The problem of designing a block-precoder to minimize bit/symbol error rate when storing an i.i.d. source on a magnetic recording channel is studied. A precoder of length $b$-bits is defined by a permutation $\pi$ on $2^b$ blocks and the corresponding bit error rate is given by:

$$e(\pi) = \frac{1}{b} \sum_{i,j} H_{ij} P_{\pi(i)\pi(j)}$$

where $H$ and $P$ are the Hamming distance matrix and equivalent channel transition matrix, respectively.

We show that the problem of finding a permutation for the precoder that minimizes bit/symbol error rate is equivalent to solving the Quadratic Assignment Problem (QAP), a well-known combinatorial optimization problem. Finding an exact or approximate solution to a QAP is known to be NP-complete. We exploit the isometries of the $b$-dimensional hypercube that represents $H$ to reduce the search space, allowing a branch-and-bound technique to find the optimal 5-bit precoders. We also implement a local search algorithm that can find good precoders for larger blocklengths. Finally, we propose a modified APP-detector that allows use of precoders to generate soft-information for LDPC decoding. We then design precoders for MTR-constrained user bits and unconstrained parity bits, and we evaluate the resulting SNR gains in a turbo equalization setting.