Early Production System (EPS) Barge Movement and Installation at Olero Creek Production Platform, Benin River Area

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Key words: Barge Move, Positioning, Settlement Monitoring, Tide information, Hydrographic services.

SUMMARY

The request for the Early Production System (EPS) barge movement and installation at Olero creek production platform was initiated in order to continue the flow and production of oil at the platform. This initiative came as a result of the damage to the existing production facilities at the Benin river area.
The EPS is a concept designed to continue the flow and production of oil pending when the rebuild process of the damaged facilities will be completed. The terms of reference for the project were given as follows:

- EPS barge movement from the Company base yard to the site.
- Sand pad preparation of the site.
- Positioning and ballasting of the EPS barge.
- Installation of 16nos 12" double length piles (Restraining, Guide and Bumper piles).
- Monitoring of the barge sitting for a period to establish settlement trend.

The movement of barge was preceded by channel check. The entire route could not be checked or investigated due to logistic constraint, however some critical areas were investigated and movement was designed to avoid all observed obstacles and navigational hazards.
Datum was established for the survey and tagged project datum. The datum established was based on the 1m mark at GB-3 location, Olero creek.

The pre-survey carried out included the topographic and bathymetric appraisal of the entire flow station area. The information was used to reappraise the setting out before sand dropping and to design the sand padding to accommodate the overlap including loses. The sand pad area including the overlap was set out and long pegs were used to mark out the edges.
Positioning of the barge was tied to the tidal situation (spring tide), while the movement was synchronized with tidal motion to avert the possibility of being dragged back by tide.

This paper will highlight the experience, the tasks, and moreover the challenges faced during the EPS barge movement to site, the sand padding of the site and installation of the barge at the production platform, Benin river area.

1. INTRODUCTION

What informed the need for the EPS barge movement and Installation at Olero Creek production area?

- Continuous flow and production of oil at the platform.
- Operational and facilities management.
- Platform restoration project initiative due to the vandalized facilities by the militants at Olero Creek area during the 2003 crisis in the Niger Delta region of Nigeria.
- Increase demand for hydrographical services within the company.

What are the key value drivers?
The key value drivers for the project are:

- Safety – incident and injury free.
- Cost
- Do-ability
- Production impact.

2. PURPOSE AND TERMS OF REFERENCE

2.1 Purpose:

1. To have an early production system installed, commissioned, and functioning on site pending the restoration of the vandalized production facilities.
2. To provide topographic and bathymetric appraisal of the entire production facilities area.
3. To provide information on the tidal behaviour and datum used.

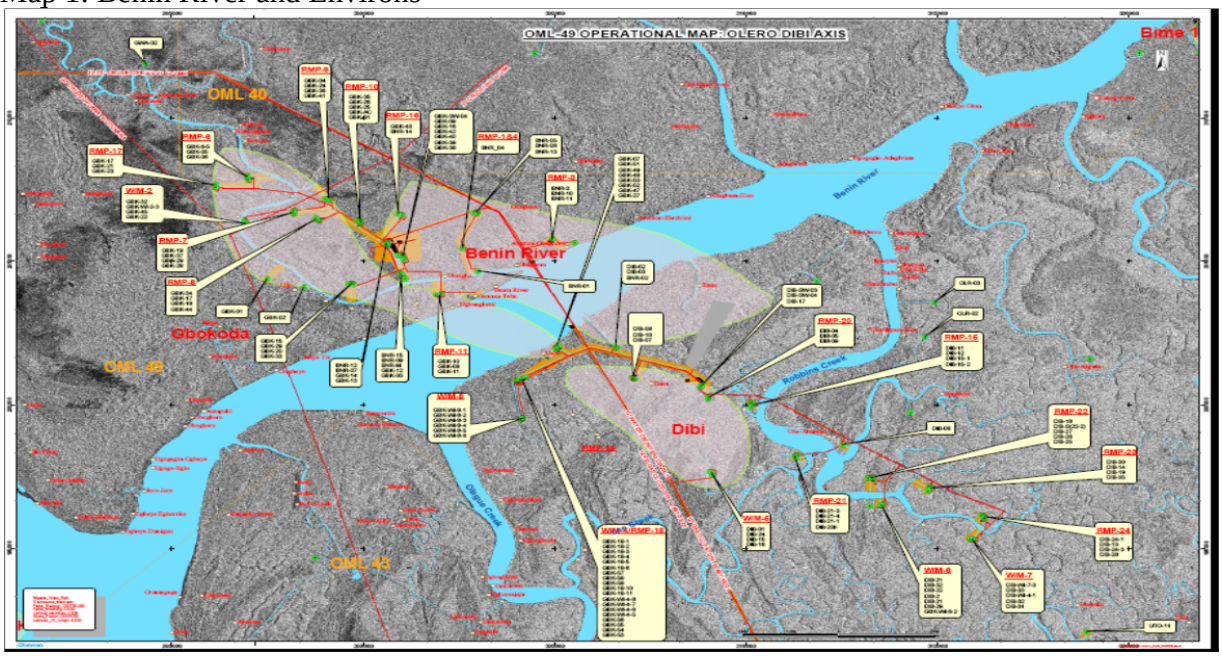
2.2 Terms of reference:

1. EPS barge movement to location
2. Sand pad preparation and development of the site
3. Positioning and Ballasting of the EPS barge on location
4. Installation of 16nos 12" double length piles (restraining, guide, and bumper piles)
5. Monitoring of the barge sitting for a period to establish settlement trend.

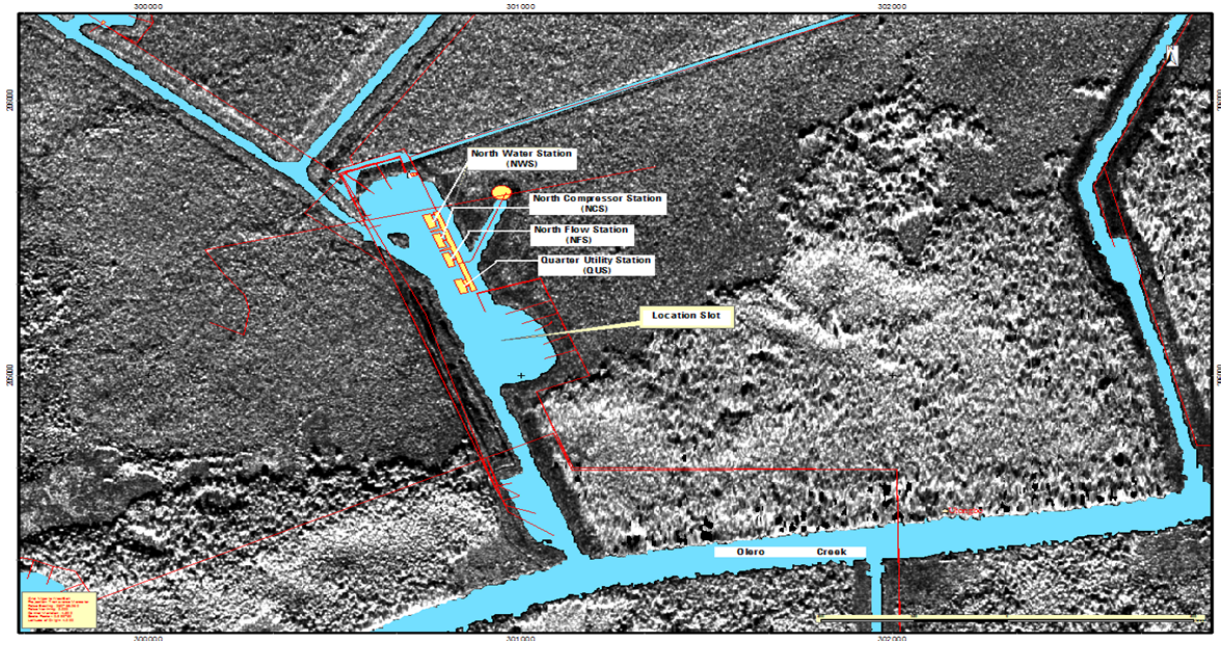
3. PROJECT STUDY AREA

The maps below show the project study area.

Map 1: Benin River and Environs



Map 2: Olero Creek Production Platform Map



4. PRE-SURVEY

A pre-survey of the entire project area was carried out which involved:

1. Channel Check.
   - Bathymetric and site specific hazard survey and appraisal of the entire route.
2. Site Preparation.
   - Topographic and bathymetric appraisal of the entire production facilities area.
   - Evaluation of sand pad height and quantity of sand required.
   - Sand dropping, padding and depth monitoring.
3. Tide Monitoring and Datum Used.
   Provide information on:
   - tidal behaviour, and
   - datum used.

4.1 Channel Check:

The movement was preceded by channel check. The entire route could not be checked due to logistics constraints. However the following critical areas were investigated.

i. Company Dock Yard in Warri to Warri River through Crawford Creek
ii. Batan Flat
iii. Warri River / Chanomi Creek junction
iv. Escravos / Nana Creek junction
v. Nana Creek / Benin River junction

vi. Benin River / Olero Creek junction
vii. Benin River Entrance through Olero Creek to the production platform area.

Note: A distance of about 160km was covered during the check.

4.2 Site Preparation:

Pre-survey of the site was carried out which required topographic and bathymetric appraisal of the entire production platform area. This information was used to reappraise the setting out of the EPS barge location before sand padding, evaluate the sand pad height and quantity of sand required. The area set-out was 60m by 30m (1,800 square metres).

4.3 Tide Monitoring and Datum Used:

Datum adopted for channel check was Lowest Astronomical Tide (LAT) as charted on the tide table, while the 1m mark reference datum at GB-3 location, Olero Creek was used for the project and tagged project datum. There was continuous tide monitoring to determine the nature and water behaviour.

5. FIELD OBSERVATION

5.1 Methodology

Personnel:

Project management team:	1 Senior Surveyor (Registered) in charge of the project, 1 QA/QC Surveyor, and 1 HES Specialist.
Survey crew:	8 personnel (comprising of 2 Surveyors and 6 Survey Assistants).
Pilling crew:	8 personnel (comprising of Pilling Supervisor, Foreman, Top man, Operator, Welder and Pilling hands).

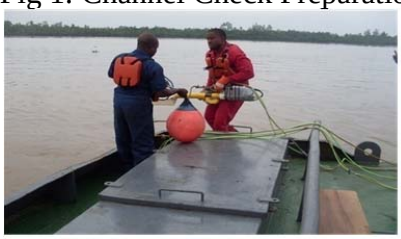
Operations:

i. Channel check to determine water depth, pipeline crossing, route wide and navigational hazards such as underwater debris, wrecks and obstacles.
ii. Topographic and bathymetric appraisal of the entire production platform area.
iii. Setting out of the EPS location for sand pad preparation and development.
iv. Setting up and installation of tide gauge in water for tide observation / monitoring at every 15 minutes for 24hours daily.
v. Check on the 1m mark reference datum used at GB-3 location for tide correction.
vi. Sand padding of the EPS location, determination of the sand pad thickness and depth monitoring.
vii. Movement of the EPS barge to location for positioning, ballasting, and hook-up.
viii. Installation of 16nos 12” double length piles (restraining, guide and bumper piles) at the location.
ix. Monitoring of the EPS barge sitting for a period to establish settlement trend.

x. Daily data input, processing , result analysis, and Integrity check (for quality assurance).

6. FIELD OBSERVATION

Fig 1: Channel Check Preparation, Section of Route with some Villages along the Route



Deployment of Underwater Sensors in preparation for Channel Check

A Section of the Route

Some Villages along the Route which were also investigated

Fig 2: EPS Site Layout and Preparation

EPS barge site layout marked Red

Survey crew on site during EPS site layout setting out and preparation.

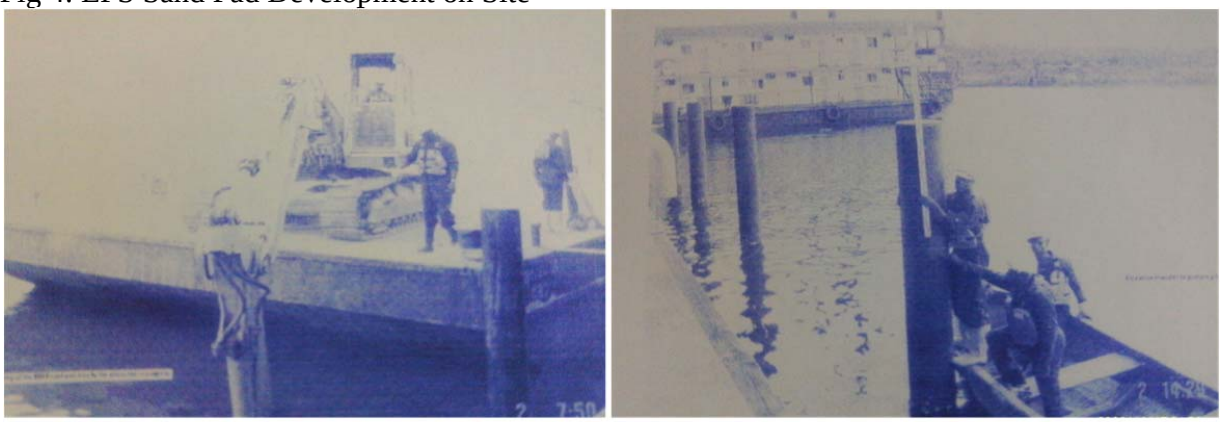
Fig 3: Reference Datum and Tide Gauge Installation

Olero GB-3 location with the 1m mark.

Check on the 1m mark at GB-3 location.

Tide Gauge Installation at the project area.

Fig 4: EPS Sand Pad Development on Site



EPS sand padding process and height determination on site

Note: *Sand padding on site was achieved by dropping and spreading of sand at the laid out area by the use of wheel excavator mounted on a barge.*

Fig 5: EPS Barge Movement to Location

EPS barge tow to location at Olero Creek powered by 4 tug boats, assisted by Community chase boats and GSF

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Fig 6: Installation of Piles at the EPS Barge Location

Installation of 16nos 12" double length Piles using vibro pile hamper and Welding work at the EPS barge location

7. RESULTS AND DISCUSSION

7.1 Evaluation Of Sand Pad And Quantity Required

The entire platform production area was already dredged to an average depth of 3.1m +/-0.15m LLWS before the EPS sand pad process and movement commenced.

Evaluation of Sand Pad Height (Thickness):

Dredged Depth	=	3.1m +/- 0.15m (Dredging report)
EPS Barge Draft	=	2.3m (Expected water depth)
Pad Height	=	3.1m – 2.3m = 0.8m
Initial Settlement	=	0.15m

Final Pad Height	=	0.8m + 0.15 = 0.95m
Sand Pad Height (Thickness)	=	**0.95m**

Quantity of Sand Required:

Sand Pad Height	=	0.95m
Area of Pad/Overlap	=	60m x 30m = 1800 square metres
Volume of Sand Required	=	1800 x 0.95 = 1710 cube metres
Volume including loses (30%)	=	1710 x 1.3 = 2223.00 cube metres
Quantity of Sand Required	=	**2223.00 cube metres**

Note: *The final volume assumed loses to the tune of 30%.The evaluated quantity happened to be the quantity of sand dropped.*

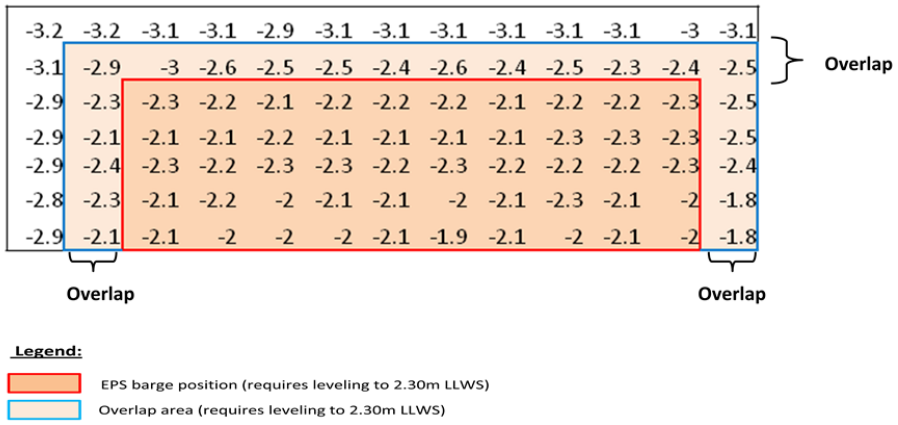
7.2 Datum Used, Sand Padding And Depth Monitoring

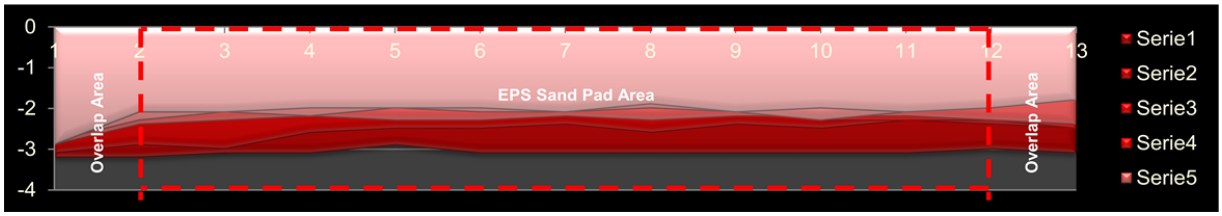
The datum adopted and used for the project is the 1m mark reference datum at GB-3 Location, Olero Creek, Benin River area. The tide gauge established on site for tide monitoring was based on the 1m mark low low water spring (LLWS).

Sand padding on site was achieved by dropping and spreading of sand at the laid out area by the use of wheel excavator mounted on a barge. The padding was designed to accommodate the overlap including loses, and was closely monitored by the survey crew to ensure compliance to specification. Final pad level below datum was 2.15m; hence the constructed pad height was 0.95m (that is, 3.1m – 2.15m = 0.95m).

Depth monitoring of the laid out area was carried out at 5m interval to cover the sand pad and overlap. This was achieved by continuous bathymetric appraisal as padding progressed.

Fig 7: The sketch and graph below show the final EPS sand pad and depth monitoring on location.





Note:
Dredging Depth = 3.1+/-0.15m LLWS (Given)
Sand Pad Height (Thickness) = 0.80m (Given)
Expected Water Depth = 2.3m

7.3 EPS barge positioning and ballasting on location

Positioning of EPS barge on location commenced after de-ballasting of the barge to 1.7m – 1.8m above water level. The positioning time and method were discussed by all parties involved. Positioning was achieved by gradually manoeuvering of the barge to location using three tug boats at the early hours of day because of tide. At about 6.00hours the EPS barge was in the sitting position on the pad, thereafter, measurement was taken to ascertain deviation from specification.

Having carried out all the necessary checks, ballasting of the barge commenced. At the completion of first phase of the ballasting procedure, measurement was taken round the barge to ascertain the deviation from specification. Ballasting and de-ballasting continued to establish required sitting arrangement for the barge. The inclination achieved was within specification 1/350 – 1/550.

Table 1: Shows the EPS barge sitting position on location.

Point	Eastings (m)			Northings (m)		
	Given	As-built	Difference	Given	As-built	Difference
A	300781.037	300781.040	0.003	205386.439	205386.690	0.251
B	300764.415	300764.408	0.007	205432.502	205432.553	0.051
C	300784.103	300784.179	0.076	205439.607	205439.583	0.024
D	300800.725	300800.477	0.248	205393.543	205393.640	0.097

Table 2: Shows the distance between EPS barge sitting position and the vandalized flowstation as installed on location.

Given	Installed	As-built	Difference	
			Given & Installed	Given & As-built
2.743m	2.800m	2.948m	0.057m	0.205m

7.4 EPS barge pile positions and installation on locatION

Piling of the 16nos 12" double length piles (restraining, guide and bumper) was achieved on site using vibrating (vibro) hammer mounted on a mobile crane, under the guidance of the Surveyors to ensure alignment and verticality until cut off point. The guide and restraining piles were installed at opposite end of the barge, while the bumper piles were installed along the barge. All cut off points were marked and established.

Table 3: The table below shows the result (deduced and as-built) of the EPS barge pile positions and installation on location.

	Eastings (m)			Northings (m)		
Pipe Point	**Deduced**	**As-built**	**Difference**	**Deduced**	**As-built**	**Difference**
R1	300777.774	300777.835	0.061	205437.696	205437.746	0.050
R2	300778.087	300778.044	0.043	205392.540	205392.537	0.003
G	300794.820	300794.841	0.021	205390.725	205390.768	0.043
B1	300779.344	300779.341	0.003	205382.640	205382.589	0.051
B2	300778.002	300777.867	0.135	205387.041	205387.038	0.003
B3	300776.440	300776.257	0.083	205391.441	205391.369	0.072
B4	300775.008	300774.844	0.166	205395.542	205395.491	0.051
B5	300773.237	300773.158	0.079	205399.942	205399.925	0.017
B6	300771.785	300771.715	0.070	205404.143	205404.070	0.073
B7	300770.133	300770.125	0.008	205408.543	205408.439	0.104
B8	300768.681	300768.581	0.100	205412.844	205412.833	0.011
B9	300767.129	300767.05	0.079	205417.045	205417.030	0.015
B10	300765.577	300765.476	0.101	205421.545	205421.444	0.101
B11	300764.025	300763.936	0.089	205425.746	205425.663	0.083
B12	300762.374	300762.341	0.033	205430.146	205430.133	0.013
B13	300760.922	300760.826	0.096	205434.447	205434.434	0.013
Mean Deviation			**0.073**			**0.044**

Note:
The difference between deduced barge position and as-built was due to gradual drift during piling. The drift was however curtailed by the installation of the second restraining pile. Final position is within tolerance.

7.5 EPS barge settlement monitoring on location

Fig 8: Shows sketch of EPS barge alongside the vandalized Flowstation.

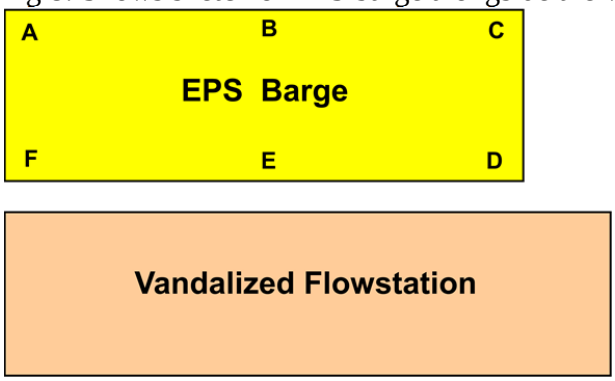


Table 4: Shows the EPS barge Settlement Monitoring on site for 2 weeks.

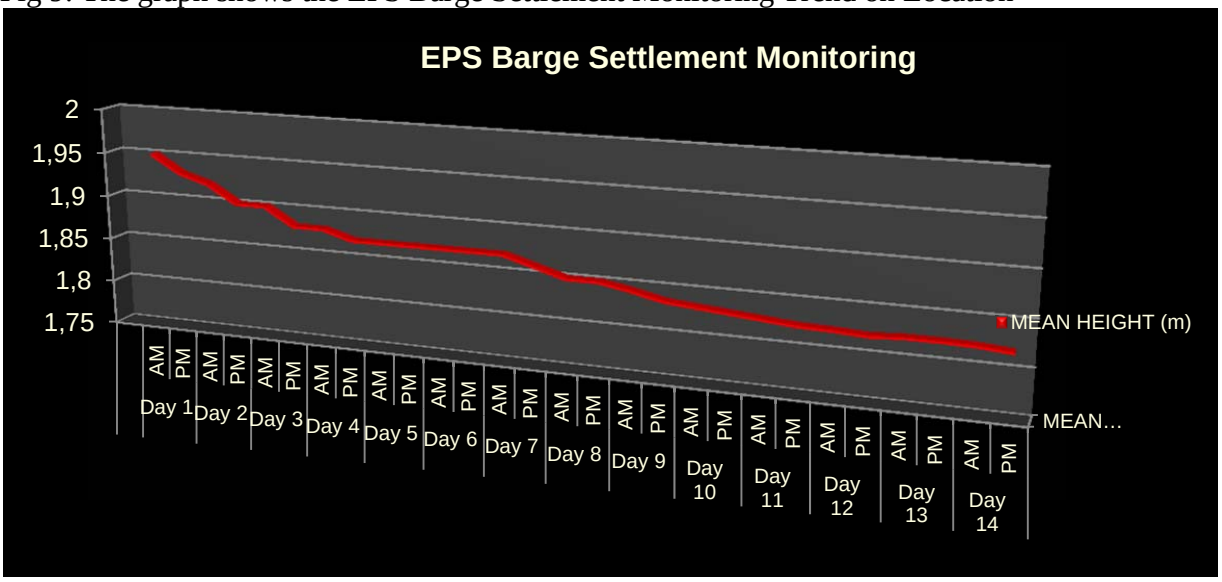
DATE	TIME	STATION						MEAN HEIGHT (m)
		A	B	C	D	E	F	
Day 1	AM	1.85	1.89	1.91	2.02	2.00	2.01	1.95
	PM	1.82	1.87	1.91	2.01	1.97	1.98	1.93
Day 2	AM	1.83	1.85	1.88	1.99	1.97	1.97	1.92
	PM	1.81	1.83	1.85	1.98	1.96	1.96	1.90
Day 3	AM	1.81	1.83	1.85	1.97	1.95	1.96	1.90
	PM	1.81	1.82	1.82	1.96	1.94	1.95	1.88
Day 4	AM	1.79	1.81	1.83	1.96	1.94	1,95	1.88
	PM	1.78	1.79	1.81	1.95	1.93	1.95	1.87
Day 5	AM	1.77	1.81	1.83	1.95	1.93	1.94	1.87
	PM	1.77	1.80	1.82	1.95	1.93	1.94	1.87
Day 6	AM	1.77	1.80	1.82	1.94	1.93	1.94	1.87
	PM	1.77	1.80	1.82	1.94	1.93	1.94	1.87
Day 7	AM	1.77	1.80	1.82	1.93	1.93	1.94	1.87
	PM	1.76	1.79	1.81	1.93	1.92	1.93	1.86
Day 8	AM	1.75	1.79	1.81	1.94	1.92	1.92	1.85
	PM	1.75	1.80	1.82	1.94	1.92	1.92	1.85
Day 9	AM	1.733	1.786	1.831	1.931	1.898	1.888	1.844
	PM	1.728	1.783	1.810	1.915	1.895	1.886	1.836
Day 10	AM	1.734	1.784	1.804	1.920	1.888	1.883	1.833

	PM	1.731	1.780	1.801	1.898	1.886	1.882	1.830
Day 11	AM	1.731	1.780	1.800	1.892	1.881	1.879	1.827
	PM	1.726	1.774	1.796	1.894	1.880	1.872	1.824
Day 12	AM	1.716	1.772	1.801	1.903	1.878	1.867	1.823
	PM	1.713	1.767	1.798	1.901	1.879	1.869	1.821
Day 13	AM	1.708	1.767	1.805	1.907	1.88	1.869	1.823
	PM	1.712	1.765	1.805	1.908	1.88	1.87	1.823
Day 14	AM	1.704	1.764	1.803	1.91	1.88	1.87	1.822
	PM	1.702	1.76	1.799	1.905	1.88	1.869	1.819

Note: *The height of the vandalized Flowstation is 1.685m (Given).*
Monitoring of the EPS barge settlement was carried out morning and evening for four weeks to ascertain height conformity with specification.

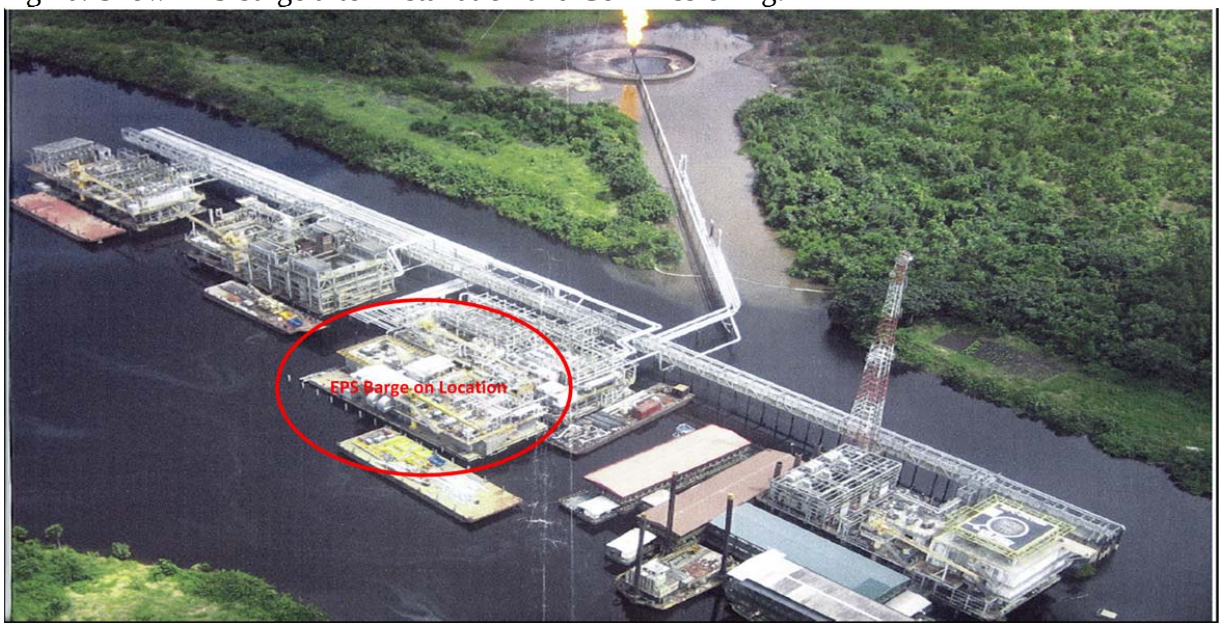
7.5 EPS barge settlement monitoring on loction

Fig 9: The graph shows the EPS Barge Settlement Monitoring Trend on Location



7.6 After installation and commissioning

Fig 10: Show EPS barge after Installation and Commissioning.



8. CHALLENGES AND PROBLEMS ENCOUNTERED

8.1 Challenges

i. Navigational hazards such as wrecks along the route, the most pronounced were the abandoned dredging spuds along Olero Creek close to the production platform area.
ii. Fishing nets and traps in some specific areas along the route.
iii. Under estimation of tidal influence along the channel checked (most challenging areas were Otunana to Chanomi Creek, and between Escravos/Nana Creek Junction and Otunana , where the tug boats were only struggling to keep the tow line against the receding tide.
iv. Conflict on the quantity of sand required – emanated due to poor understanding of the soil nature, tidal evaluation and datum error.
v. Delay in completion of the sand pad process due to down time as a result of equipment break down.
vi. Improper evaluation of sand loses due to overlap.

8.2 Problems

1. **Communication gap and dogmatism:**
    i. People concentrating on design rather than harmonize the design with ground situation.

ii. Undue interference by people who probably have little or no knowledge of the activity.

2. **Logistics constraint:**
   i. Movement to-and-fro the site was always synchronized to fit in with the Client convoy movement days due to security issues within the region, hence equipment break down or replacement as the case may be must have to wait for the convoy movement days.
   ii. Padding designed for two weeks took almost one month to complete.

3. **Information delay:**
   i. EPS barge information was not available until padding commenced.
   ii. Ballasting information was not available until the first phase of ballasting and de-ballasting was concluded on site.

9. CONCLUSION AND RECOMMENDATION

9.1 Conclusion

Study has demonstrated and shown:

- Do-ability and cost saving of the Early Production System (EPS) in operational and facilities management.
- Increase demand for hydrographic services within the company – opportunity for tidal studies and management of company facilities.
- Meet the purpose for the project objectives and the platform restoration initiative.
- Commitment to safety – incident and injury free, project completed without a lost time injury (LTI).

9.2 Recommendation.

- Good planning and effective communication reduce time loss on project of this magnitude – most of the shortcomings experienced during the project would have been averted and taken care of by involving all stakeholders in planning.
- Synchronize movement with tidal motion to avert the possibility of being dragged back by tide – favourable tide often assists movement.
- Always involve the right people in decisions that affect procedure and equipment.

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BIOGRAPHICAL NOTES

Surv. Sylvester Efe Owhojeta, born in 1967 in Lagos, Nigeria. He is a full member of the Nigerian Institution of Surveyors and an active member of the State Chapter where he resides. Graduated with a B.Sc. (Hons) degree in Surveying, Geodesy and Photogrammetry from University of Nigeria, Nsukka, Nigeria and obtained a Masters degree in Petroleum Economics from Ambrose Alli University, Ekpoma, Nigeria. He was registered to practice as a Surveyor in Nigeria in 2001 and since then, he has been in practice to date as a Registered Surveyor. He has been on contract engagement with the GIS-Survey Unit, Chevron Nigeria Limited since July 2005, working in Escravos and Warri, Nigeria. He co-presented a paper at the FIG Working Week 2008 and 2009 in Stockholm, Sweden and Eilat, Israel respectively with his Chief Surveyor - Surv. Ajayi E. O.

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