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ARCHEOLOGY METHODS

ARCHEOLOGY – FINDING AND RECORDING "SMALL THINGS FORGOTTEN"

Although you may have watched archeologists work in some distant and exotic land on the *Discovery Channel*, you should know that through the efforts of the Delaware Department of Transportation, we are learning more about early Delaware history right here in our own backyard. And it is a very interesting story to tell.

Archeology — long considered the "science of man's past" — is learning about earlier human societies from the detailed study of features and artifacts left behind – the "small things forgotten." These artifacts are unearthed during fieldwork—a process of detailed excavation and painstaking documentation. Archeologists study a wide array of occupations ranging from Native American camp sites or villages thousands of years old, to Revolutionary or Civil War-period sites, to the occupations and lives of early twentieth-century workers of the industrial revolution.

Photo 4-1. Archeologists at work (water power system), Cubbage Pond. Note archeologists (top to bottom), hand-excavating and taking notes – an important part of fieldwork.

Artifacts and features (finds) are as varied as the sites themselves and include anything from fire pits, stone tools, animal bone, and shell objects manufactured by Native Americans, to those dating from the historical period such as building foundations and brick-lined wells, to those fashioned from glass, ceramic, and metal. Archeologists use these finds to help reconstruct the history of sites. In other words, how people lived – their housing, diet, health and hygiene, the types of work they engaged in, use of technology, and changes in these behaviors over time. When integrated with historical documentation, as was done at Cubbage Pond, these finds provide the archeologist with a more complete picture of the mill including its construction, overall operation, and the work and lives of the miller and family, mill workers, and local residents.

Photo 4-2. Nineteenth- and twentieth-century artifacts from Cubbage Mill (whiskey bottle, Coca-cola bottle, prescription bottles, cut nails, screwdriver).

Photo 4-3. Some tools of the trade for survey and hand excavation (compass, paintbrush, flagging tape, tape measure, trowel, pick, plastic artifact bags, permanent marking pens, work gloves)

Photo 4-4. Shovel Testing at Cubbage Pond. Archeologist at left is screening soil through 1/4-inch mesh.

Photo 4-5. The backhoe is used to carefully lift and move heavy mill sections, in this case dismantling Penstock No. 2 from the water power area.

In the Field

Archeologists prepare a comprehensive account of their excavations so that present and future generations of scientists can meaningfully interpret their work. This includes thoroughly documenting a site by taking detailed field notes, sketching excavations, and taking photographs. These data help us determine the context of site features and artifacts, which helps us better understand their relationship to one another and, consequently, their meaning in time and space. We must always remember that through digging an archeological site, we essentially destroy the information it contains. Therefore, detailed notes of the field effort are critical to the successful interpretation of the site. These records allow the archeologist to pull together the essential "pieces of the puzzle," for reconstructing the site's history.

Archeologists' tools range from tiny dental picks and paint brushes where painstaking excavation is required, to mason's trowels, shovels, screens and, in some cases, heavy machinery, such as backhoes. You may have seen archaeologists sifting excavated soil through hardware mesh screens (usually measuring ¼-inch in diameter). This standard archaeological technique helps them recover artifacts that might otherwise not be seen. To recover very small artifacts like seeds, nuts, fish scales, and tiny bone fragments, archaeologists often use an even finer-meshed screen.

At the Cubbage Pond Mill site, machinery was used during fieldwork for lifting heavy sections of the mill as it was dismantled and to quickly and efficiently remove large amounts of dirt and overburden covering important archeological features. (Once these features were identified, however, archeologists relied on hand tools for excavation.)

GETTING TO THE HEART OF THE MATTER: ARTIFACT AND SPECIALIZED ANALYSES

It has been said that fieldwork represents only about one third of the necessary work archeologists must do for properly documenting and interpreting a site. The remaining phases include laboratory study and preparation of site reports, which provide an opportunity to document the goals, methods and results so that others, now and in the future, can learn from and compare this work to similar sites.

Photo 4-6. Plain and decorated ceramics from Cubbage Mill [plates, saucers, porcelain insulator (center)].

Artifacts Recovered

Most of the nearly 5,000 artifacts recovered at the site were related to the construction, repair, and demolition of the structure (nails, brick, window glass). Other items included smaller numbers of bottles and ceramics (discarded plates, bottle fragments) related to food consumption. About 10 percent of the artifacts recovered were clothing, personal goods, or so small and fragmented to be unidentifiable. Based on their overall context, some artifacts were clearly associated with mill occupants, while others were likely "washed in" by flood events at Cubbage Mill.

Photo 4-7. Artifacts are carefully washed, removing soil inside and out. A toothbrush works well for gently cleaning fragile or embossed artifacts.

Artifact Analysis

Laboratory work involves artifact washing, labeling, and analysis, and coding information for computer database entry. This work helps "uncover the clues" hidden in the artifacts and features encountered during archeological fieldwork. Artifacts often provide answers to important research questions posed at the beginning of the study. They can tell us the type and time period of the site based on, for example, when and where an artifact was manufactured, how expensive, rare, or common it may be, and other important information.

To recover very small artifacts, archeologists remove a one-liter bag of soil from different portions of the site. These "flotation samples" are brought to the archeology lab for processing. When soil settles in water, small, light artifacts (seeds, hulls, nuts, fish scales) float to the surface and are sent to an archeological scientist for specialized identification and analysis.

Photo 4-8. A lab technician paints the artifact identification number in tiny but readable print (many times the artifact is as small as a thumbnail or a dime). The number will forever identify the artifact and its location within the site.

*A flotation machine is a specialized piece of equipment--often a modified 55-gallon drum connected to a water source that floods the device. When soil is placed in an agitated bath, light artifacts (seeds, nuts, small bone fragments) float to the surface, are collected and sent to a specialist for detailed analysis.

Photo 4-9. Artifact details are entered into a computer database. Later, an artifact catalog is produced for the report and the archives--a complete inventory of artifacts found during the archeology project at Cubbage Mill.

Artifact analysis requires special handling, detailed record keeping and tracking, and in many cases, volumes of reference books. With historic archaeological sites like Cubbage Pond, these sources are referred to for information on a wide variety of topics, such as ceramic type and maker's marks, various types of bottles and jars, coins, medicine containers, clothing parts, and mill machinery.

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Cubbage Mill artifacts were delivered to GAI's laboratory for analysis.

Depending on the type of site, specialized analyses are sometimes conducted. For example, the large number of mill timbers at the Cubbage Pond site provided an opportunity for the use of a dating technique called dendrochronology.

"The Present is the Key to the Past" -- Dendrochronology

Selected structural members of the five courses of timber were sent to a dendrochronologist for tree-ring dating so that the time period of mill construction, additions, and changes to the mill could be determined, and perhaps associated with ownership. To interpret the sequence of construction, Austin Short from the Delaware State Forest Service and Dendrochronologist Dr. Jack Heikkenen sampled and analyzed the wood beams and pilings uncovered during excavations.

Tree-ring sequences from trees that grow in a seasonal climate can be compared so that these "rings" can be dated to the calendar year in which they were formed. Crossdating, or matching patterns of ring-growth from one tree to another and assigning rings to specific years, is possible only among trees growing in the same general climatic region. Wood or charcoal samples taken from standing buildings or excavated from archaeological sites can be crossdated with each other and with wood from living trees to extend the tree-ring chronology beyond the date of the oldest ring of the oldest living tree in the region. Dendrochronology is the only archeometric technique where determination of absolute dates accurate to the year is either theoretically or practically possible.

Using a patented "key-year" dendrochronology method, Dr. Heikkenen summarized his findings for selected timbers within various courses of the Cubbage Mill:

> **"The key-year dendrochronology study has established that selected structural members within the various courses of the Cubbage Mill were hewed and sawed from trees that were felled after the growing seasons of 1703, 1824, and 1881."**

Photo 4-10. Austin Short (with chainsaw) and Dr. Jack Heikkenen select samples from the water power area of Cubbage Mill for dendrochronological dating.

Dendrochronological analysis of the upper course of Penstock No. 1, composed variously of oak and tulip poplar species, rendered a circa 1881 date--all of which appeared to have been cut with a circular saw, consistent with this date. The lower course contained nine white oak timbers (six were sampled) revealing a circa 1824 date. Interestingly, this course contained primarily hand-hewn timbers reflecting the early-19th century date.

The single course of Penstock No. 2, composed of white oak, tulip poplar, and American chestnut, was dated circa 1824, and may have serviced the earlier waterwheel mill at this location.

Photo 4-11. Dr. Heikkenen observes a "tree-ring" sample from the mill. The sample, labeled with detailed information providing its specific location within the site, was subsequently taken to the laboratory for analysis.

The single course of Penstock No. 3 was represented by 28 identified hand-hewn timbers, of which 11 were sampled. Composed of white cedar and white oak, this course was dated circa 1703. The recovery of highly desirable and easily worked

DENDROCHRONOLOGY

Simply put, dendrochronology is the dating of past events (climatic changes) through study of tree ring growth. Botanists, foresters and archaeologists began using this technique during the early part of the 20th century.

Discovered by A.E. Douglass from the University of Arizona, who noted that the wide rings of certain species of trees were produced during wet years and, inversely, narrow rings during dry seasons.

Each year a tree adds a layer of wood to its trunk and branches, thus creating the annual rings we see when viewing a cross section. New wood grows from the cambium layer between the old wood and the bark. In the spring, when moisture is plentiful, the tree devotes its energy to producing new growth cells. These first new cells are large, but as the summer progresses, their size decreases until, in the fall, growth stops and cells die, with no new growth appearing until the next spring. The contrast between these smaller old cells and next year's larger new cells is enough to establish a ring, thus making counting possible.

Credit:
www.sonic.net/bristlecone/dendro.html

white cedar, exclusively in lower courses, suggests that local supplies may have been exhausted by the early nineteenth century. As noted in Chapter 3, the site history clearly indicates that the first mill at the site dates no earlier than the last quarter of the eighteenth century. As such, it is only reasonable to conclude that the timbers used to construct Penstock No. 3 were derived from earlier structures on or near the property. Given the grade elevation of Penstock No. 3, it was undoubtedly associated with the waterwheel at Cubbage Mill.

The fifth and lowest course was represented by two hand-hewn specimens of white cedar sunken into the streambed beneath the waterwheel pit. Unfortunately, the small sample size was not sufficient for a reliable dendrochronological analysis date.

ADDING TO THE ARCHIVES: THE FINAL REPORT

Photo 4-12. Each artifact is logged by number, description, and site location (this is some of the information that is later entered into an artifact catalog database).

The importance of reporting cannot be overemphasized—once an archeological project is complete the report is often the only surviving document linking all facets of work at a site, preserving important information for the foreseeable future, and to other researchers for years to come.

The Artifact Catalog, an addendum to the final report, provides a listing of all artifacts collected, processed, and analyzed from a site, and is packaged with the artifacts and samples for curation. All field notes, drawings, photographs, analyses, maps, and other relevant materials must be curated with the artifacts. Delaware state-approved repositories for archeological projects or donated private collections include either the Island field repository or other institutions approved by the Delaware State Historic Preservation Office.

By curating these materials, the site information is preserved for future generations of archeologists.

5

INTRODUCTION

DelDOT's planned construction of a new bridge over Cubbage Pond had an unintended benefit--the recovery and documentation of the remnants of a 200+-year old gristmill. A 7-square-foot concrete box culvert beneath Road 214 had shielded and preserved the southern end of the site for decades.

Photo 5-1. View of partially dismantled concrete culvert (below roadway). See upper mill timbers in foreground, and brick foundation to right. View to West.

DISCOVERY AND RECOVERY: ARCHEOLOGICAL INVESTIGATIONS

Based on architectural details of mill components and completed archeological and historical investigations, the mill's brick foundation likely dates to the mid-19th century and represents a *second* mill building on the site. During the last days of fieldwork, archeologists uncovered evidence of an earlier building when they unearthed layers of massive Lincoln Log-type timber courses that aligned with the northern and western walls of the brick foundation. It is reasonable to assume that these logs represent the original late-18th-century Cubbage Mill foundation. This section summarizes some of the archeological investigations, finds, and results that brought the fascinating history of Cubbage Pond Mill to light.

DIGGING IN (FIELDWORK)

When the field crew arrived in November 1997, their first challenge was to determine whether the site would be damaged by construction by finding the boundaries of the Cubbage Mill. If it had been determined that the mill was not in the path of construction, archeological investigations would likely have ended and the mill would have been preserved in-place. On the first day, however, archeologists sampled the ground surface with a thin, steel probe ("tile probe") and found the foundation beneath Road 214, directly in line with planned road/bridge construction. The foundation, then, became the immediate focus of intensive excavations. For the archeological record, the foundation was labeled "Feature 1."

Photo 5-2. View of northeast corner, brick foundation, and silt fence (upper left). It was the installation of this fence that led to discovery of the mill's foundation.

Photo 5-3. West foundation wall to mill, buried under several feet of fill below Road 214. View to North.

Photo 5-4. Judgmental STP placed along the west foundation wall. Note 5-course brick foundation overlying concrete floor. View to West.

Photo 5-5. Archeologist searches for precise Munsell soil color to accurately identify soil sample.

Feature 1

Archeologists attempted to determine the method of construction, dimensions, age, and integrity of the foundation, as well as to find associated artifacts and additional features that would contribute to a better understanding of the mill site. Their efforts revealed that the structure contained an extensive brick foundation, and a series of brick piers, spaced at regular intervals, characterized the addition. Investigations proceeded with the excavation of shovel test pits, test units, and backhoe trenches to gather more evidence of the site's meaning and importance.

Shovel Test Pit Excavation

The eastern portion of the site, thought to contain the mill, was flagged in 10x10′ grids, then 1-1/2-foot diameter shovel test pits (STPs) were excavated along transects to gather associated artifacts, identify possible features, and complete a visual outline of the mill structure. STPs were excavated in layers, and a record was kept of the STP number, mapped field location, depth, recovered artifacts, and soil attributes. Soil screened through 1/4″ hardware mesh recovered artifacts that were sent to the archeological laboratory for processing and analysis. In this area of the site, evidence for a possible mill addition was first noted by several brick piers revealed when a thin covering of leaves was removed from the ground surface.

Reading the Soil

The depth of each excavated layer was determined by a visible change in soil traits, features encountered, and/or recovered artifacts; excavations generally ended when natural, undisturbed subsoil was reached. It is very important for archeologists to be able to "read the soil." The color and texture (i.e., silt loam, coarse sand, clay loam or clay) of soil layers reveal what went before, similar to the way tree-rings disclose the tree's age (dendrochronology; see Chapter 4) and the environmental changes it endured over many years.

The archeological standard for soil descriptions is found in a 321-color Munsell soil chart. Much like paint color chips are coded to indicate which colors to mix for the desired effect, the Munsell Chart provides a precise code for each color hue of soil. The Munsell soil color code provides an objective standard for various soil hues that may be encountered at the site; an important aspect of archeological documentation.

Test Unit Excavation

Larger (5x5-foot) excavations called test units (TUs) were placed where smaller STPs indicated there might be deposits related to mill activity or where features (such as the brick foundation or log foundation at Cubbage Mill) had been exposed. A feature usually reflects activity that, with archeological study and analysis, provides a clue to how people lived in the past. In addition to the precise measurements and descriptions recorded for STPs, TUs were photographed both in color and black and white, and sketches of features (called unit profiles) were drawn to scale. The unit profiles and photographs provided a consistent and thorough record of archeological fieldwork. STPs and TUs were backfilled and restored to their original condition, after being recorded.

Backhoe Excavations

One or more archeologists supervised mechanical (backhoe) excavation of trenches to assure that important features were not damaged before they were recorded. A backhoe was used to remove up to five feet of recent fill from the modern road construction (overburden). A 50-gallon sample of each layer of soil was screened for artifacts, and color and black and white photos were taken of each mechanical trench and archeological feature. The seven backhoe trenches at Cubbage Pond Mill served to expose the log foundation and uncover timbers associated with the mill's waterpower systems. When a Nor'easter deluged the site, a backhoe helped improve drainage while archeologists and contractors struggled to overcome waterlogged excavations, "running sands," and miserable field conditions.

Photo 5-6. Field archeologists use trowels to excavate a Test Unit adjacent to a brick pier addition at Cubbage Mill.

Photo 5-7. Archeologists supervise backhoe trenching to make certain that soil layers are systematically exposed, sampled, and recorded, and that artifacts are recovered, and features are documented prior to their removal.

Photo 5-8. The aftermath of a Nor'easter provided archeologists with a realistic sense of the water control problems experienced by Delaware millers. View of penstock and brick foundation. View to Northwest.

History and Archeology

While archeologists diligently uncovered mill remains, equally diligent historians "excavated" libraries and court records in search of the mill's past, often uncovering information that was essential to guiding archeologists in their excavations and interpretation of artifacts or finds (see Chapter 3). Historians found records of multiple ownerships and mid-19th century technical improvements at the mill.

Photo 5-9. Archeologists representing DelDOT and the Delaware State Historic Preservation Office confer with GAI staff on the results and progress of the Cubbage Mill excavations.

Another source of historical research is the "local informant." Interviews with local and former residents can sometimes contribute to the history of the site with family photos, memories, and stories retold from generation to generation.

Information shared by archeologists experienced in the study of similar sites was invaluable, as they visited the excavation to offer advice and express their opinions on site interpretation. Researchers pieced together these various lines of evidence in order to reconstruct the history of the Cubbage Mill.

Main Structure

Test units inside the 24x40-foot brick foundation identified a 3-inch-thick concrete floor over a shallow layer of burned wood and brick fragments, and an irregularly paved surface of whole and fragmented bricks (several charred). When archeologists removed the brick floor, they identified yet another layer of brick rubble, burned wood, and cut nails. They also found broken plates and dishes (refined white earthenware ceramics) called *sherds,* fragments of pharmaceutical vials and broken window glass (some melted). These burned and charred fragments were physical evidence of the fire referred to in researched documents about the history of the mill. The artifacts dated the concrete floor to after 1875, and the fire to the second half of the 19th century. Fire was a constant concern with these generally wooden mills that contained highly combustible products (i.e., grain dust) and friction-generating equipment.

Photo 5.10. View of charred brick floor (Feature 4)--evidence of a fire at the mill, Test Unit 1. (Feature 3 refers to an excavated sandy soil containing a small number of artifacts and charcoal overlying the brick floor.)

A dependable water source was the lifeblood of early waterwheel-driven mills seated on stream

WHAT ARCHEOLOGISTS LEARNED
Historic maps and records verified that the brick foundation coincided with a late-18th to early-20th-century mill at this location, and that the site largely functioned as a custom gristmill, where the miller processed grain in return for a share of the product (flour, meal).

Photo 5-11. Circular-saw-cut footer and wood block underpinning brick foundation--evidence of miller's attempt to offset subsidence due to saturated (sandy) soils.

flats, but it wreaked havoc on the structures, built on saturated soils. Archeologists observed a number of the wooden piers driven into the sandy substrate and surrounded by plank cribbing to intermittently support wooden sills underpinning the brick foundation--a clear attempt to offset building subsidence problems. A review of mill excavations and historical documents indicates similar settling issues at other Delaware area mills, as well as the introduction of water-control features not unlike those at Cubbage Pond.

Attempts to compensate for settling in soft, sandy, soils were ongoing, as evidenced by buttressing elements of brick and wooden footers, concrete pads, and hardware fasteners that post-date the original brick and wooden sill construction.

Evidence for dating foundation improvements was found in the wood footers supporting the brick foundation. Circular saw marks detected on wood footers supporting the brick foundation could be dated to after circa 1850-1860, when circular saws first became available.

Lean-to Addition

Three rows of uniformly spaced brick piers were eventually uncovered over a broad area, marking the location of an approximate 16x20-foot lean-to addition. Based on historical and archeological evidence, the lean-to was built by circa 1868, the date of a Kent County Mutual Insurance record that detailed the size of the main mill structure *and* addition. We know from oral history, archival research, and similar mill excavations, that the area containing the addition would likely have housed a short-lived sawmilling business and woodworking shop, not uncommon as a supplemental income during the slack growing months in late fall and winter.

WHAT ARCHEOLOGISTS LEARNED
Historical documents detail a devastating flood in 1799 that prompted a significant rebuild of the mill and dam. Owner William Draper appropriated the remains of earlier large-beamed structures (possibly from one of his earlier mills), impounded Cedar Creek, and likely built a log (foundation) mill. The mill did not resume full operation until 1802.

During fieldwork, archeologists confirmed that the concrete floor identified in the brick foundation continued at the same elevation under the lean-to. The absence of burn layers in the area of the

lean-to clearly demonstrates that the fire was limited to the main mill building.

Soils saturated with fuel and oil residues around a cut-sandstone footer uncovered in the central area of the lean-to, suggested use of a kerosene engine during the early to mid-20th century. Interviews with local informants confirmed use of a kerosene engine to drive mill machinery during winter months or periods of low water.

Photo 5-12. Hand-hewn log feature, possibly representing the original mill constructed on site (circa 1770s). Note wooden footings beneath "later" brick foundation. View to South.

Log Feature

During the last days of fieldwork, backhoe trenches revealed a hand-hewn log structure of five vertical courses extending up to 7 feet in height. Given the sheer dimension and characteristics of hand-hewn construction, archeologists surmised that the log walls represented the northern and western walls of an earlier mill foundation--possibly the first mill constructed on the site (late 1770s to early 1780s). Although historical documents in conjunction with dates derived from penstock courses seemed to indicate that the log feature undoubtedly supported a mill building, dendrochronology attempts to determine the age of these specimens lacked an adequate sample for dating purposes.

If the log feature did, indeed, serve as an earlier mill foundation, it is reasonable that the brick foundation that closely parallels the log footprint was built in the same general location to take advantage of the earlier, intact, retaining dam and penstocks adjacent to Cedar Creek. It is also reasonable that the log construction may simply represent the remains of a 19th-century bullwark or retaining wall designed to impede the effects of hydrostatic pressure from the nearby millpond.

Waterpower System

Exposure and removal of structural beams, pilings, and architectural features associated with the mill waterpower system comprised the lion's share of fieldwork and documentation. When the backhoe removed the concrete culvert beneath the road surface, the waterpower system of Cubbage Mill was exposed.

Five courses of timber (mortised beams) spanned more than five vertical feet. Timber courses were systematically characterized, numbered, and mapped until each beam had been removed, one

WHAT ARCHEOLOGISTS LEARNED

Some of the most significant changes occurred in the mid-to-late 1860s, when owner Charles Miles made improvements to the mill in hope of increasing economic returns. He is likely responsible for building the brick mill foundation, the lean-to addition, the miller's house north of the mill, and for introducing and/or upgrading mechanical systems, including a turbine.

Photo 5-13. The Cubbage Mill Waterpower System. The entire crew pitched in to shovel, trowel, measure, record, and remove the five timber courses exposed under the modern road. The field crew worked 12 hours/day, 6 days a week in the wake of two Nor'easters. View to Northwest.

by one, and stockpiled on site. The sand fill between timbers was hand excavated (trowel and shovel) in collection units, but because artifacts had likely washed-in over time and were not related to the mill, the sand was not screened. A "picture" of the mill began forming as the horizontal position and elevation of each architectural component was carefully recorded, drawn, and photographed.

The waterpower system revealed wing walls (dams) and, not one, but two waterpower systems--turbine and waterwheel--representing the mill's different periods of operation. A detailed master list was produced to track timber orientation, location, course, and type (i.e., hand hewn, circular sawn), and whether they were associated with structural beams or the mill's waterpower system; representative nails, when present, were removed from each timber section. These details would help archeologists "reconstruct" the mill on paper.

Penstock

Penstocks (also known as flumes) channel water from a dammed pond or stream to a mill's power source (waterwheel or turbine). Three overlapping courses of penstock (mortised beams) were recovered at Cubbage Mill, tree-ring dated in order of recovery to 1881, 1824, and 1703. Although it is unlikely (and undocumented) that a mill was constructed on the site at the turn of the 18th century, it is not unreasonable for William Draper and his successors to have scavenged or recycled from older, ruined structures on or near the property. Indeed, the number of unused notches and mortises were evidence that the Cubbage Mill penstocks and wheel pit were cobbled together with elements of earlier structures.

Photo 5-14. View of "second" penstock of mortised and wood-peg crossbeams. Wing wall in foreground to right. Looking Southeast.

1881 - The first course of penstock (about ten 28' oak and poplar mortised beams) appeared to have served as a foundation for the concrete culvert and was surrounded by a series of upright posts that supported vertical cribbing.

1824 - The remains of a second course of penstock exhibited hand-hewn beams (oak, poplar, and chestnut, about 12' long) around a ladder-like rectangle of mortised and wood-peg crossbeams and three 9" cross-braces. Again, notches cut into the timber indicated recycled timbers.

1703 - The third penstock of plank flooring was comprised of six 8 to 12′ long planks supported by the incomplete remains of a rectangular frame of cedar and oak timbers. Located directly west of the wheel pit frame, this penstock is clearly associated with the Cubbage Mill waterwheel system. The plank floor and underlying beams and braces were well-preserved and provided a rare opportunity to observe the construction details of an early mill on Delaware's Coastal Plain. The remains of a wheel pit were identified at the eastern end of this lowermost penstock.

WHAT ARCHEOLOGISTS LEARNED

William Draper, his heirs, and Lemuel Shockley continued to operate Cubbage Mill during the first decades of the 19th century. The elevation grades suggest that the lowermost penstock was probably discontinued and backfilled, and the middle penstock was constructed on the new surface, continuing to service the waterwheel for the next few decades. The middle penstock also may have been built to create a more efficient breast-wheel, given its slightly higher elevation in comparison to the waterwheel.

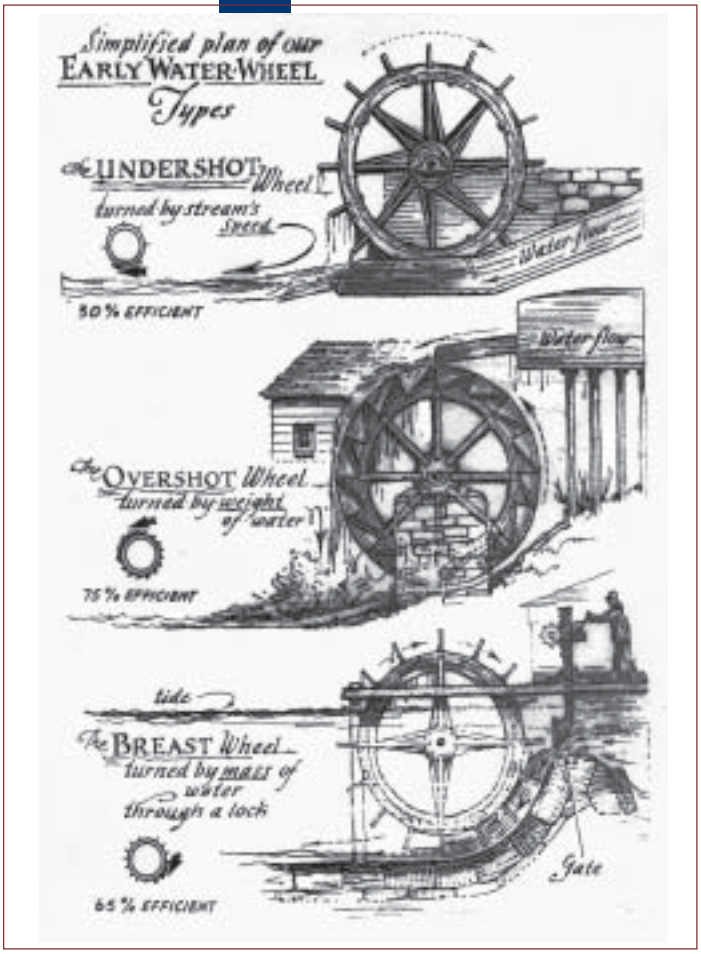
Waterwheel Pit

The waterwheel pit contained a lattice of three 9″ x 20′ beams mortised with six beams about 11′ long. The mortised beams were cut atop the north-south braces, indicating that posts or vertical risers were likely secured at these locations. The archeologists surmised that this feature may have supported a tandem or face wheel. The waterwheel pit was probably first built in the last quarter of the 18th century, because by the third quarter of the 19th century, the more efficient and more durable turbine likely replaced waterwheels throughout the region. Historical documents indicate that the waterwheel was probably in service for no more than 60 years.

Photo 5-15. View of Cubbage Mill wheel pit. Intact plank flooring in foreground. View to West.

The Waterwheel

A waterwheel converts the power of active streams and impounded bodies of water by channeling flow against a rotating wheel that is connected to drive shafts and gears that turn a grinding stone. A technology dating to the time of the Roman Empire, there are four basic waterwheel types (classified according to where the water strikes the wheel). The main differences between waterwheels were in the diameter, breadth, and direction of rotation.



Types of Water Wheels. Credit: "American Yesterday" Volume of Eric Sloan's America, 1954.

The potential energy generated by waterwheel mills is influenced by the "head" (the vertical distance that water drops to the point of impact with the wheel) and "flow" of the water source. In flat coastal areas like Cubbage Pond, millers impounded rivers and streams to create a millpond that would ensure a predictable water supply.

Millponds typically afforded sufficient water to run the mill for a limited period of time. Once the "head" was exhausted, the miller had to close the dam gate and allow stream water to replenish the pond. Adjustable floodgates at the dam enabled millers to fill penstocks that led to a gated sluiceway and constricted the final watercourse striking the wheel. Because waterwheels had a limited use-life and required constant maintenance, penstocks were usually constructed with trash racks to filter out debris that would impede or damage the waterwheel.

When grinding was underway, millers had to monitor water flow closely. Insufficient water flow would slow wheel rotation and the grains would not be ground to a satisfactory consistency of meal. By contrast, excessive water flow sped the wheel, increasing the friction of the grinding stones, and causing customer complaints about the "burned" taste of the meal.

Although no one knows for sure, oral history and site analysis suggest that Cubbage Mill may have used an undershot wheel. Typically constructed to the same vertical height as the head of the pond, undershot wheels generally exhibited a series of horizontal paddles or boxes separated along the arc of the wheel at the same distance as their dimensional width. Although easily built,

undershot varieties were the least efficient of the water wheel types, so it is not surprising that the waterwheel system was discontinued at Cubbage Mill and replaced with a turbine in the late 19th century when more efficient mechanical technology became available.

Turbine

Invented by a Frenchman in 1827, turbines generally replaced the earlier and less-efficient waterwheels during the mid to late-19th century. Turbines produced so much additional energy that they outstripped the dynamic capabilities of earlier waterwheels. In some locations, smaller more efficient turbines enabled millers to work throughout the year--even during the cold winter months.

WHAT ARCHEOLOGISTS LEARNED

Turbines were not rare in the mid-19th century, and it is likely that Miles would have introduced at least one mechanical device toward his goal of making substantial improvements. Given the short time span between the date established for the mill foundation and the date of recorded improvements at the site, it is reasonable that the brick foundation was, from the onset, a turbine-powered mill. By contrast, the waterwheel and its components likely predated the brick foundation and relate to the earlier hand-hewn log structure.

Evidence for a turbine was revealed early in the excavation (see Chapter 3). When archeologists removed the circa 1900 concrete culvert (comprising the upper penstock), they observed a 4′-diameter cutout that contained an interior ledge that may have secured an iron band to support a turbine. It appears that the culvert was built to accommodate milling at the turn of the 20th century, and likely functioned as a headrace to channel water from the millpond to the turbine. This discovery confirmed informant reports of a transition from waterwheel to turbine-powered system sometime in the late 19th century.

Although water was traditionally delivered to the turbine through a single vertical iron or wood pipe, this did not appear to be the case at Cubbage Pond, where local millwrights were challenged by the flat coastal plain that lacked sufficient elevation. At Cubbage Pond and other area mills (e.g., Cedar Creek Mill, Abbott's Mill), the turbine was placed at the bottom of a rectangular chamber formed by a watertight penstock of concrete and wood. By sealing a small door at the tailrace end of the chamber, the penstock became flooded and thereby provided the pressure needed to turn the turbine.

INTO THE 20TH CENTURY

By the turn of the 20th century, sawmill operations apparently ceased and Cubbage Mill concentrated on producing meal. Owner Mark Davis installed a (metal) roller grinder to bolster his small custom operation. At the same time, the concrete culvert was installed, marking a significant improvement over the wooden penstocks that had characterized the site for the past century. Unfortunately, technological improvements could not offset problems in Delaware's agricultural and economic market. Records indicate a significant

decline in agricultural production during the first few decades of the 20th century. Despite economic realities and a dour forecast, a miller who had tried his hand at farming (Samuel Cubbage) bought the mill in 1908, and worked the gristmill until 1921. The pond and mill still bear his name.

Over the next two decades, ownership frequently changed--most owners supplemented mill proceeds with other ventures in order to survive the waning economy. Edgar Waples, who produced flour and cornmeal (feed) at the mill from 1921 to 1928, also owned a blacksmithing shop and sold produce, fishing supplies, and general merchandise to tourists at Cubbage Pond. There is little evidence that 20th century owners improved site or mill conditions.

In 1954, Cubbage Mill was transferred through final sale. Records imply that the new owners quickly razed the abandoned mill, which had become a fire and safety hazard.

Visible from the roadside, the rehabilitated miller's house symbolizes the last vestige of the historic Cubbage Mill operation. In the front yard are two grinding stones. Once the very heart of the milling operation, the grinding stones are a testament to the circa 175-year history of Cubbage Mill.

Photo 5-15. Recent view of Miller's House likely built by Charles Miles, circa 1866-1868. Looking Northeast.

6

PUBLIC OUTREACH

DELDOT ATTUNED TO PUBLIC NEED-TO-KNOW

The Transportation Equity Act for the Twenty-first Century (TEA-21) requires development of a long-range, Statewide Transportation Plan (SWTP) that incorporates public involvement and long-range visioning in decision-making, as do revised federal regulations concerning archeological and historical research.

Archaeological excavations are one way that DelDOT works with the community during studies and planning for construction of roadways and highways throughout Delaware. DelDOT Archaeologist, Kevin Cunningham, is especially community-conscious and involved in seeking out state-of-the-art approaches to alert, inform, involve, and educate Delaware citizens. Excavations like this one offer a unique opportunity to learn how earlier residents lived and worked, and what the community may have looked like in that time period.

When early excavations confirmed the location of the buried Cubbage Pond Mill, Kevin Cunningham immediately tasked the GAI archaeology team with designing a public information mailer and invitation to the site. Later, a second mailer with updated information, and a two-page *FYI* flyer with color photos and illustrations accompanying a few paragraphs of Cubbage Mill history, were released (shown on following pages).

While the Final Technical Report would normally contain hundreds of pages of tables, technical discussion, and an artifact catalog familiar primarily to students of archaeology, the Cubbage Pond report is designed with public interest at the forefront. By content and format, this volume of the final report is presented in a very readable and understandable, well illustrated, format.

Together, Volumes I and II of the Cubbage Pond Report will meet all Federal and State Historic Preservation Office regulations. Both volumes are available to the public.

This, and other archaeological and historic preservation reports can be found on DelDOT's web site--another way that DelDOT reaches out:

www.deldot.net/static/projects/archaeology/index.html.

DELAWARE

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- Delaware Archaeology Month
  ·www.delawarearchaeology.org/
- Delaware State Historic Preservation Office
  ·www.state.de.us/shpo/
- Delaware State Parks
  ·www.destateparks.com/Activities/archeo/index.htm
- Resources for Educators
  ·www.state.de.us/shpo/educators.htm
- Archaeology in State Parks
  ·www.destateparks.com/Activities/archeo/
- Archaeological Network
  ·www.state.de.us/shpo/Archaeological%20Network.htm

FOR YOUR INFORMATION

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DelDOT

BYWAYS TO THE PAST

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FACT SHEET

CUBBAGE POND MILL SITE (7S-C-61)

December 3, 1997

COUNTY
Sussex

PROJECT
Replacement of Bridges 3-936 and 3-937 on Road 214 over Cubbage Pond

HIGHLIGHTS
Phase II Archeology

THE ARCHEOLOGICAL FIND

While construction was underway to replace Bridges 3-936 and 3-937 over Cubbage Pond in Sussex County, highway construction workers discovered a deeply buried brick foundation. The structure is located along Road 214, and was built atop an old earthen dam across Cedar Creek. Alert to the possibilities of unearthing deeper archaeological clues to Delaware's past, the workers ceased construction and contacted DelDOT's archeologist, Kevin Cunningham.

DelDOT's check-and-balance system for preserving Delaware's historical past was put into place, and archeologists and historians were enlisted to examine the recorded history of activity and ownership of the mill and uncover clues to the importance of the site.

HISTORICAL BACKGROUND—THE CUBBAGE POND MILL SITE

To DelDOT's archeologists, the remnants of the brick foundation at Cubbage Pond appear to be related to the grist mill owned by William Draper as early as 1808. The locals called it the "Old Mill," then. It appears that the "Old Mill" may have burned down and been reconstructed at least once during the 19th century. Historic research also revealed that the mill was still operating during the first decade of the 20th century, under the ownership of F.W. Davis.

HISTORY—ABOUT DELAWARE'S MILLS

After the American Revolution, Delaware's population moved from farming communities to industrial centers, where jobs were more plentiful. Grist mills, cotton mills, saw mills, and woolen mills rapidly became industrial hubs surrounded by taverns, shops, and stores to serve workers and their families.

(over)

A number of grist and saw mills were formerly located along Cedar Creek in the late 18th and 19th centuries. Mills require a stream as a water source which, when dammed, creates a mill pond to drive water wheels and, in turn, power the mill. Mill dams often became ready-made causeways for travelers who needed to cross the mill pond.

Because few mills have been studied in Delaware's Lower Coastal Plain and most town-centered mills were abandoned by the early 20th century, the opportunity to examine the Cubbage Pond Mill Site is especially meaningful. Additional study will enhance our interpretation of early industry in the area of Cedar Creek Hundred during this time period.

In the interest of understanding and recording this meaningful "byway to the past" for Delaware's future generations, DelDOT has temporarily halted bridge reconstruction at this site until clues to the past have been revealed.

As archeological excavations uncover evidence of the mill at Cubbage Pond, we will all gain information about the importance of water-powered industries on Delaware's past inhabitants—information that might otherwise be lost forever.

For Your Information

Byways to the Past

Cubbage Pond Mill Site
Sussex County
Delaware

Delaware's Heritage Preserved

An archeological site is a location that contains valuable information about the people and industries of the past—their lifeways, skills, knowledge, and adaptation to change. Because few mills have been studied in Delaware's Lower Coastal Plain, and because most mills were abandoned by the early 20th century, the archeological investigation of the Cubbage Mill site will enhance our interpretation of early industry in the area of Cedar Creek Hundred during the 18th, 19th, and first half of the 20th century.

Tandem Wheel Pit, Cubbage Mill Site. Looking West. (Photo by GAI Consultants, Inc.)

The Cubbage Mill project has greatly benefited from the teamwork of the following individuals and organizations.

GAI Consultants, Inc., Archeologists under contract to DelDOT—Project Supervisors: Diane Landers, Ben Resnick, and Karen Orrance (412) 856-9220

Daniel Griffith, State Historic Preservation Officer

Gwen Davis, Archeologist, State Historic Preservation Office

George & Lynch, Inc.—Vicki Megonigal, Project Manager, Wayne Cronic and Terry Turnbull

First State Crane, Inc.—Robert Hayden

DelDOT—Eugene Abbott, Director of Planning

DelDOT—Steve Forst, Construction Inspector

DelDOT—Allan Redden, South District Engineer

DelDOT—Kevin Cunningham, Archeologist

DelDOT (302) 739-3826

Visit one of Delaware's "Byways to the Past."

Cubbage Mill Abandoned

1950 Photograph Courtesy of Betty Cofer, and Dave Kenton, Milford Historical Society

Memory Mill

I remember them well:
The sagging floor where the grain sacks lay,
And the idling wheel, waiting
For the swell
Of the lazy river and the dam's slow play
Over the flume. It's a tale to tell.
Dusty miller, do you remember me?
I remember you well.

--author, unknown

Byway to the Past

Imagine. The Revolutionary War has ended (1783), and farming families near Cubbage Pond are searching for survival, plentiful jobs, and new beginnings. Their needs are met by one of the original industries in Delaware—a gristmill—built on farmland adjacent to a dam along the North Fork of Cedar Creek. Soon after the property was acquired by William Draper, probably in the late 18th century, the mill echoed the rhythmic clop of mules, the slapping cadence of the mill wheel, and the grinding whir of millstones.

William Draper's eldest son, Samuel, acquired the "old mill tract of two acres" through Orphan's Court in about 1821, some 12 years after his father died. A succession of millers owned or managed the mill from 1825 (when it was purchased along with other mill properties in the area by entrepreneur Lemuel Shockley) through the early 20th century.

During various ownerships, it was known as "Miles Mill," "Davis Mill," and "Cubbage Mill." Recorded owners also include John C. Davis (1833-1863), Hiram Barber (1863-1866), Charles Miles (1866-1879), John DuBois (1879-1881), Mark H. Davis, third son of John C. Davis (1881-1892), Frank Davis, eldest son of Mark Davis (1892-1908), and Sam Cubbage (1908-1917). The Davis Family intermittently owned the mill for well over 50 years, advertising it as Mark H. Davis & Son Flouring Mills during the late 1880s to the early 1890s.

Archeological and historical investigations suggest that the mill burned and was rebuilt at least twice—once in the early 1800s, and again in the last quarter of that century. Orphan's Court and Road Petition Survey maps clearly depict a two-story gristmill by the first quarter of the 19th century. Insurance and tax assessment records of 1868 describe a "flouring grist and sawmill," measuring 24x40 feet, with a 16x20-foot addition, probably built by Millwright Charles M. Miles who, for "many years, traveled from place to place, working at his trade." Several logs and a concentration of sawdust suggest that the 16x20-foot addition was for the sawmill.

The Archeological Find

While construction was underway to replace Bridge 3-936 over Cubbage Pond in Sussex County, highway construction workers discovered a deeply buried brick foundation. The structure (unidentified at first) was found partially buried below Road 214, across from Cedar Creek. Alert to the possibilities of unearthing deeper archeological clues to Delaware's past, the workers ceased construction and contacted DelDOT's archeologist. Since then, much has been learned about the structure—its history, architecture, and association with one of Delaware's earliest industries.

Recording for the Future

Archeological work began at the site when an intensive review of files, maps, and publications confirmed that the brick foundation uncovered by the construction crew could, indeed, be one of Delaware's earliest gristmills. This work recorded the exceptional integrity and importance of the site's archeological record, making it eligible for listing on the National Register of Historic Places. For this reason, intensive archeological investigations were conducted. These investigations documented the mill at Cubbage Pond, and have the potential to reveal important information about water-powered industries on Delaware's Coastal Plan—information that might otherwise be lost forever.

Early excavations of the mortared brick foundation uncovered a cement floor overlying two distinct "burn" layers. From a single patent bottle-finish fragment recovered, archeologists were able to date the cement floor to no earlier than the last quarter of the 19th century. Later excavations revealed at least one, possibly two, lower brick floors and, 8 to 12 feet below the current roadbed, several courses of timber. Up to five timber courses spanning more than five vertical feet, were identified and removed. These wooden beams (mortised) and pilings were associated with the mill's water power systems. At least two separate water power systems representing different technologies were identified at the site—a water-wheel system (as represented by a tandem wheel pit) and a turbine system.

Preliminary site interpretations suggest that the water wheel at Cubbage Pond was an undershot wheel, possibly one of the few in the region at that time. The turbine, a more efficient source of water power, began to replace water wheels in about 1840, although they were not generally introduced on a large scale until after the Civil War. The turbine pit at Cubbage Pond appears to have been installed during the mid-to-late 19th century.

Evidence for an earlier timber structure was revealed by a log foundation identified parallel to the north and west walls of the brick structure. The log foundation contained large, hand-hewn, corner-timbered logs, held in place with vertical posts.

Early mills were constructed of three or more levels. Operations began with the water wheel , which converted the power of streams by transferring energy from a system of gears to the millstones for grinding. The uppermost level was usually reserved as a "dry" storage area for grain.

This sophisticated "four-quarter" dress millstone, like the one used at Cubbage Pond, is divided into 10 sections called "harps."

7

GLOSSARY OF TERMS

A - E

AGING: A step in the milling process by which flour stood for a considerable period after grinding until its original creamy color turned white, improving its appearance and quality.

ARTIFACTS: Remains of past man-made objects, such as millstones and waterwheels or stone tools, found on archeological sites, and which provide information on the function and time period of the site.

BED STONE: The lower (stationary) stone in a pair of millstones.

BRAKE WHEEL: The large wheel which, when rotated by the sails or mill wheel, drives all the active parts of the mill.

CIRCA (or ca.): Approximate. Usually used with a date (circa 1856) or quantity.

CLEARS: The coarser parts of a straight flour. The finer parts are called patents.

CHANCERY COURT: Having jurisdiction in matters of equity not obtainable in the courts of common law.

CHRONOLOGICAL PERIOD: The time range within which a property existed.

COMPLEX: In an architectural survey, this is a group of related buildings or structures built either as a unit or for a single purpose. In an archeological survey, a complex is a defined cultural sub-unit of a larger time period, characterized by a specific group of artifact types.

COMPREHENSIVE SURVEY: Recording the location and description of either all archeological or all standing resources (structures) within a project area.

CONDITION: Physical state of a resource, including its level of repair and function.

CONTEXT: Conditions in which artifacts or sites exist including their location, time period, and function.

CRITERIA, FROM CONTEXT: Specific standards of integrity and significance of a property type, against which a particular property is measured to determine eligibility.

CRITERIA, NATIONAL REGISTER: General standards of age, integrity, and significance defined by the National Park Service for the National Register of Historic Places Program.

CURATION: Maintenance of an archeological collection and documentation.

CULTURAL RESOURCE: A historic building, site, object, or district (property), sometimes including related buildings or landscape features.

CULTURAL RESOURCES MANAGEMENT: Term used to describe the identification, evaluation, and treatment of archeological and architectural resources as a result of planned construction projects.

CUTTER ROLLER: The more rapidly rotating roller of a pair.

ELIGIBILITY: Ability for a specific property to meet National Register criteria.

ENVIRONMENT: Physical surroundings of a property.

EVALUATION: Assessment of a property's eligibility for National Register listing.

GLOSSARY OF TERMS

F-P

FACE: The level surface on a millstone, between the furrows.

FANCY PATENT: A very short patent flour (~ under 60% of the total produced).

FEATURES: Remains of human activity that are not usually removable (building or foundation walls, trash pits, storage pits, fire hearths, etc.). Archeologists study features to learn how people lived in the past.

FIELDWORK: Archeologists systematically retrieve information from sites, using specialized methods and techniques. Findings are recorded on forms and in photographs, and are documented in a site report.

FEATHER EDGE: The gentle sloping edge of a millstone furrow.

FEATURES: Unlike artifacts, a feature is an immovable by-product of cultural activity at a site such as a foundation, trench, refuse pit, fire pit, etc.

FURROWS: The grooves or channels cut into the face of a millstone.

FUNCTION: How a historic property is and/or has been used.

GEOGRAPHIC ZONE: Defined in Delaware's State Plan, the bounded geographical areas determined by a common development pattern.

HISTORIC ARCHEOLOGICAL SITE: These are occupations that date since the advent of the written record and begin generally with European colonization, e.g., Jamestown (1607), extending all the way through early to mid-20th century sites.

HISTORIC CONTEXT: The historic background of a resource by which its historical significance is evaluated—the framework of geographic area, time period, and historical theme to be considered.

HISTORIC THEME: The organizing principal that explains the existence, use, and abandonment of historic properties.

INTEGRITY: The degree to which an historic property has retained the physical characteristics that identify it.

LEVY COURT: Pertaining to the raising or collection of taxes.

LOW MILLING: Grinding with the millstones close together to produce as much flour as possible at one grinding.

MIDDLINGS: Coarse bits of the floury part of a wheat berry (grain of wheat). Also called sharps.

NATIONAL REGISTER: List of buildings, sites, districts, objects deemed worthy of preservation, based on their importance to our history.

ORPHAN'S COURT RECORDS: State documents pertaining to the estates and persons of orphans.

OVERBURDEN: Material overlying an important archeological (or geological) deposit.

OVERSHOT WHEEL: A water wheel in which the water reaches the buckets on the circumference of the power wheel at the top of the wheel (turning the wheel with the weight of the water).

PATENTS: The better (finer) parts of straight flour, made solely from purified middlings. Some mills turned out as many as four patents or clears.

PROBATE RECORDS: Documents related to the last will and testament of a deceased person.

REPOSITORY: A secure, environmentally safe, climate-controlled structure for storing archeological collections (artifacts, photographs, slides, field drawings, documents).

RESEARCH DESIGN: A written plan for conducting research that states objectives, methods, and expected results.

RUNNER: The upper (rotating) stone of a pair of millstones.

SHOVEL TEST PIT: An approximately one-foot-square hole, dug with a shovel by hand, used to identify the presence, location, and boundaries of an archeological site.

SIGNIFICANCE: The historical importance or research value of a property.

SIZING: Breaking down and grading the coarser middlings (semolinas).

SKIRT: The outer portion of a millstone.

STONE: A millstone, often used in phrases like "a mill of six run of stones."

STRATIGRAPHY: The sequence of soil layers on an archeological site or within a feature, distinguished by color, texture, and inclusions.

TAILINGS: The material that exits a bolter or sieve because it is too coarse to pass through.

UNDERSHOT WHEEL: A waterwheel in which the water reaches the buckets on the power wheel near the bottom of the wheel; the wheel is turned by the impact of the water versus the weight of the water at the top of the wheel (an Overshot Wheel).

WARBLER: The clapper or bell in old mills that sounded automatically when the hopper was empty.

YIELD: The unit of finished product expressed in terms of the number of bushels of grain required to make the unit.

GLOSSARY OF TERMS

R - Y