

**Assessment of the
off-site geomorphic
impacts of uranium
mining on Magela
Creek, Northern
Territory, Australia**



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This report should be cited as follows:

WD Erskine & MJ Saynor 2000. *Assessment of the off-site geomorphic impacts of uranium mining on Magela Creek, Northern Territory, Australia*. Supervising Scientist Report 156, Supervising Scientist, Canberra.

The Supervising Scientist is part of Environment Australia, the environmental program of the Commonwealth Department of Environment and Heritage.

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Supervising Scientist
Environment Australia
GPO Box 461, Darwin NT 0801 Australia

ISSN 1325-1554

ISBN 0 642 24360 3

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Printed in Darwin by NTUniprint

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Summary

The aim of this report was to complete the following three tasks from a review of the relevant literature and from the authors' field work in the Alligator Rivers region and past experience.

1. Review all of the existing data relevant to the discharge of solutes and particulate material from the rehabilitated mine site at Ranger uranium mine and from nearby tributaries of Magela Creek;
2. Determine the fate of particulates in the off-site system; and
3. Collate and review all of the existing material relevant to an understanding of the long-term behaviour of Magela Creek and its tributaries.

In relation to the first task, rainfall at the Ranger uranium mine is acidic and has a low dissolved solids and nutrient content. Magela Creek water is characterised by very low conductivity and low suspended solids concentrations that exhibit exhaustion as the Wet season progresses. The suspended particulate matter of Magela Creek contained approximately 25% organic matter, 15% iron oxide, and the remainder consisted of varying amounts of clay (predominantly kaolinite with some chlorite), quartz and aluminium oxide. Sediment and solute yields of Magela Creek are less than 11.8 and 2.5 t/km² yr, respectively, and are low by world standards. Bedload yield is a relatively high proportion (48.6%) of the total sediment load yield and this occurs at all scales from waste rock dump plots to major rivers in the Alligator Rivers Region. Disturbed sites generate sediment yields that are an order of magnitude higher than those from natural catchments (up to 5100 t/km².yr). Large storms dominate soil erosion and sediment transport. Any future climate change due to the enhanced greenhouse effect that increases rainfall intensities and/or storm frequencies will increase soil erosion rates and sediment yields. Up to 7 m of erosion and 20.4 x 10⁶ t of sediment will be eroded from the rehabilitated mine site over the 1000 years structural life. Assuming sediment delivery ratios of between 0.24 and 0.50, up to 15.5 x 10⁶ t will be stored on the rehabilitated mine site and 10.2 x 10⁶ t will be transported off the mine site. Assuming a sediment delivery ratio of 0.28, which was measured for a local catchment in the Alligator Rivers Region, 9.1 x 10⁶ t will be stored on the rehabilitated mine site and 3.6 x 10⁶ t will be exported. The rehabilitated mine site should be stabilised by revegetation, the installation of convexo-concave slope profiles, the spreading of surficial gravel lags and protection of the site from fire.

In relation to the second task, not all of the sediment eroded from the rehabilitated mine site during the 1000 years structural life will be exported off-site. Published empirical relationships of sediment delivery ratios versus catchment area indicate that between 50 and 76 % of the eroded sediment will be retained on the rehabilitated mine site. The most significant sediment storage sites downstream of the mine site will be the mine site tributaries and their associated floodplains and backflow billabongs. It is predicted that between 3.1 and 10.2 x 10⁶ t will be exported to the mine site tributaries and that between 3.1 and 7.0 x 10⁶ t will be stored there. The backflow billabongs will be completely infilled with mine-derived sediment over the 1000 years structural life of the rehabilitated mine site. For the most likely rehabilitated mine site scenario, 3.6 x 10⁶ t will be exported from the rehabilitated mine site to these tributaries and 3.5 x 10⁶ t will be stored. Little research has been conducted on the sediment dynamics and storage of these tributaries to date. Relatively minor sediment supply will occur in the anastomosing sand zone of Magela Creek. The lower Magela Creek floodplain is unlikely to receive any mine-site-derived sediment. However, should this occur, essentially all of the mine-derived sediment supplied to the lower floodplain will be trapped.

In relation to the third task, environmental responses to greenhouse-induced climate and sea level changes as well as to longer term hydro-isostatic climate changes are manifested through hydrological, hydrodynamic, geomorphological and ecological processes that interact with each other. Greenhouse-induced climate and sea level changes to the year 2030 are likely to include an increase in storminess due to greater rainfall intensities, more heavy rain events and/or local topographic effects on rainfall, a rise in sea level by between 80 and 300 mm and an increase in temperature by 0.85 to 1.0°C. Increased storminess will cause higher soil and channel erosion rates and hence will increase suspended loads, bedloads and sediment yields. Reductions in wet season vegetative cover and/or increases in dry season fire extent and/or intensity will also cause further increases in sediment yields. Sea level rise will re-establish tidal connection with the old tidal channels and cause extensive salinisation of the most downstream wetlands on Magela Creek. This will cause the remobilisation of stored sediments but a large proportion should be redeposited elsewhere on the floodplain.

A substantial fall in sea level due to the start of the next glacial will result in incision of Magela Creek downstream of the Ranger mine site and the remobilisation of massive amounts of stored sediments and the oxidisation of the remaining sediments. Mine site tributaries will be rejuvenated and any stored mine site generated sediment will be flushed into Magela Creek.

While a disproportionately large effort has been directed at understanding the evolution and behaviour of the sand anastomosing reach and lower floodplain of Magela Creek, these sections will not be the initial repositories for mine-derived sediment. The geomorphic behaviour and sediment dynamics of mine site tributaries are not as well understood but are certainly more important sediment stores and sediment pathways for mine-derived particulates. The reason for this discrepancy in research effort is that the lower Magela wetlands are internationally significant and have, therefore, been perceived as being the most important ecosystem likely to be impacted by mining. Under the most likely post-rehabilitation scenario, no mine site generated particulates will reach the lower Magela wetlands. Additional hydrological, geomorphic and limnological monitoring of mine site tributaries and backflow billabongs is recommended.

It is essential that the probability and magnitude of extreme storms and floods are more accurately defined because of their potential significance for soil erosion, sediment transport, channel changes and avulsions, and landform evolution modelling by SIBERIA. Additional slackwater deposit research is recommended on Katherine River (January 1998 flood), East Alligator River upstream of the area mapped in detail by Pickup et al (1983; 1987) and investigated by Murray et al (1992) and Wohl (1988; Wohl et al 1994a), and Magela Creek gorge below Magela Falls. The role of catastrophic floods in causing two avulsions on the East Alligator River floodplain at Cahill's Crossing also needs to be determined to assess the potential for avulsions on Magela Creek next to the rehabilitated mine site.

Acknowledgments

Bryan Smith and Joan Mount are thanked for their considerable efforts in locating all of the publications that we requested at short notice. Ken Evans introduced us to the geomorphology and hydrology of ERA Ranger Mine and Kakadu National Park. Arthur Johnston, Bernard Prendergast and Ken Evans improved this report by sharing their knowledge of the Alligator Rivers Region and their expectations of this project. Robin Warner, Ellen Wohl and Steve Riley also assisted with the supply of information and/or discussion of the geomorphology of the Alligator Rivers Region. Their help is gratefully acknowledged. The Environmental Research Institute of the Supervising Scientist is thanked for sponsoring the visits to Jabiru, by Dr Wayne D Erskine and for commissioning this report. Selected additional information on the aerial inspections for this report is contained in Saynor and Erskine (1998). Ken Evans, Rob Warner, Ian Eliot and Peter Cornish constructively criticised and improved this report.