4. PHYSICAL FACTORS AFFECTING SITING OF NAVIGATION STRUCTURES

Physical conditions affecting affecting selection of sites for navigation locks and dams include the following.

4.1 Terrain

Stream gradient influences the number of dams required and the height and spacing of dams. On a steep river, the pools will be deeper and shorter than on a river of flatter gradient. Bank heights limit the pool elevations (and dam heights) that can be used without permanently flooding lands outside the normal channel limits.

The location of tributary streams may influence dam location because of the effects of tributary flood flows on dam operation, deposition of sediment carried by the tributary in the quiet water of the navigation pool above the dam, backwater effects along the tributary related to impoundment, and sediment deposition in the downstream reach of the tributary that could increase local flood heights along the tributary. In general, a dam site immediately above a major tributary is better than a site immediately below the tributary.

The valley cross section should be wide enough for the locks and a spillway of adequate length to pass flood flows without raising water surface elevations substantially. On alluvial rivers, if the channel must be widened significantly in the vicinity of the project to accommodate the required spillway length, problems with sediment deposition are likely to occur in the vicinity of the structure.

4.2 Geology and Soils

The best foundation material for a lock and dam is sound rock at reasonable depth, but structures can be built successfully on other materials. Because geologic formations often vary radically along a river, moving a damsite a few kilometers upstream or downstream may result in safer and more economical foundation materials. Locks set on alluvial materials usually require a pile foundation for structural stability.

River banks in the vicinity of a damsite should be relatively stable and permanent. Recently formed banks are usually low and costly to protect. Leakage through the dam foundation may result in piping that threatens structural failure of the lock and dam, and impervious cutoff walls may be needed. Impervious clay blankets upstream of the dam may be used to prevent loss of water by seepage from the upper pool.

4.3 Streamflow and River Stage

The spillway of a navigation dam is designed to pass the selected maximum design discharge, typically a lesser and more frequent flow than used for the design of high dams.

Minimum streamflow must be sufficient to operate the locks and to meet other water requirements, such as leakage through the locks and dam, seepage from the pool and under the dam, evaporation from the pool, and any required consumptive uses. If minimum flows are too low to meet these requirements, special measures are needed to reduce seepage, recirculate lockage water, or supplement low flows.

If large or rapid fluctuations in streamflow are typical, frequent use of spillway gates will be required to maintain normal pool elevation.

Maximum water surface level determines the minimum height for gate piers on the spillway crest and the clearance required for overhead structures, such as a bridge across the dam. Piers must be high enough for fully-open gates to clear the maximum design water surface. Navigation dams are designed to have minimum effect on flood levels through the pool, and the backwater effect is generally limited to about one foot.

Minimum stage affects design of the stilling basin below the dam spillway. Minimum pool elevation determines the extent of lands permanently flooded and, therefore, acquired for a project. In a canalized river, the water surface in navigation pools is generally above natural low-water elevations, and minimum pool level is the major factor determining the impact of the project on the groundwater table and drainage of adjacent lands.

At the head of a pool, water surface levels fluctuate between normal pool elevation and flood stages much the same as under preproject, open-river conditions. Depending on dam height, stages just upstream of the dam may be permanently above natural flood levels.

4.4 Ground Water

Maintaining pool levels that are higher than pre-project normal low river stages will increase ground water levels in the vicinity.

4.5 Climate

The effects of humidity in areas of frequent or prolonged fog and the combination of heat and humidity in the tropics must be given special consideration, especially in design and maintenance of electrical machinery and the metal parts of structures.

Temperature range also may influence the type and design of operating machinery selected. Ice can be a problem in cold climates if there is winter navigation, and special measures may be required to limit icing on gates, trash racks, water intakes, and lock chamber walls. Even without winter navigation, navigation structures in cold climates are designed to pass large volumes of ice to avoid ice jams in the river.

4.6 Sediment

In a typical low-head navigation project, spillway gate sills are set very near river bed elevation, Figure 4.1, and spillway gates are operated to pass flood flows with a minimum of

surcharge so that essentially open-river conditions prevail at high flows and the river can continue to pass its normal sediment load.

Dams must be spaced along a river so that project depth exists in the upstream (head) end of each navigation pool, Figure 4.2. On alluvial rivers, some maintenance dredging typically is required in such reaches, and frequently is necessary to contract the channel locally to maintain sediment transport capacity at the heads of pools, Figure 4.2.

4.8 Environmental Resources

In designing a navigation project, consideration must be given to potential impacts on water quality; flora, fish, and wildlife resources; historical, archaeological, and paleontological resources; and recreational opportunities.

4.9 Infrastructure and Commercial Resources

Urban development, highways, railroads, bridges, and pipeline and utility crossings may need to be relocated or modified to accommodate a canalization project. Urban areas may be affected by changes in flooding pattern, rise in ground water levels, and pool levels that interfere with sewer outfalls. Problems in urban areas can be minimized by locating navigation dams upstream (rather than downstream) of urban areas where feasible or by using several low dams through an urban area rather than one higher structure.

Where there is extensive agricultural development in the river valley or mining in the overbank, consideration should be given to two or more lower dams, rather than a single dam, to reduce costs for land acquisition, relocations, and damages.

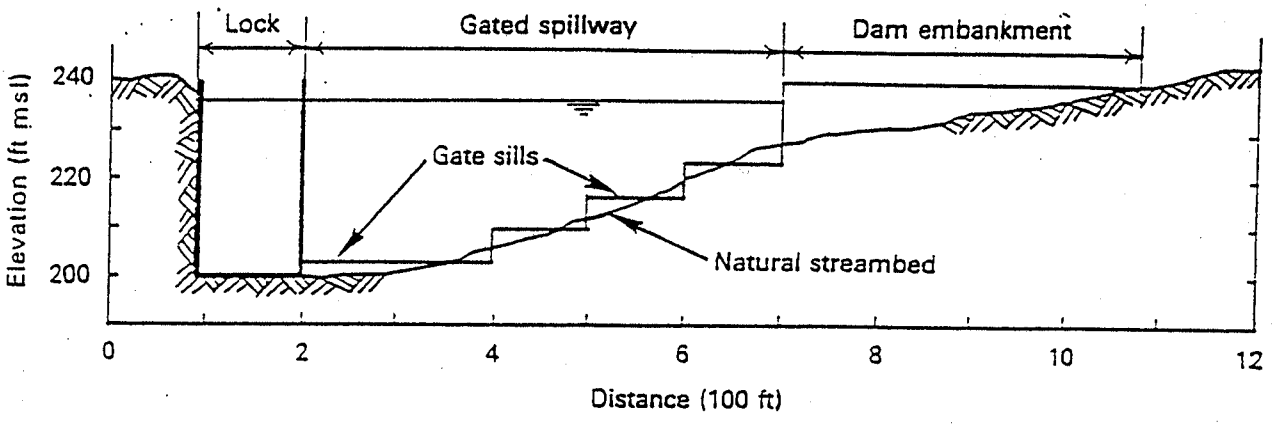

Figure 4.1 Cross section, typical low-head navigation dam.

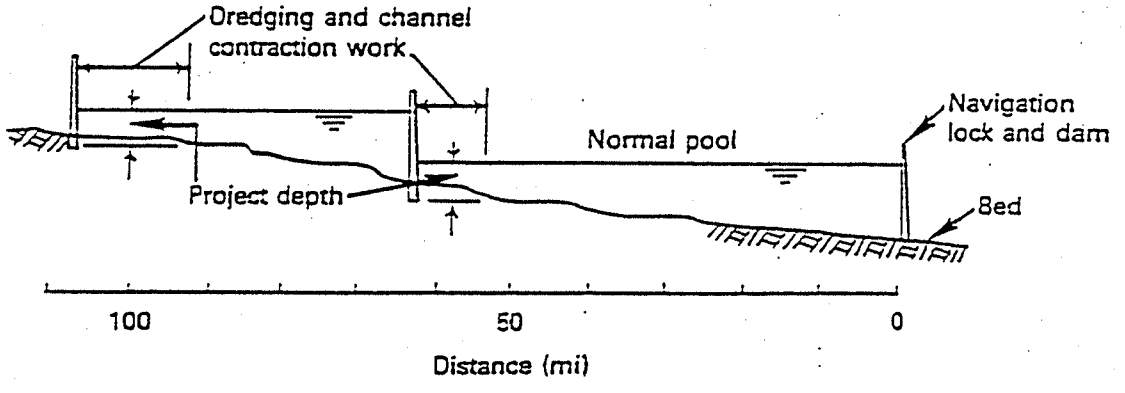

Figure 4.2 Typical location of dredging and contraction work at heads of pools.