CHAPTER 9: CONCLUSIONS

THE ARCHAEOLOGY OF WATERPOWER

The hydrology of the Middleford Mills provides a context for understanding the operation of the mills during their nearly 150-year history. The first dam was built during the 18th-century to power a bloomery forge. The dam was later rebuilt downstream to create a larger, deeper pond, that powered as many as four mills.

The data suggest several reasons why the early dam was relocated after 1805. Moving the dam downstream, and making the dam higher created a pond with a higher head loss, greater capacity, and a longer dam that may have allowed for more openings, and consequently a higher discharge capacity. The Middleford Mills were rebuilt at a time when mill engineers were gaining an improved understanding of mill hydraulics. The greater power potential of a higher dam may have been made attractive by the innovations developed by Oliver Evans. Evans' design placed milling operations on multiple floors and was more efficient than previous designs, but required more power.

However, the mill redesign happened before the science of hydrology had advanced to the point where millers could accurately predict seasonal variation in stream flow. The field of hydrology was developing in the early 19th century, but would not mature until after steam had largely replaced water as the principal source of industrial power. The 18th- and 19th-century Middleford Mills seemed to have had an adequate water supply throughout their period of operation, although the later, 19th-century dam improved this. Other early 19th-century mill sites suffered from inadequate water supply. Some mill centers in New England were designed for year-round water flows much greater than was available. The Collins works, in Collinsville, Connecticut, had enough water to run at full capacity for 164 days a year (1,000 horsepower, and 674 cfs); while the Springfield Armory Water Shops in Massachusetts probably only had enough water to run 164 days (240 cfs) and the Whitney Armory may only have had enough water to operate 100 days out of the year (Gordon 1985). That the 19th-century mills did not use all of the available capacity suggests that the enterprise was limited by market forces, rather than available water. By the late 19th century, large, centralized roller mills had come to dominate the milling industry, and may have ultimately doomed the mills as Middleford.

Flood control at Middleford Mills may have been more of a problem than water supply. The 18th-century complex may not have had enough storage capacity in the pond, or discharge capacity through the dam to adequately control storm water. The simulation suggests that the post 1807 complex likely fared better in this, although the ability of the 19th-century waste gates to discharge sufficient water to avoid flooding during high water is still undemonstrated. The archaeology at Bridge 238 suggests the location may have been prone to flood damage in the past. For example, excavation of the stream channel showed evidence of gouging from a flood during the 1930s that washed out the bridge. The gate foundations contained circular saw marks, suggesting that the original timbers had been replaced, and other features showed evidence of at least occasional repairs. Perhaps these repairs were needed because of flooding.

CONTRIBUTIONS TO EVALUATING MILL SITES

Just what can be learned from excavating a mill site is a common problem in archaeology. Review of some of the literature on mill sites, and discussion with those who have excavated mills, has sometimes shown a certain disappointment in what was actually learned about the site through excavation as compared with historical research. For example, upon completion of data recovery excavation at the East Creek Mill site in New Jersey, project archaeologists felt that excavation had not been as successful in addressing the research design focusing on milling technology as had documentary research (Morin 1991).

This is a matter of particular concern for DOTs because mills are common elements of the American landscape and are often associated with bridges. As DOTs face a growing number of bridge replacement projects across the country, the fact that many of these bridges may cross millraces, or are located along mill dams, means that the issues surrounding the evaluation of these resources will become more prevalent.

There are several reasons for the limits on the ability of mill sites to address questions concerning milling technology. The use of waterpower was a fairly conservative technology, and apart from the introduction of turbines in the 19th-century, the technology of milldams, races, and wheels may not have changed very much over time. Changes in the internal workings of mills are very difficult to get at through archaeology because the machinery from abandoned mills tended to be salvaged rather than left in place. This suggests that either mills do not have as much research potential as perhaps was thought, or that we may wish to reconsider the kinds of questions we bring to mills.

One research topic that archaeological mill sites have the potential to address is how well mill designers chose sites that would provide an adequate water supply to provide the power necessary for their operations. Recent historical research has shown that, at least among New England millers, water supply was a major problem, and that partly owing to a poor state of knowledge concerning hydrology, many mills suffered from inadequate power for their designs.

The results of the simulation conducted in the current investigation show that given detailed historical documentation of a mill system and archaeological preservation of certain of a mill district's hydrological features, it is possible to reconstruct the operating parameters of the mill complex and thereby assess the siting of the mill with respect to water supply. Particularly valuable historical data necessary for this reconstruction include:

1. Feet of fall;
2. Historical stream flow data;
3. Number of mills employed, and their horsepower;
4. Size and type of wheels used.

Archaeological dimensions that need to survive include:

1. Height of the dam (especially in areas like southern Delaware where mills were sited on the dams);
2. Width and depth of all waste gates;

3. Type of gates employed;
4. Dimensions of head and tailraces.

If all or most of these data can be collected, then it should be possible to reconstruct the optimum power needs of the mill, and how those compared to seasonal water supply. How well a mill adapted to the available water supply would provide information about how much the mill designers knew about the local hydrology (or how lucky they were) and what kinds of constraints there might have been on their business success. With these data available, the case can be made that the water control features within the mill complex retain sufficient integrity to provide important information related to economic history and the history of milling. If the complex lacks all or most of these data, then there may be little that can be learned about the hydrological operation of the mill, and thus the water control devices associated with it would be less likely to be eligible for the National Register.

THE VALUE OF MORE ARCHAEOLOGY AT MIDDLEFORD MILLS

Excavation and analysis of remains underneath Bridge 238 show that the mill-related features found there contained information that would contribute to the National Register Eligibility of the Middleford Mills archaeological district. Furthermore, the results suggest that the middle gates area of the Middleford mills may contain information important to the district as a whole as well. Excavations under the bridge there (Bridge 237) may help show how wide and how deep those gates were originally. They may also show what type of gates were used there, and whether there is evidence of past flood damage.

Excavation further west along the mill dam may show whether there was in fact once an additional race for the planing mill, as suggested by the insurance records. Excavations in the mill races themselves may show how wide the wheels were, which would allow for a refining of the formulae calculating their discharge rates.

There is also likely considerable archaeological potential within other areas of the old mill complex, and the town of Middleford. Further study could illuminate the date and function of other mill-related features identified during the GPS survey, and identify the location of the 18th-century forge. Further PIXE analysis would have the potential to define more about the history of iron making in the area. The old town of Middleford appears not to have been developed extensively since the mills were abandoned. There is therefore a potential for sites associated with the town to be fairly well preserved. All of these resources together constitute an invaluable asset to the early industrial history of Sussex County.