Their composition is very similar to the sediments predominating in Botany Bay and they reflect their origin as beach sands and wind blown sands of the natural coastal environment prior urbanisation.

*Group 2*

Group 2 has a primary mode of 2 – 2.5 Φ (15 – 23%), and a secondary mode with grain-sizes between 5.5 – 6.6 Φ (3 – 5%) representing additional fine sediments of fluvial origin. The patchy occurrence of this group suggests that the sand mode is a function of occasional and localized high-energy flow of water during flooding events, while the secondary mode in this and the following groups of stations, in the range of medium to fine silt, is the result of the reduced energy in the flow of the river during normal flow conditions.

*Group 3*

Group 3, with a primary mode between 6 – 9 Φ (7 – 11%), appears to be the most "natural" sediment group with a smaller input of anthropogenic-origin coarse sediment from high-energy flooding events, and a dominance of smaller sized particles, the products of natural erosion from the catchments and transported by normal flow conditions. The anthropogenic component consists of 5-8% of fine sand (1.75-2.25 Φ).

*Group 4*

This group, as the groups 5A and 5B, shows the presence of anthropogenic inputs of medium to coarse sand in variable amounts. Its primary mode ranges between 0.75-1 Φ, with up to 20% relative abundance; a secondary mode (6-6.5 Φ) represents the average fluvial transport. The presence in group 4 stations of sand in the borderline from medium to coarse sand is the first major anthropogenic inputs.

*Groups 5A and 5B*

All stations in Group 5 show the typical fluvial sediment seen in previous groups (5.5 – 8 Φ). In addition a primary mode is recorded in the medium to coarse sands; these large grain-size sediments are the product of higher energy run-off events within the associated catchments. Group 5B, in particular, shows a secondary sand mode of –1.25 to 0.5 Φ,

which may be defined as sediments ranging from gravel (-2 to -1 Φ), through very coarse sand (-1 to 0 Φ), to coarse sand (0 to 1 Φ). Stations in Group 5A have a smaller input of coarse sediments than Group 5B stations. It is this Group 5 that represents the section of the river most affected by anthropogenic activities.

*Discussion*

The relatively large proportion of coarse sediments in the river immediately downstream of the cemented, channelised section is representative of the high-energy transport. An increase in flow and additional inputs occur where other drains enter the main channel,

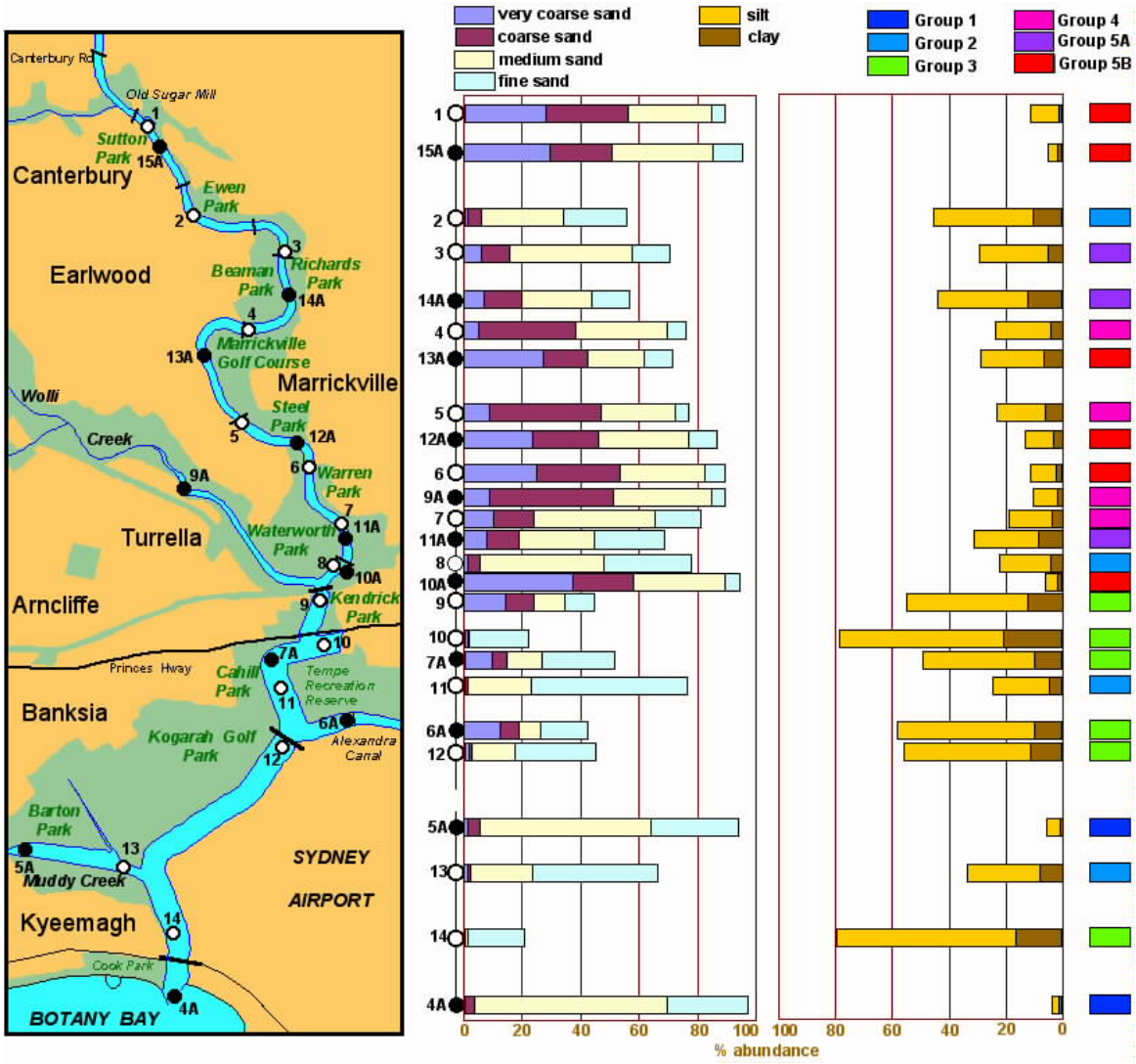


Figure 5 – Sediment compositions along Cooks River

contributing water and sediments. For example Cup and Saucer Creek has a visible input of sediments across the grain size range, from fines to coarse, contributing to the sand bank where it meets the river proper.
Figure 5 illustrates the different distributions of the unconsolidated sediments along the river course.

The fact that the next station downstream (CR02) is made predominantly of fine sands, suggests that the anthropogenic sediment input into the system has been deposited locally. The lack of coarse sediments at this location further suggests that any coarse sediment observed in stations downstream is a product each sub-catchment.

An indication of the different inputs from different catchments and of the limited sediment transport is illustrated by the closely spaced stations CR11A (group 5A), CR10A (group 5B) and CR8 (group 2) (Fig. 5).
The smaller input of coarse sediment at CR11A reflects the relatively smaller catchment serviced by the drain entering at Mackey Park as compared to that entering at Tempe Station (CR10A). The Mackey Park drain collects water from residential, commercial and industrial areas as well as some areas associated with the railway system. Similar land use predominates in the catchment of the drain entering at Tempe Station, perhaps with a greater proportion being industrial and railway system related, however the surface area is greater and thus the resultant flow is higher. The relatively smaller proportion of coarse sediment from the Mackey Park drain could also be attributed to the presence of a gross pollutant device where it enters the river.
The transport of the coarse to very coarse sand entering the river at the Tempe Station drain is limited to its immediate vicinity as CR8 has a primary mode in fine sand and silt (Appendix 1).

The identification of the anthropogenic inputs supports the need for an assessment of the local sub-catchment and for the remedial and preventive work necessary to restore Cooks River.
Furthermore the present data form a base-line database for monitoring purposes.

## Sediment Geochemistry

Sediments of the Cooks River were found to be highly enriched with trace metals with concentrations of Pb, Zn, Cu, As, Cr and Sb exceeding ANZECC sediment quality guidelines in several samples.
Sediment quality guidelines have been established for Australia (ANZECC 2001), based on the values used by the U.S National Oceanic and Atmospheric Administration (NOAA) and developed by Long *et.al.* (1995). The values proposed regard the ranges of chemical concentrations associated with adverse biological effects and set limits determining if further investigation is required.

The Cooks River has a history of industrial waste and sewage discharge, which has since been restricted by legislation (Birch *et al.*, 1996). Industrial discharge could still have an impact on the Cooks River via sewage overflow. Irvine (1980) suggests metal contributions from the sewage system are significant.

In Appendix 3 the concentrations of the 32 elements considered are given and their use in domestic or industrial activities is diagrammatically listed in Appendix 4.
The distributions of some of the elements are illustrated in figures 6-17. The ANZECC guideline values are also present for a visual assessment together with the median value of each element. Some general comments are also included although these are not exhaustive and they simply indicate the need for a more detailed analysis of land use and activities in each sub-catchment where anomalous concentrations are recorded.
In general station CR4A, at the entrance of Cooks River, shows the lowest concentrations.

*Major elements*

**Titanium** (concentrations determined as $TiO_2$) (Fig. 6).
Titanium, in trace minerals, is a component of the sediments occurring in the catchment, however some comments are needed to draw attention to some anomalies. Titanium oxide ($TiO_2$) is a white pigment typically used as a component of paint, but also used in plastics, rubber, paper, ceramics, fibres, printing inks, cosmetics, and foodstuffs (Whitehead 1991). $TiO_2$ is chemically inert.

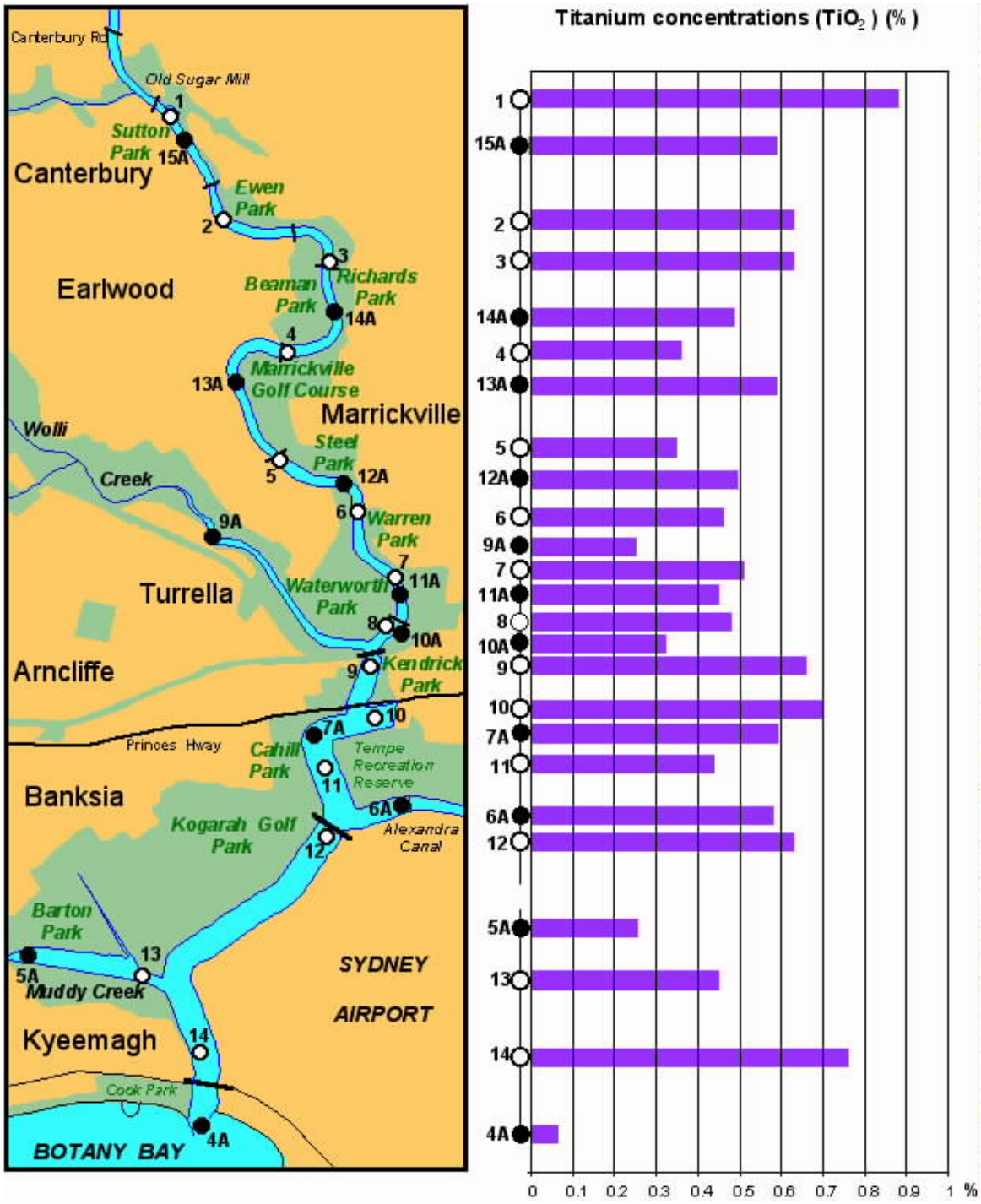


Figure 6 – Distribution of titanium concentrations

There are several elevated values of $TiO_2$:

- in the uppermost reaches of the study area, which could be due to the proximity to local input of industrial runoff contributed by Cup and Saucer Creek;
- at the Tempe boat harbor that may be related to boat cleaning and repair, or waste from a number of other activities;
- from Alexandra Canal