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CASE STUDY SERIES #10

THE PROJECT	LARGE-SCALE EROSION GULLY	**APPLICATION**	MASS GRAVITY RETAINING WALL
LOCATION	NANKA, ANAMBRA STATE, NIGERIA	**DATE**	NOVEMBER 2011 – OCTOBER 2016

CLIENT	THE PRESIDENCY, ECOLOGICAL FUND OFFICE, ABUJA
DESIGN	SANI MUSTAPHA AND PARTNERS
CONTRACTOR	RHINO CONSTRUCTION LTD

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Nanka Recent Landslide Erosion Project: mid-term construction, photographed in September 2012, showing landslides caused by seasonal storm water. Geologically, the area comprises friable, erodible and sandy soils which are further subject to the effects of extreme erosion caused by storm water run-off. The lack of proper drainage infrastructure would be addressed during the intial phase of groundworks and site preparation.

PROJECT BACKGROUND

In 2011 Rhino Construction Limited purchased the nationally advertised tender as part of a sealed bidding process. The procurement process was monitored by the Federal Ministry of Environment. A total of 16 applications were submitted from competing construction companies.

Of these, 14 companies submitted tenders for the project in June 2011. The procurement process was conducted under a sealed bid procedure which culminated in the public bid opening in July 2011. This preceded a further evaluation period, prior to the award of the final construction contract.

Enviromesh assisted throughout the project, both at intial tender stage with engineering and technical advice as well as quantifying the material requirements for the scheme as a whole. The project would need 4,000 no. gabion mesh baskets, 280 no. mattresses and associated wire accessories; together with a comprehensive training programme.

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PROJECT BRIEF

Phase 1 of the project is intended to provide gully base stabilisation through a combination of both hard and soft engineering solutions. This comprising of two mass gravity gabions walls with mattress toe protection coupled with extensive embankment planting on the slopes.

Phase 2 is currently in planning to provide additional stability to Nanka and Oko embankments which will complete the scheme.

The main challenges

- Local geology: friable, erodible and sandy soils which are further subject to the effects of extreme erosion caused by storm water run-off.
- Extremes of the local climate: here it is typically equatorial with six months of seasonal heavy rains.
- Training the local workforce: to assemble and install the large retaining walls to specification.
- Access for heavy machinery: break in to the gully through the Nanka side perimeter and create access to allow for the delivery of materials on site.
- Working with heavy machinery: to excavate site and prepare wall foundations, excavating drainage channels, with a build programme that would span three seasonal rains.

MATERIAL REQUIREMENTS

GABION BASKETS

- 2m × 1m × 1m
  Hexagonal double-twist, woven wire mesh baskets.
- 4,000 no.
- Nominal mesh size 80mm × 100mm.
- The nominal wire diameter for the mesh fabric shall be 2.70mm and 3.40mm for the selvedge wire.
- The end wires of the mesh panel are terminated by being wrapped around a heavy selvedge wire.
- All wire is in accordance with BS EN 10218-2:2012 and BS EN 10223-3:2013 with an ultimate tensile strength of between 350 to 550N/mm^2.
- All wire zinc coated in accordance with BS EN 10244-2:2009 (Class A) with an additional extruded organic polymer powder coating (grey) of nominal 0.5mm nominal radial thickness. This organic polymer powder coating is in accordance with BS EN 10245-2:2011.

LACING WIRE

Substantial quantities of plastic coated lacing wire to joint the gabions and mattresses together to form one monolithic structure. Nominal 2.2mm wire diameter in accordance with BS EN 10218-2:2012 and a tensile strength that falls within a range of 350 to 550 N/mm^2.

MATERIAL REQUIREMENTS

GABION MATTRESSES

- 5m × 2m × 300mm
  Hexagonal double-twist, woven wire mesh mattresses.
- 280 no.
- Nominal mesh size 60mm × 80mm.
- The nominal wire diameter for the mesh fabric shall be 2.00mm and 2.40mm for the selvedge wire.
- The end wires of the mesh panel are terminated by being wrapped around a heavy selvedge wire.
- All wire is in accordance with BS EN 10218-2:2012 and BS EN 10223-3:2013 with an ultimate tensile strength of between 350 to 550N/mm^2.
- All wire zinc coated in accordance with BS EN 10244-2:2009 (Class A) with an additional extruded organic polymer powder coating (grey) of nominal 0.5mm nominal radial thickness. This organic polymer powder coating is in accordance with BS EN 10245-2:2011.

GEOTEXTILE MEMBRANE

Needle punched non-woven geotextile membrane to the rear of the walls and to their foundations. Specified as 200g/m^2.

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AWARD OF CONTRACT

In November 2011, the contract was awarded to Rhino Construction Limited by the Presidency, Ecological Fund Office in Abuja. Sani Mustapha and Partners were the appointed project designers.

During November and December 2011, Rhino Construction initiated a number of pre-construction site surveys and then moved on to the site in January 2012, in order to commence works.

The role of Enviromesh required that we would schedule and coordinate the manufacture and supply of the gabion mesh material components, as well as ensuring a timely delivery in accordance with the overall projected timeframes and works schedule.

As a number of workers from the local community were employed to assist with providing labour, Enviromesh additionally provided the necessary training and technical construction advice throughout key stages of the construction period. This would ensure the structure was built in accordance with the specification and to the required standard.

PRELIMINARY WORKS

Climatic influences and local geological conditions (friable, erodible and sandy soils which are further subject to the effects of extreme erosion caused by storm water run-off and poor infrastructure planning), meant that a clear plan for dealing with the heavy rain experienced in the region. This involved a number of surveys and follow-up groundworks whereupon installation of a new perimeter drainage channel system was undertaken (see photo, right).

Storm water gully preparation: The site shown here during a survey to determine alignment and levels. The photo shows excavation and the first stages in blinding the drainage gullies (a total of 3.9 km of gullies would be constructed in total). These gullies were built to help manage and channel storm water run-off away from the main construction zone into a local creek.

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STORM WATER DRAINAGE INFRASTRUCTURE

Construction of the drainage infrastructure would need to consider the existing site topography, as well as providing an effective means to manage storm water and surface water run-off. The drains were designed and installed at the start of the project to carry heavy flood waters away from the main Nanka gully into the creek downstream.

By improving communications with the rehabilitation of 3.9 km of local roadways, together with the associated drainage improvements, agricultural land would be once again freed-up to become productive. This would have the knock-on effect of providing reemployment for the local workforce at the end of the project.

The concrete reinforcement steelwork (left) prior to concrete pour, shown here during the early stages of the works. The completed and partly back-filled rectangular RFC drains. Remedial works included provision of asphalted community roads, fast-growing grasses and vegetation in order to reinstate areas affected by the site works.

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NANKA GULLY LANDSLIDE EROSION SCHEME

Work in the main gully started in January 2012 and the initial, formidable challenge, was to break in to the gully through the Nanka side perimeter and create access for heavy machinery and delivery of materials to the construction team.

The access works were completed within three months with work proper starting on shaping the gully's embankments and preparing the wall foundations, from June 2012 onwards.

Wire mesh gabion mattresses

- Installation of hexagonal woven, wire mesh gabion mattresses for ground stabilisation/foundations.
  Individual mattress dimensions: 5m × 2m × 300mm
  280 no. mattresses supplied by Enviromesh

Wire mesh gabion baskets

- Installation of two, four-metre high stepped-face gabion retaining walls, 270 metres in length (each wall).
  Individual basket dimensions: 2m × 1m × 1m
  4,000 no. baskets supplied by Enviromesh

Severe flooding occurred at the commencement of the seasonal rains in May 2012 as a result of a collapse of an existing storm water drain on the Oko side perimeter which created major landslides affecting the work in progress. An additional 240,000 cubic metres of landslide was cleared from the gully base, which inevitably delayed the build programme to the start of the following dry season.

A view of one end of the Nanka gully ersoion scheme, with the construction of the first gabion wall underway. Shown here are the completed sections of the lowermost courses.

As the project progressed, additional protection work was undertaken in the form of a lateral retaining wall installation at end of the two main structures. The scale of the project is evident to the far treeline.

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GABION WALL INSTALLATION

Two parallel walls were constructed along the gully, each of which was 270 metres long by four metres high.

The 'mass gravity' walls were designed by the consultants and founded on a hexagonal woven wire mesh mattress apron. The courses of hexagonal woven wire mesh gabion baskets comprised a stepped face, with a geotextile membrane sited both behind and below the structure to prevent future erosion of the sub-soils through the walls.

Working in the gully is subject to climate extremes of high humidity and temperature. The day-to-day welfare and safety of the workers was critical — and keeping them hydrated was a major priority in order to maintain productivity.

Typically, 200 cubic metres of gabions and mattresses were assembled, installed, jointed and filled with a granite 6G graded stone each day.

Physical installation of the walls commenced February 2016 and were completed by September 2016.

Gabion mesh wall installation: The build project in the Nanka gully at mid-term with the local workforce constructing the first course of the second gabion wall. Note the location of the geotextile membrane which is installed in order to prevent future erosion of the sub-soils through the walls.

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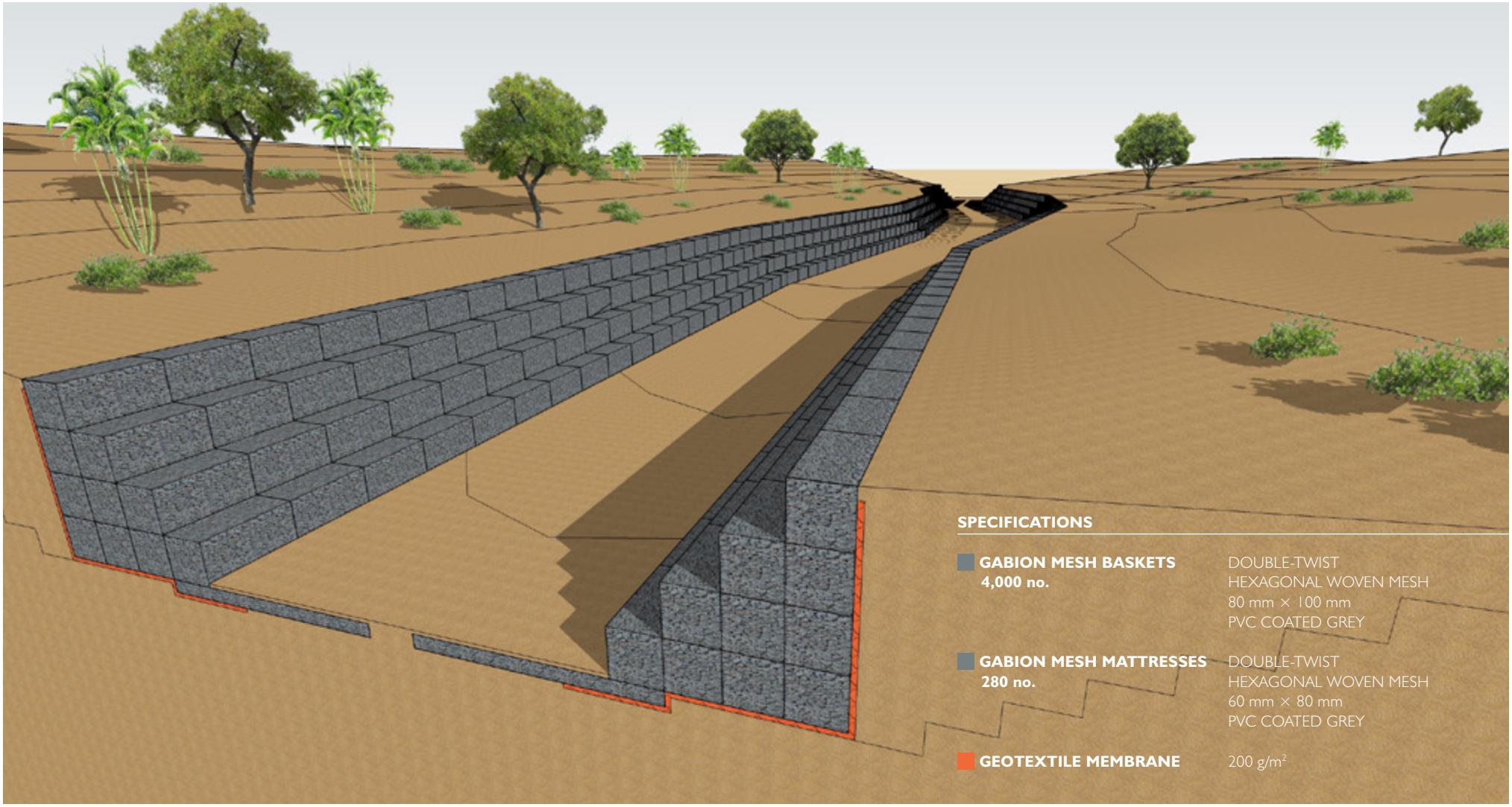

SPECIFICATIONS

GABION MESH BASKETS **4,000 no.**	DOUBLE-TWIST HEXAGONAL WOVEN MESH 80 mm × 100 mm PVC COATED GREY
GABION MESH MATTRESSES **280 no.**	DOUBLE-TWIST HEXAGONAL WOVEN MESH 60 mm × 80 mm PVC COATED GREY
GEOTEXTILE MEMBRANE	200 g/m²

Three-dimensional rendering showing the location of the finished gabion retaining wall structure. The four-metre high walls were constructed to prevent further erosion of the gully and comprised four courses of gabion mesh baskets, four metres wide at the base tapering to one metre wide at the top. Each wall, 270 metres long is founded on 5.0m × 2.0m × 0.3m gabion mesh mattresses at the foot and backed with a geotextile membrane.

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MATERIAL SPECIFICATIONS

- **Fabric type**, gabions and mattresses
  Hexagonal woven, double-twist wire mesh
  PVC/Zinc coated
- **BS EN 10218-2:2012** and **BS EN 10223-3:2013**
  Steel wire and wire products
- **Tensile strength (wire)**
  350 to 550 N/mm^2
- **BS EN 10244-2:2009 (Class A)**
  Zinc and zinc alloy coatings on steel wire. Additional extruded organic polymer powder coating (grey) of nominal 0.5mm nominal radial thickness. This organic polymer powder coating is in accordance with BS EN 10245-2:2011.
- **BBA certification**

Rockfill

Granite: 6G grade (100mm to 200mm). Sourced from a local quarry in Ishiagu some 80 km away from the site. 16,000 tonnes at 35 tonnes per truck, two loads daily.

Geotextile membrane

Needle-punched, non-woven geotextile, 200g/m^2.

Above, a finished section of gabion mesh wall with dry stacked, hand-faced finish for consistent appearance and aesthetics; 6G graded stone being delivered to site via 35T dumper; mass gravity walls during construction phase with evidence of geotextile membrane in the foreground.

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Above and left
Mid term progress photo showing the fourth and final course of the wall under construction, using (6G) granite stone, with double- twist hexagonal woven mesh gabion baskets. The finished quality of the facing stone having been hand-placed, is evident in the photo, left.

Far left
The management and construction team (from left) Akins Awoyele, Procurement and Logistics Director, Rhino; Scot Kilgrow, Construction Manager Rhino; Neil Holmes, Director, Enviromesh; Trevor Jewitt, Managing Director, Rhino.