Review of Adequacy of ESIA for the TEP Uganda Tilenga Oil Development Project

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I. Summary

The Total Exploration and Production, B.V. Uganda ("TEP Uganda") Tilenga Project ESIA is inadequate and does not meet Best Available Technology ("BAT"). The TEP Uganda ESIA should be revised to incorporate the following project modifications:

Issue	BAT recommendations
Consolidate well pads in Murchison Falls National Park	Reduce the number of well pads in Murchison Falls National Park from ten well pads to one well pad. Locate this one pad at or near the current location of well pad JBR-06. Locate the second well pad south of the Victoria Nile border with MFNP to reach oil reservoirs that would otherwise be served by pads JBR-01, JBR-02, and JBR-10.
Well drilling in MFNP and border area	Use extended reach drilling as necessary to reach the well targets in the MFNP from a single well pad within MFNP and a second well pad to the south of the Victoria Nile on the southern border of the Park near proposed well pad GNA-02.
Drilling mud	Use only non-hazardous water-based mud ("WBM") for drilling wells. No synthetic-based mud ("SBM") should be used, as SMB has much higher toxicity than WBM and for that reason is not best practices.
Disposal of drilling cuttings	Reinject drilling cuttings and drilling fluids. Do not dispose of drilling cuttings in landfills, to avoid 1,000s of truck trips and potential leakage at landfill(s).
Produced water	Reinject produced water (as currently proposed by TEP Uganda).
Lake Albert makeup water	Do not use Lake Albert to sustain oil reservoir pressure. Reinject produced gas into the oil reservoirs to maintain reservoir pressure. Crude oil should substitute for gas as fuel for power generation at the Central Processing Facility.
Sewage effluent	Inject treated sewage effluent via the produced water wells.
Visual impacts	Locate only one well pad inside the Park. Locate the well pad in a low-lying site relative to immediate surroundings to minimize visibility to Park visitors and wildlife. The other well pad used to reach targets in the Park, located near the southern border of Park, should be positioned in a similar manner.
Construction ROW width – general,	International best practices for pipeline construction right-of-way ("RoW') is 15 m. Maximum pipeline construction RoW width should be 15 m.
critical areas	Maximum construction RoW in permanent wetlands should be 10 m.
Waterbody crossings	Utilize horizontal directional drilling to cross permanent rivers and streams in the project area.

The development of ten (10) well pads within Murchison Falls National Park ("Park") does not represent BAT. TEP Uganda proposes to build the Tilenga Project on the same general footprint as the original exploratory drilling pads and associated infrastructure. The exploratory well development program caused high negative impacts on wildlife in the Park, specifically elephant migration in and around the exploratory well pads.

Extended reach drilling ("ERD") is a drilling technique in use since the 1990s that enables reaching oil deposits up to 14 km from the drilling pad.[1] Two well pads should be utilized to reach the oil deposits inside the Park, with one well pad located inside the Park and the second well pad located just south of the Park boundary. ERD should be utilized to drill the longer wells from these two well pads.

Drilling cuttings and drilling fluids comprise the overwhelming majority of hazardous waste that will be generated by the Tilenga Project.[2] Direct injection of drilling waste at the well pad is best practices and avoids the potential for spills or mismanagement at a permanent waste storage site.

II. Introduction

The purpose of this review of the Total Exploration & Production ("TEP") Uganda B.V. Tilenga Project ESIA is to determine: 1) the extent to which the Tilenga Project as it is currently designed does not meet international best practices, and 2) whether the project is likely to have a serious and irreversible impact on the environmental and social health of the affected communities.

The ESIA for the Tilenga Project was issued in May 2018. A total of 412 wells are planned to be drilled, including 190 oil producers, 190 water injectors, and 32 observation wells, from 34 well pads.[3] These wells will access oil and gas reservoirs from 250 meters to 900 meters below the surface.[4] A single Central Processing Facility ("CPF") will be located about 5 kilometers south of the Victoria Nile, which forms the southern border of the Park. The production and injection network will transport produced fluids and associated gas from the well pads to the CPF. Production fluids and gas will be gathered, treated and stabilized in the CPF. The treated and stabilized oil will be sent from the CPF to the oil export system via the Tilenga Feeder pipeline.[5]

TEP Uganda proposes that the Tilenga Project's power generation needs will be met using produced gas associated with the oil production.[6] Excess power will supply the Tilenga Feeder Pipeline, and the East Africa Crude Oil Export Pipeline Kabaale Pumping Station 1 and Pumping Station 2.[7]

TEP Uganda identifies as a primary project design objective "*the reuse of temporary (exploration phase) facilities for life-of-field permanent facilities whenever it is possible*."[8] This

[1] offshoreenergytoday.com, *Rosneft drills "world's longest well" in the Sea of Okhotsk*, November 17, 2017. See: https://www.offshoreenergytoday.com/rosneft-drills-worlds-longest-well-in-the-sea-of-okhotsk/.
[2] ESIA, Non-Technical Summary, p. 50. "Drilling wastes constitute by far the largest potentially hazardous waste stream."
[3] ESIA Volume 1, p. 4-5.
[4] Ibid, p. 4-5.
[5] Ibid, p. 4-5.
[6] ESIA Volume 1, Section 4.3.4.
[7] Ibid, p. 4-7.
[8] ESIA, Volume 1, p. 4-111.

is not a good project design strategy when the oil reservoirs to be developed are located in or near highly sensitive environments such as the Park. The purpose of the exploratory drilling program is to assess the commercial viability of the oil deposits, typically by locating the drilling pad(s) as close to the deposit as possible. It is not to achieve a balance between oil production cost, over what could be a 40- to 50-year operational lifetime, and minimum impact on the people and environment of the affected area.

Total claims that a top priority is minimizing the impact of drilling operations in the Park. Total states that *"[the development area] falls partly inside the Murchison Falls National Park (MFNP). Total accepted the challenge of demonstrating that oil development activities can harmoniously exist with the environment of the Park*,"[9] and that "*In Murchison Falls National Park (Uganda), minimizing the impact of drilling operations on the park's particularly diverse wildlife is top priority*."[10] This claim is not supported TEP Uganda actions.

The close proximity of the ten proposed well pads in the Park will not allow oil development activities in the Park to harmoniously co-exist with wildlife. The JBR-01 to JBR-10 well pads may form an impenetrable barrier to elephants seeking to avoid the noise and activity at these proposed well pad sites, which on average are about 2 km apart or less, based on a 2011 study by Wildlife Conservation Society and Uganda Wildlife Authority.[11]

The 2011 study by Wildlife Conservation Society and Uganda Wildlife Authority asserts that the exploratory well pads, with only 2 to 3 km of separation, were too close together to avoid major negative impacts on wildlife in the Park:[12]

> It appears though that activities at the pad (even simple pad maintenance where little activity occurred) could lead to an avoidance reaction by the animals. Where pad maintenance was taking place this was generally within 250-500 meters of the pad but where significant activities were happening such as pad construction and drilling on the pad where large machinery is being used and the noise is considerably greater, many of the animals avoided the nearest 500-1000 m of the pad. Several of the wells in the park are 2-3 km apart at the moment and there is a good likelihood that many more wells will be drilled here in future. If this is to take place we would suggest that pads be placed at least 5 km apart from each other, and that a process of rotation of activities takes place to ensure that a minimum of a 5 km buffer is maintained to allow mammals to move between active pads while drilling or pad construction are taking place.

The Netherlands Commission on Environmental Assessment ("NECA") observed following its review of the Tilenga Project ESIA that no analysis of the impact of proposed TEP Uganda operations in the Park on wildlife is included in the ESIA, stating:[13]

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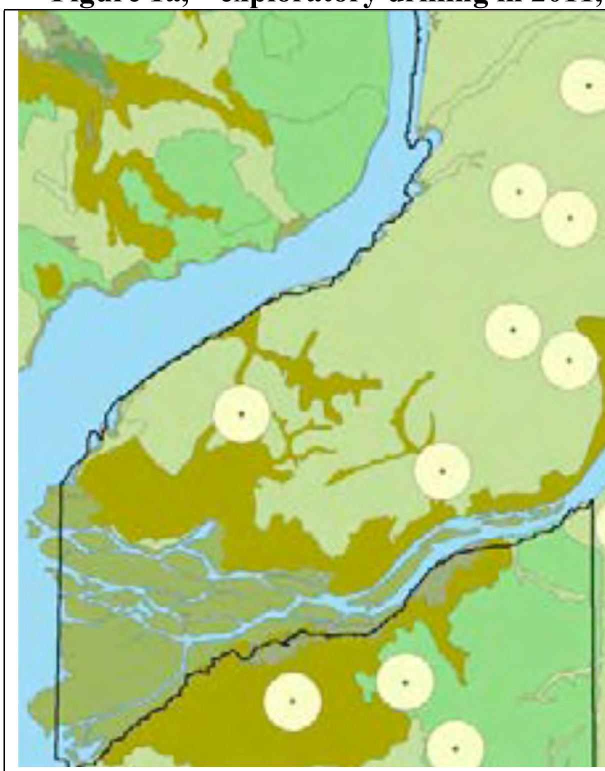
[9] Total, *Our Activities in Uganda*, technical brochure, July 2017, p. 4.
[10] Total, *CSTJF Excellence in Technology – Exploration & Production*, technical brochure, 2013, p. 30.
[11] Wildlife Conservation Society and Uganda Wildlife Authority, *Measuring Responses of Wildlife to Oil Operations in Murchison Falls National Park*, September 2011, p. 22.
[12] Ibid.
[13] NCEA, *Review of the Environmental and Social Impact Assessment (ESIA) Report for the Tilenga Project*, July 26, 2018, p. 9.

Information is missing about animal migration corridors and places where animals frequently visit. It is neither clear if the well-pad sites that are rich in animal wildlife, ever have been considered to be relocated. In addition, the ESIA does not provide insight in how the animals will react to the changes in the landscape and what the potential impacts of this will be on other areas in the park.

The close proximity of well pads in the exploratory drilling program in the Park will be replicated by TEP Uganda in the operational phase. As a result, the same impacts on wildlife documented in the 2011 study by Wildlife Conservation Society and Uganda Wildlife Authority are likely to recur in the operational phase. The locations of the exploratory well pads and the proposed permanent well pads are shown in Figures 1a and 1b.

Figure 1a,[14] exploratory drilling in 2011, & Figure 1b,[15] proposed permanent well pads



Note: Circles in Figure 2a are 2 km in diameter.

The Ugandan Cabinet approved the framework for implementation of Strategic Environmental Assessment (SEA) for the Albertine Graben in 2015.[16] The SEA states that:[17]

[14] Wildlife Conservation Society and Uganda Wildlife Authority, Measuring Responses of Wildlife to Oil Operations in Murchison Falls National Park, September 2011, Figure 8, p. 22. "Figure 8 is a map of the western half of Murchison Falls National park showing the location of each well site with a 1 km buffer around it. This is effectively the amount of habitat that was lost to elephants during the time of pad preparation and drilling."

[15] ESIA Volume 1, p. 4-8.

[16] ESIA Volume 1, p. 2-29.

[17] Ibid.

> If the Government decides to open up for petroleum activities in highly sensitive hotspot areas, both parties have a clear responsibility of doing whatever possible to minimise the impacts on the environment" to "take the opportunity to benefit biodiversity in and around project sites," and "ensure maintenance of the status-quo of the ecosystem and the biodiversity or even improving it.

The close spacing of the proposed production well pads in the Park will: 1) have a negative impact on elephant migration within the Park, 2) not maintain the status-quo of the ecosystem, and 3) not be in conformance with the SEA.

The ESIA describes highly sensitive environmental and social conditions in the area where the Tilenga Project will be developed:

> The Project Area is naturally split between the north and south banks of the Victoria Nile River. This area includes the Murchison Falls-Albert Delta Wetland System Ramsar site along the Victoria River Nile. This is also an Important Bird Area (IBA) and is known to support rare, vulnerable and endangered species. [A significant portion of the Tilenga Project] is within the Murchison Falls National Park (MFNP) which is the largest and the second-most visited national park in Uganda and it is ecologically important for a number of globally and regionally threatened species.[18]
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> Land is a common source of tension. The difficulties in implementing land administration system makes customary land owners vulnerable to speculation, which is a source of tension. Furthermore, there is a lack of structures and institutions with the capacity to resolve competing claims between communal ownership rights and individual rights. Competition over productive resources between pastoralists and crop farmers is also a common source of dispute. There are historic tensions between the Acholi of Nwoya District and Jonam (Alur) of Nebbi District relating to competing claims over land ownership east of the Albert Nile.[19]

The proposed location of the Tilenga oil production infrastructure will convert a significant portion of the Park and border areas into an industrial oil production center. Contamination of the Victoria Nile feeding Lake Albert and/or the Park could potentially occur.[20] The most effective alternative available to minimize the environmental and social impacts on the Park and border areas is to minimize above-ground oil production infrastructure and roads in these areas.

The May 2018 ESIA Volume 1 states that "*the ESIA was prepared in line with relevant standards and guidelines of the international oil and gas industry obtained from publications*

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[18] Ibid, p. 42, p. 55, p. 69, p. 72, p. 92, p. 94, p. 97.
[19] ESIA, Non-Technical Summary, p. 77.
[20] Toyota Tsusho Corporation, *Hoima-Lokichar-Lamu Crude Oi l Pipeline - FINAL REPORT*, 2015, p. 213. "Oil pipelines have a risk of spills as a primary concern. Historically, pipelines lead to some number of oil spills over the course of their operating life regardless of design, construction and safety measures." It is my experience that this same statement holds true for oil production facilities as well as pipelines.

produced by the following organisations: International Finance Corporation (IFC) (particularly the Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development (Ref. 2-132)."[21] It further states that "*The facilities design has been developed in line with Ugandan regulatory requirements and has incorporated Best Available Techniques (BAT) (as per European Union (EU) BAT Reference Document (BREF)), IFC EHS guidelines and GIIP requirements*,"[22] and "*a systematic assessment of Best Available Technique has been undertaken during FEED for the permanent facilities. The purpose of the review was to assess the proposed design against BAT criteria as defined with the associated BREF documents and demonstrate that the technology minimizes as much as possible its future potential impact on the environment and implements the most technically feasible and cost-efficient technologies on the available market and has considered maintenance and operability issues as a key component*."[23]

The IFC's *Onshore Oil and Gas* guidelines are used in this review as the principal point of reference to determine if the Tilenga Project is consistent with international best practices for oil and gas projects. The term "international best practices" in this review means that multiple oil and gas projects have used, or have proposed to use, a specific practice that most effectively avoids or mitigates the environmental or safety challenge being presented.

In addition to the Tilenga ESIA and the IFC's *Onshore Oil and Gas Guidelines*, I relied on the following documents in the course of my review:

- E-Tech International, *Best Practices: Design of Oil and Gas Projects in Tropical Forests*, 2012 and 2015 editions.
- Penn State Extension (U.S.), *Negotiating Pipeline Rights-of-Way in Pennsylvania*, 2015.[24]
- Toyota Tsusho Corporation, *Hoima-Lokichar-Lamu Crude Oi l Pipeline - Final Report*, 2015.
- www.plosone.org, *Potential of Best Practice to Reduce Impacts from Oil and Gas Projects in the Amazon*, PLOS One, Volume 8, Issue 5, May 2013.
- Society of Petroleum Engineers, *Critical Aspects Experienced in Drilling a World Record Extended Reach Well in South China Sea*, SPE 50876, 1998.
- Society of Petroleum Engineers, *Design of Water-Based Drilling Fluids for an Extended Reach Well with a Horizontal Displacement of 8,000 m in the Liuhua Oilfield*, SPE130959, 2010.
- Society of Petroleum Engineers, *Extended Reach Drilling at the Uttermost Part of the Earth*, Total Austral S.A. SPE 48944, September 1998. National Petroleum Council (U.S.), North American Resource Development Study, *Sustainable Drilling of Onshore Oil and Gas Wells*, Paper #2-23, prepared by the Technology Subgroup of the Operations & Environment Task Group, September 15, 2011.

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21 ESIA, Volume 1, p. 2-37.
22 Ibid, p. 4-105.
23 Ibid, p. 4-107
24 See: https://extension.psu.edu/negotiating-pipeline-rights-of-way-in-pennsylvania.

- Society of Petroleum Engineers, *Simultaneous Operations in a Multi-Well Pad: A Cost-Effective Way of Drilling Multi-Well Pad and Delivering Eight Fracs a Day*, SPE-170744-MS, October 2014.
- Society of Petroleum Engineers, *Methods to Establish Canopy Bridges to Increase Natural Connectivity in Linear Infrastructure Development*, prepared by Smithsonian Conservation Biology Institute, 12LAHS-P-157-SPE, 2013.
- MINEM (Peru Ministry of Energy and Mines), *Directorate Resolution – EIA for the Development Phase of Blocks 67A and 67B*, No. 202-2012-MEM/AAE, August 3, 2012.
- Exponent, Inc., *Integrity Analysis of the Camisea Transportation System, Peru, S.A.,* prepared for Inter-American Development Bank, June 2007.

A challenging aspect of this project, from a monitoring and enforcement standpoint, is that the Government of Uganda is a junior partner in the Tilenga consortium.[25] The government is not a neutral party to the application and enforcement of the requirements described in the ESIA. It is Ugandan civil society and the environment that will be impacted by the disruptions and environmental impacts during construction, as well by impacts, such as oil spills, that may occur during the operation of the Tilenga Project and the associated feeder pipeline.

This is a situation where independent auditors monitoring compliance with the conditions of the ESIA must be working on behalf of civil society interests. This is necessary to assure that the monitoring and enforcement function is perceived as transparent and legitimate by the Ugandan public and the international community.

III. Tilenga Project design does not meet international best practices or BAT

A. Well drilling technique to be used and drilling pad location(s)

The IFC *Onshore Oil and Gas Guidelines* include the following requirements related to minimizing the impact of well pads:

Page	Paragraph	2017 (draft) IFC Onshore Oil and Gas Guideline Requirements[26]
20	88	Site all facilities in locations that avoid critical terrestrial and aquatic habitat and plan construction activities to avoid sensitive times of the year.
21	88	Minimize well pad size for drilling activities and satellite/cluster, directional, extended reach drilling techniques should be considered, and their use maximized in sensitive locations.
21	88	Avoid construction of facilities in a floodplain, whenever practical, and within a distance of 100 m of the normal high-water mark of a water body or a water well.

[25] ESIA, Non-Technical Summary, p. 10.
[26] The draft 2017 guideline elements include the elements in the 2007 *Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development* final document, as well as additional elements.

Drilling oil wells in national parks is generally prohibited around the world. The Park is "critical terrestrial and aquatic habitat" where, according to the IFC Onshore Oil and Gas Guideline Requirements, the siting of oil and gas facilities is to be avoided. However, Total asserts that ". . . *for the Project to remain (economically) viable however, it is necessary to develop fields located both North and South of the Victoria Nile*."[27] North of the Victoria Nile is the Park. TEP Uganda plans to drill 132 wells in the Park.[28]

This is a fundamental problem with the Tilenga Project. According to TEP Uganda, oil reservoirs in the Park must be developed for the overall project to be economically viable. Yet the Tilenga Project, as proposed, will substantially degrade the Park. According to NECA, the economic benefit to Uganda of tourism in the Park may be greater than the projected income from oil produced in the Park.[29] This conflict between the economic value of tourism in the Park and oil development in the Park is not addressed in the ESIA.

TEP Uganda estimates approximately 600 heavy truck trips per month in the Park during the construction phase.[30] TEP Uganda also projects 61,600 vehicle movements per month in the Park, over 2,000 vehicle movements per day, traveling between well pads during the operations phase.[31] The high number of oil-related vehicle movements in a relatively small area in the heart of the Park will inevitably have a negative impact on the tourism value of the Park.

TEP Uganda states that "*The overall objective of the Project is to establish production of the oil fields . . . in an economically robust manner using sound reservoir management principles and best industry practice*."[32] Best industry practice to reduce surface environmental impacts of well pads and other infrastructure in the Park, including roads, is ERD.[33]

The industrialization of the Park is not inevitable if best industry practice, otherwise known as Best Available Technique ("BAT"), is utilized. TEP Uganda has committed to a minimum footprint in the Park, stating: "*Taking into consideration the sensitivity of the Victoria Nile and the Ramsar status of the Murchison Falls-Albert Delta Wetland System, the Project Proponents committed to minimising the impact by ensuring that permanent above ground footprint is minimised*."[34] The impact of drilling and production operations on wildlife in the Park can be minimized by consolidating all drilling and production activity in the Park at a single centrally located site.

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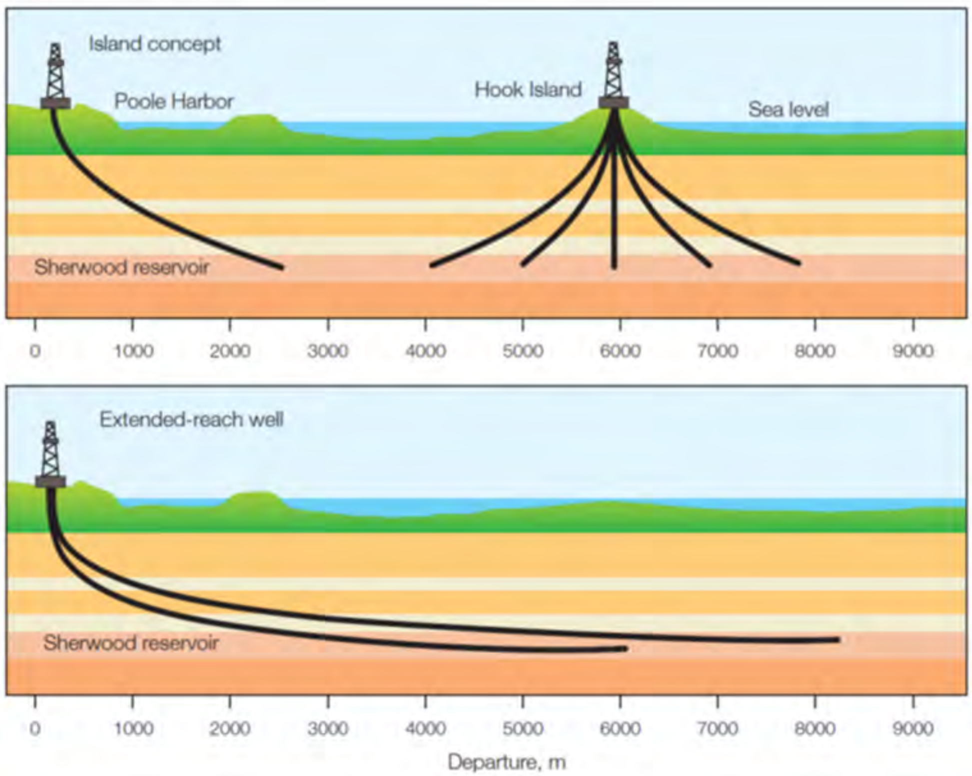
[27] ESIA Volume 1, p. 4-111.
[28] Ibid, Table 4-7 (JBR-01 through JBR-10), p. 4-19.
[29] NCEA, *Review of the Environmental and Social Impact Assessment (ESIA) Report for the Tilenga Project*, July 26, 2018, p. 11. ". . . the economic value of tourism in the MFNP may outweigh the value of the oil production in the Park."
[30] ESIA, Volume 1, Table 4-30: Indicative Construction Traffic Movements, p. 4-86.
[31] Ibid, p. 4-31.
[32] Total Exploration & Production Uganda B.V, *Tilenga Project Environmental and Social Impact Assessment - Non-Technical Summary*, May 2018, p. 6.
[33] Ibid, p. 2-10. "Offshore geotechnical data are limited to shallow subsurface information. Risks associated with earthquake impact on well bores and the potential escape of produced water along fault zones will be investigated in more detail by the contractor."
[34] ESIA, Volume 1, p. 4-117.

To make this possible, some wells would be drilled using ERD to reach targets up to 5 km from the well pad. See Figure 3b. ERD is a drilling technique in use since the 1990s that enables reaching oil reservoirs, depending on the reservoir depth, that are up to 14 km from the drilling pad.[35]

ERD is a refinement of the directional drilling technique that has been in use in the oil drilling industry for many decades. The National Petroleum Council (U.S.) identifies ERD as a "key technology" to enable sustainable drilling.[36] A graphic comparison of conventional directional drilling, the approach proposed by TEP Uganda for the Tilenga Project, and ERD is provided in Figure 2.

Figure 2. Comparison of conventional directional drilling (top) and ERD (bottom)[37]



The primary challenge with drilling long horizontal wells in the Park is the shallow depth of the oil reservoirs, about 400 meters on average in the Park.[38] TEP Uganda proposes to locate ten drilling pads, JBR-01 through JBR-10, in the Park. See Figure 3. Each well will take up to 11 days to drill and drilling will occur around-the-clock.[39]

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[35] www.offshoreenergytoday.com, *Rosneft drills "world's longest well" in the Sea of Okhotsk*, November 17, 2017. See: https://www.offshoreenergytoday.com/rosneft-drills-worlds-longest-well-in-the-sea-of-okhotsk/.

[36] National Petroleum Council, *Sustainable Drilling of Onshore Oil and Gas Wells*, Paper #2-23, prepared by the Technology Subgroup of the Operations & Environment Task Group, September 15, 2011, p. 7.

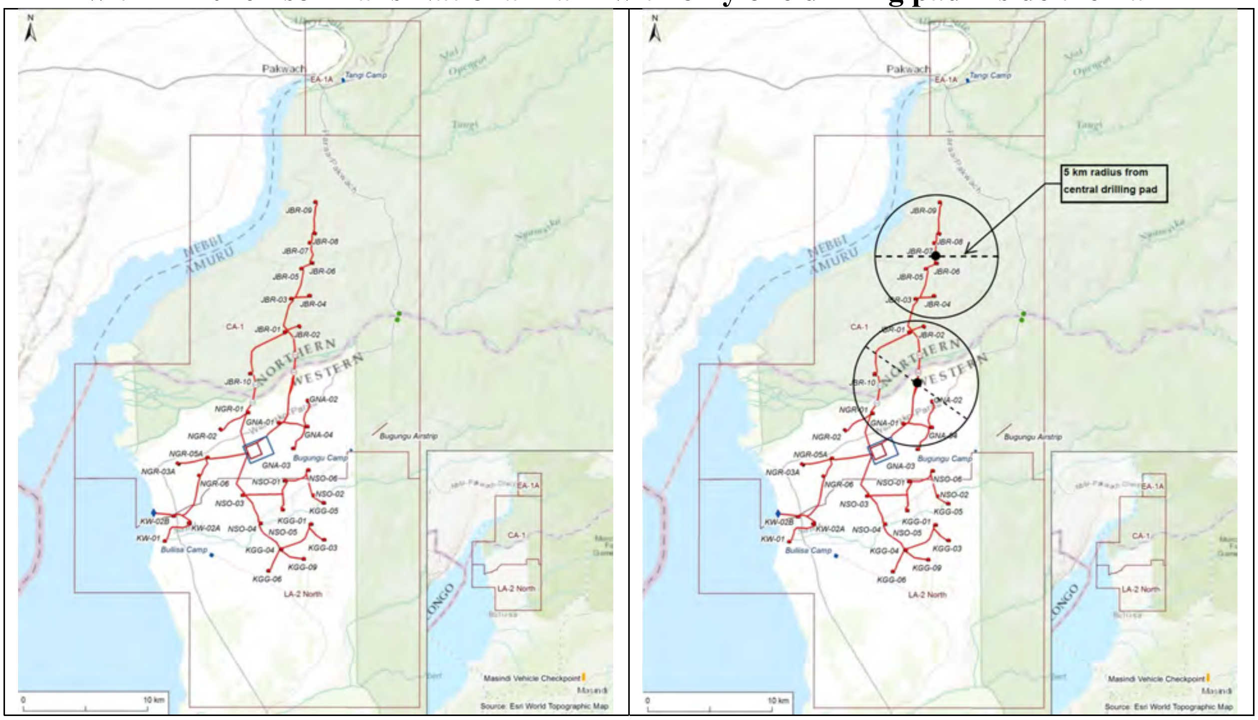
[37] Schlumberger - Oilfield Review, *Extended-Reach Drilling: Breaking the 10 km Barrier*, winter 1997.

[38] Tilenga ESIA Volume 1, *Figure 4-3: Oil Characteristics across the Project Area (Jobi-Rii production area - JBR)*, p. 4-8. Total vertical depth of JBR wells range from 250 to 530 meters.

[39] Ibid, p. 25.

All target oil reservoirs in the Park can be reached by locating one ERD well pad in the Park near currently proposed well pad JBR-06, and a second well pad outside the Park boundary, about 2 km northwest of proposed well pad GNA-02 on the south side of the Victoria Nile. The TEP Uganda drilling plan described in the ESIA is the minimum cost, maximum surface impact approach, not the "*best industry practice*" approach that TEP Uganda states it will follow. The approximate locations of the two alternative well pad sites proposed by Powers Engineering, consolidating 13 proposed well pads into two ERD well pads, are shown in Figure 3.

Figure 3. Alternative ERD well pad locations (two black dots) to access all drilling targets within Murchison Falls National Park with only one drilling pad inside the Park[40]

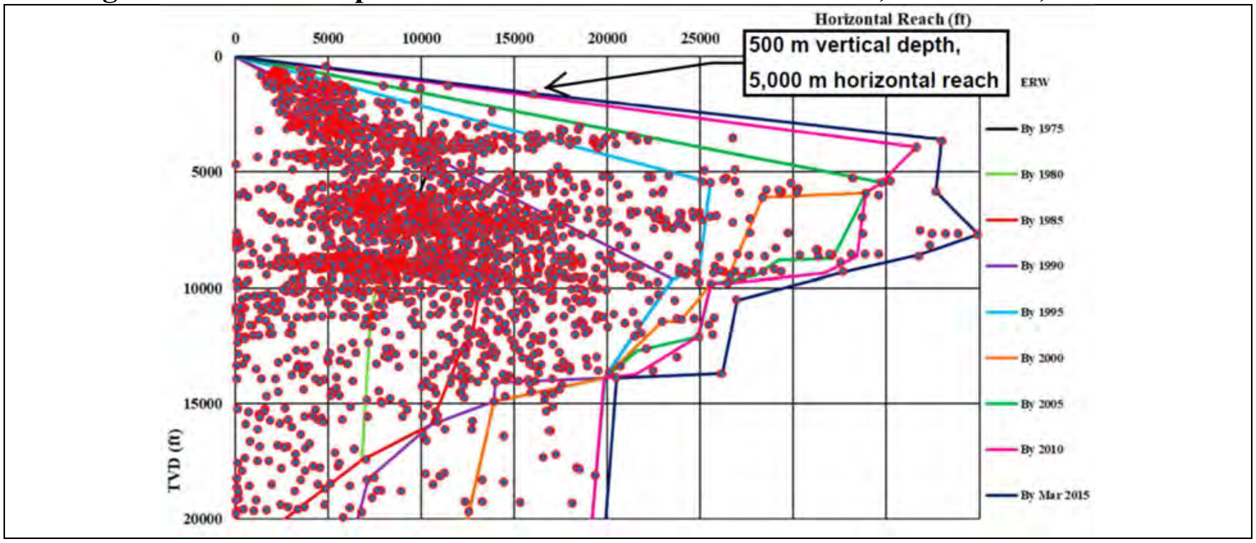


Note: black dots and circles added by B. Powers represent potential ERD drill pad locations to access oil deposits within Murchison Falls National Park. Due to the shallow depths of the oil deposits, on average 500 m. or less, the maximum horizontal reach of ERD wells would be about 5,000 meters (5 km) based on the current state of ERD drilling technology.

A graphical presentation of the horizontal length and the depth of existing ERD wells around the world is shown in Figure 4. Wells with target vertical depths of approximately 500 meters (1,600 feet) have been drilled 5,000 meters horizontally (16,000 feet) using ERD. The mean vertical depth of Tilenga Project wells in the Park will be approximately 400 meters.[41] As a result, Powers Engineering assumes in this analysis that wells drilled using ERD can reach shallow reservoirs 5 km distant based on prior ERD drilling campaigns, as documented by the ERD wells in Figure 4, that have "demonstrated in practice" this capability.

[40] Total Exploration & Production Uganda B.V, *Tilenga Project Environmental and Social Impact Assessment - Non-Technical Summary*, *Figure 3: Indicative Layout of Tilenga Project*, May 2018, p. 7.
[41] ESIA, Volume 2, Figure 4-3, p. 4-8.

Figure 4. Vertical depth and horizontal reach of ERD wells, worldwide, as of 2015[42]



Powers Engineering does not concur with TEP Uganda that "*the number of well pads has been optimised and reduced to as low as practicable including by use of directional drilling to concentrate more wells onto a well pad*."[43] TEP Uganda proposes that the Tilenga wells extend up to about 2,000 meters horizontally from the well pad.[44] This horizontal distance is well short of the "demonstrated in practice" horizontal displacement for shallow ERD wells shown in Figure 4.

The number of well pads needs to be further optimized. TEP Uganda proposes to drill 98 wells from seven well pads, JBR-03 to JBR-09, that would be difficult to reach with ERD wells from outside the Park. The reservoirs these wells are intended to access should be developed from a single well pad inside the Park, as shown in Figure 4. TEP Uganda should further optimize/ reduce the number of wells to be drilled to minimize the potential for wellbore collisions. The layout of the single pad in the Park should be based on the layout of concentrated well clusters on offshore oil platforms, that have as many as 80 wells.[45]

Developing only one well pad within the Park is consistent with TEP Uganda's objective of ". . . *further refinement of the well pads including minimisation of the footprint, which has been a key driver with the benefit of both minimizing environment and social impacts (including effects on land use and visual amenity)*."[46]

Total drilled and completed an 8 km ERD well in 1997 in South America,[47] and has drilled many ERD wells since that time. There have also been many advances in ERD technology over the last

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[42] X. Chen et al, Energies 2018, *The Maximum-Allowable Well Depth While Drilling of Extended Reach Wells Targeting to Offshore Depleted Reservoirs*, April 26, 2018, p. 2 of 17.
[43] ESIA Volume 1, p. 4-111.
[44] ESIA Volume 1, p. 4-63. "The maximum (total) well length will be 2,300 m."
[45] The Week, *Oil rigs: Cities at sea*, May 14, 2010: https://theweek.com/articles/494480/oil-rigs-cities-sea.
[46] Ibid, p. 4-111.
[47] Society of Petroleum Engineers, *Extended Reach Drilling at the Uttermost Part of the Earth*, Total Austral S.A. SPE 48944, September 1998.

20 years.[48] Total has the skill and technology to limit the number of well pads located within the Park to one by using ERD to reach outlying oil deposits.[49]

B. Management of drill cuttings

Page	Paragraph	2017 (draft) IFC Onshore Oil and Gas Guideline Requirements[50]
20	88	Feasible alternatives for the treatment and disposal of drilling fluids and drilled cuttings are: 1) injection into dedicated well, 2) injection into annular space of well, 3) temporary storage in tanks or lined pits, 4) recycling of fluids, 5) productive use of non-hazardous cuttings, and 6) landfarming (with limitations).

The *IFC Onshore Oil and Gas Guidelines* identifies the injection of drilled cuttings, either through a dedicated well or into the annual space of a well casing, as best practices. Direct injection of drilling waste at the point of generation is the most secure approach to prevent drilling waste from contaminating the surface environment.

TEP Uganda acknowledges that "*The best options for drilling waste management were considered in discussion with NEMA. Three alternatives came up: Reinjection in the formation, landfilling, and recycling*."[51] However, there is no information in the ESIA on why the best practice of reinjection was not selected. The ESIA states only that "*In consideration of the geological uncertainties associated with injecting large volumes of cuttings and fluids into the relatively shallow sedimentary rock system above the basement granite, the conventional treatment solution has been selected*."[52] Reinjecting drilling cuttings in geologically active areas like the Albertine Graben is common industry practice. "*Geological uncertainties*," without detailed supporting analysis, is not a sufficient reason to reject the reinjection of cuttings wastes.

TEP Uganda simply states "*Cuttings and fluids will be transported to a suitable and licensed facility*,"[53] and that the location of facilities was not defined at the time the Tilenga Project ESIA was prepared.[54] There are no hazardous waste landfills within 100 km of the Tilenga Project.[55] There are also no hazardous waste landfills in Uganda that meet Good International Industry

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48 For example, long ERD wells can now be drilled exclusively with water-based drilling mud ("WBM"). See: Society of Petroleum Engineers, *Design of Water-Based Drilling Fluids for an Extended Reach Well with a Horizontal Displacement of 8,000 m in the Liuhua Oilfield*, SPE130959, 2010.
49 Society of Petroleum Engineers, *Extended Reach Drilling at the Uttermost Part of the Earth*, Total Austral S.A. SPE 48944, September 1998, p. 9. "The progress achieved so far, both in performance and cost reduction, tend to support the objective of a 12 km departure (ERD horizontal displacement) within two years."
50 The draft 2017 guideline elements include the elements in the 2007 *Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development* final document, as well as additional elements.
51 ESIA, Volume 1, p. 5-19.
52 ESIA, Volume 2, p. 12-28.
53 ESIA, Non-Technical Summary, p. 31.
54 Ibid, p. 31.
55 ESIA, Volume 2, p. 12-14.

Practice ("GIIP"), as noted in the ESIA.[56] There is no history in Uganda of successful operation of hazardous waste landfills at a standard necessary to process drilling wastes from the Tilenga Project.

The National Petroleum Council (U.S.) identifies injection of spent drilling wastes into a subsurface formation as the most effective drilling waste disposal technique.[57] TEP Uganda currently proposes transporting the drilling waste from the well pads via truck to a hazardous waste landfill.[58] TEP Uganda estimates that a total of 230,000 tonnes of cuttings and fluids will be generated.[59] Truck traffic during the drilling phase of the Tilenga Project would be dramatically reduced, by approximately 80 percent,[60] if cuttings and fluids are reinjected where they are generated and not transported to an offsite hazardous waste landfill.

Transport to landfills is not best practices for drill cuttings and associated fluids. It creates three pathways to environmental contamination not present with the injection of drilling wastes at the well pad: 1) spillages on the well pads, 2) spillages during truck transport or truck transport accidents, and 3) spillages and leaks into groundwater at the hazardous waste landfill.

Direct injection of drilling cuttings and fluids is a common practice in developing countries. Oil projects permitted in the geologically active Peruvian Amazon in recent years have required injection of all liquid wastes, both hazardous and domestic. For example, the operation permit for French oil company Perenco's Block 67 oil development project includes the following waste disposal requirements:[61]

- The final disposal of produced water will be achieved by reinjection.
- Industrial and household effluents will be reinjected along with produced water, in order to ensure zero discharge into the environment.
- The final disposal of all drilling waste, and mud associated with drilling, will be achieved by reinjection, thus ensuring zero discharge into the environment.

C. Drilling mud composition

[56] ESIA, Volume 2, p. 12-40. "Existing waste management facilities in Uganda are limited, and in many cases they either do not comply with GIIP, or their compliance status is uncertain."

[57] National Petroleum Council, North American Resource Development Study, *Paper #2-23 Sustainable Drilling of Onshore Oil and Gas Wells*, prepared by the Technology Subgroup of the Operations & Environment Task Group, September 15, 2011, p. 12.

[58] ESIA, Volume 1, p. 4-70. "The total amount of cuttings and fluids to be generated is estimated to be approximately 230,000 tonnes. Spent muds will be temporarily stored in containers prior to removal by a vacuum truck, waste cuttings will be collected via augers . . . and transferred off the well pad for treatment and disposal. Conventional treatment of cuttings and fluids, whereby cuttings and fluids would be transported offsite for treatment and disposal in a dedicated facility, is the preferred option. . . The resultant solid fraction (of SBM cuttings) will then be stabilised and disposed of via an engineered landfill."

[59] Ibid.

[60] ESIA, Volume 2, p. 12-23 and p. 12-24. "Table 12-5. Estimated Waste:
Approximately 80% of hazardous waste, ~160,000 tonnes, is drilling cuttings and fluids, equally split between WBM cuttings/fluids and SBM cuttings/fluids. Remainder of hazardous waste is: 1) oily water & tank slops – 17,400 tonnes, 2) pigging wastes – 9,100 tonnes, 3) sludge – 3,600 tonnes, and 4) bitumen – 1,750 tonnes.

[61] MINEM (Peru Ministry of Energy and Mines), Directorate Resolution – EIA for the Development Phase of Blocks 67A and 67B, No. 202-2012-MEM/AAE, August 3, 2012.

Best practices is the exclusive use of water-based drilling mud ("WBM") on the Tilenga Project wells to minimize the environmental impacts of any release of drilling fluid into the environment. No synthetic-based drilling mud ("SBM") should be utilized to drill the Tilenga wells. TEP Uganda's basis for proposing use of both WBM and SBM, that "*At least five wells can be drilled with an SBM prior to the fluid requiring replacement, whilst only two wells can be drilled with WBM before the fluid needs to be replaced*,"[62] places lowest-cost drilling ahead of environmental protection. Exclusive use of WBM eliminates one source of a substantially more hazardous substance, SBM, that could contaminate the Tilenga Project area.

WBM is effective for drilling ERD wells. CNOOC, TEP Uganda's partner developing the Kingfisher Project on Lake Albert, was drilling ERD wells with a horizontal reach of 8 km almost a decade ago exclusively using WBM, in the Liuhua offshore oilfield in the South China Sea.[63] The U.S. National Petroleum Council states that, ". . *the development of high-performance WBM may be ideal when considering the needs of an extended-reach or multilateral wellbore*."[64]

CNOOC specifically chose to exclusively use WBM on the 8 km ERD well because it considered the South China Sea to be an "environmentally sensitive area."[65] Lake Albert and the Tilenga Project area also environmentally sensitive areas and merit the same level of environmental stewardship applied in the South China Sea in 2010 where WBM was selected to drill ERD wells. BAT is WBM for the drilling of all wells on the Tilenga Project.

D. Produced water reinjection

Page	Paragraph	2017 (draft) IFC Onshore Oil and Gas Guideline Requirements[66]
9	38	Alternatives may include injection into the reservoir to enhance oil recovery, or injection into a dedicated disposal well drilled to a suitable receiving subsurface geological formation. Other possible uses such as irrigation, dust control, or use by other industry, may be appropriate to consider if the chemical nature of the produced water is compatible with these options, and if no adverse environmental and/or human health impacts are caused. Produced water discharges to surface waters or to land should be the last option considered and only if there is no other option available.

[62] ESIA, Volume 2, p. 12-31.
[63] Society of Petroleum Engineers, *Design of Water-Based Drilling Fluids for an Extended Reach Well with a Horizontal Displacement of 8,000 m in the Liuhua Oilfield*, SPE130959, 2010.
[64] National Petroleum Council, North American Resource Development Study, *Sustainable Drilling of Onshore Oil and Gas Wells*, Paper #2-23, prepared by the Technology Subgroup of the Operations & Environment Task Group, September 15, 2011, p. 13.
[65] Society of Petroleum Engineers, *Design of Water-Based Drilling Fluids for an Extended Reach Well with a Horizontal Displacement of 8,000 m in the Liuhua Oilfield*, SPE130959, 2010.
[66] The draft 2017 guideline elements include the elements in the 2007 *Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development* final document, as well as additional elements.

The ESIA plan for produced water is partially adequate. The ESIA states that "*all produced water will be will be re-injected into the reservoirs."*[67] Reinjection of produced water is best practices.

However, TEP Uganda also proposes to extract large volumes of makeup water from Lake Albert and inject this fresh water along with the produced water to maintain reservoir pressure. The ESIA states that "*water abstracted from Lake Albert will be . . . mixed with the produced water to provide sufficient volumes for reinjection."*[68] The maximum quantity of water to be drawn from Lake Albert for pressure maintenance in the Tilenga Project oil reservoirs is approximately 12,762,000 cubic meters (m^3) per year,[69] or approximately 9.3 million gallons per day. The extraction of this water from Lake Albert will create potential conflict with local communities that rely on this water to sustain fishing and agriculture.[70]

However, Lake Albert water is not the only fluid available to maintain reservoir pressure in the project area. Relatively large amounts of gas will be co-produced with the oil production and can be reinjected into the oil reservoirs to maintain reservoir pressure. The ESIA indicates that up to 30 million cubic feet of day of gas will be produced.[71] The current plan is to use this gas to generate power at the CPF. This gas can instead be used to maintain reservoir pressure, as noted by the IFC, "*Alternative options may include gas utilization for . . . gas injection for reservoir pressure maintenance*."[72] Crude oil processed at the CPF would then be used, in combination with the excess gas not needed for reservoir pressure maintenance or by itself, to generate power at the CPF.

BAT is use of produced water and produced gas for reservoir pressure maintenance, and no extraction of Lake Albert water for this purpose.

E. Sewage effluent disposal

TEP Uganda states "*Wastewater generated during the Commissioning and Operations Phase will be processed by a dedicated WWTP at the Industrial Area and Tangi Camp Operation Support Base*."[73] This sewage effluent disposal approach is not best practices and does create the potential for localized eutrophication in Lake Albert. Injection of treated sewage effluent is BAT and the most effective method to assure treated sewage effluent does not contribute to eutrophication in Lake Albert.

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[67] ESIA, Volume 1, p. 4-9.
[68] ESIA, Volume 1, p. 4-23.
[69] Ibid, p. 10-83. 12,762,000 m^3 per year is equivalent to 10.3 million gallons per day. (12,762,000 m^3/yr × 35.315 ft^3/m^3 × 7.5 gallons/ft3) ÷365 day/yr = 9,260,754 gallons per day.
[70] NCEA, *Review of the Environmental and Social Impact Assessment (ESIA) Report for the Tilenga Project*, July 26, 2018, p. 8. "The proposed extraction of water from Lake Albert will result in conflict between the developer and the surrounding communities. Stretching 1.5 km of water pipe in the lake will inevitably restrict fishing around the installation. In the long run, there will be a standoff."
[71] Ibid, p. 4-9. "Gas treatment and compression for peak gas production of some 30 million standard cubic feet per day (MMscf/d)."
[72] IFC, *Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development (Draft)*, April 4, 2017, p. 5.
[73] ESIA Volume 1, p. 4-105.

F. Noise and air emissions from drilling rigs

The ESIA states regarding the impact of drilling noise that "*Drilling of wells on a 24-hour basis (will occur) at well pads*."[74] The ESIA also indicates there will negligible impacts on human receptors from drilling at the ten well pads proposed in the Park.[75] Drilling noise in the Park will be intense, 102 decibels,[76] and will be experienced by wildlife, not human receptors. It is the loud noise associated with drilling operations in the park that contributed to the avoidance behavior of migrating elephants during the exploratory drilling phase in the Park, as depicted in Figure 2a.

IFC Guidelines for Onshore Oil and Gas indicate that "*drilling contracting companies should be requested to provide generators able to comply with the local air emissions standards or, as a minimum, to retrofit the exhausts of the power units with catalytic converters*." [77] Catalytic converters are emissions control BAT for diesel generators used for drilling operations.

BAT to minimize the effect of noise from drilling rigs in the Park on wildlife, in addition to state-of-the-art mufflers, is to consolidate all drilling at one well pad location in the Park, as shown in Figure 4. Consolidating well pads outside the Park would be equally effective in reducing drilling noise impacts on human receptors in the area.

G. Lighting mitigation

The ESIA states that "*Lighting will be reduced to the minimum without impacting safety and security. Where feasible, the light will be directed inwards the facilities and will be of a warm/neutral colour so as to limit nuisance to the surrounding communities and to avoid attracting animals.*"[78] BAT is the mandatory direction of light inward toward the facilities and use of warm/neutral color lighting to limit nuisance. The term "where feasible" must be deleted from the ESIA description of lighting mitigation measures for these mitigation measures to be considered BAT.

H. Flare visible emissions

BAT for flares is an enclosed ground flare. The ESIA describes Option 1 for the flare as, "*Enclosed Ground Flare (EGF) will be approximately 26 m high with a diameter of approximately 13 m. During operations there will be no visible flame, smoke and minimal noise*."[79] The enclosed ground flare avoids a visible flame during flaring events, unlike the elevated flare alternative. Ground flare efficiency is also unaffected by crosswinds. BAT for flares is the enclosed ground flare.

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[74] ESIA, Volume 2, p. 7-25.
[75] Ibid, p. 7-52.
[76] Ibid, Table 7-21, p. 7-35.
[77] IFC, *Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development (Draft)*, April 4, 2017, p. 4.
[78] ESIA, Volume 1, Table 4-3, p. 4-12.
[79] Ibid, p. 4-23.

I. Production and Injection Network pipeline right-of-way (ROW) width

1. General

The ESIA states that a 30-meter right-of-way ("RoW") will be cleared for the 181 km of Production and Injection Network pipelines included in the Tilenga Project.[80] The IFC *Onshore Oil and Gas Guidelines* include the following requirements related to the width of the pipeline RoW:

Page	Paragraph	2017 (draft) IFC Onshore Oil and Gas Guideline Requirements[81]
20	88	Minimize areas to be cleared. Use hand cutting where possible, avoiding the use of heavy equipment such as bulldozers, especially on steep slopes, water and wetland crossings, and forested and ecologically sensitive areas.
21	88	Minimize the width of a pipeline right-of-way or access road during construction and operations as far as possible.
21	88	Install appropriate erosion and sediment control measures, slope stabilization measures, and subsidence control and minimization measures at all facilities, as necessary.

The 30-meter construction RoW proposed in the ESIA for the Production and Injection Network pipelines is an industry typical RoW width, and not representative of international best practices or BAT. A pipeline construction RoW width as narrow as 13 meters has been demonstrated-in-practice in sensitive tropical environments. A maximum pipeline construction RoW width of 15 meters (50 feet) is a general requirement in some parts of the U.S. This includes the state of Pennsylvania, a shale gas production region that has undergone intensive pipeline development in recent years.

Pipeline construction is a specialized industry with relatively few companies. These companies are accustomed to applying a similar conventional approach on every project. Priority is placed on maintaining the pace of pipeline installation, which imposes its own conditions of construction, including: RoW width, disposal of soils and debris, contouring of RoW slopes, and the equipment that is used in each construction stage. These are unchanging elements for conventional pipeline RoW builders. These accumulated habits and routines, which have evolved over the years among pipeline construction firms, constitute a major source of resistance to innovative RoW construction techniques.

The "narrow RoW" technique puts primary emphasis on manual labor and less emphasis on heavy machinery to open and close the RoW. The narrow RoW technique emphasizes having the RoW follow the natural terrain, as well as the manual logging of trees and bushes (instead of using heavy machinery) to further reduce impacts, especially on steep slopes. See E-Tech International, *Best Practices: Design of Oil and Gas Projects in Tropical Forests*, October 2012

[80] ESIA, Non-Technical Summary, p. 25. "A permanent Right of Way (RoW) will be established extending 15 m either side of all pipeline routes. Construction activities will be contained within this RoW."
[81] The draft 2017 guideline elements include the elements in the 2007 *Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development* final document, as well as additional elements.

for examples of pipelines and flowlines built in narrow RoWs in tropical environments.[82]

Manual clearing creates opportunities for short-term employment during pipeline construction, an additional social benefit in contexts where expectations for jobs are high. Figure 5a and 5b show labor crews opening and closing a 13-meter RoW in Peru for a 20-inch diameter flowline.

Figures 5a and 5b. Opening and closing narrow ROW using labor intensive technique[83]

The standard 15-meter pipeline construction RoW in Pennsylvania is shown in Figures 6a and 6b. The 15-meter RoW is the space between the two temporary plastic orange fences.

Figures 6a and 6b. Typical Pennsylvania 15-meter pipeline RoW (25 feet on either side of centerline),[84] **and clearing of RoW for 20-inch diameter Mariner East Pipeline**[85]

[82] See: https://static1.squarespace.com/static/52d71403e4b06286127a1d48/t/531cf8bce4b04c1bc67a1768/1394407612599/E-Tech.2012_BestPracticesHydrocarbonProjects.pdf

[83] INMAC Peru, *Comparaciones de calidad y costo entre un gasoducto verde y una construcción tradicional*, presented at E-Tech Independent Monitoring Forum, Cusco, Peru, 2010.

[84] Penn State Extension, *Tips for Negotiating Pipeline Rights of Way* [in Pennsylvania], video, 2019. Screenshot showing ROW measuring 25 feet on either side of ROW centerline (50 feet total).

[85] State Impact Pennsylvania, *Mariner East: A Pipeline Project Plagued by Mishaps and Delays*, March 2019. See: https://stateimpact.npr.org/pennsylvania/tag/mariner-east-2/.

International best practices and BAT for a pipeline construction RoW is 15 meters. The maximum allowable construction RoW for the Production and Injection Network pipelines should be 15 meters.

2. *Critical areas*

The maximum width of the construction RoW in critical areas of the Park, such as known wildlife migration corridors, should be no more than 10 meters. The primary reason for this width restriction is to minimize the amount of ground-level disturbance. Figure 7 is a photograph of a construction RoW cross-section limited to 8 meters in the Peruvian jungle.

Figure 7. 8-meter construction RoW[86]

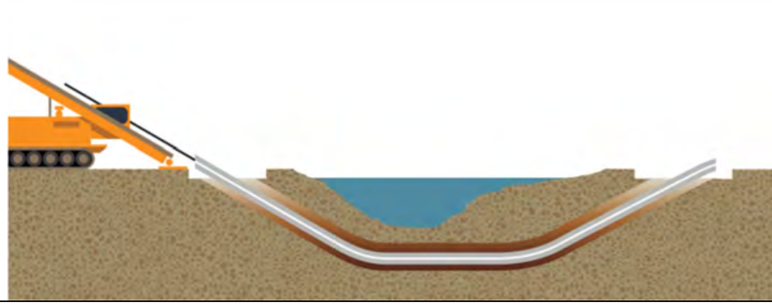
J. Crossing technique to be utilized at permanent rivers and streams

Page	Paragraph	2017 (draft) IFC Onshore Oil and Gas Guideline Requirements
21	88	Carefully consider all of the feasible options for the construction of pipeline river crossings including horizontal directional drilling.

There are two primary options available to cross rivers and streams: 1) horizontal directional drilling ("HDD") under the water body, and 2) open-cut trenching. The comparative cost of these two crossing alternatives is not discussed in the Tilenga ESIA. However, HDD is in routine use in the pipeline construction industry to cross waterbodies. The HDD technique involves drilling under the waterbody and avoiding any disruption to the waterbody itself. See Figure 8.

[86] Society of Petroleum Engineers, *Methods to Establish Canopy Bridges to Increase Natural Connectivity in Linear Infrastructure Development*, prepared by Smithsonian Conservation Biology Institute, 12LAHS-P-157-SPE, 2013.

Figure 8. Schematic of horizontal directional drilling under a river[87]



Open-cut technique: The streambed where the pipeline will be located is physically isolated to allow laying of the pipeline in dry conditions. Pipes pass through the temporary barriers to allow water from the waterbody to continue to flow. However, the open-cut technique has the potential for substantial negative environmental impacts on aquatic fauna in perennial rivers and streams due to the disruption to natural flow. A photograph of this technique, with river/stream water flowing in pipes above the pipeline trench, is shown in Figure 9.

Figure 9. Open-cut pipeline crossing, horizontal pipes above pipeline for water flow[88]

HDD will be used to cross the Victoria Nile.[89] Use of HDD is BAT for crossing a permanent river. However, in all other cases, "*the pipelines will be installed using open-cut trench methods*."[90] The open-cut trench method is not BAT for permanent rivers or perennial streams. The ESIA states that there are several rivers within the (Tilenga Project) study area, as well as perennial streams, intermittent streams, ephemeral streams, and wetlands:[91]

- Tangi River (North of the Nile);
- Sambiye River (South of the Nile);
- Biraizi River (South of the Nile);

[87] Pittsburg Post-Gazette, *The lessons of Mariner East 2*, October 23, 2018: https://newsinteractive.post-gazette.com/mariner-east-2-pipeline-horizontal-directional-drilling/.
[88] CNOOC, *ESIA: CNOOC Kingfisher Oil Project, Uganda*, Volume 1, p. 2-78.
[89] ESIA, Non-Technical Summary, p. 25.
[90] Ibid, p. 25.
[91] ESIA, Volume 2, p. 10-71.

- Waiga River (South of the Nile);
- Wanseko River (North of the Nile); and
- Unnamed perennial streams, intermittent streams, ephemeral streams and wetlands, North and South of the Victoria Nile River.

Open-cut trenching of pipelines in streambeds carries operational risks. A major rupture on the Camisea liquids pipeline in Peru occurred sixteen months after the pipeline began operation at a point where the pipeline had been placed under the steambed of the Paratori River using open-cut trenching.[92] The river is less than 10 meters across where the rupture took place. The pipeline was exposed due to scouring of the streambed during a period of heavy rain.[93] It had been buried 2.1 meters below the stream bed.[94]

The automatic leak detection system did not register that a leak had occurred. The pressure reduction caused by the rupture "*was not sufficiently large to activate the automatic rupture detection mechanism of the block valves upstream and downstream of the rupture*."[95] The rupture was detected when control room operations staff identified a reduction in flow at the downstream pump station. The nearest block valves were ultimately closed about one hour after the rupture occurred. Approximately 4,600 barrels of liquid hydrocarbons were spilled into the stream.[96] Figure 10 shows the damaged pipe section and the pipeline bridge that replaced the pipeline section that had been buried under the streambed.

Figure 10. Photographs of the open-cut buried pipe section that ruptured and the replacement pipeline bridge[97]

HDD must be done properly to achieve the intended environmental and water quality protection purposes. There will be strong pressure in the field to keep laying pipe sections as fast as

[92] Exponent, Inc., *Integrity Analysis of the Camisea Transportation System, Peru, S.A.*, prepared for Inter-American Development Bank, June 2007, p. 21.
[93] Ibid.
[94] Ibid.
[95] Ibid.
[96] $(736\ m^3 \times 35.31\ ft^3/m^3 \times 7.5\ gallons/ft^3)/(42\ gallons/barrel) = 4{,}641$ barrels.
[97] Exponent, 2007, pp. 23-24.

possible. A clear, detailed and sufficient work plan must be developed for each HDD crossing, and onsite independent inspection must verify that the work plan is being followed.

A recent 500 km pipeline project in the U.S. includes over 100 HDD crossings.[98] The pipeline company chose the best practices HDD technique to speed environmental approvals and begin construction sooner. However, due to restrictions on state regulation in this case, government authorities were not permitted to independently assess the adequacy of the HDD crossing designs planned by the pipeline company. The results in some cases were not acceptable, either because the HDD contractor had not drilled the pipeline bore at sufficient depth under the water body, or the contractor was under time pressure to keep moving at a fast pace and cut corners to stay on schedule. The problems encountered on this project underscore the need for independent review and approval of HDD work plans prior to the commencement of field work.

In summary, HDD is BAT for crossing permanent rivers and streams. HDD has no construction footprint on the waterbody itself. In contrast, open-cut has a large and negative footprint, at least temporarily, on the waterbody being crossed.

IV. Summary of Recommendations

Numerous elements of the Tilenga Project ESIA do not meet BAT. The ESIA should be revised to incorporate the following modifications:

Issue	BAT recommendations
Consolidate well pads in Murchison Falls National Park	Reduce the number of well pads in the Park from ten well pads to one well pad. Locate this one pad at or near the current location of well pad JBR-06. Locate the second well pad south of the Victoria Nile border with MFNP to reach oil reservoirs that would otherwise be served by pads JBR-01, JBR-02, and JBR-10.
Well drilling in MFNP and border area	Use ERD as necessary to reach the well targets in the MFNP from a single well pad within MFNP and a second well pad to the south of the Victoria Nile on the southern border of the Park near proposed well pad GNA-02.
Drilling mud	Use only non-hazardous WBM for drilling wells. No synthetic-based mud SBM should be used, as SMB has much higher toxicity than WBM and for that reason is not best practices.
Disposal of drilling cuttings	Reinject drilling cuttings and drilling fluids. Do not dispose of drilling cuttings in landfills, to avoid 1,000s of truck trips and potential leakage at landfill(s).
Produced water	Reinject all produced water (as currently proposed by TEP Uganda).
Lake Albert makeup water	Do not use Lake Albert to sustain oil reservoir pressure. Reinject produced gas into the oil reservoirs to maintain reservoir pressure. Crude oil should substitute for gas as fuel for power generation at the CPF.
Sewage effluent	Inject treated sewage effluent via the produced water wells.

[98] Ibid.

Visual impacts	Locate only one well pad inside the Park. Locate the well pad in a low-lying site relative to immediate surroundings to minimize visibility to Park visitors and wildlife. The other well pad used to reach targets in the Park, located near the southern border of Park, should be positioned in a similar manner.
Construction ROW width – general,	International best practices for pipeline construction RoW is 15 m. Maximum pipeline construction RoW width should be 15 m.
critical areas	Maximum construction RoW in permanent wetlands should be 10 m.
Waterbody crossings	Utilize HDD to cross permanent rivers and streams in the project area.