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2-D Electrical Resistivity Tomography and Seasonal Variation Assessment of Groundwater around the Olushosun Dumpsite, South-West, Nigeria

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Presentation Outline

- ✓ Introduction
  - Background to the study
  - Aim and Objectives of the study
  - Literature review
  - Geology of the study Area
- ✓ Materials and method
- ✓ Results and Discussion
- ✓ Conclusions
- ✓ References

1.0 Background to the study

- Dumping are the most used methods of municipal solid waste disposal in Nigeria.
- Nigeria generates an average of 0.58 kg solid waste per person daily (Adewumi et al., 2005). With a population of over 170 million people, this huge figure if unabated would lead to serious environmental problems.
- Landfill report on LAWMA website (www.lawma.gov.ng) indicates that in the month of February 2012 alone, about 79,946.98 metric tons of waste was deposited on Olushosun dumpsite.

1.0 Background to the study cont'd

Fig 1.0: Pictorial view of the Olushosun dumpsite

1.1 Aim and objectives of the study

The aim of the this research work is to assess the impact of leachates from the dumpsite on the soil and groundwater around the study area.

The specific objectives are to:

- ✓ investigate the vertical extent of contaminants migration around the dumpsite
- ✓ analyze the physical properties of water samples from existing hand dug wells and boreholes near the sites.
- ✓ Examine time-lapse effect of contaminants migration on the subsurface environment from VES data

2.0 Literature review

- Most previous time-lapse ERT studies have been aimed at understanding subsurface solute transport by using time-varying electrical responses related to known injections of saline tracers into aquifers or known injections of water into the vadose zone (e.g., Slater et al., 2000; Singha and Gorelick, 2005; Slater and Binley, 2006; Müller et al., 2010; Wilkinson et al., 2010b).

- A few studies have taken advantage of pre-existing electrical contrasts between the properties of subsurface fluids, such as those related to movements of contaminant plumes or those related to salt water - fresh water contacts within coastal aquifers (e.g., Acworth and Dasey, 2003; de Franco et al., 2009; Maurer et al., 2009; Ogilvy et al., 2009).

2.1 Geology of the study area

Table 1.0: Stratigraphy of eastern Dahomey basin

ERA	Jones & Hockey (1964)			Omatsola & Adegoke (1981)		
	Age	Formation	Lithology	Age	Formation	Lithology
Quaternary	Recent	Alluvium				
Tertiary	Pleistocene-Oligocene	Coastal Plain Sands		Pleistocene-Oligocene	Coastal Plain Sands	
Tertiary	Eocene	Ilaro		Eocene	Ilaro, Ososhun	
Tertiary	Paleocene	Ewekoro		Paleocene	Akinbo, Ewekoro	
Late Cretaceous	Late Senonian	Abeokuta		Maastrichtian Neocomian	Araromi, Afowo, Ise	
PRE - CAMBRIAN CRYSTALLINE BASEMENT						

- Alluvial sediments
- Siltstone/mudstone
- Unconsolidated sands and silty sands
- Poorly consolidated shale/clay
- Laminated fossiliferous shale
- Limestone, fossiliferous
- Basal conglomerate with grits and siltstone

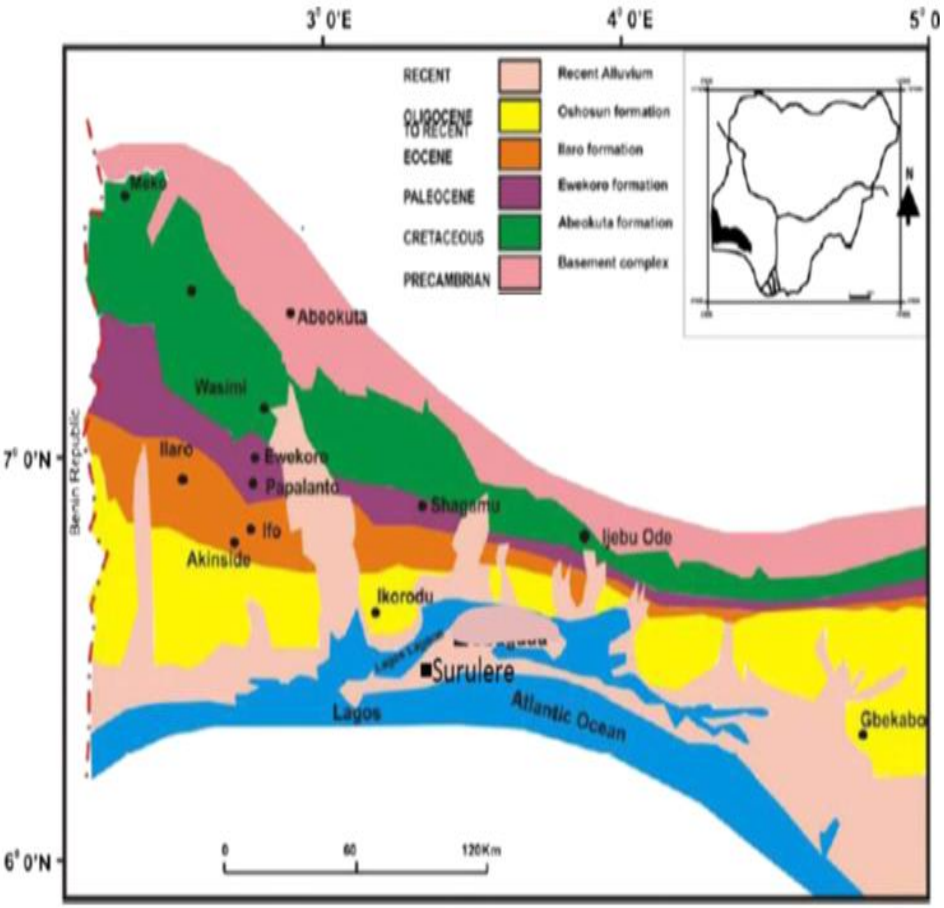


Figure 2.0: Geological map of eastern Dahomey Basin (modified after Billman 1992)

3.0 Materials and Method

3.1 Data acquisition

3.1.1 2D resistivity survey

- The ERT surveys were carried out with the aid of a digital readout Super Sting R8 Earth Resistivity/IP metre. It is a multi-electrode system that uses 84 electrodes.
- The 2D resistivity data were collected along all the traverses using Dipole-Dipole and Pole-Dipole arrays with spacing of electrodes dependent on the level of accessibility on and around the sites
- Available time-lapse VES data obtained on the site in 2001, 2002 and 2006 were obtained and analyzed

3.0 Materials and methods cont’d

3.1.2 Water sample analysis

- Assessment of physical properties of water

- A portable EC/TDS meter was used insitu for this analysis

- Borehole and hand dug well water samples within and around the selected dumpsites were analyzed for the content of their total dissolved solid (TDS), pH values, temperature and electrical conductivity (EC)
- Measured parameters were later compared with the World Health Organization (WHO, 2004) and Standard Organization of Nigeria (SON, 2007) standards

3.0 Materials and methods cont'd

3.2 Data processing

3.2.1 2d resistivity data

- The 2D resistivity data were processed and inverted using the EarthImager inversion software.
- interpretation of the VES data was done using curve matching technique to generate the initial resistivity and depth models. These served as input data for computer iteration using WINRESIST software.

3.2.3 Physicochemical data

- Data obtained were also plotted as histograms on the Microsoft excel software and compared with WHO and SON standard

3.0 Materials and methods cont'd

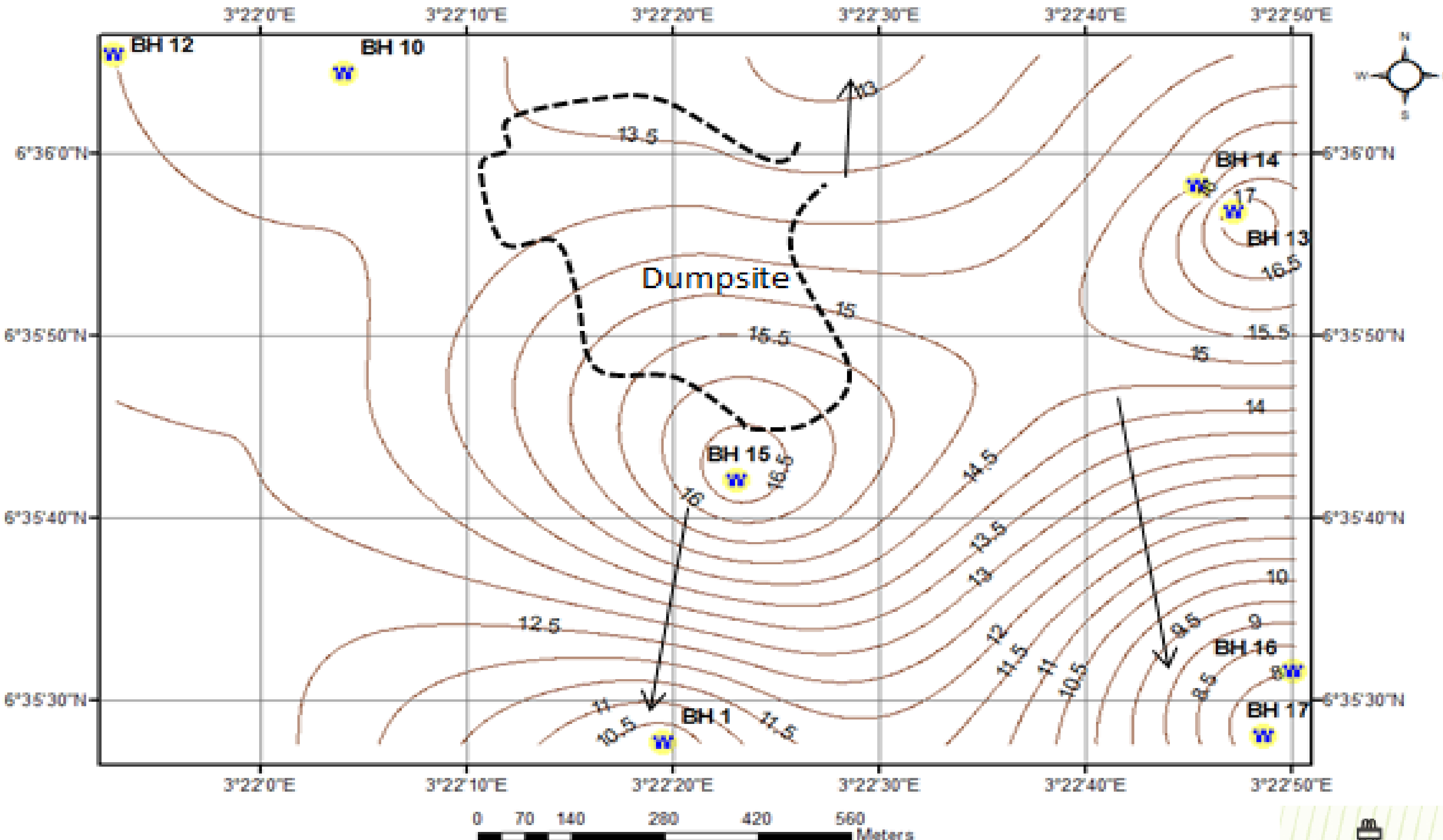


Figure 3.0: Contour Map of Olushosun dumpsite showing Groundwater flow direction

3.0 Materials and methods cont’d

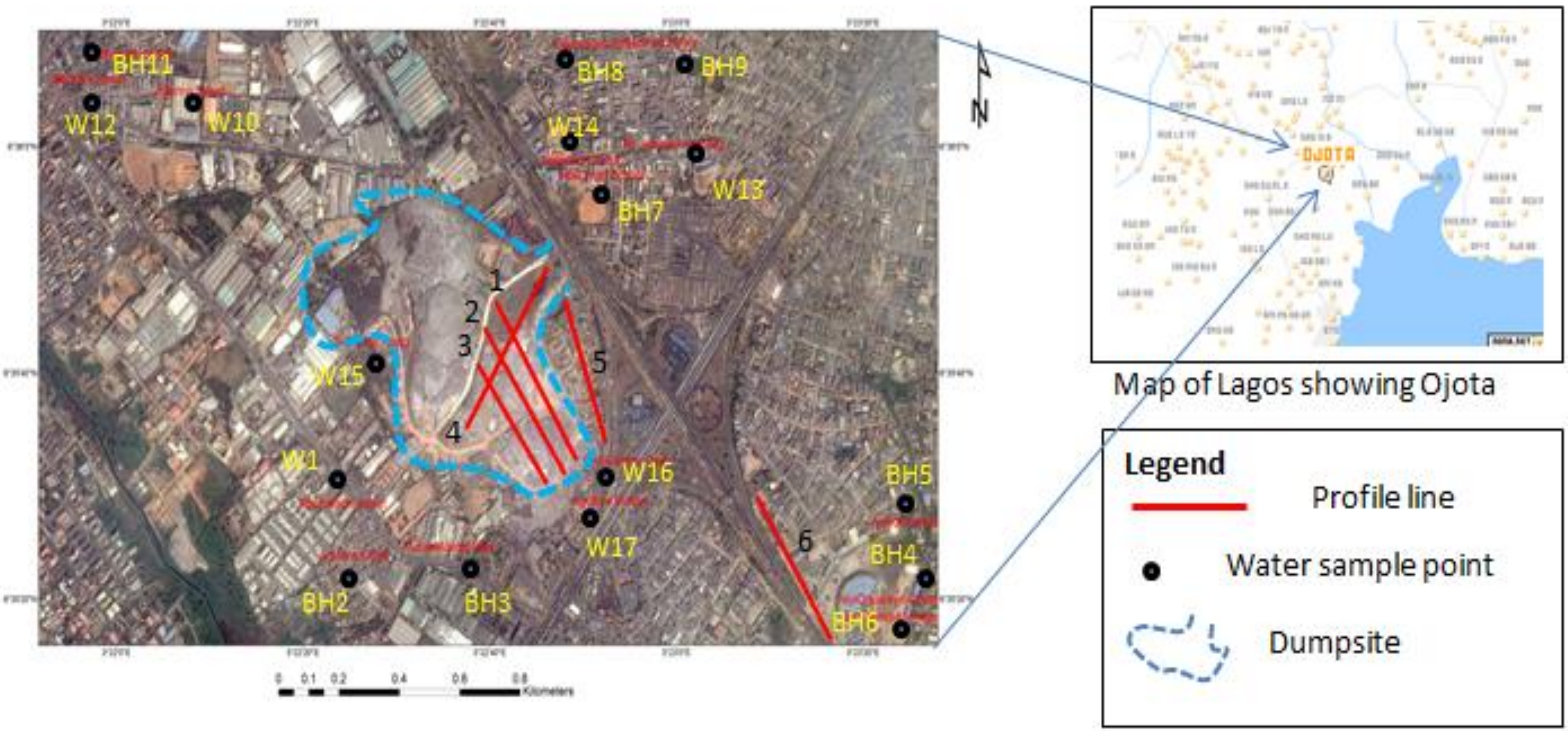


Figure 3.1: Satellite image of Olushosun dumpsite and surrounding areas showing ERT lines and water sampling points

4.0 Results and discussion

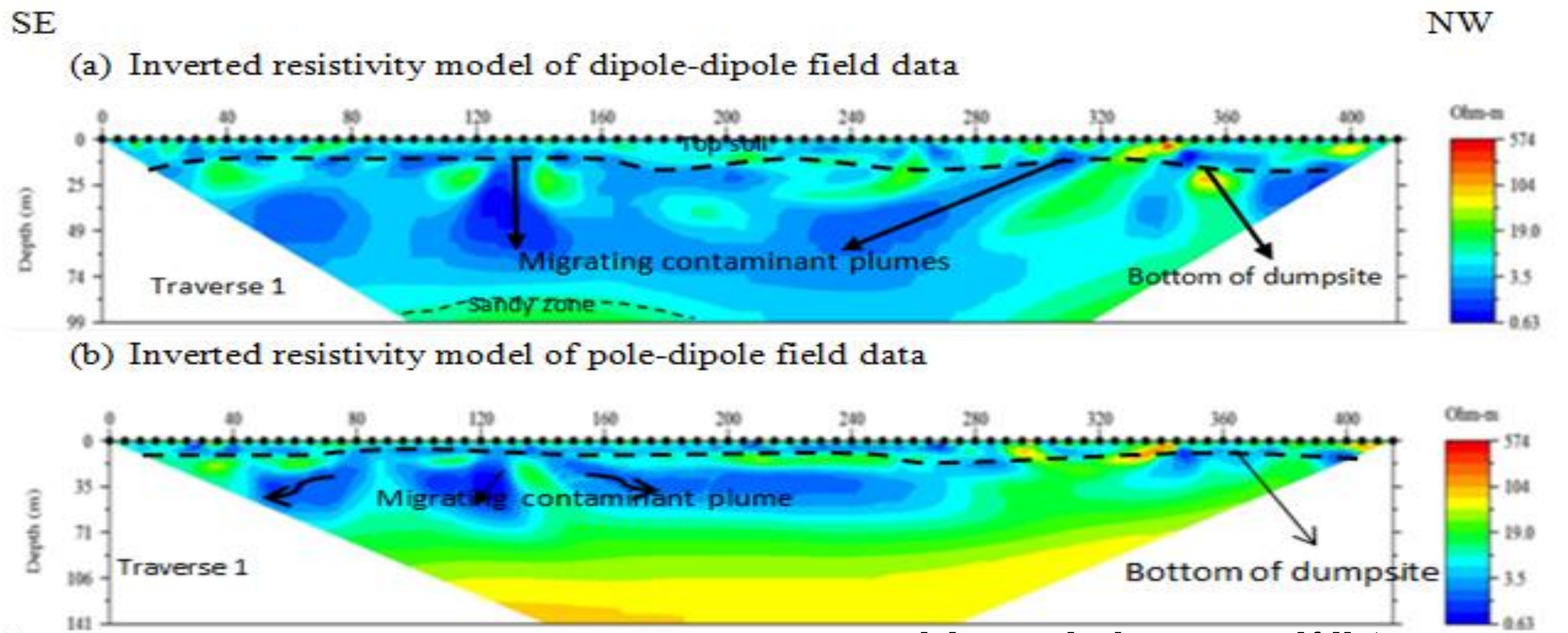
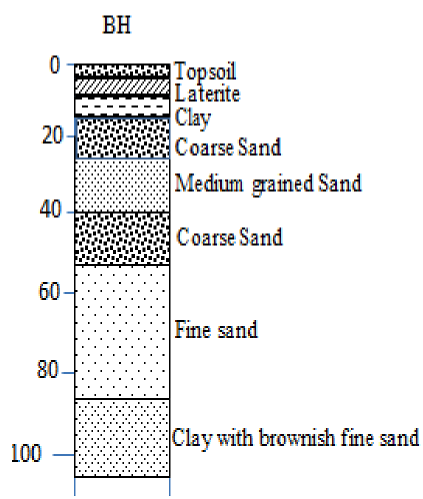
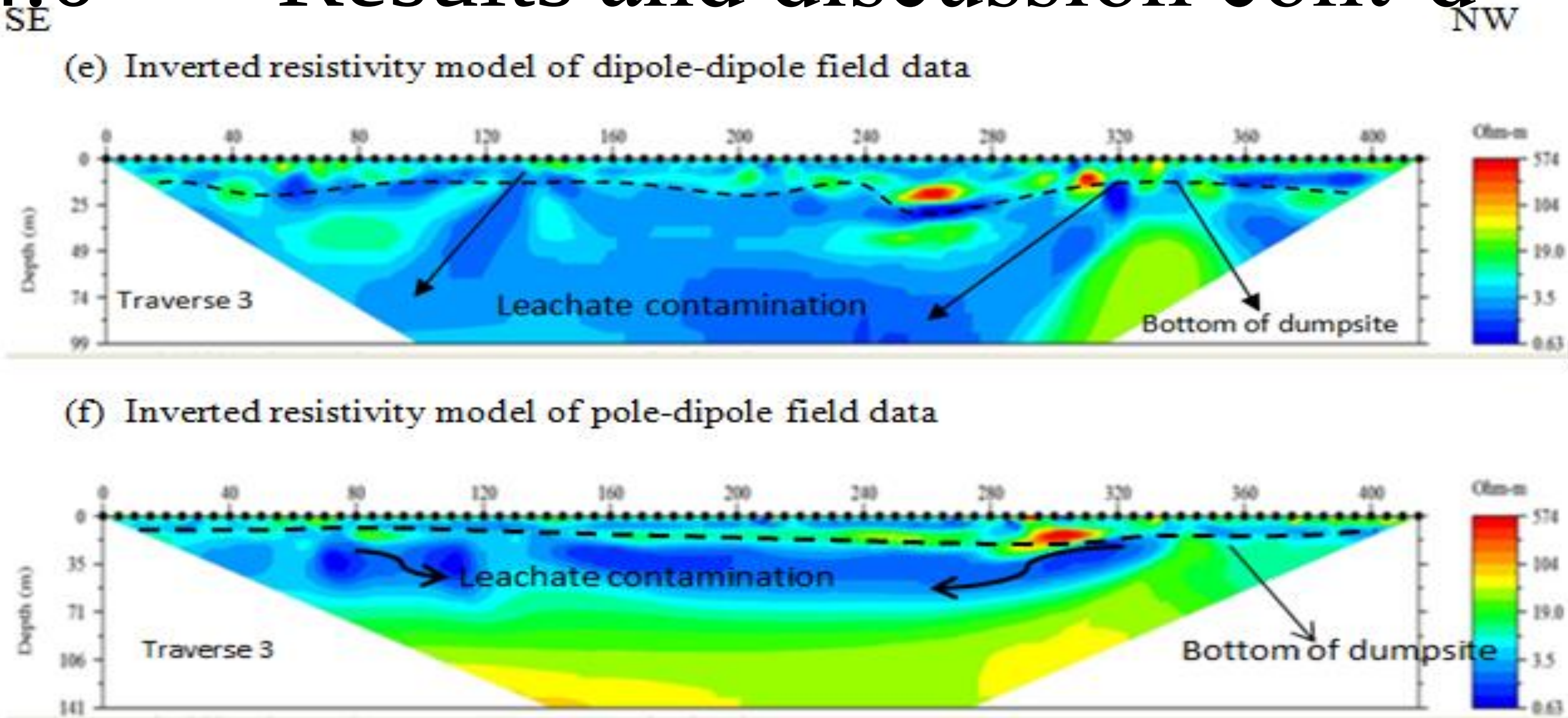


Figure 4.0: 2D resistivity inversion models on Olushosun Landfill (Traverses 1)



4.0 Results and discussion cont'd



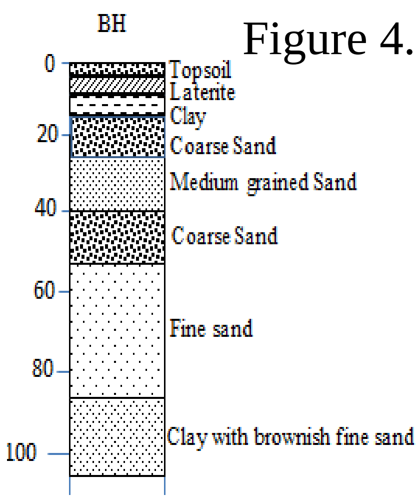
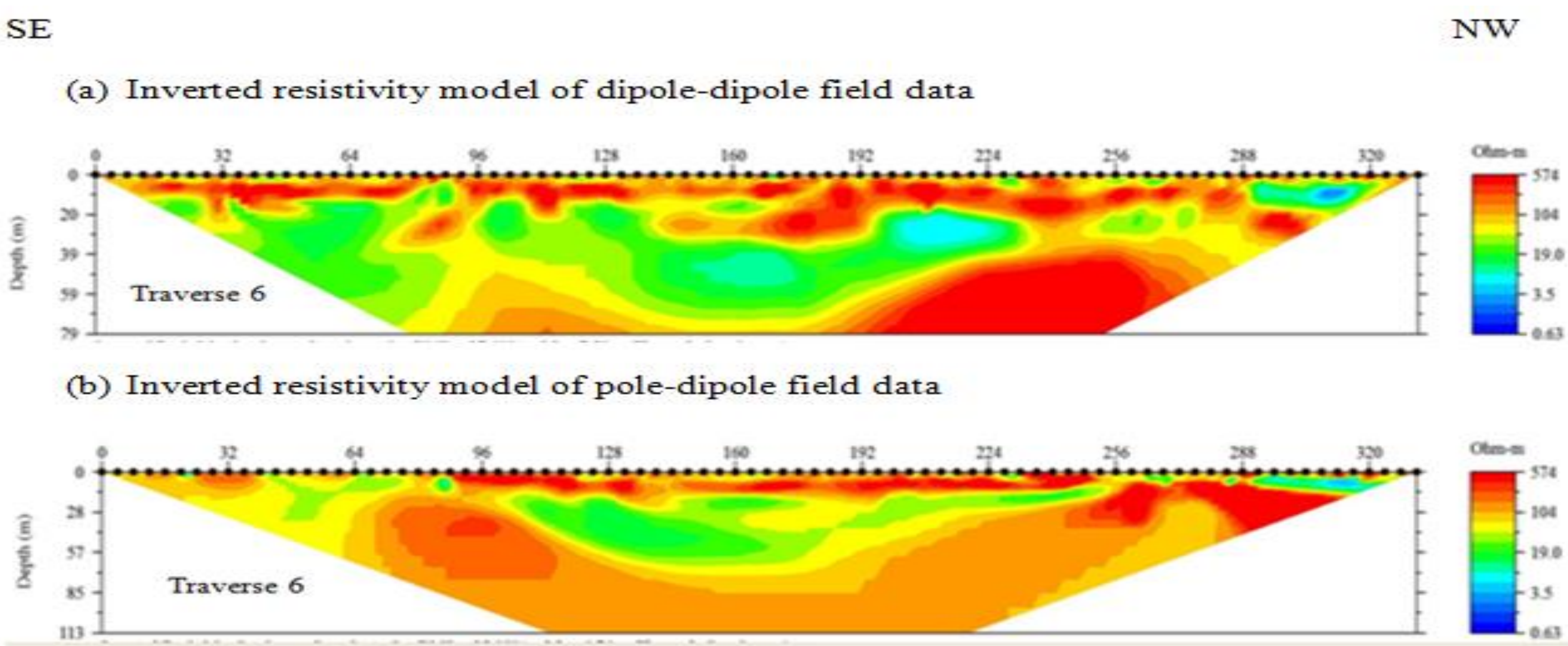


Figure 4.1: 2D resistivity inversion models on Olushosun Landfill (Traverse 3)

4.0 Results and discussion cont’d



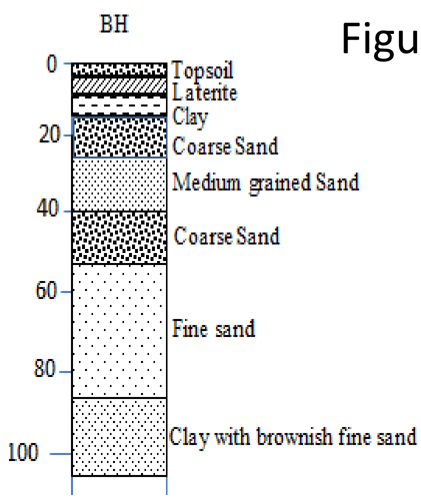
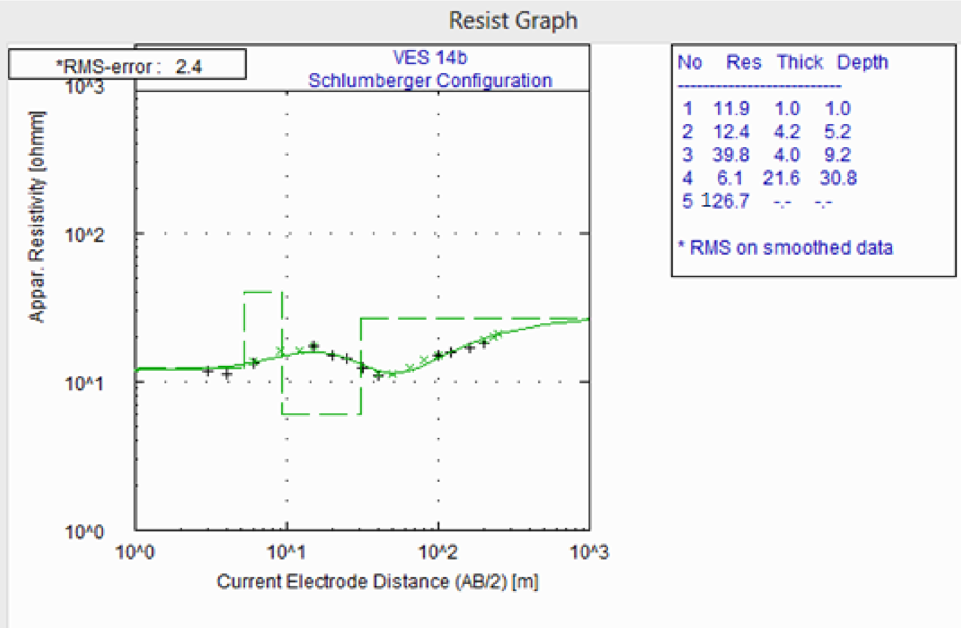
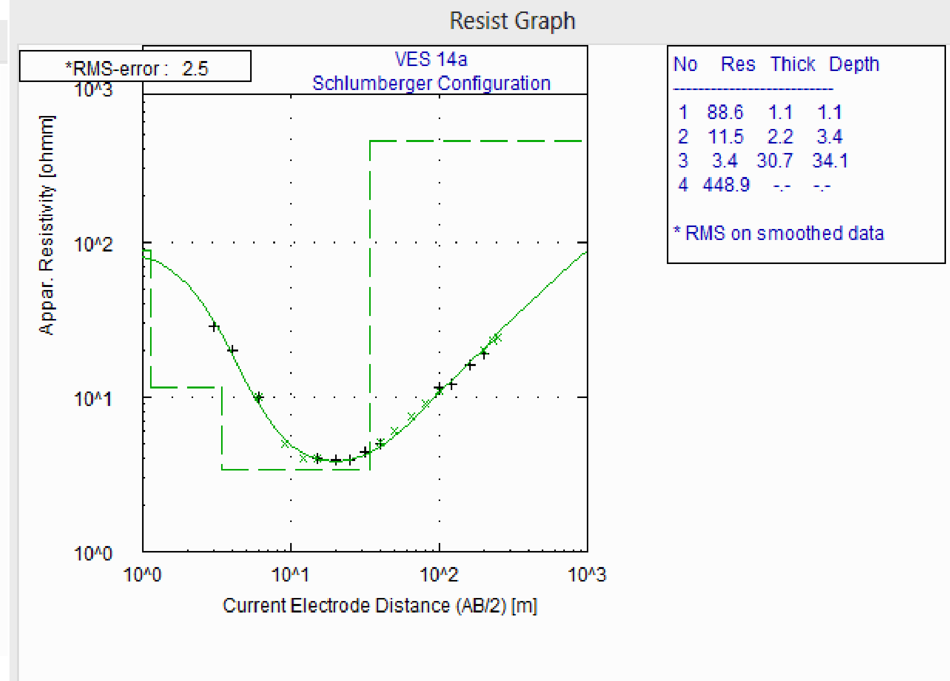


Figure 4.2: Surface 2D resistivity for Olushosun Landfill (Control Traverse)

4.0 Results and discussion cont'd





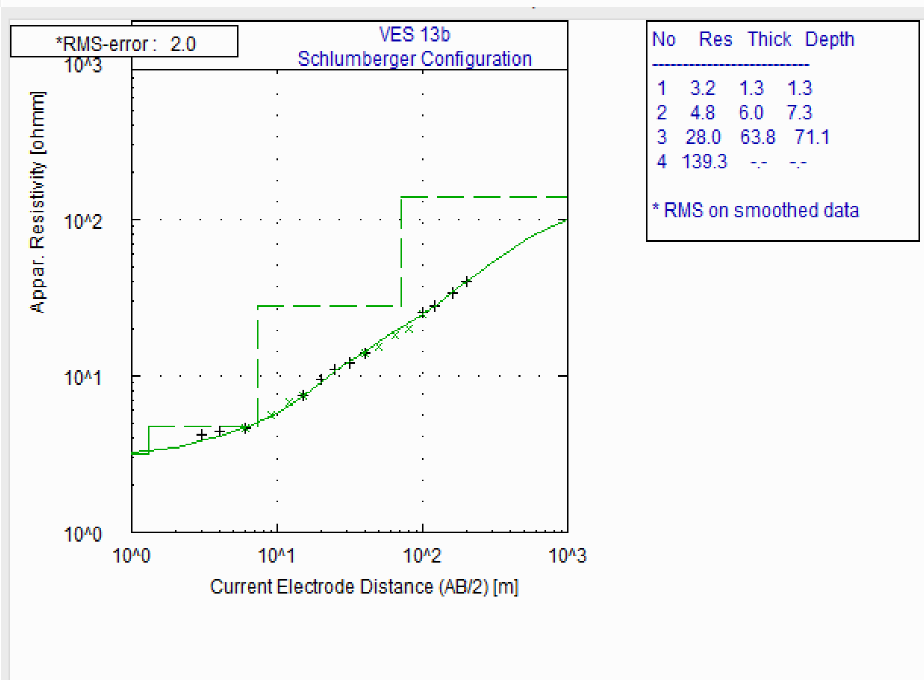


Figure 4.3: VES sounding curves obtained along traverse 1 on the dumpsite in 2001, 2002 and 2006

4.0 Results and discussion cont'd

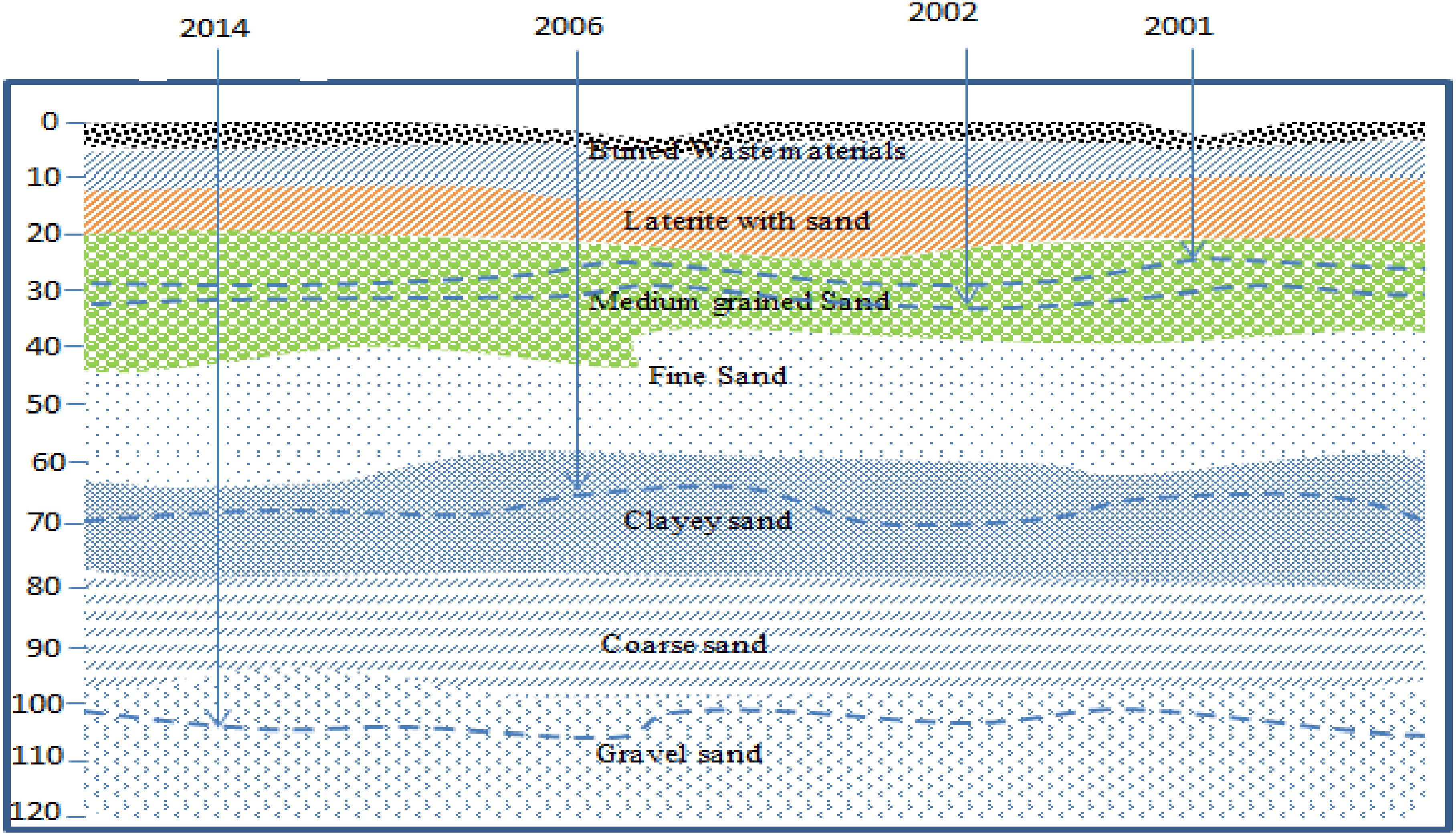


Figure 4.4: Geologic section along traverse 1 showing increase in the depth of migration of leachate with time

4.0 Results and discussion Cont'd

Table 4.1: Seasonal Paired Samples Statistics of groundwater hydrophysical parameters around Olushosun landfill

August 2014 results (black) — December 2015 results (red)

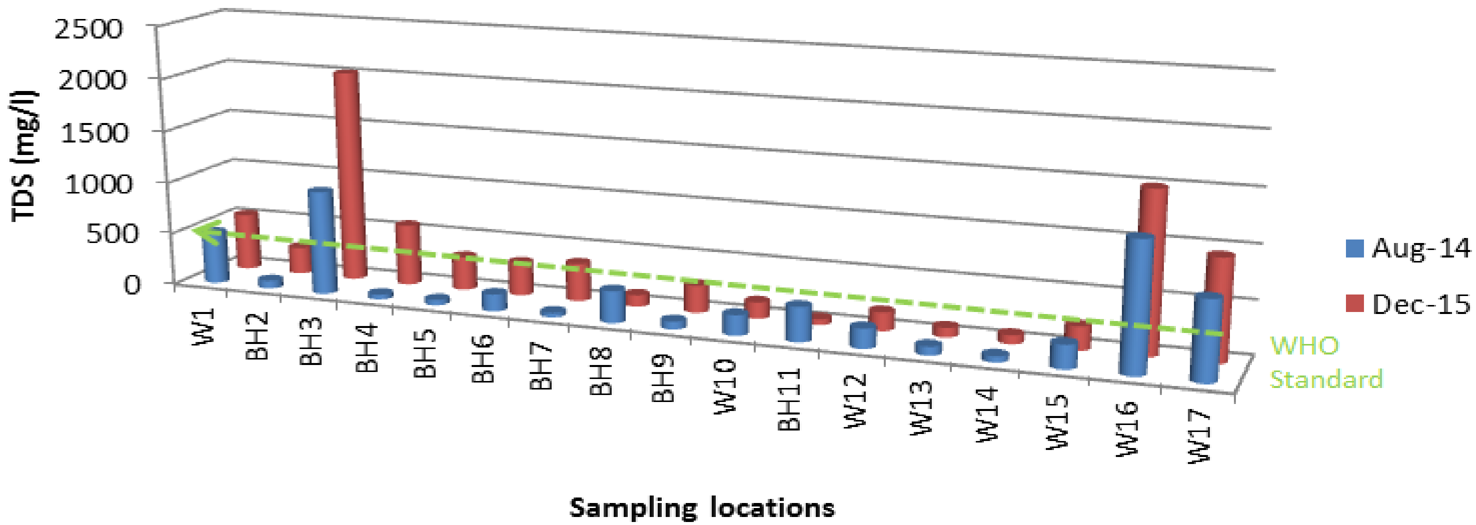
Sample	**Location**	**Coordinate**	**pH**	**Temp (°C)**	**EC (µS/cm)**	**TDS (ppm/mg/l)**	**Hardness (mg/l)**
W 1	Mashalachi street	06^0 35′ 27.69″N 003^0 22′ 19.48″E	6.52 6.71	27.4 30.7	1024 1079	496 539	125.0 200.0
BH 2	Anisere Close	06^0 35′ 23.13″N 003^0 22′ 21.75″E	6.96 6.67	26.4 30.7	147 575	73 257	65.0 80.0
BH 3	Kudirat Abiola Way	06^0 35′ 23.86″N 003^0 22′ 30.67″E	6.21 7.06	27.3 30.6	1950 4043	992 2021	145.0 246.0
BH 4	Ayinde Street	06^0 35′ 26.12″N 003^0 23′ 26.79″E	6.79 6.46	27.0 30.7	139 1158	48 579	70.0 160.0
BH 5	Niyi Ogunleye Street	06^0 35′ 19.26″N 003^0 23′ 24.76″E	6.83 6.14	27.4 30.4	137 646	50 321	90.0 95.0
BH 6	By Chinese Village	06^0 35′ 17.74″N 003^0 23′ 18.73″E	6.81 6.10	26.2 30.8	325 634	161 319	60.0 95.0
BH 7	By Jehovah Witness	06^0 35′ 59.49″N 003^0 22′ 54.21″E	6.85 4.08	26.7 30.4	117 727	40 361	60.0 100.0
BH 8	Ikosi Street	06^0 36′ 08.46″N 003^0 22′ 56.23″E	3.83 4.49	28.1 30.6	607 219	304 110	75.0 75.0
BH 9	Ogunmoyo Street	06^0 36′ 08.39″N 003^0 22′ 47.71″E	6.67 4.29	28.0 30.3	140 521	75 257	80.0 125.0
W 10	Adeniyi Street	06^0 36′ 04.19″N 003^0 22′ 04.16″E	4.02 4.45	27.1 30.5	397 306	193 154	45.0 105.0
BH 11	Bankole Street	06^0 36′ 07.44″N 003^0 21′ 58.17″E	4.00 5.76	26.9 30.6	790 107	325 53	95.0 75.0
W 12	Bankole Street	06^0 36′ 05.23″N 003^0 21′ 53.09″E	4.31 4.61	27.8 30.4	366 353	187 176	70.0 85.0

4.0 Results and discussion Cont'd

Table 4.1: Seasonal Paired Samples Statistics of groundwater hydrophysical parameters around Olushosun landfill Cont'd

Sample	Location	Coordinate	pH	Temp (°C)	EC (µS/cm)	TDS (ppm/mg/l)	Hardness (mg/l)
W 13	Ikosi High School	06^0 35′ 56.92″N 003^0 22′ 47.30″E	6.21 4.67	28 28.5	160 178	83 90	68 75
W 14	Anglican Church	06^0 35′ 58.11″N 003^0 22′ 45.44″E	6.77 5.42	27.0 28.0	127 170	56 80	64 80
W 15	Supreme Road	06^0 35′ 42.03″N 003^0 22′ 23.20″E	5.84 4.80	29.3 30.0	482 400	222 220	82 98
W 16	Ojota Motor Park	06^0 35′ 31.47″N 003^0 22′ 50.05″E	6.79 4.21	32.4 30.7	2,589 3,200	1,200 1,500	167 367
W 17	Agofure Motors	06^0 35′ 27.95″N 003^0 22′ 48.84″E	6.83 5.20	33.6 31.7	1,437 1,734	738 950	156 256
Mean			6.01 5.36		643.18 944.12	308.41 469.82	89.23 136.29
Range			3.83-6.69 4.08-7.06		117-2589 107-4043	40-1200 53-2021	45-167 75-367
St. Dev.			1.17 1.00		722.1 1100.9	350.94 542.56	36.53 83.57
Coef. Of Variation(%)			19.47 18.65		112.3 116.6	92.25 115.5	40.93 61.31
	WHO/SON Standard		6.5-8.5	-	1000	500	150

4.0 Results and discussion Cont'd



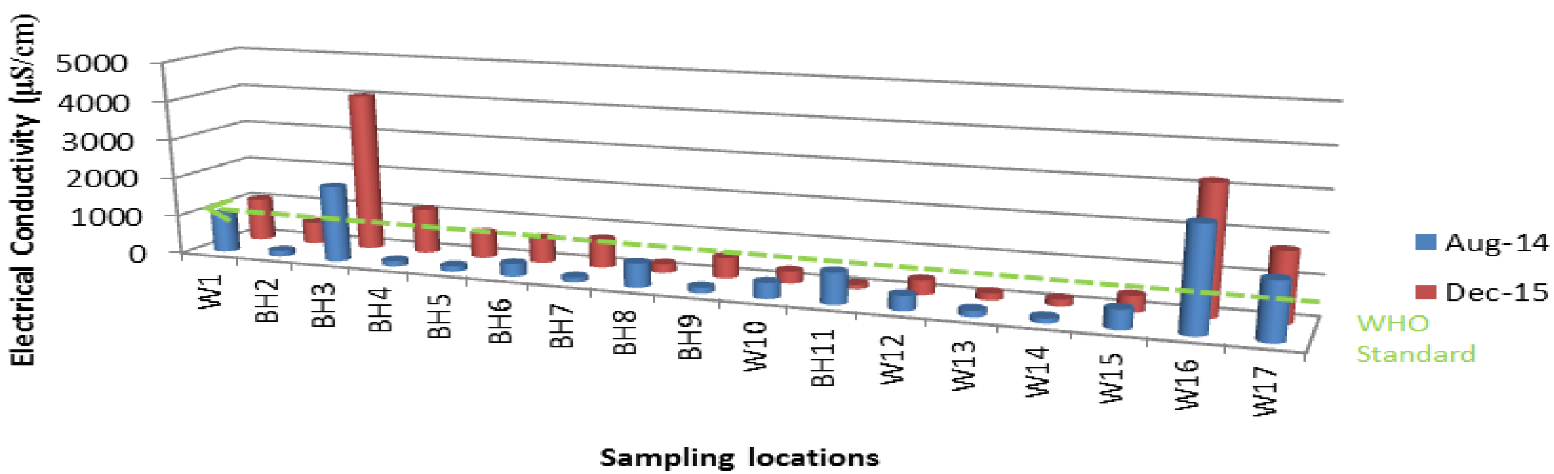


Figure 4.5: Seasonal variations in TDS and EC concentration of water sample versus WHO standard around the Olushosun dumpsite

4.0 Results and discussion Cont'd

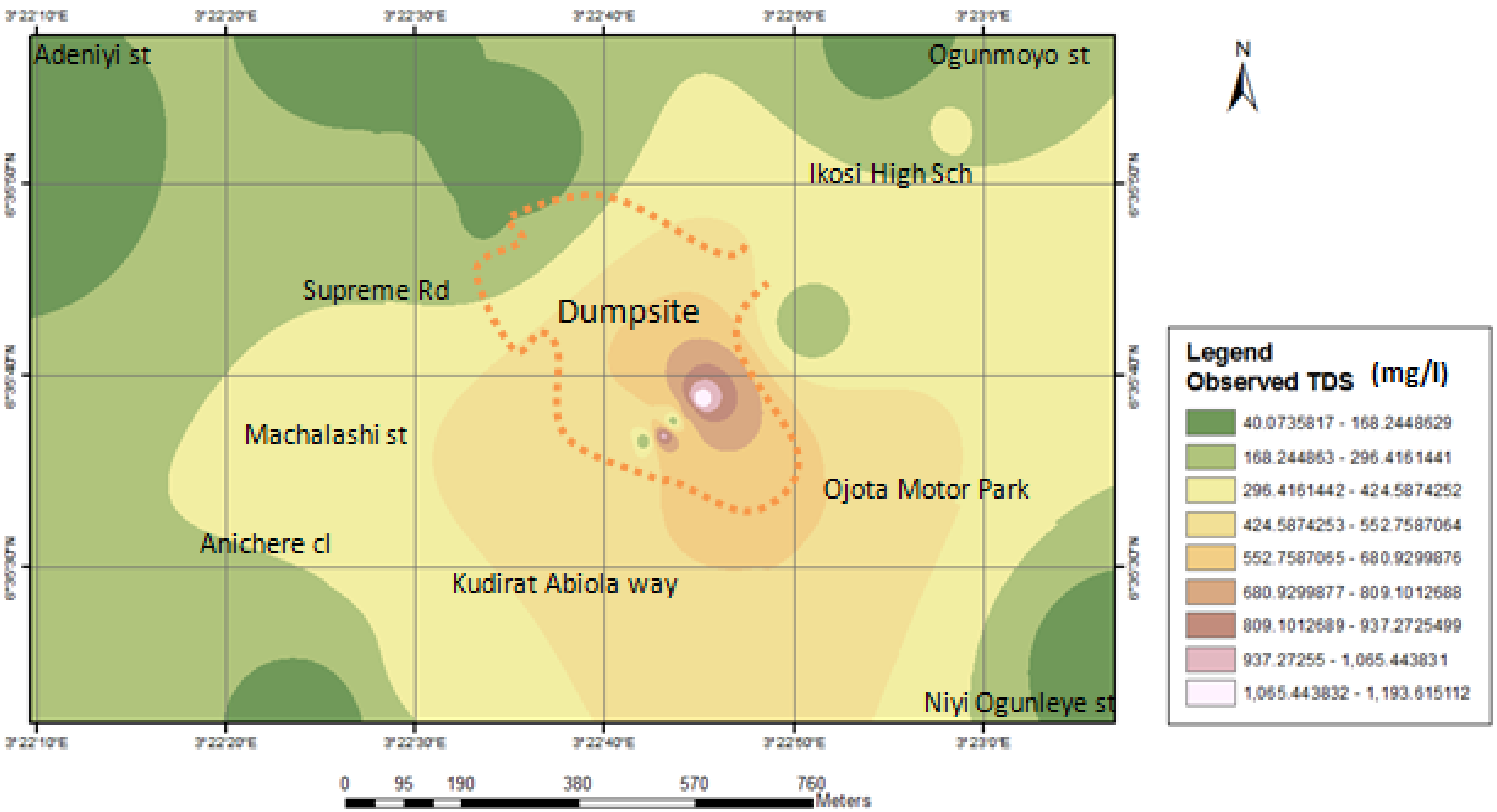


Figure 4.6: Spatial distribution of total dissolved solid within the study area

4.0 Results and discussion Cont'd

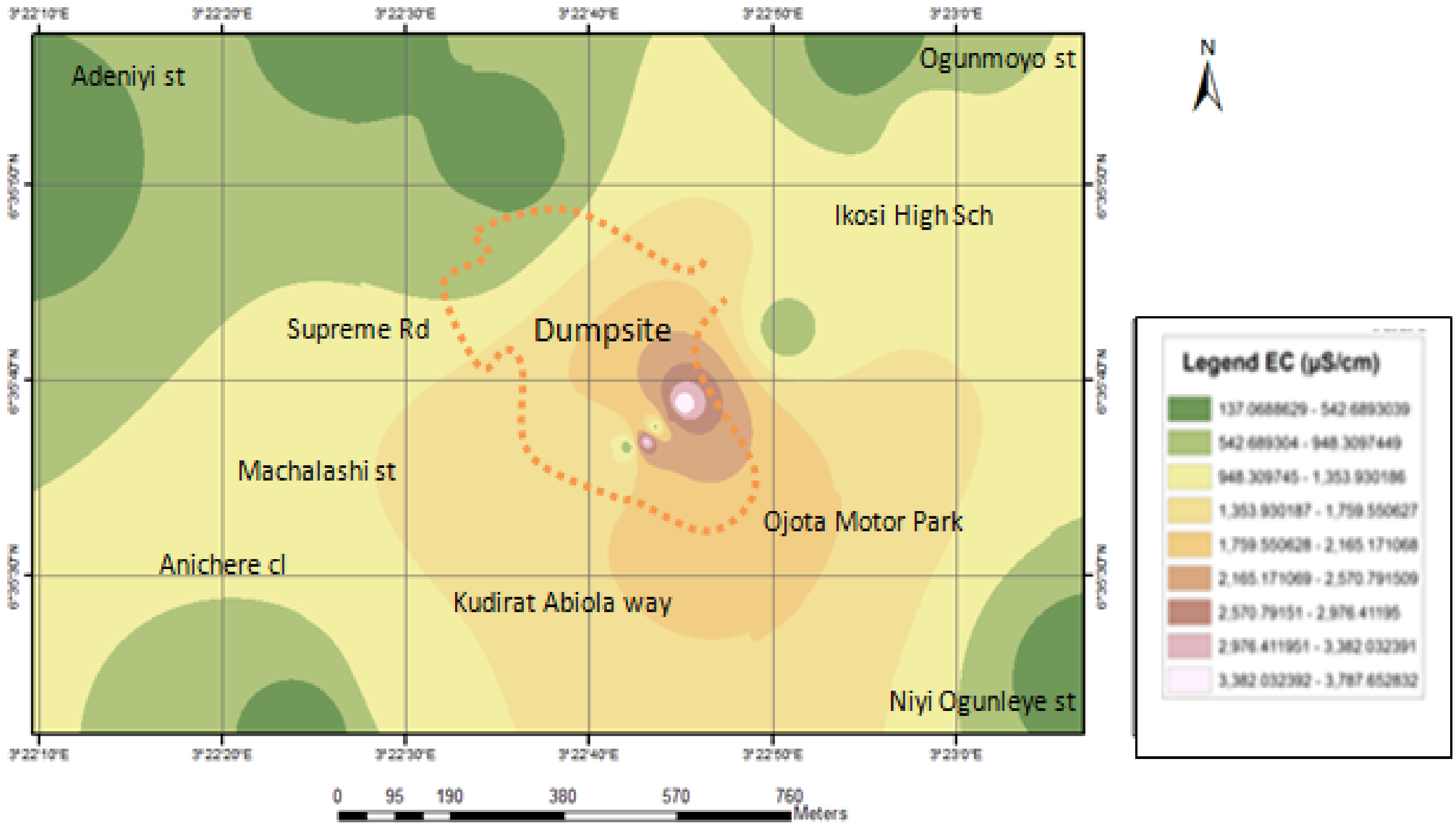


Figure 4.7: Spatial distribution of Electrical conductivity within the study area

5.0 Conclusion

- The results of the 2D resistivity study was able to revealed the depth of 106m of contamination around the Olushosun dumpsite.
- The time-lapse geophysical survey and physical property analysis of groundwater was crucial in establishing temporal variation in groundwater quality, and the progressive lateral and vertical spread of contaminants around the selected dumpsites with time .

5.0 Conclusion

- This information will facilitate decisions on improving protection of water resources and decreasing the impact of the pollutants on the subsurface environment.

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Thank you for listening!!!