO2)
Annual Concentrations
Date:
September 2014
Project No.:
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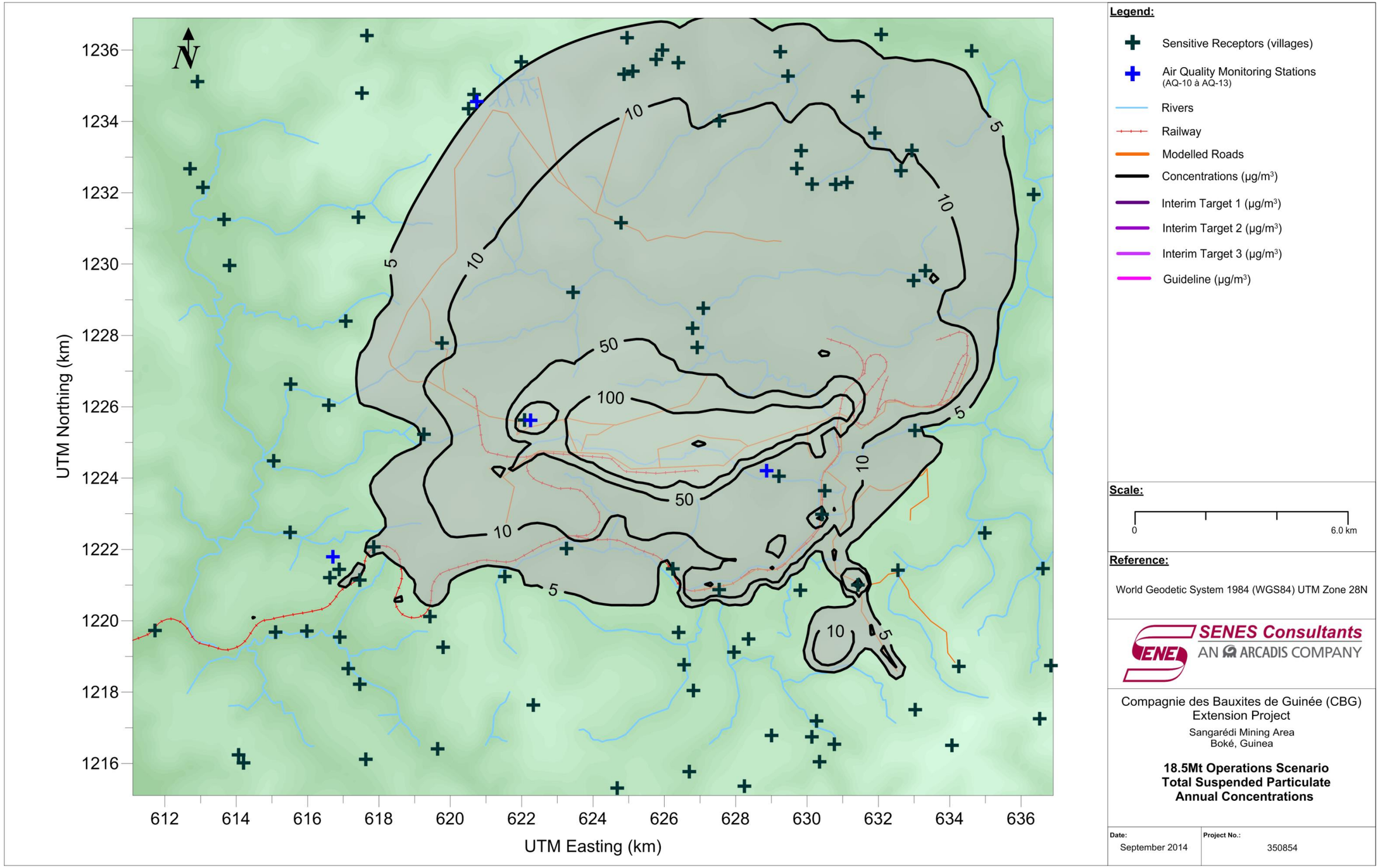
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Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
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Modelled Roads
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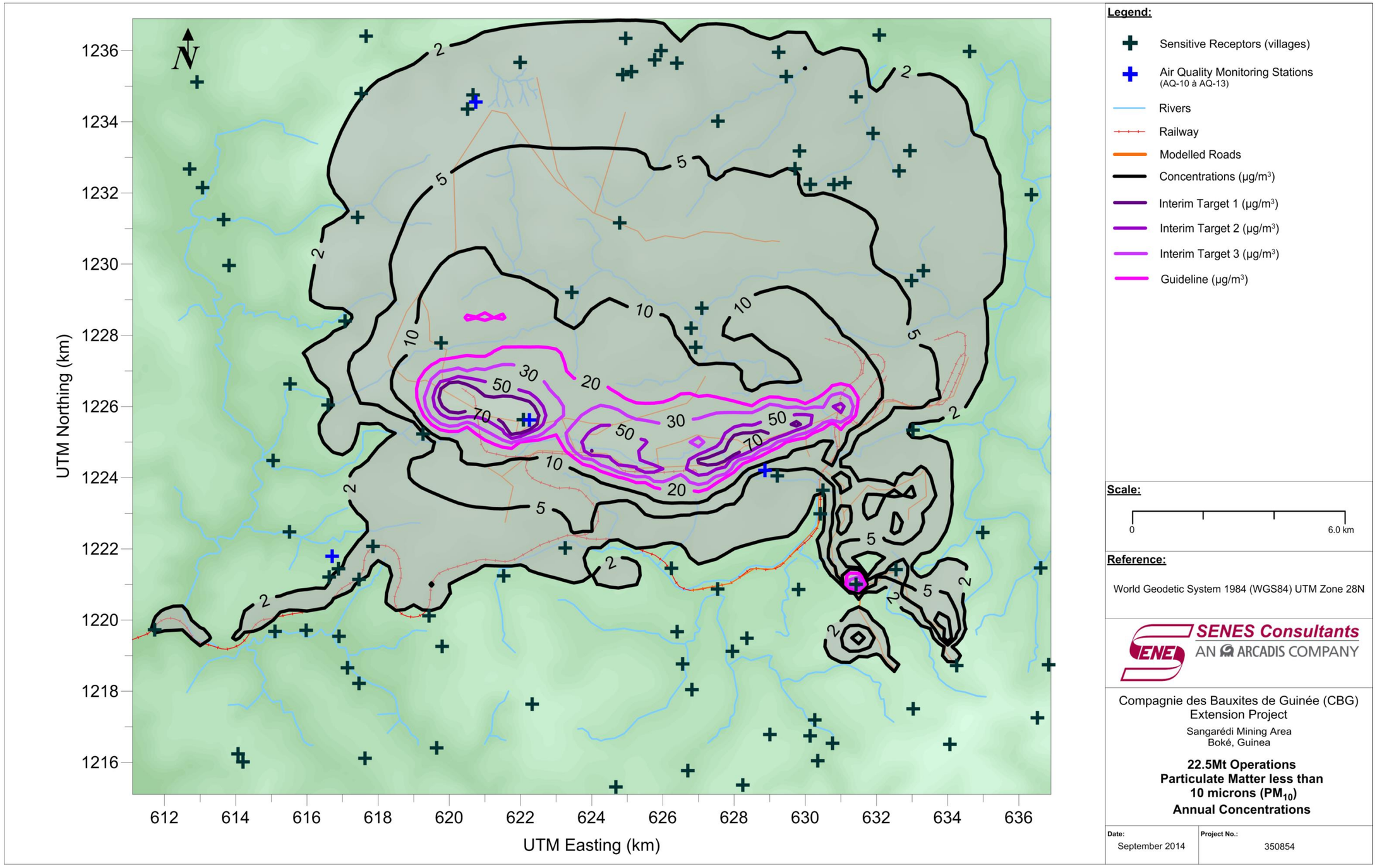
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
18.5Mt Operations Scenario
Total Suspended Particulate
Annual Concentrations
Date:
September 2014
Project No.:
350854

Sangarédi

22.5 MTPY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Air Quality Monitoring Stations
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SENES Consultants
AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
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22.5Mt Operations
Particulate Matter less than
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Annual Concentrations
Date:
September 2014
Project No.:
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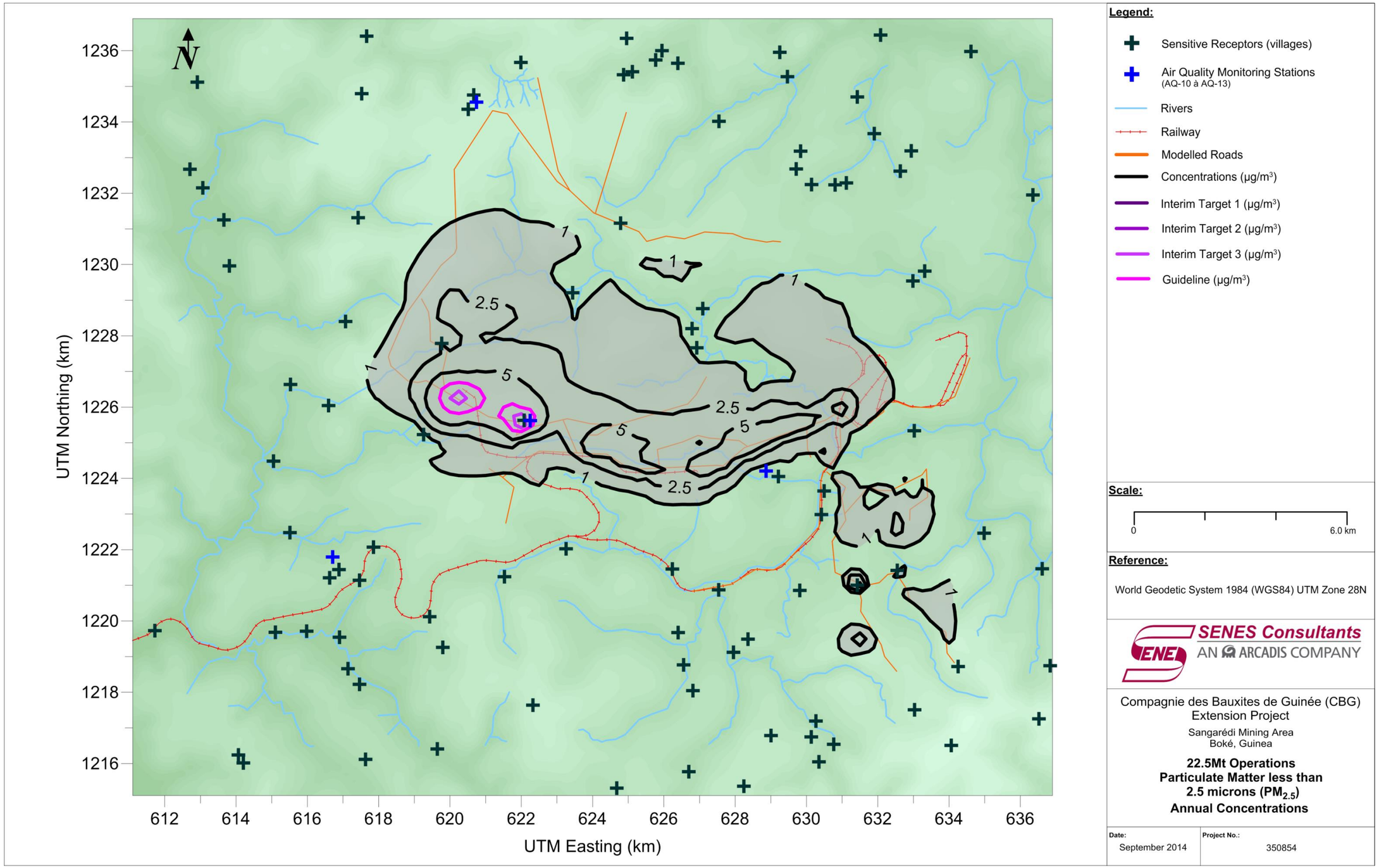
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Air Quality Monitoring Stations
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Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
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Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
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AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
22.5Mt Operations
Particulate Matter less than
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Annual Concentrations
Date:
September 2014
Project No.:
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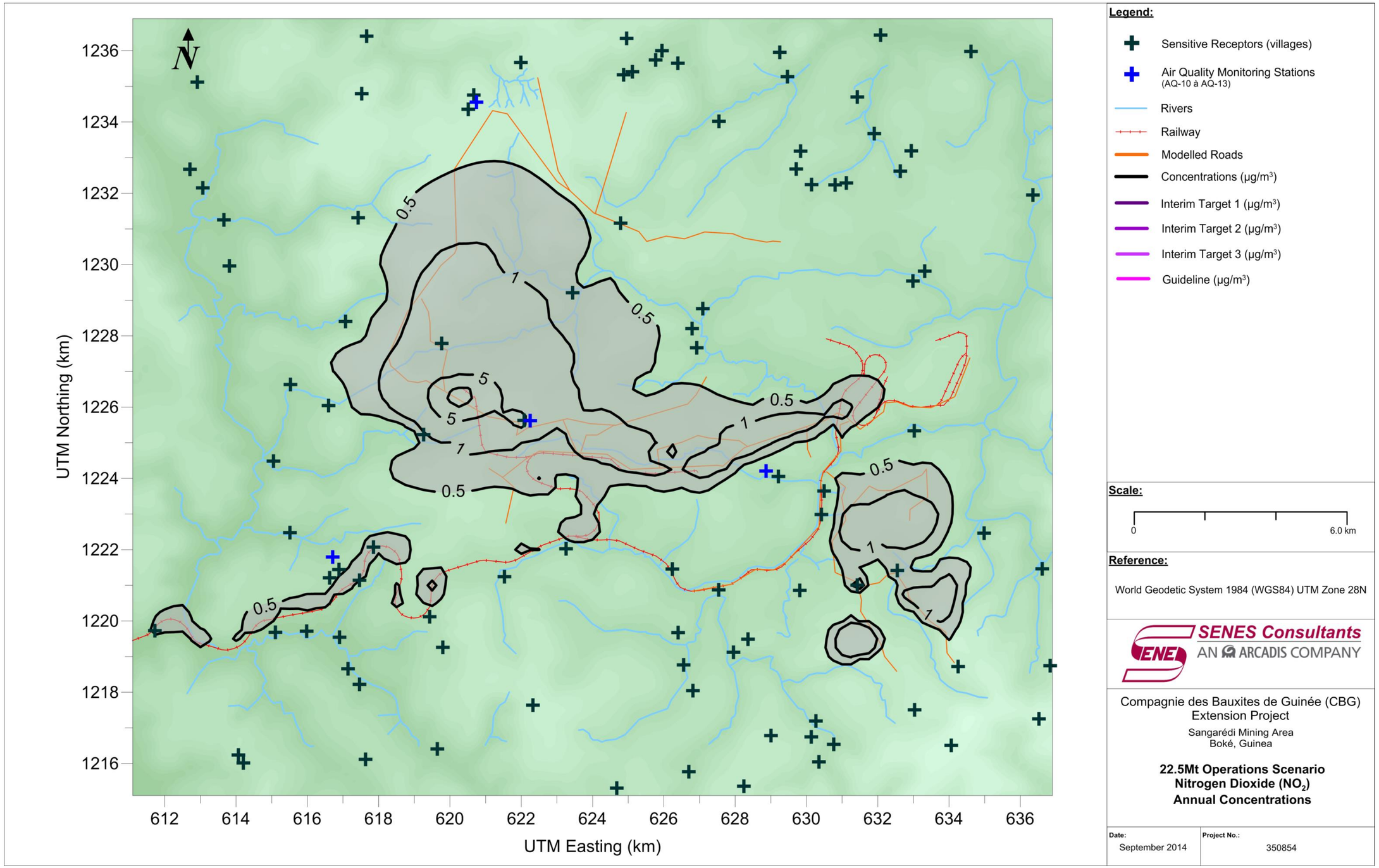
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Legend:
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Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
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Interim Target 3 (µg/m³)
Guideline (µg/m³)
Scale:
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AN ARCADIS COMPANY
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
22.5Mt Operations Scenario
Nitrogen Dioxide (NO2)
Annual Concentrations
Date:
September 2014
Project No.:
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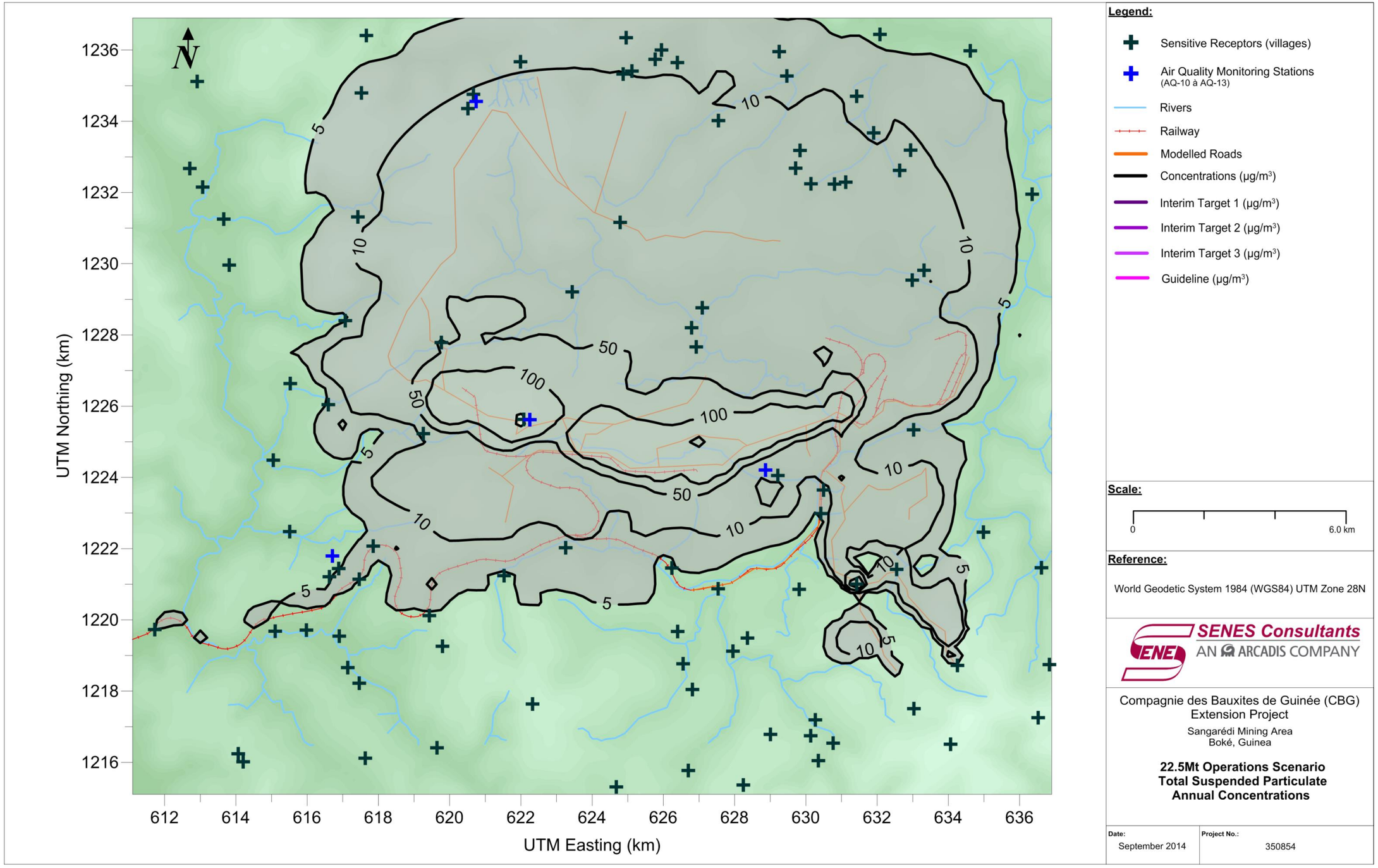
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Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
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Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
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Scale:
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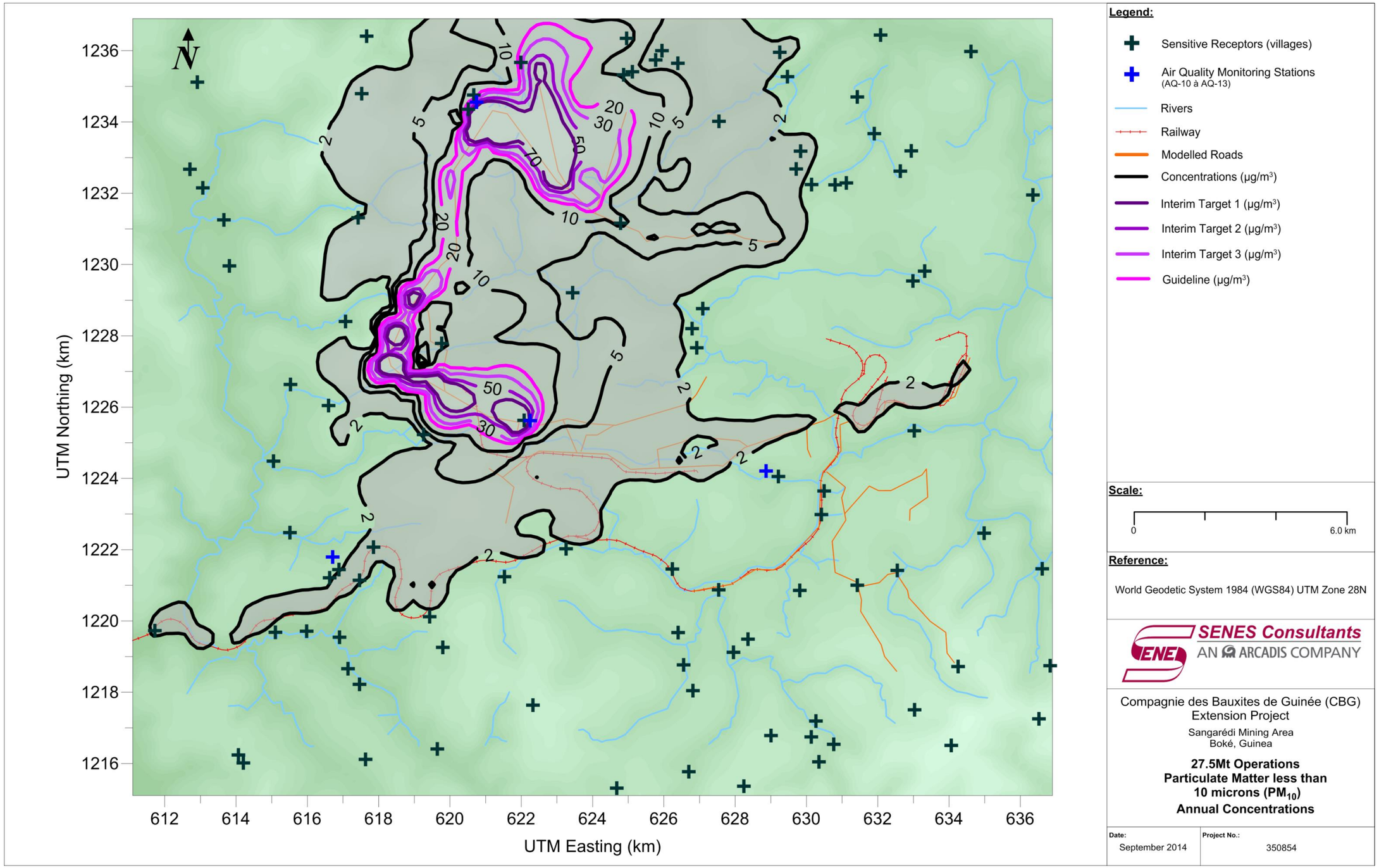
Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
22.5Mt Operations Scenario
Total Suspended Particulate
Annual Concentrations
Date:
September 2014
Project No.:
350854

Sangarédi

27.5 MTPY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Legend:
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Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
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Concentrations (µg/m³)
Interim Target 1 (µg/m³)
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SENES Consultants
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Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
27.5Mt Operations
Particulate Matter less than
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Annual Concentrations
Date:
September 2014
Project No.:
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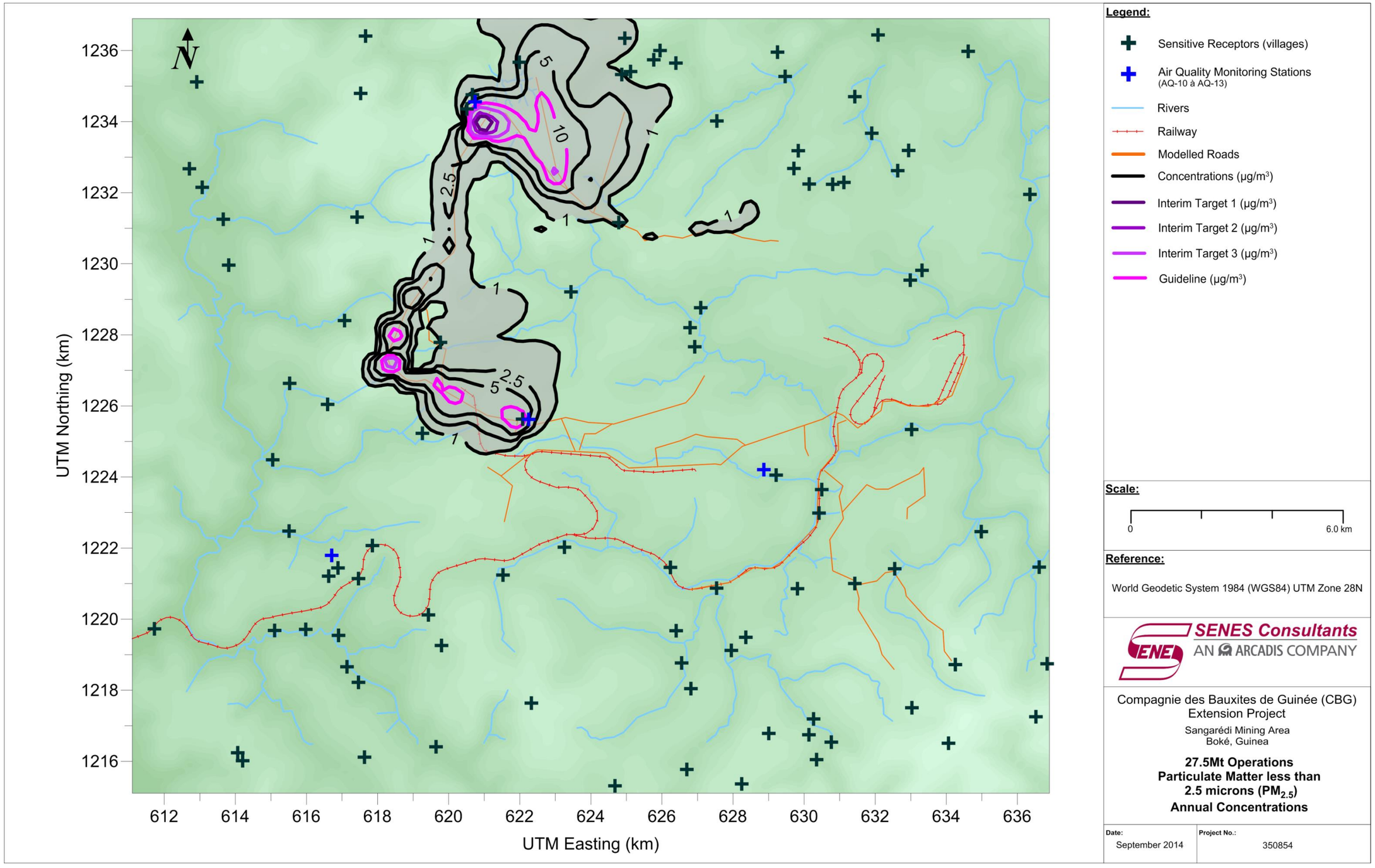
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Legend:
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Air Quality Monitoring Stations
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Rivers
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Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
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27.5Mt Operations
Particulate Matter less than
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Annual Concentrations
Date:
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Project No.:
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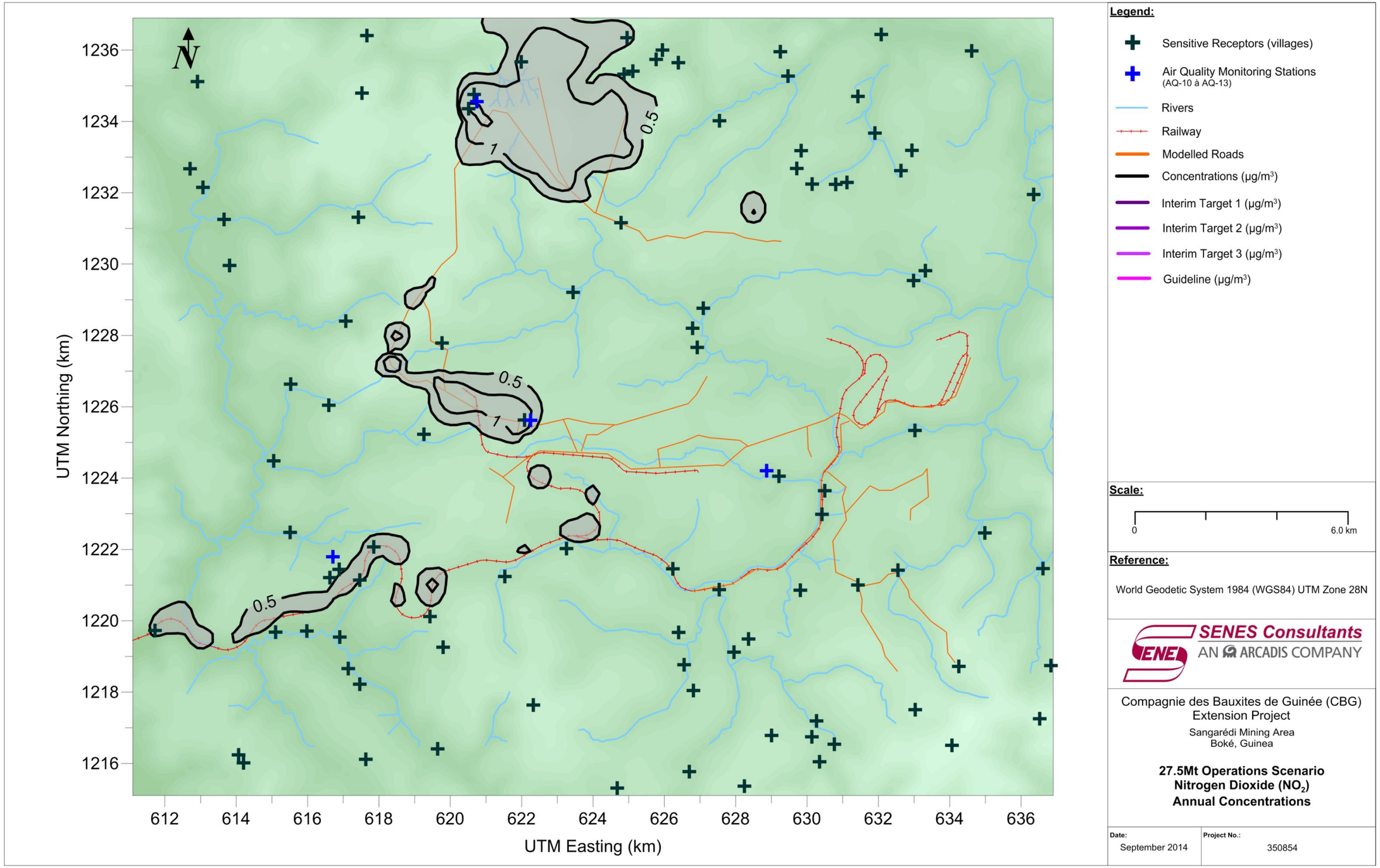
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Legend:
Sensitive Receptors (villages)
Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
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Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
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Guideline (µg/m³)
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Extension Project
Sangarédi Mining Area
Boké, Guinea
27.5Mt Operations Scenario
Nitrogen Dioxide (NO2)
Annual Concentrations
Date:
September 2014
Project No.:
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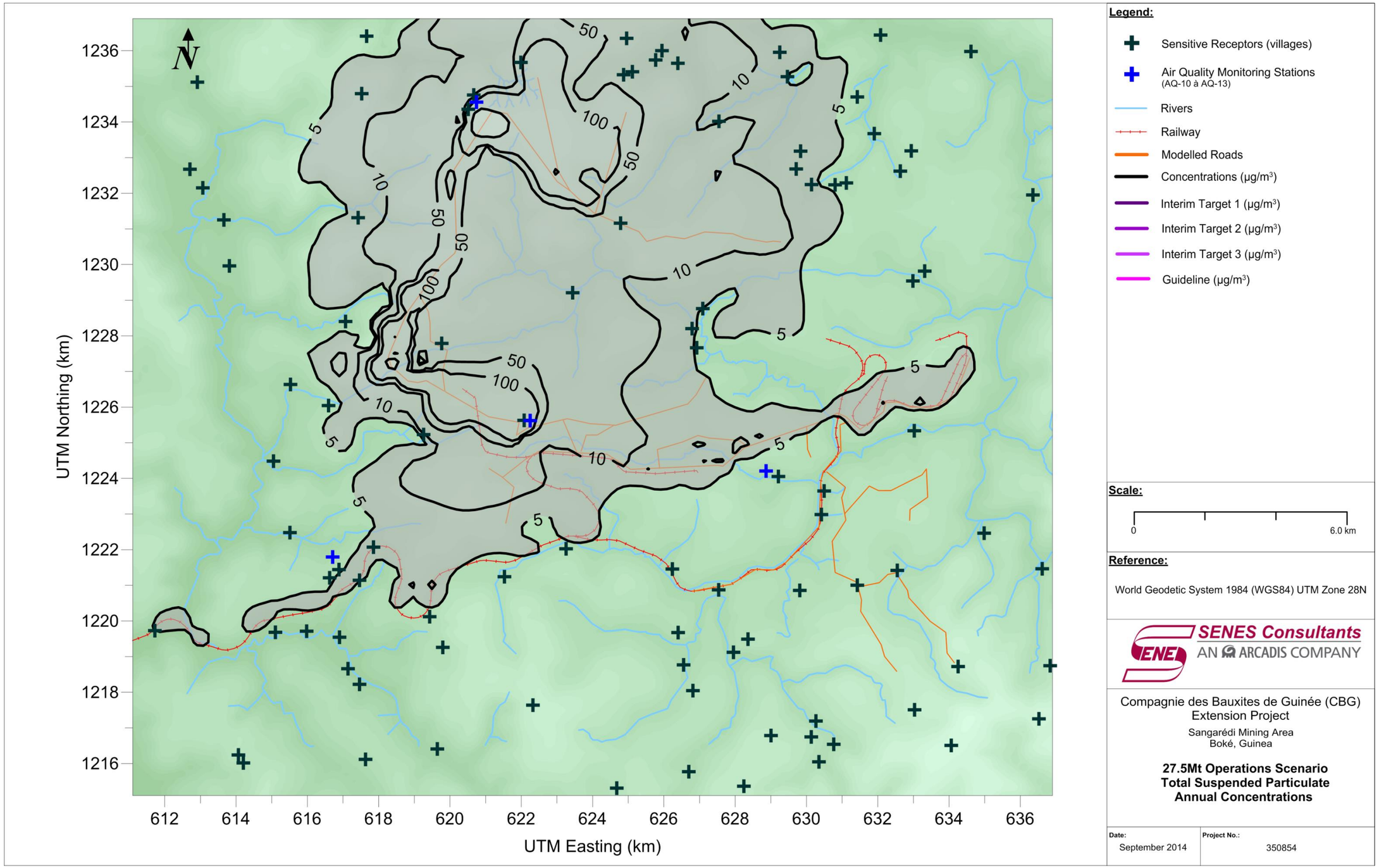
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Air Quality Monitoring Stations
(AQ-10 à AQ-13)
Rivers
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Modelled Roads
Concentrations (µg/m³)
Interim Target 1 (µg/m³)
Interim Target 2 (µg/m³)
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Guideline (µg/m³)
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Compagnie des Bauxites de Guinée (CBG)
Extension Project
Sangarédi Mining Area
Boké, Guinea
27.5Mt Operations Scenario
Total Suspended Particulate
Annual Concentrations
Date:
September 2014
Project No.:
350854

ATTACHMENT B:
VARIABLES AND ASSUMPTIONS FOR AIR EMISSIONS CALCULATIONS

Table B.1: Production for Kamsar and Sangarédi

	Units	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY	Comments
Total Annual Production						
Plant throughput @12.5% moisture	million tonnes per yr	14.9	20.5	24.9	30.5	Based on: ▪ AECOM 2011 ▪ Fluor 2014
Plant throughput @6.7% moisture	million tonnes per yr	13.5	19.2	23.4	28.6	
Plant throughput @3% moisture	million tonnes per yr	13.5	18.5	22.5	27.5	

Table B.2: Metal Content of Bauxite Ore and Overburden

	Relative Metal Content (as percent of TSP)						
	Al	**Sb**	**As**	**Cd**	**Cr**	**Cu**	**Ni**
Bauxite Ore [1, 2]	26%	0.0003%	0.003%	0.00002%	0.1%	0.01%	0.01%
Overburden [3]	4%	0.0001%	0.0005%	0.000004%	0.02%	0.002%	0.0009%

Notes:
[1] Relative Al content of bauxite ore is assumed based on an ore quality of 50% Al_2O_3 (i.e., 26% Al by weight).
[2] Relative metallic content of bauxite ore is scaled based on Al content of ore relative to overburden.
[3] Relative metallic content of overburden is based on the average of surface soil samples SI1 (AECOM 2011, page 3-79), SENES S1 & S3.

VARIABLES AND ASSUMPTIONS FOR THE KAMSAR PROCESSING FACILITY

Table B.3: Activity Data for Kamsar

	Units	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY	Comments
Trains per day	#	5.0	5.7	6.9	8.1	Based on: ▪ AECOM 2011 ▪ Fluor 2014
Net wagon capacity	tonnes	82	82	82	82	
Wagons per train	#	120	120	120	126	
Wagons per hour	#	37	44	53	65	
Unloading hours per train	#	3.3	2.7	2.3	1.9	
Locomotives per train	#	2	3	3	3	
Yard locomotives	#	2	2	2	2	Assumed

Table B.4: Fuel Consumption at the Kamsar Processing Facility

Source	Fuel Type	Daily Fuel Consumption (L per day)			
		Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Old Generators [1] (6 units, 2.5MW each)	Fuel Oil (No. 6)	34,333	-	-	-
Old Generator [1] (Unit 9, 3.3MW)	Fuel Oil (No. 6)	7,553	8,829	9,409	12,492
Old Generator [1] (Unit 10, 6MW)	Fuel Oil (No. 6)	13,733	16,052	17,107	22,713
	Diesel	1,616	1,616	1,616	1,616
New Generators [1] (Units 11 and 12, 7.4MW each)	Fuel Oil (No. 6)	33,876	39,596	42,198	56,026
New Generators [1] (Units 13 and 14, 7.4MW each)	Fuel Oil (No. 6)	-	39,596	42,198	56,026
New Generator [1] (Unit 15, 7.4MW)	Fuel Oil (No. 6)	-	19,798	21,099	28,013
Steam Boilers [1] (2 units, 0.9MW total)	Fuel Oil (No. 6)	1,682	2,408	2,566	3,407
Locomotives [2]	Diesel	4,856	8,304	10,053	11,801
Yard Locomotives [2]	Diesel	971	-	-	-

Notes:

[1] Fuel consumption totals for generators and boilers were based on the fuel inventory for Centrale Kamsar in CBG greenhouse gas inventories (2012 and 18.5 MTPY, 22.5 MTPY & 27.5MTPY). Fuel totals were split based on the nominal power of the units (AECOM 2011; Fluor 2014).

[2] Fuel consumption for locomotives was based on a nominal horsepower rating (3,000 hp per locomotive; AECOM 2011, Annex F), the number of locomotives per train (Fluor 2014) and fuel densities in the U.S. EPA document Nonroad Emission Factors for Locomotives.

Table B.5: Material Handling Rates in Kamsar (Existing)

Source Description	Max Operating Feed Rate (tonnes/hr)	Equipment Utilization Rate (%)	Feed Rate (tonnes/hr)	Control (%)	Comments
Primary crusher	3000	65%	1950	80%	Crusher building and transfer towers partially enclosed.
Secondary crusher	3000	65%	1950	80%	
Transfer tower (TAN001)	3000	65%	1950	80%	
Transfer tower (TAN002)	3000	65%	1950	80%	
Transfer tower (TAN003)	3000	65%	1950	80%	
Transfer tower (TAN004)	3000	65%	1950	80%	
Transfer tower (TAN006)	2000	65%	1300	80%	
Transfer tower (TAN007)	5000	65%	3250	80%	
Dry product hopper (TAN010)	5000	65%	3250	80%	
Transfer tower at Corner Island	4500	65%	2925	80%	
Dryer#1 (FOR001)	900	65%	585	99%	Controlled by dryer scrubber (99% efficiency)
Dryer#2 (FOR002)	900	65%	585	99%	
Dryer#3 (FOR003)	900	65%	585	99%	
Microgranulation	27	65%	18	80%	Material handling rate assumed to be 1% of total for existing dryers
Loading activities at dry product storage pile	2000	65%	1300	95%	Indoor source
Ship berth#1	4500	65%	2925	95%	Drop into ship hold

Note: Material handling rates from AECOM 2011 Figure 3.2

Table B.6: Material Handling Rates in Kamsar (18.5 MTPY)

Source Description	Max Operating Feed Rate (tonnes/hr)	Equipment Utilization Rate (%)	Feed Rate (tonnes/hr)	Control (%)	Comments
Primary crusher (CNC301)	3600	65%	2340	96%	New crusher building with dry fogging/dust control system (additional 80% control efficiency)
Secondary crusher (CNC302)	3600	65%	2340	96%	
Transfer tower (TAN001)	4000	65%	2600	96%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Transfer tower (TAN002)	4000	65%	2600	80%	
Transfer tower (TAN003)	4000	65%	2600	80%	Partially enclosed
Transfer tower (TAN004)	5400	65%	3510	96%	
Transfer tower (TAN006)	900	65%	585	80%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Transfer tower (TAN007)	5000	65%	3250	80%	Partially enclosed
Dry product hopper (TAN010)	5000	65%	3250	80%	
Transfer tower at Corner Island	4500	65%	2925	80%	
Transfer tower (TAN301)	4000	65%	2600	96%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Transfer tower (TAN305)	1400	65%	910	96%	
Dryer#1 (FOR001)	900	65%	585	99%	Controlled by dryer scrubber (99% efficiency)
Dryer#2 (FOR002)	900	65%	585	99%	
Dryer#3 (FOR003)	900	65%	585	99%	
Microgranulation	27	65%	18	80%	Partially enclosed
Dryer#4 (FOR004)	1400	65%	910	99%	Controlled by dryer scrubber (99% efficiency)
Loading activities at dry product storage pile	900	65%	585	99%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Ship berth#1	4500	65%	2925	95%	Drop into ship hold

Note: Material handling rates from process flow drawing no. KMH-SK-201 (Fluor 2014).

Table B.7: Material Handling Rates in Kamsar (22.5 MTPY)

Source Description	Max Operating Feed Rate (tonnes/hr)	Equipment Utilization Rate (%)	Feed Rate (tonnes/hr)	Control (%)	Comments
Primary crusher (CNC301)	2200	65%	1430	96%	New crusher building with dry fogging/dust control system (additional 80% control efficiency)
Secondary crusher (CNC302)	2200	65%	1430	96%	
Primary crusher (CNC303)	2200	65%	1430	96%	
Secondary crusher (CNC303)	2200	65%	1430	96%	
Transfer tower (TAN001)	4400	65%	2860	96%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Transfer tower (TAN002)	4400	65%	2860	96%	
Transfer tower (TAN003)	4400	65%	2860	96%	
Transfer tower (TAN004)	5800	65%	3770	96%	
Transfer tower (TAN006)	2900	65%	1885	96%	
Transfer tower (TAN007)	7000	65%	4550	96%	
Dry product hopper (TAN010)	7000	65%	4550	96%	
Transfer tower at Corner Island	6000	65%	3900	96%	
Transfer tower (TAN301)	4400	65%	2860	96%	
Transfer tower (TAN305)	1400	65%	910	96%	
Dryer#1 (FOR001)	900	65%	585	99%	Controlled by dryer scrubber (99% efficiency)
Dryer#2 (FOR002)	900	65%	585	99%	
Dryer#3 (FOR003)	900	65%	585	99%	
Microgranulation	27	65%	18	80%	Partially enclosed
Dryer#4 (FOR004)	1400	65%	910	99%	Controlled by dryer scrubber (99% efficiency)
Loading activities at dry product storage pile	2900	65%	1885	99%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Ship berth#1	6000	65%	3900	95%	Drop into ship hold

Note: Material handling rates from process flow drawing no. KMH-SK-202 (Fluor 2014).

Table B.8: Material Handling Rates in Kamsar (27.5 MTPY)

Source Description	Max Operating Feed Rate (tonnes/hr)	Equipment Utilization Rate (%)	Feed Rate (tonnes/hr)	Control (%)	Comments
Primary crusher (CNC301)	2700	65%	1755	96%	New crusher building with dry fogging/dust control system (additional 80% control efficiency)
Secondary crusher (CNC302)	2700	65%	1755	96%	
Primary crusher (CNC303)	2700	65%	1755	96%	
Secondary crusher (CNC303)	2700	65%	1755	96%	
Transfer tower (TAN001)	5400	65%	3510	96%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Transfer tower (TAN002)	5400	65%	3510	96%	
Transfer tower (TAN003)	5400	65%	3510	96%	
Transfer tower (TAN004)	8200	65%	5330	96%	
Transfer tower (TAN006)	1500	65%	975	96%	
Transfer tower (TAN007)	7000	65%	4550	96%	
Dry product hopper (TAN010)	7000	65%	4550	96%	
Transfer tower at Corner Island	6000	65%	3900	96%	
Transfer tower (TAN301)	5400	65%	3510	96%	
Transfer tower (TAN305)	1400	65%	910	96%	
Transfer tower (TAN306)	1400	65%	910	96%	
Transfer tower (TAN308)	6000	65%	3900	96%	
Transfer tower (TAN309)	6000	65%	3900	96%	
Dry product hopper (TRE303)	7000	65%	4550	96%	
Dryer#1 (FOR001)	900	65%	585	99%	Controlled by dryer scrubber (99% efficiency)
Dryer#2 (FOR002)	900	65%	585	99%	
Dryer#3 (FOR003)	900	65%	585	99%	
Microgranulation	27	65%	18	80%	Partially enclosed
Dryer#4 (FOR004)	1400	65%	910	99%	Controlled by dryer scrubber (99% efficiency)
Dryer#5 (FOR005)	1400	65%	910	99%	
Loading activities at dry product storage pile #1	750	65%	488	99%	Upgraded dry fogging/dust control system (additional 80% control efficiency)
Loading activities at dry product storage pile #2	750	65%	488	99%	
Ship berth#1	6000	65%	3900	95%	Drop into ship hold
Ship berth#2	6000	65%	3900	95%	

Note: Material handling rates from process flow drawing no. KMH-SK-203 (Fluor 2014).

Table B.9: Stockpile Characteristics at the Kamsar Processing Facility

	Silt Content [1] (%)	Frequency of Winds >5.4m/s [2] (%)	Active Surface Area (ha) [3]			
			Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Raw storage piles	15%	6.5%	9.1			
Area outside dry storage building	15%	6.5%	0.4			

Notes:

[1] Silt content obtained from Table 13.2.4-1 from AP-42, Chapter 13.2.4 - Aggregate Handling and Storage Piles. Bauxite assumed to be similar to "exposed ground".

[2] Frequency of unobstructed wind speed exceeding 5.4 m/s (at mean pile height) derived from CALMET dataset.

[3] Dimensions based on satellite imagery from Bing Maps (2014). Assumed dimensions for outdoor stockpile of 300 m x 300 m x 1 m.

VARIABLES AND ASSUMPTIONS FOR THE SANGARÉDI MINING AREA

Table B.10: Activity Data for Sangarédi

	Units	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY	Comments
Active Work Areas		*2014*	*2017*	*2019*	*2027*	
No. of work areas	#	33	47	56	56	Based on 2014 CBG mine plan. Assumes: ▪ Working area sizes as shown in Figure 10
Total area covered	ha	112.6	177.1	195.6	199.6	
Drilling & Blasting						
Average size of blast	tonnes of ore per blast	48,609	67,136	81,637	99,804	Based on total annual production. Assumes: ▪ 6.11 blasts per week (AECOM 2011, Annex F) ▪ material density of 1.4 tonnes/m^3 (Fluor 2014) ▪ ore depth of 8 m ▪ hole spacing of 5 m
Average horizontal blast area	m per blast	4,340	5,994	7,289	8,911	
Holes drilled	# per day	152	209	254	311	
Quantity of ANFO	tonnes per blast	9	12	15	18	
Clearing & Dozing						
Area of overburned cleared	m per day	3,788	5,232	6,362	7,778	Based on total annual production. Assumes: ▪ material density of 1.4 tonnes/m^3 (Fluor 2014) ▪ ore depth of 8 m ▪ dozer blade width of 4.65 m and blade capacity of 16.4 m^3 (CAT D9R)
Volume of overburned cleared	m per day	1,894	2,616	3,181	3,889	
One-way dozer trips	movements per day	115	160	194	237	
Length of a Dozer Movement	m per movement	44	51	56	62	
Haul Trucks						
Total one-way haul truck trips	trips per yr	165,000	227,889	277,111	338,778	Based on total annual production. Assumes: ▪ haul truck capacity of 90 tonnes (CAT 777F) ▪ no. of haul trucks listed in CBG GHG inventory
One-way trips per haul truck	trips per truck per yr	8,250	8,765	9,237	9,410	
Haul truck empty weight	tonnes	73	73	73	73	Based on: ▪ typical values for CAT 777F
Length of active haul roads	km	14.8	33.7	33.5	33.6	Based on: ▪ length of roads and active work areas shown in Figure 10
Total VKT of active haul trucks	VKT per day	3,934	10,341	12,986	41,970	

	Units	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY	Comments
Light, Medium & Heavy Vehicles						
Length of active roads	km	12.8	12.8	12.8	12.8	Based on: ▪ length of roads and active work areas shown in Figure 10 Assumes: ▪ vehicles are active on roads between CBG office and train loading areas ▪ no. of vehicles listed in CBG GHG inventory
Total VKT of light vehicles	VKT per day	253	253	253	253	
Total VKT of medium and heavy vehicles	VKT per day	169	169	169	169	
Light vehicle average weight	tonnes	1.55	1.55	1.55	1.55	Based on: ▪ vehicles listed in CBG existing equipment list ▪ typical values for Toyota Land Cruiser (J70) and GMC TopKick
Medium and heavy vehicle average weight	tonnes	5.1	5.1	5.1	5.1	
Train Loading						
Number of switching locomotives	#	1	1	1	1	Assumed
One-way train trips	trains per day	5.0	5.7	6.9	8.1	Based on: ▪ Fluor 2014
Locomotives per train	locomotives per train	2	3	3	3	
Train size	wagons per train	120	120	120	126	
Quantity of ore stockpiled	tonnes of ore	157,500	179,550	217,350	255,150	Based on satellite imagery of existing train loading area available from Bing Maps (2014). Assumes: ▪ stockpile dimensions of 50 m x 450 m x 5 m ▪ material density of 1.4 tonnes/m^3 (Fluor 2014)
Number of active ore stockpiles	#	10	11	14	16	
Total surface area of an ore stockpiles	ha	24.3	27.7	33.5	39.3	

Table B.11: Mobile Vehicle and Equipment Fleet in Sangarédi

Source	Total Number of Units				Comments
	Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY	
Mining Equipment					Based on: ▪ no. of vehicles listed in CBG GHG inventory ▪ AECOM 2011 ▪ inventory of existing equipment and vehicles provided by CBG
Loader	11	13	16	18	
Truck 90T	20	26	30	36	
Dozer D9	7	7	7	7	
Dozer D10		2	3	4	
Wheel Dozer	2	3	3	4	
Grader	2	3	3	4	
Small Excavator	3	3	3	4	
Light vehicles	42	42	42	42	
Medium/heavy vehicles	22	22	22	22	

Table B.12: Fuel Consumption in the Sangarédi Mining Area (Short-term Effects Emissions Scenario)

Source	Fuel Type	Daily Fuel Consumption (L per day)			
		Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Centrale Sangarédi [1]	Diesel	19,129	21,261	23,584	24,649
Mobile Equip - Mining machinery [1]	Diesel	448	409	398	446
Mobile Equip - Haul trucks (on site) [2]	Diesel	530	484	468	562
Mobile Equip - Haul trucks (passing) [2]	Diesel	4,578	2,639	3,078	3,677
Mobile Equip - Light vehicles [2]	Diesel	19	19	19	19
Mobile Equip - Heavy vehicles [2]	Diesel	33	33	33	33
Mobile Equip - Track equipment [1]	Diesel	184	285	443	472
Locomotives – Hauling [3]	Diesel	320	547	663	778
Locomotives – Switching [3]	Diesel	34	34	34	34

Notes:

[1] Fuel consumption totals for Centrale Sangarédi and Mining Machinery were based on the fuel inventory in CBG greenhouse gas inventories (2012 and 18.5 MTPY, 22.5 MTPY & 27.5MTPY)

[2] Fuel consumption totals for vehicles were based on the fuel inventory in CBG greenhouse gas inventories (2012 and 18.5 MTPY, 22.5 MTPY & 27.5MTPY) and apportioned based on road length and vehicle trips

[3] Fuel consumption for locomotives was based on a nominal horsepower rating (3,000 hp per locomotive; AECOM 2011, Annex F), the number of locomotives per train (Fluor 2014) and fuel densities in the U.S. EPA document Nonroad Emission Factors for Locomotives.

Table B.13: Fuel Consumption in the Sangarédi Mining Area (Long-term Effects Emissions Scenario)

Source	Fuel Type	Daily Fuel Consumption (L per day)			
		Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Centrale Sangarédi [1]	Diesel	19,129	21,261	23,584	24,649
Mobile Equip - Mining machinery [1]	Diesel	14,781	19,240	22,264	24,995
Mobile Equip - Haul trucks [2]	Diesel	17,486	22,731	26,229	31,474
Mobile Equip - Light vehicles [2]	Diesel	62	62	62	62
Mobile Equip - Heavy vehicles [2]	Diesel	105	105	105	105
Mobile Equip - Track equipment [1]	Diesel	184	285	443	472
Locomotives – Hauling [3]	Diesel	320	547	663	778
Locomotives – Switching [3]	Diesel	34	34	34	34

Notes:

[1] Fuel consumption totals for Centrale Sangarédi and Mining Machinery were based on the fuel inventory in CBG greenhouse gas inventories (2012 and 18.5 MTPY, 22.5 MTPY & 27.5MTPY)

[2] Fuel consumption totals for vehicles were based on the fuel inventory in CBG greenhouse gas inventories (2012 and 18.5 MTPY, 22.5 MTPY & 27.5MTPY) and apportioned based on road lengths and vehicle trips

[3] Fuel consumption for locomotives was based on a nominal horsepower rating (3,000 hp per locomotive; AECOM 2011, Annex F), the number of locomotives per train (Fluor 2014) and fuel densities in the U.S. EPA document Nonroad Emission Factors for Locomotives.

Table B.14: Fuel Consumption in the Sangarédi Mining Area (Rail Siding Emissions Scenario)

Source	Fuel Type	Daily Fuel Consumption (L per day)			
		Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Idling Locomotives at Rail Siding [1]	Diesel	18,155			

Notes:

[1] Fuel consumption for locomotives was based on a nominal horsepower rating (3,000 hp per locomotive; AECOM 2011, Annex F), the number of locomotives per train (Fluor 2014) and fuel densities in the U.S. EPA document Nonroad Emission Factors for Locomotives.

Table B.15: Material Handling Rates in Sangarédi (Existing)

Timeframe	Source Description	Moisture Content (%)	Wind Speed (m/s) [2]	Handling Rate (tonnes/hour)	Control (%) [3]
Short-term Effects Scenario	Drop to haul truck from loader [1]	12.5%	2.80	63	0%
	Drop to stockpile from haul truck			2050	
	Drop to train from loader			2050	
Long-term Effects Scenario	Drop to haul truck from loader	12.5%	2.35	1768	29%
	Drop to stockpile from haul truck			1768	
	Drop to train from loader			1768	

Notes:
[1] In the short-term effects scenario, drops to the haul truck only consider activities at the generic working area. All other material handling rates consider the full Sangarédi study area.
[2] Wind speeds derived from CALMET dataset. Maximum monthly wind speed used for short-term effects scenario; average monthly wind speed used for long-term effects scenario.
[3] Annual emissions account for a natural control efficiency of 29% due to precipitation (i.e., 101 days per year with > 0.25 mm of precipitation; derived from CALMET)

Table B.16: Material Handling Rates in Sangarédi (18.5 MTPY)

Timeframe	Source Description	Moisture Content (%)	Wind Speed (m/s) [2]	Handling Rate (tonnes/hour)	Control (%) [3]
Short-term Effects Scenario	Drop to haul truck from loader [1]	12.5%	2.80	55	0%
	Drop to stockpile from haul truck			2442	
	Drop to train from loader			2442	
Long-term Effects Scenario	Drop to haul truck from loader	12.5%	2.35	2442	29%
	Drop to stockpile from haul truck			2442	
	Drop to train from loader			2442	

Notes:
[1] In the short-term effects scenario, drops to the haul truck only consider activities at the generic working area. All other material handling rates consider the full Sangarédi study area.
[2] Wind speeds derived from CALMET dataset. Maximum monthly wind speed used for short-term effects scenario; average monthly wind speed used for long-term effects scenario.
[3] Annual emissions account for a natural control efficiency of 29% due to precipitation (i.e., 101 days per year with > 0.25 mm of precipitation; derived from CALMET)

Table B.17: Material Handling Rates in Sangarédi (22.5 MTPY)

Timeframe	Source Description	Moisture Content (%)	Wind Speed (m/s) [2]	Handling Rate (tonnes/hour)	Control (%) [3]
Short-term Effects Scenario	Drop to haul truck from loader [1]	12.5%	2.80	61	0%
	Drop to stockpile from haul truck			2969	
	Drop to train from loader			2969	
Long-term Effects Scenario	Drop to haul truck from loader	12.5%	2.35	2969	29%
	Drop to stockpile from haul truck			2969	
	Drop to train from loader			2969	

Notes:
[1] In the short-term effects scenario, drops to the haul truck only consider activities at the generic working area. All other material handling rates consider the full Sangarédi study area.
[2] Wind speeds derived from CALMET dataset. Maximum monthly wind speed used for short-term effects scenario; average monthly wind speed used for long-term effects scenario.
[3] Annual emissions account for a natural control efficiency of 29% due to precipitation (i.e., 101 days per year with > 0.25 mm of precipitation; derived from CALMET)

Table B.18: Material Handling Rates in Sangarédi (27.5 MTPY)

Timeframe	Source Description	Moisture Content (%)	Wind Speed (m/s) [2]	Handling Rate (tonnes/hour)	Control (%) [3]
Short-term Effects Scenario	Drop to haul truck from loader [1]	12.5%	2.80	73	0%
	Drop to stockpile from haul truck			3630	
	Drop to train from loader			3630	
Long-term Effects Scenario	Drop to haul truck from loader	12.5%	2.35	3630	29%
	Drop to stockpile from haul truck			3630	
	Drop to train from loader			3630	

Notes:
[1] In the short-term effects scenario, drops to the haul truck only consider activities at the generic working area. All other material handling rates consider the full Sangarédi study area.
[2] Wind speeds derived from CALMET dataset. Maximum monthly wind speed used for short-term effects scenario; average monthly wind speed used for long-term effects scenario.
[3] Annual emissions account for a natural control efficiency of 29% due to precipitation (i.e., 101 days per year with > 0.25 mm of precipitation; derived from CALMET)

Table B.19: Stockpiles and Wind Erosion Sources in Sangarédi

Timeframe	Source Description	Silt Content [4] (%)	Frequency of Winds >5.4m/s [5] (%)	Active Surface Area (ha)			
				Existing	18.5 MTPY	22.5 MTPY	27.5 MTPY
Short-term Effects Scenario	Active work areas [1]	15%	2.7%	4.0	4.0	4.0	4.0
	Stockpiles at the train loading area [2]	15%	2.7%	24.3	27.7	33.5	39.3
	Open railcars [3]	15%	100.0%	1.2	1.4	1.7	2.0
Long-term Effects Scenario	Active work areas [1]	15%	2.7%	56.3	88.6	97.8	99.8
	Stockpiles at the train loading area [2]	15%	2.7%	24.3	27.7	33.5	39.3
	Open railcars [3]	15%	100.0%	1.2	1.4	1.7	2.0

Notes:
[1] Work area dimensions based on CALPUFF sources shown in Figure 10 and Figure 11; 50% of total work area assumed to be active wind erosion sources for long-term effects scenario.
[2] Dimensions based on satellite imagery from Bing Maps (2014). Assumed dimensions for outdoor stockpile of 50 m x 450 m x 5 m.
[3] Assumes number of railcars and trains noted in Table B.10; dimensions of railcar based on typical values (2 m x 10 m).
[4] Silt content obtained from Table 13.2.4-1 from AP-42, Chapter 13.2.4 - Aggregate Handling and Storage Piles. Bauxite assumed to be similar to "exposed ground".
[5] Frequency of unobstructed wind speed exceeding 5.4 m/s (at mean pile height) derived from CALMET dataset. Railcars move at speeds >5.4 m/s and are thus susceptible to wind erosion 100% of the time on each train trip.

ATTACHMENT C:
ADDITIONAL INFORMATION FOR
CALMET/CALPUFF

CALMET INFORMATION

CALMET Results

The main CALMET outputs that govern atmospheric dispersion are discussed below. These outputs include different meteorological parameters such as wind speed and direction, temperature, precipitation and mixing height and atmospheric stability.

Wind Speed and Direction

Hourly surface wind speed and direction simulated by CALMET at grid points nearest to Project activities are shown in the form of a wind rose plots in Figure C.1 for each year in the meteorological modelling period (2009 to 2013). Figure C.1 shows that the prevailing winds in Kamsar are out of the southwest followed by the west-southwest. At the mine, the winds are predominately from the south to the west-southwest. The average wind speed in Kamsar over the five year period is 3.3 m/s, while the wind speed in Sangarédi is slightly lower on average at 2.3 m/s. This reflects the fact that Kamsar is located on the shore where winds are expected to be stronger.

Figure C.1 also shows that there is little annual variability in wind direction and wind speed in both Kamsar and Sangarédi. As a result, limited year-to-year variability can also be expected in the dispersion modelling results.

Temperature

Monthly average, minimum and maximum surface temperatures generated by CALMET in Kamsar and Sangarédi are provided in Figure C.2 and Figure C.3, respectively. On average, the temperature in Kamsar and Sangarédi is about 25°C. Average monthly temperature shows little variation, but maximum temperatures are shown to be higher during the dry season in both locations (i.e., October to April). However, maximum modelled temperatures in Sangarédi are higher and more variable than Kamsar.

It is not unexpected that maximum temperatures in Kamsar are less extreme than Sangarédi since nearby waters help to regulate air temperature. Locations further inland tend to experience more intense daytime heating and nighttime cooling events. This is also evident in Figure C.4 which shows the diurnal pattern of average surface temperature from CALMET for both Kamsar and Sangarédi.

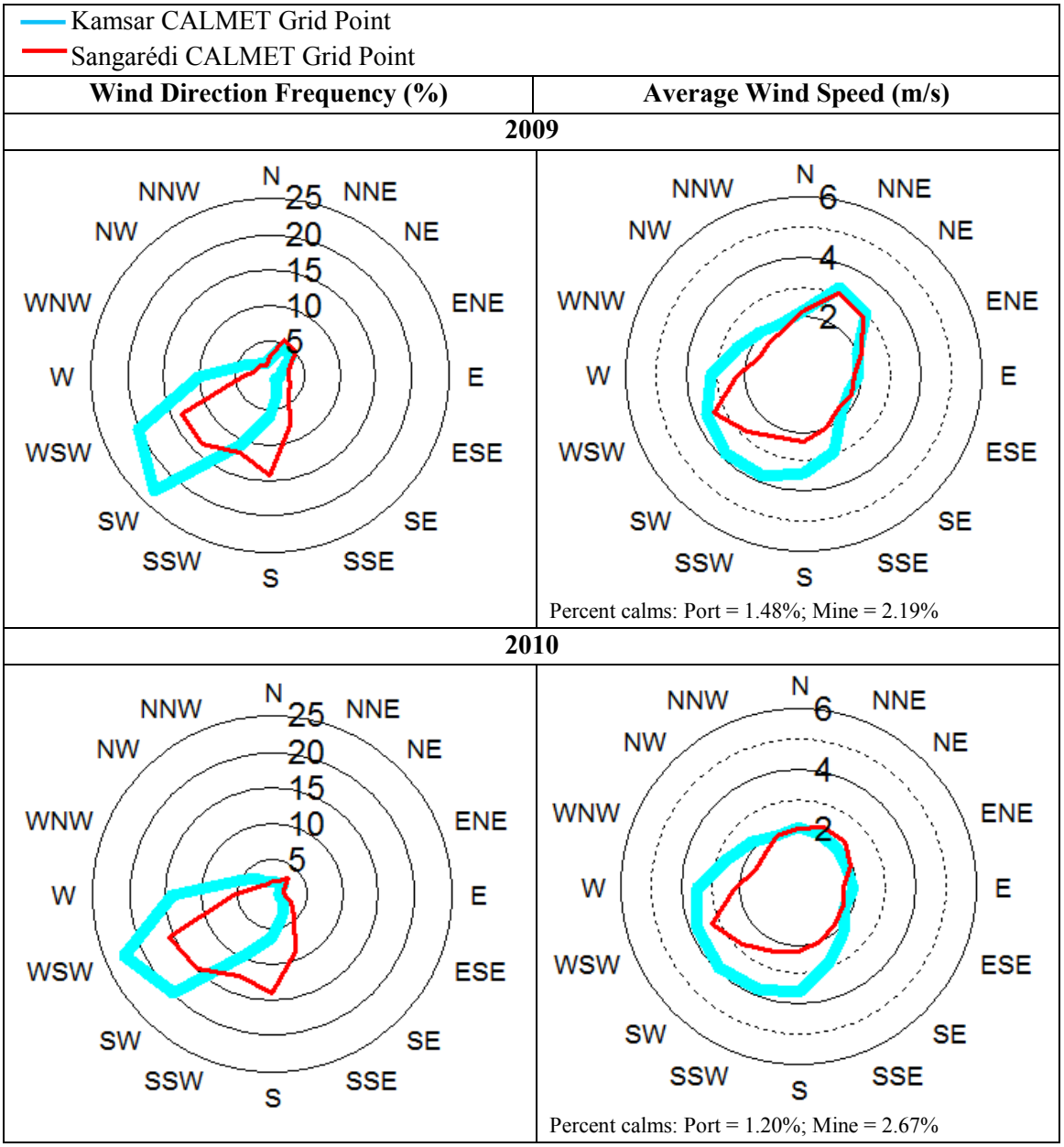
Atmospheric Stability Class and Mixing Height

The frequency of occurrence of each Pasquill-Gifford (Pasquill 1962) stability class as predicted by CALMET for Kamsar and Sangarédi over the 5 year meteorological period is presented in

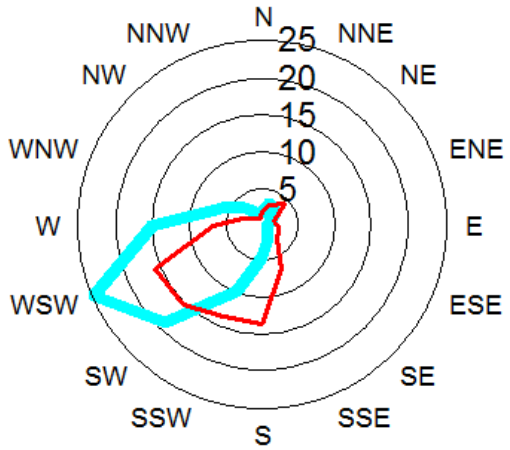
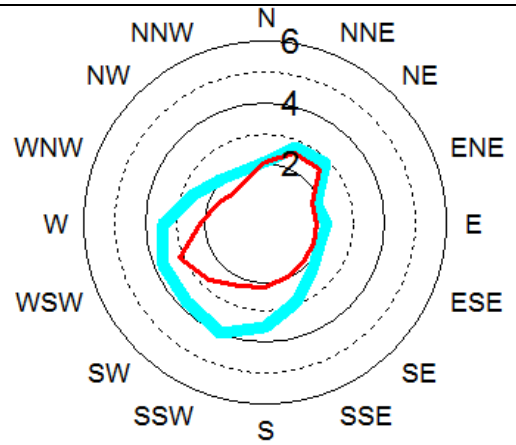
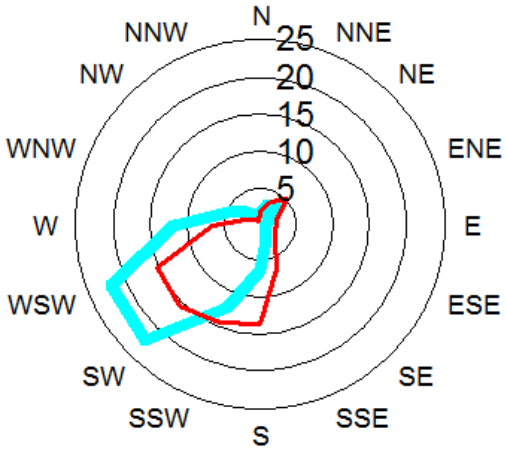
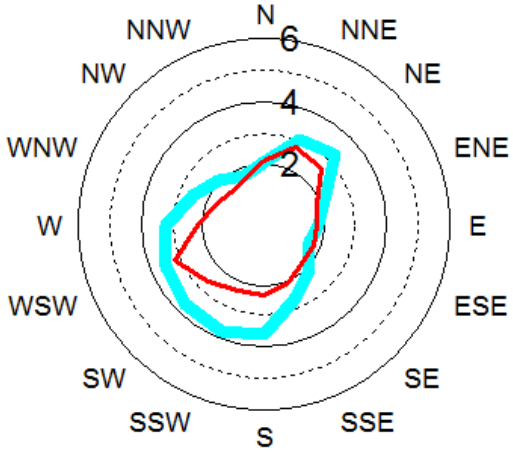
Figure C.5. The results indicate that the stability class with highest frequency is stability class "F". The stability classes "E" and "F" are indicative of stable atmospheric conditions and conducive to moderate to low levels of mechanical mixing. Stability class "B", which represents unstable conditions, was predicted for 20% of the time in Kamsar and 23% of the time in Sangarédi over the 5 year meteorological period.

Mixing height information was also extracted from CALMET for all 5 years and the diurnal variation of the average annual mixing height is illustrated in Figure C.6 for Kamsar and Sangarédi. As can be seen in the Figure, mixing heights tend to increase during the day, reaching a peak in the afternoon and decrease during the nighttime. In addition, Figure C.6 shows the differences in the diurnal variation of mixing height between Kamsar and Sangarédi. The afternoon mixing height in Sangarédi is higher than Kamsar on average. This is a result of stronger daytime heating effects discussed previously and shown in Figure C.4.

Figure C.1: CALMET Wind Roses for the Kamsar Port and Sangarédi Mine, 2009 to 2013



Kamsar CALMET Grid Point
Sangarédi CALMET Grid Point

Wind Direction Frequency (%)	Average Wind Speed (m/s)
2011	
	 Percent calms: Port = 1.22%; Mine = 2.75%
2012	
	 Percent calms: Port = 1.08%; Mine = 2.27%

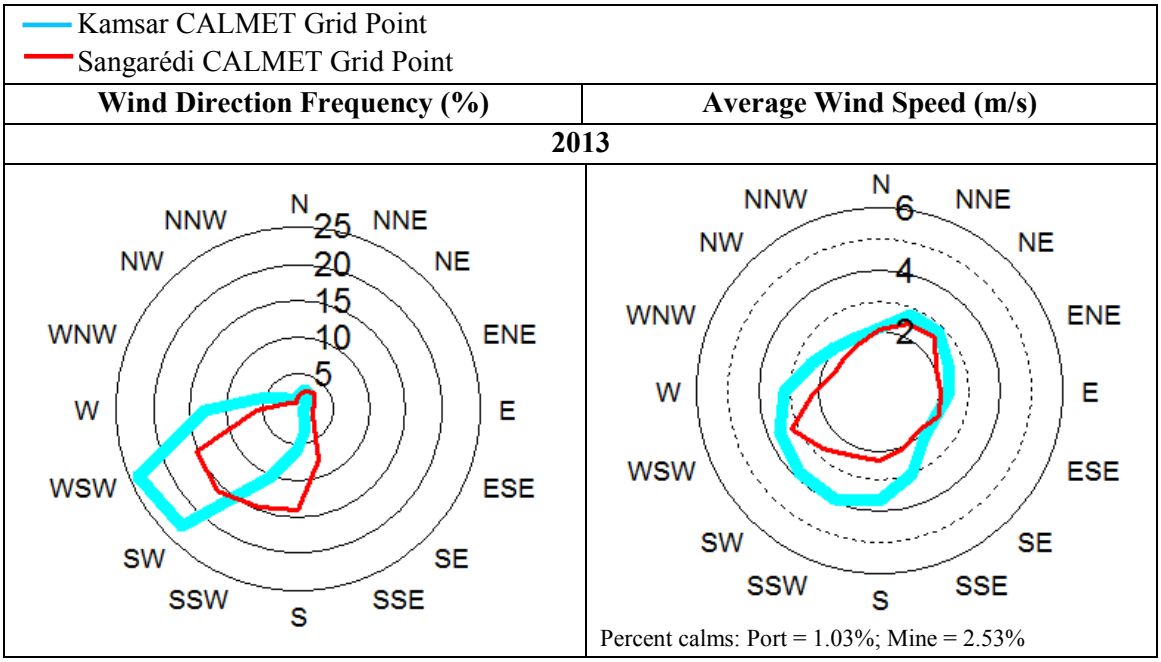


Figure C.2: Kamsar Monthly Temperature Trend, 2009 to 2013

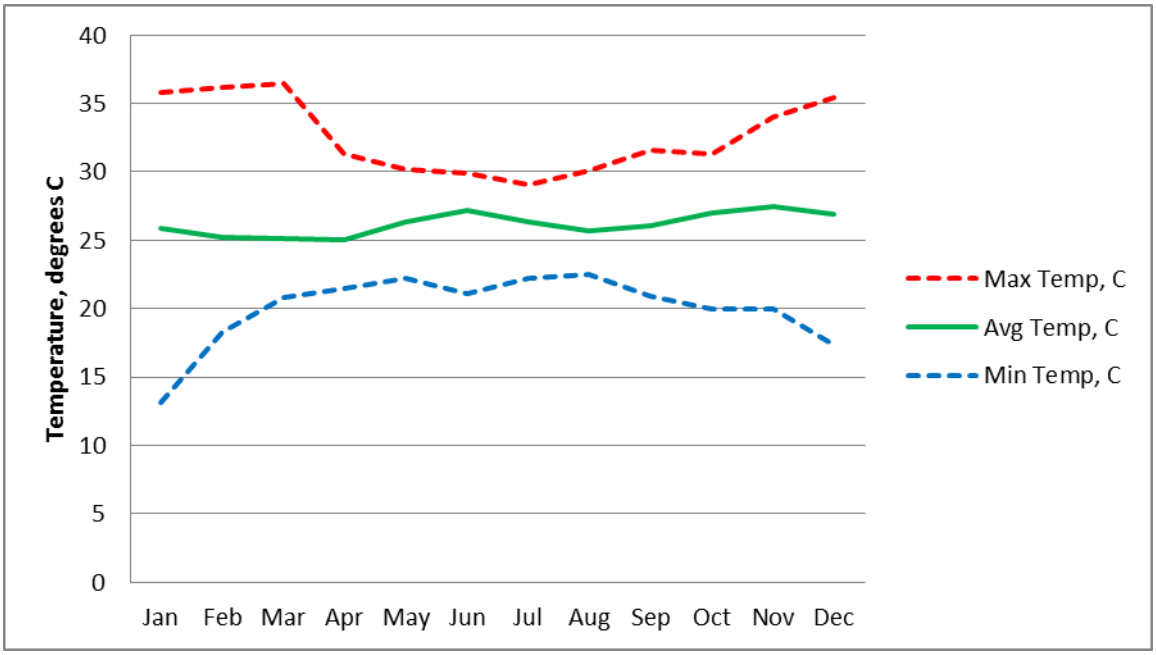


Figure C.3: Sangarédi Monthly Temperature Trend, 2009 to 2013

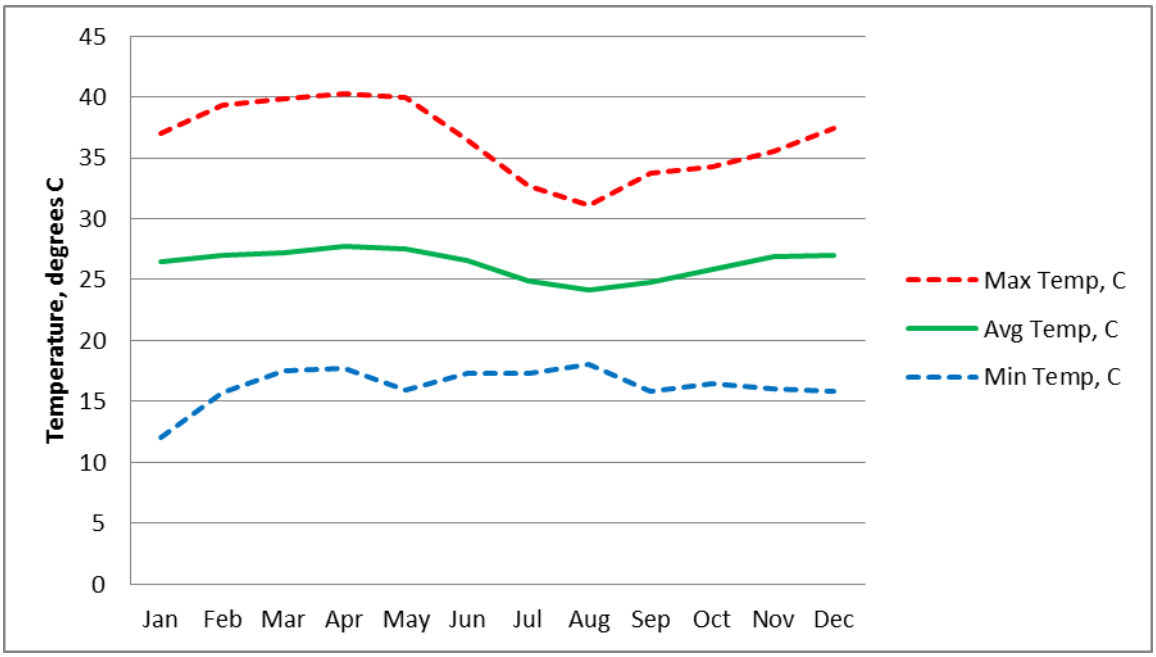


Figure C.4: Kamsar and Sangarédi Diurnal Temperature Trend, 2009 to 2013

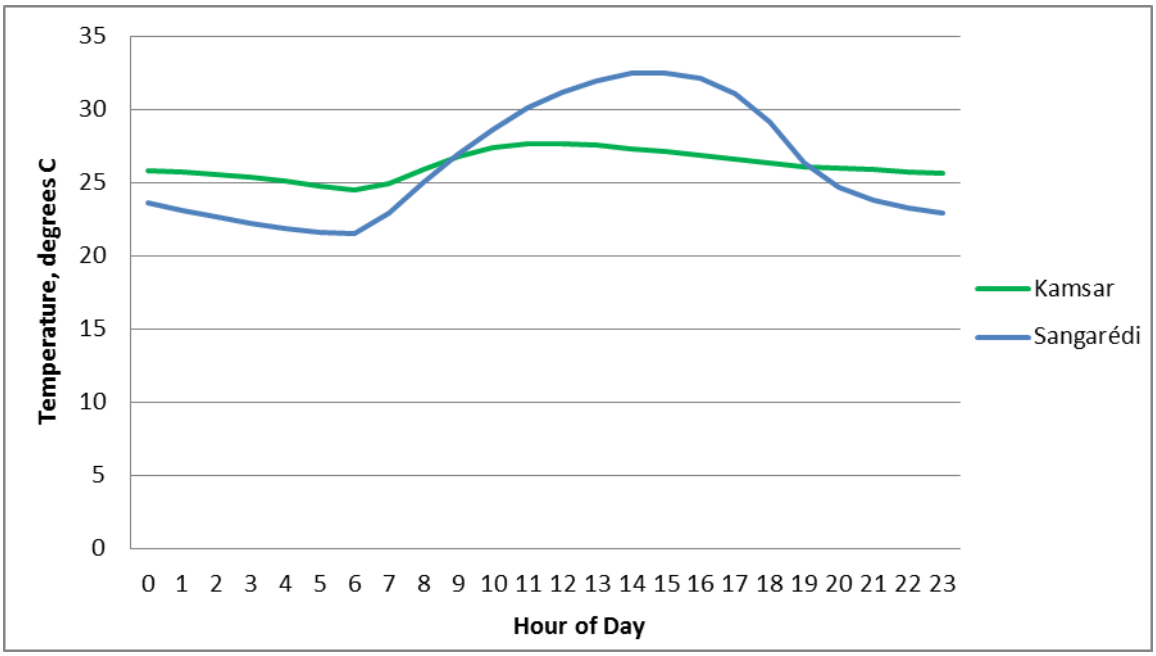
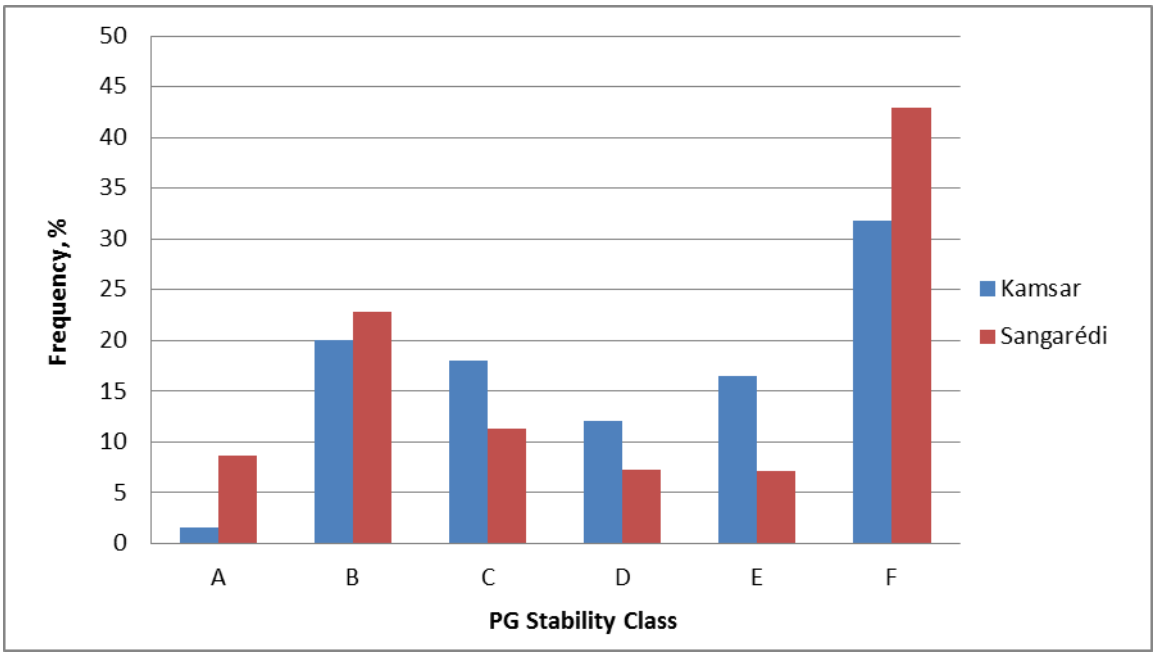
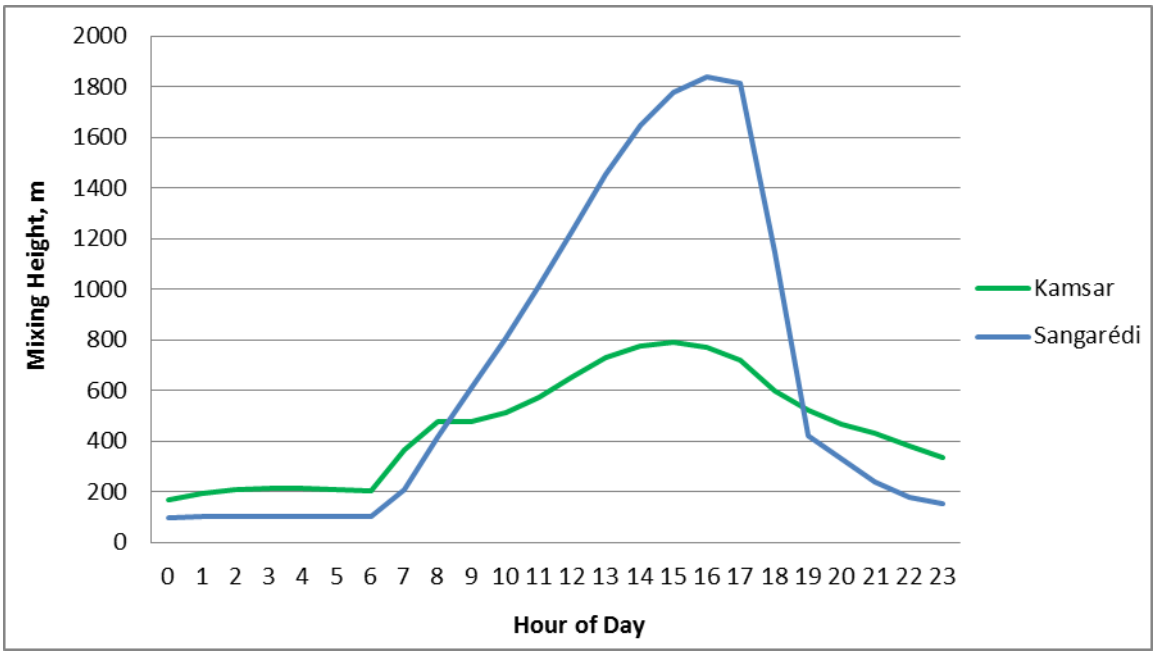


Figure C.5: Kamsar and Sangarédi Stability Class Frequency, 2009 to 2013



Notes:
A = very unstable; B = unstable; C = moderately unstable; D = Neutral; E = Slightly stable; F = Stable

Figure C.6: Kamsar and Sangarédi Diurnal Mixing Height Trend, 2009 to 2013



CALPUFF INFORMATION

CALPUFF Sensitivity Tests

As discussed in Section 6.2 of the main Air Quality Impact Assessment report, the CALPUFF modelling approach was simplified in order to reduce model run times. As discussed in Section 3.3.2, the CALPUFF model runs were performed for a single gaseous contaminant assuming no dry or wet deposition. This approach is conservative for particulate matter since it does not consider the depletion of particulates within a plume. In reality, heavier particles will fall out of a plume close to a source reducing the concentrations of particulate further beyond a source. Consequently the air concentrations of TSP, PM_{10} and $PM_{2.5}$ have been overestimated in the assessment. To understand how conservative the predicted particulate air concentrations are, two sensitivity tests were performed (one in each study area) to determine the differences between modelling particulate matter as a gas with no deposition and modelling particulate matter as a particle with dry deposition. The methodology and results are outlined below.

Model setup

In the Kamsar study area, volume source TAN010 (transfer tower 10) was used to determine the effect of dry deposition on concentrations of TSP. In the Sangarédi study area, a volume source representing a segment of a haul road was used. The same source parameterizations described in Table 6.9 of the main report were used. Both sources were modelled using a 1 g/s emission rate.

In each study area, two (2) model runs were completed:

1. Particulate matter (TSP, PM_{10} and $PM_{2.5}$) was modelled as a gas with no deposition, using the model options outlined in Table 6.3 of the main report.
2. Particulate matter was modelling as a particle with using the dry deposition option (MDRY = 1). All other model options were the same as what is shown in Table 6.3 of the main report.

The dry deposition parameters used in model run #2 were as follows:

Species	Geometric mass mean diameter (µm)	Geometric standard deviation (µm)	NINT
TSP	20.00	1.24	9
PM_{10}	5.00	1.24	9
$PM_{2.5}$	1.25	1.24	9

Sensitivity Test Results

Figure C.7 and Figure C.8 present the resulting concentrations of 24-hour TSP in the Kamsar study area, for model run #1 (no deposition) and run #2 (with deposition), respectively. As can be seen in the Figures, concentrations of TSP are lower when TSP is modelled as a particle with dry deposition. For example, near the air quality monitoring stations, predicted concentrations for model run #1 (as a gas) is about 80 µg/m , whereas for model run #2 (as a particle) the concentration is approximately 60 µg/m .

A contour plot showing the ratio of 24-hour TSP concentrations as a gas vs. concentrations as a particle are also presented in Figure C.9 for Kamsar. Figure C.9 shows that closer to the property, there is little difference in the concentrations. However, as you get further from the source, the ratio decreases. This reflects the fact that heavier particles will fall out of a plume in close proximity to a source so that by the time the plume has travelled some distance, a portion of the particles will have been removed, resulting in lower concentrations further afield. This occurrence is also apparent in the modelling results in Sangarédi, which are discussed below.

Figure C.10 shows how the ratio of TSP concentrations as a gas vs. concentrations as a particle change with distance, both downwind and upwind from the modelled road source. The Figure illustrates that when dry deposition of particles is considered, 24-hour TSP concentrations predicted downwind of a road source are reduced by approximately 20% by about 300 m. Upwind of a road, concentrations are reduced by approximately 16% at 300 m. By 500 m, the model results show that 24-hour concentrations of TSP are reduced by almost 70% on either side of the road.

Estimated TSP deposition rate

The model results from model run #2 at Kamsar described above, were also used to estimate an average TSP deposition rate. The deposition rate was estimated simply by dividing TSP concentrations (in units of µg/m) by the dry deposition fluxes of TSP calculated by CALPUFF (in units of µg/m /s). This resulted in a deposition rate in units of m/s at each receptor within the Kamsar modelling domain. The deposition rates across all receptors were then averaged and found to be about 0.03 m/s or 3 cm/s.

The calculated deposition rate was applied to annual concentrations of TSP and metals within the Kamsar and Sangarédi modelling domains in order to determine the annual average deposition fluxes of TSP and metals. Selected results were provided as inputs to the water quality and biological impact assessments. The results are summarized in Attachment D.

Figure C.7: Kamsar Sensitivity Test: 24-hour Concentrations for TSP modelled as a gas without deposition

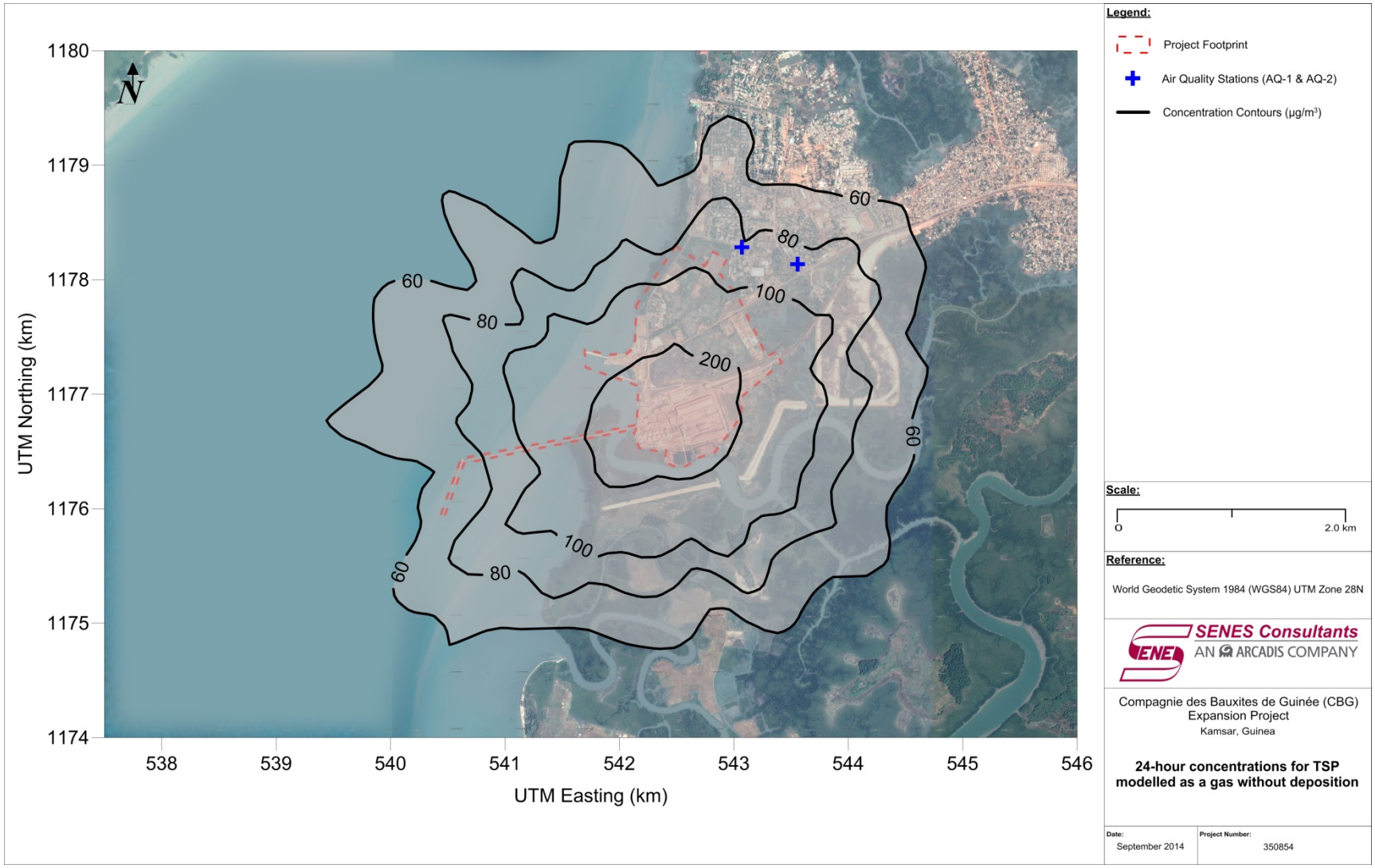


Figure C.8: Kamsar Sensitivity Test: 24-hour Concentrations for TSP modelled as a particle with dry deposition

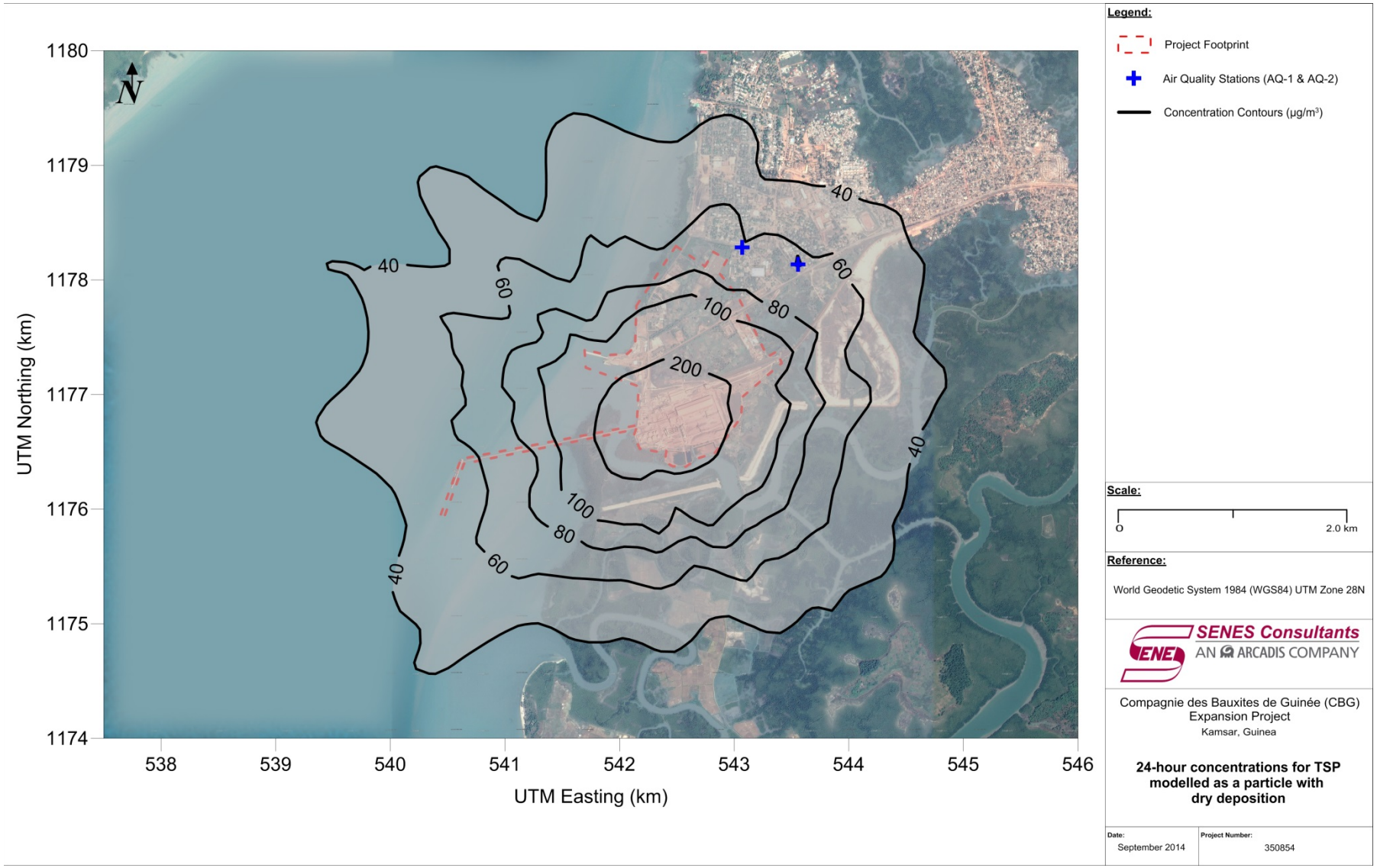


Figure C.9: Kamsar Sensitivity Test: Ratio of TSP concentrations modelled as a gas vs. concentrations modelled as a particle

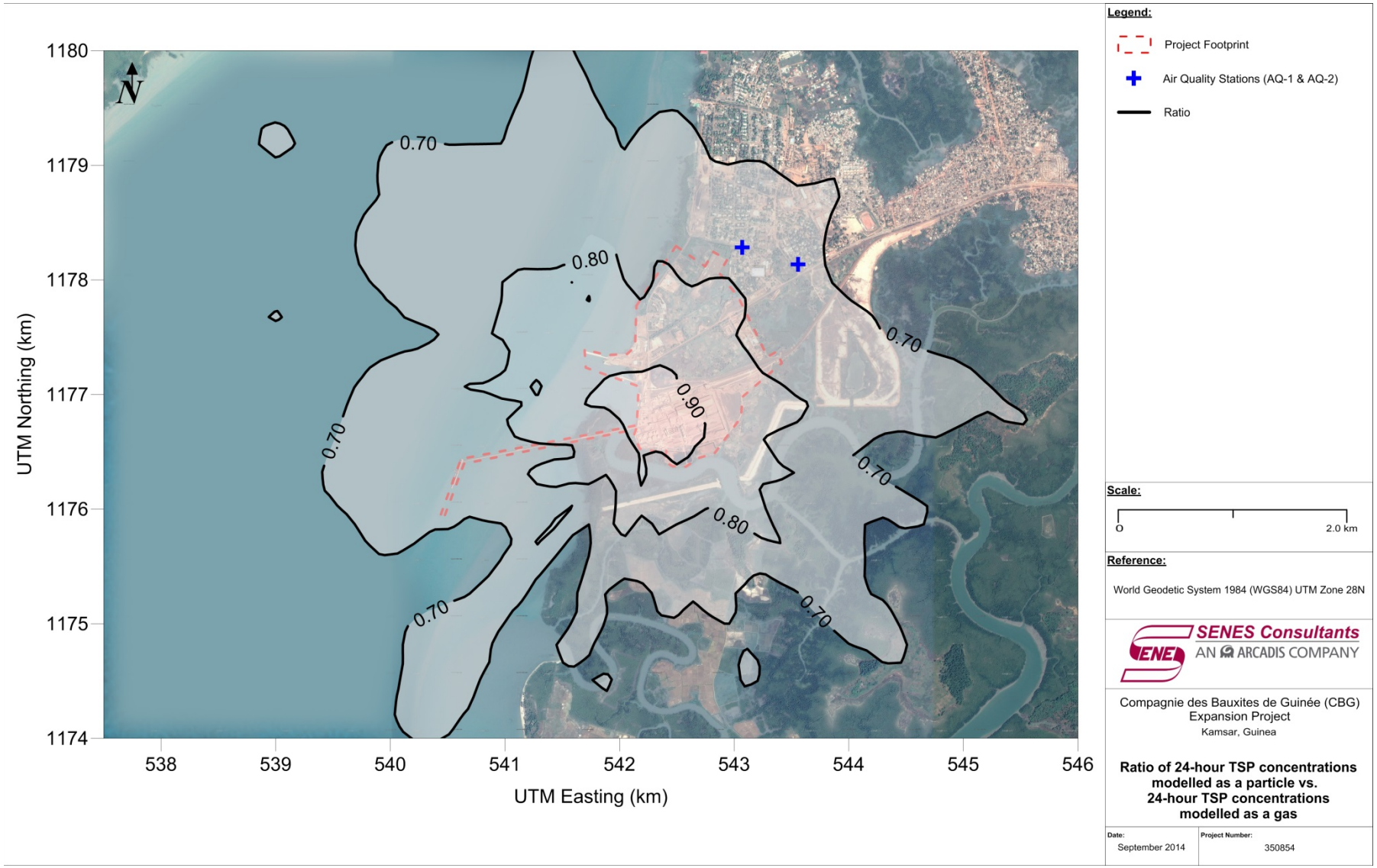
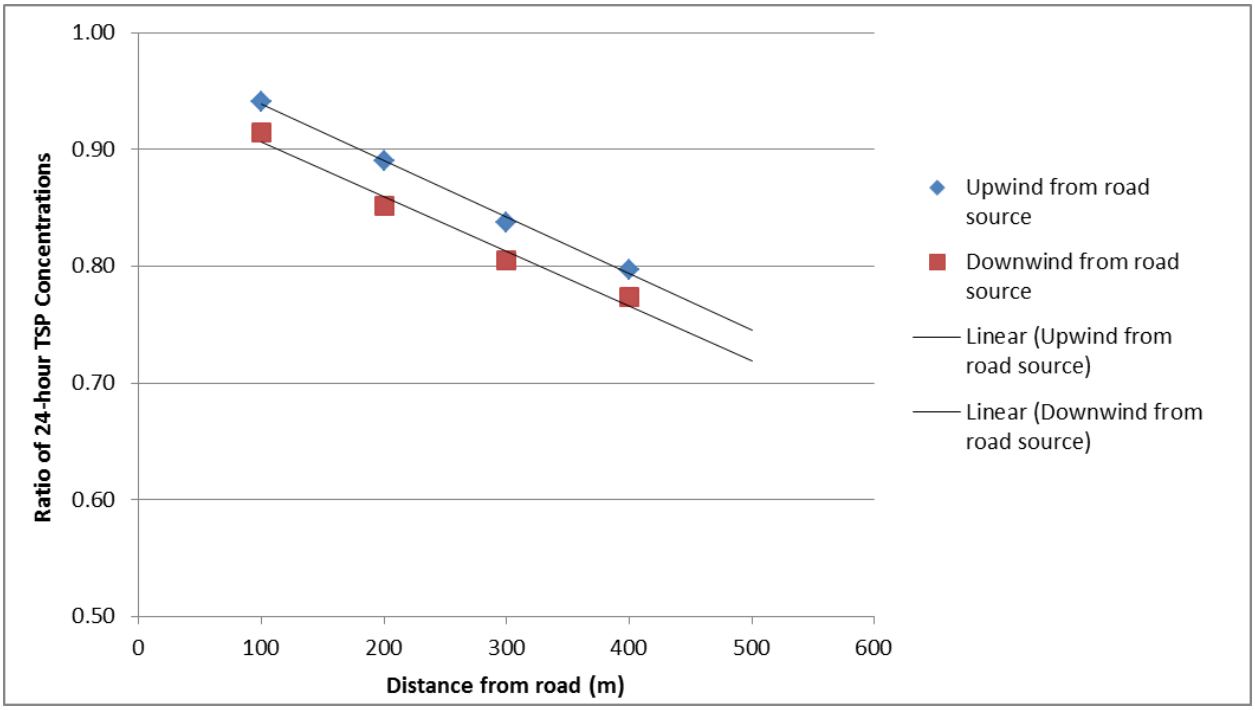


Figure C.10: Sangarédi Sensitivity Test: Ratio of TSP concentrations modelled as a gas vs. concentrations modelled as a particle



ATTACHMENT D:
AIR DISPERSION MODELLING RESULTS TABLES

RESULTS FOR THE SANGARÉDI MINING AREA

Table D. 1: 18.5 MTPY - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
AQ10	AQ-10 Kourawel	620.746	1234.554	1.5	0.2	0.2
AQ11	AQ-11 Hamdallay	622.252	1225.617	83.7	15.2	13.6
AQ12	AQ-12 Petoun BW	628.870	1224.203	5.7	0.8	0.5
AQ13	AQ-13 Paravi	616.710	1221.796	1.0	0.2	0.2
SR1	Boundi Foulasso	612.914	1235.118	0.2	0.02	0.02
SR2	Feto Kewewol	612.704	1232.674	0.2	0.03	0.02
SR3	Pomboniwol	613.069	1232.155	0.2	0.03	0.03
SR4	Sintiourou Nalbewou	613.659	1231.256	0.3	0.04	0.03
SR5	Boullere	613.813	1229.964	0.3	0.05	0.04
SR6	Bandodji Nyalbi	617.423	1231.312	1.1	0.2	0.1
SR7	Daara	617.521	1234.795	0.7	0.1	0.1
SR8	Bossere	617.662	1236.411	0.5	0.08	0.06
SR9	Kourawel	620.668	1234.753	1.5	0.2	0.2
SR10	Sintiourou Kourawel	620.513	1234.360	1.5	0.2	0.2
SR11	Bandodji Touguidje	617.072	1228.404	0.7	0.1	0.1
SR12	Mbourore	619.769	1227.786	2.8	0.4	0.3
SR13	Sintiourou Lenguere	615.527	1226.635	0.5	0.1	0.1
SR14	Gueguere	616.594	1226.045	1.0	0.2	0.1
SR15	Fassely Belendere	615.049	1224.486	0.4	0.06	0.05
SR16	Parawi	615.513	1222.477	0.5	0.1	0.1
SR17	Fassely Fouta Be	619.263	1225.230	2.0	0.3	0.3
SR18	Filo Bowal	611.720	1219.724	1.6	0.3	0.4
SR19	Kalinko Ley	615.105	1219.682	0.6	0.1	0.1
SR20	Sintiourou Madina	615.976	1219.710	0.5	0.1	0.1
SR21	Kankalare	616.622	1221.213	1.3	0.2	0.3
SR22	Kankalare Hacoude	616.889	1221.438	1.4	0.2	0.3
SR23	Telli Bofi	617.465	1221.143	2.1	0.3	0.5
SR24	Madina Kankalare	617.858	1222.070	3.0	0.5	0.7
SR25	Nyangaba	616.903	1219.541	0.5	0.1	0.1
SR26	Kalinko Guessore	617.142	1218.656	0.4	0.06	0.05
SR27	Kalinko Poutai	617.465	1218.221	0.4	0.06	0.05
SR28	Parawol Malassi	619.432	1220.117	1.5	0.2	0.2
SR29	Parawol Kouradje	619.797	1219.260	1.0	0.1	0.1
SR30	Souka	617.634	1216.114	0.4	0.06	0.04
SR31	Wadiya	614.206	1216.016	0.3	0.04	0.03
SR32	Wossou	614.066	1216.241	0.3	0.04	0.03
SR33	Kalinko Rounde	619.642	1216.409	0.4	0.06	0.04
SR34	Hore Lafou	621.524	1221.241	1.7	0.2	0.2
SR35	Kagneka	622.325	1217.638	0.9	0.1	0.1
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	0.4	0.05	0.03
SR37	Lougal	624.677	1215.312	0.4	0.06	0.04
SR38	Djoloun	626.696	1215.772	0.4	0.05	0.04
SR39	Ndiarinde Misside	626.812	1218.047	0.9	0.1	0.1

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR40	Ndiarinde Rounde	626.556	1218.763	0.9	0.1	0.1
SR41	Hafia 1	626.403	1219.671	1.5	0.2	0.2
SR42	Missira	627.949	1219.121	0.8	0.1	0.1
SR43	Wendou Baga	628.243	1215.363	0.3	0.05	0.04
SR44	Sintiourou Missira	628.358	1219.492	1.2	0.2	0.1
SR45	Sakidje	627.540	1220.872	6.1	0.8	0.4
SR46	Hamdalaye	622.082	1225.627	46.6	6.4	3.8
SR47	Lafou Mbayla	623.258	1222.022	2.9	0.4	0.3
SR48	Sintiourou Baladaroul	626.925	1227.663	7.7	1.0	0.5
SR49	Ndantary	626.794	1228.202	8.0	1.0	0.5
SR50	Boundou Wande	629.210	1224.050	4.9	0.8	0.6
SR51	Kare Dabbhel	629.809	1220.856	1.6	0.3	0.2
SR52	Petoum Nyalbi	629.002	1216.784	0.6	0.1	0.1
SR53	Pora Hodho	630.131	1216.744	0.4	0.07	0.06
SR54	Sintiourou Thiewere	630.269	1217.191	0.4	0.06	0.05
SR55	Pora Banla	630.768	1216.534	0.3	0.05	0.03
SR56	Sintiourou Saikou Timbi	630.348	1216.048	0.3	0.04	0.03
SR57	Daroul	630.497	1223.646	15.4	1.9	1.0
SR58	Pora PK130	630.420	1222.985	59.3	6.4	1.9
SR59	Carrefour Parawol	631.430	1221.004	27.8	2.9	0.8
SR60	Kahel Mbody	621.990	1235.671	1.5	0.2	0.1
SR61	Nyale Djaiman	624.955	1236.344	1.8	0.2	0.1
SR62	Nyale Boussoura	625.120	1235.411	2.2	0.3	0.2
SR63	Sintiourou Boussara	624.872	1235.328	2.4	0.3	0.2
SR64	Nyale Moussa	625.947	1236.002	1.8	0.2	0.1
SR65	Nyale Hogo	625.770	1235.742	1.9	0.2	0.1
SR66	Nyale Misside	626.396	1235.647	2.1	0.3	0.2
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	3.2	0.4	0.2
SR68	Thiangui Bonodji	629.255	1235.955	2.2	0.3	0.1
SR69	Thianghe	629.467	1235.269	1.9	0.2	0.1
SR70	Sella Rounde	631.428	1234.702	2.7	0.3	0.2
SR71	Daba Ley	629.833	1233.178	4.4	0.5	0.3
SR72	Daba Dow	629.715	1232.682	4.9	0.6	0.3
SR73	Hore Sella 3	630.141	1232.245	4.5	0.5	0.3
SR74	Hore Sella 2	630.802	1232.233	4.6	0.6	0.3
SR75	Hore Sella 1	631.121	1232.292	4.5	0.5	0.3
SR76	Parawol Aliou	624.789	1231.158	5.7	0.7	0.4
SR77	Paragogo	623.443	1229.209	5.3	0.7	0.5
SR78	Koungnoube	627.093	1228.760	6.2	0.8	0.4
SR79	Doumoun Cogon	632.078	1236.439	1.1	0.1	0.1
SR80	Passago	634.618	1235.978	1.1	0.1	0.1
SR81	Sellawol	631.901	1233.675	2.7	0.3	0.2
SR82	Sambou 1	632.940	1233.190	3.5	0.4	0.2
SR83	Sambou 2	632.633	1232.623	3.5	0.4	0.2
SR84	Cogon Lengue	636.354	1231.950	1.1	0.1	0.1
SR85	Ndanta Fongne Ley	633.318	1229.812	3.9	0.5	0.2
SR86	Ndanta Fongne Dow	632.988	1229.540	4.5	0.5	0.3

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR87	Sintiourou Nyaka	633.023	1225.335	2.2	0.3	0.2
SR88	Bourreti	634.984	1222.464	0.6	0.1	0.1
SR89	Ndantari	636.614	1221.460	0.3	0.04	0.03
SR90	Sitako	634.252	1218.719	0.4	0.06	0.05
SR91	Thiankwe	636.839	1218.743	0.2	0.03	0.02
SR92	Limbiko	633.035	1217.503	0.4	0.06	0.05
SR93	Diandian	634.063	1216.510	0.2	0.03	0.03
SR94	Sintiourou Daroul Diandian	636.520	1217.255	0.2	0.02	0.02
SR95	Sintiourou Kerkere	636.933	1215.577	0.1	0.01	0.01
SR96	Sintiourou Hafia	626.238	1221.457	2.1	0.3	0.2
SR97	Madina Dian	632.551	1221.418	1.1	0.2	0.1

Table D.2: 22.5 MTPY - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
AQ10	AQ-10 Kourawel	620.746	1234.554	3.5	0.5	0.3
AQ11	AQ-11 Hamdallay	622.252	1225.617	121.1	12.8	4.0
AQ12	AQ-12 Petoun BW	628.870	1224.203	5.0	0.5	0.2
AQ13	AQ-13 Paravi	616.710	1221.796	1.7	0.2	0.3
SR1	Boundi Foulasso	612.914	1235.118	0.3	0.04	0.03
SR2	Feto Kewewol	612.704	1232.674	0.4	0.05	0.04
SR3	Pomboniwol	613.069	1232.155	0.4	0.05	0.04
SR4	Sintiourou Nalbewou	613.659	1231.256	0.5	0.1	0.05
SR5	Boullere	613.813	1229.964	0.6	0.1	0.1
SR6	Bandodji Nyalbi	617.423	1231.312	2.7	0.4	0.3
SR7	Daara	617.521	1234.795	1.9	0.3	0.2
SR8	Bossere	617.662	1236.411	1.3	0.2	0.1
SR9	Kourawel	620.668	1234.753	3.4	0.5	0.3
SR10	Sintiourou Kourawel	620.513	1234.360	3.6	0.5	0.3
SR11	Bandodji Touguidje	617.072	1228.404	1.4	0.2	0.2
SR12	Mbourore	619.769	1227.786	18.8	2.6	1.8
SR13	Sintiourou Lenguere	615.527	1226.635	0.8	0.1	0.1
SR14	Gueguere	616.594	1226.045	1.9	0.3	0.2
SR15	Fassely Belendere	615.049	1224.486	0.6	0.1	0.1
SR16	Parawi	615.513	1222.477	0.8	0.1	0.1
SR17	Fassely Fouta Be	619.263	1225.230	5.5	1.0	1.0
SR18	Filo Bowal	611.720	1219.724	2.0	0.3	0.5
SR19	Kalinko Ley	615.105	1219.682	0.8	0.1	0.1
SR20	Sintiourou Madina	615.976	1219.710	0.7	0.1	0.1
SR21	Kankalare	616.622	1221.213	2.0	0.3	0.3
SR22	Kankalare Hacoude	616.889	1221.438	2.1	0.3	0.4
SR23	Telli Bofi	617.465	1221.143	2.8	0.4	0.6
SR24	Madina Kankalare	617.858	1222.070	4.1	0.6	0.9
SR25	Nyangaba	616.903	1219.541	0.6	0.1	0.1
SR26	Kalinko Guessore	617.142	1218.656	0.6	0.1	0.1
SR27	Kalinko Poutai	617.465	1218.221	0.6	0.1	0.05
SR28	Parawol Malassi	619.432	1220.117	1.9	0.2	0.3
SR29	Parawol Kouradje	619.797	1219.260	1.3	0.2	0.1
SR30	Souka	617.634	1216.114	0.5	0.1	0.04
SR31	Wadiya	614.206	1216.016	0.4	0.05	0.04
SR32	Wossou	614.066	1216.241	0.4	0.06	0.04
SR33	Kalinko Rounde	619.642	1216.409	0.5	0.06	0.03
SR34	Hore Lafou	621.524	1221.241	1.8	0.2	0.2
SR35	Kagneka	622.325	1217.638	1.0	0.1	0.1
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	0.4	0.05	0.03
SR37	Lougal	624.677	1215.312	0.4	0.06	0.03
SR38	Djoloun	626.696	1215.772	0.4	0.05	0.03
SR39	Ndiarinde Misside	626.812	1218.047	0.9	0.1	0.06
SR40	Ndiarinde Rounde	626.556	1218.763	0.9	0.1	0.05
SR41	Hafia 1	626.403	1219.671	1.3	0.1	0.1
SR42	Missira	627.949	1219.121	0.8	0.1	0.05

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR43	Wendou Baga	628.243	1215.363	0.4	0.05	0.04
SR44	Sintiourou Missira	628.358	1219.492	1.2	0.2	0.1
SR45	Sakidje	627.540	1220.872	1.2	0.1	0.1
SR46	Hamdalaye	622.082	1225.627	203.8	21.0	7.4
SR47	Lafou Mbayla	623.258	1222.022	2.6	0.3	0.2
SR48	Sintiourou Baladaroul	626.925	1227.663	7.1	0.8	0.3
SR49	Ndantary	626.794	1228.202	7.6	0.8	0.3
SR50	Boundou Wande	629.210	1224.050	4.0	0.4	0.2
SR51	Kare Dabbhel	629.809	1220.856	1.4	0.2	0.1
SR52	Petoum Nyalbi	629.002	1216.784	0.6	0.1	0.1
SR53	Pora Hodho	630.131	1216.744	0.5	0.1	0.06
SR54	Sintiourou Thiewere	630.269	1217.191	0.5	0.1	0.05
SR55	Pora Banla	630.768	1216.534	0.4	0.05	0.04
SR56	Sintiourou Saikou Timbi	630.348	1216.048	0.3	0.05	0.04
SR57	Daroul	630.497	1223.646	2.2	0.3	0.2
SR58	Pora PK130	630.420	1222.985	1.7	0.2	0.1
SR59	Carrefour Parawol	631.430	1221.004	83.1	8.7	2.0
SR60	Kahel Mbody	621.990	1235.671	2.9	0.4	0.3
SR61	Nyale Djaiman	624.955	1236.344	2.4	0.3	0.2
SR62	Nyale Boussoura	625.120	1235.411	2.9	0.4	0.2
SR63	Sintiourou Boussara	624.872	1235.328	3.3	0.4	0.2
SR64	Nyale Moussa	625.947	1236.002	2.2	0.3	0.2
SR65	Nyale Hogo	625.770	1235.742	2.4	0.3	0.2
SR66	Nyale Misside	626.396	1235.647	2.6	0.3	0.2
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	3.5	0.4	0.2
SR68	Thiangui Bonodji	629.255	1235.955	2.5	0.3	0.1
SR69	Thianghe	629.467	1235.269	2.2	0.3	0.1
SR70	Sella Rounde	631.428	1234.702	2.9	0.3	0.1
SR71	Daba Ley	629.833	1233.178	4.7	0.5	0.2
SR72	Daba Dow	629.715	1232.682	5.2	0.6	0.2
SR73	Hore Sella 3	630.141	1232.245	4.7	0.5	0.2
SR74	Hore Sella 2	630.802	1232.233	4.9	0.6	0.2
SR75	Hore Sella 1	631.121	1232.292	4.7	0.5	0.2
SR76	Parawol Aliou	624.789	1231.158	7.0	0.9	0.5
SR77	Paragogo	623.443	1229.209	7.0	0.9	0.6
SR78	Koungnoube	627.093	1228.760	6.1	0.7	0.3
SR79	Doumoun Cogon	632.078	1236.439	1.2	0.1	0.1
SR80	Passago	634.618	1235.978	1.2	0.1	0.1
SR81	Sellawol	631.901	1233.675	2.9	0.3	0.1
SR82	Sambou 1	632.940	1233.190	3.7	0.4	0.2
SR83	Sambou 2	632.633	1232.623	3.7	0.4	0.2
SR84	Cogon Lengue	636.354	1231.950	1.2	0.1	0.1
SR85	Ndanta Fongne Ley	633.318	1229.812	4.1	0.5	0.2
SR86	Ndanta Fongne Dow	632.988	1229.540	4.7	0.5	0.2
SR87	Sintiourou Nyaka	633.023	1225.335	2.4	0.3	0.2
SR88	Bourreti	634.984	1222.464	0.9	0.2	0.2
SR89	Ndantari	636.614	1221.460	0.4	0.1	0.05

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR90	Sitako	634.252	1218.719	1.6	0.2	0.1
SR91	Thiankwe	636.839	1218.743	0.3	0.04	0.03
SR92	Limbiko	633.035	1217.503	0.5	0.1	0.1
SR93	Diandian	634.063	1216.510	0.3	0.04	0.03
SR94	Sintiourou Daroul Diandian	636.520	1217.255	0.2	0.03	0.02
SR95	Sintiourou Kerkere	636.933	1215.577	0.1	0.02	0.01
SR96	Sintiourou Hafia	626.238	1221.457	1.9	0.2	0.1
SR97	Madina Dian	632.551	1221.418	22.0	2.4	0.8

Table D.3: 27.5 MTPY - Model Predicted Average Annual Concentrations in Sangarédi (µg/m³)

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
AQ10	AQ-10 Kourawel	620.746	1234.554	47.5	11.0	11.8
AQ11	AQ-11 Hamdallay	622.252	1225.617	53.0	5.4	1.0
AQ12	AQ-12 Petoun BW	628.870	1224.203	0.6	0.1	0.04
AQ13	AQ-13 Paravi	616.710	1221.796	1.5	0.2	0.2
SR1	Boundi Foulasso	612.914	1235.118	0.3	0.03	0.02
SR2	Feto Kewewol	612.704	1232.674	0.3	0.04	0.02
SR3	Pomboniwol	613.069	1232.155	0.3	0.04	0.02
SR4	Sintiourou Nalbewou	613.659	1231.256	0.4	0.05	0.03
SR5	Boullere	613.813	1229.964	0.5	0.1	0.04
SR6	Bandodji Nyalbi	617.423	1231.312	2.2	0.3	0.1
SR7	Daara	617.521	1234.795	2.8	0.4	0.2
SR8	Bossere	617.662	1236.411	1.4	0.2	0.1
SR9	Kourawel	620.668	1234.753	26.4	5.2	4.9
SR10	Sintiourou Kourawel	620.513	1234.360	52.2	12.9	14.4
SR11	Bandodji Touguidje	617.072	1228.404	1.2	0.1	0.1
SR12	Mbourore	619.769	1227.786	9.5	1.0	0.2
SR13	Sintiourou Lenguere	615.527	1226.635	0.7	0.1	0.1
SR14	Gueguere	616.594	1226.045	1.5	0.2	0.1
SR15	Fassely Belendere	615.049	1224.486	0.6	0.1	0.1
SR16	Parawi	615.513	1222.477	0.8	0.1	0.1
SR17	Fassely Fouta Be	619.263	1225.230	2.9	0.3	0.1
SR18	Filo Bowal	611.720	1219.724	2.4	0.4	0.6
SR19	Kalinko Ley	615.105	1219.682	0.8	0.1	0.1
SR20	Sintiourou Madina	615.976	1219.710	0.6	0.1	0.1
SR21	Kankalare	616.622	1221.213	1.8	0.3	0.3
SR22	Kankalare Hacoude	616.889	1221.438	2.0	0.3	0.3
SR23	Telli Bofi	617.465	1221.143	3.0	0.4	0.6
SR24	Madina Kankalare	617.858	1222.070	4.2	0.6	0.9
SR25	Nyangaba	616.903	1219.541	0.6	0.1	0.05
SR26	Kalinko Guessore	617.142	1218.656	0.5	0.1	0.04
SR27	Kalinko Poutai	617.465	1218.221	0.5	0.06	0.04
SR28	Parawol Malassi	619.432	1220.117	1.5	0.2	0.2
SR29	Parawol Kouradje	619.797	1219.260	0.8	0.1	0.1
SR30	Souka	617.634	1216.114	0.4	0.05	0.02
SR31	Wadiya	614.206	1216.016	0.4	0.05	0.02
SR32	Wossou	614.066	1216.241	0.4	0.05	0.03
SR33	Kalinko Rounde	619.642	1216.409	0.3	0.03	0.02
SR34	Hore Lafou	621.524	1221.241	1.0	0.1	0.1
SR35	Kagneka	622.325	1217.638	0.5	0.06	0.03
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	0.2	0.02	0.01
SR37	Lougal	624.677	1215.312	0.2	0.02	0.01
SR38	Djoloun	626.696	1215.772	0.2	0.02	0.01
SR39	Ndiarinde Misside	626.812	1218.047	0.3	0.03	0.02
SR40	Ndiarinde Rounde	626.556	1218.763	0.3	0.03	0.02
SR41	Hafia 1	626.403	1219.671	0.4	0.04	0.02
SR42	Missira	627.949	1219.121	0.3	0.03	0.02

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR43	Wendou Baga	628.243	1215.363	0.2	0.02	0.01
SR44	Sintiourou Missira	628.358	1219.492	0.4	0.04	0.02
SR45	Sakidje	627.540	1220.872	0.3	0.04	0.02
SR46	Hamdalaye	622.082	1225.627	175.0	17.6	2.7
SR47	Lafou Mbayla	623.258	1222.022	1.1	0.1	0.2
SR48	Sintiourou Baladaroul	626.925	1227.663	1.5	0.2	0.1
SR49	Ndantary	626.794	1228.202	1.8	0.2	0.1
SR50	Boundou Wande	629.210	1224.050	0.6	0.1	0.03
SR51	Kare Dabbhel	629.809	1220.856	0.4	0.04	0.02
SR52	Petoum Nyalbi	629.002	1216.784	0.2	0.03	0.01
SR53	Pora Hodho	630.131	1216.744	0.2	0.02	0.01
SR54	Sintiourou Thiewere	630.269	1217.191	0.2	0.02	0.01
SR55	Pora Banla	630.768	1216.534	0.1	0.02	0.01
SR56	Sintiourou Saikou Timbi	630.348	1216.048	0.1	0.02	0.01
SR57	Daroul	630.497	1223.646	0.4	0.05	0.02
SR58	Pora PK130	630.420	1222.985	0.4	0.04	0.02
SR59	Carrefour Parawol	631.430	1221.004	0.4	0.04	0.02
SR60	Kahel Mbody	621.990	1235.671	29.7	4.2	2.4
SR61	Nyale Djaiman	624.955	1236.344	16.8	2.3	1.3
SR62	Nyale Boussoura	625.120	1235.411	6.8	0.9	0.5
SR63	Sintiourou Boussara	624.872	1235.328	10.7	1.4	0.8
SR64	Nyale Moussa	625.947	1236.002	4.4	0.6	0.3
SR65	Nyale Hogo	625.770	1235.742	4.6	0.6	0.3
SR66	Nyale Misside	626.396	1235.647	4.4	0.6	0.3
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	3.3	0.4	0.2
SR68	Thiangui Bonodji	629.255	1235.955	2.7	0.3	0.2
SR69	Thianghe	629.467	1235.269	1.7	0.2	0.1
SR70	Sella Rounde	631.428	1234.702	1.5	0.2	0.1
SR71	Daba Ley	629.833	1233.178	2.9	0.4	0.2
SR72	Daba Dow	629.715	1232.682	3.3	0.4	0.2
SR73	Hore Sella 3	630.141	1232.245	1.9	0.2	0.1
SR74	Hore Sella 2	630.802	1232.233	1.8	0.2	0.1
SR75	Hore Sella 1	631.121	1232.292	1.7	0.2	0.1
SR76	Parawol Aliou	624.789	1231.158	15.8	1.6	0.3
SR77	Paragogo	623.443	1229.209	4.0	0.4	0.1
SR78	Koungnoube	627.093	1228.760	1.6	0.2	0.1
SR79	Doumoun Cogon	632.078	1236.439	0.8	0.1	0.04
SR80	Passago	634.618	1235.978	0.6	0.1	0.03
SR81	Sellawol	631.901	1233.675	1.2	0.1	0.06
SR82	Sambou 1	632.940	1233.190	1.4	0.2	0.1
SR83	Sambou 2	632.633	1232.623	1.2	0.1	0.05
SR84	Cogon Lengue	636.354	1231.950	0.4	0.04	0.02
SR85	Ndanta Fongne Ley	633.318	1229.812	0.8	0.1	0.03
SR86	Ndanta Fongne Dow	632.988	1229.540	0.9	0.1	0.04
SR87	Sintiourou Nyaka	633.023	1225.335	0.4	0.05	0.02
SR88	Bourreti	634.984	1222.464	0.2	0.02	0.01
SR89	Ndantari	636.614	1221.460	0.1	0.01	0.01

Receptor ID	Description	UTM Easting (km)	UTM Northing (km)	Annual Concentration (µg/m³)		
				PM_{10}	$PM_{2.5}$	NO_2
			WHO Interim Target 1	70	35	-
			WHO Interim Target 2	50	25	-
			WHO Interim Target 3	30	15	-
			WHO Guideline	20	10	40
SR90	Sitako	634.252	1218.719	0.2	0.02	0.01
SR91	Thiankwe	636.839	1218.743	0.1	0.01	0.01
SR92	Limbiko	633.035	1217.503	0.2	0.02	0.01
SR93	Diandian	634.063	1216.510	0.1	0.01	0.01
SR94	Sintiourou Daroul Diandian	636.520	1217.255	0.1	0.01	0.00
SR95	Sintiourou Kerkere	636.933	1215.577	0.1	0.01	0.00
SR96	Sintiourou Hafia	626.238	1221.457	0.5	0.06	0.03
SR97	Madina Dian	632.551	1221.418	0.3	0.03	0.01

Table D.4: 18.5 MTPY - Model Predicted Maximum Short-term Concentrations in Sangarédi (µg/m^3)

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR1	Boundi Foulasso	612.914	1235.118	7595	4285	0.1	0.0	0	0.0	0.0
SR2	Feto Kewewol	612.704	1232.674	7285	4317	0.1	0.0	0	0.0	0.0
SR3	Pomboniwol	613.069	1232.155	6700	4108	0.1	0.0	0	0.0	0.0
SR4	Sintiourou Nalbewou	613.659	1231.256	5745	4005	0.1	0.0	0	0.0	0.0
SR5	Boullere	613.813	1229.964	5085	2072	0.1	0.0	0	0.0	0.0
SR6	Bandodji Nyalbi	617.423	1231.312	2660	1832	0.3	0.0	0	0.1	0.0
SR7	Daara	617.521	1234.795	3325	298	53.4	5.1	3431	5.6	0.4
SR8	Bossere	617.662	1236.411	4090	1915	0.1	0.0	0	0.0	0.0
SR9	Kourawel	620.668	1234.753	675	232	90.6	8.7	7108	7.3	0.6
SR10	Sintiourou Kourawel	620.513	1234.360	585	100	439.4	42.0	62493	16.1	1.9
SR11	Bandodji Touguidje	617.072	1228.404	1475	549	7.4	0.7	217	2.1	0.1
SR12	Mbourore	619.769	1227.786	100	585	260.4	24.9	146	12.4	1.3
SR13	Sintiourou Lenguere	615.527	1226.635	2845	511	9.9	1.0	329	2.4	0.1
SR14	Gueguere	616.594	1226.045	2065	246	81.1	7.8	6075	7.0	0.5
SR15	Fassely Belendere	615.049	1224.486	4235	485	12.2	1.2	438	2.7	0.1
SR16	Parawi	615.513	1222.477	5385	303	51.8	5.0	3265	5.6	0.4
SR17	Fassely Fouta Be	619.263	1225.230	1340	204	113.9	10.9	9688	8.3	0.7
SR18	Filo Bowal	611.720	1219.724	9945	1962	4.4	0.7	0	0.8	0.2
SR19	Kalinko Ley	615.105	1219.682	7140	1037	1.2	0.2	1	0.6	0.1
SR20	Sintiourou Madina	615.976	1219.710	6350	1189	0.8	0.1	0	0.4	0.0
SR21	Kankalare	616.622	1221.213	5165	191	127.9	12.4	11149	9.3	0.8
SR22	Kankalare Hacoude	616.889	1221.438	4845	353	37.1	3.7	1882	5.2	0.4
SR23	Telli Bofi	617.465	1221.143	4390	989	5.8	0.9	2	1.6	0.3
SR24	Madina Kankalare	617.858	1222.070	3760	1068	7.4	1.2	1	2.1	0.3
SR25	Nyangaba	616.903	1219.541	5650	1570	0.5	0.1	0	0.2	0.0
SR26	Kalinko Guessore	617.142	1218.656	6020	2444	0.4	0.1	0	0.2	0.0
SR27	Kalinko Poutai	617.465	1218.221	6100	2138	0.4	0.1	0	0.2	0.0
SR28	Parawol Malassi	619.432	1220.117	3375	700	6.2	0.9	42	2.5	0.2
SR29	Parawol Kouradje	619.797	1219.260	3905	765	2.2	0.3	20	1.3	0.1
SR30	Souka	617.634	1216.114	7700	2481	0.3	0.0	0	0.1	0.0
SR31	Wadiya	614.206	1216.016	9965	4159	0.3	0.0	0	0.1	0.0
SR32	Wossou	614.066	1216.241	9920	3918	0.3	0.0	0	0.1	0.0
SR33	Kalinko Rounde	619.642	1216.409	6620	1098	0.3	0.0	1	0.4	0.0
SR34	Hore Lafou	621.524	1221.241	1500	627	5.9	0.7	92	2.2	0.1
SR35	Kagneka	622.325	1217.638	5155	172	146.2	14.0	13715	9.4	0.8
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	6570	1144	0.2	0.0	0	0.3	0.0
SR37	Lougal	624.677	1215.312	5910	1579	0.2	0.0	0	0.1	0.0
SR38	Djoloun	626.696	1215.772	5055	2439	0.1	0.0	0	0.1	0.0
SR39	Ndiarinde Misside	626.812	1218.047	2780	1024	0.5	0.1	1	0.4	0.0
SR40	Ndiarinde Rounde	626.556	1218.763	2080	1003	0.5	0.1	1	0.4	0.0
SR41	Hafia 1	626.403	1219.671	1230	1655	0.5	0.1	0	0.3	0.0
SR42	Missira	627.949	1219.121	1880	2357	0.3	0.0	0	0.1	0.0
SR43	Wendou Baga	628.243	1215.363	5355	3638	0.1	0.0	0	0.1	0.0

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR44	Sintiourou Missira	628.358	1219.492	1595	1997	0.4	0.1	0	0.2	0.0
SR45	Sakidje	627.540	1220.872	100	660	260.2	24.9	64	12.5	1.3
SR46	Hamdalaye	622.082	1225.627	145	185	183.5	17.7	11917	10.8	1.0
SR47	Lafou Mbayla	623.258	1222.022	1830	1645	2.2	0.4	0	0.8	0.1
SR48	Sintiourou Baladaroul	626.925	1227.663	845	1740	1.4	0.2	0	0.8	0.0
SR49	Ndantary	626.794	1228.202	1400	1420	0.8	0.1	0	0.2	0.0
SR50	Boundou Wande	629.210	1224.050	1055	336	39.9	3.8	2266	5.1	0.3
SR51	Kare Dabbhel	629.809	1220.856	865	1156	0.9	0.1	0	0.7	0.0
SR52	Petoum Nyalbi	629.002	1216.784	3880	2569	0.2	0.0	0	0.1	0.0
SR53	Pora Hodho	630.131	1216.744	3015	2165	0.2	0.0	0	0.1	0.0
SR54	Sintiourou Thiewere	630.269	1217.191	2625	1684	0.2	0.0	0	0.1	0.0
SR55	Pora Banla	630.768	1216.534	2700	2363	0.1	0.0	0	0.1	0.0
SR56	Sintiourou Saikou Timbi	630.348	1216.048	3345	2849	0.1	0.0	0	0.1	0.0
SR57	Daroul	630.497	1223.646	100	286	260.2	24.9	3931	12.4	1.3
SR58	Pora PK130	630.420	1222.985	100	302	260.2	24.9	3299	12.4	1.3
SR59	Carrefour Parawol	631.430	1221.004	100	486	260.2	24.9	433	12.5	1.3
SR60	Kahel Mbody	621.990	1235.671	625	1166	4.1	0.4	0	1.6	0.1
SR61	Nyale Djaiman	624.955	1236.344	2070	1874	0.2	0.0	0	0.1	0.0
SR62	Nyale Boussoura	625.120	1235.411	1150	928	0.6	0.1	3	0.5	0.0
SR63	Sintiourou Boussara	624.872	1235.328	1055	851	0.9	0.1	8	0.7	0.0
SR64	Nyale Moussa	625.947	1236.002	1995	1741	0.2	0.0	0	0.1	0.0
SR65	Nyale Hogo	625.770	1235.742	1685	1459	0.2	0.0	0	0.1	0.0
SR66	Nyale Misside	626.396	1235.647	1995	1780	0.2	0.0	0	0.1	0.0
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	2600	2226	0.3	0.0	0	0.1	0.0
SR68	Thiangui Bonodji	629.255	1235.955	4620	4127	0.2	0.0	0	0.0	0.0
SR69	Thianghe	629.467	1235.269	4620	3454	0.2	0.0	0	0.0	0.0
SR70	Sella Rounde	631.428	1234.702	4590	3828	0.2	0.0	0	0.1	0.0
SR71	Daba Ley	629.833	1233.178	2590	1630	0.4	0.1	0	0.2	0.0
SR72	Daba Dow	629.715	1232.682	2080	1174	0.5	0.1	0	0.3	0.0
SR73	Hore Sella 3	630.141	1232.245	1815	1341	0.4	0.1	0	0.4	0.0
SR74	Hore Sella 2	630.802	1232.233	2200	1995	0.4	0.1	0	0.1	0.0
SR75	Hore Sella 1	631.121	1232.292	2470	2314	0.4	0.1	0	0.1	0.0
SR76	Parawol Aliou	624.789	1231.158	100	183	260.5	24.9	12128	12.4	1.3
SR77	Paragogo	623.443	1229.209	2290	374	29.6	2.9	1492	4.2	0.3
SR78	Koungnoube	627.093	1228.760	1905	1114	0.7	0.1	0	0.6	0.0
SR79	Doumoun Cogon	632.078	1236.439	6430	4240	0.1	0.0	0	0.0	0.0
SR80	Passago	634.618	1235.978	7545	2770	0.1	0.0	0	0.0	0.0
SR81	Sellawol	631.901	1233.675	4005	2914	0.2	0.0	0	0.1	0.0
SR82	Sambou 1	632.940	1233.190	4460	1778	0.3	0.0	0	0.1	0.0
SR83	Sambou 2	632.633	1232.623	3895	1983	0.3	0.0	0	0.1	0.0
SR84	Cogon Lengue	636.354	1231.950	4890	545	7.5	0.7	227	2.1	0.1
SR85	Ndanta Fongne Ley	633.318	1229.812	2735	754	1.7	0.2	23	1.0	0.0
SR86	Ndanta Fongne Dow	632.988	1229.540	2675	1135	0.4	0.1	0	0.5	0.0
SR87	Sintiourou Nyaka	633.023	1225.335	660	1755	3.2	0.3	0	2.5	0.1

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR88	Bourreti	634.984	1222.464	1875	817	1.0	0.1	11	0.8	0.0
SR89	Ndantari	636.614	1221.460	3235	1627	0.1	0.0	0	0.1	0.0
SR90	Sitako	634.252	1218.719	150	591	174.3	16.7	137	10.2	0.9
SR91	Thiankwe	636.839	1218.743	2685	1832	0.1	0.0	0	0.1	0.0
SR92	Limbiko	633.035	1217.503	1190	2226	0.2	0.0	0	0.2	0.0
SR93	Diandian	634.063	1216.510	2315	2800	0.1	0.0	0	0.1	0.0
SR94	Sintiourou Daroul Diandian	636.520	1217.255	2845	2500	0.1	0.0	0	0.0	0.0
SR95	Sintiourou Kerkere	636.933	1215.577	4275	4140	0.0	0.0	0	0.0	0.0
SR96	Sintiourou Hafia	626.238	1221.457	840	1007	1.3	0.2	1	0.9	0.0
SR97	Madina Dian	632.551	1221.418	100	776	260.1	24.9	18	12.5	1.3

Table D.5: 22.5 MTPY - Model Predicted Maximum Short-term Concentrations in Sangarédi (µg/m^3)

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR1	Boundi Foulasso	612.914	1235.118	7595	4285	0.1	0.0	0	0.0	0.0
SR2	Feto Kewewol	612.704	1232.674	7285	4317	0.1	0.0	0	0.0	0.0
SR3	Pomboniwol	613.069	1232.155	6700	4108	0.1	0.0	0	0.0	0.0
SR4	Sintiourou Nalbewou	613.659	1231.256	5745	4005	0.1	0.0	0	0.0	0.0
SR5	Boullere	613.813	1229.964	5085	2072	0.2	0.0	0	0.1	0.0
SR6	Bandodji Nyalbi	617.423	1231.312	2660	1832	0.6	0.1	0	0.1	0.0
SR7	Daara	617.521	1234.795	3325	298	65.1	6.2	4172	6.8	0.5
SR8	Bossere	617.662	1236.411	4090	1915	0.2	0.0	0	0.1	0.0
SR9	Kourawel	620.668	1234.753	675	232	110.4	10.6	8643	8.9	0.7
SR10	Sintiourou Kourawel	620.513	1234.360	585	100	534.6	51.1	75991	19.6	2.3
SR11	Bandodji Touguidje	617.072	1228.404	1475	549	9.1	0.9	264	2.6	0.1
SR12	Mbourore	619.769	1227.786	100	585	317.9	30.5	177	15.2	1.6
SR13	Sintiourou Lenguere	615.527	1226.635	2845	511	12.1	1.2	400	3.0	0.1
SR14	Gueguere	616.594	1226.045	2065	246	98.7	9.5	7387	8.5	0.7
SR15	Fassely Belendere	615.049	1224.486	4235	485	14.8	1.4	532	3.3	0.2
SR16	Parawi	615.513	1222.477	5385	303	63.0	6.1	3971	6.8	0.5
SR17	Fassely Fouta Be	619.263	1225.230	1340	204	138.7	13.3	11780	10.1	0.9
SR18	Filo Bowal	611.720	1219.724	9945	1962	5.3	0.9	0	1.0	0.2
SR19	Kalinko Ley	615.105	1219.682	7140	1037	1.4	0.2	1	0.7	0.1
SR20	Sintiourou Madina	615.976	1219.710	6350	1189	1.0	0.2	0	0.5	0.0
SR21	Kankalare	616.622	1221.213	5165	191	155.4	15.1	13557	11.3	1.0
SR22	Kankalare Hacoude	616.889	1221.438	4845	353	45.1	4.5	2289	6.3	0.5
SR23	Telli Bofi	617.465	1221.143	4390	989	6.9	1.1	2	2.0	0.3
SR24	Madina Kankalare	617.858	1222.070	3760	1068	8.8	1.4	1	2.5	0.4
SR25	Nyangaba	616.903	1219.541	5650	1570	0.6	0.1	0	0.3	0.0
SR26	Kalinko Guessore	617.142	1218.656	6020	2444	0.5	0.1	0	0.3	0.0
SR27	Kalinko Poutai	617.465	1218.221	6100	2138	0.5	0.1	0	0.3	0.0
SR28	Parawol Malassi	619.432	1220.117	3375	700	7.5	1.1	50	3.0	0.3
SR29	Parawol Kouradje	619.797	1219.260	3905	765	2.8	0.3	25	1.5	0.1
SR30	Souka	617.634	1216.114	7700	2481	0.4	0.1	0	0.2	0.0
SR31	Wadiya	614.206	1216.016	9965	4159	0.4	0.1	0	0.1	0.0
SR32	Wossou	614.066	1216.241	9920	3918	0.4	0.1	0	0.1	0.0
SR33	Kalinko Rounde	619.642	1216.409	6620	1098	0.4	0.1	1	0.4	0.0
SR34	Hore Lafou	621.524	1221.241	1500	627	7.1	0.9	112	2.6	0.2
SR35	Kagneka	622.325	1217.638	5155	172	177.7	17.0	16678	11.4	1.0
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	6570	1144	0.2	0.0	0	0.3	0.0
SR37	Lougal	624.677	1215.312	5910	1579	0.2	0.0	0	0.1	0.0
SR38	Djoloun	626.696	1215.772	5055	2439	0.1	0.0	0	0.1	0.0
SR39	Ndiarinde Misside	626.812	1218.047	2780	1024	0.5	0.1	1	0.5	0.0
SR40	Ndiarinde Rounde	626.556	1218.763	2080	1003	0.5	0.1	2	0.5	0.0
SR41	Hafia 1	626.403	1219.671	1230	1655	0.4	0.1	0	0.4	0.0
SR42	Missira	627.949	1219.121	1880	2357	0.3	0.0	0	0.2	0.0
SR43	Wendou Baga	628.243	1215.363	5355	3638	0.1	0.0	0	0.1	0.0

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR44	Sintiourou Missira	628.358	1219.492	1595	1997	0.3	0.1	0	0.2	0.0
SR45	Sakidje	627.540	1220.872	100	660	316.3	30.2	78	15.2	1.6
SR46	Hamdalaye	622.082	1225.627	145	185	227.2	22.1	14491	13.2	1.3
SR47	Lafou Mbayla	623.258	1222.022	1830	1645	2.6	0.4	0	0.9	0.1
SR48	Sintiourou Baladaroul	626.925	1227.663	845	1740	1.4	0.2	0	0.9	0.0
SR49	Ndantary	626.794	1228.202	1400	1420	0.6	0.1	0	0.3	0.0
SR50	Boundou Wande	629.210	1224.050	1055	336	48.3	4.6	2756	6.2	0.4
SR51	Kare Dabbhel	629.809	1220.856	865	1156	1.0	0.1	0	0.9	0.0
SR52	Petoum Nyalbi	629.002	1216.784	3880	2569	0.2	0.0	0	0.1	0.0
SR53	Pora Hodho	630.131	1216.744	3015	2165	0.2	0.0	0	0.1	0.0
SR54	Sintiourou Thiewere	630.269	1217.191	2625	1684	0.2	0.0	0	0.1	0.0
SR55	Pora Banla	630.768	1216.534	2700	2363	0.1	0.0	0	0.1	0.0
SR56	Sintiourou Saikou Timbi	630.348	1216.048	3345	2849	0.1	0.0	0	0.1	0.0
SR57	Daroul	630.497	1223.646	100	286	316.3	30.2	4780	15.1	1.6
SR58	Pora PK130	630.420	1222.985	100	302	316.3	30.2	4012	15.1	1.6
SR59	Carrefour Parawol	631.430	1221.004	100	486	316.3	30.2	527	15.1	1.6
SR60	Kahel Mbody	621.990	1235.671	625	1166	5.1	0.5	0	1.9	0.1
SR61	Nyale Djaiman	624.955	1236.344	2070	1874	0.3	0.0	0	0.1	0.0
SR62	Nyale Boussoura	625.120	1235.411	1150	928	0.7	0.1	4	0.6	0.0
SR63	Sintiourou Boussara	624.872	1235.328	1055	851	1.1	0.1	10	0.8	0.0
SR64	Nyale Moussa	625.947	1236.002	1995	1741	0.2	0.0	0	0.1	0.0
SR65	Nyale Hogo	625.770	1235.742	1685	1459	0.3	0.0	0	0.1	0.0
SR66	Nyale Misside	626.396	1235.647	1995	1780	0.3	0.0	0	0.1	0.0
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	2600	2226	0.3	0.1	0	0.1	0.0
SR68	Thiangui Bonodji	629.255	1235.955	4620	4127	0.2	0.0	0	0.1	0.0
SR69	Thianghe	629.467	1235.269	4620	3454	0.2	0.0	0	0.0	0.0
SR70	Sella Rounde	631.428	1234.702	4590	3828	0.2	0.0	0	0.1	0.0
SR71	Daba Ley	629.833	1233.178	2590	1630	0.4	0.1	0	0.2	0.0
SR72	Daba Dow	629.715	1232.682	2080	1174	0.5	0.1	0	0.4	0.0
SR73	Hore Sella 3	630.141	1232.245	1815	1341	0.4	0.1	0	0.5	0.0
SR74	Hore Sella 2	630.802	1232.233	2200	1995	0.3	0.1	0	0.2	0.0
SR75	Hore Sella 1	631.121	1232.292	2470	2314	0.3	0.1	0	0.1	0.0
SR76	Parawol Aliou	624.789	1231.158	100	183	316.8	30.3	14747	15.1	1.6
SR77	Paragogo	623.443	1229.209	2290	374	36.2	3.5	1814	5.2	0.3
SR78	Koungnoube	627.093	1228.760	1905	1114	0.6	0.1	1	0.7	0.0
SR79	Doumoun Cogon	632.078	1236.439	6430	4240	0.1	0.0	0	0.0	0.0
SR80	Passago	634.618	1235.978	7545	2770	0.1	0.0	0	0.0	0.0
SR81	Sellawol	631.901	1233.675	4005	2914	0.2	0.0	0	0.1	0.0
SR82	Sambou 1	632.940	1233.190	4460	1778	0.2	0.0	0	0.1	0.0
SR83	Sambou 2	632.633	1232.623	3895	1983	0.2	0.0	0	0.1	0.0
SR84	Cogon Lengue	636.354	1231.950	4890	545	9.1	0.9	276	2.6	0.1
SR85	Ndanta Fongne Ley	633.318	1229.812	2735	754	1.9	0.2	28	1.2	0.0
SR86	Ndanta Fongne Dow	632.988	1229.540	2675	1135	0.4	0.1	0	0.5	0.0
SR87	Sintiourou Nyaka	633.023	1225.335	660	1755	3.8	0.4	0	3.0	0.1

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR88	Bourreti	634.984	1222.464	1875	817	1.2	0.1	14	1.0	0.0
SR89	Ndantari	636.614	1221.460	3235	1627	0.1	0.0	0	0.1	0.0
SR90	Sitako	634.252	1218.719	150	591	211.9	20.3	167	12.4	1.2
SR91	Thiankwe	636.839	1218.743	2685	1832	0.1	0.0	0	0.1	0.0
SR92	Limbiko	633.035	1217.503	1190	2226	0.2	0.0	0	0.3	0.0
SR93	Diandian	634.063	1216.510	2315	2800	0.1	0.0	0	0.1	0.0
SR94	Sintiourou Daroul Diandian	636.520	1217.255	2845	2500	0.1	0.0	0	0.0	0.0
SR95	Sintiourou Kerkere	636.933	1215.577	4275	4140	0.0	0.0	0	0.0	0.0
SR96	Sintiourou Hafia	626.238	1221.457	840	1007	1.4	0.2	2	1.0	0.0
SR97	Madina Dian	632.551	1221.418	100	776	316.2	30.2	22	15.1	1.6

Table D.6: 27.5 MTPY - Model Predicted Maximum Short-term Concentrations in Sangarédi (µg/m^3)

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR1	Boundi Foulasso	612.914	1235.118	7595	4285	0.1	0.0	0	0.0	0.0
SR2	Feto Kewewol	612.704	1232.674	7285	4317	0.1	0.0	0	0.0	0.0
SR3	Pomboniwol	613.069	1232.155	6700	4108	0.1	0.0	0	0.0	0.0
SR4	Sintiourou Nalbewou	613.659	1231.256	5745	4005	0.2	0.0	0	0.0	0.0
SR5	Boullere	613.813	1229.964	5085	2072	0.2	0.0	0	0.1	0.0
SR6	Bandodji Nyalbi	617.423	1231.312	2660	1832	0.7	0.1	0	0.2	0.0
SR7	Daara	617.521	1234.795	3325	298	79.5	7.6	5101	8.4	0.6
SR8	Bossere	617.662	1236.411	4090	1915	0.3	0.0	0	0.1	0.0
SR9	Kourawel	620.668	1234.753	675	232	134.9	12.9	10566	10.9	0.9
SR10	Sintiourou Kourawel	620.513	1234.360	585	100	653.5	62.5	92901	23.9	2.8
SR11	Bandodji Touguidje	617.072	1228.404	1475	549	11.1	1.1	323	3.1	0.1
SR12	Mbourore	619.769	1227.786	100	585	388.6	37.3	217	18.6	1.9
SR13	Sintiourou Lenguere	615.527	1226.635	2845	511	14.8	1.4	489	3.6	0.2
SR14	Gueguere	616.594	1226.045	2065	246	120.7	11.6	9031	10.4	0.8
SR15	Fassely Belendere	615.049	1224.486	4235	485	18.1	1.8	651	4.0	0.2
SR16	Parawi	615.513	1222.477	5385	303	77.0	7.4	4854	8.4	0.6
SR17	Fassely Fouta Be	619.263	1225.230	1340	204	169.6	16.3	14402	12.3	1.1
SR18	Filo Bowal	611.720	1219.724	9945	1962	6.6	1.1	0	1.1	0.2
SR19	Kalinko Ley	615.105	1219.682	7140	1037	1.8	0.3	2	0.8	0.1
SR20	Sintiourou Madina	615.976	1219.710	6350	1189	1.3	0.2	0	0.6	0.1
SR21	Kankalare	616.622	1221.213	5165	191	190.1	18.4	16573	13.8	1.3
SR22	Kankalare Hacoude	616.889	1221.438	4845	353	55.2	5.5	2798	7.7	0.6
SR23	Telli Bofi	617.465	1221.143	4390	989	8.7	1.4	3	2.3	0.4
SR24	Madina Kankalare	617.858	1222.070	3760	1068	10.9	1.7	1	2.9	0.5
SR25	Nyangaba	616.903	1219.541	5650	1570	0.8	0.1	0	0.3	0.0
SR26	Kalinko Guessore	617.142	1218.656	6020	2444	0.7	0.1	0	0.3	0.0
SR27	Kalinko Poutai	617.465	1218.221	6100	2138	0.6	0.1	0	0.3	0.0
SR28	Parawol Malassi	619.432	1220.117	3375	700	9.4	1.3	62	3.6	0.3
SR29	Parawol Kouradje	619.797	1219.260	3905	765	3.4	0.4	30	1.9	0.1
SR30	Souka	617.634	1216.114	7700	2481	0.5	0.1	0	0.2	0.0
SR31	Wadiya	614.206	1216.016	9965	4159	0.4	0.1	0	0.2	0.0
SR32	Wossou	614.066	1216.241	9920	3918	0.5	0.1	0	0.2	0.0
SR33	Kalinko Rounde	619.642	1216.409	6620	1098	0.5	0.1	1	0.5	0.0
SR34	Hore Lafou	621.524	1221.241	1500	627	8.8	1.0	137	3.2	0.2
SR35	Kagneka	622.325	1217.638	5155	172	217.2	20.8	20389	14.0	1.3
SR36	Sintiourou Kaouri Bowe	623.616	1215.082	6570	1144	0.3	0.0	0	0.4	0.0
SR37	Lougal	624.677	1215.312	5910	1579	0.2	0.0	0	0.1	0.0
SR38	Djoloun	626.696	1215.772	5055	2439	0.2	0.0	0	0.1	0.0
SR39	Ndiarinde Misside	626.812	1218.047	2780	1024	0.6	0.1	2	0.6	0.0
SR40	Ndiarinde Rounde	626.556	1218.763	2080	1003	0.6	0.1	2	0.7	0.0
SR41	Hafia 1	626.403	1219.671	1230	1655	0.5	0.1	0	0.4	0.0
SR42	Missira	627.949	1219.121	1880	2357	0.3	0.1	0	0.2	0.0
SR43	Wendou Baga	628.243	1215.363	5355	3638	0.2	0.0	0	0.1	0.0

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR44	Sintiourou Missira	628.358	1219.492	1595	1997	0.4	0.1	0	0.3	0.0
SR45	Sakidje	627.540	1220.872	100	660	386.7	37.0	96	18.5	1.9
SR46	Hamdalaye	622.082	1225.627	145	185	277.5	27.0	17715	16.0	1.6
SR47	Lafou Mbayla	623.258	1222.022	1830	1645	3.2	0.5	0	1.1	0.1
SR48	Sintiourou Baladaroul	626.925	1227.663	845	1740	1.7	0.2	0	1.1	0.0
SR49	Ndantary	626.794	1228.202	1400	1420	0.8	0.1	0	0.3	0.0
SR50	Boundou Wande	629.210	1224.050	1055	336	59.0	5.7	3369	7.5	0.5
SR51	Kare Dabbhel	629.809	1220.856	865	1156	1.2	0.1	0	1.1	0.0
SR52	Petoum Nyalbi	629.002	1216.784	3880	2569	0.2	0.0	0	0.1	0.0
SR53	Pora Hodho	630.131	1216.744	3015	2165	0.2	0.0	0	0.1	0.0
SR54	Sintiourou Thiewere	630.269	1217.191	2625	1684	0.2	0.0	0	0.1	0.0
SR55	Pora Banla	630.768	1216.534	2700	2363	0.2	0.0	0	0.1	0.0
SR56	Sintiourou Saikou Timbi	630.348	1216.048	3345	2849	0.1	0.0	0	0.1	0.0
SR57	Daroul	630.497	1223.646	100	286	386.7	37.0	5844	18.4	1.9
SR58	Pora PK130	630.420	1222.985	100	302	386.7	37.0	4905	18.4	1.9
SR59	Carrefour Parawol	631.430	1221.004	100	486	386.6	37.0	644	18.5	1.9
SR60	Kahel Mbody	621.990	1235.671	625	1166	6.3	0.6	0	2.3	0.1
SR61	Nyale Djaiman	624.955	1236.344	2070	1874	0.3	0.1	0	0.1	0.0
SR62	Nyale Boussoura	625.120	1235.411	1150	928	0.9	0.1	5	0.7	0.0
SR63	Sintiourou Boussara	624.872	1235.328	1055	851	1.4	0.2	12	1.0	0.0
SR64	Nyale Moussa	625.947	1236.002	1995	1741	0.3	0.0	0	0.1	0.0
SR65	Nyale Hogo	625.770	1235.742	1685	1459	0.3	0.1	0	0.1	0.0
SR66	Nyale Misside	626.396	1235.647	1995	1780	0.3	0.1	0	0.1	0.0
SR67	Sintiourou Hakounde Thiangui	627.542	1234.017	2600	2226	0.4	0.1	0	0.1	0.0
SR68	Thiangui Bonodji	629.255	1235.955	4620	4127	0.3	0.0	0	0.1	0.0
SR69	Thianghe	629.467	1235.269	4620	3454	0.2	0.0	0	0.1	0.0
SR70	Sella Rounde	631.428	1234.702	4590	3828	0.3	0.0	0	0.1	0.0
SR71	Daba Ley	629.833	1233.178	2590	1630	0.4	0.1	0	0.2	0.0
SR72	Daba Dow	629.715	1232.682	2080	1174	0.6	0.1	0	0.4	0.0
SR73	Hore Sella 3	630.141	1232.245	1815	1341	0.5	0.1	0	0.5	0.0
SR74	Hore Sella 2	630.802	1232.233	2200	1995	0.4	0.1	0	0.2	0.0
SR75	Hore Sella 1	631.121	1232.292	2470	2314	0.4	0.1	0	0.1	0.0
SR76	Parawol Aliou	624.789	1231.158	100	183	387.3	37.1	18029	18.5	1.9
SR77	Paragogo	623.443	1229.209	2290	374	44.3	4.3	2218	6.3	0.4
SR78	Koungnoube	627.093	1228.760	1905	1114	0.7	0.1	1	0.8	0.0
SR79	Doumoun Cogon	632.078	1236.439	6430	4240	0.1	0.0	0	0.0	0.0
SR80	Passago	634.618	1235.978	7545	2770	0.1	0.0	0	0.0	0.0
SR81	Sellawol	631.901	1233.675	4005	2914	0.3	0.0	0	0.1	0.0
SR82	Sambou 1	632.940	1233.190	4460	1778	0.3	0.0	0	0.1	0.0
SR83	Sambou 2	632.633	1232.623	3895	1983	0.3	0.0	0	0.1	0.0
SR84	Cogon Lengue	636.354	1231.950	4890	545	11.1	1.1	338	3.1	0.1
SR85	Ndanta Fongne Ley	633.318	1229.812	2735	754	2.4	0.2	34	1.5	0.0
SR86	Ndanta Fongne Dow	632.988	1229.540	2675	1135	0.4	0.1	1	0.6	0.0
SR87	Sintiourou Nyaka	633.023	1225.335	660	1755	4.6	0.5	0	3.5	0.1

ID	Description	UTM Easting (km)	UTM Northing (km)	Distance to Nearest Road (m)	Distance to Nearest Working Area (m)	99th 24h PM_{10}	99th 24h $PM_{2.5}$	1h NO_2	10 min SO_2	24h SO_2
					WHO Interim Target 1	150	75	40	-	125
					WHO Interim Target 2	100	50	-	-	50
					WHO Interim Target 3	75	37.5	-	-	-
					WHO Guideline	50	25	200	500	20
SR88	Bourreti	634.984	1222.464	1875	817	1.4	0.1	17	1.2	0.0
SR89	Ndantari	636.614	1221.460	3235	1627	0.1	0.0	0	0.1	0.0
SR90	Sitako	634.252	1218.719	150	591	259.1	24.8	204	15.1	1.4
SR91	Thiankwe	636.839	1218.743	2685	1832	0.1	0.0	0	0.1	0.0
SR92	Limbiko	633.035	1217.503	1190	2226	0.2	0.0	0	0.3	0.0
SR93	Diandian	634.063	1216.510	2315	2800	0.1	0.0	0	0.1	0.0
SR94	Sintiourou Daroul Diandian	636.520	1217.255	2845	2500	0.1	0.0	0	0.1	0.0
SR95	Sintiourou Kerkere	636.933	1215.577	4275	4140	0.1	0.0	0	0.0	0.0
SR96	Sintiourou Hafia	626.238	1221.457	840	1007	1.8	0.2	2	1.3	0.1
SR97	Madina Dian	632.551	1221.418	100	776	386.6	36.9	27	18.5	1.9

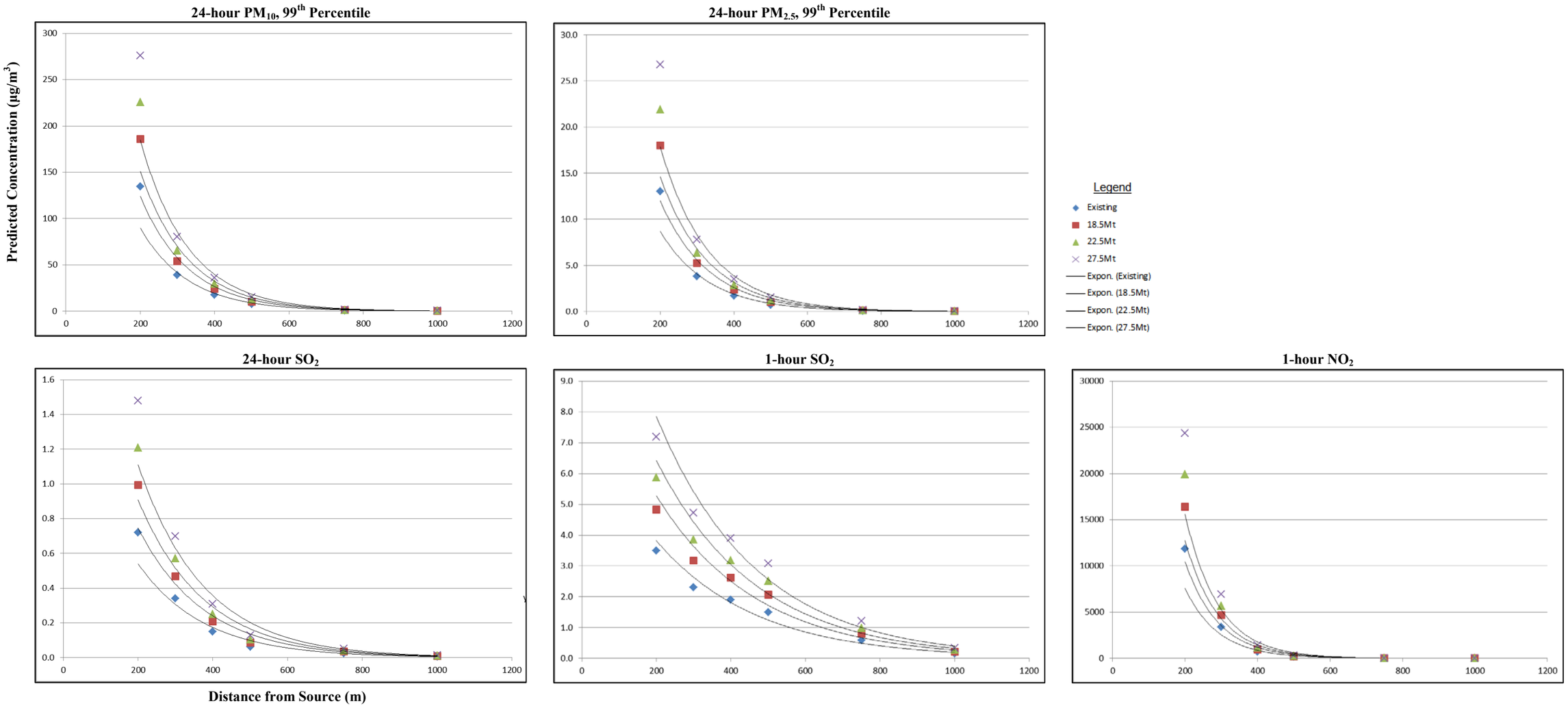
Table D. 7: Regression Parameters for Short-term Concentration Curves

COPC	Averaging Period	Parameter	Existing	18.5MTPY	22.5 MTPY	27.5 MTPY
PM_{10}, 99th Percentile	24-hour	C_0	418.7	578.3	703.3	859.8
		a	0.008	0.008	0.008	0.008
		r^2	0.976	0.976	0.976	0.976
$PM_{2.5}$, 99th Percentile	24-hour	C_0	40.0	55.2	67.2	82.1
		a	0.008	0.008	0.008	0.008
		r^2	0.976	0.976	0.976	0.976
SO_2	24-hour	C_0	1.7	2.3	2.8	3.5
		a	0.006	0.006	0.006	0.006
		r^2	0.977	0.977	0.977	0.977
	1-hour	C_0	8.1	11.1	13.5	16.6
		a	0.004	0.004	0.004	0.004
		r^2	0.979	0.979	0.979	0.979
NO_2	1-hour	C_0	66071	91254	110964	135658
		a	0.011	0.011	0.011	0.011
		r^2	0.978	0.978	0.978	0.978

Note:
Concentrations of COPCs decrease exponentially with distance from a source(s) according to the following relationship:

$$C(x) = C_0 * e^{-a * x}$$

where, $C(x)$ = concentration at distance x
x = distance in metres
C_0 = regression parameter
a = regression parameter
r^2 = coefficient of determination


24-hour PM10, 99th Percentile
24-hour PM2.5, 99th Percentile
24-hour SO2
1-hour SO2
1-hour NO2
Predicted Concentration (µg/m3)
Distance from Source (m)
Legend
Existing
18.5Mt
22.5Mt
27.5Mt
Expon. (Existing)
Expon. (18.5Mt)
Expon. (22.5Mt)
Expon. (27.5Mt)

RESULTS FOR METALLIC CONSTITUENTS OF TSP

While not considered to be a measure of the impact to air quality, average deposition rates of annual TSP and its metallic constituents were calculated in order to inform the biological and water quality impacts assessments. These results are presented in Table D.8 and Table D.9 below.

Table D.8: Average Over-water Deposition Rates ($g/m^2/s$) in Kamsar for TSP and its Metallic Constituents

Scenario	TSP	Al	Sb	As	Cd	Cr	Cu	Ni
Existing	1.22E-06	3.22E-07	4.52E-12	3.54E-11	3.04E-13	1.36E-09	1.53E-10	7.41E-11
18.5MT	1.10E-06	2.91E-07	4.09E-12	3.18E-11	2.78E-13	1.22E-09	1.37E-10	6.74E-11
22.5MT	6.41E-07	1.68E-07	2.57E-12	1.86E-11	1.76E-13	7.06E-10	8.02E-11	4.22E-11
27.5MT	1.24E-06	3.25E-07	4.70E-12	3.60E-11	3.20E-13	1.37E-09	1.55E-10	7.65E-11

Note:
[1] Deposition rates are presented as an average across the over-water area (42 km^2) within the Kamsar study area (see Figure 1). These results were used as input to the water quality impact assessment.
[2] Deposition rates are developed from the TSP concentration contours (presented in Attachment A) with an assumed settling velocity of 3 cm/s.

Table D.9: Average Deposition Rates ($g/m^2/s$) in Sangarédi for TSP and its Metallic Constituents

Scenario	TSP	Al	Sb	As	Cd	Cr	Cu	Ni
Existing	3.52E-07	2.40E-08	3.07E-13	2.64E-12	2.04E-14	1.02E-10	1.14E-11	5.04E-12
18.5MT	5.20E-07	3.37E-08	4.30E-13	3.71E-12	2.89E-14	1.42E-10	1.61E-11	7.04E-12
22.5MT	6.08E-07	3.76E-08	4.80E-13	4.14E-12	3.22E-14	1.60E-10	1.79E-11	7.92E-12
27.5MT	5.07E-07	2.70E-08	3.44E-13	2.98E-12	2.31E-14	1.15E-10	1.29E-11	5.65E-12

Note:
[1] Deposition rates are presented as an average across the Sangarédi study area (572 km^2; see Figure 1). These results were used as input to the water quality impact assessment.
[2] Deposition rates are developed from the TSP concentration contours (presented in Attachment A) with an assumed settling velocity of 3 cm/s.

ATTACHMENT E:
MAXXAM LABORATORY REPORTS

Mini-Vol Particulate Sampling

Certificates of Analysis

Maxxam

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Your C.O.C. #: 15707

Attention:Paul Kirby

SENES Consultants Limited
121 Granton Dr
Unit 12
Richmond Hill, ON
CANADA L4B 3N4

Report Date: 2014/05/05
Report #: R3019943
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B462845
Received: 2014/04/17, 13:35

Sample Matrix: Filter
Samples Received: 84

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Hexavalent Chromium (modified CARB039)	12	2014/04/29	2014/04/30	BRL SOP-00106	Modified CARB 039
Total Metals on Lo-Vol Filter (6010Cmod)	12	2014/05/01	2014/05/01		EPA 6010Cmod
Total Metals (6010Cmod)	12	2014/04/28	2014/04/29	CAM SOP-00408 / BRL SOP-00102	EPA 6010Cmod
Particulates on Lo-Vol Filters	84	N/A	2014/05/01		
Total Particulate	84	N/A	2014/04/24	BRL SOP-00109	
Air Volume from LoVol Sampling	84	N/A	2014/04/24		

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Theresa Stephenson, Project Manager
Email: TStephenson@maxxam.ca
Phone# (905)817-5763
==========
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Maxxam Job #: B462845
Report Date: 2014/05/05

SENES Consultants Limited
Sampler Initials: SD

RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0603	VP0604	VP0605	VP0606		
Sampling Date		2014/03/15 14:40	2014/03/15 14:40	2014/03/15 14:40	2014/03/15 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14020715-AQ1-PM10**	**14020713-AQ1-PM25**	**14021001-AQ2-TSP**	**14020711-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	106	59	253	147	14	3590893
Particulate Weight on Filter	mg	0.75	0.42	1.82	1.06	0.10	3581747
Volume	m3	7.100	7.100	7.200	7.200	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam ID		VP0607		VP0608		VP0609		
Sampling Date		2014/03/15 14:40				2014/04/11 14:40		
COC Number		15707		15707		15707		
	Units	**14020712-AQ2-PM25**	**RDL**	**14020716-BLANK**	**RDL**	**14021060-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	73	14	ND	5000	99	14	3590893
Particulate Weight on Filter	mg	0.52	0.10	0.34	0.10	0.70	0.10	3581747
Volume	m3	7.100	N/A	0	N/A	7.100	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0610	VP0611	VP0612	VP0613		
Sampling Date		2014/04/11 14:40	2014/04/11 14:40	2014/04/11 14:40	2014/04/11 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021061-AQ1-PM10**	**14021062-AQ1-PM25**	**13092301-AQ2-TSP**	**14021051-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	66	46	117	93	14	3590893
Particulate Weight on Filter	mg	0.47	0.33	0.83	0.66	0.10	3581747
Volume	m3	7.100	7.100	7.100	7.100	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0614	VP0615	VP0616	VP0617		
Sampling Date		2014/04/11 14:40	2014/04/03 14:40	2014/04/03 14:40	2014/04/03 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021052-AQ2-PM25**	**13082223-AQ1-TSP**	**13082224-AQ1-PM10**	**13082225-AQ1-PM25**	**RDL**	**QC Batch**
Particulate	ug/m3	63	53	28	ND	14	3590893
Particulate Weight on Filter	mg	0.45	0.38	0.20	ND	0.10	3581747
Volume	m3	7.100	7.200	7.200	7.200	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug		ND			0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0618	VP0619	VP0620		VP0621		
Sampling Date		2014/04/03 14:40	2014/04/03 14:40	2014/04/03 14:40				
COC Number		15707	15707	15707		15707		
	Units	**13082226-AQ2-TSP**	**13082227-AQ2-PM10**	**14020701-AQ2-PM25**	**RDL**	**13092302-BLANK**	**RDL**	**QC Batch**
Particulate	ug/m3	85	43	55	14	ND	5000	3590893
Particulate Weight on Filter	mg	0.61	0.31	0.39	0.10	0.51	0.10	3581747
Volume	m3	7.200	7.200	7.100	N/A	0	N/A	ONSITE
Metals								
Hexavalent Chromium (Cr 6+)	ug	ND			0.01			3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0622	VP0623	VP0624	VP0625		
Sampling Date		2014/04/04 14:40	2014/04/04 14:40	2014/04/04 14:40	2014/04/04 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14020703-AQ1-TSP**	**14020704-AQ1-PM10**	**14020705-AQ1-PM25**	**14020702-AQ2-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	189	127	72	165	14	3590893
Particulate Weight on Filter	mg	1.34	0.90	0.51	1.17	0.10	3581747
Volume	m3	7.100	7.100	7.100	7.100	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0626	VP0627		VP0628	VP0629		
Sampling Date		2014/04/04 14:40						
COC Number		15707	15707		15707	15707		
	Units	**14020706-AQ2-PM10**	**14021059-AQ2-PM25**	**RDL**	**13092304-BLANK**	**13092303-BLANK**	**RDL**	**QC Batch**
Particulate	ug/m3	118	47	14	ND	ND	5000	3590893
Particulate Weight on Filter	mg	0.84	0.34	0.10	0.46	0.44	0.10	3581747
Volume	m3	7.100	7.200	N/A	0	0	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0630	VP0631	VP0632		VP0633		
Sampling Date						2014/04/07 14:40		
COC Number		15707	15707	15707		15707		
	Units	**13092305-BLANK**	**13092306-BLANK**	**13092307-BLANK**	**RDL**	**14021046-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	ND	ND	ND	5000	124	14	3590893
Particulate Weight on Filter	mg	0.42	0.38	0.41	0.10	0.88	0.10	3581747
Volume	m3	0	0	0	N/A	7.100	N/A	ONSITE
Metals								
Hexavalent Chromium (Cr 6+)	ug					ND (1)	0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable
(1) 1/2 filter extracted in 10ml Rodi water. Results are total ug/filter.

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0634	VP0635	VP0636	VP0637		
Sampling Date		2014/04/07 14:40	2014/04/07 14:40	2014/04/07 14:40	2014/04/07 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021047-AQ1-PM10**	**14021048-AQ1-PM25**	**14021049-AQ2-TSP**	**14021050-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	70	42	134	85	14	3590893
Particulate Weight on Filter	mg	0.50	0.30	0.95	0.60	0.10	3581747
Volume	m3	7.100	7.100	7.100	7.100	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

Maxxam ID		VP0638	VP0639	VP0640	VP0641		
Sampling Date		2014/04/07 14:40	2014/04/04 14:40	2014/04/05 14:40	2014/04/05 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021056-AQ2-PM25**	**14020710-AQ2-PM25**	**14020707-AQ1-TSP**	**14020708-AQ1-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	69	48	136	114	14	3590893
Particulate Weight on Filter	mg	0.49	0.34	0.98	0.82	0.10	3581747
Volume	m3	7.100	7.100	7.200	7.200	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

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Report Date: 2014/05/05

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Sampler Initials: SD

RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0642		VP0643	VP0644		
Sampling Date		2014/04/05 14:40		2014/04/05 14:40	2014/04/05 14:40		
COC Number		15707		15707	15707		
	Units	**14020709-AQ1-PM25**	**QC Batch**	**14021063-AQ2-TSP**	**14021064-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	61	3590893	143	108	14	3590894
Particulate Weight on Filter	mg	0.44	3581747	1.03	0.78	0.10	3581749
Volume	m3	7.200	ONSITE	7.200	7.200	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug		3587398	ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

Maxxam ID		VP0645	VP0646	VP0647	VP0648		
Sampling Date		2014/04/05 14:40	2014/04/06 14:40	2014/04/06 14:40	2014/04/06 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021065-AQ2-PM25**	**14021053-AQ1-TSP**	**14021054-AQ1-PM10**	**14021055-AQ1-PM25**	**RDL**	**QC Batch**
Particulate	ug/m3	61	176	114	63	14	3590894
Particulate Weight on Filter	mg	0.43	1.27	0.82	0.45	0.10	3581749
Volume	m3	7.100	7.200	7.200	7.200	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam ID		VP0649	VP0650		VP0651	VP0652		
Sampling Date		2014/04/06 14:40	2014/04/06 14:40		2014/03/11 14:40	2014/03/11 14:40		
COC Number		15707	15707		15707	15707		
	Units	**14021057-AQ2-TSP**	**14021058-AQ2-PM10**	**RDL**	**14021025-AQ2-TSP**	**14021026-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	164	106	14	139	123	13	3590894
Particulate Weight on Filter	mg	1.18	0.76	0.10	1.06	0.92	0.10	3581749
Volume	m3	7.200	7.200	N/A	7.600	7.500	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

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Maxxam Job #: B462845
Report Date: 2014/05/05

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Sampler Initials: SD

RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0653		VP0654		VP0655		
Sampling Date		2014/03/11 14:40				2014/03/13 14:40		
COC Number		15707		15707		15707		
	Units	**14021030-AQ2-PM25**	**RDL**	**14021043-BLANK**	**RDL**	**14021003-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	62	13	ND	5000	151	14	3590894
Particulate Weight on Filter	mg	0.47	0.10	0.38	0.10	1.07	0.10	3581749
Volume	m3	7.600	N/A	0	N/A	7.100	N/A	ONSITE
Metals								
Hexavalent Chromium (Cr 6+)	ug					ND	0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0656	VP0657	VP0658	VP0659		
Sampling Date		2014/03/13 14:40	2014/03/13 14:40	2014/03/13 14:40	2014/03/13 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021004-AQ1-PM10**	**14021005-AQ1-PM25**	**14021045-AQ2-TSP**	**14021006-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	119	79	153	131	14	3590894
Particulate Weight on Filter	mg	0.86	0.56	1.10	0.93	0.10	3581749
Volume	m3	7.200	7.100	7.200	7.100	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0660		VP0661		VP0662	VP0663		
Sampling Date		2014/03/13 14:40				2014/03/15 14:40	2014/03/05 14:40		
COC Number		15707		15707		15707	15707		
	Units	**14021002-AQ2-PM25**	**RDL**	**14021007-BLANK**	**RDL**	**14020714-AQ1-TSP**	**14021032-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	80	14	ND	5000	204	304	14	3590894
Particulate Weight on Filter	mg	0.57	0.10	0.54	0.10	1.43	2.13	0.10	3581749
Volume	m3	7.100	N/A	0	N/A	7.000	7.000	N/A	ONSITE
Metals									
Hexavalent Chromium (Cr 6+)	ug		0.01				ND	0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0664	VP0665	VP0666	VP0667		
Sampling Date		2014/03/05 14:40	2014/03/05 14:40	2014/03/05 14:40	2014/03/05 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021019-AQ1-PM10**	**14021034-AQ1-PM25**	**14021035-AQ2-TSP**	**14021031-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	247	118	318	249	14	3590894
Particulate Weight on Filter	mg	1.73	0.84	2.26	1.74	0.10	3581749
Volume	m3	7.000	7.100	7.100	7.000	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0668		VP0669		VP0670		
Sampling Date		2014/03/05 14:40				2014/03/07 14:40		
COC Number		15707		15707		15707		
	Units	**14021033-AQ2-PM25**	**RDL**	**14021036-BLANK**	**RDL**	**14021017-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	124	14	ND	5000	200	14	3590894
Particulate Weight on Filter	mg	0.87	0.10	0.38	0.10	1.44	0.10	3581749
Volume	m3	7.000	N/A	0	N/A	7.200	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0671	VP0672	VP0673	VP0674		
Sampling Date		2014/03/07 14:40	2014/03/07 14:40	2014/03/07 14:40	2014/03/07 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021018-AQ1-PM10**	**14021021-AQ1-PM25**	**14021022-AQ2-TSP**	**14021023-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	156	92	230	163	14	3590894
Particulate Weight on Filter	mg	1.12	0.66	1.63	1.17	0.10	3581749
Volume	m3	7.200	7.200	7.100	7.200	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam ID		VP0675		VP0676		VP0677		
Sampling Date		2014/03/07 14:40				2014/03/09 14:40		
COC Number		15707		15707		15707		
	Units	**14021024-AQ2-PM25**	**RDL**	**14021016-BLANK**	**RDL**	**14021037-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	92	14	ND	5000	143	14	3590894
Particulate Weight on Filter	mg	0.66	0.10	0.44	0.10	1.03	0.10	3581749
Volume	m3	7.200	N/A	0	N/A	7.200	N/A	ONSITE
Metals								
Hexavalent Chromium (Cr 6+)	ug					ND	0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		VP0678	VP0679	VP0680	VP0681		
Sampling Date		2014/03/09 14:40	2014/03/09 14:40	2014/03/09 14:40	2014/03/09 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021038-AQ1-PM10**	**14021039-AQ1-PM25**	**14021040-AQ2-TSP**	**14021041-AQ2-PM10**	**RDL**	**QC Batch**
Particulate	ug/m3	107	72	150	117	14	3590894
Particulate Weight on Filter	mg	0.76	0.52	1.08	0.84	0.10	3581749
Volume	m3	7.100	7.200	7.200	7.200	N/A	ONSITE
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3587398

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

Maxxam ID		VP0682			VP0683		VP0684		
Sampling Date		2014/03/09 14:40					2014/03/11 14:40		
COC Number		15707			15707		15707		
	Units	**14021044-AQ2-PM25**	**RDL**	**QC Batch**	**14021042-BLANK**	**RDL**	**14021027-AQ1-TSP**	**RDL**	**QC Batch**
Particulate	ug/m3	75	14	3590894	ND	5000	ND	13	3590895
Particulate Weight on Filter	mg	0.54	0.10	3581749	0.38	0.10	1.21	0.10	3581751
Volume	m3	7.200	N/A	ONSITE	0	N/A	7.600	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

Maxxam ID		VP0685	VP0686		
Sampling Date		2014/03/11 14:40	2014/03/11 14:40		
COC Number		15707	15707		
	Units	**14021028-AQ1-PM10**	**14021029-AQ1-PM25**	**RDL**	**QC Batch**
Particulate	ug/m3	ND	ND	13	3590895
Particulate Weight on Filter	mg	0.81	0.58	0.10	3581751
Volume	m3	7.500	7.600	N/A	ONSITE

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

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CALCULATED ELEMENTS (FILTER)

Maxxam ID		VP0615	VP0618		VP0633	VP0636		
Sampling Date		2014/04/03 14:40	2014/04/03 14:40		2014/04/07 14:40	2014/04/07 14:40		
COC Number		15707	15707		15707	15707		
	Units	13082223-AQ1-TSP	13082226-AQ2-TSP	RDL	14021046-AQ1-TSP	14021049-AQ2-TSP	RDL	QC Batch
Metals								
Total Aluminum (Al)	ug/m3	1.57	1.79	0.69	2.71	2.01	0.70	3591040
Total Antimony (Sb)	ug/m3	ND	ND	0.14	ND	ND	0.14	3591040
Total Arsenic (As)	ug/m3	ND	ND	0.083	ND	ND	0.085	3591040
Total Cadmium (Cd)	ug/m3	ND	ND	0.028	ND	ND	0.028	3591040
Total Chromium (Cr)	ug/m3	ND	ND	0.069	ND	ND	0.070	3591040
Total Copper (Cu)	ug/m3	ND	ND	0.069	ND	0.088	0.070	3591040
Total Nickel (Ni)	ug/m3	ND	ND	0.042	ND	ND	0.042	3591040

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

Maxxam ID		VP0640	VP0643		VP0655		VP0658		
Sampling Date		2014/04/05 14:40	2014/04/05 14:40		2014/03/13 14:40		2014/03/13 14:40		
COC Number		15707	15707		15707		15707		
	Units	14020707-AQ1-TSP	14021063-AQ2-TSP	RDL	14021003-AQ1-TSP	RDL	14021045-AQ2-TSP	RDL	QC Batch
Metals									
Total Aluminum (Al)	ug/m3	2.88	2.65	0.69	2.39	0.70	2.43	0.69	3591040
Total Antimony (Sb)	ug/m3	ND	ND	0.14	ND	0.14	ND	0.14	3591040
Total Arsenic (As)	ug/m3	ND	ND	0.083	ND	0.085	ND	0.083	3591040
Total Cadmium (Cd)	ug/m3	ND	ND	0.028	ND	0.028	ND	0.028	3591040
Total Chromium (Cr)	ug/m3	ND	ND	0.069	ND	0.070	ND	0.069	3591040
Total Copper (Cu)	ug/m3	ND	ND	0.069	ND	0.070	ND	0.069	3591040
Total Nickel (Ni)	ug/m3	ND	ND	0.042	ND	0.042	ND	0.042	3591040

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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CALCULATED ELEMENTS (FILTER)

Maxxam ID		VP0663		VP0666		VP0677	VP0680		
Sampling Date		2014/03/05 14:40		2014/03/05 14:40		2014/03/09 14:40	2014/03/09 14:40		
COC Number		15707		15707		15707	15707		
	Units	**14021032-AQ1-TSP**	**RDL**	**14021035-AQ2-TSP**	**RDL**	**14021037-AQ1-TSP**	**14021040-AQ2-TSP**	**RDL**	**QC Batch**
Metals									
Total Aluminum (Al)	ug/m3	7.16	0.71	8.31	0.70	1.74	1.79	0.69	3591040
Total Antimony (Sb)	ug/m3	ND	0.14	ND	0.14	ND	ND	0.14	3591040
Total Arsenic (As)	ug/m3	ND	0.086	ND	0.085	ND	ND	0.083	3591040
Total Cadmium (Cd)	ug/m3	ND	0.029	ND	0.028	ND	ND	0.028	3591040
Total Chromium (Cr)	ug/m3	ND	0.071	ND	0.070	ND	ND	0.069	3591040
Total Copper (Cu)	ug/m3	ND	0.071	ND	0.070	ND	ND	0.069	3591040
Total Nickel (Ni)	ug/m3	ND	0.043	ND	0.042	ND	ND	0.042	3591040

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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MISCELLANEOUS (FILTER)

Maxxam ID		VP0615	VP0618	VP0633	VP0636		
Sampling Date		2014/04/03 14:40	2014/04/03 14:40	2014/04/07 14:40	2014/04/07 14:40		
COC Number		15707	15707	15707	15707		
	Units	**13082223-AQ1-TSP**	**13082226-AQ2-TSP**	**14021046-AQ1-TSP**	**14021049-AQ2-TSP**	**RDL**	**QC Batch**
Metals							
Aluminum (Al)	ug	11.3	12.9	19.3	14.3	5.0	3586795
Antimony (Sb)	ug	ND	ND	ND	ND	1.0	3586795
Arsenic (As)	ug	ND	ND	ND	ND	0.60	3586795
Cadmium (Cd)	ug	ND	ND	ND	ND	0.20	3586795
Chromium (Cr)	ug	ND	ND	ND	ND	0.50	3586795
Copper (Cu)	ug	ND	ND	ND	0.63	0.50	3586795
Nickel (Ni)	ug	ND	ND	ND	ND	0.30	3586795

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

Maxxam ID		VP0640	VP0643	VP0655	VP0658		
Sampling Date		2014/04/05 14:40	2014/04/05 14:40	2014/03/13 14:40	2014/03/13 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14020707-AQ1-TSP**	**14021063-AQ2-TSP**	**14021003-AQ1-TSP**	**14021045-AQ2-TSP**	**RDL**	**QC Batch**
Metals							
Aluminum (Al)	ug	20.7	19.1	17.0	17.5	5.0	3586795
Antimony (Sb)	ug	ND	ND	ND	ND	1.0	3586795
Arsenic (As)	ug	ND	ND	ND	ND	0.60	3586795
Cadmium (Cd)	ug	ND	ND	ND	ND	0.20	3586795
Chromium (Cr)	ug	ND	ND	ND	ND	0.50	3586795
Copper (Cu)	ug	ND	ND	ND	ND	0.50	3586795
Nickel (Ni)	ug	ND	ND	ND	ND	0.30	3586795

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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MISCELLANEOUS (FILTER)

Maxxam ID		VP0663	VP0666	VP0677	VP0680		
Sampling Date		2014/03/05 14:40	2014/03/05 14:40	2014/03/09 14:40	2014/03/09 14:40		
COC Number		15707	15707	15707	15707		
	Units	**14021032-AQ1-TSP**	**14021035-AQ2-TSP**	**14021037-AQ1-TSP**	**14021040-AQ2-TSP**	**RDL**	**QC Batch**
Metals							
Aluminum (Al)	ug	50.1	59.0	12.5	12.9	5.0	3586795
Antimony (Sb)	ug	ND	ND	ND	ND	1.0	3586795
Arsenic (As)	ug	ND	ND	ND	ND	0.60	3586795
Cadmium (Cd)	ug	ND	ND	ND	ND	0.20	3586795
Chromium (Cr)	ug	ND	ND	ND	ND	0.50	3586795
Copper (Cu)	ug	ND	ND	ND	ND	0.50	3586795
Nickel (Ni)	ug	ND	ND	ND	ND	0.30	3586795

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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GENERAL COMMENTS

Half filters were digested for metals. Results are total ug/filter.

RESULTS OF ANALYSES OF FILTER

Total Particulate: VP0659-01R *FT**LFT*
VP0668-01R *FT**LFT*

LFT Loose filter material in the petri dish
FT Filter torn

Results relate only to the items tested.

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QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3586795	APT	Spiked Blank	Aluminum (Al)	2014/04/29		103	%	85 - 115
			Cadmium (Cd)	2014/04/29		107	%	85 - 115
			Chromium (Cr)	2014/04/29		108	%	85 - 115
			Copper (Cu)	2014/04/29		103	%	85 - 115
			Nickel (Ni)	2014/04/29		104	%	85 - 115
			Antimony (Sb)	2014/04/29		117 (1)	%	85 - 115
			Arsenic (As)	2014/04/29		105	%	85 - 115
3586795	APT	RPD	Aluminum (Al)	2014/04/29	1.8		%	20
			Cadmium (Cd)	2014/04/29	1.1		%	20
			Chromium (Cr)	2014/04/29	0.9		%	20
			Copper (Cu)	2014/04/29	1.6		%	20
			Nickel (Ni)	2014/04/29	1		%	20
			Antimony (Sb)	2014/04/29	2.2		%	20
			Arsenic (As)	2014/04/29	1.1		%	20
3586795	APT	Method Blank	Aluminum (Al)	2014/04/29	ND , RDL=5.0		ug	
			Cadmium (Cd)	2014/04/29	ND , RDL=0.20		ug	
			Chromium (Cr)	2014/04/29	ND , RDL=0.50		ug	
			Copper (Cu)	2014/04/29	ND , RDL=0.50		ug	
			Nickel (Ni)	2014/04/29	ND , RDL=0.30		ug	
			Antimony (Sb)	2014/04/29	ND , RDL=1.0		ug	
			Arsenic (As)	2014/04/29	ND , RDL=0.60		ug	
3587398	LLE	Reagent Blank	Hexavalent Chromium (Cr 6+)	2014/04/30	ND , RDL=0.01		ug	
3587398	LLE	Matrix Spike [VP0633-01]	Hexavalent Chromium (Cr 6+)	2014/04/30		106	%	80 - 120
3587398	LLE	Spiked Blank	Hexavalent Chromium (Cr 6+)	2014/04/30		95	%	90 - 110
3587398	LLE	Method Blank	Hexavalent Chromium (Cr 6+)	2014/04/30	ND , RDL=0.01		ug	
3587398	LLE	RPD [VP0633-01]	Hexavalent Chromium (Cr 6+)	2014/04/30	NC		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Reagent Blank: A blank matrix containing all reagents used in the analytical procedure. Used to determine any analytical contamination.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

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VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Brenda Moore

Brenda Moore, Team Lead

Frank Mo, B.Sc., Inorganic Lab. Manager

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Chain of Custody Form - AIR

15707

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ANALYSIS REQUESTED

CLIENT INFORMATION

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SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: Stephane Dallaire, CBE

17-Apr-14 13:35
Keshani Vijh
B462845

NNA

AIR-001

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)
14020715-AQ1-PM10	7153.7	5.0	14-03-15	1440	✓
14020713-AQ1-PM25	7174.6	5.0	14-03-15	1440	✓
14021001-AQ2-TSP	7223.6	5.0	14-03-15	1440	✓
14020711-AQ2-PM10	7216.1	5.0	14-03-15	1440	✓
14020712-AQ2-PM25	7152.4	5.0	14-03-15	1440	✓
14020716-BLANK	—	—	—	—	✓
14021060-AQ1-TSP	7154.8	5.0	14-04-11	1440	✓
14021061-AQ1-PM10	7165.2	5.0	14-04-11	1440	✓
14021062-AQ1-PM25	7156.5	5.0	14-04-11	1440	✓
13092301-AQ2-TSP	7147.2	5.0	14-04-11	1440	✓
14021051-AQ2-PM10	7147.8	5.0	14-04-11	1440	✓
14021052-AQ2-PM25	7149.0	5.0	14-04-11	1440	✓

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBE
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

COC-1031 (04/13) - Air

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Page 2 of ___

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Granton Dr Suite 12
Richmond Hill, ON, L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: STEPHANE DALAIRE CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
13082223 - AQ1 - TSP	7213.4	5.0	14-04-03	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13082224 - AQ1 - PM10	7212.2	5.0	14-04-03	1440	✓												
13082225 - AQ1 - PM25	7229.7	5.0	14-04-03	1440	✓												
13082226 - AQ2 - TSP	7213.9	5.0	14-04-03	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13082227 - AQ2 - PM10	7204.0	5.0	14-04-03	1440	✓												
14020701 - AQ2 - PM25	7194.1	5.0	14-04-03	1440	✓												
13092302 - BLANK	—	—	—	—	✓												
14020703 - AQ1 - TSP	7190.9	5.0	14-04-04	1440	✓												
14020704 - AQ1 - PM10	7152.2	5.0	14-04-04	1440	✓												
14020705 - AQ1 - PM25	7169.8	5.0	14-04-04	1440	✓												
14020702 - AQ2 - TSP	7123.1	4.9	14-04-04	1440	✓												
14020706 - AQ2 - PM10	7132.9	5.0	14-04-04	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
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PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

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Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

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Page 3 of ___

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Granton Dr Suite 12, Richmond Hill, ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: Stephane Dallaire CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel
14021059 - AQ2 - PM25	7207.4	5.0		1440	✓								
13092304 - BLANK	—	—	—	—	✓								
13092303 - BLANK	—	—	—	—	✓								
13092305 - BLANK	—	—	—	—	✓								
13092306 - BLANK	—	—	—	—	✓								
13092307 - BLANK	—	—	—	—	✓								
14021046 - AQ1 - TSP	7179.8	5.0	14-04-07	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021047 - AQ1 - PM10	7179.2	5.0	14-04-07	1440	✓								
14021048 - AQ1 - PM25	7188.6	5.0	14-04-07	1440	✓								
14021049 - AQ2 - TSP	7174.0	5.0	14-04-07	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021050 - AQ2 - PM10	7172.8	5.0	14-04-07	1440	✓								
14021056 - AQ2 - PM25	7181.6	5.0	14-04-07	1440	✓								

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
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PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
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Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

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CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121, Granton Dr Suite 12
Richmond Hill ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: Stephane Dallaire CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Air)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
14020710-AQ2-PM25	7160.5	5.0	14-04-04	1440	✓												
14020707-AQ1-TSP	7260.7	5.0	14-04-05	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14020708-AQ1-PM10	7224.2	5.0	14-04-05	1440	✓												
14020709-AQ1-PM25	7249.7	5.0	14-04-05	1440	✓												
14021063-AQ2-TSP	7270.4	5.0	14-04-05	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14021064-AQ2-PM10	7287.9	5.1	14-04-05	1440	✓												
14021065-AQ2-PM25	7140.8	5.0	14-04-05	1440	✓												
14021053-AQ1-TSP	7219.0	5.0	14-04-06	1440	✓												
14021054-AQ1-PM10	7219.6	5.0	14-04-06	1440	✓												
14021055-AQ1-PM25	7238.9	5.0	14-04-06	1440	✓												
14021057-AQ2-TSP	7208.0	5.0	14-04-06	1440	✓												
14021058-AQ2-PM10	7207.4	5.0	14-04-06	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
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PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

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EDD ☐

Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

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Page 5 of ____

ANALYSIS REQUESTED

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: Paul Kirby
e-mail: pkirby@senes.ca
Address: 121 Mryton Dr Suite 12
Richmond Hill ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: STEPHANE DALLAIRE C&C

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
14021025-AQ2-TSP	7645.9	5.3	14-03-11	1440	✓												
14021026-AQ2-PM10	7533.3	5.2	14-03-11	1440	✓												
14021030-AQ2-PM25	7620.1	5.3	14-03-11	1440	✓												
14021043-BLANK	—	—	—	—	✓												
14021003-AQ1-TSP	7106.2	4.9	14-03-13	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14021004-AQ1-PM10	7219.0	5.0	14-03-13	1440	✓												
14021005-AQ1-PM25	7162.9	5.0	14-03-13	1440	✓												
14021045-AQ2-TSP	7215.8	5.0	14-03-13	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14021006-AQ2-PM10	7139.1	5.0	14-03-13	1440	✓												
14021002-AQ2-PM25	7157.3	5.0	14-03-13	1440	✓												
14021007-BLANK	—	—	—	—	✓												
14020714-AQ1-TSP	7068.6	4.9	14-03-15	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
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PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

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Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: C&C
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

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CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Bramton Dr Suite 12
Richmond Hill ON L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: Stephane Dallaire CBB

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled (L)	Flow Rate (L/min)	Collection Date	Sample Collection Time (min)	GRAVIMETRIC (DUST)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel
14021032-AQ1-TSP	7094.9	4.9	14-03-05	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021019-AQ1-PM10	7079.3	4.9	14-03-05	1440	✓								
14021034-AQ1-PM25	7139.3	5.0	14-03-05	1440	✓								
14021035-AQ2-TSP	7112.4	4.9	14-03-05	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021031-AQ2-PM10	7093.5	4.9	14-03-05	1440	✓								
14021033-AQ2-PM25	7047.0	4.9	14-03-05	1440	✓								
14021036-BLANK	–	–	–	–	✓								
14021017-AQ1-TSP	7257.7	5.0	14-03-07	1440	✓								
14021018-AQ1-PM10	7295.4	5.1	14-03-07	1440	✓								
14021021-AQ1-PM25	7269.8	5.0	14-03-07	1440	✓								
14021022-AQ2-TSP	7187.0	5.0	14-03-07	1440	✓								
14021023-AQ2-PM10	7281.3	5.1	14-03-07	1440	✓								

TAT Requirement

STD 10 Business day ☐
Rush 5 Business day * ☐
Rush 2 Business day * ☐
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PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

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Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBC
Date/Time: 14-04-17

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35.

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Page 7 of ___

CLIENT INFORMATION

Company Name: SENES CONSULTANT LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121, Beaver Dr. Suite 12
Richmond Hill ON L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: Stephane Dallaire CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetry (Dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel
14021024-AQ2-PM25	7255.6	5.0	14-03-07	1440	✓								
14021016-BLANK	—	—	—	—	✓								
14021037-AQ1-TSP	7218.8	5.0	14-03-09	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021038-AQ1-PM10	7166.2	5.0	14-03-09	1440	✓								
14021039-AQ1-PM25	7222.3	5.0	14-03-09	1440	✓								
14021040-AQ2-TSP	7216.1	5.0	14-03-09	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021041-AQ2-PM10	7281.7	5.1	14-03-09	1440	✓								
14021044--AQ2-PM25	7247.0	5.0	14-03-09	1440	✓								
14021042-BLANK	—	—	—	—	✓								
14021027-AQ1-TSP	7627.3	5.3	14-03-11	1440	✓								
14021028-AQ1-PM10	7528.2	5.2	14-03-11	1440	✓								
14021029-AQ1-PM25	7612.2	5.3	14-03-11	1440	✓								

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
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PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

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Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-04-11

Received by: DAVID CHAN
Affiliation: MAXXAM
Date/Time: 2014/04/17 13:35

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Your C.O.C. #: 17030

Attention: Paul Kirby
SENES Consultants Limited
121 Granton Dr
Unit 12
Richmond Hill, ON
CANADA L4B 3N4

Report Date: 2014/06/17
Report #: R3061262
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B492435
Received: 2014/06/02, 11:39

Sample Matrix: Filter
Samples Received: 12

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Hexavalent Chromium (modified CARB039)	2	2014/06/09	2014/06/16	BRL SOP-00106	Modified CARB 039
Total Metals on Lo-Vol Filter (6010Cmod)	2	2014/06/16	2014/06/16		EPA 6010Cmod
Total Metals (6010Cmod)	2	2014/06/10	2014/06/12	CAM SOP-00408 / BRL SOP-00102	EPA 6010Cmod
Particulates on Lo-Vol Filters	12	N/A	2014/06/09		
Total Particulate	12	N/A	2014/06/09	BRL SOP-00109	
Air Volume from LoVol Sampling	11	N/A	2014/06/03		
Air Volume from LoVol Sampling	1	N/A	2014/06/13		

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Theresa Stephenson, Project Manager
Email: TStephenson@maxxam.ca
Phone# (905) 817-5763

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SENES Consultants Limited

Maxxam Job #: B492435
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5614	WD5615	WD5616			
Sampling Date		2014/03/18	2014/03/18	2014/03/18			
COC Number		17030	17030	17030			
	Units	**14020719-AQ10-TSP**	**14020721-AQ10-PM10**	**14020720-AQ10-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	137	106	71	14	3627286	N/A
Particulate Weight on Filter	mg	1.00	0.78	0.52	0.10	3632367	N/A
Volume	m3	7.311	7.356	7.339	N/A	ONSITE	N/A
Metals							
Hexavalent Chromium (Cr 6+)	ug	ND			0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5617		WD5618	WD5619			
Sampling Date		2014/03/18		2014/03/18	2014/03/18			
COC Number		17030		17030	17030			
	Units	**14020717-AQ13-TSP**	**RDL**	**14020718-AQ13-PM10**	**14021008-AQ13-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	142	13	90	117	14	3627286	N/A
Particulate Weight on Filter	mg	1.13	0.10	0.66	0.86	0.10	3632367	N/A
Volume	m3	7.943	N/A	7.360	7.379	N/A	ONSITE	N/A
Metals								
Hexavalent Chromium (Cr 6+)	ug	ND	0.01				3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492435
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5620		WD5621	WD5622			
Sampling Date				2014/03/19	2014/03/19			
COC Number		17030		17030	17030			
	Units	**14021011-BLANK**	**RDL**	**14021009-AQ10-TSP**	**14021010-AQ10-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	160	140	14	3627286	N/A
Particulate Weight on Filter	mg	0.46	0.10	1.17	1.03	0.10	3632367	N/A
Volume	m3	0	N/A	7.322	7.341	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5623	WD5624	WD5625			
Sampling Date		2014/03/19	2014/03/19	2014/03/19			
COC Number		17030	17030	17030			
	Units	**14020722-AQ10-PM25**	**14020723-AQ13-TSP**	**14020725-AQ13-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	109	163	432	14	3627286	N/A
Particulate Weight on Filter	mg	0.80	1.19	3.15	0.10	3632367	N/A
Volume	m3	7.329	7.306	7.296	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492435
Report Date: 2014/06/17

CALCULATED ELEMENTS (FILTER)

Maxxam ID		WD5614		WD5617			
Sampling Date		2014/03/18		2014/03/18			
COC Number		17030		17030			
	Units	**14020719-AQ10-TSP**	**RDL**	**14020717-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals							
Total Aluminum (Al)	ug/m3	0.93	0.68	0.83	0.63	3642485	N/A
Total Antimony (Sb)	ug/m3	ND	0.14	ND	0.13	3642485	N/A
Total Arsenic (As)	ug/m3	ND	0.082	ND	0.076	3642485	N/A
Total Cadmium (Cd)	ug/m3	ND	0.027	ND	0.025	3642485	N/A
Total Chromium (Cr)	ug/m3	ND	0.068	ND	0.063	3642485	N/A
Total Copper (Cu)	ug/m3	ND	0.068	ND	0.063	3642485	N/A
Total Nickel (Ni)	ug/m3	ND	0.041	ND	0.038	3642485	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492435
Report Date: 2014/06/17

MISCELLANEOUS (FILTER)

Maxxam ID		WD5614	WD5617			
Sampling Date		2014/03/18	2014/03/18			
COC Number		17030	17030			
	Units	**14020719-AQ10-TSP**	**14020717-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals						
Aluminum (Al)	ug	6.8	6.6	5.0	3635627	N/A
Antimony (Sb)	ug	ND	ND	1.0	3635627	N/A
Arsenic (As)	ug	ND	ND	0.60	3635627	N/A
Cadmium (Cd)	ug	ND	ND	0.20	3635627	N/A
Chromium (Cr)	ug	ND	ND	0.50	3635627	N/A
Copper (Cu)	ug	ND	ND	0.50	3635627	N/A
Nickel (Ni)	ug	ND	ND	0.30	3635627	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492435
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5614 **Collected** 2014/03/18
Sample ID 14020719-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3642485	2014/06/16	2014/06/16	Brenda Moore
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5615 **Collected** 2014/03/18
Sample ID 14020721-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5616 **Collected** 2014/03/18
Sample ID 14020720-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5617 **Collected** 2014/03/18
Sample ID 14020717-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3642485	2014/06/16	2014/06/16	Brenda Moore
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5617 Dup **Collected** 2014/03/18
Sample ID 14020717-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/16	2014/06/16	Lang Le

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SENES Consultants Limited

Maxxam Job #: B492435
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5618 **Collected** 2014/03/18
Sample ID 14020718-AQ13-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5619 **Collected** 2014/03/18
Sample ID 14021008-AQ13-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5620 **Collected**
Sample ID 14021011-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5621 **Collected** 2014/03/19
Sample ID 14021009-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5622 **Collected** 2014/03/19
Sample ID 14021010-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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Maxxam Job #: B492435
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5623 **Collected** 2014/03/19
Sample ID 14020722-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5624 **Collected** 2014/03/19
Sample ID 14020723-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5625 **Collected** 2014/03/19
Sample ID 14020725-AQ13-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632367	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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Maxxam Job #: B492435
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Hexavalent Chromium (modified CARB039): 1/2 filter extracted in 10ml of Rodi water

Results relate only to the items tested.

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SENES Consultants Limited
Attention: Paul Kirby
Client Project #:
P.O. #:
Site Location:

Quality Assurance Report

Maxxam Job Number: GB492435

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	%Recovery	Units	QC Limits
3634795 LLE	Reagent Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	Matrix Spike (WD5617)	Hexavalent Chromium (Cr 6+)	2014/06/16		105	%	80 - 120
	Spiked Blank	Hexavalent Chromium (Cr 6+)	2014/06/16		99	%	90 - 110
	Method Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	RPD - Sample/Sample Dup	Hexavalent Chromium (Cr 6+)	2014/06/16	NC		%	20
3635627 APT	Spiked Blank	Aluminum (Al)	2014/06/12		98	%	85 - 115
	RPD	Aluminum (Al)	2014/06/12	2.6		%	20
	Spiked Blank	Antimony (Sb)	2014/06/12		107	%	85 - 115
	RPD	Antimony (Sb)	2014/06/12	2.6		%	20
	Spiked Blank	Arsenic (As)	2014/06/12		103	%	85 - 115
	RPD	Arsenic (As)	2014/06/12	1.1		%	20
	Spiked Blank	Cadmium (Cd)	2014/06/12		104	%	85 - 115
	RPD	Cadmium (Cd)	2014/06/12	1.5		%	20
	Spiked Blank	Chromium (Cr)	2014/06/12		102	%	85 - 115
	RPD	Chromium (Cr)	2014/06/12	0		%	20
	Spiked Blank	Copper (Cu)	2014/06/12		100	%	85 - 115
	RPD	Copper (Cu)	2014/06/12	0.4		%	20
	Spiked Blank	Nickel (Ni)	2014/06/12		101	%	85 - 115
	RPD	Nickel (Ni)	2014/06/12	1		%	20
	Method Blank	Aluminum (Al)	2014/06/12	ND, RDL=5.0		ug	
		Antimony (Sb)	2014/06/12	ND, RDL=1.0		ug	
		Arsenic (As)	2014/06/12	ND, RDL=0.60		ug	
		Cadmium (Cd)	2014/06/12	ND, RDL=0.20		ug	
		Chromium (Cr)	2014/06/12	ND, RDL=0.50		ug	
		Copper (Cu)	2014/06/12	ND, RDL=0.50		ug	
		Nickel (Ni)	2014/06/12	ND, RDL=0.30		ug	

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Reagent Blank: A blank matrix containing all reagents used in the analytical procedure. Used to determine any analytical contamination.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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2-Jun-14 11:39
Mike Challis
B492435

Chain of Custody Form - AIR

15778

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CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: Paul Kirby
e-mail: pkirby@senes.ca
Address: 121 Granton Dr. Suite 12
Richmond Hill, ON L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9886
Sampled by: Stephane Dallaire CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
14020719-AQ10-TSP	7311.3	5.1	14-03-18	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14020721-AQ10-PM10	7356.4	5.1	14-03-18	1440	✓												
14020720-AQ10-PM25	7338.5	5.1	14-03-18	1440	✓												
14020717-AQ13-TSP	7942.8	5.5	14-03-18	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
14020718-AQ13-PM10	7360.0	5.1	14-03-18	1440	✓												
14021008-AQ13-PM25	7379.0	5.1	14-03-18	1440	✓												
14021011-BLANK	—	—	—	—	✓												
14021009-AQ10-TSP	7321.5	5.08	14-03-19	1440	✓												
14021010-AQ10-PM10	7340.6	5.10	14-03-19	1440	✓												
14020722-AQ10-PM25	7329.3	5.09	14-03-19	1440	✓												
14020723-AQ13-TSP	7305.6	5.07	14-03-19	1440	✓												
14020725-AQ13-PM10	7296.1	5.07	14-03-19	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 21-05-2014

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25°C

Maxxam

Success Through Science®

Your C.O.C. #: NA

Attention: Paul Kirby
SENES Consultants Limited
121 Granton Dr
Unit 12
Richmond Hill, ON
CANADA L4B 3N4

Report Date: 2014/06/17
Report #: R3061229
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B492441
Received: 2014/06/02, 13:10

Sample Matrix: Filter
Samples Received: 11

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Hexavalent Chromium (modified CARB039)	2	2014/06/09	2014/06/16	BRL SOP-00106	Modified CARB 039
Total Metals on Lo-Vol Filter (6010Cmod)	2	2014/06/16	2014/06/16		EPA 6010Cmod
Total Metals (6010Cmod)	2	2014/06/10	2014/06/12	CAM SOP-00408 / BRL SOP-00102	EPA 6010Cmod
Total Particulate	2	N/A	2014/06/09	BRL SOP-00109	Method IO-3.1
Particulates on Lo-Vol Filters	11	N/A	2014/06/09		
Total Particulate	9	N/A	2014/06/09	BRL SOP-00109	
Air Volume from LoVol Sampling	9	N/A	2014/06/03		
Air Volume from LoVol Sampling	2	N/A	2014/06/13		

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Theresa Stephenson, Project Manager
Email: TStephenson@maxxam.ca
Phone# (905) 817-5763

==========

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Total cover pages: 1

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5626	WD5627	WD5628			
Sampling Date		2014/03/22	2014/03/22	2014/03/22			
COC Number		NA	NA	NA			
	Units	**13082216-AQ13-TSP**	**13082217-AQ13-PM10**	**13082218-AQ13-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	111	75	33	14	3627286	N/A
Particulate Weight on Filter	mg	0.82	0.55	0.24	0.10	3632700	N/A
Volume	m3	7.376	7.356	7.355	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5629			WD5630			
Sampling Date					2014/03/24			
COC Number		NA			NA			
	Units	**13092309-BLANK**	**RDL**	**QC Batch**	**13082211-AQ10-TSP**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	3627286	117	9.0	3627286	N/A
Particulate Weight on Filter	mg	0.4	0.3	3632406	1.29	0.10	3632700	N/A
Volume	m3	0	N/A	ONSITE	11.07	N/A	ONSITE	N/A
Metals								
Hexavalent Chromium (Cr 6+)	ug				ND	0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492441
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5631		WD5632		WD5633			
Sampling Date		2014/03/24		2014/03/24		2014/03/24			
COC Number		NA		NA		NA			
	Units	**13082212-AQ10-PM10**	**RDL**	**13082219-AQ10-PM25**	**RDL**	**13082220-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	76.1	5.0	9.8	7.6	99	14	3627286	N/A
Particulate Weight on Filter	mg	1.53	0.10	0.13	0.10	0.72	0.10	3632700	N/A
Volume	m3	20.11	N/A	13.23	N/A	7.242	N/A	ONSITE	N/A
Metals									
Hexavalent Chromium (Cr 6+)	ug					ND	0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5634		WD5635			
Sampling Date		2014/03/24		2014/03/24			
COC Number		NA		NA			
	Units	**13082221-AQ13-PM10**	**RDL**	**13082222-AQ13-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	28	21	14	3627286	N/A
Particulate Weight on Filter	mg	ND	0.10	0.15	0.10	3632700	N/A
Volume	m3	3.621	N/A	7.233	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5636			
Sampling Date					
COC Number		NA			
	Units	**13092310-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	3627286	N/A
Particulate Weight on Filter	mg	0.6	0.3	3632406	N/A
Volume	m3	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492441
Report Date: 2014/06/17

CALCULATED ELEMENTS (FILTER)

Maxxam ID		WD5630		WD5633			
Sampling Date		2014/03/24		2014/03/24			
COC Number		NA		NA			
	Units	**13082211-AQ10-TSP**	**RDL**	**13082220-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals							
Total Aluminum (Al)	ug/m3	1.10	0.45	1.10	0.69	3642485	N/A
Total Antimony (Sb)	ug/m3	ND	0.090	ND	0.14	3642485	N/A
Total Arsenic (As)	ug/m3	ND	0.054	ND	0.083	3642485	N/A
Total Cadmium (Cd)	ug/m3	ND	0.018	ND	0.028	3642485	N/A
Total Chromium (Cr)	ug/m3	ND	0.045	ND	0.069	3642485	N/A
Total Copper (Cu)	ug/m3	ND	0.045	ND	0.069	3642485	N/A
Total Nickel (Ni)	ug/m3	ND	0.027	ND	0.041	3642485	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

MISCELLANEOUS (FILTER)

Maxxam ID		WD5630	WD5633			
Sampling Date		2014/03/24	2014/03/24			
COC Number		NA	NA			
	Units	**13082211-AQ10-TSP**	**13082220-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals						
Aluminum (Al)	ug	12.2	8.0	5.0	3635627	N/A
Antimony (Sb)	ug	ND	ND	1.0	3635627	N/A
Arsenic (As)	ug	ND	ND	0.60	3635627	N/A
Cadmium (Cd)	ug	ND	ND	0.20	3635627	N/A
Chromium (Cr)	ug	ND	ND	0.50	3635627	N/A
Copper (Cu)	ug	ND	ND	0.50	3635627	N/A
Nickel (Ni)	ug	ND	ND	0.30	3635627	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5626 **Collected** 2014/03/22
Sample ID 13082216-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5627 **Collected** 2014/03/22
Sample ID 13082217-AQ13-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5628 **Collected** 2014/03/22
Sample ID 13082218-AQ13-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5629 **Collected**
Sample ID 13092309-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632406	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5630 **Collected** 2014/03/24
Sample ID 13082211-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3642485	2014/06/16	2014/06/16	Brenda Moore
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5631 **Collected** 2014/03/24
Sample ID 13082212-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5632 **Collected** 2014/03/24
Sample ID 13082219-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5633 **Collected** 2014/03/24
Sample ID 13082220-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3642485	2014/06/16	2014/06/16	Brenda Moore
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5634 **Collected** 2014/03/24
Sample ID 13082221-AQ13-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5635 **Collected** 2014/03/24
Sample ID 13082222-AQ13-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5636
Sample ID 13092310-BLANK
Matrix Filter

Collected
Shipped
Received 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632406	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/13	

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SENES Consultants Limited

Maxxam Job #: B492441
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Hexavalent Chromium (modified CARB039): 1/2 filter extracted in 10ml of Rodi water

Results relate only to the items tested.

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SENES Consultants Limited
Attention: Paul Kirby
Client Project #:
P.O. #:
Site Location:

Quality Assurance Report

Maxxam Job Number: GB492441

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	%Recovery	Units	QC Limits
3634795 LLE	Reagent Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	Matrix Spike	Hexavalent Chromium (Cr 6+)	2014/06/16		105	%	80 - 120
	Spiked Blank	Hexavalent Chromium (Cr 6+)	2014/06/16		99	%	90 - 110
	Method Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	RPD - Sample/Sample Dup	Hexavalent Chromium (Cr 6+)	2014/06/16	NC		%	20
3635627 APT	Spiked Blank	Aluminum (Al)	2014/06/12		98	%	85 - 115
	RPD	Aluminum (Al)	2014/06/12	2.6		%	20
	Spiked Blank	Antimony (Sb)	2014/06/12		107	%	85 - 115
	RPD	Antimony (Sb)	2014/06/12	2.6		%	20
	Spiked Blank	Arsenic (As)	2014/06/12		103	%	85 - 115
	RPD	Arsenic (As)	2014/06/12	1.1		%	20
	Spiked Blank	Cadmium (Cd)	2014/06/12		104	%	85 - 115
	RPD	Cadmium (Cd)	2014/06/12	1.5		%	20
	Spiked Blank	Chromium (Cr)	2014/06/12		102	%	85 - 115
	RPD	Chromium (Cr)	2014/06/12	0		%	20
	Spiked Blank	Copper (Cu)	2014/06/12		100	%	85 - 115
	RPD	Copper (Cu)	2014/06/12	0.4		%	20
	Spiked Blank	Nickel (Ni)	2014/06/12		101	%	85 - 115
	RPD	Nickel (Ni)	2014/06/12	1		%	20
	Method Blank	Aluminum (Al)	2014/06/12	ND, RDL=5.0		ug	
		Antimony (Sb)	2014/06/12	ND, RDL=1.0		ug	
		Arsenic (As)	2014/06/12	ND, RDL=0.60		ug	
		Cadmium (Cd)	2014/06/12	ND, RDL=0.20		ug	
		Chromium (Cr)	2014/06/12	ND, RDL=0.50		ug	
		Copper (Cu)	2014/06/12	ND, RDL=0.50		ug	
		Nickel (Ni)	2014/06/12	ND, RDL=0.30		ug	

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Reagent Blank: A blank matrix containing all reagents used in the analytical procedure. Used to determine any analytical contamination.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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2-Jun-14 13:10
Mike Challis
B492441
FW AIR-RmTmp

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CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL Kirby
e-mail: pkirby@senes.ca
Address: 121 Brandon Dr Suite 12
Richmond Hill, ON L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: Stephane Dallaire CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel
13082216-AQ13-TSP	7376.0	5.12	14-03-22	1440	✓								
13082217-AQ13-PM10	7355.8	5.11	14-03-22	1440	✓								
13082218-AQ13-PM25	7355.2	5.11	14-03-22	1440	✓								
13092309-BLANK	—	—	—	—	✓								
13082211-AQ10-TSP	11072.9	5.00	14-03-24	2214	✓	✓	✓	✓	✓	✓	✓	✓	✓
13082212-AQ10-PM10	20111.9	5.00	14-03-24	4020	✓								
13082219-AQ10-PM25	13229.1	5.01	14-03-24	2640	✓								
13082220-AQ13-TSP	7242.4	5.03	14-03-24	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
13082221-AQ13-PM10	3620.5	5.03	14-03-24	720	✓								
13082222-AQ13-PM25	7232.9	5.02	14-03-24	1440	✓								
13092310-BLANK	—	—	—	—	✓								

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: C136
Date/Time: 21-05-2014

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25 C

Maxxam

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Your C.O.C. #: 15778

Attention: Paul Kirby
SENES Consultants Limited
121 Granton Dr
Unit 12
Richmond Hill, ON
CANADA L4B 3N4

Report Date: 2014/06/17
Report #: R3061269
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B492442
Received: 2014/06/02, 13:10

Sample Matrix: Filter
Samples Received: 12

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Hexavalent Chromium (modified CARB039)	2	2014/06/09	2014/06/16	BRL SOP-00106	Modified CARB 039
Total Metals on Lo-Vol Filter (6010Cmod)	2	2014/06/03	2014/06/09		EPA 6010Cmod
Total Metals (6010Cmod)	2	2014/06/10	2014/06/12	CAM SOP-00408 / BRL SOP-00102	EPA 6010Cmod
Total Particulate	1	N/A	2014/06/09	BRL SOP-00109	Method IO-3.1
Particulates on Lo-Vol Filters	12	N/A	2014/06/09		
Total Particulate	11	N/A	2014/06/09	BRL SOP-00109	
Air Volume from LoVol Sampling	10	N/A	2014/06/03		
Air Volume from LoVol Sampling	2	N/A	2014/06/13		

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Theresa Stephenson, Project Manager
Email: TStephenson@maxxam.ca
Phone# (905) 817-5763

==========

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Total cover pages: 1

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5637		WD5638		WD5639			
Sampling Date		2014/03/19 14:40				2014/03/21 14:40			
COC Number		15778		15778		15778			
	Units	**14020724-AQ13-PM25**	**RDL**	**14021012-BLANK**	**RDL**	**14021013-AQ10-TSP**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	14	ND	5000	211	14	3627286	N/A
Particulate Weight on Filter	mg	ND	0.10	0.56	0.10	1.55	0.10	3632700	N/A
Volume	m3	7.313	N/A	0	N/A	7.344	N/A	ONSITE	N/A
Metals									
Hexavalent Chromium (Cr 6+)	ug					ND	0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5640	WD5641	WD5642			
Sampling Date		2014/03/21 14:40	2014/03/21 14:40	2014/03/21 14:40			
COC Number		15778	15778	15778			
	Units	**14021014-AQ10-PM10**	**14021015-AQ10-PM25**	**13082228-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	195	153	107	14	3627286	N/A
Particulate Weight on Filter	mg	1.43	1.12	0.79	0.10	3632700	N/A
Volume	m3	7.333	7.338	7.375	N/A	ONSITE	N/A
Metals							
Hexavalent Chromium (Cr 6+)	ug			ND	0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5643	WD5644			WD5645			
Sampling Date		2014/03/21 14:40	2014/03/21 14:40						
COC Number		15778	15778			15778			
	Units	**13082229-AQ13-PM10**	**13082230-AQ13-PM25**	**RDL**	**QC Batch**	**13092308-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	78	54	14	3627286	ND	5000	3627286	N/A
Particulate Weight on Filter	mg	0.57	0.40	0.10	3632700	0.8	0.3	3632406	N/A
Volume	m3	7.345	7.356	N/A	ONSITE	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5646		WD5647	WD5648			
Sampling Date		2014/03/22 14:40		2014/03/22 14:40	2014/03/22 14:40			
COC Number		15778		15778	15778			
	Units	**13082215-AQ10-TSP**	**RDL**	**13082214-AQ10-PM10**	**13082213-AQ10-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	128	14	105	38	13	3627286	N/A
Particulate Weight on Filter	mg	0.95	0.10	0.78	0.28	0.10	3632700	N/A
Volume	m3	7.410	N/A	7.415	7.427	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

CALCULATED ELEMENTS (FILTER)

Maxxam ID		WD5639		WD5642			
Sampling Date		2014/03/21 14:40		2014/03/21 14:40			
COC Number		15778		15778			
	Units	**14021013-AQ10-TSP**	**RDL**	**13082228-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals							
Total Aluminum (Al)	ug/m3	1.52	0.68	1.60	0.68	3627285	N/A
Total Antimony (Sb)	ug/m3	ND	0.14	ND	0.14	3627285	N/A
Total Arsenic (As)	ug/m3	ND	0.082	ND	0.081	3627285	N/A
Total Cadmium (Cd)	ug/m3	ND	0.027	ND	0.027	3627285	N/A
Total Chromium (Cr)	ug/m3	ND	0.068	ND	0.068	3627285	N/A
Total Copper (Cu)	ug/m3	ND	0.068	ND	0.068	3627285	N/A
Total Nickel (Ni)	ug/m3	ND	0.041	ND	0.041	3627285	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

MISCELLANEOUS (FILTER)

Maxxam ID		WD5639	WD5642			
Sampling Date		2014/03/21 14:40	2014/03/21 14:40			
COC Number		15778	15778			
	Units	**14021013-AQ10-TSP**	**13082228-AQ13-TSP**	**RDL**	**QC Batch**	**MDL**
Metals						
Aluminum (Al)	ug	11.2	11.8	5.0	3635627	N/A
Antimony (Sb)	ug	ND	ND	1.0	3635627	N/A
Arsenic (As)	ug	ND	ND	0.60	3635627	N/A
Cadmium (Cd)	ug	ND	ND	0.20	3635627	N/A
Chromium (Cr)	ug	ND	ND	0.50	3635627	N/A
Copper (Cu)	ug	ND	ND	0.50	3635627	N/A
Nickel (Ni)	ug	ND	ND	0.30	3635627	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5637 **Collected** 2014/03/19
Sample ID 14020724-AQ13-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5638 **Collected**
Sample ID 14021012-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5639 **Collected** 2014/03/21
Sample ID 14021013-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/09	2014/06/09	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5640 **Collected** 2014/03/21
Sample ID 14021014-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5641 **Collected** 2014/03/21
Sample ID 14021015-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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SENES Consultants Limited

Maxxam Job #: B492442
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5642 **Collected** 2014/03/21
Sample ID 13082228-AQ13-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/09	2014/06/09	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5643 **Collected** 2014/03/21
Sample ID 13082229-AQ13-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5644 **Collected** 2014/03/21
Sample ID 13082230-AQ13-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5645 **Collected**
Sample ID 13092308-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632406	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5646 **Collected** 2014/03/22
Sample ID 13082215-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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Maxxam Job #: B492442
Report Date: 2014/06/17

Test Summary

Maxxam ID WD5647 **Collected** 2014/03/22
Sample ID 13082214-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5648 **Collected** 2014/03/22
Sample ID 13082213-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632700	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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Maxxam Job #: B492442
Report Date: 2014/06/17

RESULTS OF ANALYSES OF FILTER

Hexavalent Chromium (modified CARB039): 1/2 filter extracted in 10ml of Rodi water

Results relate only to the items tested.

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SENES Consultants Limited
Attention: Paul Kirby
Client Project #:
P.O. #:
Site Location:

Quality Assurance Report

Maxxam Job Number: GB492442

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	%Recovery	Units	QC Limits
3634795 LLE	Reagent Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	Matrix Spike	Hexavalent Chromium (Cr 6+)	2014/06/16		105	%	80 - 120
	Spiked Blank	Hexavalent Chromium (Cr 6+)	2014/06/16		99	%	90 - 110
	Method Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	RPD - Sample/Sample Dup	Hexavalent Chromium (Cr 6+)	2014/06/16	NC		%	20
3635627 APT	Spiked Blank	Aluminum (Al)	2014/06/12		98	%	85 - 115
	RPD	Aluminum (Al)	2014/06/12	2.6		%	20
	Spiked Blank	Antimony (Sb)	2014/06/12		107	%	85 - 115
	RPD	Antimony (Sb)	2014/06/12	2.6		%	20
	Spiked Blank	Arsenic (As)	2014/06/12		103	%	85 - 115
	RPD	Arsenic (As)	2014/06/12	1.1		%	20
	Spiked Blank	Cadmium (Cd)	2014/06/12		104	%	85 - 115
	RPD	Cadmium (Cd)	2014/06/12	1.5		%	20
	Spiked Blank	Chromium (Cr)	2014/06/12		102	%	85 - 115
	RPD	Chromium (Cr)	2014/06/12	0		%	20
	Spiked Blank	Copper (Cu)	2014/06/12		100	%	85 - 115
	RPD	Copper (Cu)	2014/06/12	0.4		%	20
	Spiked Blank	Nickel (Ni)	2014/06/12		101	%	85 - 115
	RPD	Nickel (Ni)	2014/06/12	1		%	20
	Method Blank	Aluminum (Al)	2014/06/12	ND, RDL=5.0		ug	
		Antimony (Sb)	2014/06/12	ND, RDL=1.0		ug	
		Arsenic (As)	2014/06/12	ND, RDL=0.60		ug	
		Cadmium (Cd)	2014/06/12	ND, RDL=0.20		ug	
		Chromium (Cr)	2014/06/12	ND, RDL=0.50		ug	
		Copper (Cu)	2014/06/12	ND, RDL=0.50		ug	
		Nickel (Ni)	2014/06/12	ND, RDL=0.30		ug	

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Reagent Blank: A blank matrix containing all reagents used in the analytical procedure. Used to determine any analytical contamination.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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Chain of Custody Form - AIR

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Page 1 of 1

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED

Project Manager: PAUL Kirby

e-mail: pkirby@senes.ca

Address: 121 Granton Dr. Suite 12
Richmond Hill, ON L4B 3N4

Phone: (905) 764-9380 Fax: (905) 764-9386

Sampled by: Stephane Dallaire CBG

SECTION

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminum	Arsenic	Antimony	Cadmium	Chromium	Chromium VI	Copper	Nickel
14020724-AQ13-PM25	7312.6	5.08	14-03-19	1440	✓								
14021012-BLANK	–	–	–	–	✓								
14021013-AQ10-TSP	7344.3	5.10	14-03-21	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
14021014-AQ10-PM10	7332.6	5.09	14-03-21	1440	✓								
14021015-AQ10-PM25	7337.9	5.10	14-03-21	1440	✓								
13082228-AQ13-TSP	7374.9	5.12	14-03-21	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓
13082229-AQ13-PM10	7344.7	5.10	14-03-21	1440	✓								
13082230-AQ13-PM25	7355.9	5.11	14-03-21	1440	✓								
13092308-BLANK	–	–	–	–	✓								
13082215-AQ10-TSP	7410.0	5.15	14-03-22	1440	✓								
13082214-AQ10-PM10	7415.3	5.15	14-03-22	1440	✓								
13082213-AQ10-PM25	7427.2	5.16	14-03-22	1440	✓								

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐

Regulation

Notes

PROJECT SPECI

2-Jun-14 13:10
Mike Challis
B492442
AAF AIR-RmTmp

Client Signature:
Affiliation: CBG
Date/Time: 21-05-2014

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25°C

Maxxam

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Your C.O.C. #: 15778

Attention: Paul Kirby
SENES Consultants Limited
121 Granton Dr
Unit 12
Richmond Hill, ON
CANADA L4B 3N4

Report Date: 2014/06/18
Report #: R3062403
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B492443
Received: 2014/06/02, 13:10

Sample Matrix: Filter
Samples Received: 42

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Hexavalent Chromium (modified CARB039)	6	2014/06/09	2014/06/16	BRL SOP-00106	Modified CARB 039
Total Metals on Lo-Vol Filter (6010Cmod)	6	2014/06/03	2014/06/03		EPA 6010Cmod
Total Metals (6010Cmod)	6	2014/06/10	2014/06/12	CAM SOP-00408 / BRL SOP-00102	EPA 6010Cmod
Total Particulate	20	N/A	2014/06/09	BRL SOP-00109	Method IO-3.1
Particulates on Lo-Vol Filters	42	N/A	2014/06/09		
Total Particulate	22	N/A	2014/06/09	BRL SOP-00109	
Air Volume from LoVol Sampling	36	N/A	2014/06/03		
Air Volume from LoVol Sampling	2	N/A	2014/06/13		
Air Volume from LoVol Sampling	4	N/A	2014/06/18		

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Theresa Stephenson, Project Manager
Email: TStephenson@maxxam.ca
Phone# (905) 817-5763

==========

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Total cover pages: 1

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SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5649	WD5650	WD5651			
Sampling Date		2014/04/17	2014/04/17	2014/04/17			
COC Number		15778	15778	15778			
	Units	**13092314-AQ10-TSP**	**13092312-AQ10-PM10**	**13092313-AQ10-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	110	110	41	41	3627286	N/A
Particulate Weight on Filter	mg	0.8	0.8	0.3	0.3	3632726	N/A
Volume	m3	7.297	7.299	7.274	N/A	ONSITE	N/A
Metals							
Hexavalent Chromium (Cr 6+)	ug	ND			0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5652			WD5653			
Sampling Date		2014/04/17			2014/04/17			
COC Number		15778			15778			
	Units	**13092311-AQ12-TSP**	**RDL**	**QC Batch**	**13090913-AQ12-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	109	41	3627286	109	14	3627286	N/A
Particulate Weight on Filter	mg	0.8	0.3	3632726	0.80	0.10	3632717	N/A
Volume	m3	7.356	N/A	ONSITE	7.355	N/A	ONSITE	N/A
Metals								
Hexavalent Chromium (Cr 6+)	ug	ND	0.01	3634795				1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5654		WD5655			
Sampling Date		2014/04/17					
COC Number		15778		15778			
	Units	**13090914-AQ12-PM25**	**RDL**	**13090921-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	83	14	ND	5000	3627602	N/A
Particulate Weight on Filter	mg	0.61	0.10	0.39	0.10	3632717	N/A
Volume	m3	7.350	N/A	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5656	WD5657	WD5658			
Sampling Date		2014/04/18	2014/04/18	2014/04/18			
COC Number		15778	15778	15778			
	Units	**13092322-AQ10-TSP**	**13092321-AQ10-PM10**	**13092320-AQ10-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	150	96	55	41	3627602	N/A
Particulate Weight on Filter	mg	1.1	0.7	0.4	0.3	3632726	N/A
Volume	m3	7.328	7.325	7.298	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5659	WD5660	WD5661			
Sampling Date		2014/04/18	2014/04/18	2014/04/18			
COC Number		15778	15778	15778			
	Units	**13092316-AQ12-TSP**	**13092317-AQ12-PM10**	**13092318-AQ12-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	162	108	68	41	3627602	N/A
Particulate Weight on Filter	mg	1.2	0.8	0.5	0.3	3632726	N/A
Volume	m3	7.408	7.380	7.376	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5662		WD5663	WD5664			
Sampling Date				2014/05/08	2014/05/08			
COC Number		15778		15778	15778			
	Units	**13092324-BLANK**	**RDL**	**13092328-AQ10-TSP**	**13092329-AQ10-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	137	ND	41	3627602	N/A
Particulate Weight on Filter	mg	0.4	0.3	1.0	0.3	0.3	3632726	N/A
Volume	m3	0	N/A	7.309	7.317	N/A	ONSITE	N/A
Metals								
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5665	WD5666	WD5667			
Sampling Date		2014/05/08	2014/05/08	2014/05/08			
COC Number		15778	15778	15778			
	Units	**13092330-AQ10-PM25**	**13092325-AQ12-TSP**	**13092326-AQ12-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	55	82	96	41	3627602	N/A
Particulate Weight on Filter	mg	0.4	0.6	0.7	0.3	3632726	N/A
Volume	m3	7.297	7.309	7.317	N/A	ONSITE	N/A
Metals							
Hexavalent Chromium (Cr 6+)	ug		ND		0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5668		WD5669			
Sampling Date		2014/05/08					
COC Number		15778		15778			
	Units	**13092327-AQ12-PM25**	**RDL**	**13092323-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	55	41	ND	5000	3627602	N/A
Particulate Weight on Filter	mg	0.4	0.3	0.4	0.3	3632726	N/A
Volume	m3	7.288	N/A	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5670	WD5671	WD5672			
Sampling Date		2014/05/09	2014/05/09	2014/05/09			
COC Number		15778	15778	15778			
	Units	**13090906-AQ10-TSP**	**13090905-AQ10-PM10**	**13090903-AQ10-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	134	115	247	14	3627602	N/A
Particulate Weight on Filter	mg	0.99	0.85	1.82	0.10	3632717	N/A
Volume	m3	7.374	7.381	7.372	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5673	WD5674	WD5675			
Sampling Date		2014/05/09	2014/05/09	2014/05/09			
COC Number		15778	15778	15778			
	Units	**13090901-AQ12-TSP**	**13090902-AQ12-PM10**	**13090904-AQ12-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	158	133	ND	14	3627602	N/A
Particulate Weight on Filter	mg	1.16	0.98	ND	0.10	3632717	N/A
Volume	m3	7.362	7.370	7.340	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5676		WD5677	WD5678			
Sampling Date				2014/05/10	2014/05/10			
COC Number		15778		15778	15778			
	Units	**13090922-BLANK**	**RDL**	**13090907-AQ10-TSP**	**13090908-AQ10-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	121	101	14	3627602	N/A
Particulate Weight on Filter	mg	0.28	0.10	0.89	0.74	0.10	3632717	N/A
Volume	m3	0	N/A	7.351	7.349	N/A	ONSITE	N/A
Metals								
Hexavalent Chromium (Cr 6+)	ug			ND		0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5679	WD5680	WD5681			
Sampling Date		2014/05/10	2014/05/10	2014/05/10			
COC Number		15778	15778	15778			
	Units	**13090909-AQ10-PM25**	**13090910-AQ12-TSP**	**13090911-AQ12-PM10**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	77	124	103	14	3627602	N/A
Particulate Weight on Filter	mg	0.57	0.91	0.76	0.10	3632717	N/A
Volume	m3	7.368	7.342	7.344	N/A	ONSITE	N/A
Metals							
Hexavalent Chromium (Cr 6+)	ug		ND		0.01	3634795	1

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5682			WD5683			
Sampling Date		2014/05/10						
COC Number		15778			15778			
	Units	**13090912-AQ12-P25**	**RDL**	**QC Batch**	**13092315-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	72	14	3627602	ND	5000	3627602	N/A
Particulate Weight on Filter	mg	0.53	0.10	3632717	0.3	0.3	3632726	N/A
Volume	m3	7.314	N/A	ONSITE	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5684	WD5685	WD5686			
Sampling Date		2014/05/11	2014/05/11	2014/05/11			
COC Number		15778	15778	15778			
	Units	**13090915-AQ10-TSP**	**13090916-AQ10-PM10**	**13090917-AQ10-P25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	126	112	85	14	3627602	N/A
Particulate Weight on Filter	mg	0.92	0.82	0.62	0.10	3632717	N/A
Volume	m3	7.300	7.299	7.298	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5687	WD5688	WD5689			
Sampling Date		2014/05/11	2014/05/11	2014/05/11			
COC Number		15778	15778	15778			
	Units	**13090918-AQ12-TSP**	**13090919-AQ12-PM10**	**13090920-AQ12-PM25**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	131	101	85	14	3627602	N/A
Particulate Weight on Filter	mg	0.96	0.74	0.62	0.10	3632717	N/A
Volume	m3	7.305	7.307	7.276	N/A	ONSITE	N/A

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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RESULTS OF ANALYSES OF FILTER

Maxxam ID		WD5690			
Sampling Date					
COC Number		15778			
	Units	**13092319-BLANK**	**RDL**	**QC Batch**	**MDL**
Particulate	ug/m3	ND	5000	3627602	N/A
Particulate Weight on Filter	mg	0.5	0.3	3632726	N/A
Volume	m3	0	N/A	ONSITE	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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CALCULATED ELEMENTS (FILTER)

Maxxam ID		WD5649		WD5652	WD5663			
Sampling Date		2014/04/17		2014/04/17	2014/05/08			
COC Number		15778		15778	15778			
	Units	**13092314-AQ10-TSP**	**RDL**	**13092311-AQ12-TSP**	**13092328-AQ10-TSP**	**RDL**	**QC Batch**	**MDL**
Metals								
Total Aluminum (Al)	ug/m3	1.80	0.69	1.26	ND	0.68	3627285	N/A
Total Antimony (Sb)	ug/m3	ND	0.14	ND	ND	0.14	3627285	N/A
Total Arsenic (As)	ug/m3	ND	0.082	ND	ND	0.082	3627285	N/A
Total Cadmium (Cd)	ug/m3	ND	0.027	ND	ND	0.027	3627285	N/A
Total Chromium (Cr)	ug/m3	ND	0.069	ND	ND	0.068	3627285	N/A
Total Copper (Cu)	ug/m3	ND	0.069	ND	ND	0.068	3627285	N/A
Total Nickel (Ni)	ug/m3	ND	0.041	ND	ND	0.041	3627285	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5666	WD5677	WD5680			
Sampling Date		2014/05/08	2014/05/10	2014/05/10			
COC Number		15778	15778	15778			
	Units	**13092325-AQ12-TSP**	**13090907-AQ10-TSP**	**13090910-AQ12-TSP**	**RDL**	**QC Batch**	**MDL**
Metals							
Total Aluminum (Al)	ug/m3	0.78	ND	0.81	0.68	3627285	N/A
Total Antimony (Sb)	ug/m3	ND	ND	ND	0.14	3627285	N/A
Total Arsenic (As)	ug/m3	ND	ND	ND	0.082	3627285	N/A
Total Cadmium (Cd)	ug/m3	ND	ND	ND	0.027	3627285	N/A
Total Chromium (Cr)	ug/m3	ND	ND	ND	0.068	3627285	N/A
Total Copper (Cu)	ug/m3	ND	ND	ND	0.068	3627285	N/A
Total Nickel (Ni)	ug/m3	ND	ND	ND	0.041	3627285	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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MISCELLANEOUS (FILTER)

Maxxam ID		WD5649	WD5652	WD5663	WD5666			
Sampling Date		2014/04/17	2014/04/17	2014/05/08	2014/05/08			
COC Number		15778	15778	15778	15778			
	Units	**13092314-AQ10-TSP**	**13092311-AQ12-TSP**	**13092328-AQ10-TSP**	**13092325-AQ12-TSP**	**RDL**	**QC Batch**	**MDL**
Metals								
Aluminum (Al)	ug	13.1	9.2	ND	5.7	5.0	3635627	N/A
Antimony (Sb)	ug	ND	ND	ND	ND	1.0	3635627	N/A
Arsenic (As)	ug	ND	ND	ND	ND	0.60	3635627	N/A
Cadmium (Cd)	ug	ND	ND	ND	ND	0.20	3635627	N/A
Chromium (Cr)	ug	ND	ND	ND	ND	0.50	3635627	N/A
Copper (Cu)	ug	ND	ND	ND	ND	0.50	3635627	N/A
Nickel (Ni)	ug	ND	ND	ND	ND	0.30	3635627	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		WD5677	WD5680			
Sampling Date		2014/05/10	2014/05/10			
COC Number		15778	15778			
	Units	**13090907-AQ10-TSP**	**13090910-AQ12-TSP**	**RDL**	**QC Batch**	**MDL**
Metals						
Aluminum (Al)	ug	ND	6.0	5.0	3635627	N/A
Antimony (Sb)	ug	ND	ND	1.0	3635627	N/A
Arsenic (As)	ug	ND	ND	0.60	3635627	N/A
Cadmium (Cd)	ug	ND	ND	0.20	3635627	N/A
Chromium (Cr)	ug	ND	ND	0.50	3635627	N/A
Copper (Cu)	ug	ND	ND	0.50	3635627	N/A
Nickel (Ni)	ug	ND	ND	0.30	3635627	N/A

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Test Summary

Maxxam ID WD5649 **Collected** 2014/04/17
Sample ID 13092314-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5650 **Collected** 2014/04/17
Sample ID 13092312-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5651 **Collected** 2014/04/17
Sample ID 13092313-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5652 **Collected** 2014/04/17
Sample ID 13092311-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5653 **Collected** 2014/04/17
Sample ID 13090913-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627286	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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Test Summary

Maxxam ID WD5654 **Collected** 2014/04/17
Sample ID 13090914-AQ12-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5655 **Collected**
Sample ID 13090921-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5656 **Collected** 2014/04/18
Sample ID 13092322-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5657 **Collected** 2014/04/18
Sample ID 13092321-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5658 **Collected** 2014/04/18
Sample ID 13092320-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

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Report Date: 2014/06/18

Test Summary

Maxxam ID WD5659 **Collected** 2014/04/18
Sample ID 13092316-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5660 **Collected** 2014/04/18
Sample ID 13092317-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5661 **Collected** 2014/04/18
Sample ID 13092318-AQ12-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5662 **Collected**
Sample ID 13092324-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/13	

Maxxam ID WD5663 **Collected** 2014/05/08
Sample ID 13092328-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

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Test Summary

Maxxam ID WD5664 **Collected** 2014/05/08
Sample ID 13092329-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5665 **Collected** 2014/05/08
Sample ID 13092330-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5666 **Collected** 2014/05/08
Sample ID 13092325-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5667 **Collected** 2014/05/08
Sample ID 13092326-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5668 **Collected** 2014/05/08
Sample ID 13092327-AQ12-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/03	

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Test Summary

Maxxam ID WD5669 **Collected**
Sample ID 13092323-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/18	

Maxxam ID WD5670 **Collected** 2014/05/09
Sample ID 13090906-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5671 **Collected** 2014/05/09
Sample ID 13090905-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5672 **Collected** 2014/05/09
Sample ID 13090903-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5673 **Collected** 2014/05/09
Sample ID 13090901-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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Maxxam Job #: B492443
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Test Summary

Maxxam ID WD5674 **Collected** 2014/05/09
Sample ID 13090902-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5675 **Collected** 2014/05/09
Sample ID 13090904-AQ12-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5676 **Collected**
Sample ID 13090922-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/18	

Maxxam ID WD5677 **Collected** 2014/05/10
Sample ID 13090907-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5678 **Collected** 2014/05/10
Sample ID 13090908-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

Test Summary

Maxxam ID WD5679 **Collected** 2014/05/10
Sample ID 13090909-AQ10-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5680 **Collected** 2014/05/10
Sample ID 13090910-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Hexavalent Chromium (modified CARB039)	IC/SPEC	3634795	2014/06/09	2014/06/16	Lang Le
Total Metals on Lo-Vol Filter (6010Cmod)	CALC	3627285	2014/06/03	2014/06/03	Automated Statchk
Total Metals (6010Cmod)	ICPX	3635627	2014/06/10	2014/06/12	Archana Patel
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5681 **Collected** 2014/05/10
Sample ID 13090911-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5682 **Collected** 2014/05/10
Sample ID 13090912-AQ12-P25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5683 **Collected**
Sample ID 13092315-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/18	

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SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

Test Summary

Maxxam ID WD5684 **Collected** 2014/05/11
Sample ID 13090915-AQ10-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5685 **Collected** 2014/05/11
Sample ID 13090916-AQ10-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5686 **Collected** 2014/05/11
Sample ID 13090917-AQ10-P25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5687 **Collected** 2014/05/11
Sample ID 13090918-AQ12-TSP **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5688 **Collected** 2014/05/11
Sample ID 13090919-AQ12-PM10 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

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SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

Test Summary

Maxxam ID WD5689 **Collected** 2014/05/11
Sample ID 13090920-AQ12-PM25 **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
Total Particulate	BAL	3632717	N/A	2014/06/09	Brenda Moore
		ONSITE	N/A	2014/06/03	

Maxxam ID WD5690 **Collected**
Sample ID 13092319-BLANK **Shipped**
Matrix Filter **Received** 2014/06/02

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Total Particulate	BAL	3632726	N/A	2014/06/09	Brenda Moore
Particulates on Lo-Vol Filters	CALC	3627602	N/A	2014/06/09	Automated Statchk
		ONSITE	N/A	2014/06/18	

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SENES Consultants Limited

Maxxam Job #: B492443
Report Date: 2014/06/18

RESULTS OF ANALYSES OF FILTER

Hexavalent Chromium (modified CARB039): 1/2 filter extracted in 10ml of Rodi water

Results relate only to the items tested.

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SENES Consultants Limited
Attention: Paul Kirby
Client Project #:
P.O. #:
Site Location:

Quality Assurance Report

Maxxam Job Number: GB492443

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	%Recovery	Units	QC Limits
3634795 LLE	Reagent Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	Matrix Spike	Hexavalent Chromium (Cr 6+)	2014/06/16		105	%	80 - 120
	Spiked Blank	Hexavalent Chromium (Cr 6+)	2014/06/16		99	%	90 - 110
	Method Blank	Hexavalent Chromium (Cr 6+)	2014/06/16	ND, RDL=0.01		ug	
	RPD - Sample/Sample Dup	Hexavalent Chromium (Cr 6+)	2014/06/16	NC		%	20
3635627 APT	Spiked Blank	Aluminum (Al)	2014/06/12		98	%	85 - 115
	RPD	Aluminum (Al)	2014/06/12	2.6		%	20
	Spiked Blank	Antimony (Sb)	2014/06/12		107	%	85 - 115
	RPD	Antimony (Sb)	2014/06/12	2.6		%	20
	Spiked Blank	Arsenic (As)	2014/06/12		103	%	85 - 115
	RPD	Arsenic (As)	2014/06/12	1.1		%	20
	Spiked Blank	Cadmium (Cd)	2014/06/12		104	%	85 - 115
	RPD	Cadmium (Cd)	2014/06/12	1.5		%	20
	Spiked Blank	Chromium (Cr)	2014/06/12		102	%	85 - 115
	RPD	Chromium (Cr)	2014/06/12	0		%	20
	Spiked Blank	Copper (Cu)	2014/06/12		100	%	85 - 115
	RPD	Copper (Cu)	2014/06/12	0.4		%	20
	Spiked Blank	Nickel (Ni)	2014/06/12		101	%	85 - 115
	RPD	Nickel (Ni)	2014/06/12	1		%	20
	Method Blank	Aluminum (Al)	2014/06/12	ND, RDL=5.0		ug	
		Antimony (Sb)	2014/06/12	ND, RDL=1.0		ug	
		Arsenic (As)	2014/06/12	ND, RDL=0.60		ug	
		Cadmium (Cd)	2014/06/12	ND, RDL=0.20		ug	
		Chromium (Cr)	2014/06/12	ND, RDL=0.50		ug	
		Copper (Cu)	2014/06/12	ND, RDL=0.50		ug	
		Nickel (Ni)	2014/06/12	ND, RDL=0.30		ug	

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Reagent Blank: A blank matrix containing all reagents used in the analytical procedure. Used to determine any analytical contamination.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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Fax: (905) 817-5777

ANALYSIS REQUESTED

2-Jun-14 13:10
Mike Challis
B492443
MAF AIR-RmTmp

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Megaton Dr Suite 12
Richmond Hill, ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: Stéphane Dallaire CBG

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
13092314-AQ10-TSP	7297.1	5.07	14-04-17	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13092312-AQ10-PM10	7299.3	5.07	14-04-17	1440	✓												
13092313-AQ10-PM25	7274.0	5.05	14-04-17	1440	✓												
13092311-AQ12-TSP	7355.6	5.11	14-04-17	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13090913-AQ12-PM10	7355.0	5.11	14-04-17	1440	✓												
13090914-AQ12-PM25	7349.7	5.10	14-04-17	1440	✓												
13090921-BLANK	–	–	–	–	✓												
13092322-AQ10-TSP	7327.7	5.09	14-04-18	1440	✓												
13092321-AQ10-PM10	7325.3	5.09	14-04-18	1440	✓												
13092320-AQ10-PM25	7297.6	5.07	14-04-18	1440	✓												
13092316-AQ12-TSP	7407.6	5.14	14-04-18	1440	✓												
13092317-AQ12-PM10	7380.1	5.13	14-04-18	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-05-21

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10

25/25/25 C

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Phone: (905) 817-5700
Fax: (905) 817-5777

ANALYSIS REQUESTED

CLIENT INFORMATION

Company Name: SENES CONSULTANT LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Granton Dr Suite 12
Richmond Hill (ON) L4B 3N4

SECTION

Phone: (905) 764-9380 Fax: (905) 764-9386
Sampled by: Stéphane Dallaire CBG

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminium	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
13092318-AQ12-PM25	7376.0	5.12	14-04-18	1440	✓												
13092324-BLANK	–	–	–	–	✓												
13092328-AQ10-TSP	7309.1	5.08	14-05-08	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13092329-AQ10-PM10	7317.4	5.08	14-05-08	1440	✓												
13092330-AQ10-PM25	7297.2	5.07	14-05-08	1440	✓												
13092325-AQ12-TSP	7309.3	5.08	14-05-08	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13092326-AQ12-PM10	7317.0	5.08	14-05-08	1440	✓												
13092327-AQ12-PM25	7288.0	5.06	14-05-08	1440	✓												
13092323-BLANK	–	–	–	~~MAX~~	✓												
13090906-AQ10-TSP	7374.3	5.12	14-05-09	1440	✓												
13090905-AQ10-PM10	7380.6	5.13	14-05-09	1440	✓												
13090903-AQ10-PM25	7371.7	5.12	14-05-09	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
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PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

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EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-05-21

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25°C

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Phone: (905) 817-5700
Fax: (905) 817-5777

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: PAUL KIRBY
e-mail: pkirby@senes.ca
Address: 121 Granton Dr Suite 12
Richmond Hill, ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: Stéphane Dallaire, CBE

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminium	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel				
13090901-AQ12-TSP	7361.5	5.11	14-05-09	1440	✓												
13090902-AQ12-PM10	7369.8	5.12	14-05-09	1440	✓												
13090904-AQ12-PM25	7340.1	5.10	14-05-09	1440	✓												
13090922-BLANK	–	–	–	–	✓												
13090907-AQ10-TSP	7350.7	5.10	14-05-10	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13090908-AQ10-PM10	7348.5	5.10	14-05-10	1440	✓												
13090909-AQ10-PM25	7367.6	5.12	14-05-10	1440	✓												
13090910-AQ12-TSP	7341.9	5.10	14-05-10	1440	✓	✓	✓	✓	✓	✓	✓	✓	✓				
13090911-AQ12-PM10	7344.1	5.10	14-05-10	1440	✓												
13090912-AQ12-PM25	7313.8	5.08	14-05-10	1440	✓												
13092315-BLANK	–	–	–	–	✓												
13090915-AQ10-TSP	7300.4	5.07	14-05-11	1440	✓												

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-05-21

Received by: RACHEL DEVLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25 C

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Toll Free: 1-800-668-0639
Phone: (905) 817-5700
Fax: (905) 817-5777

CLIENT INFORMATION

Company Name: SENES CONSULTANTS LIMITED
Project Manager: Paul Kirby
e-mail: pkirby@senes.ca
Address: 121, Granton Dr Suite 12
Richmond Hill, ON L4B 3N4

SECTION

Phone: (905)764-9380 Fax: (905)764-9386
Sampled by: Stephane Dallaire, CBG

ANALYSIS REQUESTED

Field Sample ID	Total Volume Sampled	Flow Rate	Collection Date	Sample Collection Time	Gravimetric (Dust)	Aluminium	Antimony	Arsenic	Cadmium	Chromium	Chromium VI	Copper	Nickel
13090916-AQ10-PM10	7299.2	5.07	14-05-11	1440	✓								
13090917-AQ10-PM25	7297.6	5.07	14-05-11	1440	✓								
13090918-AQ12-TSP	7305.0	5.07	14-05-11	1440	✓								
13090919-AQ12-PM10	7306.9	5.07	14-05-11	1440	✓								
13090920-AQ12-PM25	7275.9	5.05	14-05-11	1440	✓								
13092319-BLANK	–	–	–	–	✓								

TAT Requirement

STD 10 Business day ☒
Rush 5 Business day * ☐
Rush 2 Business day * ☐
* need approval from Maxxam

PROJECT INFORMATION

Project #:
Name:
PO #:
Maxxam Quote #:
Maxxam Contact:

REPORTING REQUIREMENTS

Summary Report only ☐
EDD ☐
Regulation

Notes

PROJECT SPECIFIC COMMENTS

Client Signature:
Affiliation: CBG
Date/Time: 14-05-21

Received by: RACHEL DELLIN
Affiliation:
Date/Time: 2014/06/02 13:10 25/25/25 C

Passive Sampling

Certificates of Analysis

Maxxam

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Your Project #: 2014/02/28 - 2014/04/02

Attention:JENNIFER KIRKALDY

SENES CONSULTANTS LIMITED
121 GRANTON DRIVE, UNIT 12
RICHMOND HILL, ON
CANADA T4B 3N4

Report Date: 2014/07/03
Report #: R1596445
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B432816
Received: 2014/04/25, 15:42

Sample Matrix: Air
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
NO2 Passive Analysis (1)	1	2014/05/08	2014/07/03	PTC SOP-00148	Passive NO2 in ATM
NO2 Passive Analysis (1)	1	2014/07/03	2014/07/03	PTC SOP-00148	Passive NO2 in ATM
NOx Passive Analysis (1)	2	2014/05/08	2014/07/03	PTC SOP-00148	Tang Passive NO2 in
SO2 Passive Analysis (1)	2	2014/05/08	2014/07/03	PTC SOP-00149	Tang Passive SO2 in

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) The detection limit is based on a 30 day sampling period.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Levi Manchak, Customer Service
Email: LManchak@maxxam.ca
Phone# (780) 378-8500
==========
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Edmonton: 6744 - 50th Street T6B 3M9 Telephone(780) 378-8500 FAX(780) 378-8699

Maxxam Job #: B432816
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/02/28 - 2014/04/02

RESULTS OF CHEMICAL ANALYSES OF AIR

Maxxam ID		JL9659	JN4539	JN4540	JN4541	JN4542	JN4543		
Sampling Date		2014/02/28 11:42	2014/02/28 11:40	2014/02/28 11:41	2014/02/28 11:47	2014/02/28 11:45	2014/02/28 11:46		
	Units	**001-AQ-1**	**002-AQ-1**	**003-AQ-1**	**011-AQ-1**	**012-AQ-1**	**013-AQ-1**	**RDL**	**QC Batch**
Passive Monitoring									
Calculated NO2	ppb	2.9			2.7			0.1	7478595
Calculated NOx	ppb		8.1			6.8		0.1	7478640
Calculated SO2	ppb			1.3			2.7	0.1	7478717
RDL = Reportable Detection Limit									

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Maxxam Job #: B432816
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/02/28 - 2014/04/02

GENERAL COMMENTS

Samples received at Maxxam Campobello with water in sample containers.
No Blanks returned with samples.
Meteorological data provided incomplete; met. data from Conakry, Guinea combined with provided data for calculation of results.

Results relate only to the items tested.

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Maxxam

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Maxxam Job #: B432816
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/02/28 - 2014/04/02

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7478595	DF4	Spiked Blank	Calculated NO2	2014/05/08		99	%	90 - 110
7478595	DF4	Method Blank	Calculated NO2	2014/05/08	<0.1		ppb	
7478640	DF4	Spiked Blank	Calculated NOx	2014/05/08		99	%	N/A
7478640	DF4	Method Blank	Calculated NOx	2014/05/08	<0.1		ppb	
7478717	DF4	Spiked Blank	Calculated SO2	2014/05/08		100	%	90 - 110
7478717	DF4	Method Blank	Calculated SO2	2014/05/08	<0.1		ppb	

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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Maxxam Job #: B432816
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/02/28 - 2014/04/02

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Carmen Toker, CT, Manager Air Laboratory Services

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Your Project #: 2014/03/17 - 2014/04/17

Attention:JENNIFER KIRKALDY

SENES CONSULTANTS LIMITED
121 GRANTON DRIVE, UNIT 12
RICHMOND HILL, ON
CANADA T4B 3N4

Report Date: 2014/07/03
Report #: R1596442
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B446018
Received: 2014/06/05, 10:24

Sample Matrix: Air
Samples Received: 12

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
NO2 Passive Analysis (1)	4	2014/06/17	2014/07/03	PTC SOP-00148	Passive NO2 in ATM
NOx Passive Analysis (1)	4	2014/06/17	2014/07/03	PTC SOP-00148	Tang Passive NO2 in
SO2 Passive Analysis (1)	4	2014/06/17	2014/07/03	PTC SOP-00149	Tang Passive SO2 in

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The detection limit is based on a 30 day sampling period.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Levi Manchak, Customer Service
Email: LManchak@maxxam.ca
Phone# (780) 378-8500
==========
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Maxxam Job #: B446018
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/03/17 - 2014/04/17

RESULTS OF CHEMICAL ANALYSES OF AIR

Maxxam ID		JT5998	JT5999	JT6000	JT6001	JT6002	JT6003	JT6054		
Sampling Date		2014/03/17 14:00	2014/03/17 14:02	2014/03/17 14:04	2014/03/17 14:08	2014/03/17 14:10	2014/03/17 14:06	2014/03/17 16:50		
	Units	**KOUR1**	**KOUR2**	**KOUR3**	**KOUR11**	**KOUR12**	**KOUR13**	**BWD01**	**RDL**	**QC Batch**
Passive Monitoring										
Calculated NO2	ppb	0.5			0.5			1.2	0.1	7528208
Calculated NOx	ppb		0.6			1.1			0.1	7528210
Calculated SO2	ppb			0.2			0.2		0.1	7528233
RDL = Reportable Detection Limit										

Maxxam ID		JT6055	JT6056	JT6219	JT6225	JT6226		
Sampling Date		2014/03/17 16:52	2014/03/17 16:48	2014/03/17 16:54	2014/03/17 16:56	2014/03/17 16:58		
	Units	**BWD03**	**BWD02**	**BWD11**	**BWD13**	**BWD13**	**RDL**	**QC Batch**
Passive Monitoring								
Calculated NO2	ppb			1.4			0.1	7528208
Calculated NOx	ppb	1.9			2.8		0.1	7528210
Calculated SO2	ppb		<0.1			<0.1	0.1	7528233
RDL = Reportable Detection Limit								

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Maxxam Job #: B446018
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/03/17 - 2014/04/17

GENERAL COMMENTS

Sample ID labels differ from those listed on Chain of Custody.
No blanks returned. Default lab blanks use. - DF

Results relate only to the items tested.

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Maxxam Job #: B446018
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/03/17 - 2014/04/17

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7528208	DF4	Spiked Blank	Calculated NO2	2014/06/17		96	%	90 - 110
7528208	DF4	Method Blank	Calculated NO2	2014/06/17	<0.1		ppb	
7528210	DF4	Spiked Blank	Calculated NOx	2014/06/17		96	%	N/A
7528210	DF4	Method Blank	Calculated NOx	2014/06/17	<0.1		ppb	
7528233	DF4	Spiked Blank	Calculated SO2	2014/06/17		101	%	90 - 110
7528233	DF4	Method Blank	Calculated SO2	2014/06/17	<0.1		ppb	

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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Maxxam Job #: B446018
Report Date: 2014/07/03

SENES CONSULTANTS LIMITED
Client Project #: 2014/03/17 - 2014/04/17

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Carmen Toker, CT, Manager Air Laboratory Services

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Your Project #: 2014/04/17 - 2014/06/14
Site Location: ALCOA

Attention:JENNIFER KIRKALDY

SENES CONSULTANTS LIMITED
121 GRANTON DRIVE, UNIT 12
RICHMOND HILL, ON
CANADA T4B 3N4

Report Date: 2014/07/08
Report #: R1599137
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B455190
Received: 2014/07/02, 10:53

Sample Matrix: Air
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
NO2 Passive Analysis (1)	2	2014/07/07	2014/07/08	PTC SOP-00148	Passive NO2 in ATM
NOx Passive Analysis (1)	2	2014/07/07	2014/07/08	PTC SOP-00148	Tang Passive NO2 in
SO2 Passive Analysis (1)	2	2014/07/04	2014/07/08	PTC SOP-00149	Tang Passive SO2 in

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) The detection limit is based on a 30 day sampling period.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Levi Manchak, Customer Service
Email: LManchak@maxxam.ca
Phone# (780) 378-8500
==========
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Maxxam Job #: B455190
Report Date: 2014/07/08

SENES CONSULTANTS LIMITED
Client Project #: 2014/04/17 - 2014/06/14
Site Location: ALCOA

RESULTS OF CHEMICAL ANALYSES OF AIR

Maxxam ID		JZ4447	JZ4500		
Sampling Date		2014/05/14	2014/05/14		
	Units	**AQ-1-ALCOA A**	**AQ-1-ALCOA B**	**RDL**	**QC Batch**
Passive Monitoring					
Calculated NO2	ppb	2.4	2.7	0.1	7554488
Calculated NOx	ppb	7.5	6.6	0.1	7554506
Calculated SO2	ppb	1.7	1.9	0.1	7552247
RDL = Reportable Detection Limit					

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Maxxam Job #: B455190
Report Date: 2014/07/08

SENES CONSULTANTS LIMITED
Client Project #: 2014/04/17 - 2014/06/14
Site Location: ALCOA

GENERAL COMMENTS

Meteorological data provided incomplete; met. data from Conakry, Guinea combined with provided data for calculation of results.
SO2 Travel blank <JZ4501> outside QA acceptability criteria, default lab blank value used in the calculation of final results. SS

Results relate only to the items tested.

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Maxxam Job #: B455190
Report Date: 2014/07/08

SENES CONSULTANTS LIMITED
Client Project #: 2014/04/17 - 2014/06/14
Site Location: ALCOA

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7552247	SS6	Spiked Blank	Calculated SO2	2014/07/04		102	%	90 - 110
7552247	SS6	Method Blank	Calculated SO2	2014/07/04	<0.1		ppb	
7554488	SS6	Spiked Blank	Calculated NO2	2014/07/07		102	%	90 - 110
7554488	SS6	Method Blank	Calculated NO2	2014/07/07	<0.1		ppb	
7554506	SS6	Spiked Blank	Calculated NOx	2014/07/07		102	%	N/A
7554506	SS6	Method Blank	Calculated NOx	2014/07/07	<0.1		ppb	

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Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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Maxxam Job #: B455190
Report Date: 2014/07/08

SENES CONSULTANTS LIMITED
Client Project #: 2014/04/17 - 2014/06/14
Site Location: ALCOA

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Linda Lin, Supervisor, Centre for Passive Sampling Technology

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