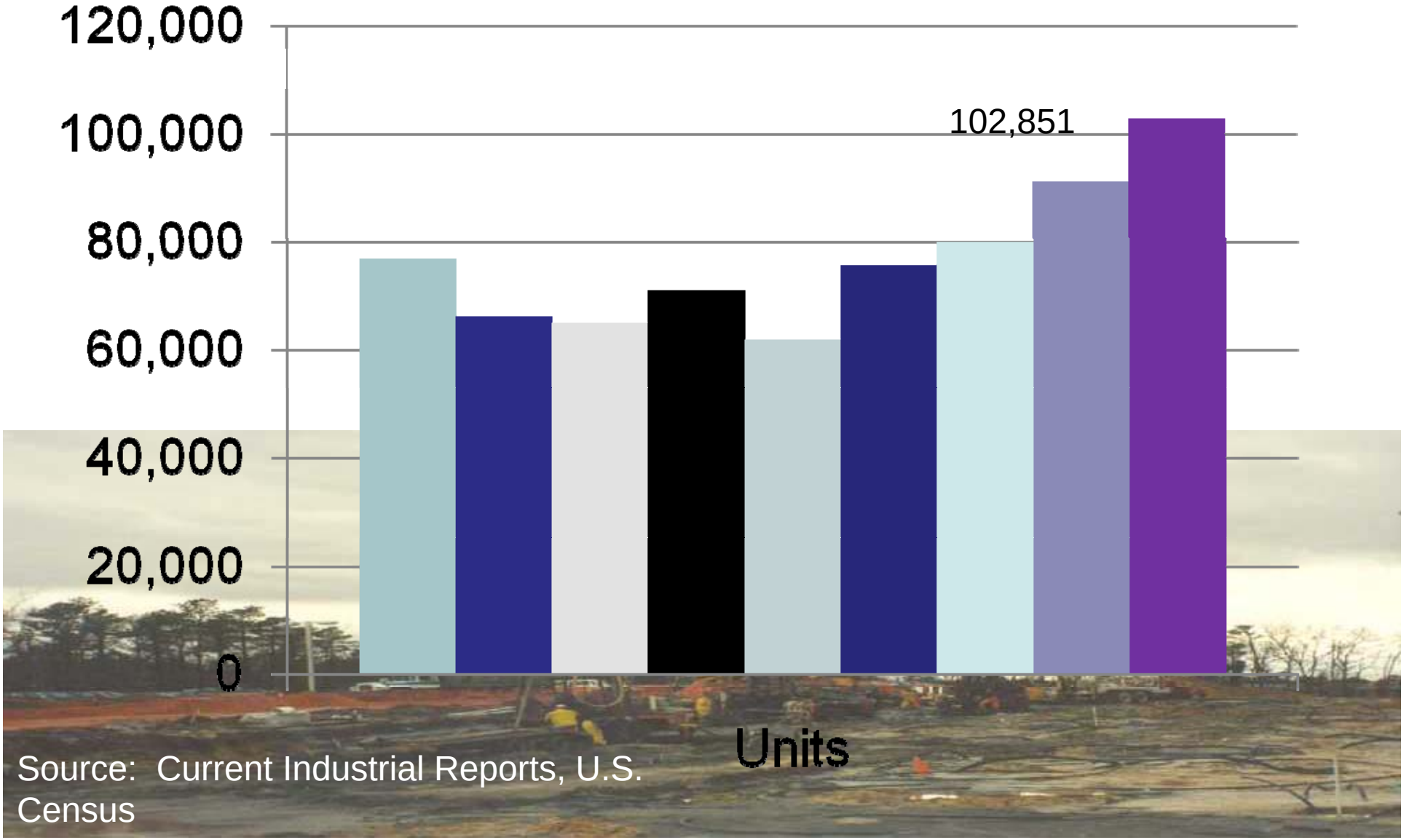
Ground Source Heat Pump Systems

Assisting Energy Savings While Protecting Groundwater

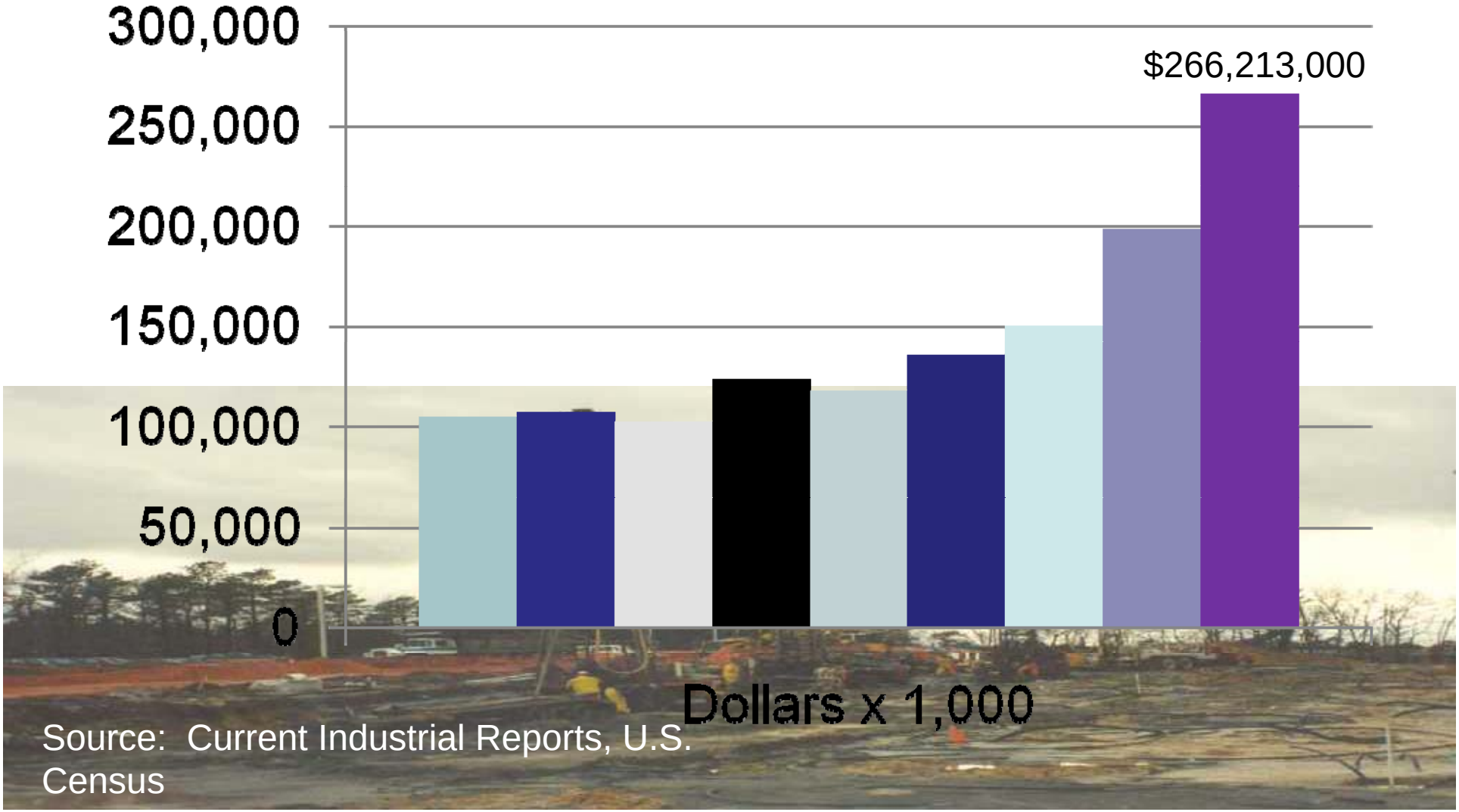
2009 REVISIONS TO GUIDELINES FOR THE CONSTRUCTION OF VERTICAL BOREHOLES FOR CLOSED LOOP HEAT PUMP SYSTEMS

Units Shipped: 1999-2007



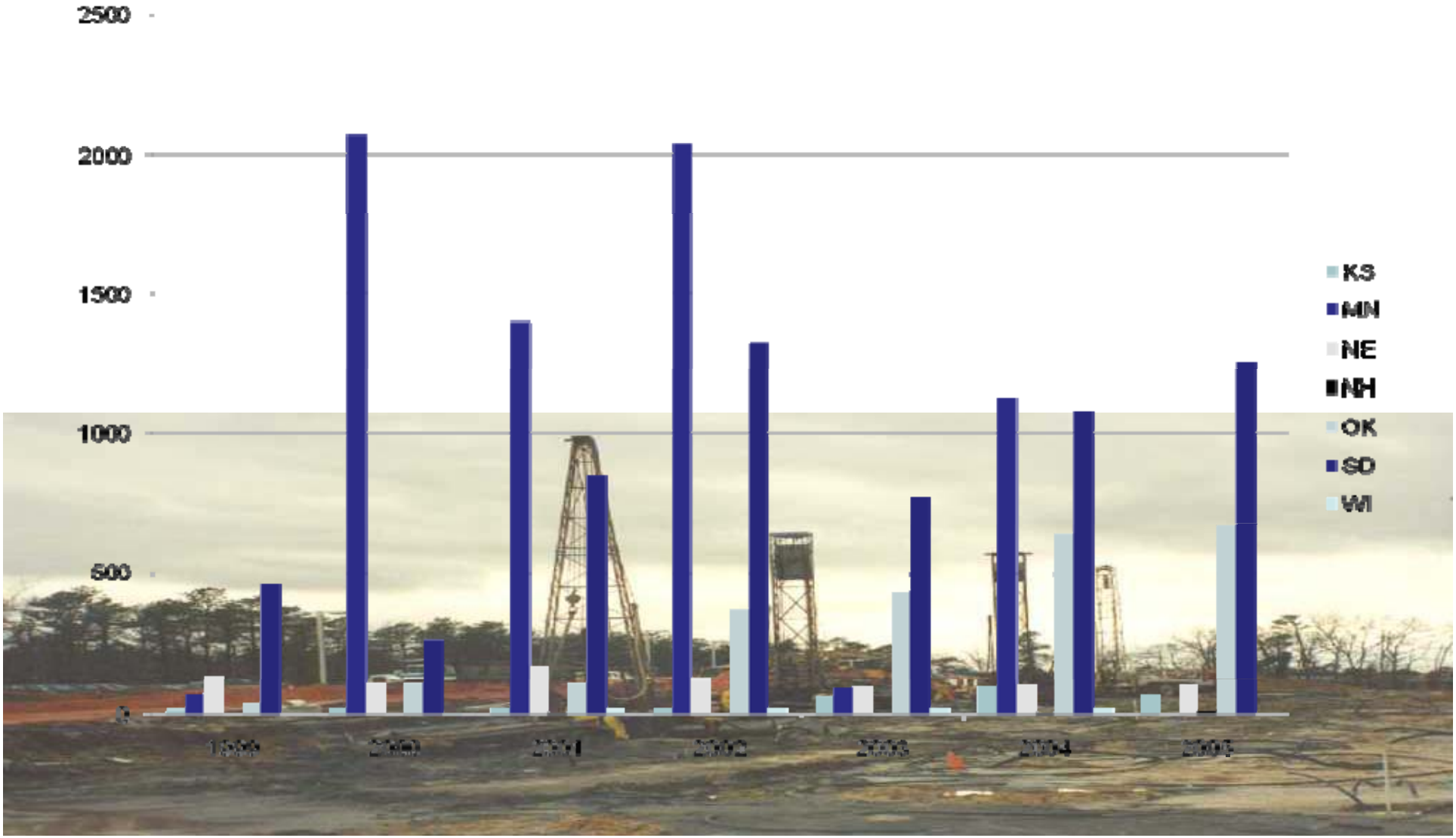
Source: Current Industrial Reports, U.S. Census

Value of Units Shipped: 1999-2007



Source: Current Industrial Reports, U.S. Census

Ground Source Heat Pump Boreholes: 1999-2005



Loop Field Design

- Borehole Spacing
- Site Limitations
- Topography & Site Access
- Property lines

Loop Field Design

- Underground utilities
- Aboveground utilities
- Septic fields
- Other contaminant sources
- Sanitary protection
- Drilling
- Potable supply wells
- Surface water or wetlands
- Buildings/structures
- Right-of-way
- Isolation

Loop Field Design

- Borehole spacing dependent upon:
  - balance of the annual thermal loading;
    - Risk of thermal pollution
  - land surface restrictions.

Loop Field Design

- Borehole diameter impacts heat transfer rate.
- Borehole diameter must be large enough to allow use of tremie for placing grout from bottom to top.

Loop Field Design

- Site conditions that dictate modifications to borehole construction must be brought to designer's attention.
- Drilling contractor must inspect site to ensure rig & support equipment's safety
- System designer must consider space limitations for drill rig.

WARNING!

- **Special care must be taken when working around overhead power lines.**
- **Know location of underground structures.**

Loop Field Design

- Must protect against surface contamination of the aquifer.
- Must protect against cross-contamination of hydraulically separated aquifers.

Hydraulic Connectivity

Borehole Construction

- Drilling contractor must use potable water adjusted to the correct pH at all times.
- Drilling fluids must comply with state and/or local requirements -- some states require ANSI/NSF compliance.
- Drilling fluids must be used as prescribed by the manufacturer.

Borehole Alignment

- The borehole shall be in alignment to such an extent that the closed-loop piping can be placed to the entire borehole depth, grouted with a tremie pipe from bottom to top, and such that the borehole does not intersect another nearby borehole.

Borehole Grouting

Grout materials to be used

- Use of Portland cement
- Use of sand cement grout
- Use of neat cement grout
- Use of bentonite grouts
- Use of enhanced thermal conductivity grout

Grout to...

- Protect the aquifer
- Increase the borehole heat transfer rate

Borehole Grouting

- Must consider existing surface conditions and subsurface conditions when grouting.
- The entire length of each borehole shall be grouted from bottom to top.
- Formations yielding water must be sealed off to prevent cross-contamination of the formations.

Borehole Grouting

- Loop placement and grouting should begin as soon as possible after drilling.
- Loop placement and grouting should be completed same day as the borehole is constructed.

Borehole Grouting

- Grout must be placed by tremie pipe from the bottom of the hole to the surface.

Temporary Loop Capping

- Any vertical closed loop that is to be temporarily removed from service, or which is completed for a period prior to being placed in service, or is left uncompleted due to a recess or delay in construction shall be equipped with a water-tight cap.

Loop Field Identification

- Site plan.
- Tracer tape or marker.
- GPS position of boreholes

Loop Field Trenches

- Be aware of open trench hazards.

Permanent Loop Piping Decommissioning

- Loop pipe flushing.
- Grout materials.
- Grout placement.
- Special conditions.
- Vertical loop piping and header decommissioning records.

Permanent Loop Piping Decommissioning

- If a loop is abandoned (decommissioned) must fill the loop to prevent worst case scenario of loop piping failure acting as conduit to the subsurface.

Revision Soon to be Available

- Will be disseminated at no charge to state regulatory oversight agencies for their consideration
- Will be available to ground source heat pump system designers and other professionals

Thank You

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