CHAPTER 10

SITE

INTERPRETATIONS

Introduction

It is useful to provide a general sequence of events for Cubbage Mill, as a backdrop for addressing site interpretation based on archeological studies, research context, and research themes and questions. Reconstruction of site chronology is followed by discussions of each research theme:

- Mill Location
- Evolution of technology and the manufacturing process
- Economics of the site
- The gristmill as a property type

Individual research questions (listed in Chapter 8) are grouped and addressed under their relevant theme, and designed to elicit information for a gristmill in the Lower Peninsula in Sussex County during the period 1770-1940—a manufacturing site noted in the *Management Plan for Delaware's Historical Archeological Resources* (DeCunzo and Catts 1990).

Site Chronology

Cubbage Mill was built around 1784 and was razed in 1954. During the intervening years, the mill experienced multiple changes reflecting the evolution of mill technology and necessary remodeling. Changes may be associated with renovations needed to replace or repair structural elements or mechanical parts that+ became worn out or that decayed with advancing years, with major disasters (floods and fires), or with additions to the mill structure. Evidence from the site, then, reflects transformations occurring in both the industry and at this particular site. To interpret these changes, it is necessary to determine a general site chronology that will elicit meaning from the archeological evidence.

Multiple lines of evidence (including historical research, archeological investigations, geomorphology, and dendrochronology) were used to analyze and interpret Site 7S-C-61. The information presented below weaves this evidence into a general chronology of the Cubbage Mill site (Figure 10.1).

Circa 1776-1799

John Draper constructed his mill at this location between 1776 and 1784. Although the original mill may have been built with wood beams recycled from an earlier structure, the size of the beams required for heavy mill construction make this unlikely. Draper built a dam to impound the waters of the North Fork of Cedar Creek, and built the waterpower system (wing walls, penstock, and wheelpit) into the streambed. Two beams beneath the waterwheel pit, and Penstock No. 3, are all that seemed to remain from the original 18th-century construction of the waterpower system. Historical records document a devastating flood that washed through Cedar Creek in 1799, causing the dam to fail, demolishing the original mill.

Circa 1800-1823

The dawning of the 19th century marked a new beginning for the mill, when William Draper substantially rebuilt the mill with large beams hewn from roughly 125-year-old Atlantic white cedar trees cut from virgin forests, along with any salvageable logs or beams from the original mill.

Archeological evidence includes the lower courses of two log walls related to a massive structure found parallel to the northern and western walls of the brick foundation (Figure 10.2), that probably represented the location of the rebuilt circa 1800 mill. Laid with lap joints (a corner joint construction method), the logs did not lock into place and were not built to be permanent. Draper may have chosen to expedite repairs using the faster and less expensive corner-timbering method. (The same 1799 Cedar Creek flood that demolished the original mill also damaged other mills along Cedar Creek, sending grain farmers to the first available mill in operation.) The mill did not resume operations until 1802.

Repairs by Draper were necessarily frugal for a business operating only a short period of time each year. Further, his stepfather was unwilling to contribute to mill repairs (see Volume I, Chapter 3). According to a court-documented legal battle between Draper and his stepfather, rent receipts, and the records of a trained millwright that operated the mill from 1804-1806, Draper seemed to have considered the mill a rental property or business investment.

Penstock No. 3 and its associated wheelpit represent early-19th-century remains associated with the waterpower system (see Figure 10.1) supplied by Cedar Creek, where a dam was built across the creek channel. When the mill was in use, water flowed through the penstock and wheelpit; when not in use, water flowed over the spillway. Penstock No. 3 and the associated wheelpit were dated 1800-1823, based on the flood date of 1799 and the circa 1824 dendrochronology date for a later penstock (No. 2). An activity area identified in remains found beneath the east addition floor included early (ca. 1795-1820) cut nails and wood fragments, attributing it to the same time period.

Lap joints, again, held together the 8-foot-wide x 20-foot-long beams from the wheelpit foundation, which was large enough to accommodate a nearly 8-foot-wide waterwheel with a 17-19-foot diameter. Mortise-and-tenon joints held the vertical framework in place. Dendrochronology indicates that Penstock No. 3 and the wheelpit (both constructed with lap joints) were built with hand-hewn Atlantic white cedar beams felled after 1703. Observed grade elevations suggest that an undershot type waterwheel (as expected from historical and contextual background research) operated at the site during this earliest period.

Draper petitioned the courts for a road leading from his mill to provide access to the mill by farmers and their wagonloads of grain. When the road was built is uncertain, but it is depicted on the 1821 Orphans Court Map created to show the proposed division of Draper's property (Figure 10.3).

Figure 10.3

Proposed Division of the Land of William Draper

Source: Sussex County Orphan's Court Book "M," pages 151-153 (redrawn from original).

Circa 1824-1866

Cubbage Mill continued to operate primarily under the ownership of Samuel Draper, Lemuel Shockley, and John C. and Mark H. Davis during the early-to-mid 19th century. Evidence that Penstock No. 3 was discontinued and backfilled during this period is revealed in the wood construction elements that appear to have been dismantled and reused for the new penstock and wheelpit (i.e., recycled cedar Beam 110 used in Penstock No. 2 built above the newly constructed surface over Penstock No. 3). A construction date of mid-to-late 1820s

for Penstock No. 2 and the wheelpit is provided by dendrochronological evidence--many of the new timbers were hewn from trees cut circa 1824. The beams were primarily hewn from virgin forest oak trees over 100 years old. It is assumed that the mill was still a log building at this time. Penstock No. 2 serviced the new waterwheel at the site for the next several decades. The 16x8.3-foot (approx.) wheelpit could have supported an 8-foot-wide waterwheel with a 13-15-foot diameter.

The short drop in elevation from the pond to the wheelpit and the use of an undershot wheel imply that Cubbage Mill could not have operated during times of low water flow. Engart (1933) notes that mills became unprofitable when drought led either to an inability to provide service, or to meager profits being depleted by efforts to stay in business by installing costly engines or motors. Introduced during the 1840-1850s, the switch to turbine technology from waterwheel power must have tempted many millers.

1863-1868

Changes to Cubbage Mill during this brief five-year interval included the addition of a sawmill, rebuilding the gristmill on a brick foundation, and other additions driven by economics and production. It is difficult to clearly sort the order of transformations at Cubbage Mill based solely on documentary research. Access to the mill was changed from a private to a public roadway during these five years. By this time, a dam across the valley of *both* the North and South Forks of Cedar Creek created a millpond whereby the water passed through the penstock and tailrace before reentering the North Fork stream channel east of the mill complex. The dam spillway now released water into the South Fork of Cedar Creek to maintain pool elevation (Figure 10.4).

Figure 10.4

A Portion of the Atlas of the State of Delaware by Beers and Pomeroy (1868).

The value of the mill increased considerably during ownership between 1863 and 1866 by Hiram Barber--a miller with expertise in the sawmill industry. Increased value during his ownership may be the best evidence that Barber added a sawmill at this time. There were four basic requirements for a mill containing a circular saw:

1) a track at least twice the length of the longest log to be cut;
2) a wheeled carriage or log beam outfitted with lot supports to carry the logs back and forth past the saw blade;
3) a firmly-mounted husk frame to hold the saw, bearings, etc. in place at the midpoint of the track; and
4) a power source capable of turning the saw blade and moving the carriage.

The capability of cutting a 20-foot log required a track that was at least 41-feet long. If the sawmill was confined to the mill built on the brick foundation, then the circular saws could accommodate a log no longer than 11 feet long—too short to meet many of the lumber needs of the time. It is likely that the east addition became a necessary improvement to house extended sawmill tracks.

1866-1880

Millwright Charles Miles likely completed Barber's renovations. Tax assessment value increased 75 percent from Miles' purchase in 1866 ($2,000) to 1868 ($3,500) when it is listed as a sawmill and gristmill (Sussex County Land Tax Records 1866, 1868), indicating that the sawmill and new mill structure were completed by the 1868 assessment. The miller's house and a barn were also included in the insurance policy purchased by Miles in 1868. The policy describes the mill complex as a two-story frame building measuring 24x40 feet with a 10x20-foot addition--considerably larger than the 24-foot (N-S) by 20-foot (E-W) brick mill foundation—with two sets of millstones, two circular saws, and two turning lathes. Because sawmill and gristmill equipment requires a solid foundation to minimize vibration to mechanized parts, the mill was likely rebuilt during this period, probably with lumber cut at Cubbage Mill.

Miles invested heavily in mill renovations during his ownership. Taking full advantage of the impounded pond and associated raceways that had survived earlier occupations, Miles rebuilt his new mill nearly on top of the earlier foundation. Striving to improve mill business and increase economic returns, Charles Miles is the owner most likely responsible for introducing a turbine-power system, after dismantling the waterwheel and converting the wheelpit to a turbine chamber, likely using the same penstock and tailrace.

Charles Miles was not an owner-operator; rather, two hired hands who resided at the miller's house operated the sawmill and the gristmill. As a millwright, Miles likely purchased Cubbage Mill as an investment property.

Deed research indicates that that Miles sold the mill at a loss and moved to Minnesota. The loss in value may have been the result of flood or fire damage—common events experienced by Cubbage Mill owners.

Circa 1880-1899

Sometime in the 1880s, a fire apparently damaged the mill and prompted interior restorations, evidenced by the archeological record of burned timbers and bricks resting atop the brick floor. Archeological investigations revealed a layer of flood deposits between the burned debris (above the brick surface) and the circa 1900 concrete floor. These soil deposits may indicate a hiatus of several years when the mill was not in operation. It is also possible that sawmill operations were abandoned at this time and the building modified, as reflected in repairs to the northeast and northwest corners of the brick foundation.

The 1880 Manufacturing Census indicates that the John DuBois sawmill employed two hired hands who cut approximately 100,000 board-feet that year (1879). Based on the rate of pay for the two employees and annual wages, the sawmill only operated about 75 days that year.

Circa 1900-1954

By the turn of the 20th century, the mill concentrated singularly on meal production (Photograph 10.1).

Photograph 10.1

Oakland Roller Mills of Samuel Cubbage. Looking Southeast. Photograph ca. 1910-1915.

Credit: Mrs. Mitch (Lottie) Jones, Lincoln, Delaware

Owner Frank Davis, trying to bolster his small custom operation, installed a metal-roller grinder at the site. In 1900, the concrete culvert and concrete turbine pad were installed, marking a significant improvement over the wooden penstocks and wood-lined (turbine) chamber that characterized the site for the past century. A concrete floor covering the

interior of the mill, and part of the east mill addition were also added during this period (see Figure 10.1).

Available records indicate a significant decline in agricultural production during the first few decades of the 20th century. Despite the realities and dour economic forecast, Samuel Cubbage—a miller who had tried farming—bought the mill in 1908. Working the gristmill until 1921, the pond still bears his name. Other activities likely took place here, as evidenced for example by the presence of a wheelwright shop in the early 20th century (Tom Brewer, personal communication 1998). Additional turbines and engines at the site at this time significantly expanded the capabilities of the operation.

The short list of owners over the next two decades seem to have survived the local economy by supplementing mill income with other ventures. Edgar Waples, who operated the mill from 1921 to 1928, produced flour and cornmeal (feed), while also owning a blacksmith shop and providing produce, fishing supplies, and general merchandise to Cubbage Pond tourists and vacationers (Jane Waples Serio, personal communication 1998). There is little evidence that these owners improved conditions within the mill or at the site. Cubbage Mill was transferred through final sale in 1954. Records suggest that the new owners razed what remained of the abandoned mill, which had become a fire and safety hazard (see Figure 10.1).

Mill Location

Water-powered industries are dependent upon their environmental and cultural settings. Ideally, a mill seat was located in a relatively flat setting near a stream that provided an adequate water supply for generating power. At the same time, it was advantageous to select a location that might avoid frequent flooding and that did not infringe on the water rights of nearby landowners.

Evaluation of Cubbage Mill's geographic location is based on evidence collected during this study that suggests some significant problems were associated with the natural setting of this mill seat. The gentle slope of the Coastal Plain and the slow-moving Cedar Creek contributed to marshy conditions in the vicinity of Cubbage Mill. This study determined that the wheelpit and penstock was partially constructed on a layer of peat (an accumulation of partly decomposed plant remains formed in soils waterlogged by high levels of rainfall, or an area where water naturally accumulates). These anaerobic waterlogged soils slowed plant decomposition and contributed to preserving the remains of the wood penstock. Essentially, then, the penstock, wheelpit, and tailrace, redirected a section of Cedar Creek from its former channel. While channeling the stream may have taken place during the late-18th century (when the mill was first built), it more likely occurred after the mill dam (creating Cubbage Pond) was constructed.

The mill foundation was cut into a natural escarpment along Cedar Creek at a higher elevation than the ponds (formed in marsh after heavy rains). Soils indicate that the stream once flowed through the area of TU3 (within the east addition), but the stream channel was redirected to the mill. This area of the site was subjected to frequent flooding, despite alteration to the stream channel. Geomorphology (Appendix D) and archeology studies indicate that poor drainage also exposed the mill to flooding hazards.

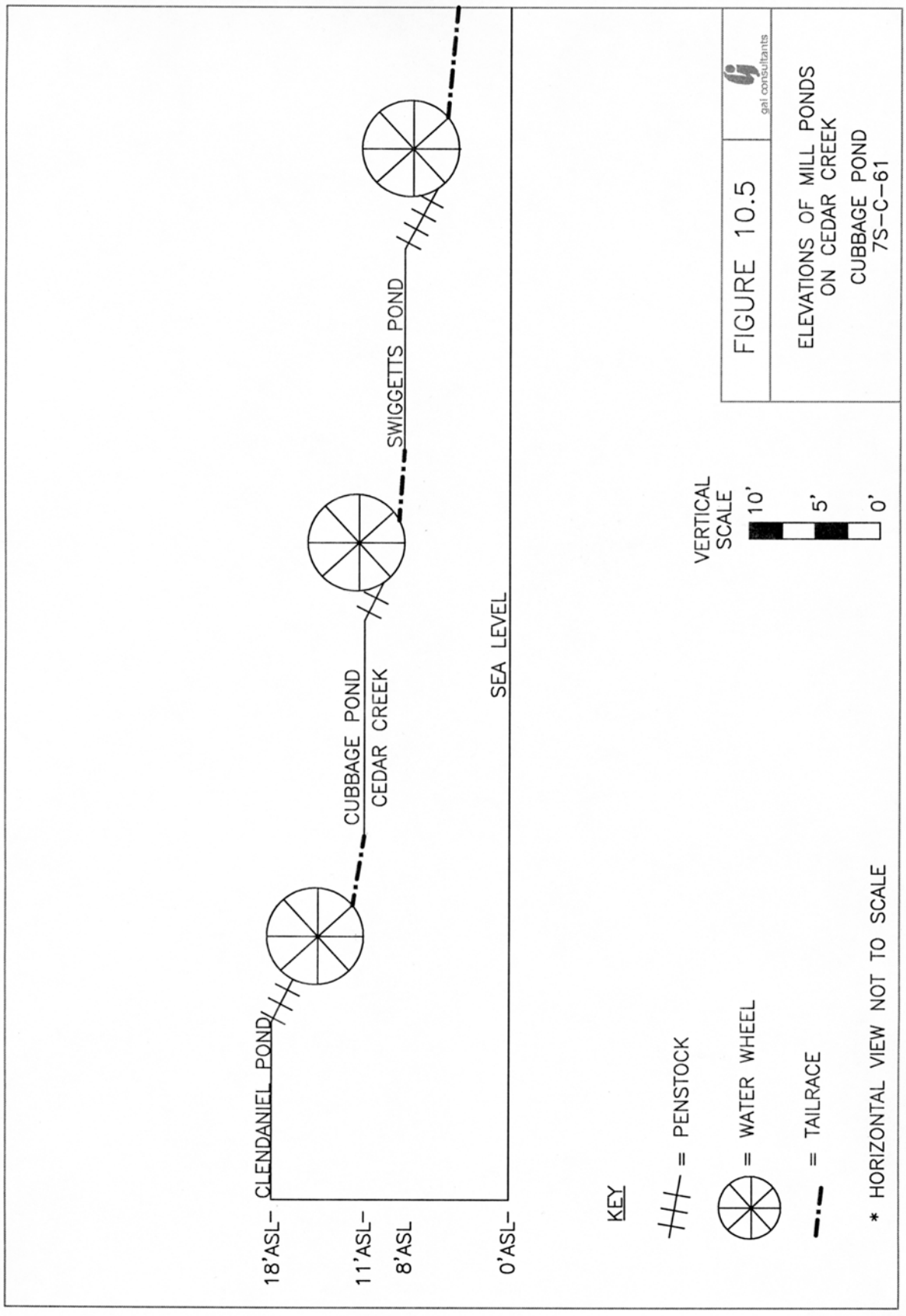
As virgin forests in the region were harvested, (water) runoff would have contributed to topsoil washing into the streams. Millponds trap much of the suspended silts and sands that, over time, would have diminished water capacity. One should note that a water-powered mill could only operate until the draw-down of the pond water was at or above the crest of the sluice gate; then, the miller would have to wait until the stream replenished the water supply to resume operations. Heavy rains likely caused frequent flooding because the dam did not have the capacity to impound much more than the water required to operate the mill for two or three days at a time.

Excavations at the 18th-to-19th-century Middleford Mill in Sussex County (Crane et al. 2002:80) reported that penstocks were usually constructed with trash racks, designed to filter debris that would otherwise impede or damage the waterwheel. As an increased measure of safety, the miller and his staff spent considerable time physically maintaining the dam and gates to reduce the occurrence of breaches. Nevertheless, such accidents still occurred, often destroying the immediate site and threatening mills located further downstream.

A review of mill excavations and historical documents indicates that similar sediment issues and water-control problems were common at other Delaware mills. At the Middleford Mills complex in the Nanticoke River watershed of Sussex County, GIS analysis suggests that the 18th-century mill, and possibly the rebuilt 19th-century mill, "may not have had enough storage capacity in the pond, or discharge capacity through the dam, to adequately control stormwater" (Crane et al. 2002: 109). In all likelihood, the lack of adequate data on the area hydrology in 18th to 19th century Delaware made mill construction a risky business, especially for individuals unfamiliar with the region.

As noted above, archeological evidence indicated the presence of significant flood deposits within both the brick mill foundation (set into the escarpment) and the east mill foundation (partially located within a marshy area of the pre-millstream channel). Several Nor'easters hit southern Delaware during the excavations, creating a pond in the tailrace and around the penstocks, covering the southern end of the east addition—a clear demonstration of the water damage potential of downstream flooding to foundations (mill building and waterpower system) that mill owners/operators faced.

Waterpower availability at Cubbage Mill can be compared to two other nearby mills along Cedar Creek. Of the three mills (Clendaniel, Cubbage, and Swiggerts) built on the lower reaches of Cedar Creek, Cubbage Mill had the least amount of head (i.e., drop in water elevation available for power generation (Figure 10.5). There was about a 3-foot drop in elevation from Cubbage Pond (11 feet) to Swiggetts Pond (8 feet). The drop in elevation from Clendaniel Pond (18 feet) and Cubbage Pond created a head of nearly 7 feet. Cubbage Pond's head of only two to three feet dictated either an undershot wheel or a horizontal or "tub" wheel. The horizontal wheel did not generate enough power for most gristmills, and neither the undershot nor the horizontal produced as much power as a breast or overshot waterwheel. It appears then, that in the early period, Cubbage Mill used an undershot wheel as a power generator.


CLENDANIEL POND
CUBBAGE POND
CEDAR CREEK
SWIGGETTS POND
SEA LEVEL
18'ASL
11'ASL
8'ASL
0'ASL
KEY
= PENSTOCK
= WATER WHEEL
= TAILRACE
* HORIZONTAL VIEW NOT TO SCALE
VERTICAL SCALE
10'
5'
0'
FIGURE 10.5
gai consultants
ELEVATIONS OF MILL PONDS
ON CEDAR CREEK
CUBBAGE POND
7S-C-61

Advances in technology mitigated problems associated with an inadequate water supply. In the mid to late 1800s, turbines were widely introduced at mills across the region for their increased efficiency. Turbines were smaller than the conventional waterwheel and, able to operate at higher speeds, providing greater power. They could also operate during most drought conditions, and reduced maintenance costs by being able to operate below the waterline where they were better protected. The advent of turbine technology expanded the length of operation for a mill, including Cubbage which, based on documentary research, switched to turbine power around 1868.

Question: Was the mill placed in a beneficial location for a mill seat? Based on information collected to date, the location for Cubbage Mill had many drawbacks. Flooding, a heavy structure built on wet unconsolidated sand, and minimal head available for generating waterpower were constant problems, from its initial construction until ca. 1868, when the mill switched to turbine power.

Several past problems were addressed in the process of accommodating the transfer to turbine technology. First, the new penstock, built on a foundation of large beams held together with mortise-and-tenon joints, provided a more secure construction method. At that time, steps were also taken to insure a more stable foundation for the main mill structure.

Archeologists observed numerous wooden stakes underpinning the foundation, confirming the tenuous nature of construction on saturated soils. Vertical cribbing was in place to keep water from undermining the western and southern foundation walls and portions of the penstock and wheelpit (Photographs 10.2 and 10.3). Clearly, there were ongoing efforts to stabilize the foundation, such as the addition of wood blocks to support wooden sills (brick foundation) and brick nogging between the piers.

Photograph 10.2

Vertical cribbing placed to protect the south end of the west foundation wall from water.

Photograph 10.3

Vertical Cribbing around the Penstock and Wheelpit.

Wet, loose sand continued to be a problem, however, resulting in later measures to stabilize the foundation. Flooding events also continued, as evidenced by the presence of sterile flood deposits capping burned debris atop the brick floor. By 1900, mill owners added a concrete floor, culvert, and turbine pad.

Based on information presented here, Cubbage Mill experienced frequent problems as a result of its natural environment. This may also be true for many of the mills in portions of Sussex County and the Delaware Tidewater and Coastal Plain, where the gently sloping terrain and broad stream valleys would have presented a challenge in identifying a suitable mill seat. That the mill continued to operate with some success until the early-20th-century, indicates that the owners were able to compensate for the many drawbacks of location.

Question: Was there enough demand within the local community for mill services? The second research question is addressed by thorough documentary research (see Chapter 3). In his discussion of early gristmills, Engart (1933) noted:

> "…the era of easy transportation, good roads, and patent flour was then still in the future. Most people in a certain locality were forced to patronize the nearest mill because the expense, time, and the difficulty of hauling grain to another mill and then going for the finished grist was [sic] too great."

In this case, there were three gristmills associated with three millponds (Clendaniel, Cubbage, and Swiggetts) in close proximity to each other, sharing water privileges of Cedar Creek. Each mill was equally accessible by road to local residents. Because Cubbage Mill was flanked by the other two gristmills, its customer base would likely have been slighter than its neighboring mills. Cedar Creek, a small community established near the easternmost of the three mills (Swiggetts Mill), would have enjoyed a competitive location advantage over Cubbage Mill.

By the early-20th century, mill owners expanded into other business enterprises to supplement their income. This was a time when large commercial mills were producing

flour and meal in direct competition with locally-owned mills—an emerging national trend that led to the abandonment of numerous custom gristmills.

Based on information collected, it did not appear that Cubbage Mill was highly profitable for most of the 19th and 20th centuries. However, various mill owners continued to purchase the mill, attempting to turn it into a profitable business enterprise.

Question: Was there adequate transportation to the mill? Mills played an important role in any 18th- or early-19th-century community, especially those in farming regions where grains were transported to the mill in wagons and reliable transportation routes were critical. It was not until 1807 that William Draper petitioned the Sussex County court for permission to build a road leading to the mill. Soon thereafter, his private road was completed and later, improved as a public road.

The nearby town of Lincoln was established in the late-19th century. Cubbage Mill was described as being located "on the road leading from Lincoln to Milton" (Kent County Mutual Insurance Policy 1868) that later became a major transportation link for area residents.

Summary

Based on information presented here, the location of Cubbage Mill had major problems. Advances in technology—particularly the switch from the waterwheel to turbine power and from grinding stones to a roller mill enabled Cubbage Mill to compete with neighboring mills.

Except for the sawmill component listed in the 1880 Manufacturing Census, Cubbage Mill did not reach the $500 threshold necessary to be listed in the Industrial Census. Of the three mills located along this part of Cedar Creek, Cubbage had the lowest proceeds, which might also explain why, despite Charles Miles' investment in upgrades, renovations, and additions (sawmill), the mill was still sold at a loss. While Cubbage Mill provided a vital service in the area as an agricultural-processing industry in the 18th and 19th centuries, it never quite realized the success envisioned by many of its owners.

Evolution of the Technology and Manufacturing Process

The second research domain involves changes in mill structures that could shed light on variations in mill technology and/or the manufacturing process. A summary of construction elements and their change through time is presented as part of the background information for individual research questions. Construction and technology changes are briefly described below and summarized in Table 10.1.

Table 10.1

Construction Details at Cubbage Mill Site

MILL BUILDING	FLOOR	PENSTOCK	TURBINE WHEEL PIT	OTHER SITE AREAS
(1776-1784)-1799 (MILL BUILT BY JOHN DRAPER)				
A flood in 1799 broke dam and demolished original gristmill			Two beams found beneath original wheelpit associated with Penstock No. 3 represent earliest evidence of a wheelpit. Based on elevation between pond and wheelpit, use of an undershot wheel is likely.	
ca. 1800-1824 (MILL REBUILT BY WILLIAM DRAPER)				
Early mill remains are most likely associated with the rebuilt (north and south wall) log mill building. The logs were one+foot in diameter, left in the round, with lap-joined corners. The lower 4 to 5 courses were still intact.	Possible wood plank floor (found beneath brick floor within (brick) mill footprint).	Penstock No. 3: box frame of exterior beams, interior joists held in place with lap joints, lined with vertical cribbing; also plank floor, beams hand-hewn, mostly of Atlantic white cedar.	Wheel pit associated with Penstock No. 3 foundation of east-west beams held together with lap joints. Measures approx. 20x8 feet, indicating a waterwheel with a maximum width of about 7.6 feet and a maximum diameter of 19 feet. Vertical cribbing and a plank floor provided additional support; mortise-and-tenon joints held vertical framework in place. The weight of the waterwheel supported by wood pillow blocks. Wheel pit made from hand-hewn beams, mostly of Atlantic white cedar.	Petitioned for a road between Draper's (Cubbage) Mill and William Martin's land in 1807. Activity area identified by wood fragments and early cut nails located in the area of east addition.
ca. 1825-1863 (ROUTINE MAINTENANCE UPGRADES)				
Rebuilt log mill was likely still in use		Routine maintenance upgrades resulted in constructing Penstock No. 2 over the foundation of Penstock No. 3. Penstock No. 2 foundation had a "box-like" frame securing three interior joists (all beams w/mortise-and-tenon joints); likely had vertical cribbing and plank floor, solid construction designed for maximum stability and support. Beams generally made from mature (131-233-year-old) oak and a recycled beam of Atlantic white cedar. Both hand-hewn and cut (circular saw) beams were used in construction.	Waterwheel was replaced, and wheelpit rebuilt to fit new waterwheel. Wheel pit associated with Penstock No. 2 had a base built with parallel beams, necessitating crossbracing on vertical posts to secure framework. Cribbing surrounding the wheelpit and floor planking provided additional stability. Wheel pit associated with Penstock No. 2 was built on top of earlier wheelpit. New wheelpit measured approx. 16x8.3 feet and could have supported 8-foot-wide waterwheel with max. diameter of 15 feet. Breadth was several inches narrower, and diameter several feet smaller than previous waterwheel.	Evidence of a flood episode was found across the site.

MILL BUILDING	FLOOR	PENSTOCK	TURBINE WHEEL PIT	OTHER SITE AREAS
ca. 1863-1868 (MAJOR MODIFICATIONS BY HIRAM BARBER AND CHARLES MILES)				
Mill was rebuilt. New brick mill foundation measured 24-1/2x21 feet and was of hand-made common bricks. Foundation had a plinth base—usually found on (heavy) load-bearing walls. Bricks were laid in American bond w/mortar and set on wood sills cut with a circular saw. Sills laid on brick piers (mortared). Later, wood piers (blocks of wood with planks) were added, and brick nogging was placed in interstices between piers for extra support.			Wheel pit was converted to house a chamber for the turbine. The wood used included hand-hewn and cut (circular saw) beams, indicating reuse of old beams and timber.	East addition built on brick piers with a wood floor. Addition was accessed through door opening on east wall of brick mill foundation, and measured at least 24x20 feet. East addition frequently flooded. Based on early-20th-century Photographs, it comprised a 2-story addition with a shed roof. Location of sawdust (outside north foundation wall of brick mill) likely indicated the presence of a north addition to support the track length needed for two circular saws.
ca. 1868-1880 (SAWMILL AND GRISTMILL IN OPERATION)				
The log mill's north and west wall (lower courses) now serve as retaining walls. Posts driven along the east side of the west (log) wall section prevent it from collapsing into the new mill building. Evidence (wood shavings) of the turning lathes found inside the mill.	A brick floor, made with bricks and brick bats (half brick or larger pieces) and laid on a bed of sand, covered the floor of the new mill building. Bricks are at the same elevation as lowest course of foundation bricks. The floor was constructed around machinery already in place.			The North Addition, likely damaged after a fire in 1880, was not rebuilt. (Note: no archeological evidence of the North Addition was identified during excavations.)

MILL BUILDING	FLOOR	PENSTOCK	TURBINE WHEEL PIT	OTHER SITE AREAS
ca. 1880-1899 (SAWMILL COMPONENTS REMOVED FROM COMPLEX - CIRCULAR SAWS, TURNING LATHES)				
Evidence of fire and flood episodes was observed within mill.	Burned brick floor and burned wood found on floor indicate a major fire.	Penstock No. 1, lower course, was built over the foundation of Penstock No. 2. Many of the beams were made from white oak trees, 41-75 years old when felled, except for some recycled beams from trees over 100 years old.	Turbine chamber associated with Penstock No. 1 built over previous turbine compartment foundation. Tulip Poplar was main wood type found in construction.	Flood damage and flood deposits noted across site.
ca. 1900-1950 (FRANK DAVIS RENOVATES MILL WITH CONCRETE, AND CONVERTS TO ROLLER MILL; KEROSENE GENERATOR ADDED)				
Grinding mechanism switched from sets of millstones to metal rollers. Product is now custom animal feed (corn). Brick mill foundation continues as main mill structure. Encountered brick machinery supports on new concrete floor, as well as two anchor bolts (machine mounts). Early 20th-century Photographgraph shows structure as a three-story wood frame building with a brick foundation; two additions to the south and two additions to the east. There was a door on each floor on the north side of the building for hoisting grains to top of mill.	Concrete floor placed atop burned debris and flood deposits capping brick floor. Brick footers, serving as machine supports and hardware were present.	Parallel beams and vertical posts recycled from Penstock No. 1 supported concrete culvert measuring about 8-feet-wide x 5-feet-high. Constructed with parallel north-south trending beams held together with crossbraces and cribbing. The few beams subjected to closer analysis were recycled white oak logs from older (66-130-year-old) trees, with red oak (46 years old) and Tulip Poplar posts. Vertical cribbing indicates that this penstock was built before the concrete floor was added, and then modified to support the new enclosed water-delivery system.	Base of turbine chamber was a concrete pad which rested on beams; vertical supports were used to help support the concrete pad and turbine. The size of the turbine chamber was approximately 7 feet by 9 feet. Water exited the chamber through a 1.7 ft by 3.5 ft rectangular hole in the concrete pad. Turbine mount added for second turbine-- in this case, the water exited through a 4-foot diameter hole in the base of the concrete pad. A mount for the turbine was built into the concrete.	Concrete floor covered part of the east addition; cut sandstone was used for machine supports. The north addition was not needed after the sawmill operations ceased c. 1880, and was likely removed (or was burned and not rebuilt) at about this same time

The earliest construction evidence indicates that the mill was originally a wooden structure built with logs in round and lap joints (see Table 10.1). Penstock No. 3, which appears to be contemporaneous, was built with lap joints for the joists of the penstock base. The wheel pit measured approximately 20 feet long and 8 feet wide, and could have held an undershot waterwheel nearly 8 feet wide and up to 19 feet in diameter. Dendrochronology analyses indicate that both the penstock and wheel pit were built using mainly hand-hewn beams of Atlantic white cedar from trees that were more than 100 years old when they were felled. Evidence of a plank floor, beneath the brick floor, may be associated with the earlier log mill, as were wood fragments and early cut nails found beneath the east addition.

The major rebuilding of the mill in circa 1863-1868 resulted in major changes to the structure and waterpower system (see Table 10-1), to include tearing down of the south and east walls of the log mill and the slightly shifted (east and south) mill footprint, probably to make additional room for the road over the mill dam.

The penstock was rebuilt with a sturdy foundation of wooden beams tied together using mortise-and-tenon joints. The wheel pit, made for an undershot wheel measuring about 8 feet wide and up to 15 feet in diameter (wider, yet slightly smaller in diameter than the previous waterwheel) was converted for use as a turbine. The remodeled wheel pit employed both hand-hewn (recycled) and cut (circular saw) beams.

A complete sawmill component was added to the mill, to include two circular saws and two lathes, and would have required a long building to house the circular saws, likely an addition to the north or east. This may have been an open structure built on a wood (post) and pier foundation with a crawl space, rather than a full-height basement. While the east addition was documented during excavations, no clear evidence of a north extension was identified. However, a layer of sawdust found along the north side of the mill potentially indicates the presence of a North Addition for the mill.

It appears that a fire damaged the mill around 1880, possibly marking the ending of sawmill operations. After the fire and prior to 1900, floodwaters deluged the mill, leaving a thick layer of sand inside the mill building. The flood may have caused significant damage to the east addition, which was closer to the stream/tailrace and at a slightly lower elevation than the mill.

The year 1900 marked another major construction period for the mill—once again, this was accompanied by changes in technology (see Figure 10.1). At this time, Frank Davis replaced the wood penstock with a concrete culvert, and the turbine was housed in concrete, perhaps to prevent floodwaters from destroying the penstock and reducing vulnerability to water damage. A kerosene-powered generator was placed in the addition to run the mill during droughts and when the turbine was not operating. Documentary research indicates that the gristmill was switched to a roller mill at about this time.

Question: What parts of the mill complex have been documented? Archeological investigations identified evidence of buildings, including a log mill and a brick mill with an east addition. A possible outbuilding was identified to the northeast—its function could not

be determined owing to flood damage. Investigations also uncovered information on the waterpower system, including a sequence of penstocks and turbine/wheel pits. Beyond the mill itself, archeological investigations identified the mill pond, mill dam/bridge, and sluice gates. The mill dam/bridge impounded and traversed the North and South Fork of Cedar Creek and the marshy floodplain in-between. Built along the North Fork, sluice gates allowed water to flow through the mill and exit into the tailrace and Cedar Creek. The South Fork typically served as the only pond (water) outflow when the mill was not in use.

Question: How did construction methods at the site change over time? Excavations determined that the main mill building evolved from a log to weatherboard structure built on a brick foundation. The brick foundation was laid on beams that served as sills resting atop brick piers. Later, wood piers were added to provide stability and support to the sills. The brick foundation displays evidence of being designed to stabilize the structure in unconsolidated soils. Sills were laid across brick piers to provide a stable footer for the building, which undoubtedly was subject to settling. [Settling could affect the belts, gears, and drive shafts (including the machinery at the mill) and result in increased wear and tear of these important mill components.] Placement of wood piers under the sills (between the brick piers) may not have been sufficient for stabilizing the foundation since brick nogging was later used to fill in the gaps between the wood and brick piers under the west foundation wall.

The brick mill did not provide sufficient linear floor space to meet the typical needs of a sawmill; therefore, it is likely that there was another addition, beyond the east addition, that was also built on wood. It is plausible that this structure was located to the east of the east addition or north of the brick foundation. Three floor types were found associated with the mill buildings: wood plank floors, followed by a brick floor, and finally a concrete floor. (Information on these constructions is found in Chapter 9 and Figure 10.1, Table 10.1).

Question: How was the water-delivery system modified over time? Because of excellent preservation, archeological investigations documented at least six distinct episodes of rebuilding associated with the mill's water-delivery system:

1) pre-1800 (beams beneath wheel pit associated with Penstock No. 3);

2) circa 1800-1823 (wheel pit and associated Penstock No. 3);

3) circa 1824-1866 (Penstock No. 2 and associated wheel pit);

4) circa 1867-1880 (Penstock No. 2 and wheel pit converted for turbine use);

5) 1880-1899 (Penstock No. 1—lower course and turbine chamber base); and

6) 1900-1930s (concrete culvert and concrete turbine mounts, upper course of Penstock No. 1).

The size of the wheel pit changed slightly over time, indicating that the undershot wheel dimensions also changed. The waterwheel, like other wood subjected to alternating periods of wet and dry conditions, would have rotted and required occasional replacement (see Chapter 9 and Figure 10.1).

Question: How did the power source of the mill change over time? Information obtained from excavation of the water-delivery system, landscape analysis, and documentary research addressed changes in the mill's power source. The original power source (gristmill) was an undershot waterwheel, using water from the North Fork of Cedar Creek. The turbine/wheel pit associated with Penstock No. 2 indicates a conversion from an undershot water wheel to a more efficient water-powered turbine (circa 1863-1868). By this time, a dam had been built across Cedar Creek, creating a large pond that served as the primary power source for operating mill equipment. Archeological excavations and informant interviews (Appendix E) documented a backup (kerosene-powered) generator placed in the east addition during the early-20th century, likely used during periods of low water or, perhaps, during the cold winter months.

Question: Does the site display evidence of technological innovations? Site remains illustrate construction adaptations that apply to Cubbage Mill's built environment. This was shown in the adaptive reuse of two construction walls of the log mill to form retaining walls for the newer brick structure. Posts placed on the mill side of the wall sections secured the logs in place, away from the brick structure.

Most importantly, Frank Davis solved the problem of water escaping from the penstock by creating an enclosed waterpower system in 1900. Water from the millpond was channeled into a concrete culvert from the wing walls, beneath the road, and then through a chamber housing the turbines before exiting into the tailrace.

Summary

The site displays evidence that the mill building, water-delivery system, and power system changed over time. Many mills were making similar changes to stay competitive. Documentary research (Appendix F) and informant interviews discussed in Chapter 3 provide an overview of the shift at Cubbage from a custom gristmill to a grist and sawmill, and finally to a roller mill for the production of primarily animal feed. (Technological innovations associated with grinding grain would be found in the equipment used at the site and was not part of the archeological record.)

Economics of Cubbage Mill

The third major research domain addresses economics of Cubbage Mill, which operated as a gristmill for more than 150 years, with an associated sawmill complex for more than 20 years. While the long lifespan of the mill would seem to suggest at least a moderately successful business operation, documentary research indicates otherwise. Draper built the mill toward the end of the 18th century. A series of court proceedings in the early-19th century indicated that repairs to the mill (1804 and 1806) made by millwright John Spencer cost more than the mill rents and tolls. There was also evidence of a fire at the site sometime

prior to completion of Barber's and Miles' major renovations in 1868. The outlay of capital required to rebuild or repair any damage would have reduced profits generated from the mill at this time.

The real estate value of the mill varied widely during the mid- to late-19th century. Mark Davis and his wife sold the mill and 36 acres to Hiram Barber for $2,500 in 1863. Barber ran a successful operation during his four years of ownership (Runk 1899) and sold it to Charles Miles for $4,200 in 1866. Since Barber had a background in sawmill work, it is possible that the increased valuation is the result of adding a sawmill component at the site.

Documentary research indicates that Miles renovated the grist and sawmill operations between 1866 and 1868, as well as building the miller's house and nearby barn. He had two tenants or hired hands that operated the mill and lived in the miller's house during this period. In 1879, Miles sold the mill to John DuBois for $2,000--$2,200 less than his purchase price, despite the fact that the property now included the miller's house and a large barn. Archeological evidence of a fire in the main mill building between 1879 and 1880, along with a major flood, spelled a series of misfortunes at Cubbage Mill that may have led to the absence of a listing in the 1879-1880 local business directory (Peninsula Directory 1880), and the significantly reduced property value when John DuBois purchased the mill.

Archeological and documentary evidence is further confused by the 1880 Manufacturing Census, which lists John DuBois' sawmill (but not the gristmill) at a value of $3,000. The sawmill operation employed two part-time hired hands that were paid a total of $150.00 in wages the previous year. The men worked 10-hour days for just under 75 days to produce about 100,000-boardfeet of lumber for the year. While it is possible that the gristmill did not generate enough income to be listed, no other sawmills or flourmills were listed for the Cedar Creek Hundred in the 1880 Manufacturing Census. The census data seems to indicate the DuBois generated a profit at the mill prior to the fire and floods discussed above.

The mill was sold twice in 1881, ending up in the hands of Mark Davis and his business partner, Bevins Cain. In the 1890s and early-1900s, the operation focused on grinding corn for cattle and poultry feed. At about the same time, it switched to a rolling mill to try to recapture some of the local market. Davis sold the mill to his son in 1892 for $6,000, reflecting a profitable business and/or major improvements to the mill.

Samuel Cubbage purchased the mill from the Davis Family in 1908, long after the time when most local mills ceased operations because of competition from larger commercial roller mills. A Photographhgraph from this period illustrates a well-maintained mill (see Photograph 10.1). Cubbage and his son were both listed in the Milford Directory (Polk 1908-1909) as farmers, poultry keepers, and fruit growers, perhaps indicating that multiple sources of income were needed to supplement mill income.

Edgar Waples purchased the mill in 1921 for $4,500, a decrease of $1,500 in property value between 1892 and 1921. Waples built and operated a general store and blacksmith shop on the property, and rented small cottages to tourists to supplement family income.

Question: Was the mill a successful business during the period it was in operation? There were three notable periods when the mill seemed economically successful during 150+ years of operation. The first was when Barber purchased the mill and added the sawmill component, followed by Miles' rebuilding the mill and adding the miller's house and a barn (1863-1870). A fire, however, prevented continuous prosperity. It appears that, for a brief time, John DuBois' sawmill was profitable (circa 1878-1880) prior to being flood damaged. The last time the mill appeared to be economically successful was under the ownership of Mark Davis and his son Frank (circa 1886-1899), when the mill was successfully transitioned from a (custom) flour mill with two sets of millstones, to a (custom) roller mill specializing in cattle and poultry feed. Eventually, changes in commercialization of the livestock and poultry feed industry led to a decline in the market for small operations like Cubbage Mill.

Question: Was the mill owner-operated or tenant-operated? Over the course of the mill's history, it appears there were occasions when the mill was rented to tenants; other times it was clearly owner-operated. The most notable difference is that owners were required to pay for improvements, repairs, and occasionally, major renovations to keep the mill in working order, which was done by several mill owners who also served as millwrights. With profits often scarce, owning a mill was more than purely a business venture.

Question: Did mill owners adapt to changing trends in agriculture, transportation, and industrial development? The shift from solely a custom flour mill, to a gristmill and sawmill, and then to a roller mill focusing on primarily animal feed, indicates that the owners were diversifying and adapting the mill economy to match changing trends in farming and the needs of local customers. Changes to newer, more efficient, technologies are reflected in the transition from an undershot waterwheel to up to two turbines, and finally the addition of a kerosene generator. Technological change can also be seen with the shift from the use of millstones to metal rollers. Transportation changes include the addition of a road across the dam, road ownership from private to public control, and periodic road maintenance. In general, technological improvements at Cubbage Mill could not offset larger problems occurring in the national agricultural and economic market, and specifically in Delaware during the shift from self-sufficient farming to a more industrialized and urban society.

The Gristmill as a Property Type

Question: Did archeological investigations at Cubbage contribute to our understanding of gristmills during the period 1770-1940? Discovery of Cubbage Mill has changed our thinking concerning the archeological potential of future bridge replacement projects and, as such, provides a baseline for evaluating the National Register significance of similar sites. The gristmill property type has not been well studied in the region, including the three time periods of interest: 1770-1830, Early Industrialization; 1830-1880, Industrialization and Early Urbanization; and 1880-1940, Urbanization and Early Suburbanization. A gristmill includes more than the mill building itself; it also encompasses the water source (mill pond), water system (headrace, tailrace, penstock, etc.), power supply (waterwheel, turbine, steam engine, etc.), and a variety of mechanical equipment, grouped under the term "mill complex" or mill seat.

Archeological remains from Cubbage Mill provide information not available from the few standing mills scattered across Delaware. Existing working mills are wonderful examples of a mill in operation, especially in observing the manufacturing process for producing finished products (flour and meal). However, these rare examples generally do not shed light on the problems encountered by early millers, the ways in which they adapted to the changing needs of their customers, or their response to an often "hostile" environment. Moreover, for questions regarding the manufacturing process and technology, archeological research was also capable of addressing changes in construction technology over time, and the evolution of the water delivery and power system. This was a time when Delaware shifted from a rural agrarian society to one increasingly impacted by the development of large population centers, expansion of large commercial factories, and the growth of a market economy. While historical research can provide insight into these issues, combining this information with the results of archeological investigations provides a more complete picture of the historic past.