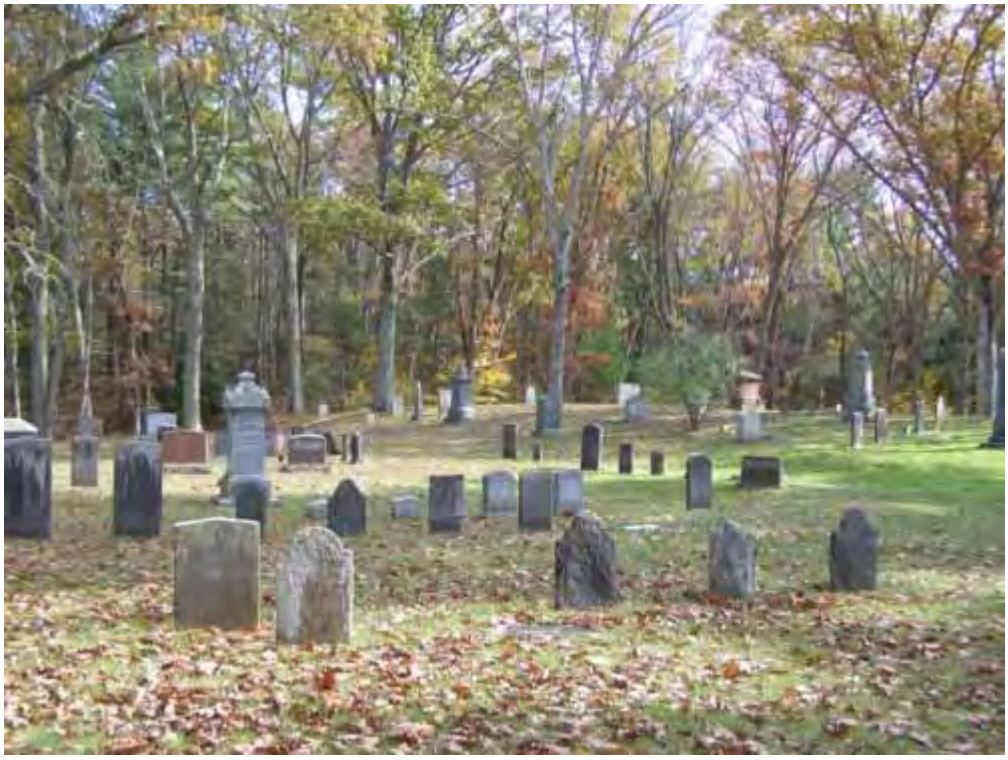
Quabbin Park Cemetery Restoration Project

Final Report



June 2012

Department of Conservation and Recreation
Historic Landscape Preservation Initiative
Wendy Pearl

Local Project Coordinator
David Small

Conservator – Historic Gravestone Services
Ta Mara Conde

Final report prepared by – Ta Mara Conde

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Armstrong, Jeremiah
Date of Death	

Material	Marble
Marker Type	Tablet
Base	No
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

JEREMIAH ARMSTRONG
CO.1
37.MASS.INF.

Previous Work	Concrete foundation stuck on base
Stone Condition	Leaning, biological growth
Treatment	Clean and reset level


JEREMIAH ARMSTRONG
CO. I
37 MASS. INF


JEREMIAH ARMSTRONG
CO. I
37 MASS. INF

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Armstrong, Fannie E.
Date of Death	May 10, 1903

Material	Marble
Marker Type	Die on base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

Dau. of J. & A.M.
ARMSTRONG
Died May 10, 1903
Æ.2 y's 6 m's 11 d's
"at rest"

Previous Work	Concrete foundation stuck on base
Stone Condition	Leaning, biological growth
Treatment	Clean, excavate and reset level


ARMSTRONG

Cemetery	Quabbin Park	
Location	Ware, MA	
Record Date	May 2012	
Name	Bancroft, George	Elizabeth J.
Date of Death	Jan. 7, 1933	February 5th, 1926

Material	Marble
Marker Type	Monument
Base	Yes
No. Commemorated	2
Border	
Carving Condition	Good

Inscription

GEORGE G. BANCROFT
DIED
JAN. 7, 1833
Æ 77

ELIZABETH J. BANCROFT
DIED
FEB.5.1926

Previous Work	Concrete foundation stuck on base
Stone Condition	Moss growth, Cracks in the center a lower sections. Cracks may penetrate through the stone.
Treatment	Bottom section of the monument was cleaned for further inspection. Cracks should be monitored for signs of expansion.


GEORGE C. BANCROFT
DIED
JAN. 7, 1838,
AE. 77.
BANCROFT.


BANCROFT.

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	William Brigham
Date of Death	July 11, 1872

Material	Marble
Marker Type	Monument
Base	Yes
No. Commemorated	2
Border	
Carving Condition	Good

Inscription

WILLIAM BRINGHAM
DIED
July 11, 1872
AE 79 Yrs, 9 Mos.

HARRIET
HIS WIFE
Died Feb. 24. 1885
AE 79 yrs, 10 mos.
&13 ds.

Previous Work	Concrete foundation stuck on base
Stone Condition	Broken, Bio growth
Treatment	Clean, Excavate and reassemble level with mortar


BRIGHAM

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Crowl, Almina E. E.
Date of Death	Feb 23, 1849

Material	Marble
Marker Type	Die on base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

Dau. of
Hartwell & Betsey L
CROWL
Died Feb 23, 1849
Æ.7 mos. & 4 days.

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth
Treatment	Clean


CROWL

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Crowl, Betsey L.
Date of Death	March 30, 1890

Material	Marble
Marker Type	Tablet w/ base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

BETSEY L. CROWL
DIED
MAR. 30, 1890
Æ 69.
Rest, loved ones, rest.

Previous Work	Concrete foundation stuck on base
Stone Condition	Fallen, Biological growth
Treatment	Clean, Excavate and reset level with mortar


BETSEY L. CROWL
DIED
Mar. 30. 1890.
AE. 69.

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Crowl, Howard W.
Date of Death	Jan 9, 1898

Material	Marble
Marker Type	Die on base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

EDWARD W. CROWL
DIED
Jan. 9, 1898.
Æ 46.

Previous Work	Concrete foundation stuck on base
Stone Condition	Fallen over, Biological growth
Treatment	Clean, excavate and reset die and base level


DIED

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Crowl, Hartwell L.
Date of Death	

Material	Marble
Marker Type	Die on base 3 pieces
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

HARTWELL L. CROWL
DIED

Previous Work	Concrete foundation stuck on base
Stone Condition	Fallen, Biological growth
Treatment	Clean, excavate and reset die and base level


HAMWELL CROWL
DIED

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Doubleday, Susannah
Date of Death	Nov. 11, 1880

Material	Marble
Marker Type	Monument
Base	Multi piece
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

SUSANNAH

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth, Fallen, broken 2 pieces
Treatment	Clean, Reset level and reattach broken piece with Jahn mortar

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Father
Date of Death	

Material	Marble
Marker Type	Die on base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

FATHER

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth, Fallen
Treatment	Clean, excavate and reset level with mortar


FATHER

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Flagg, Joshua
Date of Death	August 30, 1871

Material	Marble
Marker Type	Die on base
Base	No
No. Commemorated	1
Border	Yes
Carving Condition	Good

Inscription

JOSHUA FLAGG
DIED
Aug. 30, 1871
Æ 66 yrs.
God called thee home, ere we could say
Farewell.

Previous Work	Concrete foundation stuck on base
Stone Condition	Fallen, Biological Growth, missing base
Treatment	Excavate, clean and reset level in a new base


DIED
Aug. 30, 1871.
E. 66 yrs.


JOSHUA FLAGG
DIED
Aug. 30, 1871.
E. 66 yrs.

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Giles, Laura Ann
Date of Death	April 6, 1848

Material	Marble
Marker Type	Tablet
Base	No
No. Commemorated	1
Border	
Carving Condition	Fair

Inscription

LAURA ANN,
Daughter of
James Parthena
Giles
Died April 6, 1848
Aged 6 yrs, 8 mos.
Sleep on dear child.
And take thy rest;
While thy parents mourn
Love and best

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth, leaning
Treatment	Clean, excavate and reset level with new base

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Giles, Parthena
Date of Death	1856

Material	Marble
Marker Type	tablet
Base	No
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

PARTHENA GILES
1816 - 1856

Previous Work Concrete foundation stuck on base

Stone Condition Biological growth

Treatment Clean


PARTHENA S.
1816 — 1856

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	J.T.
Date of Death	

Material	Marble
Marker Type	Die on base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Fair

Inscription

J.T.

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth, Loose in base
Treatment	Clean, Excavate, reset level in base with mortar

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Lincoln, George W.
Date of Death	1923

Material	Marble
Marker Type	Die on base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

GEORGE W. LINCOLN
1856 - 1923

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth, Leaning
Treatment	Clean, Excavate, reset level on base


GEORGE W. LINDSEY

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Chelifoux, Bernice
Date of Death	1910

Material	Marble
Marker Type	Die on base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

BERNICE
CHELIFOUX
1888 – 1910
WIFE OF
PETER PLUFF

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth, Leaning
Treatment	Clean, Excavate, reset level on base


PETER PLUFF


BERNICE
CHELIFOUX
1888 — 1910
WIFE OF
PETER PLUFF

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Ramsdell, Frederic H.
Date of Death	Dec. 7, 1904

Material	Marble
Marker Type	Monument, 3 piece
Base	Multi piece
No. Commemorated	2
Border	
Carving Condition	Fair

Inscription

FREDERIC H.
RAMSDELL
DIED
Dec.7, 1904
Æ. 29.
So the living will under
Stand

HIS WIFE
EVA MAY
DIED
June 10, 1923
Æ. 36

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth, Leaning
Treatment	Clean, Excavate, reset pieces level with mortar


RAMSDELL

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Richards, Calvin W.
Date of Death	July 26,1888

Material	Marble
Marker Type	Die on base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

CALVIN W. RICHARDS
BORN
Dec 19, 1812,
DIED
July 26, 1888

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth
Treatment	Clean


CALVIN W. RICHARDS
BORN
DIED


CALVIN W. RICHARDS
BORN
DIED

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Shattuck, A.L.
Date of Death	December 22, 1982

Material	Marble
Marker Type	Monument
Base	Yes
No. Commemorated	2
Border	
Carving Condition	Good

Inscription

A.L. SHATTUCK
DIED
DEC. 22, 1892
Æ 59.

Previous Work	Concrete foundation stuck on base
Stone Condition	Broken pieces, biological growth
Treatment	Clean, Reattach pieces with Jahn mortar


SHATTUCK


SHATTUCK

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Tolman, John
Date of Death	November 6, 1849

Material	Marble
Marker Type	Tablet
Base	No
No. Commemorated	2
Border	
Carving Condition	Good

Inscription

JOHN TOLMAN
DIED
Nov. 6, 1849,
Aged 67 years.
DEBA,
HIS WIFE, DIED
Dec. 14, 1843,
Aged 55 years

Previous Work	Concrete foundation stuck on base
Stone Condition	Leaning
Treatment	Clean, excavate and reset level as a tablet


DIED
Nov. 6. 1849
DEBA.
HIS WIFE. DIED
Dec. 14. 1843.


JOHN TOLMAN
DIED
Nov. 6, 1849.
aged 67 years.
DEBA.
HIS WIFE. DIED
Dec. 14. 1843.
aged 55 years.

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Tourtellott
Date of Death	

Material	Granite
Marker Type	Monument
Base	Multi part
No. Commemorated	
Border	
Carving Condition	Good

Inscription

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth, Obelisk fallen and broken into two pieces
Treatment	Clean, Reattach broken pieces with Jahn mortar

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Weeks, Lorenzo M.
Date of Death	1911

Material	Granite
Marker Type	Three piece monument
Base	Yes
No. Commemorated	4
Border	
Carving Condition	Good

Inscription

LORENZO M. WEEKS
1834-1911
LOIS M. WEEKS
1839-1863
HARRIET C. WEEKS
1839-1897
FANNY WEEKS
1841-19-28

Previous Work	Concrete foundation stuck on base
Stone Condition	Fallen, Biological growth
Treatment	Excavate, clean and reset level with mortar


LORENZO N. WEEKS
1834 — 1911
LOIS M. WEEKS
1838 — 1863
HARRIET C. WEEKS
1838 — 1897
FANNY WEEKS
1841 — 19 — 28


LORENZO N. WEEKS
1834 — 1911
LOIS M. WEEKS
1838 — 1863
HARRIET C. WEEKS
1838 — 1897
FANNY WEEKS
1841 — 19 — 28
WEEKS

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Wheeler, Belle C.
Date of Death	

Material	Marble
Marker Type	Die on base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

BELLE C. WHEELER
Wife of
C.W. LINCOLN

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth
Treatment	Clean

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Wheeler, Emma
Date of Death	1871

Material	Marble
Marker Type	Die on base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

EMMA WHEELER
1855 - 1871.

Previous Work Concrete foundation stuck on base

Stone Condition Biological growth

Treatment Clean

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Wheeler, Harriet
Date of Death	April 16, 1810

Material	Marble
Marker Type	Tablet
Base	No
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

Harriet L.
Daughter of
Cyrus &
Charlotte
Wheeler
Died
April 16, 1810
Æ 6 Ys.

Previous Work	Concrete foundation stuck on base
Stone Condition	Fallen, Biological growth, broken in two pieces
Treatment	Clean, reattach pieces with Jahn mortar, new base

HISTORIC GRAVESTONE SERVICES *Conservation Form* TLC* 2012

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Wheeler, John
Date of Death	Sept. 2, 1851

Material	Marble
Marker Type	Tablet
Base	No
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

JOHN WHEELER
DIED
Sept. 2, 1851,
Æt. 69.

Previous Work	Concrete foundation stuck on base
Stone Condition	Leaning, Biological growth, weak bottom section
Treatment	Clean, provide new base collar


JOHN WHEELER
DIED
Sept. 2. 1851.
Æt. 69.

HISTORIC GRAVESTONE SERVICES *Conservation Form* TLC* 2012

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Wheeler, John A.
Date of Death	1922

Material	Marble
Marker Type	Die on base
Base	No
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

JOHN A. WHEELER
1833 - 1851

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth
Treatment	Clean

HISTORIC GRAVESTONE SERVICES *Conservation Form* TLC* 2012

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Wheeler, Martha E.
Date of Death	March 1,1868

Material	Marble
Marker Type	Tablet in base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

MARTHE E.
Daughter of
Thomas and Susan
WHEELER,
Died March 1, 1868,
Aged 16 years.
Father and Mother Farewell

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth, weak bottom section
Treatment	Clean, reset level in existing base and provide new base collar


MARTHA E.
Daughter of
Thomas & Susan
WHEELER
Died March 1. 1868.
Aged 16 years.

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Wheeler, Martha M. Vaughn
Date of Death	1910

Material	Marble
Marker Type	Die in base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

MARTHE M. Vaughn
Wife of
J. A. WHEELER,
1833 - 1910

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth, Loose in base
Treatment	Clean, reset level in existing base with mortar


MARTHA M. VAUGHN
WIFE OF
J. A. WHEELER
1833 — 1910


J. A. WHEELER
1910

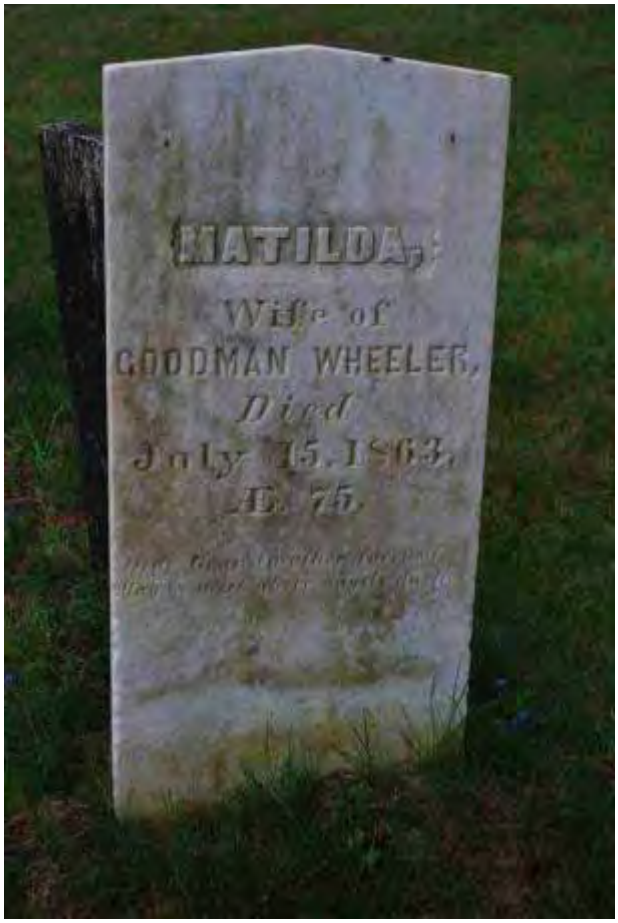
Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Wheeler, Matilda
Date of Death	July 15, 1863

Material	Marble
Marker Type	Tablet
Base	No
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

MATILDA
Wife of
GOODMAN WHEELER,
Died July 15, 1863,
Æ 75
Dear Grandmother farewell:
May we meet where angels dwell.

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth, Fallen
Treatment	Clean, reset level as a tablet


MATILDA,
Wife of
GOODMAN WHEELER,
Died
July 15, 1863,
AE. 75.


MATILDA,
Wife of
GOODMAN WHEELER,
Died
July 15, 1863.
AE. 75.

Cemetery	Quabbin Park
Location	Ware, MA
Record Date	May 2012
Name	Wheeler, Rosa
Date of Death	1894

Material	Marble
Marker Type	Die on base
Base	Yes
No. Commemorated	1
Border	
Carving Condition	Good

Inscription

Jesus loves the pure and holy
ROSA G. WHEELER
Wife of
E. A. FROST,
1869 - 1894

Previous Work	Concrete foundation stuck on base
Stone Condition	Biological growth
Treatment	Clean


E. A. FROST

CONSERVATION METHODOLOGY

CLEANING

Cleaning gravestones is generally not recommended unless performing repairs. Biological soiling will degrade stone surfaces over a long time. The affects of this degradation needs to be weighed against the degrading affects of cleaning. Depending on the method of cleaning this can be beneficial or detrimental.

If cleaning is necessary the stone surfaces should be rinsed with a generous amount of water and brushed with a natural bristle brush. Repeat as necessary. If a stone has biological growth, it can be treated with an anti-biological solution. D2 Biological Solution (Cathedral Stone Products) is the recommended product for this application. D2 is a water soluble, non toxic, anti-biological solution which does not react with the stone or leave soluble salts.

Removal of failed repairs

Repairs are considered as having failed if they are no longer functional, are unsightly, or are a hazard. Failed adhesives, mortars and pins require careful removal before proceeding with conservation treatment. Some temporary stabilization may be necessary as poorly attached fragments are disassembled.

Removal of degraded structural resins may be particularly difficult and time-consuming. Mechanical removal is generally done with small hand tools. The cutting of pins and fasteners may require power tools. Ferrous metal pins are most often locked in place by corrosion expansion. Their removal is best done by careful drilling with a properly sized coring bit.

RESETTING

Eighteenth and early nineteenth century New England gravestones are typically stone tablets that were set directly in the ground. By the first half of the 19th century many headstones began to use bases. Stones were either mortared into slots or pined to the base. In some cases older tablets were cut and reset with a base.

Larger monuments are often made of several elements and can be both large and heavy. Specialized hoisting equipment is often required. Competent operation and structural engineering considerations are required when performing this work.

Resetting in ground

Tilted stones set directly in the ground can be made plumb by careful excavation of the soil with hand tools, to permit re-setting in the proper position and drainage. When excavating, all large stones should be removed as ice heaves can cause an underground stone to push on the gravestone. A typical tablet will have approximately 1/3 of its length buried in the ground. If

there is not an adequate length of below grade material to support the marker a new cast concrete below grade base will be required. Once the stone is carefully placed into the vertical position and at the proper depth, the stone is made plumb and level, and aligned with adjacent markers. Backfill with a mixture of course sand and pea gravel wetted and compacted. Disturbed areas of the ground are re-graded with topsoil and seeded as required.

Resetting on/in existing base

Unsecured stones in existing bases require re-setting. Generally the base should be reset level and aligned with adjacent stones. Pins should be removed if present. The stone can then be re-set level and plumb in the existing slot.

Re-set stone on a full bed of modified lime (or hydraulic lime) mortar. Historically ratios of 1 part cement, 4 parts lime and 8 parts fine sand have been used with reasonable results. This mix is generally considered to be a soft mortar. Some conservation recommendations have specified ratios as high as 3 parts cement, 2 parts lime and 8 parts sand. The increased cement and reduced lime content has the effect of increasing the strength and adhesion of the mortar. In theory this would tend to make the mortar last longer than the traditional mix. The negative aspect is that the higher cement ratio produces a harder joint which induces a compression stress on the stone as the stone swells with varying weather conditions.

Our recommendation is to use 2 parts cement, 4 parts lime and 8 parts fine sand which, increases the strength somewhat while still retaining some of the softer properties to help reduce stress on the stone.

Resetting into new cast concrete base

There are several situations where a new cast base will be required. Usually tablets which are broken near grade level or have been cut years earlier and set into bases that have failed are typical examples of when a new base is needed. Bases can be set above grade or below depending on the stone, aesthetics or other factors. Bases can be cast on site or pre-cast and set in place on a level bed of gravel and sand.

Cast concrete bases are typically made with a slot that is ½” wider and thicker than the stone and is recessed 3”-4”. Depending on the size of the stone the base is usually 8”-12” deep, 8”-12” greater thickness and 6”-8” wider than the stone. This method is fine when resetting stones with a square bottom.

Some conservation specifications recommend squaring the bottom of the stone by cutting the stone with a saw. This is not recommended as the use of power tools on old stones can cause damage to the stone. In addition valuable history including inscriptions may be lost. If the bottom of the stone is not square a base with the same dimensions as above should be made but the slot should go completely through the base. This allows the excess stone to extend under the base level if needed and provides for better support. This also allows broken fragments, belonging to the stone, to be either attached to or buried beneath the stone.

Restoration mortar repair

Repairs to gravestones, generally involves reassembly of broken pieces and fragments of stone, filling open joints, cracks and delaminating. Depending on the stone and type of break will determine which method of reattachment.

STRUCTURAL REATTACHMENTS

Broken stones to be bonded should be carefully cleaned and dry fitted to insure proper fit. The area around the stone should be probe for any missing pieces which may belong to the stone. Traditional method of two part epoxy (Aboweld 55-22, Abatron) is the common way of bonding stones that require structural integrity. Epoxy is very strong, although it also is moisture insensitive. This has the effect of creating a moisture barrier at the repair joint. For marble and slate stones this can cause stone degradation over time due to the inability of the moisture to wick away from the area. Field observations have shown that failures usually occur adjacent to the repair joint which has been attributed to the strength of the epoxy being stronger than the marble. Closer observations have shown that the stone at the new break is usually degraded. Epoxy should be reserved for conditions where high shear forces are acting on the stone. Several factors such as angle of break, thickness of the stone, weight and bonding surface area need to be considered when deciding to use epoxy.

For most bonding applications, a non polymer, cement based restoration mortar (Jahn Restoration Mortars, Cathedral Stone) should be used. The specific bonding method should conform to the manufacturer’s specifications for the specific stone and should be performed by a

certified Jahn Products Technician. Bonding with restoration mortars is preferable since the mortars are permeable to moisture and allow the stones to breath. Over time the stone integrity is maintained and should last longer than the epoxy. Restoration mortars should be tinted to match the stone color and texture after cleaning. Tinting can be achieved through appropriate pigments (alkali stable oxides) which are available through Cathedral Stone or mason supply.

Reinforcement

The routine use of pins has been the traditional way of reinforcing broken stones. This method is in debate and controversial. The use of pins should be avoided except in some very extreme situations where it is unavoidable. Generally, the use of pins is to provide extra support to keep two pieces together. If the stone begins to lean and the adhesion joint fails between the stones, then the pins are carrying the full weight of the stone. The pin extends the moment arm which can cause a large blow out on the face of the stone next to the pin.

If pins are required then stainless steel threaded rods ranging from 3/8”-3/4” diameter should be used and should never exceed 1/3 of the thickness of the stone. Stones should be drilled using a wet coring drill and at a slow speed. Pins are then secured using an epoxy structural adhesive.

Repair mortars/ crack fillers

Areas of missing stone can be filled using commercially available restoration mortars (Jahn Restoration Mortars, Cathedral Stone) tinted to match the stone. Tinting can be accomplished in the same way as described above in bonding mortars. Large cracks can also be filled using the same mortars. Mortar repairs should not be performed if there is a risk of freezing temperatures within two weeks after performing work.

Filling of delaminating stones

De-lamination occurs in many stones typically slate and sandstone. Repair of delaminated stones is designed to adhere the separated layers and prevent water penetration. The first step is to thoroughly clean the interior surfaces of the crack to remove debris. Depending on the nature of the crack, hand tools and compressed are can be used to clean out the area. Interior surfaces should then be wetted with water or a solution of water and isopropanol. For cracks larger than a 1/8” commercially available M40 flowable grout (Cathedral Stone) can be used. For smaller cracks M32 can also be used. Grouts should be tinted to match the stone after cleaning. Flowable grouts should be applied using manufacturers recommendations.

Reattachment of small fragments

Small stone fragments or friable areas are typically reattached with a solution of Acryloid B-72 in solution of acetone. This method is mainly for non structural applications where a zero thickness bonding joint is desired. Care should be taken as the B-72 forms moisture impermeable layers at the joint similar to epoxy. Depending on the geometry of the break it is possible to create a moisture trap which can cause deterioration over time.

Consolidation of friable stone

Stones showing signs of sugaring or de-lamination should be consolidated to maintain the granular integrity of the stone. Consolidation should be performed before further treatment is done. Consolidation should be performed using Conservaire OH100 (Prosoco) following manufacturers specifications for proper application. OH100 should be applied a minimum of 6 applications to promote deep penetration. Failure to perform this task can cause a hard skin to form and cause the layer to de-laminate. OH100 binds the grains of the stone without filling the voids between the grains. This allows the stone to continue to breath and expel water from the interior of the stone.