

# **Assessing the Impact of an Operating Tailings Storage Facility on Catchment Surface and Groundwater Quality: A Case Study of Adamus Resources Limited (Nzema Gold Mine) in the Ellembele District of the Western Region of Ghana**

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## **ABSTRACT**

The study assessed the impact of an operating Tailings Storage Facility (TSF) of Adamus Resources Limited (Nzema Gold Mine) in the Ellembele District, Western Ghana, on catchment surface and groundwater quality. Water samples were collected between June and December 2014 from seventeen (17) sampling sites including the TSF decant water (TSF-DW), three (3) streams, a water storage dam, a pond and eleven (11) groundwater monitoring boreholes within 500m radius of the mine's Tailings Storage Facility. Samples were analyzed for pH, true colour, electrical conductivity (EC), total dissolved solids (TDS), total suspended solids (TSS), biological oxygen demand (BOD), dissolved metals (arsenic, cadmium, copper, mercury) and cyanide (weak acid dissociable cyanide (WAD), free cyanide and total cyanide) using standard procedures. Structured questionnaires were also administered to one hundred and twenty inhabitants living close to the TSF to solicit their opinion regarding the impact of the facility (TSF) on water quality in the communities out of which one hundred people responded. Results obtained from the analysis of water samples from the TSF-DW indicated that pH values range from 7.4 – 8.9 (mean 8.2), EC 1340 – 1630  $\mu\text{S}/\text{cm}$  ( mean 1507.1  $\mu\text{S}/\text{cm}$ ), TSS 19 – 105 mg/l (mean 55.3 mg/l), arsenic 0.17 - 5 mg/l (mean 1.26 mg/l), cadmium 0.0001- 0.0004 mg/l (mean 0.0002 mg/l), copper 0.058 - 0.35 mg/l (mean 0.15 mg/l), mercury <0.0001 - 0.0002 mg/l ( mean 0.002 mg/l), Weak Acid Dissociable (WAD) cyanide <0.005 - 1.04 mg/l (mean 1.04 mg/l), total cyanide <0.0005 - 1.55 mg/l (mean 0.59 mg/l) and free cyanide <0.005 - 1.04 mg/l (mean 0.38 mg/l). pH values of surface water samples collected ranged from 6.3 -7.3 (mean 6.7), EC 55.5 – 185.7  $\mu\text{S}/\text{cm}$  (mean 116.8), TSS 10.7- 990 mg/l (mean 230 mg/l), arsenic 0.001- 0.021 mg/l (mean 0.021 mg/l), copper 0.001 – 0.004 mg/l (mean 0.0020 mg/l). Cyanide (free, WAD and total), cadmium and mercury concentrations in surface water were however, below laboratory detection limit. However, copper in surface water had a strong positive correlation with TDS ( $r=0.88$ ) and TSS ( $r=0.84$ ). The pH of groundwater varied between 6 – 7.6 (mean 6.6), EC 114.7-441 mg/l (mean 233.8 mg/l), TSS 2.9-29.6 mg/l (mean 10.0 mg/l), arsenic 0.0005-0.0063 mg/l (mean 0.0014mg/l) and copper <0.001-0.0026 mg/l (mean 0.0015 mg/l). Cyanide (free, WAD and total), cadmium and mercury concentrations in groundwater were below laboratory detection limit. There was a significant positive correlation between groundwater cadmium and copper ( $r=0.68$ ). Pearson's Product Moment Correlation revealed arsenic in TSF-DW had strong positive correlation with copper ( $r=0.87$ ), total, free and WAD cyanide ( $r=0.88$ , 0.85 and 0.93, respectively). The tailings decant water reported elevated arsenic, free cyanide and TSS concentrations above GHEPA guideline for

effluent discharge which could be attributed to arsenopyrite ore mined and processed by the mine and chemicals used in ore processing. Free cyanide, arsenic and TSS values in the TFS were above GHEPA guidelines. Elevated TSS and arsenic concentrations above GHEPA limits were reported in PWSD which is a pond uphill of the TSF and a receptor to effluents from illegal mining sites on the mine's concession. All other parameters recorded in surface and groundwater bodies studied were within WHO guideline limit for potable water. Results of the study suggest that the quality of surface and groundwater around the TSF has not been adversely affected even though the TSF is contaminated. Study findings suggest that well-engineered tailings dam of ARL with its effective liner and management systems and may have provided a safe structure and prevented contamination of water resources within its catchment. Adherence to the mining industry's best practices by ARL with regards to TSF management could also be a contributing factor to the quality of water bodies in close proximity to the facility. However, inhabitants living close to the TSF believe their water quality has been impacted adversely by the facility with five percent (5%) of the respondents relating the impact to smell, 78% to colour and 17% to odour.

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