STATE OF MICHIGAN

JOHN ENGLER, Governor

DEPARTMENT OF ENVIRONMENTAL QUALITY

"Better Service for a Better Environment"

HOLLISTER BUILDING, PO BOX 30473, LANSING MI 48909-7973

RUSSELL J. HARDING, Director

REPLY TO:

DRINKING WATER & RADIOLOGICAL
PROTECTION DIVISION
3423 N MARTIN L KING JR BLVD
PO BOX 30630
LANSING, MI 48909-8130

November 25, 1998

TO: Local Health Departments
Attn: Environmental Health Directors
Supervising Sanitarians
Field Sanitarians

FROM: Michael Gaber, Chief
Well Construction Unit
Drinking Water and Radiological Protection Division

SUBJECT: **Water Wells Producing Sand or Turbidity**

This memorandum provides technical information and guidance on investigating complaints involving sand pumping or other sediment that causes turbidity in well water. Sanitarians will find the information useful for understanding the steps taken or proposed by well drilling contractors to correct such problems.

New wells occasionally pump a small amount of sand or turbidity initially. Once a well is put into routine service the intake area generally stabilizes. Sand grains bridge on the outside of the well screen and sand production ceases. Existing wells can occasionally develop sand/turbidity (ST) problems after several years of service. Over time, corrosion of metallic casing or screens can allow sand or sediment to enter a well. Erosion in the production zone, loss of a drive-shoe seal, and overpumping can cause ST problems. Persistent ST problems can be challenging to correct.

Well Code Requirements

Three regulations contained in Part 127, 1978 PA 368 (Michigan Well Construction Code), pertain to sand production, water clarity, and well development. A new well that produces sand violates R 325.1639(1), which states the following:

> *"A water supply well that is installed in unconsolidated sand and gravel aquifers shall ordinarily be fitted with a screen that has openings which are properly sized so that the aquifer can be properly developed to produce sand-free water at the pumping rate of the permanent pump."*

Another applicable regulation is R 325.1639(5), which states the following:

> *"A new, repaired, or reconditioned well shall be developed and pumped to waste at a pumping rate which equals or exceeds that of the permanent pump, until the water is as clear as is reasonably possible considering the groundwater conditions in the area. The permanent pump shall not be used to develop the well without the owner's consent."*

R 325.1621(2) also applies to ST producing wells. It states:

> *"A well shall be adequate in size, design, and development for the intended use giving due consideration to local groundwater conditions."*

Water well drilling contractors (and property owners who install their own wells) are responsible for complying with these regulations.

Problems Associated with ST Production

1. While ingestion of small amounts of sand or sediment from a water well is not a health concern, their presence can be aggravating and troublesome.
2. Excessive sand and other sediment can damage and decrease service life of the following:
   - pump impellers or bearings, which can decrease pump efficiency
   - pressure tanks
   - valves
   - geothermal heat pumps
   - water treatment devices
   - water heaters
   - aerators
   - plumbing fixtures
   - dishwashers, clothes washers, and dryers
   - clothing and linens
   - finishes of appliances, automobiles, countertops, sinks, utensils, showers, and glass.
3. Severe ST problems can cause reduction of septic system capacity, and plugging of lawn irrigation systems, showerheads, water softener resin tanks, and water lines.

Complaint Evaluation and Problem Diagnosis

Investigation of an ST complaint should involve the following steps:

- Confirm the problem – Visit the site to check the severity of the problem and determine the nature and source of the particulate matter. Is it sand, silt, clay, scale, drilling fluid, or something else that needs to be identified in a laboratory? Sand has a distinctive, hard, gritty texture, while silt feels slippery and claylike. Precipitated iron scale can also cause turbidity. This reddish/brown/orange scale usually rubs away between the fingers, leaving a colored residue. A black scale that leaves a residue with a rotten egg or sewage odor when smeared between the fingers, may be attributed to sulfate-reducing bacteria. Sometimes turbidity is the result of biofilm formation due to microbial growth in the well. Turbidity can also be due to residual bentonite drilling fluid used in rotary drilling operations or bentonite grout that may have infiltrated the filter-pack or native permeable formation surrounding the well screen.

- Review well construction details on the well record. Compare the depth and geologic formation sequence of the problem well to other wells in the vicinity. Surrounding wells that produce clear water may have been completed in a different aquifer or at a different zone within the same aquifer.
- If a replacement well was drilled, ask the owner about the old well. Was it replaced because it produced sand? Is the replacement well free of sand and is the observed sand residual from the distribution system? If so, correction will involve thorough flushing of the plumbing system.

- Determine when the problem began and how often it occurs – Some questions to ask the well owner are:
  1. Was ST present as soon as the well was placed into service?
  2. If ST started after the well was placed into service, how long afterward did it appear?
  3. Was the casing hit by a vehicle or did a lightning strike occur just before the ST started? If so, the casing could have been damaged, allowing sand to enter.
  4. Is ST production continuous or sporadic?
  5. Does the ST problem clear up with extended pumping or does it worsen?
  6. Were there any major increases in water demand (e.g., installation of a lawn irrigation system, pump replaced with higher capacity pump, etc.)? Increased pump capacity will increase water entrance velocity into the well, enabling the water to carry sand into the well.
  7. Does the problem exist at particular faucets, out buildings, or individual pipelines?

- Collect a sample of sand or sediment – Run water into a clean, white 5 gallon pail from the sample tap or outside faucet that bypasses the water softener. To determine the problem's source, it is best to isolate the well from the pressure tank and piping. Before collecting a well sample for sand verification, be sure that the pump is running. This will ensure that the sample represents new water and not water stored in the well. Distribution system samples can be obtained from toilet tanks (if no filter is present) or from filter housing, if a sediment filter is present. Allow sand to settle.

- Inspect sand and compare grain size to well screen slot size shown on well record. This will help diagnose the source of the sand. For example, if the well record shows a 20 slot (0.020 inch opening) and the sand sample is about 0.010," the contractor may have selected an improper well screen. Portable sieves and gauges can be used to identify particle sizes.

- If the screen slot is smaller than the sand sample (e.g., screen slot is 0.010 inches and the sand is in the 0.020 – 0.030" range), improper well screen selection is not the problem. The following causes are possible: (1) the screen may have been damaged during installation, (2) the casing may have been damaged, or (3) the K-packer between the screen and casing may be faulty.

- In filter-packed wells, sand problems may result from improper filter-pack sand selection, bridging of filter-pack above screen, nonuniform or incomplete placement of filter-pack, noncentered screen, or insufficient development.

Common Correction Methods

No single approach will solve all ST problems. Some are easily cured while others can be stubborn. It is important to determine whether the ST problem is an isolated case or if it is surrounded by other wells with the same problem. Most often, an ST problem is an isolated case and can be corrected.

An important factor to consider is the type of well development method and extent of development used by the well driller. Premature termination of the well development stage by the contractor, is a common cause of sand/turbidity problems in new wells. Further development or using alternate development methods may resolve the problem. Ask the driller to explain how the well was developed and the proposed corrective action. One of the following methods may be applicable:

1. Replace the well screen with one having smaller slot openings.
2. Use a portable air compressor or drilling rig compressor to redevelop the screen until the well is sand-free at a pumping rate at least twice that of the permanent pump. A well will generally remain sand free if the permanent pumping rate is lower than the discharge rate used during final development.

3. Switch to a different development method than that used initially. For example, if the well was developed with air, redevelopment with a plunger may be successful. Another technique is to water jet within the well screen. A high pressure, high velocity water stream is injected through a pipe placed within the screen. Jets or nozzles near the end of the pipe, or on a special jetting tool, force water horizontally through the screen openings. Sand-laden water is then air lifted out of the well.
4. Resetting the screen at a different elevation may solve the problem. Sometimes, deepening the well a few feet will move the screen into a zone with different sand gradation.
5. If redevelopment is unsuccessful, or if screen replacement is not possible, replacement of the well with a filter-packed well (also known as "gravel-packed") may be necessary. This involves placing specially selected filter sand outside the well screen. Filter-packing technology has reduced sand production problems throughout Michigan.
6. Reduction of the pumping rate may alleviate ST production. Decreasing the pumping rate lowers the water entrance velocity. Therefore, the energy of the water to carry suspended solids is reduced. Installation of a flow-restricting valve on the pump drop pipe may provide relief.
7. The installation of an additional well screen (if sufficient formation is present) is a common correction method. The added intake area lowers the water entrance velocity.
8. While performing corrections to remedy an ST problem, the well depth should be checked and compared to the depth reported on the well record. Sediment that has accumulated in the bottom of the borehole should be flushed out.
9. ST problems in existing wells can result from mineral incrustation or biolfilm formation. Partial screen plugging increases water entrance velocity and energy. The faster-moving water is able to carry particulate matter more readily. Rehabilitation of a well to restore well yield can correct an ST problem.

Other Causes

Some additional causes of ST problems are:

- An unsealed annular space - sediment can move downward from the annulus into the well intake during pumping. A complaint that a well becomes cloudy after a rainfall, or subsidence around the casing, are likely signs of an ungrouted annulus.
- Placement of bentonite grout adjacent to the well screen.
- A failing check valve above a submersible pump can also cause an ST problem because of the surging action of water exiting the drop pipe.
- In bedrock wells, sand or turbidity may be the result of inadequate sealing between the casing and the bedrock or leakage around the drive shoe. Sediment can enter from a sand-bearing formation above the bedrock. Sometimes, reseating the drive-shoe will resolve the problem.
- Sloughing shale formations or friable sandstone zones can cause ST problems. Correction can often be achieved by installing a liner with packers to isolate the problem strata.
- Some flowing wells may produce slight turbidity when the flow is restricted or upon severe changes in barometric pressure.

Filters and Separators

If the ST problem is present because of geological limitations and the well has been properly designed, correction options may be limited. Sediment filters and sand separators do not correct the source of the problem, but can be effective at preventing particles from reaching the water distribution system. Their use should be considered only if the ST problem is geologically controlled. Devices such as filters or separators should be used only as a last resort and not as a substitute for proper well design or development. Always try to address sand/turbidity problems at their source.

Clean-up of Water System

After the source of the ST problem has been corrected, sediment should be flushed from the water distribution system. Failure to do so will result in residual sand or sediment continuing to show up at sinks, showers, and toilets. To the well owner, it will appear as though the problem has not been corrected.

Once clear water is being produced from the well, all distribution system piping should be flushed. Hook a garden hose to a tap at the end of the building opposite from the pressure tank. Do not discharge the hose into the septic system. Turn on the tap and flush at full force. Gently tap exposed plumbing lines to loosen sediment. Remove and clean showerheads and aerator screens from faucets. Drain water heater and pressure tank (several flushings may be needed). Be sure to turn off poser to hot water tank before draining. Clean any sand filters and filter housings that may be present. Contact a water treatment dealer to flush sediment that has accumulated in the water softener resin tank. Injecting compressed air into pipelines also helps eliminate sand or other sediment.

For Further Information or Technical Assistance

Contact the Michigan Department of Environmental Quality, Well Construction Unit, at phone 517-335-9183 or fax 517-335-9434 or the Upper Peninsula Office at phone 906-784-6410 or fax 906 786-0624.

MSG:ckh