How drinking water reservoirs develop manganese problems?

Depends on the manganese levels contained in bottom sediments and changes in oxidation-reduction potential near and in the sediments. Normally manganese is contained in bottom sediments as insoluble particulate oxides. During warm summer months, a number of things can happen to reduce the dissolved oxygen (DO) content in the water near these bottom sediments. A lack of rainfall with inadequate mixing of fresh and stagnant water, increased algae growth, deterioration of organic matter as the water warms up, and low wind conditions, can all contribute to depletion of DO levels. If a reservoir becomes stratified as a function of temperature, the bottom layer will be very low in DO.

This leads to the development of anaerobic conditions in the deeper portions of the lake bottom sediments. Manganese is converted from oxide forms that are insoluble through bacterial action to manganese ions (Mn++) which are very soluble and now leach out of the sediments. A manganese concentration of just 0.5 mg/L is ten times the drinking water standard and can cause significant color and staining problems. One of the cheapest methods of manganese removal, chlorine oxidation, often cannot be used on such water sources due to the formation of trihalomethanes (THMs) and haloacetic acid (HAA) from the dissolved organic carbon in the water.

Under anoxic conditions (i.e. waters where oxygen is absent), increased release of iron and manganese from bottom sediments may result in elevated concentrations of these metals in the water. High concentrations of iron and manganese can impair the use of water, as the metals are precipitated upon re-aeration during the water treatment process. This is typically where the manganese problems begin during stratification.

Concentrations of phosphorus, ammonia, iron and manganese are greatly influenced by the presence of oxygen in lake water and sediments. Ammonia is a breakdown product of proteins. When little or no oxygen is present at the sediment-water interface, concentrations of ammonia can be quite high. Ammonia is toxic and represents a further threat to aquatic life. Sediments in lakes can contain a lot of iron, manganese and phosphorus. These can be released in large quantities from the bottom of the lake when oxygen levels are very low.

Iron and manganese can cause treatment problems in water treatment plants. Phosphorus released in the water fuels yet more plant growth. Bottom sediments can provide a significant source of phosphorus to prairie lakes. Phosphorus bound to the bottom sediments is released to the overlying waters when the water overlying the bottom sediments in a lake become anoxic. During the summer, most deep lakes experience a temperature-density gradient in the lake profile from warmer surface (epilimnion) waters and cooler bottom (hypolimnion) waters.

The process of establishing a density gradient in a lake, either in winter or summer, can be beneficial in slowing down manganese is termed stratification. Phosphorus-rich hypolimnetic water is isolated at the bottom of the lake if the water is anoxic and a temperature-density gradient exists. However, when the temperature gradient disappears during the spring and fall, the entire water column in the lake mixes or 'turns over'. This allows the phosphorus-rich bottom water to circulate to the lake surface where the combination of available nutrients and sunlight facilitates algal growth. An additional source of phosphorus to lake water is the resuspension of sediments. Sediments can release phosphorus and manganese when resuspended into the water column of a lake by wind action.