Executive summary

A literature review has found that there is limited background information on the environmental characteristics of the Swift (Ngarradj) Creek catchment, which contains the portal, retention pond and other head works for the Jabiluka uranium mine. To determine the baseline geomorphic characteristics of catchments in the Jabiluka Mineral Lease as well as the physical impacts of uranium mining, 13 sub-projects were proposed within the framework of a sediment budget.

1 **Geomorphic mapping**. The location and characteristics of the channel network and catchment geomorphology should be mapped by differential GPS and air photograph interpretation to produce a detailed geomorphic map of the Swift Creek catchment that can be used for environmental impact assessment of the mine.

2 **River reach definition and mapping**. Morphologically homogeneous channel reaches should be mapped and described throughout the catchment to provide a spatial framework for monitoring and impact assessment and to measure future changes in reach boundaries and/or characteristics. A preliminary classification based on air photograph interpretation and limited field inspections has been produced for further testing and refinement.

3 **Historical channel stability/instability**. The historical stability/instability of each channel reach should be assessed from all available vertical air photographs to provide an understanding of pre-mining channel behaviour and to provide baseline conditions for the assessment of post-mining channel changes.

4 **Fluvial sediments**. Grain size characteristics of channel boundary and floodplain sediments and the volume of the alluvial store should be determined for each channel reach to provide baseline conditions for the assessment of post-mining impacts on sediment movement.

5 **Digital elevation model**. A digital elevation model of the whole catchment should be constructed for landform evolution modelling by SIBERIA for environmental impact assessment, mine management, design of a stable rehabilitated mine site and prediction of mine-derived sediment deposition sites downstream of the mine site.

6 **River gauging stations**. At least four river gauging stations (two on control rivers and two on mine-impacted rivers) with pluviometers should be installed and operated to obtain hydrological information on natural catchment conditions and on the impact of mining. The control rivers are Swift Creek upstream of the mine site and Tributary East. Energy Resources of Australia (ERA) also operate two gauging stations on 7J and North Magela Creeks, which are appropriate controls, if they are not impacted by road construction. The mine-impacted stations are Swift Creek downstream of the mine site and Tributary Central.

7 **Suspended sediment transport and turbidity**. Detailed suspended sediment and turbidity measurements should be undertaken at each ***eriss*** river gauging station to calculate natural and mine-induced suspended sediment loads during the Wet season.

8 **Bedload transport**. Detailed bedload measurements should be undertaken at each ***eriss*** river gauging station to calculate natural and mine-induced bed-material loads. Bedload constitutes a large proportion of the total sediment load in the Alligator Rivers Region and is essential for an assessment of the impact of mining on total sediment yield.

9 **Bed scour depths**. Scour chains should be installed and measured annually at each gauging station and on mine site tributaries to determine the maximum depth of bed scour (active bedload) during each Wet season.

10 **Contemporary channel erosion rates**. Bank erosion and knickpoint migration rates should be selectively measured to determine the significance of in-channel sediment sources in comparison to the sediment yields generated on the mine site and from the undisturbed catchment.

11 **Contemporary channel stability**. Permanently marked cross sections should be installed and used to monitor the amount of bed sediment storage and/or large scale channel erosion throughout the river network.

12 **Sediment storages**. The volume of sediment in discrete sediment storages downstream of the mine site should be mapped and measured.

13 **Riparian vegetation and large woody debris**. The significance of riparian forests and large woody debris for stabilising sinuous sandy channels and storing bed material on Swift Creek and East Tributary should be evaluated.

These projects were proposed, described and initiated at short notice before the commencement of the 1998/1999 Wet season. This was necessary to ensure that some catchment characteristics had been measured before the first flush of the Wet season after initial disturbance for mine establishment. No program of hydrologic and geomorphic research had been commenced in the Swift Creek catchment by ***eriss*** before June 1998. Furthermore, initial geomorphic measurements of the mine site tributaries and Swift Creek were also required before the first flush of the 1998/1999 Wet season to help determine the environmental impacts of mining.

The above projects target channel stability/instability, sediment sources, sediment storages, sediment pathways and sediment fluxes within the channel network of Swift Creek. Sites impacted by uranium mining will be compared with similar natural sites upstream of the influence of mining. A standard or modified BACI (Before After Control Impact) design was not possible because mining had started before any of the projects could be implemented.

Key Words: Jabiluka, uranium mining, geomorphic mapping, river reaches, sediment storages, channel erosion, river gauging, suspended sediment, turbidity, bedload, hydrology, GIS, digital elevation model.

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Glossary

The purpose of this Glossary is to define the hydrologic, geomorphic and sedimentologic terms used in this report.

Alluvial fan. This is an accumulation of sediment that has been deposited where a sediment-laden stream emerges from a confined upland valley onto a piedmont where it spreads laterally and deposits its load as a semicircular sediment body (Schumm et al 1987).

Anabranch. This is a relatively long channel that separates from the main stream and usually rejoins it downstream. In some cases, such branches may join another river. Anabranches are usually separated from the main channel by floodplain (Schumm et al 1996).

Avulsion. The abrupt, wholesale abandonment of a relatively long reach of river for a new location, usually at a lower elevation on the floodplain (Schumm et al 1996).

Bankfull. The stage at which the floodplain first gets inundated (ie the channel-floodplain junction) and which often corresponds to the minimum width-maximum depth ratio for a channel cross section (Riley 1972).

Bar. This is a large scale bedform which has a length of the same order as the channel width or greater, and a height comparable to the mean depth of the generating flow (Brush et al 1966).

Base flow. This refers to relatively low, progressively diminishing streamflows produced by soil water and groundwater drainage to a stream. In the Alligator Rivers Region, base flows are relatively high during the Wet season but slowly decline to zero as the soil water and groundwater stores are progressively depleted during the onset of the Dry season.

Bedform. This is a geometric configuration of bed material on the river bed surface that is more than one grain diameter high and that is formed by the flow. Large scale bedforms have lengths at least equivalent to channel width and heights comparable to the mean depth of the generating flow (Brush et al 1966). Small scale bedforms have lengths less than channel width and heights much less than bankfull depth.

Bench. This is a depositional landform which is an essentially tabular, often vegetated, elongate, usually discontinuous, sometimes paired, usually bank-attached sediment body and which occurs at intermediate elevations between the river bed and the main valley flat level (Erskine & Livingstone 1999). Benches develop at various locations within the channel (Erskine & Livingstone 1999), most commonly in straight reaches as parallel benches, on the inside of bends as crescentic point benches, which often extend away form the bend to join parallel benches, and less commonly, along the outside of bends as concave benches (Woodyer 1975).

Billabong. This is a standing body of water that has formed either within a river channel or on the floodplain. They are formed either by scour or impoundment and Hart and McGregor (1982) recognised three types on Magela Creek, namely backflow billabongs, channel billabongs and floodplain billabongs.

Braided river. These are relatively steep, straight, wide rivers with multiple, often laterally shifting thalwegs separated by numerous bars.

Channel control. A stable channel cross section, such as a riffle or a constriction, that determines the upstream gauge height-discharge relationship in the backwater-affected area.

Clay. This refers to sediment with a diameter less than 0.0039 mm (Wentworth grain size scale).

Control structure. This is a precisely constructed weir or flume with known hydrodynamic behaviour that is theoretically rated by a weir or flume equation.

Fan delta. This is an alluvial fan that progrades into a body of water from an adjacent highland. A fan delta has many of the surface characteristics of an alluvial fan and many of the subaqueous characteristics of a delta (Schumm et al 1987).

Floodout. This is a valley-floor zone where most flows are incompetent to transport the bed material, resulting in a fan-like form of aggradation (Erskine & Melville 1983a). Deposition and drainage disorganisation are caused by a substantial reduction in flow velocity and channel capacity as the channel approaches the intersection point (Erskine & Melville 1983a). Intermediate floodouts where channels reform downstream (Tooth 1999), are characteristic of the Swift Creek catchment.

Floodplain. This is a relatively flat alluvial plain bordering a river channel and subject to periodic flooding.

Gravel. This refers to sediment with a diameter greater than 2 mm (Wentworth grain size scale).

Gully. This is a relatively deep, recently formed, eroded channel that is cut into unconsolidated sediment where no well defined channel previously existed (Schumm et al 1984).

Intersection point. The distal end of a channel where the bed and bank profiles intersect, extinguishing the channel. They are associated with alluvial fans and floodouts (Erskine & Melville 1983a).

Knickpoint. This is a zone where bed slope increases abruptly (Brush & Wolman 1960). Primary knickpoints at the upstream limit of a gully are often vertical falls whereas secondary knickpoints are steep sections of the gully bed eroding temporarily stored sediment.

Meandering river. These rivers have a sinuosity of at least 1.5, a series of regular bends with alternating curvature, large-scale pool-riffle bedforms and point bars on the inside of bends.

Plunge pool. This is a relatively deep scour pool eroded at the base of a waterfall or a knickpoint and enclosed by an arcuate downstream bar of sediment eroded from the plunge pool.

Point bar. This is a largely unvegetated body of sediment within the channel against the convex (inside) bank of a bend (Nanson 1980).

Pool. This is a large-scale bedform that is a relatively deep part of the river bed with a flat water surface profile and slow flow under base flow and which is floored with relatively fine sediments. Pools usually alternate with riffles in gravel bed streams and are rhythmically spaced at about 5–7 channel widths.

Rating curve. The relationship between gauge height and discharge established at a gauging station by a number of velocity-area gaugings over a range of gauge heights. It is used to convert continuously recorded gauge heights into a continuous discharge record.

Riffle. This is a large-scale bedform that is a relatively shallow part of the river bed with a steep water surface profile and fast flow under base flow and which is floored with relatively coarse sediment. Riffles usually alternate with pools in gravel bed streams and are

rhythmically spaced at about 5–7 channel widths. Generally they are areas of subcritical flow modified by local free-surface instabilities and small hydraulic jumps over bed roughness element (Grant et al 1990). Only 5–10% of the water surface area exhibits supercritical flow (Grant et al 1990).

River reach. This is a length of river exhibiting relatively homogeneous channel characteristics or a consistent pattern of repetitive/alternating characteristics.

Run. This is a large-scale bedform that is intermediate between pools and riffles under base flow. It is characterised by uniform steady flow because the bed and water surface profiles are parallel. Glides are also recognised as a less turbulent and less steep version of a run.

Sand. This refers to sediment with a diameter between 0.0625 and 2 mm (Wentworth grain size scale).

Secondary channel. This is a channel which is much smaller than the main stream.

Silt. This refers to sediment with a diameter between 0.0039 and 0.0625 mm (Wentworth grain size scale).

Sinuosity. This refers to the ratio of channel length to valley length. It may also be expressed as the ratio of channel slope to valley slope and is essentially a measure of the degree of meandering.

Thalweg. This is the path followed by the line of maximum flow velocity (Rhoads & Welford 1991). While the thalweg usually follows the path of maximum depth, this is not necessarily the case when secondary channels are present (Wolman & Brush 1961).

Tributary-mouth bar. This is a downstream elongated sediment body that originates at the confluence of one usually smaller channel with another (Petts 1984).

Velocity-area gauging. This is the field measurement of the mean flow velocity by a current meter and cross sectional area by tape and wading rod for a specific gauge height at a stable gauging site. The results of a number of velocity-area gaugings for a range of gauge heights are needed to construct a reliable rating curve.