PAST AND PRESENT WATER-QUALITY CONDITIONS IN THE HANFORD REACH, COLUMBIA RIVER

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Abstract. Twelve water quality variables from upstream and downstream locations in the Hanford Reach of the mainstem Columbia River, southcentral Washington, were compared statistically for the two time periods 1951 to 1953 and 1986 to 1988. During the 1951 to 1953 period, beta radioactivity and, most likely, water temperatures in the Hanford Reach were significantly higher downstream than upstream, while dissolved oxygen and sulfate were significantly lower. The increased beta radioactivity and temperature downstream were due to the discharge of cooling water from five single-purpose production reactors then operating on the Hanford Site. The last production reactor closed in January 1971. During the 1986 to 1988 period, beta radioactivity and water temperatures were similar upstream and downstream, but nitrate nitrogen had become significantly higher downstream. Comparison of 1951 to 1953 with 1986 to 1988 showed, as expected, that beta radioactivity was much lower today, at essentially background levels. Phosphate in the Hanford Reach had decreased significantly over the 35 year interval, while biochemical oxygen demand, dissolved oxygen, and nitrate nitrogen had increased. These changes, while detectable statistically, were relatively small. Today, the quality of water in the Hanford Reach remains well within Washington State standards for Class A waters. Occasional low pH values, which appear to originate upriver, violate these standards.

1. Introduction

We examined twelve water-quality variables from the Hanford Reach, Columbia River during two time periods, 1951 to 1953 and 1986 to 1988. These periods are separated by 35 years, over which major changes have taken place in Hanford Site activities and over the Columbia River basin of eastern Washington. We present the results, as far as available data permit, of quantitative comparisons, first between upstream and downstream stations relative to the Hanford Reach within each period, and second, between the two periods.

The Hanford Site covers 1450 km² in the desert-steppe region of southeastern Washington. The site was selected during World War II (1943) as an isolated area to produce a new and unique radioactive element – plutonium. Since that time, Hanford has served as a national center for the production of defense materials, for energy research and development, and for environmental research. Recent work under the U.S. Department of Energy (DOE) has emphasized disposal of radioactive waste and remedial actions, as well as physicochemical characterization of the site environment. Hanford operations, for the most part, have always complied with applicable regulations on protection of environmental quality. Hanford’s long-term environmental monitoring and current site assesse-
ment programs have developed into one of the most extensive of their kind anywhere (e.g. Becker and Gray 1989).

Some Hanford activities have always required direct use and release of water from the Columbia River. From 1944 to January 1971, river water was used to cool as many as eight single-purpose Pu-production reactors and to chemically recover the desired isotopes from irradiated fuel. The single-purpose reactors used once-through cooling and released relatively large amounts of radioactivity and heat, and small amounts of chemicals, to the Columbia River in their cooling water effluent (Foster et al., 1961; Foster 1972). At first, no environmental regulations applied to these releases. But they were, nevertheless, controlled and closely monitored to avoid adverse affects on aquatic biota and people living downstream. Initial environmental studies at Hanford, especially those in the Columbia River, opened a new field of scientific inquiry – radioecology (Becker 1990).

In recent years, river water has been used to cool a dual-purpose reactor (N Reactor) that produced both plutonium and steam, an adjacent facility that converted the steam to electricity [Hanford Generating Project (HGP)], and a commercial, nuclear-fueled power plant [Washington Public Power Supply System Nuclear Project-2 (WNP-2)]. The new facilities, to comply with federal and state regulations on environmental protection, release very little radioactivity, heat, or chemicals to the Hanford Reach. These point-source effluents are controlled by National Pollution Discharge Elimination System (NPDES) permits. However, small amounts of radioactivity and a few process chemicals from past releases of low-level radioactive solutions to the ground near the interior of the Hanford Site now enter the Columbia River via groundwater seepage (McCormack and Carlile, 1984; Evans et al., 1989).

Our objective was to identify significant changes in water quality that might have occurred in the Hanford Reach over a 35 year interval. If any changes were detected, they were examined for possible links with activities on the Hanford Site or with events taking place in the upper Columbia River Basin. The selected time frames represent the best compilation of water quality data from the Hanford Reach during the production reactor era and the most recent.

2. The Hanford Reach

The Hanford Reach extends from the city of Richland at river kilometer (RKm) 545 to Priest Rapids Dam at RKm 654 (Figure 1). At this point, the Columbia River flows through the northern part of the Hanford Site and along its eastern boundary. Historically, flows in the mainstem Columbia River have alsways peaked with the spring spate, May through June, and temperatures are highest in late August and early September (Whelan and Newbill, 1983). Over the past 35 years, eleven hydroelectric and water storage dams have been built below the Canadian border on the mainstem Columbia River. Only the Hanford Reach remains flowing, but its flows fluctuate under the influence of releases at upriver dams.

The largest dam, Grand Coulee, was completed above Hanford in 1941, while another,