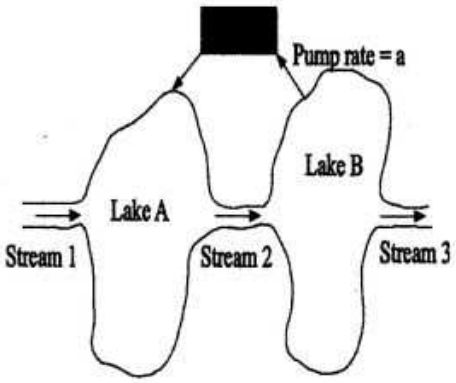
Use MAPLE 10 for this modeling assignment. Your report should conform to the requirements given in the information sheet; you should in particular describe fully how you solved these modeling problems. Use the text insertion capabilities of MAPLE to add text describing each MAPLE command before you execute it.

Two small lakes in South Alabama have been contaminated by the rather nasty carcinogen dioxin released from a local paper mill. The EPA has ordered the mill owners to clean



up the lakes within one year, and they have hired you as a consultant to model the clean up process and in particular to recommend an effective strategy for doing this in the allotted time.

Lake A contains $1,000,000$ cubic meters of water contaminated with $110,000$ parts per trillion of dioxin and lake B contains $500,000$ cubic meters of water contaminated with $1,600,000$ parts per trillion of dioxin. Lake A is fed by freshwater stream 1 flowing at $30,000$ cubic meters per day, and stream 2 flows from lake A to lake B at $30,000$ cubic meters per day; stream 3 alllows water to exit lake B at $30,000$ cubic meters per day.

1. The mill owners propose to pump water from lake B, at a rate a (cubic meters per day) to be determined, filter out the dioxin, and pump the filtered water back into lake A, at the same rate a, with the understanding that the flow rate in stream 2 from lake A to lake B will naturally increase by the same amount so as to not effect the water levels in lake A and lake B during the process. It is also understood that for technical reasons, at each instant of time only 90% of the dioxin in the water being filtered is actually removed by the filters; the rest is recycled back to lake A, to be subjected to further filtering later. The EPA has determined that the dioxin levels in both lakes have to be reduced to 0.09 parts per trillion, or less (the level of a typical US resident existing

on a vegan diet by the way), and this must be achieved over a period of no more than one year from the commencement of the clean up process. The faster one pumps the contaminated water from lake B to the filtering plant, the faster the dioxin is removed from the system. But, faster pumping uses more energy and raises the cost. Your task is to compute the lowest flow rate a for pumping from lake B, in cubic meters per day, that will effect the clean up in one year.

2. It turns out that there is a problem with this first solution. Preliminary flow tests by the mill company indicate that stream 2, connnecting Lakes A and B, can handle at most an additional flow of $a = 11000$ cubic meters per day. If this rate is exceeded, the water level in Lake A would begin to rise, leading to flooding of lakefront properties owned by one R. H. ("Bubba") Bing, a powerful local real estate developer and county commissioner. Fearful of the political consequences, the mill owners have told you to limit the pumping of contaminated water from Lake B (and consequent recycling to Lake A) to $a = 11000$ cubic meters per day. The solution entails buying more expensive filters that use reverse osmosis membrane technology, which removes a greater percentage of the dioxin. Adjust the DE's used above and find the smallest value of the *dioxin removal percentage* b (currently, $b = 90\%$) that will get the job done here.

Your report should include the recommended pumping rates for each problem, as well as the final dioxin concentations (in ppt) for each lake in each case